RS53/42
Draft 01
March 9, 2007

RS53/RS42 – Waste Rock Characteristics/Waste Water Quality Modeling - Waste Rock and Lean Ore – NorthMet Project - DRAFT

Report Prepared for

Polymet Mining Inc.

Report Prepared by

SRK Consulting
Engineers and Scientists

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Executive Summary

PolyMet Mining (PolyMet) is proposing to develop the NorthMet Project (former Dunka Road Project of US Steel) near Babbitt, Minnesota. As a part of the Minnesota Department of Natural Resources (MDNR) “Permit to Mine” process a complete “mine waste characterization” is required (Minnesota Rules Chapter 6132.1000). RS53/42 describes characterization of waste rock (including waste rock, lean ore and ore) and prediction of rock stockpile drainage chemistry.

The issues associated with waste rock at NorthMet are expected to include acid rock drainage (ARD) and leaching of some heavy metals. The latter in particular are expected to include nickel and cobalt both of which do not require acidic conditions to be mobilized at elevated concentrations.

The MDNR has been researching ARD in Duluth Complex and related host rocks (Virginia Formation) since the late 1970s. The research has focused on mineralized rocks associated with North Shore Mining’s taconite Dunka Pit in the South Kawishiwi Intrusion and the Babbitt and NorthMet Deposits in the Partridge River Intrusion. The results of this research were the basis for design of PolyMet’s geochemical testing program for waste rock, lean ore and ore at the NorthMet Project developed in the consultation with the MDNR. PolyMet’s extensive test program and includes 92 ASTM humidity cells and 20 kinetic tests using MNDR methods. The samples being tested were characterized using a variety of chemical and mineralogical techniques.

Interpretation of MDNR’s long term (nearly two decades) data, and about 1 year of PolyMet’s data resulted in the following main findings for Duluth Complex rocks:

- Acidic leachate has not developed after 18 years of testing of samples containing less than 0.4% total sulfur despite the presence of sulfide minerals and near total absence of carbonate minerals.
- Sulfide oxidation rates are directly proportional to sulfur content with a secondary relationship related to sulfide mineralogy. Other variables (rock type, position in intrusive stratigraphy) do not appear to be important.
- If acidic conditions develop, the transition to acidic pHs takes many years. Following the onset of low pH, and depletion of sulfide minerals, pHs recover.
- Metal leaching is strongly linked to pH. Nickel in particular is sensitive to pH as it decreases below 7. Observed changes in pH and resulting enhanced metal leaching are linked to testwork conditions but provide useful information about metal leaching mechanisms.

The proposed explanation for the observations is that weathering of the main silicates (plagioclase and olivine) by weak carbonic acid (that is, atmospheric carbon dioxide dissolved in water) produces alkalinity. If the alkalinity generation rate from silicate weathering exceeds the acid generation rate from sulfide oxidation, it is predicted that leachate pHs will remain above neutral. Testwork results supported by geochemical modeling are internally consistent. It can be demonstrated that acidic

leachate is unlikely to be produced by rock containing 0.12% to 0.31% sulfur with the range due to differences in sulfide mineralogy.

The findings of the testwork program were used to develop a waste segregation scheme that includes three main categories (number 2 to 4):

1. Waste rock with negligible potential to produce ARD but likely to have drainage with component concentrations exceeding water quality objectives.
2. Waste rock with potential to produce ARD but with a delay of at least 5 years. Component concentrations are expected to exceed water quality objectives by a very wide margin.
3. Waste rock with potential to produce ARD immediately. Similarly, component concentrations are expected to exceed water quality objectives by a very wide margin.

All of these categories are defined as "reactive" because drainage would be unsuitable for direct discharge. The concept of a category for which drainage would be suitable for direct discharge was evaluated but not found to be achievable because hardness-based water quality discharges standards for copper may not be met.

Using tonnage information for waste rock and lean ore stockpiles provided by PolyMet Mining, and infiltration estimates provided by Barr Engineering, drainage chemistry was calculated on an annual basis through the operating life and closure period of the site. These predictions were adjusted to reflect water quality data for waters in contact with mineralized rock obtained by MDNR and PolyMet.

Final concentrations were provided to Barr Engineering for use in stockpile and water treatment design.

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1 Introduction

1.1 Background

PolyMet Mining (PolyMet) is proposing to develop the NorthMet Project (former Dunka Road Project of US Steel) near Babbitt, Minnesota. As a part of the Minnesota Department of Natural Resources (MDNR) "Permit to Mine" process a complete "mine waste characterization" is required (Minnesota Rules Chapter 6132.1000). RS53/42 describes characterization of waste rock (including waste rock, lean ore and ore) and prediction of rock stockpile drainage chemistry.

The issues associated with waste rock at NorthMet are expected to include acid rock drainage (ARD) and leaching of some heavy metals. The latter in particular are expected to include nickel and cobalt both of which do not require acidic conditions to be mobilized at elevated concentrations.

1.2 Objective

The specific objectives of this program include:

- Refinement of preliminary waste rock management criteria developed by PolyMet and MDNR.
- Development of water chemistry predictions for stockpile drainage water for input to water impact assessment and water treatment design.

1.3 Design and Consultation Process

The waste rock characterization program was developed in consultation with staff from the MDNR. The consultation included the following steps:

- December, 2004. PolyMet submitted a draft "Work Plan for Geochemical Characterization of Rock and Concentrator Flotation Tailings". The plan was presented to MDNR representatives.
- January 31 and February 1, 2005. Meetings were held by teleconference between SRK and MDNR representatives to further discuss the variables potentially affecting water chemistry from waste stockpiles.
- March 17, 2005. MDNR requested additional information on the tonnages of the major units and rock types, and the distribution of sulfur and minerals.
- March 28, 2005. PolyMet provided the requested information.
- April 12, 2005. MDNR provided a sample selection matrix. This matrix was accepted by PolyMet and is the basis for the selection of samples described in this document.
- May 15, 2005. MDNR provided a design for specific testwork.

- May 17, 2005. MDNR provided a design for specific testwork.
- June 6, 2005. A draft sampling plan was submitted to MDNR.
- June 15, 2005. MDNR provided comments on the draft plan.
- June 22, 2005. SRK provided responses and discussion of the MDNR comments in a letter to MDNR which were discussed during a teleconference on June 27, 2005.
- July 5, 2005. SRK provided results of candidate samples selected for kinetic testing in a memorandum to MDNR.
- July 13, 2005. MDNR provided comments on the July 5, 2005 SRK memorandum.
- July 15, 2005. SRK provided clarification on sample selection in a memorandum to MDNR.
- July 20, 2005. MDNR notified SRK and PolyMet that kinetic testing on the majority of waste rock samples could be initiated. It was recognized that analysis of a few candidate samples was ongoing.
- August 4, 2005. MDNR provided recommendations for lean ore characterization.
- August 29, 2005. As requested by SRK, MDNR provided additional rationale for the recommendations on lean ore sampling selection.
- September 14, 2005. Lean ore sample selection was further discussed during a conference call which provided the basis for completion of the characterization plan.

The resulting "Waste Rock and Lean Ore Geochemical Characterization Plan NorthMet Project, Minnesota" (Appendix A) was fully implemented in October 2005.

1.4 Structure of Report

This report combines results of two studies. RS53 provides results of characterization of waste rock, lean ore and ore and RS42 is the prediction of stockpile drainage water chemistry.

The structure of the RS42 report, which was a combination of RS53 and RS42, was agreed with the MDNR. The final version of the report outline was transmitted to the MDNR on April 26, 2006. The agreed outline has been followed, although in places this does not fit with the current thinking on the project. If any sections are redundant, the section heading is shown with a brief note to explain why the section is no longer relevant. A few minor sections have been added to help with clarity of the text.

1.5 Acknowledgements

SRK acknowledges the contribution of the following individuals to RS42:

- Barr Engineering – John Borovsky.
- Economic and Environmental Geochemistry, Inc. – Ron Schmiermund
- MDNR – Mike Berndt, Paul Eger, Jennifer Engstrom, Kim Lapakko.
- PolyMet Mining – Steve Geerts, Richard Patelke, Jim Scott.
- SRK Consulting – Stephen Day, Madeleine Corriveau, Ingrid Rozas, Kelly Sexsmith, Karen Wagner.

The SRK team recognizes in particular the contribution of our colleague Ingrid Rozas who died suddenly in July 2006.

2 Water Chemistry Prediction Methods

The method used to predict stockpile drainage chemistry dictates the inputs needed for the calculations. The following sections describe the prediction methods considered and how the approach chosen was factored into the design of the characterization program.

2.1 Theoretical Method

Several factors interact to influence the chemistry of waste rock stockpile drainage (MEND 2000). These include geology (chemical characteristics), construction method (including the effect of reclamation measures), climate (distribution of precipitation, availability of water, temperature, and air movement) and hydrogeology (origin of water flow).

Northwest Geochem (1991) comprehensively reviewed modeling methods to predict the chemistry of waste rock stockpile drainage and concluded that "no model exists which can even generally simulate the most critical physical, geochemical, and biological processes in waste-rock piles". Subsequently, MEND (2000) concluded that "If assessments of the behavior of waste rock stockpiles are required, it should be realized that no reliable modeling approaches are available. Advances have been made in understanding and modeling the various processes (e.g. flow in unsaturated materials, pyrite oxidation) but reliably coupling the models remains primarily a topic of research."

For the purpose of predicting drainage chemistry from waste rock stockpiles at NorthMet, theoretical modeling has been limited to consideration of well-established thermodynamic first principles.

2.2 Analog and Empirical Methods

2.2.1 Analog

The analog method uses comparisons with other sites in similar geological settings to predict water chemistry (Plumlee and Nash 1995).

For example, Caruccio and Ferm (1974) first proposed that paleo-environment is an important factor in determining water quality for coal mines because coal seams formed in salt water environments have higher initial sulfur content and are therefore more prone to the formation of pyrite during lithification and therefore generation of acid when these materials are exposed during mining.

Recently, Day and Rees (2006) compiled data for six porphyry copper mine sites in western Canada and found strong similarities between geographically scattered sites despite variations in host rock geology and climate. Porphyry deposits form by interaction of hot water with volcanic or plutonic rocks typically in a sub-volcanic environment. The similarities in drainage chemistry reflected the relatively simple sulfide mineralogy of these deposits and the formation of common alumino-silicate alteration minerals.

2.2.2 Empirical

The Empirical Method is also sometimes referred to as "scale-up calculations" because it involves translation of results from small laboratory or field tests to full-scale facilities. The attraction of this approach is that it involves the use of site-specific laboratory and field data, and does not rely on theoretical calculations. The results are transparent and easily explained. However, a significant issue is that the resulting concentrations are typically excessively conservative. This may be attractive for environmental assessment purposes but the resulting overly conservative predictions may unreasonably drive the need for mitigation measures to address potential water quality impacts which in turn may result in other impacts. A necessary component of the Empirical Method is the adjustment of resulting predictions to reflect basic geochemical controls as determined by geochemical modeling (Theoretical Method) and experience from other sites (the Analog Method).

There are three main steps in the method:

1. Design of a laboratory program to collect site specific chemical weathering rate information;
2. Calculation of component concentrations based on rock mixtures, scale-up factors, and hydrological considerations; and
3. Adjustment of calculated component concentrations to reflect geochemical constraints indicated by testwork, thermodynamic constraints and experience.

Additional description of these steps is provided in the following sections.

Laboratory Program

The laboratory program is designed to obtain weathering rates, typically expressed as mass of component released per mass of rock per time step (e.g. week). Rates are obtained for all rock types and a range of the characteristics for each rock type. Generally, the objective is to obtain rates that can be correlated with bulk characteristics of the rock so that overall rates can be calculated for mixtures. Examples of strong correlations of sulfur content with sulfate release are common and include humidity cell data obtained for this project. When good correlations are established, the rates can be interpolated between points.

Calculation of Concentrations Using Scale-Up Factors

The purpose of the scale-up calculation is to convert laboratory measured generation rates (for example in mg/kg/week) to drainage concentrations (in mg/L). The scale-up calculations need to consider the rock type mixture, temperature effects, grain size, rock mass, flow path development, and water volume. If a variety of different rock types are present, pore water concentrations are calculated for each rock type, and then mixed according to the proportion of rock types in the stockpile as provided by mine planners.

Temperature should be considered because oxidation rates decrease as temperatures decrease and vice versa. This correction is typically applied based on the average annual site temperature, and can be calculated using the Arrhenius equation. This equation provides a good approximation of actual rate decrease observed in laboratory experiments (SRK and Mehling Environmental 2006). The laboratory rate (R) is therefore adjusted using a constant factor (k_T) to obtain the adjusted rate (R_a):

$R_a = R.k_T$

This correction should be applied cautiously for reactive materials because the sulfide oxidation reaction is exothermic and will offset cooler site conditions.

The next step is to consider particle size effects. There are two issues to consider:

- Oxidation is a surface area phenomenon. A larger surface area provides a greater reactive surface area, and
- Reactive minerals encapsulated in large rock types do not oxidize at the same rate as exposed reactive particles because oxygen must diffuse through a solid rather than a gas.

Figure 2-1 illustrates the relationship between particle size and surface area for particles occurring as cubes. The graph shows that below a particle size of 0.1 cm, the available surface area increases rapidly. For larger particles, the area contribution is insignificant. Therefore, a standard humidity cell containing -¼" (0.6 cm) material provides a good representation of the surface area of a rock mixture containing much larger particles. For example, in a typical rock mixture containing 5% by weight finer than this size, the particles finer than 0.6 cm can account for 95% of the surface area.

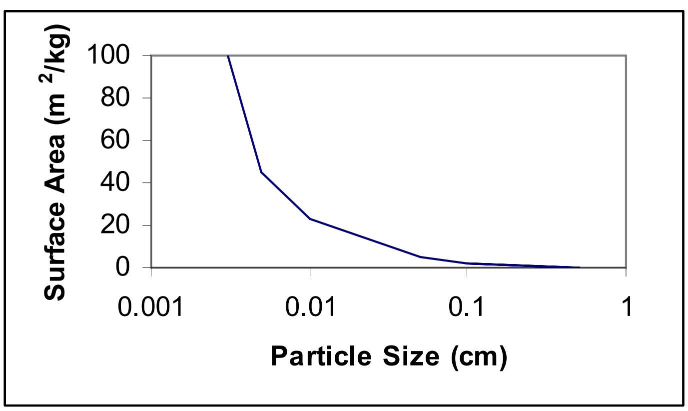

Figure 2-1: Particle Surface Area as a Function of Particle Size for Cubic Particles.

The correction for particle size then becomes a ratio of the fine-grained reactive mass (M_r) to the total mass (M):

$R_a = R.k_T.(M_r/M)$.

The scale up of rate to full scale is then obtained by multiplying by M to obtain:

$R_a^{'} = R.k_T.M_r$ (in mg/week).

$R_a^{'}$ is the scale-up of laboratory rate to field rate for total mass; however, it represents production rather than release because humidity cells are designed to be fully flushed. Under field conditions, the entire rock mass is not flushed due to flow path development. For low waste rock stockpiles, flushing is likely to be relatively thorough but as a stockpile becomes higher, the flow path length increases and the degree of flushing decreases (e.g. Morin 1991; Morin and Hutt 1997). $R_a^{'}$ can therefore be converted to leached mass (L) by multiplying by a flushed proportion (k_f):

$L = R.k_T.M_r.\ k_f$ (mg/week).

This leached loading can then be converted to a concentration (C) by dividing by the volume of infiltrating water (Q):

$C = R.k_T.M_r.k_f/Q$ (mg/L).

The term with the greatest variability in this equation is usually R. Other terms have well-defined boundary conditions that do not vary over orders-of-magnitude. By varying R to reflect uncertainty in the correlation of weathering rates to bulk rock characteristics, the sensitivity of estimates of C can be developed.

Adjustment of Calculated Concentrations

As noted above, calculation of concentrations using the empirical method often results in unusually high concentrations and it is therefore necessary to evaluate the individual concentrations with consideration of chemical principals and experience from other sites.

The first step in evaluation of the calculated scale-up concentrations is to examine the major components (sulfate, calcium, magnesium, etc) and some minor components (iron, aluminum). An appropriate approach is to enter the data into a thermodynamic equilibrium model (such as MINTEQA2, PHREEQE). These models can assist with identifying concentrations that are not supportable thermodynamically. For example, when dissolving common salt in a container of water, only a finite amount can be dissolved after which any additional salt remains as solid in the bottom of the container. The water is said to be “saturated” with respect to salt, and the resulting sodium and chloride concentrations in solution can be no greater than when the salt stops dissolving. The reverse is not always true though. It is possible for a solution to be over-saturated with respect to a solid during evaporation. In this case, the energy required to start forming (or nucleating) the first crystals is not available. Thermodynamic models must therefore be used cautiously.

In summary, the result of the empirical calculation is a set of concentrations for major components that typically exceed expected values. This indicates that some products of the weathering reactions remain stored in the rock and are not leached by infiltrating processes. This fact can be applied to adjustment of minor and trace components.

Evaluation and Adjustment of Minor and Trace Components

Evaluation of minor and trace components is treated separately because they occur at concentrations that are not a major part of the ion balance and with some exceptions occur at concentrations below limits implied by saturation controls. In some cases, concentrations can be adjusted using well known thermodynamic controls. For example, copper concentrations are commonly controlled by the formation of copper carbonate (the mineral malachite) or oxide (tenorite).

Other components, for example, lead, zinc, nickel, cobalt, cadmium and selenium are often predicted by the scale-up calculation to be released at concentrations which seem to be "high" based on experience. To refine the predictions, calculated concentrations can be compared to measurements of chemistry for waters in contact with weathering rock. These waters can include natural springs, shallow groundwater, drainage from existing mine waste facilities and results of extraction tests on weathered rock. These data sources are compiled and evaluated on component versus pH scatter plots to determine if there are any correlations with pH, which is the main geochemical control on water quality. Possible solubility limits are implied by the maximum concentration of a dissolved component at any given pH. This approach can be used to adjust the concentrations calculated by the scale-up calculation provided that there is a reasonable expectation that waters characterized by the database are in equilibrium with weathering rock.

The explanation for the high prediction is probably that these components are being released as part of weathering processes but remain stored in the rock. The expected retention of iron released by iron sulfide oxidation represents a sink for these elements through sorption processes. At many sites, pyrite and/or pyrrhotite are the dominant sources of leachable iron, and are likely also the source for many trace elements. The ratio of iron to other metals is very high and represents a significant source of sorptive capacity. Because this process is pH dependent, it is expected that component concentrations would be correlated with pH (e.g. Day and Rees 2006).

2.2.3 Method Selected

Subaerial Disposal

The method selected involved a combination of the purely empirical approach with minor use of thermodynamic theory. Similar approaches have been used recently and accepted by regulators in other jurisdictions for new mine projects (e.g. Pogo Mine, Alaska (AKDNR, AKDEC, USEPA); Brule Coal Project; Trend Coal Project and Galore Creek Project, British Columbia, Canada (Provincial agencies).

Useful analog data is available for the Duluth Complex, but a search for drainage chemistry data for similar sites with comparable low sulfur content was unsuccessful (see Section 7.2 below). The calculated concentrations obtained from the empirical method were compared to data from the relevant Duluth Complex analog sites.

Figure 2-2 illustrates conceptually the integration of mine waste rock scheduling, mine designs, hydrological information and geochemical data to develop temporal water chemistry predictions as the mine is developed.

For each year (n) of the mine, PolyMet provided the quantity and chemical composition of waste rock (M_n) placed in each waste rock and lean ore stockpile from a block model. The empirical method is then used to estimate the load leached from this waste rock mass in subsequent year m ($L_{n,m}$). The load originating from all rock placed up to year n is totaled to obtain the total load produced by the waste rock stockpile in that year. The concentration is estimated by "dissolving" this load into the estimated water inflow to the waste rock stockpile determined by the area in year m (A_m) and average annual infiltration (I) calculated by Barr Engineering (2007a) in RS21.

Figure 2-2 shows how the calculation is performed for year 1 and Year 2. The mass of rock placed in the stockpile was M_1, and the load released is $L_{1,1}$. The infiltration is A_1 x I, which becomes the volume of water leaving the stockpile (V_1). The calculated concentration is:

$$\frac{L_{1,1}}{V_1}$$

In Year 2, a mass of rock M_2 is added and the area increases to A_2. The total load released is ($L_{1,2}$ + $L_{2,2}$). The concentration in drainage in Year 2 is:

$$\frac{(L_{1,2} + L_{2,2})}{V_2}$$

Subsequent sections of the report will show that the proposed mine plan includes segregation of waste rock based on potential to produce ARD. Some waste rock is expected to have delayed generation of ARD meaning that it may be several years after the rock is placed in a stockpile before that rock begins to produce ARD. This is handled in the prediction calculation by allowing two values of L depending on whether the rock is overall non-acidic or acidic. The switch between conditions is determined based on the age of the rock relative to its year of placement in the stockpile. If the rock has been in the stockpile longer than the time expected for acidic conditions to begin then the rock is assumed to be acidic and this higher load contributes to the total load generated by the stockpile.

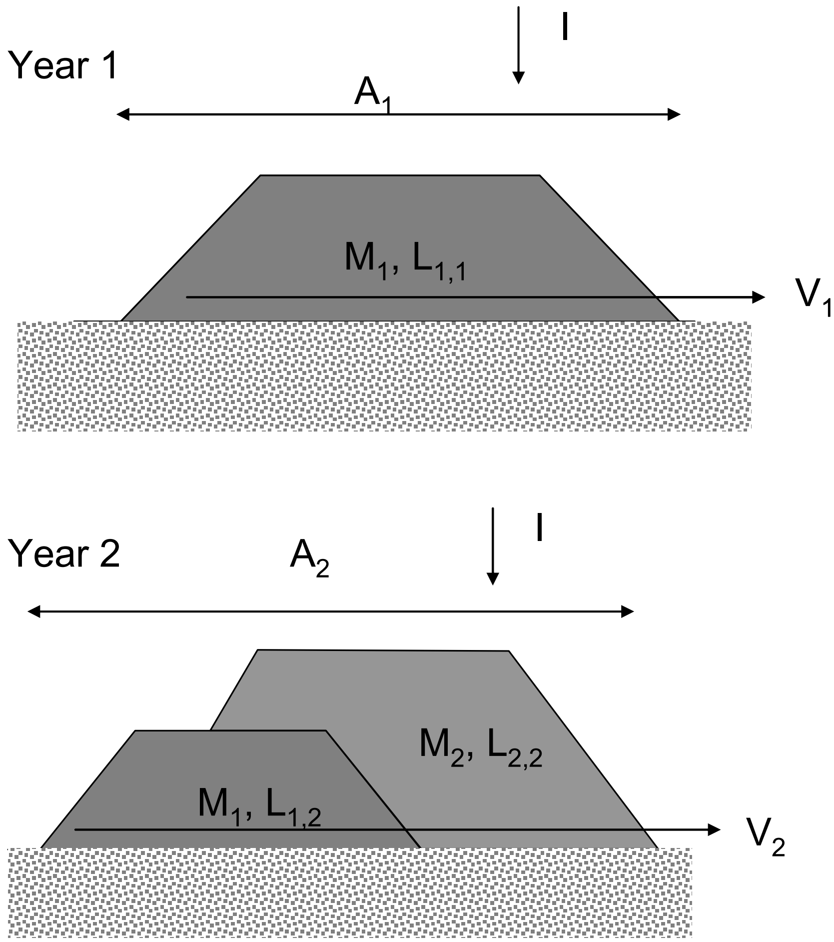

Figure 2-2: Water Quality Prediction Method

The calculated concentrations were adjusted as described for empirical method. The adjustments are described in more detail subsequently but include consideration of the formation of secondary minerals which are expected to include major minerals such as sulfates (gypsum), carbonates (calcite, dolomite), oxides (gibbsite) and silicate (e.g. kaolinite) minerals formed in response to weathering of silicate minerals, and secondary minerals formed by precipitation of metals released by oxidation of sulfide minerals.

Subaqueous Disposal

Subaqueous disposal will involve flooding of waste rock backfilled in the NorthMet East and Central Pits. The primary effect will be the leaching of accumulated weathering products as the waste rock becomes submerged. The prediction method selected involves a calculation of the rates of accumulation under subaerial conditions. The load leached during flooding is calculated as the residual of load not flushing under subaerial conditions. For the purpose of calculation, the entire oxidized load in the rock is conservatively assumed to be immediately flushed on contact with water. The effect of backfill on pit water chemistry is calculated in RS31 (in preparation by SRK).

3 Program Design

3.1 Geological Background

The NorthMet Deposit is located in the intrusive Duluth Complex of northern Minnesota. Disseminated copper-nickel-iron sulfides (chalcopyrite, cubanite, pentlandite and pyrrhotite) with associated platinum group element (PGE) mineralization will be extracted from several igneous stratigraphic horizons.

In the vicinity of the NorthMet Deposit, the Duluth Complex intruded and assimilated the Virginia Formation, which consists of argillite and greywacke with minor interbeds of siltstone, graphitic argillite, chert, and carbonate. This formation is the stratigraphic footwall of the NorthMet Deposit, but also occurs as xenoliths ("inclusions") within the deposit.

Detailed description of the geological setting of the deposit is provided in ER03 (PolyMet 2007b).

3.2 Geochemical Background

The MDNR has been involved in research on the weathering characteristics of Duluth Complex Rock in the Partridge River Intrusion (NorthMet and Babbitt deposits) and the South Kawishiwi Intrusion (Dunka Mine) since the late 1970s (e.g. Lapakko et al. 2001; MDNR 2004). The following sections provide an overview of these projects and the principal findings. The MDNR have prepared detailed reports on these projects.

3.2.1 AMAX Shaft

Test Piles

Six roughly 1000-ton test piles were constructed from rock removed from a test shaft sunk into the Babbitt Deposit in 1977 (Lapakko 1993b; Lapakko et al 2002; MDNR 2004) by AMAX. The rock contained sulfur concentrations varying from 0.64% to 1.41%, copper concentration of 0.3% to 0.4%, and nickel concentrations of 0.08% to 0.09%. The copper and nickel content was comparable to ore at NorthMet but sulfur concentrations were much higher than will be expected for most waste rock at NorthMet. The piles were constructed on lined pads, and the rock surfaces of some were reclaimed with soils, glacial tills and some were vegetated (Table 3-1). Drainage from the piles was monitored from 1977 to 1994 after which the piles were dismantled and the rock encapsulated in concrete.

The MDNR provided full leachate monitoring data for the piles and background information on the characteristics of the piles (Engstrom 2006b, d).

Table 3-1: Characteristics of AMAX Stockpiles (Lapakko et al 2002)

	FL1	FL2	FL3	FL4	FL6	FL5
Date completed	4/20/77	4/20/77	4/20/77	4/20/77	9/30/77	9/30/77
S (%)	0.64	0.64	0.64	0.64	0.79	1.41
Cu (%)	0.35	0.35	0.35	0.35	0.34	0.31
Ni (%)	0.083	0.083	0.083	0.083	0.09	0.09
Mass (T)	1100	1100	830	1700[1]	1300	815
Volume (m^3)	540	530	400	930	630	400
Collecting area (m^2)	290	340	300	330	320	340
Surface area (m^2)	330	450	430	350	390	370
Cover material	none	topsoil	coarse sand (glacial till)	none	none	sandy till over coarse sand
Avg. cover depth (cm)	0	23	34	0	0	54
Vegetated	no	yes	yes	no	no	yes
Drainage period	1978-93[2]	1978-93	1978-89[3]	1978-89	1978-93	1978-93

1 Approximately 40% of pile FL4 was removed in 1982.
2 FL1 was partially covered with plastic during 1990
3 FL3 was covered with plastic and Hypalon terminating flow at the end of the 1989 field season.

All six piles showed declining leachate pH over the monitoring period (Figure 3-1). In the first half of each year, pH tended to be higher followed by decrease into the late summer and fall. This appeared to occur regardless of whether the rock was bare or covered.

The four piles constructed from rock containing 0.64% sulfur reached lowest pHs of about 5. The large bare FL4 pile showed the lowest overall pH of this group apparently stabilizing between pH 4 and 5 before being stopped in 1989. The equivalent bare FL1 pile showed the highest pH though eventually pH declined to the same level as the same rock with a soil cover.

The drainage pH for the pile with 0.79% sulfur decreased to about 4 in 3 years and remained between 4 and 5 until the pile was dismantled. The pile containing 1.41% sulfur produced pHs between 3 and 4 in 1 year and remained at this level until 1994 though pH increased slightly.

Sulfate concentrations were greatest for the two piles containing higher sulfur concentrations. FL5 (1.4% S) showed the highest sulfate concentrations (approaching 10,000 mg/L) and a peak in 1981. FL6 (0.79% S) showed a weak peak in 1982. The other piles showed slowly increasing sulfate remaining generally below 3,000 mg/L. Seasonal variations were apparent. Sulfate concentrations tended to be greater later in the year when pH was seasonally lower. Alkalinity release tracked downwards for all tests but remained detectable for FL1 and FL2 at between 2 and 10 mg $CaCO_3$/L.

Initially for all tests, the dominant cation was sodium, then calcium. As low pH conditions developed, the ratio of Ca/Mg decreased so that tests with lowest pHs showed magnesium as the dominant cation. The downward trend in the ratio for FL1 and FL2 was continuing when the test was stopped in 1993 but had stabilized for the other continuing tests. Cations showed the same seasonal variations as sulfate.

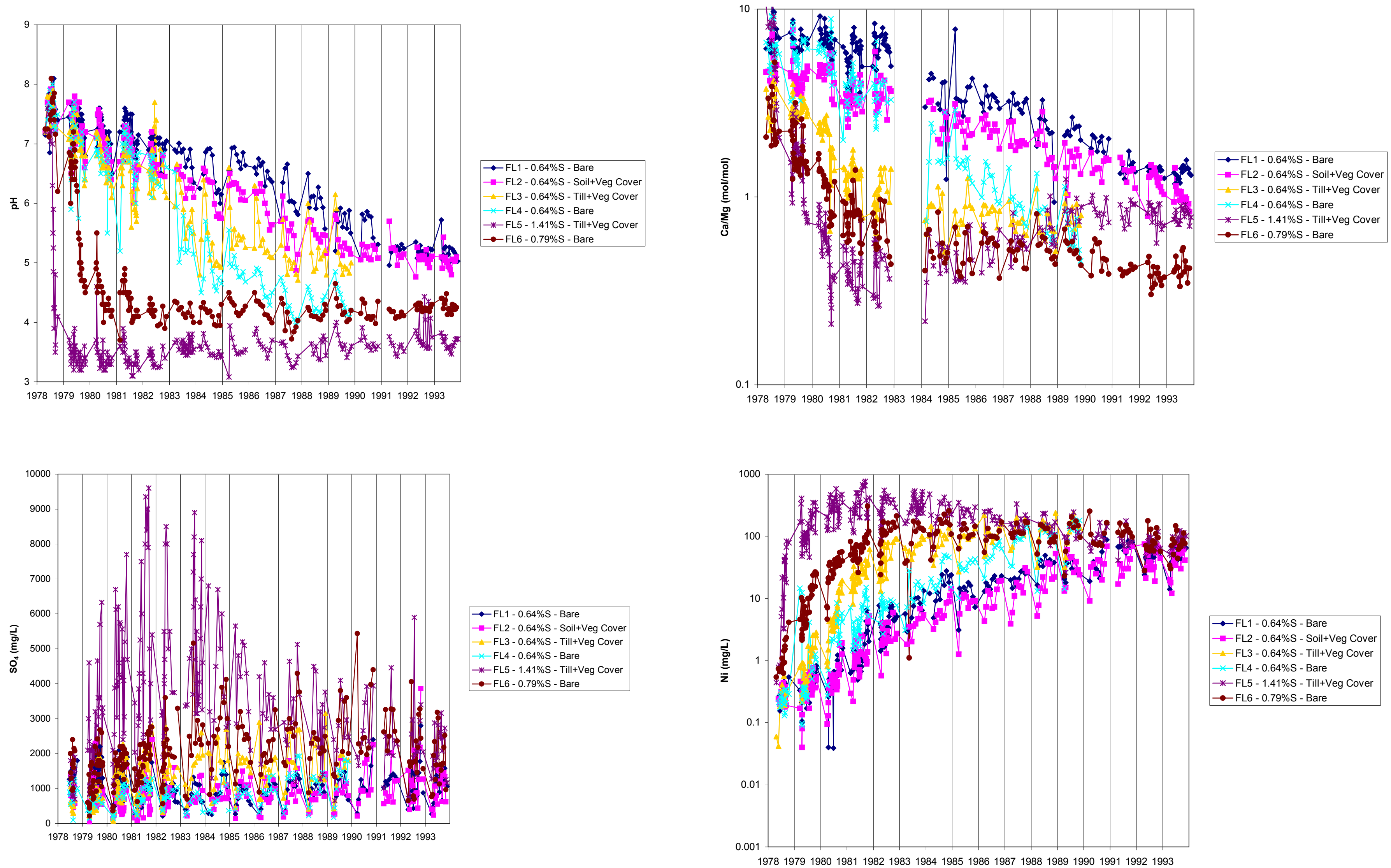

Figure 3-1: Leachate Results for AMAX Test Piles.

Nickel, copper and cobalt leaching all showed the same general trends of increasing metal concentrations as pH decreased then reaching relatively stable concentrations with seasonal variations paralleling sulfate. Nickel release for FL5 (1.4% S) initially peaked (with sulfate at concentrations approaching 800 mg/L) but then declined. Cobalt showed the same trend with peaks at 50 mg/L. Copper showed a weak long term peak approaching 200 mg/L. Zinc showed a similar trend with peaks approaching 30 mg/L.

Metal concentrations were negatively correlated with pH. The most leachable metal was nickel (concentrations were greater than 100 mg/L at lowest pHs), followed by copper (near 100 mg/L), cobalt (near 10 mg/L) and zinc (between 1 and 10 mg/L).

When the piles were dismantled, the MDNR found elemental sulfur and copper, gypsum, green precipitates and extensive cementation. The MDNR concluded that pyrrhotite was the main source of acid, and that plagioclase contributed to acid consumption for pH above 5. Below this pH, olivine became more important.

SRK used the monthly flow and sulfate concentration data provided by the MDNR to calculate the average annual release of sulfate from the piles. Where sulfate concentration data were occasionally missing, the next available data point was used for the missing value. Results of the calculation are provided in Figure 3-2.

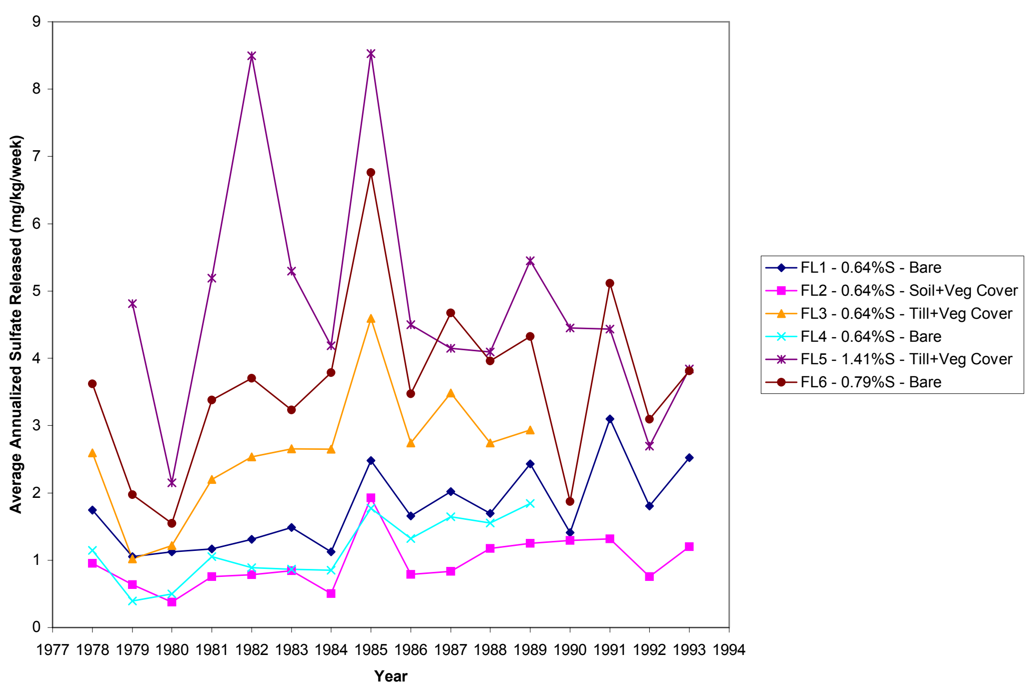

Figure 3-2: Average Sulfate Release from the AMAX Stockpiles.

The averages showed a range from 0.5 to 8.5 $mgSO_4$/kg/week. The lowest rates were for the 0.64% sulfur piles (uncovered and soil cover). The till covered pile containing 0.64% sulfur showed higher rates. The two higher sulfur piles indicated higher still sulfate release rates. FL5 with 1.41% sulfur showed the highest rates. The four lower sulfur piles all showed slight long term increases in sulfate release though the increase was not substantial.

Sulfate release may be partly limited by the presence of gypsum which was observed during dismantling of the piles. Thermodynamic modeling of the leachates generally indicated that sulfate concentrations were below levels required to form gypsum due to the high magnesium and sodium concentrations in the leachates indicating that sulfate release was also partly indicative of sulfide mineral oxidation and not just leaching of sulfate controlled by gypsum precipitation.

In summary, the monitoring data showed that rock with sulfur content at the tested levels (0.64% to 1.41%) produced acid rock drainage (ARD) but the sulfur content was a controlling factor in the severity and delay to onset of ARD.

3.2.2 AMAX Drill Core Tests

In a parallel experiment to the AMAX test piles, twenty-four 75-g samples crushed to -100+270 mesh containing sulfur concentrations between 0.47% and 2.57% were tested in MDNR's kinetic reactor (Lapakko 1993a; 1994b). The data were provided to SRK (Engstrom 2006d). The tests were operated for 30 to 49 weeks. Over this testing period, the minimum pH of the drainage varied from near 7 for the samples containing lowest sulfur to below 4 for samples containing the highest sulfur concentrations (Figure 3-3).

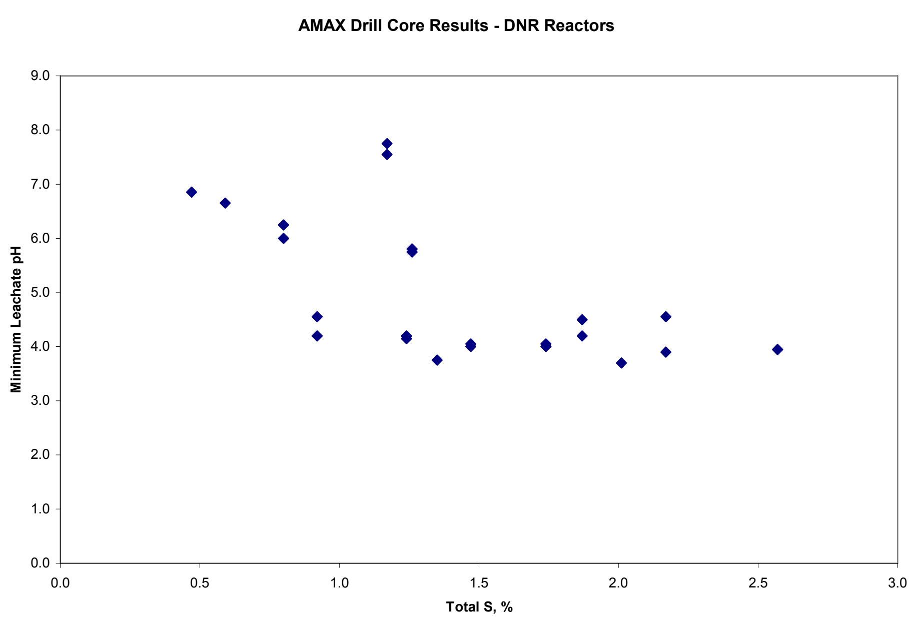

Figure 3-3: Minimum pH of AMAX Samples in MDNR Reactors as a Function of Sulfur Content.

3.2.3 AMAX Particle Size Experiment

The MDNR evaluated weathering of six particle sizes (from -0.75+0.25" to -270 mesh) of rock obtained from the pile containing 0.79% sulfur (Lapakko 1994b). SRK received pH data as a chart for 10 years.

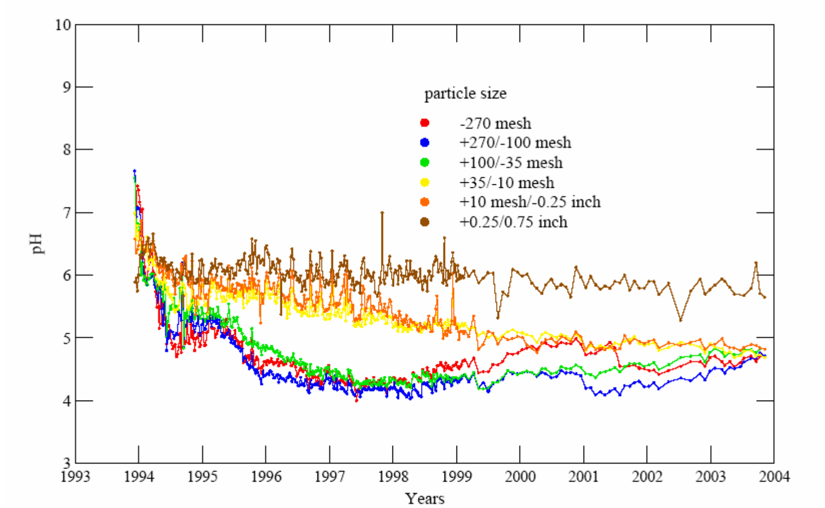

Figure 3-4: pH of Leachates from Particle Size Experiment on 0.79% Sulfur Rock from AMAX test shaft. Source: MDNR.

The coarsest size fraction generated near neutral pH leachate throughout the experiment. For the next two fractions (-0.25"+10 mesh and -10+35 mesh), pH gradually declined to just below 5 in ten years. The three finest fractions showed parallel trends with pH decreasing to near 4 for three to four years than gradually recovering to near 5.

3.2.4 Dunka Pit Stockpiles

Beginning in the 1960's, Duluth Complex rock was removed to access underlying iron formation at the Dunka Pit (MDNR 1994). Eight stockpiles varying in quantity from 0.1 to 21 million tons were constructed of which five contained mixed iron formation and Duluth Complex and three contained mainly Duluth Complex rock. Sulfur, nickel and copper concentrations were determined on the rock. Monitoring of stockpile drainage water quality is required as part of the NPDES permit for the site. Treatment of the drainage from the stockpiles using wetlands has been investigated (Eger and Lapakko 1980, 1988; Eger et al. 2000).

While monitoring of the site has produced a detailed long term record of stockpile drainage chemistry (MDNR 1994, 1996), the uncertain composition of the rock (including the possible presence of reactive components of the Virginia Formation beneath the Duluth Complex) has been confirmed by the MDNR (Eger 2006) and uncertain drainage pathways led to uncertainty about the relevance of the data to understanding weathering and leaching of Duluth Complex rock. The drainage chemistry for the stockpiles was therefore not considered to be a reliable analogue for stockpiles proposed at NorthMet.

3.2.5 Dunka Blast Holes Samples

In 1989 and 1990, MDNR began testing of 20 samples of Duluth Complex and Virginia Formation rock obtained from blast holes at the Dunka Pit in MDNR-style reactors (Table 3-2) (Lapakko 1988a,b; 1993a) for comparison with drainage from the site stockpiles. All but one sample was initially tested in duplicate. As of October 2006, three tests containing 0.18%, 0.22% and 0.82% sulfur had been stopped. None of the duplicate tests are continuing. The database of leachate chemistry was provided by MDNR (Engstrom 2006a, c). Leachates were analyzed frequently for pH and specific conductivity and sporadically for alkalinity, acidity, sulfate, silicon, calcium, magnesium, sodium, potassium, iron, aluminum, cobalt, copper, nickel and zinc. Leachate recovery from the cells was also recorded though not every week. Graphs illustrating the data are provided in Appendix B.1.

Table 3-2: Dunka Pit Samples Tested in MDNR-Style Reactors by MDNR

Sample Number	% S	Reactor #	Date of operation		Weeks as of 10/24/06
			Begin	End	
1519	0.18	1	2/14/89	---	923
		2	2/14/89	5/30/95	328
1517	0.22	3	2/14/89	---	923
		4	2/14/89	5/30/95	328
1515	0.40	5	2/14/89	7/18/06	909
		6	2/14/89	5/30/95	328
1503	0.41	7	2/14/89	12/31/02	724
		8	2/14/89	5/30/95	328
1520	0.51	9	2/14/89	12/31/02	724
		10	2/14/89	5/30/95	328
1507	0.54	11	2/14/89	7/29/97	441
		12	2/14/89	5/30/95	328
1522	0.57	13	2/14/89	7/29/97	441
		14	2/14/89	5/30/95	328
1518	0.58	15	2/14/89	12/31/02	724
		16	2/14/89	5/30/95	328
1521	0.71	17	2/14/89	12/31/02	724
		18	2/14/89	5/30/95	328
1537	0.82	43	8/12/97	---	480
1532	1.12	35	9/4/90	7/29/97	360
		36	9/4/90	5/30/95	247
1542	1.16	29	9/4/90	12/31/02	643
		30	9/4/90	5/30/95	247
1543	1.40	37	9/4/90	7/29/97	360
		38	9/4/90	5/30/95	247
1545	1.44	33	9/4/90	12/31/02	643
		34	9/4/90	5/30/95	247
1508	1.63	19	2/14/89	12/31/02	724
		20	2/14/89	8/29/94	289
1531	1.64	31	9/4/90	7/29/97	360
		32	9/4/90	5/30/95	247
1506	2.06	21	2/14/89	8/14/90	78
		22	2/14/89	8/14/90	78
1514	3.12	23	2/14/89	8/14/90	78
		24	2/14/89	8/14/90	78
1509	3.72(VF)	25	2/14/89	8/14/90	78
		26	2/14/89	8/14/90	78
1513	5.44(VF)	27	2/14/89	8/14/90	78
		28	2/14/89	8/14/90	78
Notes: Table provided by MDNR.					

The tests have shown that:

- Samples with 0.18% and 0.22% sulfur have not produced acidic leachate after 18 years. After declining for about 3 years from initial levels between 7 and 8, pH remained between 6 and 7 with no obvious upward or downward trend. At the same, sulfate concentrations declined. Calcium and magnesium concentrations also declined as pH declined then stabilized. Alkalinity declined during the first two or three years and became undetectable (<2 mg $CaCO_3$/L) in 1998. Nickel concentrations were erratic at first reaching concentrations of up to 0.07 mg/L then declined over the long term. The trend in copper concentrations was similar.
- A sample with 0.4% sulfur (Reactor 5) showed a slow decline in pH then a sharp decrease after about 14 years of weathering. The lowest pH reached was 3.8 in August 2004, after which pH recovered to 5 by June 2006. The trend in sulfate was downward to near 1 mg/L prior to the decrease in pH which resulted in a peak sulfate concentration of 37 mg/L coincident with the lowest pH. This was followed by a steep decline in sulfate concentrations to 5.8 mg/L. Calcium showed a similar peak along with aluminum and iron. Magnesium showed a subdued peak. Nickel and copper concentrations increased as pH declined reaching maximum concentrations of 0.3 mg/L and 0.4 mg/L, respectively. Peaks in metal concentrations were coincident with the pH minimum and sulfate maximum.
- Samples with 0.41% to 0.58% sulfur showed decreasing pH (to about 4) for 7 years but then increasing pH for the following 7 years. The decline in pH was also matched by increasing sulfate (peak concentrations less than 30 mg/L), calcium (though not all tests), magnesium, nickel, cobalt and copper. A distinctive feature of nickel release was the presence of double concentration peaks for long term reactors 7 (0.41% S), 9 (0.51% S) and 13 (0.57% S) and possibly also reactor 15 (0.58% S). Reactor 11 (0.54% S) did not show the same feature though there were wide gaps between analysis events and the peaks may not have been detected by the sampling schedule. The first peaks were greatest and coincident with an initial decrease in pH below 6, though sulfate release was declining at the same time. The second peaks were approximately coincident with a second sharp drop in pH below 5 which occurred at different times for different tests between 1992 and 1995. These nickel leaching peaks were coincident with sulfate peaks. Cobalt leaching showed similar trends. Copper leaching also showed double peaks, or a rise in copper leaching followed by a plateau. Where two peaks were observed, the second peaks were higher than the first peaks.
- Samples with 0.71 to 1.64% sulfur showed quickly decreasing pH (to between 3 and 4) for 5 to 7 years then pH recovery. The trend for decreasing pH was similar to the previous lower sulfur set. pHs declined rapidly then flattened between 4 and 5 before declining rapidly to the low point. This pattern appeared to be repeated during pH recovery with a short term flattening and/or decrease in pH as part of the general increase. The decrease in pH again resulted in increasing sulfate concentrations though not until pH dropped below 5. The greatest acceleration in sulfate increase occurred as pH dropped below 4. As pH recovered, sulfate concentrations dropped rapidly except for a slight flattening or increase coincident with the short term decrease

in pH noted above. Calcium and magnesium followed the same trend as sulfate. The double peak effect for nickel release was also observed though the difference in peaks varied. Reactors 20 (1.63% S), 31 (1.64% S) and 35 (1.12% S) had higher first peaks. Reactors 33 (1.44% S) and 37 (1.4% S) had higher second peaks. These two samples had the lowest pH minimums. Following the second peak nickel concentrations decreased to below 0.01 mg/L. The cobalt trends were similar to nickel but copper showed three peaks. The first minor peak was associated with the initial drop in pH. This was followed by the largest peak when pH were lowest, and a second minor peak that appeared to be associated with the pH flattening as part of the overall pH increase. Except for Reactor 33 (1.44% S), copper concentrations eventually decreased to less than 0.3 mg/L. Reactor 33 continued to have concentrations between 0.7 and 1.1 mg/L. This reactor showed the slowest pH recovery remaining below 5 until it was terminated. It also had the highest stable long term sulfate concentrations. Zinc concentrations showed some elements of the nickel and copper trends.

- MDNR also tested two Duluth complex samples that contained 2.06% and 3.12% sulfur and two Virginia Formation samples containing 3.7 and 5.4% sulfur. The tests proceeded for less than 2 years. All tests showed a rapid drop in pH to between 4 and 5 in a few weeks for the Virginia Formation samples, and a few months for the Duluth Complex samples. Declining pHs continued and when the test was stopped, the Virginia Formation sample with the highest sulfur content had a pH of 3.1. At the same time sulfate concentrations rose. Nickel and cobalt concentrations peaked early in the test period for the Duluth complex sample containing 2.1% sulfur when pH initially dropped but then declined despite the ongoing decrease in pH. Copper in the same sample peaked slightly as pH dropped at first but then showed a large peak as pH decreased. When the test was stopped, copper concentrations appeared to be decreasing.

SRK further analyzed the data provided by MDNR to evaluate the trend in sulfur depletion from the tests. Sulfur depletion was calculated by interpolating sulfate release and leachate recovered between results. The proportion of sulfur depleted varied from 4% to 101% though only one sample showed more than 84% depletion. Low depletions were indicated for tests that ran for a few years. The anomalous 101% value was for Reactor 5 (0.4% sulfur). The result was unexpected because the sample continued to leach sulfate despite the apparent depletion of more than the available sulfur. Because the calculation indicated that more than the original sulfur content was depleted, sulfur depletion was also calculated by correlating electrical conductivity with sulfate and using the resulting calculated sulfate values to calculate depletion. The calculation indicated that 107% of the original sulfur content had been depleted, confirming the original calculation. These calculations show that the original sulfur value was probably incorrect.

Figure 3-5 compares pH of leachates with the proportion of original sulfur consumed as a means of tracking how much sulfur was consumed as pH decreased and then recovered. It is apparent that for all but Reactor 5, the decrease in pH occurred before 40% of sulfur had been consumed and that pH recovered before 65% of sulfur was consumed.

Reactors 1 and 3 contained low sulfur concentrations oxidizing at low rates. However, 53% of sulfur has been removed from Reactor 1 (0.18% S) and 42% of sulfur has been removed from Reactor 3 (0.22% S). By comparison with the other tests, these samples would no longer be expected to generate acidic leachate at any time because insufficient sulfur remains. The absolute amount of sulfur remaining in these samples is 0.09% and 0.1% but no other sample showed a decrease in pH with this level of sulfur remaining.

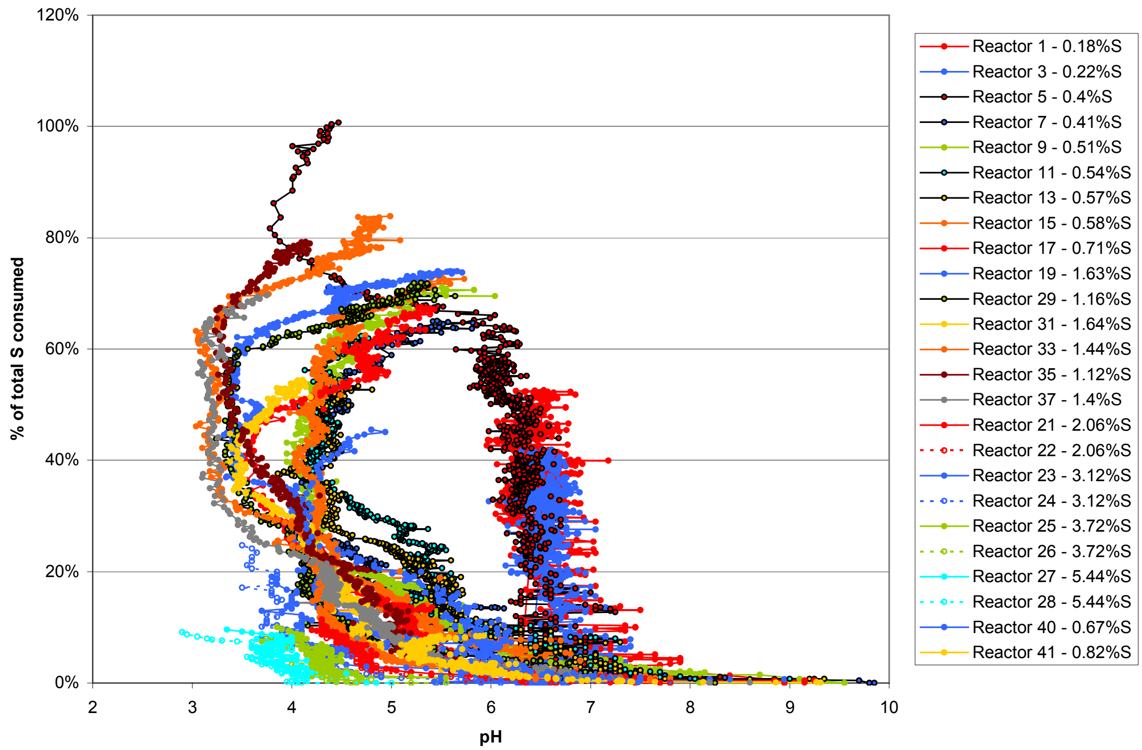

Figure 3-5: pH of Leachates Compared to Cumulative Depletion of Sulfur.

3.2.6 Babbitt and Dunka Road (NorthMet) Deposit Samples

In August 2003, MDNR began laboratory testing of ten Duluth Complex samples from the Babbitt (seven samples) and Dunka Road (three samples) deposits. Lapakko and Antonson (2006) reported data for 130 weeks of testing and the MDNR provided SRK with 170 weeks of data (Folman 2006a, b).

Sulfur and total inorganic carbon content of the samples tested are shown in Table 3-3. No other chemical analyses were available due to funding limitations (Lapakko, personal communication).

Leachates were analyzed for pH, conductivity, alkalinity, sulfate, calcium, magnesium, potassium, sodium, copper, nickel, cobalt and zinc.

Table 3-3: Characteristics of MDNR Samples from the Babbitt and Dunka Road (NorthMet) Deposits

Deposit	MDNR Reactor	%S	$\%CO_2$	Deposit	ASTM Humidity Cell	%S	$\%CO_2$
Babbitt	1	0.07	0.08	Babbitt	9	0.13	0.05
Babbitt	2	0.11	0.13	Babbitt	10	0.21	0.08
Babbitt	3	0.2	0.12	Babbitt	11	0.33	0.08
Babbitt	4	0.31	0.2	Babbitt	12	0.55	0.08
Babbitt	5 (dup. of 4)	0.31	0.2	Babbitt	13 (dup. of 12)	0.55	0.08
Babbitt	6	0.63	0.07	Babbitt	14	0.72	0.06
Babbitt	No MDNR Reactor			Babbitt	15	1.03	0.1
Babbitt	7	0.94	0.08	Babbitt	16	1.36	0.08
Dunka Road	No test	No test	No test	Dunka Road	17 (D)	0.23	0.07
Dunka Road	8 (D)	0.31	0.211	Dunka Road	18 (D)	0.31	0.211
Dunka Road	No test	No test	No test	Dunka Road	19 (D)	0.61	0.161

Babbit Deposit

The Babbitt samples were from a bulk sample collected in 2001. The rock was processed to produce suitable charge material for MDNR Reactors (-100+270 mesh) and ASTM Humidity Cells (-1/4”). Six samples were tested in MDNR style reactors with one test performed in duplicate. An additional -1/4” sample was also tested. The sulfur contents of the two fractions are not the same because they were prepared by screening rather than crushing. As shown in Table 3-3, the coarser samples used in the ASTM tests had higher sulfur contents than the finer samples used for the MDNR reactor.

Leachate results are graphed in Appendix B.2.

The overall pH trend for the samples was downward to varying degrees with the degree of pH depression observed being related to sulfur content. Three tests produced leachate with pH below 5 (ASTM tests containing 1.03 and 1.36% sulfur, and MDNR Reactor containing 0.94% S). The 0.63% S sulfur sample in a MDNR reactor generated leachates mostly with pH below 5.5. For samples containing lower concentrations of sulfur, pH depression occurred sooner and to a greater degree in the MDNR reactors. The range of pH readings for the MDNR reactors at about 30 weeks was 5.9 to 6.6 compared to 6.7 to 7.3 for the humidity cells. The difference between tests was smallest for the samples containing the lowest sulfur concentrations. As the test proceeded, pH appeared to recover for the MDNR reactors containing the lowest sulfur concentrations but remained low for samples containing more than 0.2% sulfur. The pattern of sulfate release was also different for the two types of tests. The decrease in pH observed for the MDNR reactors coincided with sulfate release peak for all samples with the exception of the reactor containing 0.07% sulfur. The magnitude of the peak was correlated with sulfur content of the sample. In contrast, even the two ASTM cells which produced acidic leachate showed only weak increases in sulfate production as pH dropped. Sulfate generation for the ASTM humidity cells was generally uniform or decreasing. The pattern of calcium and magnesium release was comparable to sulfate for both types of test.

Nickel release appeared to be related to pH of the leachate. The MDNR reactors containing more than 0.07% sulfur indicated rapid increases in nickel release as pH dropped. The effect was weakest for the sample containing 0.11% sulfur. This was followed by slowly declining nickel release. At weeks 118 and 122, nickel concentrations decreased very sharply (by two orders-of-magnitude) and then recovered by three orders-of-magnitude. The dataset beyond 120 weeks seems suspect and has not been considered further. The MDNR is evaluating the data to determine if they are erroneous.

A similar overall nickel release trend was shown by the ASTM cells containing 1.03% and 1.36% sulfur though nickel release increased more rapidly at first. The other ASTM cells and MDNR reactor containing 0.07% sulfur showed slowly increasing nickel release. The relative degree of release was correlated with sulfur content. The sample containing the greatest sulfur content in this group (0.72%) showed the greatest nickel release (0.4 mg/kg/week). The highest nickel release for the sample containing 0.13% sulfur was 0.01 mg/kg/week.

Release of copper, nickel and zinc showed similar trends.

Dunka Road (NorthMet) Deposit

The Dunka Road samples were obtained from PolyMet's drill core. Three samples were tested in humidity cells while one sample was tested in a MDNR reactor. The data were provided to SRK (Folman 2006a, b). The MDNR reactor and ASTM humidity cell samples contained the same sulfur concentration (0.31%). The sulfur content of the other samples was 0.23% and 0.61%.

Leachate chemistry data charts are provided in Appendix B.3.

The pH trend for the samples containing more than 0.23% sulfur was generally downward at first with the MDNR reactor sample showing the greatest degree of depression, but leachate pH subsequently recovered to the same level as the equivalent humidity cell. The sample containing 0.23% sulfur showed an initial small decrease in pH, but leachate pH remained generally near 7. The differences in pH resulted in differences in sulfate release which were comparable to the Babbitt tests. The MDNR reactor showed the highest sulfate release which then declined whereas the three humidity cells showed relatively stable sulfate generation after 40 weeks. The level of stable sulfate generation was correlated with sulfur content of the sample.

Calcium and magnesium showed similar trends.

The nickel trends were also similar to the Babbitt samples. The MDNR reactor showed an initial increase in nickel as pH decreased, then nickel release trended downward. The two humidity cells containing higher sulfur content showed slowly increasing nickel release whereas the sample containing 0.23% sulfur showed nickel release below the detection limit. Cobalt release showed the same trend as nickel though the early trend was obscured by sub-detection limit results. Similarly copper release trends were affected by the detection limit of 0.0005 mg/L. The MDNR reactor showed a brief peak at 0.02 mg/kg/week then copper release dropped back to near the detection limit. Only the 0.61% S sample indicated significant detection of copper leaching after about 100 weeks. This contrasted with the Babbitt samples which generally appeared to release copper at a higher rate.

3.3 Data Requirements

As indicated in Section 1.2, the objectives of characterization of waste rock were:

- Refinement of preliminary waste rock management criteria developed by PolyMet and MDNR.
- Development of water chemistry predictions for stockpile drainage water for input to water impact assessment and water treatment design.

The MDNR's testwork has shown that sulfur content is the primary variable controlling pH of leachate, oxidation rate and metal release rates. These variables are not independent but sulfur content at least appears to be the underlying control. As a result, the MDNR and PolyMet agreed on initial waste classification criteria for "reactive" and "non-reactive" waste rock as defined in the Minnesota Rules. "Non-reactive" waste rock was defined as rock with less than or equal to 0.05% sulfur. This low level of sulfur was considered to eliminate the possibility of acidic drainage (based on MDNR's findings of lack of acidity from samples containing 0.22% sulfur) and also reduce the likelihood of significant metal leaching. The "reactive" category was expected to include rock that may or may not generate ARD but regardless would leach metals at a level that would not meet discharge water quality standards.

In addition to sulfur content, the MDNR and PolyMet also discussed other potentially important variables that could affect the chemistry of drainage from stockpiles:

- Sulfide mineral type.
- Rock type.
- Fragment particle size.

Other important variables include mineral content, mineral grain size, mineral chemistry, and mode of mineral occurrence.

Sulfide mineral type can be important in terms of rate of reaction and metal release. For example, it is well know that pyrrhotite is more reactive than pyrite. Chalcopyrite and pentlandite are sources of copper and nickel, respectively in drainage. However, because the dominant sulfide mineral in the waste rock appeared to be pyrrhotite (based on distribution of metal content) and the commodity sulfide minerals (chalcopyrite, pentlandite and cubanite) were expected to be present at low concentrations, sulfide mineral type was not considered as a primary variable for sample selection. As described below, concentrations of copper, nickel, cobalt and zinc were used as secondary factors for sample selection which is expected to capture variations in sulfide mineralogy. Lean ore characterization is considered separately. All samples were characterized to evaluate assumptions about the mineralogical occurrence of the important metals.

All rock types in the Duluth Complex are variants of troctolite and to a lesser extent ultramafic rocks. Carbonate minerals are absent or occur at very low concentrations in this rock type.

Therefore, the variation in silicate content of these rocks was considered to be an important variable controlling drainage pH.

MDNR also considered that igneous layers in the intrusive complex may be a significant variable because the reactivity of the minerals may be different in each of the layers. Finally fragment particle size is an important factor because it controls exposure of the reactive minerals and the overall surface area available for reaction.

The objective of refinement of the initial waste classification criteria was therefore addressed by evaluating numerous variables that could conceivably affect water chemistry. The data necessary for water chemistry predictions was also obtained by the same program.

4 Sampling and Analytical Methods

4.1 Exploration Drilling and Chemical Analysis Database

The drilling and sampling methods used to accumulate the database of bulk rock characteristics are described in ER03 (PolyMet 2007b). The following headings were included in the outline for the RS42 report but are covered in ER03 and RS78:

- Historical (Pre-PolyMet) Data Collection Methods
- PolyMet Data Collection Methods
- Database QA
- Block Modeling
- Model Limitations

4.2 Dissolution Testwork

4.2.1 Sample Selection

Waste Rock

A sampling matrix for waste rock characterization (Table 4-1) was developed by MDNR, SRK and PolyMet through a series of discussions and exchange of relevant data. Table 4-1 shows how the main variables were translated to a sampling design. The table also provides estimates of the tonnages of each major rock type within each unit. Reading from left to right, the columns in the table show the following:

- Unit. This refers to the stratigraphic igneous layers in the complex (numbered 1 to 7). Unit 20 refers to the footwall of the deposit composed of Virginia Formation and localized igneous intrusions
- Rock Type. This refers to a generalized rock description in the associated unit.
- Estimated Rock Tonnages. These tonnages indicate the estimated amounts of each rock type within each layer and therefore their relative importance. The provisional categories were developed by MDNR and PolyMet to indicate rock with sulfur less than 0.05%[1] ("non-reactive"), sulfur greater than 0.05% but not likely ore grade ("reactive"), and rock with marginal ore grade (lean ore).

[1] Note that the non-reactive classification was a temporary criterion agreed between MDNR and PolyMet.

Selection of samples for each unit and rock type combination was based on sulfur concentrations in order to develop correlations between reactivity and bulk characteristics such as sulfur and metal content. This provides a basis for water chemistry predictions using bulk characteristics, prediction of waste management criteria (based on sulfur content and metal content) and ultimately for the selection of easily-measured parameters that can be used for waste management during mining.

Separate sulfur ranges were defined for the "non-reactive" and "reactive" categories. Within the non-reactive category, three sulfur concentrations were selected to represent the lowest possible sulfur concentration in the rock type (typically 0.01%), the upper limit to this category (0.05%) and an intermediate (0.03%). The need for samples was identified for relatively abundant rock types contributing more than 1,000,000 tons (i.e. more than 1% of the rock mass). For the reactive category, sample selections were based on sulfur concentration percentiles calculated by Polymet. Again, rock types contributing more than 1,000,000 tons were identified for testing.

Sulfide mineral variability was considered by preferring samples with higher concentrations of Ni, Co, Cu and Zn.

The search for suitable samples included all candidate sulfur values indicated in grey shading (Table 4-1).

Characterization of Lean Ore

Lean ore is defined as rock containing grades of commodity minerals below that at which processing can currently be justified, but may eventually be processed if project economics improve. In terms of sulfur content, lean ore mainly overlaps the "reactive" waste rock category and also to some degree the "non-reactive" category but contains higher nickel and copper concentrations than waste rock. Therefore, the main difference between lean ore and waste rock is expected to be in the mineralogical occurrence of sulfur. In waste rock, sulfur occurs mainly as iron sulfide but in lean ore the commodity minerals pentlandite, chalcopyrite and cubanite are expected to be more important. This has important implications for drainage chemistry. In particular, oxidation and leaching of pentlandite is expected to release more nickel than pyrrhotite due to the higher Ni/Fe ratio in pentlandite. This limits the co-precipitation of nickel with iron oxyhydroxides during oxidation. The overall approach to selection of samples was similar to that of waste rock.

Characterization of Ore

Three ore composites (referred to as "Parcels") were prepared for Pilot Plant testing described in ER03 (PolyMet 2007b). These samples were used to characterize the leaching performance of ore.

Interval Selection, Sample Shipping and Preparation

Details of these aspects of the project are provided in Appendix A.

Table 4-1: Matrix for Sample Selection in Waste Rock Types

Unit	Rock Type	Non-Reactive	Reactive	Approximate sulfur contents																				Reactive Rock
				Non-reactive[1]			Reactive[1]									Lean Ore[1]								P size
		M. tons	M. tons	NR1	NR2	NR3	P10	P25	P50	P75	P80	P85	P90	P95	P100	P10	P25	P50	P75	P80	P85	P90	P95	
1	Anorthositic	0.57	0.99				0.08	***0.1***	***0.15***	***0.29***				***1.09***	1.09	0.11	0.26	***0.36***	***0.93***				***1.95***	***4***
1	Gabbroic	0	0.68				0.06	0.07	0.07	0.08				0.19	0.5	0.09	0.1	0.18	0.37				0.5	
1	Sedimentary hornfels	0	1.6				***0.08***	***0.35***	***0.69***	***2.2***	2.32	***2.81***	3.38	3.5	3.78	0.34	1.37	***1.58***	1.76				***4.91***	
1	Troctolitic	17.2	40.1	***0.01***	***0.03***	***0.05***	0.06	**0.07**	***0.1***	0.18	***0.21***	0.26	***0.34***	***0.62***	***1.97***	0.08	***0.15***	***0.24***	0.42	0.49	***0.55***	0.68	***0.98***	***4***
1	Ultramafic	0.21	1.1				0.07	***0.08***	0.1	0.13	***0.2****	***0.3****	***0.5****	***0.8****	1.35	0.07	0.09	***0.14***	***0.33***	0.55	***0.56***	0.65	***0.81***	
1	Vein	0.055	0.022				0	0	0	0				0										
2	Anorthositic	2.4	0.56	***0.01***	***0.03***	***0.05***	0.06	0.06	0.08	0.11				0.19		0.09	0.12	0.17	0.21				0.25	
2	Basalt inclusions	0.28	0													0	0	0	0				0	
2	Gabbroic	0	0.082				0	0	0	0				0										
2	Troctolitic	16.9	9.7	***0.01***	***0.03***	***0.05***	0.06	0.06	0.07	0.09	0.09	0.1	0.11	0.12	0.25	0.05	0.07	0.12	0.18	0.2	***0.22***	0.26	***0.32***	
2	Ultramafic	0.38	0.25	***0.03***	***0.04***	***0.05***	0	0	0	0				0		0.04	***0.05***	0.07	0.12	***0.14***	0.16	0.19	***0.23***	
3	Anorthositic	9.4	1.2	***0.01***	***0.03***	***0.05***	0.07	0.08	0.08	0.12				0.14		0.06	0.08	0.12	0.27				0.38	
3	Fault-Breccia	0	0.055				0	0	0	0				0										
3	Gabbroic	0.2	0.72				0.09	0.15	0.18	0.27				0.29		0	0	0	0				0	
3	Noritic	0.11	0																					
3	Sedimentary hornfels	0.38	0.46				0.12	1.42	1.67	1.97				2.22		1.66	1.77	1.85	2.43				3.26	
3	Troctolitic (augite)	41.2	12.5	***0.01***	***0.03***	***0.05***	0.06	0.06	***0.08***	0.1	0.11	***0.12***	0.14	***0.19***	0.36	0.05	0.13	0.19	***0.32***	0.35	0.45	0.48	***0.52***	***4***
3	Ultramafic	0.24	0.071				0	0	0	0				0		0	0	0	0				0	
4	Anorthositic	0.16	0.055				0	0	0	0				0										
4	Sedimentary hornfels	0	0.055				0	0	0	0				0										
4	Troctolitic	7	2.2	***0.01***	***0.03***	***0.05***	0.06	***0.07***	0.09	***0.18***	0.19	0.19	***0.48***	***0.92***	1.53	0.09	0.15	0.22	0.47				***1.52***	***4***
4	Vein	0.055	0																					
5	Troctolitic	2.5	2	***0.01***		***0.05***	0.07	0.09	0.11	0.16				0.22	0.22	0.12	0.17	0.26	0.37				***0.45***	
6	Chlorite	0.16	0													0	0	0	0				0	
6	Fault-Breccia	0.055	0.055				0	0	0	0				0										
6	Troctolitic	6.8	0.59	***0.02***	***0.04***		0	0	0	0				0		0.01	0.01	0.03	0.07				***0.19***	
6	Ultramafic	0	0.11				0	0	0	0				0										
7	Ultramafic	0.082	0													0	0	0	0				0	
20	Troctolitic	0	0.27				3.18	3.45	3.76	4.3				4.31										
20	Virginia	0	10.4				0.59	***1.25***	2.98	***4.15***	4.49	4.85	5.07	***6.06***	7.45	0	0	0	0				0	***4***

Notes:
1. Non-reactive rock categories (lower, medium and higher sulfur contents). The designation as “non-reactive” was provisional for the purpose of sampling design.
2. Sulfur percentiles for reactive rock types calculated by PolyMet are shown. “*” indicates approximate percentiles.
3. Grey – sampling plan.
4. Bold and italic – samples obtained.
5. Bold border – duplicate cell in operation.

4.2.2 Physical Characterization

The specific gravity and particle size distribution of all samples was determined. Particle size distributions were determined by screening with five sieves at ¼", 10 mesh, 35 mesh, 100 mesh and 270 mesh.

4.2.3 Mineralogy

Optical

Two pieces of typical core from each interval sampled were taken for preparation of polished thin sections to confirm the rock type and quantify reactive minerals. Optical mineralogy reports provided mineral types, mineral abundance, grain sizes and mineral occurrence. Results are provided in Appendix D.1. Photomicrographs are provided in Appendix D.2.

Sub-Optical (Microprobe)

Sub-optical analysis included determination of the trace element content of major minerals on selected samples using microprobe analyses.

Results are provided in Appendix D.3.

4.2.4 Analytical Methods

Solids Characterization

A split of each sample was submitted for an extensive suite of analysis, as follows:

- Total sulfur and carbonate. Sulfur as sulfate was not determined because previous work shows that sulfur occurs exclusively as sulfide. Carbonate rather than neutralization potential was determined because neutralization potential determinations on rocks containing reactive silicates are ambiguous (Lapakko 1994a) and do not reflect field capacity to neutralize acid. If carbonate is present, it indicates the known field reactive component of acid neutralization potential provided that occurs in non-ferrous mineral forms.
- 27 elements by ICP scan following four-acid (nitric-hydrochloric-perchloric-hydrofluoric) digestion (near total).
- 34 elements by ICP scan following aqua regia (nitiric-hydrochloric acid) digestion.
- Whole rock oxides.

These methods were selected to provide continuity with the earlier work.

Results are provided in Appendix D.4.

In addition, 200 g of five size fractions (-20 mesh, -100+270 mesh, -35+100 mesh, -10+35 mesh and -0.25”+10 mesh) were submitted for analysis of total S and 27 elements by four acid digestion.

Results are provided in Appendix D.5.

Kinetic Testing

ASTM Humidity Cell

Humidity cell testing was performed using ASTM Procedure D 5744 – 96 (Reapproved 2001) (ASTM 2001). This procedure was selected for the following reasons:

- Similar procedures have been in use under different names since the late 1980s (e.g. MEND 1991). The results can therefore be evaluated in the context of more than a decade of experience using the procedure.
- It is a standard procedure approved by the ASTM and is therefore defensible as a method (White and Lapakko 2000).

The ASTM procedure provides some options for varying the test procedure. Appendix A provides a detailed listing of the requirement of the ASTM procedure, options chosen and any variances from the ASTM procedure.

MS Excel ® spreadsheets of the results are provided on the compact disk included with the report. Calculated release rates are charted in Appendices E.1, E.2, E.3 and E.4.

Minnesota MDNR Cell and Particle Size Experiments

The MDNR’s research has shown that particle size is an important consideration for understanding the reactivity of waste rock (e.g. Lapakko 1987). To evaluate size fraction effects, four size fractions (-100 mesh, -35+100 mesh, -10+35 mesh and -0.25”+10 mesh) from five samples are being tested using a procedure referred to as the “MDNR Reactor” experiment. These experiments also allow comparison of the ASTM method with the MDNR reactor which has been used for much of the MDNR’s prior experimentation. Similar comparisons have been made by the MDNR (Lapakko and White 2000).

The two smallest size fractions were tested in an apparatus designed by MDNR to contain 75 g (Lapakko 1988b; Appendix A; SRK 2006). The two coarser fractions are being tested in cells with the same configuration as ASTM Procedure D 5744–96.

For the small reactors, a weekly leachate volume of 200 mL was used. For the larger samples, the leachate volume was 300 mL.

MS Excel ® spreadsheets of the results are provided on the compact disk included with the report. Calculated release rates are provided in Appendix F.

Leachate Analysis

Leachates from kinetic tests were analyzed for the parameters indicated in Table 4-2. Conductivity, pH and ORP were analyzed every week. Sulfate, alkalinity, acidity, chloride and fluoride were analyzed on even numbered weeks. Every four weeks beginning on the first rinsing cycle (week 0) the metals indicated in Table 4-2 were analyzed using an ICP-MS scan in filtered samples. On other even numbered weeks (i.e. weeks 2, 6, 10 etc.), the leachates were analyzed for a higher level scan (ICP-OES) to evaluate trends in major elements. This scan also provided trace metal concentrations but at higher detection limits.

Based on experience, testing of non-reactive rock samples with very low sulfur concentrations was expected to result in very dilute leachates containing low concentrations of the metals of interest. Back-calculation of metal concentrations from other testwork performed by MDNR indicated that nickel and cobalt concentrations could be as low as 0.0002 mg/L (200 ng/L) and 0.00001 (10 ng/L), respectively. Quantification of these low metal concentrations was needed to provide reasonably constrained estimates of metals concentrations in waste rock drainage.

A number of different approaches were considered to quantify low levels of metals:

- The routine leachate analysis achieved a detection level of 0.0001 mg/L (100 ng/L). A detection limits of 50 ng/L could be obtained with additional processing effort using the same routine method.
- Specialist methods can achieve lower detection limits. These are non-routine (for example, evaporation to increase concentrations) and would need to be developed as the need arises. In order to generate a 10 times decrease in detection limit, the samples would need to be concentrated at 1east 10 times. A composite leachate sample would be prepared from several cycles.
- The MDNR's testwork (Folman 2006a) demonstrated that good correlations exist between cobalt and nickel concentrations in leachates. Detectable nickel concentrations could be used to estimate cobalt concentrations if this relationship could be demonstrated.
- The particle size experiments provide a larger surface area and provide greater likelihood that lower concentrations will be detected.
- In the event of undetectable low levels, detection limit values could be used in subsequent calculations.

The mercury detection limit of 0.02 µg/L (20 ng/L) was supplemented for selected leachates by using a method to achieve a detection limit of 2 ng/L.

Table 4-2: List of Parameters for Humidity Cell Leachate Analyses. Concentrations in mg/L except where indicated

Parameter	Limit	Parameter	Limit
pH (standard units)	-	Acidity	1
Conductivity (µS/cm)	1	Alkalinity	1
Chloride	0.2	Sulfate	0.5
Fluoride	0.05	Total Inorganic Carbon	1
ORP (mV)	-		
Dissolved Elements			
Aluminum	0.001	Mercury	0.02 µg/L
Antimony	0.0001	Molybdenum	0.00005
Arsenic	0.0001	Nickel	0.0001 (0.00005)[1]
Barium	0.0001	Potassium	0.02
Beryllium	0.0002	Selenium	0.0002
Bismuth	0.0002	Silicon	0.05
Boron	0.005	Silver	0.00005
Cadmium	0.00004	Sodium	0.01
Calcium	0.01	Strontium	0.0001
Chromium	0.0002	Tellurium	0.0002
Cobalt	0.0001 (0.00005)[1]	Thallium	0.00002
Copper	0.0001	Thorium	0.0001
Iron	0.01	Tin	0.0001
Lead	0.00005	Titanium	0.0002
Lithium	0.0002	Uranium	0.00005
Magnesium	0.005	Vanadium	0.0002
Manganese	0.00005	Zinc	0.001

Notes:

1. Low detection limits are available for cobalt and nickel as shown.

QA/QC

To summarize, QA/QC included the following components:

- Roughly 10% of all solids analyses were performed in duplicate.
- Roughly 10% of all cell and reactor tests were run as duplicates.
- A blank cell and reactor containing no sample were operated to check for contamination of leachates by construction materials.
- Individual leachate results were reviewed.
- Ion balances on leachate results were reviewed. In general, imbalances of ±10% were considered acceptable. Re-analysis if requested depending on the nature of the imbalance.
- Data trends in kinetic test leachates were analyzed to check for anomalies.

4.2.5 Interpretation Methods for Kinetic Tests

Trend Analysis

All results from kinetic plots were plotted as time series which were continually updated as the waste characterization program progressed to allow trends to be assessed. Results were plotted as raw concentrations and as loadings, or release rates calculated from:

Loading (mg/kg/week) = Concentration (mg/L) x Leachate Recovered (L) / Mass of Sample (kg)

As indicated above, metal concentrations were determined by two different methods on alternate even-numbered weeks. For the purpose of plotting and loading calculations, the following rules were used:

- If the result was determined by ICP-MS and was below the reporting limit, the value on the graph is at the reporting limit. If the value is at or above the reporting limit, the value is plotted.
- If the result was determined by ICP-ES and was determined to be below the reporting limit, no value is plotted.
- If the result was determined by ICP-ES and was determined to be above the reporting limit, the value is plotted.

These rules can result in four cycles between plotted results if the parameter is not detected by ICP-ES.

Occasionally, "saw tooth" trends are apparent in which values alternate between high and low for the ICP-ES and ICP-MS analyses. This results from analytical "noise" around the ICP-ES reporting limit when reported values are slightly above the reporting limit. Aluminum is a particular example that commonly shows reported values above the ICP-ES reporting limit of 0.05 mg/L.

Many graphs are plotted on logarithmic axes to allow data spanning a wide range of concentrations to be compared.

Average Rate Calculations

Average rates (in mg/kg/week) were calculated to evaluate correlations between bulk characteristics (e.g. metal and sulfur content, mineralogical characteristics). The following method was used to calculate average rates:

- The loading trends for sulfate were examined as an indicator of sulfide oxidation rates and the expected main factor driving other parameters such as release of metals and the products of acid neutralization.
- The loading trends typically showed relatively rapid initial release of sulfate followed by decrease, then a longer term trend (stable, increasing, or slow decrease). The initial trend is

usually a result of leaching of weathering products produced by oxidation of the sample in storage prior to testing. The trend following the short term effect reflects dissolution of weathering products produced each week. For trends showing relatively stable release, the trend was examined to find the first week when the release rate was below the highest point in the stable trend. If a decreasing or increasing trend, the trend was visually assessed to estimate when the initial flush ended. The release rates following the development of the stable trend are then used to calculate average release for the entire trend. In the event that the trend showed much more variability than other tests, the average was not calculated.

- Loading trends for other parameters were calculated using the same time period as sulfate so that comparisons between parameters could be made on a consistent basis.
- Some dissolved ions were not determined on a weekly basis, and in some cases have variable analytical frequency depending on detection by ICP-ES or ICP-MS. The average rates for individual weeks were pro-rated between analyses by summing the load leached rather than just averaging weekly rates.

Depletion Calculations

Rates were also used to evaluate depletion of rock components by totaling the load leached over the entire period of the test.

5 Results

5.1 Exploration Drilling and Chemical Analysis Database

The bulk rock characteristics are in ER03 (2007b). The following headings were included in the outline for the RS42 report but are covered in ER03:

- Unit Characteristics
- Rock Type Chemical Characteristics
- Metal Distribution
- Sulfur distribution
- Location of samples (spatial distribution within mine)

Appendix C.1 summarizes PolyMet's calculations of the distribution of sulfur, copper, nickel and zinc by rock type and unit.

5.2 Dissolution Testwork

5.2.1 Reconciliation of Sample Selections with Target Characteristics

Discussion of the sulfur composition of the 79 rock samples selected for kinetic testing compared to the target characteristics shown in Table 4-1 was provided in a memorandum dated November 24, 2005 to the MDNR.

Some deviation from the target sulfur concentrations shown in Table 4-1 was expected because (a) samples were selected using weighted average analyses in PolyMet's drill core sample database, (b) suitable samples were not always available; and (c) the actual analyses combine compositing and analytical errors for both the original database values and composite analytical results. Deviations from target values were calculated from:

$$Deviation(\%) = \frac{(S_{Actual} - S_{Target})}{S_{Target}} \times 100$$

The following summarizes resulting deviations compared to target sulfur concentrations.

- For samples with S≤0.05%:
    - o Deviations of 100% are common but they usually represent absolute differences of less than or equal to 0.02% on sulfur concentrations below 0.05% and close to the method detection limit of 0.01%.
    - o Two samples (8% of non-reactive samples) with target concentrations of 0.01% had deviations exceeding 100%.

- For samples with S>0.05%:
  - 84% of samples selected had deviations below 50%.
  - For four samples (13%), the deviation was between 50 and 100% and only one sample had a deviation of 200%. This latter sample was classified as “optional” in the selections.
- For lean ore samples, only one sample (less than 5% of samples) showed a deviation of 50%.

Based on the low overall incidence of deviation from target values and the large size of the dataset, it was concluded that the sample distribution for waste rock, lean ore and ore would provide a more than adequate database for characterization of these materials. No further sampling was proposed for these rock categories or deferred ore.

5.2.2 Mineralogical Characteristics of Samples

Appendix D.1 provides mineralogical data for samples in kinetic tests. Mineralogy is described below for each of the main sulfur groupings.

S≤0.05% Rock

The dominant silicate phases in all samples were either plagioclase or olivine. One sample of ultramafic (00-368C-460-465) showed alteration to chlorite (20%) and serpentine (30%). One sample of troctolite (00-367C-290-310) also showed alteration to chlorite (40%). The only other significant mineral group was pyroxenes which occurred in concentrations varying from 0 to 25%. Clinopyroxene was dominant.

Sulfide mineral content was described as not detected (0% sulfide), rare and trace, which was consistent with the low sulfur content of the samples. The sulfide mineral content was further described in terms of minerals and proportion of the overall sulfur content. Ten sulfide minerals were identified, but five were present at proportions exceeding 15% in at least some samples with the approximate order of importance of these minerals represented by:

Chalcopyrite > Pyrrhotite > Pentlandite > Cubanite > Bornite.

In a few samples, pyrrhotite exceeded chalcopyrite. Other sulfide minerals identified included digenite, covellite, violarite, mackinawite/valleriite and sphalerite. Pyrite was not recognized in any of the samples. The distribution of sulfide minerals in the non-reactive waste rock showed the importance of chalcopyrite rather than pyrrhotite as the main host for sulfur.

PolyMet have indicated from their mineralogical interpretation that approximately 95% to 98% of sulfide mineralization occurs interstitial to the silicate minerals. The remaining 2 to 5% of sulfide occur as inclusions in silicates, microveinlets in microfractures and secondary remobilized blebs in altered silicates.

S>0.05%

This waste rock group includes Duluth Complex igneous rocks, xenoliths and footwall Virginia Formation rocks.

With the exception of one sample (00-357C-335-340) of the Duluth Complex rocks, the non-sulfide mineralogy of the samples was dominated by plagioclase, followed primarily by olivine. As in the S<0.05% rocks, chlorite and serpentine alteration was present in some samples along with both orthopyroxene and clinopyroxene. Sample 00-357C-335-340 is an unusual example of highly to intensely altered rock, with possible contamination of partially assimilated footwall rocks. It is identified by PolyMet as an ultramafic rock from Unit 1, and is dominated by potassium feldspar, chlorite, clinopyroxene, and epidote.

Sulfide content in the Duluth Complex samples was dominated by similar minerals as the S<0.05% rocks, but pyrrhotite was the dominant sulfide, and bornite was a small proportion so that the overall order of importance was:

Pyrrhotite > Chalcopyrite > Pentlandite = Cubanite[2]

Other sulfide minerals identified were chalcocite, covellite, violarite, mackinawite/valleriite, sphalerite, galena, enargite and talnakhite.

The dominant non-sulfide minerals in the sedimentary hornfels xenoliths and Virginia Formation were potassium feldspar and cordierite. Other minerals included quartz, clinopyroxene, biotite, white mica, graphite, carbonate and idocrase. Carbonate and idocrase were identified in one sample of sedimentary hornfels (26030-1047-1052). The dominant sulfide mineral was pyrrhotite with mostly minor sphalerite, galena and chalcopyrite. One sample (26030-1047-1052) of sedimentary hornfels contained sphalerite as the dominant sulfide.

Lean Ore

The lean ore category consists mainly of Duluth Complex rock types with some xenoliths (sedimentary hornfels).

The dominant silicate minerals in the Duluth Complex samples were plagioclase and olivine, with the proportion shifting depending on the rock type. Other important silicates were orthopyroxene and clinopyroxene. Serpentine and chlorite alteration was apparent in several samples. One sample of anorthositic rock from unit 1 (00-331C-255-260) had epidote and carbonate alteration. This sample also contained no visible olivine.

The order of abundance of sulfide minerals was found to be:

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[2] The “equals” sign means that cubanite and pentlandite occur in about equal quantities.

Chalcopyrite > Pyrrhotite > Pentlandite = Cubanite

The proportions of pentlandite and cubanite were variable with pentlandite sometimes exceeding cubanite and vice versa. The bornite content was variable reaching 10 to 15% of sulfide in some samples and exceeding cubanite. Other sulfide minerals included covellite, violarite, mackinawite/valleriite and sphalerite.

One sedimentary hornfels sample was dominated by clinopyroxene, potassium feldspar, white mica and pyrrhotite. Other sulfides (chalcopyrite, sphalerite and galena) were present in low quantities.

Analysis of Mineral Grains

Microprobe was used to estimate the concentrations of Fe, Cu, S, Ni, Co, Zn, Ti and As in 268 sulfide mineral grains and SiO_2, Al_2O_3, TiO_2, FeO, MnO, MgO, K_2O, CaO, Na_2O, NiO, CuO and CoO in 236 silicate mineral grains. The grains were from non-reactive and reactive waste rock, and lean ore.

Complete analytical results are provided in Appendix D.3.

Microprobe analyses of mineral grains indicated the average compositions of the two major minerals (plagioclase and olivine) in the Partridge River Intrusion. Plagioclase averages $An_{59}Ab_{41}$ (i.e. 59% anorthite and 41% albite) and olivine averages $Fo_{57}Fa_{43}$ (i.e. 57% forsterite and 43% fayalite).

Table 5-1 provides summary statistics for nickel concentrations in the major sulfide minerals. The detection limit was approximately 0.02%. The main nickel-bearing mineral was pentlandite. In terms of overall significance as a source of nickel, pyrrhotite was the next most significant (median 0.1%). Other minerals containing nickel as a major component were cobaltite and maucherite ($Ni_{11}As_8$) but both were rare minerals. Pyrite when detected contained more nickel than pyrrhotite but it was uncommon.

Table 5-2 shows nickel concentrations in silicates minerals. Concentrations expressed as nickel oxide were converted to nickel. The detection limit was 0.016% (0.02% NiO). These results show that olivine and biotite contained comparable levels of nickel followed by the pyroxenes. Plagioclase contained low levels of nickel.

Table 5-1: Nickel Concentrations (%) in Sulfide Minerals

	Bornite	Chalcopyrite	Cobaltite	Cubanite	Maucherite	Pentlandite	Pyrite	Pyrrhotite
n	3	75	3	41	3	70	8	64
Min.	0.021	0.021	11	0.02	46	26	0.02	0.02
P5	0.029	0.021	12	0.02	47	29	0.04	0.02
Median	0.106	0.022	18	0.02	52	32	0.44	0.10
Mean	0.085	0.057	16	0.94	50	32	0.51	0.22
P95	0.126	0.131	20	1.87	53	37	1.15	0.80
Max.	0.128	0.639	20	30.75	53	43	1.22	1.48

Table 5-2: Nickel Concentrations (%) in Silicate Minerals

	Olivine	Plagioclase	Clinopyroxene	Orthopyroxene	Biotite
n	61	71	57	20	71
Min.	0.016	0.016	0.016	0.016	0.016
P5	0.016	0.016	0.016	0.016	0.016
Median	0.082	0.016	0.016	0.016	0.058
Mean	0.077	0.017	0.023	0.022	0.057
P95	0.130	0.022	0.048	0.047	0.095
Max.	0.143	0.031	0.059	0.059	0.128

Table 5-3 shows copper concentrations in sulfide minerals. Chalcopyrite and cubanite are the main copper-bearing minerals. The copper content of pentlandite and pyrrhotite was low. Table 5-4 shows that in contrast to nickel, silicate minerals contain low copper concentrations with no apparent enrichment in any particular mineral.

Table 5-3: Copper Concentrations (%) in Sulfide Minerals

	Bornite	Chalcopyrite	Cobaltite	Cubanite	Maucherite	Pentlandite	Pyrite	Pyrrhotite
n	3	75	3	41	3	70	8	64
Min.	59	33	0.3	0	0.04	0.02	0.03	0.02
P5	59	33	0.8	22	0.04	0.03	0.04	0.02
Median	60	34	5.5	23	0.05	0.13	0.07	0.04
Mean	62	34	4.5	22	0.06	0.34	0.16	0.08
P95	67	35	7.4	23	0.07	1.58	0.45	0.35
Max.	68	35	7.7	34	0.08	4.38	0.53	0.42

Table 5-4: Copper Concentrations in Silicates

	Olivine	Plagioclase	Clinopyroxene	Orthopyroxene	Biotite
N	13	71	57	20	71
Min.	0.025	0.025	0.025	0.025	0.025
P5	0.025	0.025	0.025	0.025	0.025
Median	0.025	0.025	0.025	0.025	0.025
Mean	0.025	0.025	0.025	0.025	0.025
P95	0.025	0.025	0.027	0.025	0.025
Max.	0.028	0.039	0.038	0.036	0.037

Table 5-5 shows that pentlandite is the only major sulfide mineral enriched in cobalt. Cobaltite ((Co,Fe)AsS) is present but in low quantities. Cobalt is primarily present in olivine (Table 5-6).

Table 5-5: Cobalt Concentrations in Sulfide Minerals

	Bornite	Chalcopyrite	Cobaltite	Cubanite	Maucherite	Pentlandite	Pyrite	Pyrrhotite
N	3	75	3	41	3	70	8	64
Min.	0.015	0.019	21	0.02	0.4	0.6	0.04	0.03
P5	0.016	0.021	21	0.03	0.5	0.8	0.04	0.05
Median	0.023	0.034	22	0.04	1.4	1.8	0.05	0.06
Mean	0.023	0.038	22	0.11	1.2	2.3	0.06	0.06
P95	0.031	0.064	23	0.08	1.6	6.0	0.10	0.09
Max.	0.032	0.116	23	1.77	1.7	9.4	0.11	0.20

Table 5-6: Cobalt Concentrations in Silicates

	Olivine	Plagioclase	Clinopyroxene	Orthopyroxene	Biotite
n	13	71	57	20	71
Min.	0.021	0.021	0.021	0.021	0.021
P5	0.032	0.021	0.021	0.021	0.021
Median	0.051	0.021	0.021	0.022	0.021
Mean	0.050	0.021	0.022	0.027	0.024
P95	0.073	0.021	0.025	0.044	0.033
Max.	0.080	0.025	0.040	0.048	0.041

5.2.3 Particle Size Distribution

All samples considered for dissolution testing were crushed, and screened through four sieves to obtain four size fractions (+10 mesh, -10+35 mesh, -35+100 mesh, -100+270 mesh) which were analyzed. Results for selected parameters are shown in Figure 5-1.

All fractions showed similar results, with generally increasing concentrations into the fine fractions. For sulfur, the effect was most apparent for sulfur concentrations above about 0.1%. For nickel, the finer fractions clearly contained greater concentrations though again the effect was stronger for the samples containing higher nickel concentrations. Cobalt showed a similar effect. For copper, the majority of samples did not show clear enrichment in the fine fractions though a few samples with higher concentrations showed a wide spread of concentrations with the finest fraction containing more than 150% of the copper concentration of the finest fraction.

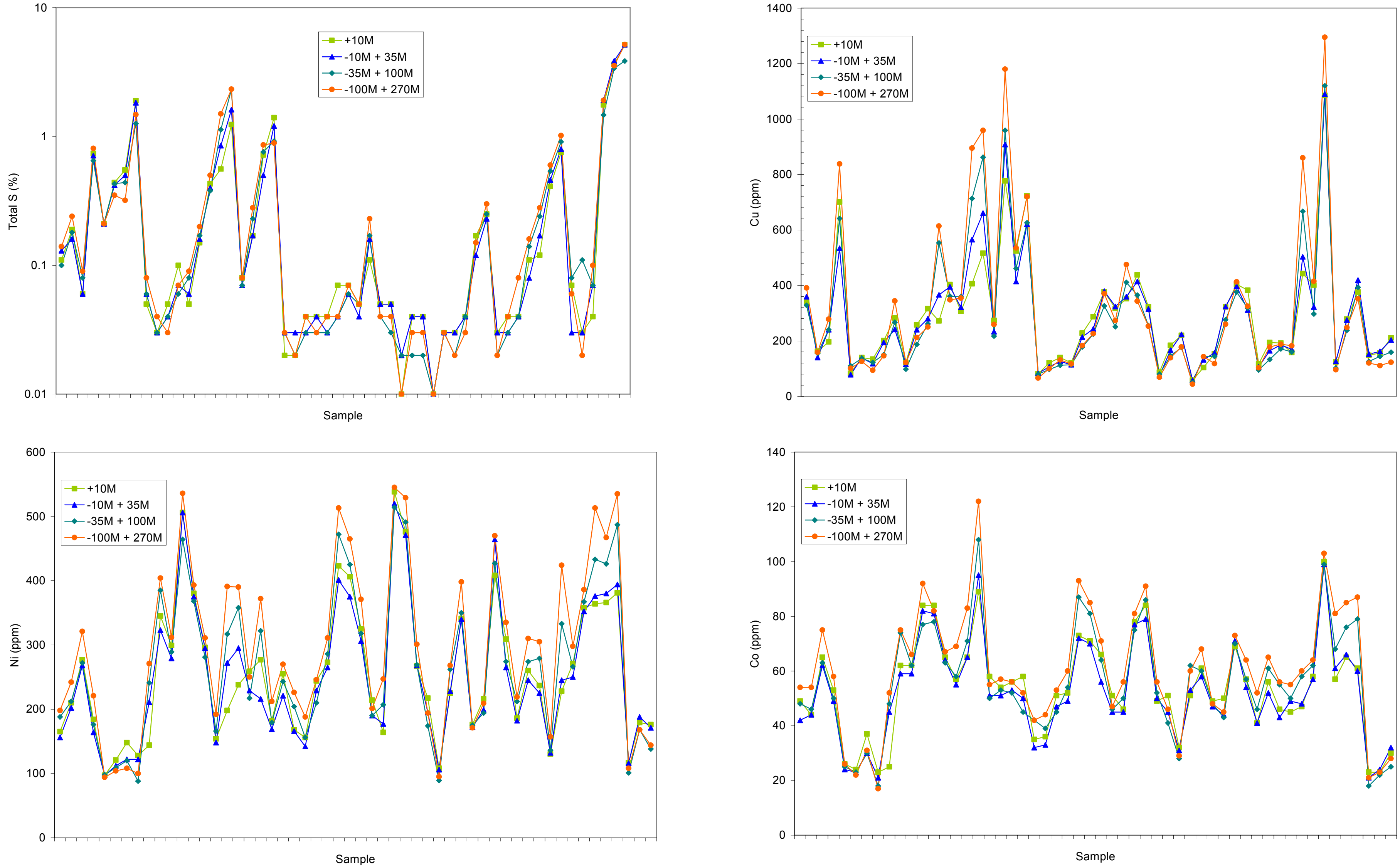


Figure 5-1: Results of Analysis of Size Fractions. x-axes are individual samples.

5.2.4 Description of Leachate Chemistry

Waste Rock Humidity Cells

Data Appendices

Trend graphs for loadings in each general group (waste rock S≤0.05%, waste rock S>0.05%, lean ore and ore) are provided in Appendices E.1, E.2, E.3 and E.4. An overall discussion of trends is provided in the following sections for each of these groups.

In the graphs, the labels indicate the drill hole (e.g. 26029), core interval in feet (815-825), intrusive layer in the Duluth Complex (e.g. U1 indicates Unit 1, U2 indicates Unit 2, etc.), rock type (e.g. TR – troctolitic; AN – Anorthositic; UM – Ultramafic; SH – Sedimentary Hornfels; VI – Virginia Formation) and sulfur content. For samples with S≤0.05%, the sulfur content is shown by the target sulfur level (0.01, 0.03, 0.05%). The waste rock and lean ore, the sulfur content is shown by the sulfur percentile (Table 4.1).

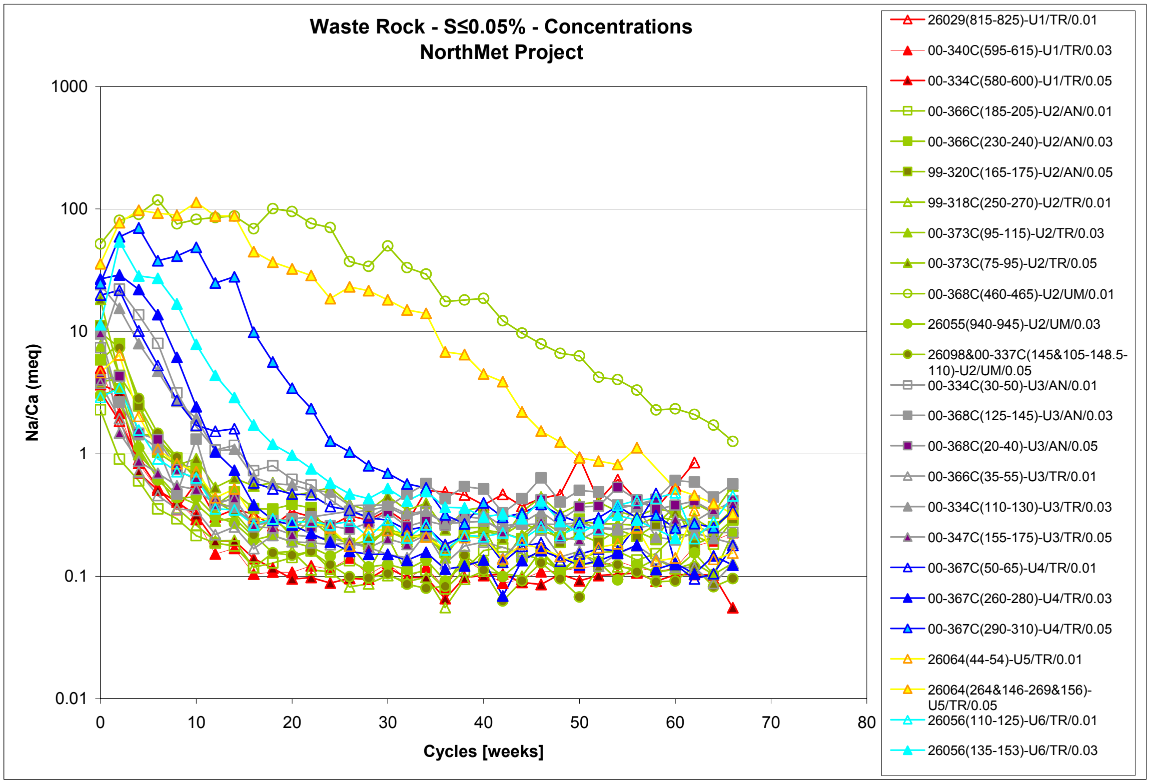
Data listings are provided on the CD attached to this report.

Waste Rock S≤0.05%

All tests showed a general decreasing pH trend starting mostly between 8 and 9.5 then decreasing to 6.7 to 7.5. Major ions in leachates were initially alkalinity and sodium. The trend in inorganic carbon in leachates was comparable to alkalinity which indicated that alkalinity was composed mainly of bicarbonate. Both alkalinity and sodium decreased as the tests proceeded, but the decrease in sodium was matched by increasing calcium. Calcium concentrations then decreased but became the major cation. Magnesium concentrations in some cases decreased steadily while in others increased and then decreased. Sulfate was less significant as an ion compared to alkalinity. It generally decreased than stabilized. No indications of increasing trends were apparent.

The ratios of Na/Ca and Mg/(Na+Ca) were examined because these relate to the leaching of major minerals in the rock (plagioclase and olivine). The trend for Na/Ca was sharply downward and then stabilizing for all but two tests (Figure 5-2). The ratio stabilized between about 0.1 and 0.9 (in meq terms). The ratio of Mg/(Na+Ca) increased sharply then stabilized between 0.1 and 0.5 indicating preferred leaching of plagioclase compared to olivine.

Trace element concentrations showed similar trends to the major ions but due to the low levels were commonly erratic. For example nickel concentrations were generally below 0.0015 mg/L and were flat or decreasing. Copper concentrations showed some erratic spikes but were generally below 0.004 mg/L and showed stable trends. Cobalt was mostly undetected at 0.0001 mg/L. Zinc concentrations were erratic between 0.001 and 0.01 mg/L and no trends were apparent.



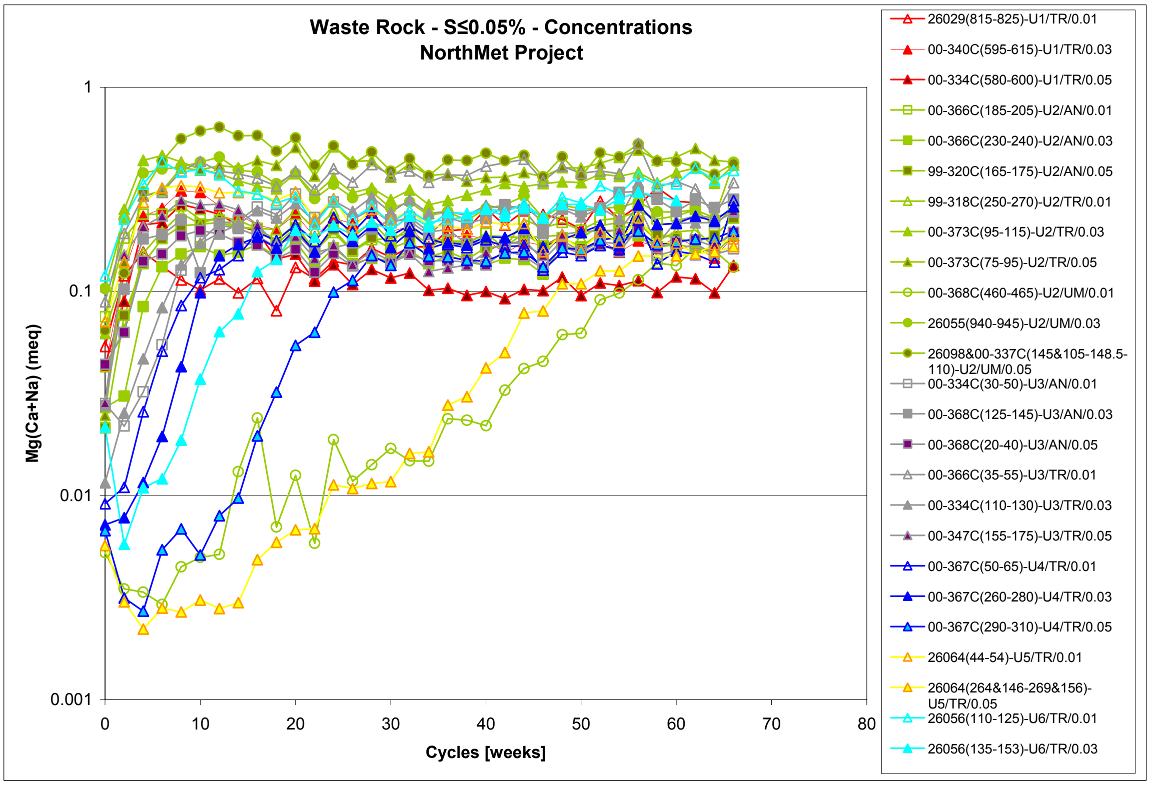


Figure 5-2: Na/Ca and Mg/(Na+Ca) Ratios for Waste Rock with S≤0.05%.

Waste rock S>0.05%

This class of waste rock includes Duluth Complex (Partridge River Intrusion) Rock, Virginia Formation in the footwall of the Complex and xenoliths of the footwall rocks included in the Complex. The latter are referred to as Sedimentary hornfels.

- **Duluth Complex Rock**. The sulfur concentration range for these samples was 0.05% to 1.7%. Leachate pH from the Duluth Complex rocks generally declined as the test proceeded, with initial pHs mostly above 8 and more recent results above 7. A few tests showed pHs between 6 and 7. These samples with slightly lower pHs were typically ultramafic rock types. Although pH decreased for a period, more recent results showed increases. Initial leachate chemistry was dominated by alkalinity and sodium with a gradual transition to comparable alkalinity and sulfate, balanced primarily by calcium. These changes mainly occurred as a result of decreasing alkalinity and sodium. Sulfate loadings were generally stable though some tests showed increasing sulfate to reach a higher stable rate. In some cases, sulfate increased then decreased (for example, troctolite from Unit 4 with 95^{th} percentile sulfur concentrations). Potassium leaching occurred at comparable levels to sodium in the later stages of testing.

  Trends in Na/Ca and Mg/(Na+Ca) were similar to the S≤0.05% samples. Na/Ca decreased then stabilized for most samples at ratios between 0.03 and 0.6 (meq terms). Mg/(Na+Ca) generally increases than stabilized between 0.08 and 0.3.

  Four samples from Unit 1 showed increasing nickel leaching trends distinct from other samples that showed generally stable nickel release at low concentrations. Three samples were ultramafic rock and one sample was troctolitic rock. The same samples also showed increasing cobalt leaching at concentrations about an order-of-magnitude below nickel. There was also some evidence of copper leaching showing the same trend at comparable concentrations to cobalt. The samples showing increasing nickel, cobalt and copper release were also the same samples showing lowest pH.

- **Virginia Formation**. Sulfur concentrations in these samples ranged from 2.0 to 5.7%. Two samples with 75^{th} and 90^{th} percentile sulfur concentrations (3.8 and 5.7% sulfur, respectively) yielded acidic leachates (pH<5) after 5 weeks of testing. The sample with 25^{th} percentile sulfur (2% sulfur) showed declining pH but lowest pHs were generally near 7. Acidic conditions were marked by rapidly increasing sulfate concentrations as the tests started which peaked and then declined. Iron was the dominant balancing cation as pH initially decreased. As sulfate generation stabilized, iron and magnesium were important cations. Trace elements showing similar trends to iron were cadmium (peak concentration 0.01 mg/L), cobalt (1 mg/L), copper (0.03 mg/L), manganese (0.6 mg/L), nickel (7.5 mg/L) and zinc (1.1 mg/L).

  The 75^{th} percentile sample yielded a lower pH (<4) than the 90^{th} percentile sample and also showed increasing cadmium and zinc concentrations as pH decreased further.

- **Sedimentary Hornfels**. Sulfur concentrations in these samples ranged from 0.24% to 2.5%. Two samples of hornfels representing the 75^{th} and 85^{th} percentile sulfur concentrations (1.7 and 2.5%) showed declining pH and eventually generated leachates with pH<5 between 40 and 50 weeks into the test. At the same time, release of sulfate and a number of ions and trace elements also increased. The group of elements was similar to the Virginia Formation. The other three samples representing 10th, 25th and 50th percentile sulfur concentrations (0.24%, 0.44% and 0.55%) all produced slightly alkaline leachates. These samples all contained detectable carbonate ranging from 4 to 22 kg $CaCO_3$/t with the highest carbonate content in the lowest sulfur sample which was described as granoblastic calc-silicate. The main feature of leachate chemistry for these samples was relatively elevated leaching of arsenic for the 10th and 25th percentile samples (up to 0.09 mg/L later in the test), antimony (0.01 mg/L) and molybdenum (0.001 mg/L) compared to the Duluth Complex igneous rocks.

Lean Ore

Lean ore samples are a variant of the S>0.05% sample set in which copper and nickel constitute a relatively greater proportion of the sulfide minerals than waste rock. This group includes both Duluth Complex Rock and mineralized footwall xenoliths.

- **Duluth Complex Rock**. Sulfur concentrations in these samples ranged from 0.06% to 1.8%. All samples showed declining leachate pH beginning at between 8 and 9.3 then falling to between 5.9 and 7.6. The lowest pHs were indicated for samples containing between 0.4% and 1.4% sulfur. Overall leachate trends were comparable to S>0.05% rock. Initial leachates were dominated by alkalinity and sodium shifting to mostly calcium with alkalinity and/or sulfate. Magnesium leaching from some samples dominated compared to calcium and sodium.

  Upward trending nickel leaching was apparent for at least five samples containing troctolitic or anorthositic rock with at least 75th percentile sulfur concentrations in Unit 1 (S>0.4%) reaching maximum concentrations of 1.3 mg/L. The highest nickel concentrations were associated with the lowest pHs. Likewise, cobalt concentrations showed the same trend reaching 0.1 mg/L. Maximum copper concentrations were 0.08 mg/L. Zinc concentrations increased to 0.06 mg/L.

- **Sedimentary Hornfels**. Two the samples were tested containing 1.5% and 4.5%. The sample containing 4.5% sulfur (95th percentile) showed initially rapidly decreasing pH which subsequently stabilized to between 4.2 and 4.7. The decrease in pH was accompanied by elevated but steady sulfate release. The main cations were iron and calcium. Iron concentrations increased then stabilized. Other metals showing similar trends were cadmium, cobalt, manganese, nickel and zinc. A second sample contained 1.5% sulfur (50th percentile) with minor detectable carbonate equivalent to 6 kg $CaCO_3$/t. This sample did not produce acidic leachate but sulfate release was equivalent to the other sample. Calcium was the dominant cation as leachate chemistry stabilized. Nickel and cobalt concentrations were increasing in the latter stages of the test. This sample released elevated arsenic concentrations (0.8 mg/L) in the first 10 weeks.

Ore

Sulfur concentrations in all three samples were 0.9%. Leachates from the samples showed slowly declining pH starting between 7 and 8 and ending between 6 and 7. The trend in major parameters was very similar to the other tests. Sodium, alkalinity and sulfate were initially dominant, but as sodium and alkalinity decreased, calcium and sulfate became dominant. Sulfate release was variable in the P3 sample. About week 30, sulfate increased than decreased. All three samples showed increasing copper, cobalt, manganese and nickel concentrations as pH decreased. Other parameters, including arsenic and antimony decreased.

Particle Size Experiments

Five samples were selected for dissolution testing on four size fractions. Characteristics of the samples are provided in Table 5-7.

Table 5-7: Characteristics of Size Fraction Samples

Sample ID (Drill Hole, Footage)	Rock Type Descriptor	Geological Unit	HC or MDNR Cell	Fraction	S	Cu	Ni	Co
					%	%	%	mg/kg
00-361C(310-320)	Anorthositic	1	HC 81	-1/4”+10#	0.19	0.016	0.021	44
			HC 82	-10+35#	0.16	0.014	0.020	44
			L1	-35+100#	0.18	0.016	0.021	46
			L2	-100#	0.24	0.016	0.024	54
00-334C(640-660)	Troctolitic	1	HC 83	-1/4”+10#	0.10	0.032	0.051	84
			HC 84	-10+35#	0.07	0.028	0.051	82
			L3	-35+100#	0.06	0.026	0.046	77
			L4	-100#	0.07	0.025	0.054	92
00-369C(305-325)	Troctolitic	3	HC 85	-1/4”+10#	0.25	0.038	0.031	57
			HC 86	-10+35#	0.23	0.031	0.027	54
			L5	-35+100#	0.25	0.032	0.027	57
			L6	-100#	0.30	0.033	0.034	64
00-367C(290-310)	Troctolitic	4	HC 87	-1/4”+10#	0.04	0.019	0.024	46
			HC 88	-10+35#	0.04	0.019	0.023	43
			L7	-35+100#	0.04	0.017	0.028	55
			L8	-100#	0.08	0.019	0.031	56
00-364C(210-229)	Virginia	20	HC 89	-1/4”+10#	3.64	0.016	0.018	23
			HC 90	-10+35#	3.87	0.016	0.019	24
			L9	-35+100#	3.39	0.014	0.017	22
			L10	-100#	3.55	0.011	0.017	23

Four of these samples were various types of Duluth Complex rock containing bulk sulfur concentrations varying from 0.04% to 0.25%. One sample was Virginia Formation rock containing bulk sulfur content of 3.8%. Results are described below in order of increasing bulk sulfur content of the sample.

Direct comparison of leachate chemistry for the four samples is not appropriate because the two finest samples are being leached using 2.7 L/kg of rock, whereas the two coarse fractions are leached at the rate of 0.3 L/kg. Therefore, release rates must be compared to see differences between fractions. Graphs showing selected results are provided in Appendix F.

- Sample 00-367C (290-310) (Unit 1 Troctolite – 0.04% Sulfur). Leachate pHs showed an initial downward trend but then stabilized between 6.5 and 7.6. Sulfate release was stable and greatest for finest size fractions. Likewise, the finest fraction also produced the highest loads of rock weathering products. Except for the initial phases of the tests, nickel and cobalt releases were barely detectable. Copper release in contrast was detected and was greater for the two finest size fractions.
- Sample 00-224C (640-660) (Unit 1 Troctolite – 0.08% Sulfur). Leachate pHs for the four fractions were between 6.5 and 7.5 with no particular trend. Sulfate release was downward trending. Sulfate release was inversely correlated with particle size. The smallest particles released the highest sulfate load on a mg/kg/week basis. Similarly, leaching of the main rock components and trace metals were greatest for the finest particles. Metal release was stable with no clear increasing or decreasing trends.
- Sample 00-361C (310-320) (Unit 1 Anorthosite – 0.18% Sulfur). Leachate pHs again decreased then stabilized except for the coarsest fraction which showed erratic pH toward the latter part of the test. At this time, lowest pHs were apparent for the two finest fractions operated in a MDNR reactor configuration. Over the duration of the test, the -10+35 mesh sample consistently had the highest pH. Sulfate release was stable and greatest for the two finest fractions. Likewise, main rock components were leached at the greatest rate for the two finest fractions. Nickel was low but appeared to be increasing for the coarsest and two finest fractions while the -10+35 mesh fraction had low stable nickel release. Cobalt showed similar results. Copper release was greatest for the two finest fractions but appeared to be stable. Zinc release was increasing for the finest fraction.
- Sample 00-369C (305-325) ((Unit 3 Troctolite – 0.25% Sulfur). Leachate pH values were consistently greater for the -10+35 mesh sample (7.3 to 7.7) compared to the coarsest and two finest fractions (6.4 to 7.1). Sulfate production was generally greatest for the two finest fractions and lowest for the coarsest fraction. Major rock weathering components showed the same trend. Nickel release was barely detectable except toward the later stages when it began to increase very slightly. Cobalt was undetected except for the first leachate. Copper was released at a greater rate for the two finest fractions and there were no clear trends.
- Sample 00-364C (210-229) (Virginia Formation – 3.79% Sulfur). All four fractions have generated acidic leachate (pH below 5). The two coarsest fractions generated the lowest pH

water (3.7) compared to a minimum pH of 4.2 for the two finer fractions. The two finest fractions showed higher sulfate release than the two coarse fractions. A similar effect was apparent for major rock weathering components. Nickel and to some extent cobalt, zinc and cadmium leaching initially peaked in the -100+270 mesh and -10+35 mesh samples, and to a lesser degree for the -35+100 mesh sample but not for the coarsest sample. Copper did not show a comparable peak but instead showed an upward trend in the two finest fractions. Iron trends showed a combination of the two effects. An initial peak occurred early in the test followed by increasing iron release in the later stages.

Comparison of Results for Different Tests

Two comparisons have been made:

- Comparison of ASTM humidity cell and MDNR Reactor results for size fractions obtained from the same sample; and
- Calculation of the weighted sum of weathering rates indicated by the particle size experiments compared to the equivalent ASTM Humidity cell.

These comparisons can be made for the same five samples tested as four size fractions.

The comparison of ASTM humidity cells and MDNR reactors indicated some consistent features. For the four samples generating leachate chemistry with pH greater than that of the deionized water used to leach the sample, the MDNR reactor consistently produced lower pH leachate. The difference was variable but was typically about 0.5 pH units with the MDNR reactors producing leachate pHs near or below 7. Sulfate concentrations tended to be greater for the ASTM humidity cells. For two samples indicating detectable nickel release (00-334C(640-660) and 00-361C(31-320)), nickel concentrations in the leachate from the MDNR reactors was greater than for the equivalent ASTM humidity cell. Also, the MDNR reactors showed an upward trend in nickel release compared to the humidity cell. Cobalt concentrations were not frequently detectable and copper concentrations showed stable release.

The Virginia Formation sample produced acidic leachate. In this case, pH was lower for the ASTM humidity cell (less than 4) and on a decreasing trend.

Low Level Analysis for Cobalt and Nickel

During planning of the program, it was expected based on MDNR experience that cobalt and to a lesser extent nickel concentrations would be below the reporting limit of the analytical method (0.0001 mg/L or 0.1 µg/L) (Folman 2006a). As described in Section 4.2.4, several approaches were considered to address this issue, one of which was to use analytical methods with lower reporting limits. The laboratory indicated that it could report concentrations of 0.05 µg/L by concentrating composite leachate samples.

Ultra low level analyses was completed for a total of 243 leachate samples collected from testwork on waste rock (Appendix G.1). Leachates were analyzed primarily because cobalt was below the reporting limit. All samples were analyzed for cobalt and about half were analyzed for nickel using the lower reporting limit of 0.05 µg/L. A summary of detections with respect to the two reporting limits is shown in Table 5-8. The results show that 201 (83%) of the cobalt results were below the original reporting limit of 0.1 µg/L. The majority of these samples (144) were below the ultra low level reporting limit. Forty-eight results were between the two reporting limits.

Table 5-8: Results of Low Level (0.05µg/L) Analysis for Cobalt and Nickel

Concentration Range (µg/L)	Number of Co Results	Number of Ni Results
Total Determinations	243	133
Less Than 0.05	144	53
Detected at 0.05	9	0
Between 0.05 and 0.1	48	7
Greater than 0.1	42	73

The results obtained have been considered in two ways:

- Do the short term release rates indicated by the results improve understanding of the correlation between the cobalt and nickel content of the rock and the release of these elements?
- Does the improved detection of nickel and cobalt allow a regression relationship to be developed between these parameters that will allow cobalt to be predicted from nickel?

The above comparison demonstrated that the majority of the cobalt concentrations below the routine reporting limits were also below the ultra low level reporting limits but Figure 5-3 shows that the low level reporting limit cobalt concentrations did not result in improved understanding of the relationship between cobalt in the rock and cobalt release.

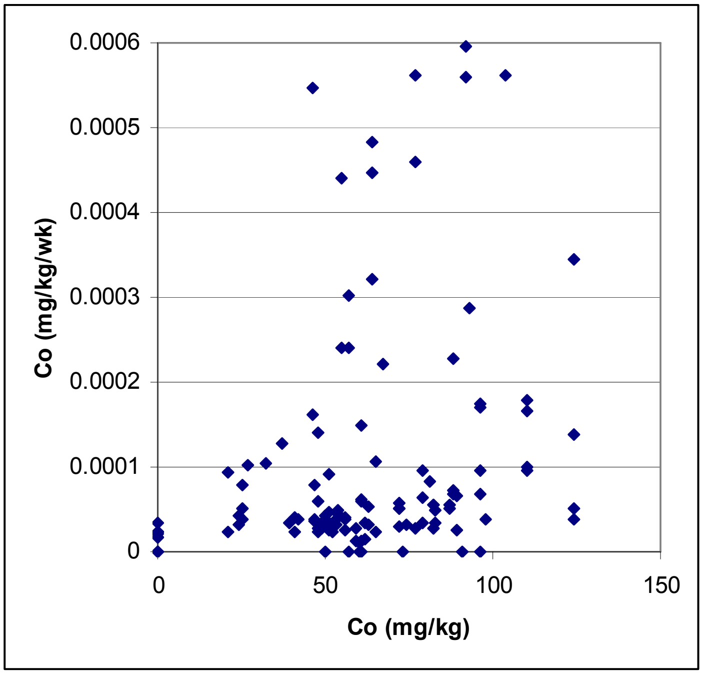


Figure 5-3: Short Term Cobalt Release Using Ultra Low Level Results Compared to Total Cobalt Content of Waste Rock.

Finally, detectable cobalt and nickel concentrations were compared to determine if cobalt could be predicted from nickel. Figure 5-4 shows that nickel and cobalt concentrations are correlated and the correlation coefficient is low (0.56) but statistically significant. However, this level of correlation is not reliable to predict cobalt release from nickel release.

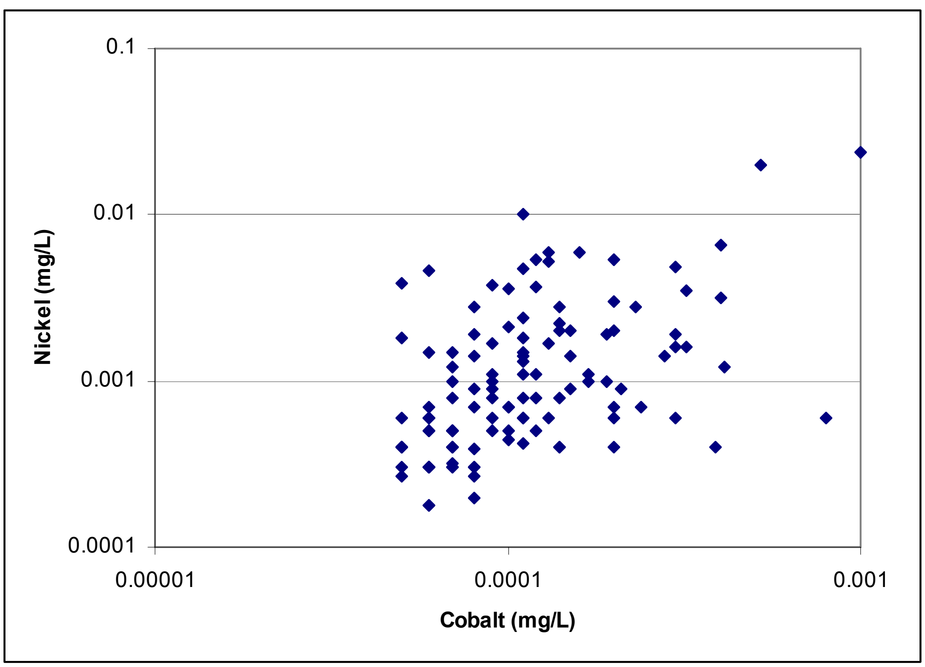


Figure 5-4: Comparison of Low Level Cobalt and Nickel Concentrations.

Low Level Analysis for Mercury

The routine ICP-MS detection limit for mercury is 0.02 µg/L (20 ng/L). In order to better understand mercury leaching from the rock, one set of water samples from all humidity cell tests was analyzed using a specific method to achieve a detection limit of 2 ng/L. A total of 93 analyses were completed (Appendix G.2).

All except one leachate contained detectable mercury concentrations, and only one sample contained a mercury concentration exceeding 20 ng/L (30.1 ng/L). The method blank contained 2.4 ng/L indicating traces of detectable dissolved mercury. Summary statistics by sulfur content and rock type are provided in Table 5-9. As shown, average mercury concentrations were between 5 and 7 ng/L and there was no statistical difference for the various groupings of the data. Because the majority of leachates contained mercury above the blank concentration, the rock leaches low levels of mercury which are unrelated to rock type or sulfur content.

Table 5-9: Summary Statistics for Mercury Analyses (in ng/L) on Humidity Cell Leachates

Group	n	Mean	Standard Deviation	95% Confidence Limit	
				Lower	Upper
S≤0.05%	27	5	2.4	4	6
S>0.05%	37	7	5.2	5	9
Lean Ore	24	6	3.9	5	8
Ore	3	7	4.0	-3	17
Anorthositic	15	6	6.9	2	9
Troctolitic	47	6	3.6	5	7
Ultramafic	15	6	3.2	4	8
Sediments	11	6	4.1	4	9

5.2.5 QA/QC

The following sections describe QA/QC results. The emphasis in these sections is on major element chemistry and parameters that can be expected to be regulated at the site. A number of trace parameters are reported in the ICP scans are not discussed below because they do not fall into either category.

Method Blanks

Method blanks have been run for both the ASTM humidity cell and MDNR reactor style tests. The ASTM method blank cell reported detectable SO_4, Al, As, Ni, K, and Si in only one to three analyses. All of these components had concentrations were less than 5 times the method detection limits (MDL) of 0.5, 0.001, 0.0001, 0.0001, 0.25, and 0.05 mg/L, respectively.

Several waters showed measurable Zn concentrations but they were all within 4 times the ICP-MS MDL of 0.001mg/L or 2 times the ICP-OES MDL of 0.005 mg/L. Two to three analyses for Pb, Mn, and Na reported concentrations up to 10 times the MDL (0.00005, 0.00005, and 0.01 mg/L, respectively). Most Ca and Cu concentrations were greater than the MDL (up to 8 times greater than the MDL of 0.01 mg/L for Ca and up to 60 times greater than the MDL of 0.0001 mg/L for Cu). In the case of copper, concentrations have been stable between about 0.001 and 0.002 mg/L. It is believed that these detections of calcium and copper represent the effect of leaching of the plastics by the weak acidity in the deionized water because there are no matching detections in the travel blank. Calcium was undetected in the travel blanks and copper concentrations were mostly undetected.

Elevated copper concentrations (up to 0.006 mg/L) were reported in the blank humidity cell in first 10 weeks prior to re-location of the laboratory and installation of new equipment to prepare the deionized water.

The MDNR reactor method blank cell reported detectable SO_4, Cr, Fe, Ni, K, Si and Na in one to four analyses. All of these concentrations were less than 5 times the MDLs of 0.5, 0.0002, 0.01, 0.0001, 0.25, 0.01, 0.0001, and 0.03 mg/L, respectively. Several analyses reported measurable Zn and Al concentrations. Most were within 5 times the MDL of 0.001 mg/L for both parameters, except one Zn analysis that was 22 times the MDL. Detectable concentrations of Ca and Cu were consistently reported. Calcium concentrations were within 6 times the MDL of 0.01 mg/L while Cu concentrations were up to 22 times the MDL of 0.0001 mg/L.

Review of testwork data for cells and reactors containing rock samples showed substantial differences in antimony leaching between the humidity cells and MDNR Reactors. A similar effect was noted for tailings samples (RS46, SRK 2007). The effect was traced to leaching of some polyvinyl chloride (PVC) components of the humidity cell apparatus leached antimony. These components were present in the waste rock humidity cells but were inadvertently not included in the waste rock humidity cell blank test started at the beginning of the program. A new blank test was started and confirmed that antimony leaching from waste rock cells was attributable to the PVC components. Leachate antimony data for the waste rock humidity cell were therefore rejected. MDNR reactor tests did not contain components that leached antimony and the antimony data have therefore been retained for subsequent data interpretation.

Ion Balances

The laboratory uses a criterion of 15% for ion balance differences. When the difference is greater than 15%, additional ions may be included in the calculation to improve the balance or there may be an analytical error that would cause the imbalance. Detection level limitations make determination of charge balance on low-strength solutions (e.g. EC<50 µS/cm) difficult, and higher ion imbalances must be accepted for these samples. *Standard Methods for the Examination of Water and*

Wastewater[3] recommends an acceptable ion balance difference of +/- 0.2 meq/L for an anion sum of 0 – 3 meq/L. Therefore, at a meq/L of 0.5 for both the anions and cations the acceptable error is 20% while at 1 meq/L for both anions and cations the acceptable error is 10%.

Approximately 1.8% of all of the ASTM analyses had ion balance differences greater than 15% (0.5% had greater than a 20% difference). These differences were largely acceptable based on *Standard Methods* criteria indicating that charge balances were excellent.

Nearly 16% of MDNR reactor analyses had ion balance differences greater than 15% (7.5% greater than 20%) due to the generally lower concentrations compared to the humidity cell leachates. Due to the low conductivities of these samples they were largely acceptable according the *Standard Methods* criteria.

Duplicate Tests

Nine duplicate tests have been run for ASTM tests, and two for the MDNR reactor tests. In general, duplicate samples demonstrated similar concentrations and trends for all parameters. One duplicate sample of waste rock (00-364C (210-229)) had Al, Cd, and Zn concentrations that were occasionally nearly an order of magnitude different, although the trends were similar. Other ions for this sample had comparable concentrations and trends.

pH

Trend analysis of pH measurements indicated a "saw tooth" trend in which values alternated between higher and lower values every other week. The reason for the pattern was that pH measurements were performed on filtered and unfiltered leachates on alternate weeks depending on whether samples were being collected for metals analysis. This was consistent with the analytical method. Because vacuum filtration potentially causes weakly buffered leachates to respond to changes in pressure by taking up or releasing carbon dioxide, determination of pH of filtered leachates was discontinued. For results prior to this point in the test program, pH measurements on filtered leachates were not reported. Where pH results were needed for interpretation of other chemical parameters, the two nearby results were averaged.

Conclusions

QA/QC measures indicated that the data generated are of very high quality. QA/QC identified a few minor concerns (antimony and pH) that were evaluated and corrected in consultation with the laboratory as the program proceeded.

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3 20th Ed. American Public Health Association, American Water Works Association Water Environmental Federation AWWA, WEF, 1998.

6 Interpretation of Dissolution Testwork

6.1 General Interpretation of Leachate Chemistry

6.1.1 Observed Effects

Understanding of waste rock stockpile drainage water quality for Duluth Complex waste rock was facilitated by developing a conceptual geochemical model that could explain both the leachate chemistry observed in a variety of small laboratory experiments and field tests conducted by the MDNR over nearly two decades and more recently laboratory testing by PolyMet specifically for the NorthMet deposit.

The salient features that have been observed in kinetic testwork and need to be explained by the geochemical model are as follows:

- Overall Observations
    - The variable long term delay in development of acidic conditions in the absence of abundant carbonate mineral buffering capacity. Acidic conditions in this context are defined as leachate pH below the deionized water pH of about 5.5.
    - The absence of acidic conditions for samples containing sulfur concentrations less than 0.4%.
    - Strong correlation of oxidation rates with sulfur content.
- Leachate pH trends
    - Initially strongly basic alkaline leachates (pH>8) followed by a steep decline in pH to less than 8 within a few months of initiation of kinetic tests.
    - Stable leachate pH for samples that have not generated acidic leachate after 18 years of testing.
    - The generally slow decline in leachate pH in kinetic tests that eventually produce acidic leachate. The initial decline is not necessarily accompanied by increasing sulfate release.
    - At times stepwise sharp decreases in pH under acidic conditions.
    - Steady (at times with steps) recovery of leachate pH following a short term pH minimum.
- Difference between test procedures
    - Generally lower leachate pHs for MDNR reactor tests compared to ASTM humidity cells on the same material when pHs are above 5.5.

- Generally lower leachate pHs for ASTM humidity cells compared to MDNR reactor tests on the same material when pHs are below 5.5.

- Metal Leaching Trends
  - Increasing nickel and cobalt concentrations as pH decreases below 7 but not necessarily in the presence of increasing sulfate release.
  - Subsequent decrease in nickel and cobalt release even as pH remains below 7 and continues to decrease.
  - Coincident sulfate, nickel, cobalt and copper concentration peaks as pH drops below 5.
  - Long term declining metal release as pH recovers following lowest pH.

The following explanation for these observations considers in turn superimposed effects of bulk rock weathering, oxidation of sulfide minerals, and storage and dissolution of secondary minerals.

6.1.2 Bulk Rock Weathering

Rock weathering under atmospheric conditions occurs in response to reaction of water and carbon dioxide dissolved in water (carbonic acid) with carbonate and silicate minerals (Drever 1982). This is the primary process responsible for chemical breakdown of silicate minerals and formation of soils (Birkeland 1984). The products of this process are dissolved alkali and alkali earth ions, dissolved alkalinity as bicarbonate, and secondary weathering products. The secondary products are usually clays, which coat the primary mineral with a weathering rind.

Initial weathering occurs when the fresh silicate mineral surfaces produced by crushing or blasting react with water. This process is analogous to generation of abrasion pH (Price 1997) and results in exchange of base cations on the surface of silicates with H^+ in the water causing the water to become enriched in hydroxyl ions and forming an initial layer of silicate clay on the surface of the primary mineral. This explains the initial high pHs observed for most kinetic tests.

The decline in pH occurs as the silicates become coated and the generation of hydroxyl ions decreases. As the rind thickens, the weathering of the primary minerals must occur by diffusion of reaction products through the rind (Drever 1982).

Troctolites of the Duluth Complex at NorthMet are composed of some of the most reactive common silicates (plagioclase and olivine) (Birkeland 1984). Weathering of the components of these minerals (anothorite, albite and forsterite) by reaction with carbonic acid can be written as:

$$CaAl_2Si_2O_8 + H_2O + 2H_2CO_3^o \rightarrow Ca^{2+} + Al_2Si_2O_5(OH)_4 + 2HCO_3^-$$

$$2NaAlSi_3O_8 + H_2O + 2H_2CO_3^o \rightarrow 2Na^+ + Al_2Si_2O_5(OH)_4 + 2HCO_3^- + 4SiO_2$$

$$Mg_2SiO_4 + 4H_2CO_3^0 + 2H_2O \rightarrow 2Mg^{2+} + SiO_2 + 4HCO_3^- + 2H_2O$$

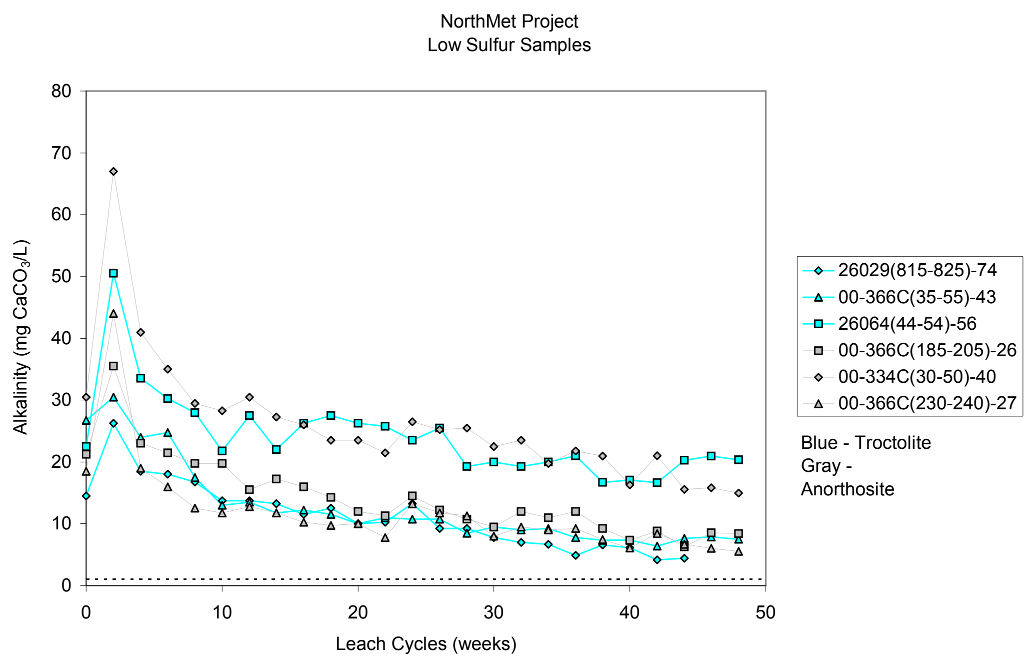
Weathering of the fayalite component of olivine releases ferrous iron which then oxidizes and precipitates as ferric hydroxide:

$Fe_2SiO_4 + 4H_2CO_3^0 + 2H_2O \rightarrow 2Fe^{2+} + H_4SiO_4^o + 4HCO_3^- + 2H_2O$

$2Fe^{2+} + 5H_2O + 0.5O_2 \rightarrow 2Fe(OH)_3 + 4H^+$.

While the weathering of fayalite produces alkalinity in the first step, it also releases acidity (H^+) in the second step which offsets the alkalinity. Overall, dissolution of fayalite does not contribute alkalinity or acidity.

The long term MDNR testwork did not include testing of samples containing sufficiently low sulfur that would allow these effects to be seen directly. Dissolution testwork on six samples containing 0.02% sulfur was conducted by PolyMet. These samples were found to leach slowly declining levels of alkalinity which was accompanied by steady or declining levels of calcium, declining then stable sodium, and stable silica concentrations. Alkalinity leaching for four samples was distinctly lower (4 to 8 mg $CaCO_3$/L) than two samples (15 to 20 mg $CaCO_3$/L) (Figure 6-1). The ratio (Ca/2 + Na/3 + 2Mg)/Si was used to evaluate the relationship between silicon leaching and the expected cations leached according to the formulae of anorthite, albite and forsterite (Figure 6-1). Leaching of the fayalite component of olivine could not be considered because iron was not detected. This does not mean that fayalite was not leaching. Precipitation of ferric hydroxide typically controls iron to sub-detectable levels.



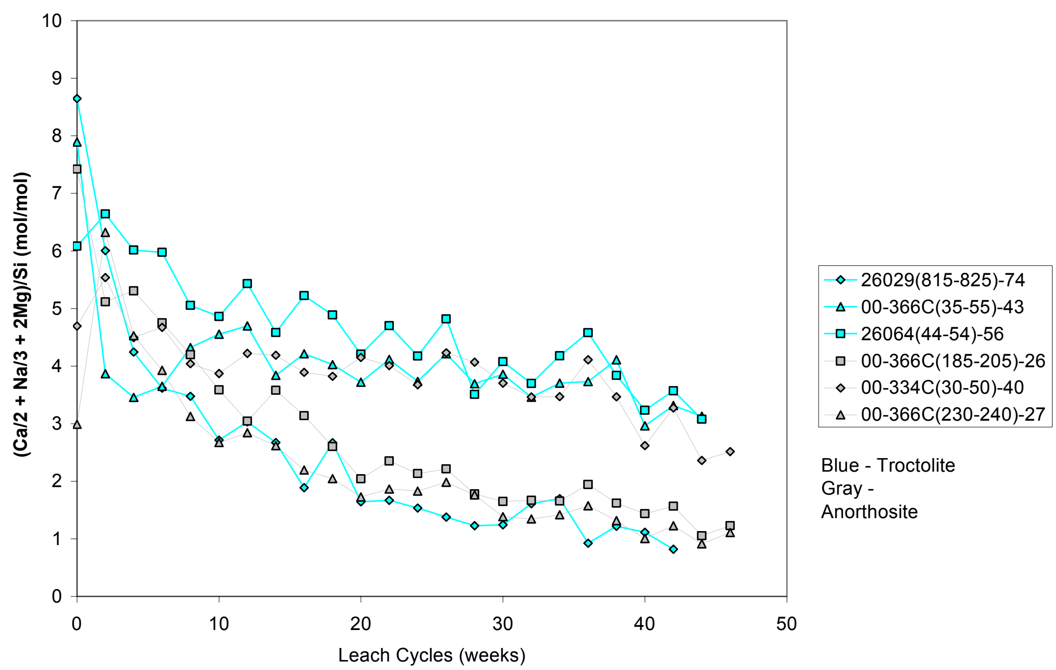


Figure 6-1: Evaluation of Silicate Mineral Weathering for Samples Containing Low Sulfur Concentrations. Top – Alkalinity Concentrations. Bottom – Silicate Ratio.

The ratio for three samples leaching low levels of alkalinity was decreasing and approached the expected value of 1 if none of the elements (including silica) were precipitating as secondary minerals. As shown by the above equations for dissolution of the silicates, calcium, sodium and magnesium would not be expected to precipitate as secondary minerals but silica might be retained as silicate clays. Three other samples showed decreasing values of the ratios. The possibility exists that alkalinity released is due to leaching of small quantities of carbonate minerals. Carbonate was detected in sample 26064(44-54) at 0.06% C just above the detection limit of 0.05% and in sample 00-334C (30-50) at the detection limit therefore proving a plausible explanation for its higher ratio. All other samples contained no detectable carbonate and the ratio was consistent with silicate weathering.

Leachate data shows that alkalinity generation occurs at low rates because silicates react relatively slowly compared to dissolution of carbonate minerals. Because kinetic testing is performed using a high liquid to solid ratio (0.5 L/kg) in the ASTM procedure, the acidity and dilution provided by the deionized water is a significant consideration. The effect of liquid to solid ratio was evaluated using Geochemist's Workbench (Bethke 2005) and assuming constant weathering rates for the silicate minerals (Figure 6-2).

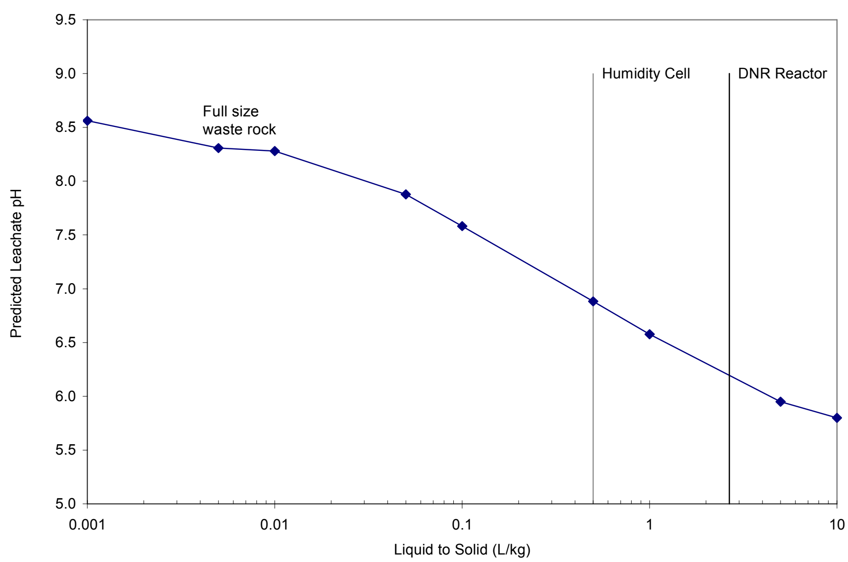


Figure 6-2: Predicted Effect of Liquid to Solid Ratio on Leachate pH with Alkalinity from Silicate Weathering.

The results indicated that at high liquid to solid ratio used for MDNR reactors and ASTM humidity cells, pHs can be expected to be in the 6 to 7 range with pHs 0.5 units higher for the ASTM test. At lower liquid to solid ratios that would be expected in a waste rock stockpile, pHs would be expected to be between 8 and 8.5. At these higher pHs, secondary carbonate minerals are predicted to form by weathering to produce a stored form of carbonate alkalinity. These findings represent important considerations for sulfide mineral oxidation and the assessment of metal mobility as described below.

6.1.3 Oxidation of Sulfide Minerals

Sulfide minerals are a trace to minor component of the rocks at NorthMet but oxidation of them results in generation of acidity by well-understood processes. The products are sulfate ions, protons, iron in some form such as dissolved ferric or ferrous iron, other dissolved metals and/or various types of precipitates.

Testing by the MDNR and for NorthMet has shown that sulfate release (which indicates sulfide mineral oxidation) is well-correlated with sulfur (i.e. sulfide mineral) content of the rock (e.g. Lapakko and Antonson 2006). This indicates that acid generation is expected to become an increasingly important process.

The following sections describe the proposed geochemical mechanisms for interaction of acidity from oxidation of sulfide minerals with alkalinity produced by weathering of silicate minerals.

At very low sulfur content, the acid produced by oxidation of sulfide minerals is easily neutralized by reaction with the bicarbonate alkalinity produced by weathering of silicates as described above. In fact, because alkalinity generation by silicate mineral weathering is independent of sulfide mineral oxidation, excess alkalinity is available to neutralize the acidity. As sulfide content and acid generation rate increase, the acid generation rate will eventually exceed the alkalinity generation rate from weathering of silicates, and there will be excess acidity. This will not immediately cause a decrease in pH because the acidity can also react directly with the silicate minerals. However, the neutralization process is less efficient because direct reaction causes formation of alumino-silicate clay weathering products where the acid contacts the silicate minerals limiting further reactions. As this process proceeds, pH depression can be expected to occur due to incomplete neutralization of acid. Depression of pH causes bacterial activity to accelerate which in turn further accelerates sulfide mineral oxidation. Downward trending pH continues as long as sulfide minerals are readily available.

Testwork results have shown that at times pH decrease occurs in steps. This reflects dissolution of secondary minerals which act as pH buffers. For example, as pH decreases, dissolution of secondary aluminum minerals formed at higher pHs will buffer pH at between 4 and 5. As this buffer is exhausted, and sulfide oxidation accelerates further, pH drops again. Buffering at pH below 4 occurs as ferric hydroxide minerals are dissolved.

A feature of the MDNR's long term testwork is the sustained and strong recovery of pH following a minimum pH. This a unique feature of these experiments because kinetic tests from rock dominated by carbonate minerals show negligible or slow pH recovery once pH has decreased below 4 (for example, Day 1994). For the MDNR's experiments, the minimum pH appears to represent the point when readily available reactive sulfide minerals are consumed and acid generation decelerates. As this occurs, reaction of acidity with silicate minerals improves and dissolved alkalinity from silicate weathering can again contribute to acid neutralization. These observations show that the onset of acidic conditions in these rocks is not the result of depletion of acid buffering minerals as occurs when carbonate minerals are involved but rather the acceleration of oxidation. As the source of acidity is depleted, the minerals which contribute buffering capacity through reaction with acid and generation of alkalinity by weathering remain and are the reason for the steady increase in pH.

Metal Leaching

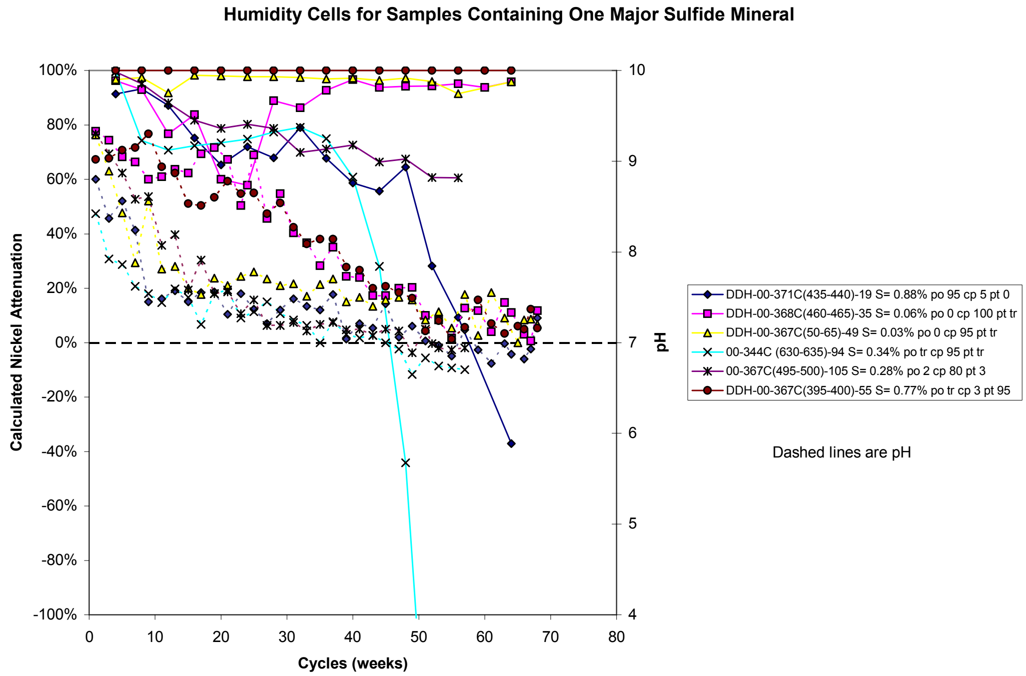
Metals are expected to leach from both silicates and sulfides. Silicates are not normally a significant source of metal leaching but the relatively elevated nickel and cobalt content of olivine and olivine's relatively high reactivity indicate that it may be important for NorthMet at lower sulfur concentrations.

In an effort to evaluate the contribution of silicate weathering to metal leaching, microprobe data and leachate data were used to construct mass balances for metals leaching from samples containing low sulfur contents. Actual nickel concentrations in leachates from these samples were very low (0.0002 mg/L after 40 weeks) but using magnesium to calculate nickel from olivine, nickel concentrations released by olivine would be between 0.001 and 0.004 mg/L. Based on these calculations, nickel was attenuated to a significant degree possibly by formation of a nickel silicate, by co-precipitation by iron released by weathering of the iron component of olivine and sulfides minerals, and adsorption to aluminum hydroxides.

A similar assessment was performed on samples containing relatively pure sulfide mineral assemblages and higher sulfide contents. Metal attenuation was estimated using magnesium to indicate olivine weathering and sulfate to indicate oxidation of the sulfide mineral (Figure 6-3). The calculation showed that nickel attenuation was initially significant but as pH decreased to between 6 and 7 nickel release increased and became greater than the nickel generated by weathering of olivine and oxidation of sulfide minerals. Copper did not show the same effect. Although pH decreased, copper continued to be attenuated in the sample.

These assessments have shown that copper and nickel are both released by weathering and oxidation but even at low concentrations are attenuated possibly as silicates, co-precipitated oxides or adsorbed to hydroxide surfaces. These products appear to be sensitive to pH in the case of nickel. As pH drops below 7, the weathering products are re-dissolved releasing nickel. Dissolution of stored products as pH drops explains the first of two peaks observed for nickel (and to a lesser degree copper) release from the MDNR's reactor experiments (Appendix B.1). As shown, nickel release increased sharply when pH dropped below 7 but then decreased despite further decreases in pH. The second peak is explained by accelerating oxidation (shown by increasing sulfate) which released nickel and copper at even lower pH. Because the oxidation products are not stored, metal release follows the sulfate peak.

As discussed in Section 6.1.3, the initial pH depression in the MDNR's reactor tests is probably an artificial effect caused by the excess acidity introduced by deionized water as the initial "abrasion pH" effect diminishes. As shown in Figure 6-2, leachate pHs at full scale are expected to be greater than in testwork due to the much lower liquid to solid ratio. This implies that provided the alkalinity produced by weathering of silicates does not exceed the acidity produced by oxidation of sulfides, pHs will remain above the critical level of around 7 below which nickel secondary minerals appear to become more soluble.



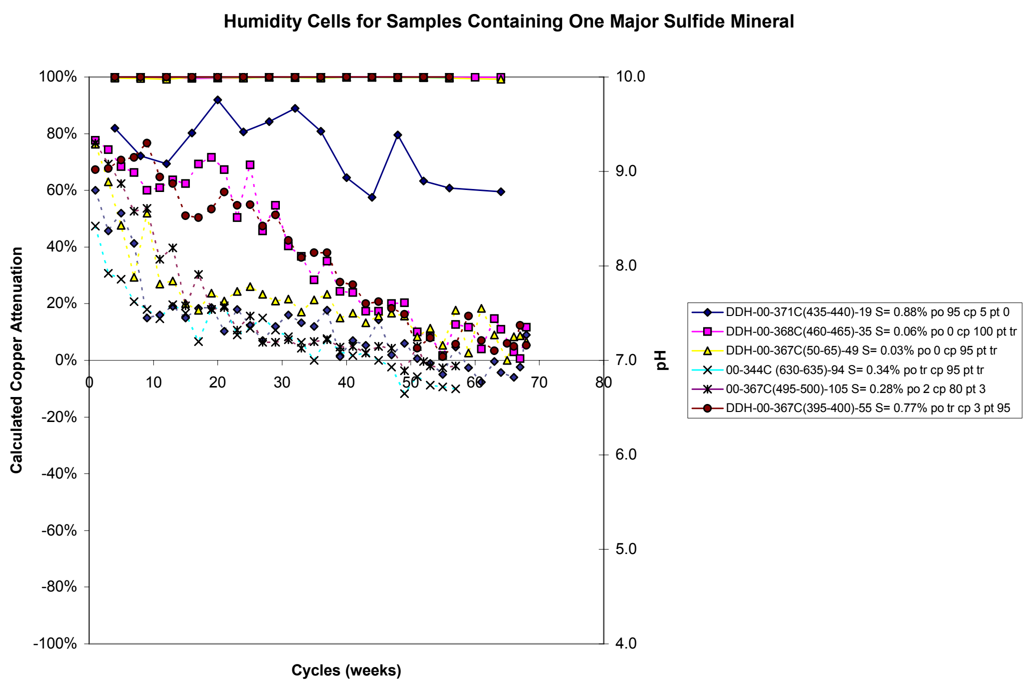


Figure 6-3: Results of Nickel and Copper Attenuation Calculation for Samples Containing One Major Sulfide Mineral (as indicated in legend). Solid lines in the figures refer to attenuation (left axis), dashed lines are pH (right axis).

Interpretation Conclusions

Table 6-1 provides a summary of the features of the data described in Section 6.1.1 and the qualitative explanation as described in Sections 6.1.2 and 6.1.3.

Table 6-1: Interpretation of Dissolution Test Observations

OBSERVATION	MDNR Testwork	NorthMet Testwork	INTERPRETATION
General			
The variable long term delay in development of acidic conditions in the absence of carbonate mineral buffering capacity.	X		Silicate minerals provide buffering capacity through carbonic acid weathering and direct reaction of sulfuric acid with silicate minerals.
The absence of acidic conditions for samples containing sulfur concentrations less than 0.41%.	X	X	Bicarbonate alkalinity produced by carbonic acid weathering of silicates permanently offsets acidity from sulfide oxidation. Sulfide oxidation is strongly correlated with sulfur content.
Leachate pH Trends			
Initially strongly basic alkaline leachates (pH>8) followed by a steep decline in pH to below 8 within a few months of initiation of kinetic tests.	X	X	Reaction of fresh silicate mineral surfaces with water ("abrasion pH").
Stable leachate pH for samples that have not generated acidic leachate after 18 years of testing	X		Steady generation of bicarbonate alkalinity by weathering of silicates.
The generally slow decline in leachate pH in kinetic tests that eventually produce acidic leachate. The initial decline is not necessarily accompanied by increasing sulfate release.	X		Bicarbonate from silicate weathering is less than acidity from sulfide oxidation and excess acid must react directly with silicate minerals. Blinding of silicate minerals limits this process.
At times stepwise sharp decreases in pH under acidic conditions.	X		Consumption of weathering mineral buffers leachate acidity. When exhausted, the pH drops sharply until the next buffer is reached.
Steady (at times with steps) recovery of leachate pH following a short term pH minimum.	X		As sulfide oxidation decelerates due to sulfide mineral depletion, silicate minerals become more effective again and pH recovers.
Difference between test procedures			
Generally lower leachate pHs for MDNR reactor tests compared to ASTM humidity cells on the same material when pHs are above about 5.5.	X	X	Higher liquid to solid ratios result in greater effect of deionized water when reacting with silicate minerals.
Increase in sulfate in some MDNR Reactor tests when pH decreases early in test	X		Lower pH enhances bacterial activity and accelerates oxidation.
Generally lower leachate pHs for ASTM humidity cells compared to MDNR reactor tests on the same material when pHs are below 5.5.	X	X	Higher liquid to solid ratios dilute acidity produced by sulfide oxidation.
Metal Leaching Trends			
Increasing nickel and cobalt concentrations as pH decreases below 7 but not necessarily in the presence of increasing sulfate release.	X	X	Secondary minerals formed above pH 7. As pH drops below 7, the secondary minerals dissolve resulting in release of metals.
Decrease in nickel and cobalt release even as pH remains below 7 and continues to increase.	X		Depletion of secondary minerals formed above pH 7.
Coincident sulfate, nickel, cobalt and copper concentration peaks as pH drops below 5.	X		Metals released by oxidation of sulfides remain in solution due to lower pH
Long term declining metal release as pH recovers.	X		Depletion of sulfide minerals

6.2 Trend Evaluation

This section was included in the agreed outline for RS42. Interpretation of trends was provided in Section 5.2.4.

6.3 Comparison of Results with Other Testwork Programs

It is apparent from the foregoing discussion that broad data trends in kinetic tests are very similar for the two programs, but direct comparison of NorthMet test program data with the MDNR's similar programs is not possible because identical samples have not been tested by the same laboratories using the same method to calibrate any differences in laboratory operating procedures.

A useful semi-quantitative comparison can be made for results of testing by MDNR and PolyMet using ASTM humidity cells on NorthMet (former Dunka Road) Project samples. Figure 6-4 shows average rates for sulfate release compared to total sulfur with release rates calculated using the same approach as the PolyMet data for the same data period (approximately 40 weeks). The large blue triangles are for the three ASTM humidity cell tests performed by the MDNR. The figure shows that despite probable differences in sample preparation methods, laboratory operating procedures and leachate analysis methods, oxidation rates indicated by the MDNR's testwork on NorthMet were similar to PolyMet's testwork. The relationship between sulfur content and oxidation rates are comparable.

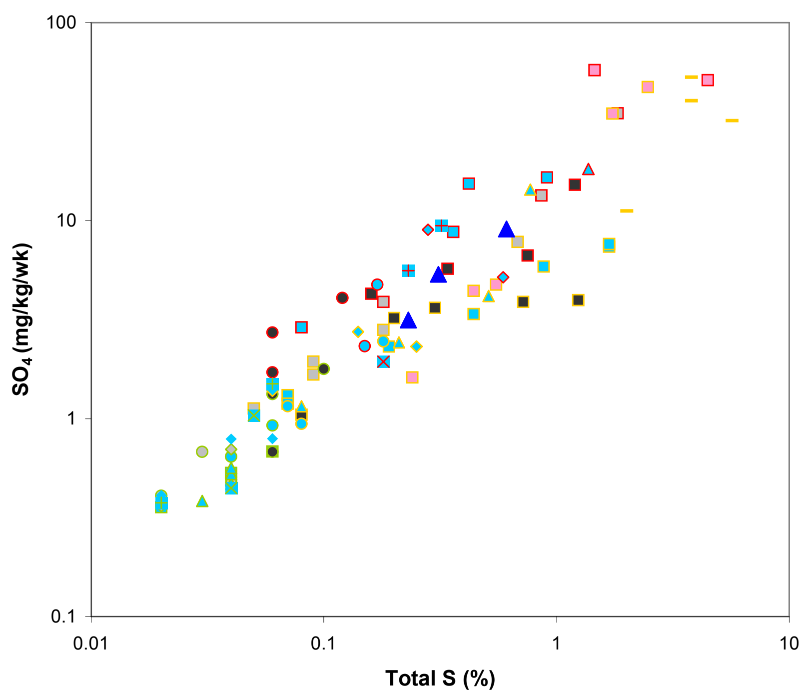


Figure 6-4: Comparison of MDNR ASTM Tests with PolyMet ASTM tests. Blue triangles are MDNR tests on NorthMet Deposit rock. Other symbols are PolyMet's tests (see Figure 6-5 for legend).

6.4 Evaluation of Waste Classification Factors

Waste classification criteria to replace the provisional criteria described in Section 4.2.1 were evaluated in order to identify the following categories of waste:

1. "Non-reactive" waste rock suitable for construction with negligible potential for ARD and metal leaching expected to produce component concentrations in drainage below water quality objectives.

2. Waste rock with negligible potential to produce ARD but likely to have drainage with component concentrations exceeding water quality objectives.

3. Waste rock with potential to produce ARD but with significant delay. Component concentrations are expected to exceed water quality objectives by a very wide margin.

4. Waste rock with potential to produce ARD immediately. Similarly, component concentrations are expected to exceed water quality objectives by a very wide margin.

The objective was to develop bulk chemical tests (or analyses) that can be linked to water chemistry and can be practically implemented during mining. The chemical tests must be easily performed at the mine laboratory and produce results rapidly so that management decisions can be made in the mine.

The approach used was to graphically compare observed average weathering rates with bulk chemical characteristics. Primary factors considered were sulfide oxidation rates as they relate to potential for ARD, and release rates for copper, nickel and cobalt. These metals have been identified as the critical parameters with respect to meeting water quality objectives.

6.4.1 Silicate Mineralogy and Content

The dominant silicate minerals are plagioclase and olivine. The relative proportions of these minerals determined the major rock sub-divisions into anorthositic, troctolitic, and ultramafic gabbro variants. The proportion of plagioclase relative to olivine decreases from anorthositic to ultramafic gabbro, therefore evaluation of weathering effects with respect to rock type provides an indication of mineralogical effects. Rocks of the Virginia Formation are lithologically distinct and show different weathering behavior.

The following was observed for the Duluth Complex rocks:

- Silicate mineral content had no effect on sulfide oxidation rates or copper release rates.

- Ultramafic (olivine-rich) rocks leach more nickel. As described below, this is partly related to the higher nickel content of ultramafic rocks.

6.4.2 Rock Type

Rock type and silicate mineralogy are effectively the same factor as described above.

6.4.3 Sulfur Mineralogy and Content

Correlation of Sulfur Content with Oxidation Rates

The result of this evaluation was that a strong relationship was found between average sulfate release and sulfide content of the rock (Figure 6-5). The relationship was well constrained at lower sulfur concentrations (<0.2%) but became more scattered above this level. In general the extension of the relationship at lower sulfur concentrations was continued by samples classified mainly as lean ore (red lines in symbols) whereas samples showing somewhat lower oxidation rates for the same sulfur content were classified mainly as waste rock (amber lines in symbols). The difference in oxidation behavior appeared to be related to mineralogical assemblage. Waste rock samples with lower sulfur content and lean ore have a copper sulfide (mainly chalcopyrite) dominated assemblage whereas waste rock with higher sulfur content has both pyrrhotite and chalcopyrite. This difference in sulfide assemblage was quantified using the ratio of Cu/S (by weight) as a surrogate for mineralogy. The separation between samples showing somewhat higher and lower oxidation rates for a given sulfur content was indicated by Cu/S=0.3. Generally, the higher oxidation rates were for samples with Cu/S>0.3 (chalcopyrite dominated).

The finding that a sulfide mineral assemblage containing more chalcopyrite is more reactive than an assemblage containing pyrrhotite as the dominant mineral was unexpected because pyrrhotite is widely considered the most reactive of the common sulfide minerals. The explanation remains empirical at this point as none of the mineralogical (crystal formation, particle size or liberation of grains, contact between grains) or crystal chemistry (trace element content) factors commonly linked to differences in mineral reactivity can be quantified.

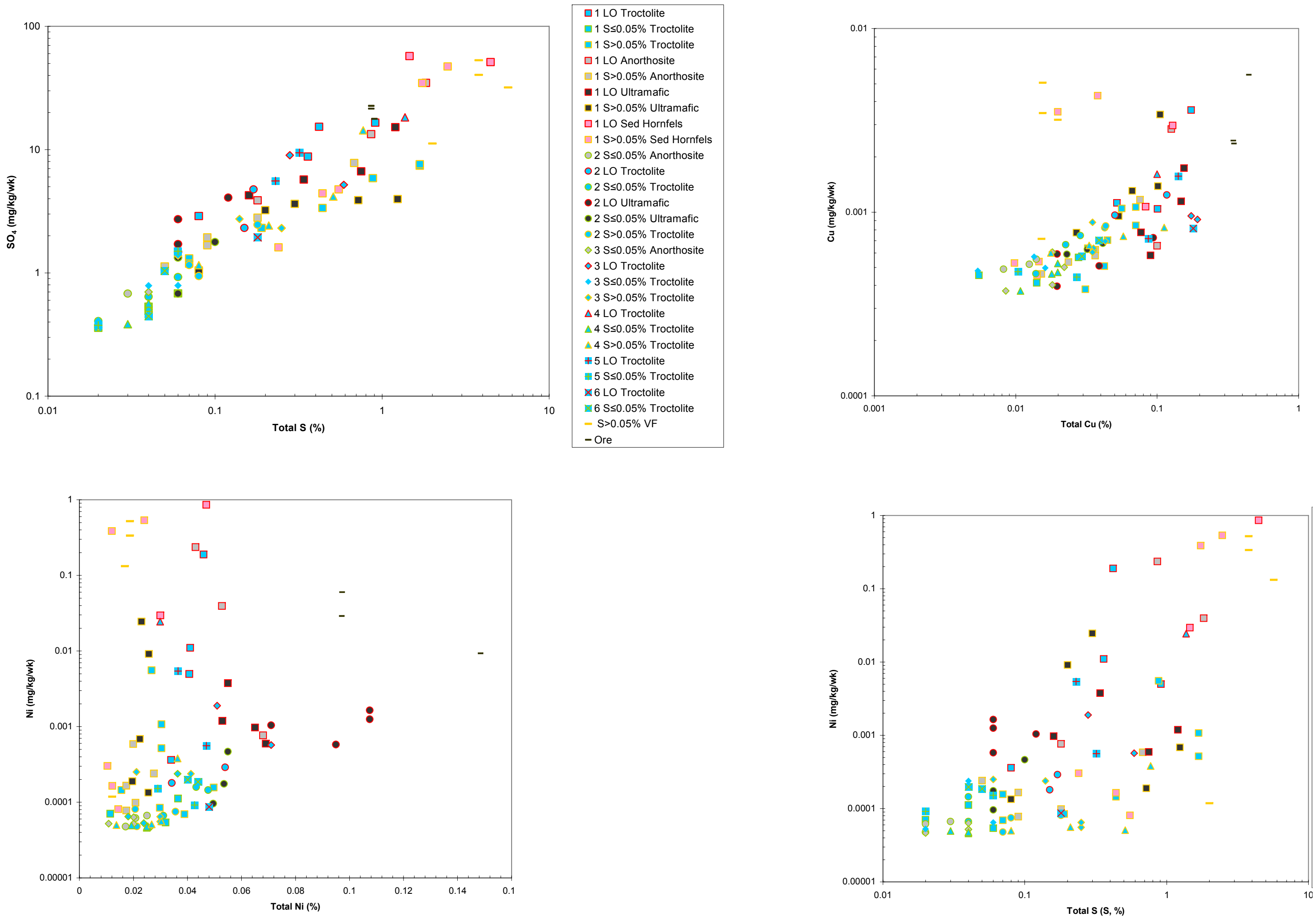


Figure 6-5: Comparison of Average Release Rates of Sulfate, Copper and Nickel Compared to Bulk Content of the Rock. Individual labels indicate intrusive layer (e.g. 1), S content, lean ore (LO) and rock type.

Development of Sulfur Content Criteria for ARD Potential

Based on the above findings, a method was used to estimate criteria that would allow an initial level of classification into low ARD potential and high ARD potential (Categories 1 and 2; and Categories 3 and 4). The secondary level of classification was then evaluated.

As described in Section 6.1.3, interpretation of leachate chemistry indicated that low level generation of alkalinity by silicate weathering should offset similarly low levels of acid generation by oxidation of sulfide minerals. Because oxidation rates are correlated with sulfide content, the critical level of oxidation at which alkalinity from silicate mineral weathering exceeds acid generation can be related to sulfide content, a measurable parameter during mine operation. The method used to develop conservative criteria were:

- Estimate bicarbonate generation rate for silicate minerals using samples containing low levels of sulfur (Figure 6-1) and exhibiting lowest levels of alkalinity. The rate used in the calculation is the lower 95% confidence limit on the average of measurements toward the latter part of the test.
- Convert alkalinity generation rate to equivalent acidity generation rate expressed as sulfate generation.
- Determine regression relationships between oxidation rate (sulfate generation rate) and sulfur content. One regression relationship was calculated for the straight line trend represented by the chalcopyrite-dominated waste rock and lean ore (Cu/S>0.3). The second relationship was calculated for the pyrrhotite-dominated waste rock (Cu/S<0.3). For each regression relationship, the lower regression envelope was calculated. The predicted sulfur content equivalent to the sulfate generation rate determined above was calculated using the lower regression envelope (95% confidence limit). This resulted in the lowest equivalent sulfur for the oxidation rate that would balance alkalinity generation.

The resulting classifications of waste rock according to sulfur and Cu/S content are provided in Table 6-2. These classifications are consistent with the MDNR's long term findings on the generation of ARD from samples under laboratory conditions. The MDNR's results have shown acid leachate from one sample with sulfur content of 0.41% and no ARD from samples with sulfur concentrations of 0.22% and 0.18%. The proposed classifications do not exceed the observed sulfur level that has resulted in acidic leachate in MDNR tests. Figure 6-2 shows that the humidity cell tests are conservative when compared to expected pH in a stockpile. A further conservative factor is that the proposed sulfur criteria are thresholds rather than average targets. The average characteristics of the rock in a stockpile will be much lower (about 0.08% sulfur) indicating that excess alkalinity will be generated by silicate weathering.

Table 6-2: Matrix of ARD Criteria

Cu/S Criteria	S Criteria		
	S<0.12%	**0.12≤S<0.31**	**S≥0.31**
Cu/S<0.3	Category 1/2	Category 1/2	Category 3 or 4
Cu/S≥0.3	Category 1/2	Category 3 or 4	Category 3 or 4

Criterion for Severity of ARD and Onset of ARD (Categories 3 and 4)

The purpose of this criterion is to separate rock that is expected to produce severe ARD rapidly from rock that will likely produce ARD at some in the future. NorthMet kinetic test database provided some information to address this aspect. Lowest pHs have been observed for samples of Virginia Formation and Sedimentary Hornfels with more than 1.7% sulfur (Figure 6-6). Leachates from other tests were not below the pH of the deionized water used to leach the samples and therefore are not yet acidic. The results showed at this stage of testing that rapid (<1 year) onset to ARD can be expected for rock containing more than 1.7% sulfur.

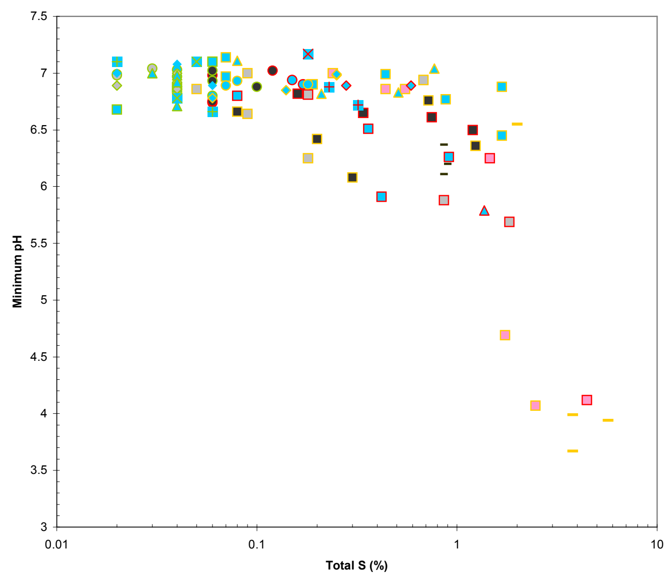


Figure 6-6: Minimum pH as a Function of Sulfur Content. Refer to Figure 6-5 for explanation of legend.

The MDNR's studies at other sites have demonstrated that sulfur is an important control on the timing of ARD and minimum pH of leachates. The AMAX test piles constructed from shaft development rock at the Babbitt Deposit showed that rock with sulfur content of 0.79% and 1.4% developed ARD with pH less than 5 in about 1 year whereas rock containing 0.64% sulfur took 6 to 15 years. The rock containing 1.4% sulfur developed the most severe ARD with the highest metal content and lowest pH.

These findings have been used to propose a sulfur criterion of 0.6% to separate Category 3 and 4 rock.

6.4.4 Metal Mineralogy and Content

Average release rates for copper and nickel were compared to absolute quantities of sulfide minerals and ratios of sulfide minerals indicated by optical mineralogy. No useful relationships were found. Copper release was related to copper content of the rock though the relationship generally defined an upper bound to copper release (Figure 6-5). Samples of sedimentary hornfels and Virginia Formation that produced acidic leachate during the test period showed higher copper release due to the greater mobility of copper at lower pHs. Nickel release was generally uncorrelated with nickel content of the rock though ultramafic samples containing higher nickel concentrations showed higher nickel release rates. Upper limits to nickel release however were related to the sulfur content of the rock. As sulfur content increased, maximum observed nickel concentrations also increased (Figure 6-5) though some samples with elevated sulfur content also showed negligible nickel leaching. The scatter in nickel release data is probably partly related to the strong sensitivity to pH of leachates as discussed in Section 6.1.3.

6.4.5 Particle Size Distribution

Particle size distribution was considered as a potential classification factor by size screening of waste rock.

As described in Section 5.2.4, sulfur and metal concentrations are enriched in the finer size fractions. Figure 6-7 also shows that average release rates for sulfate, metal release and rock weathering components increased as particle size decreased. This relationship showed that rock weathering processes are driven by surface area which increases as particle size decreases.

The weighted sum of release weathering rates was calculated using the size fraction analyses for the five samples. This calculated release rate was then compared to observed release rate for the equivalent ASTM Humidity cell (Figure 6-8). The comparison serves to determine if the individual components are performing the same separately as they do in the mixture, and whether there are effects due to the differences in the volume of water applied on a per weight basis for each fraction.

For the four Duluth Complex samples, common features were apparent. Sulfate release indicated by the humidity cell was close to the calculated rate shown by the size fractions. Calcium release was greater for the calculated rate compared to the measured rate typically for 10 to more than 30 weeks. After this period, calculated calcium release became equivalent or greater than the ASTM cell. Magnesium showed a similar trend and typically rates became equivalent toward the latter part of the tests. Evaluation of cobalt and nickel release was complicated by concentrations near the detection limit for leachate from the coarsest fraction. This fraction comprised the majority of the mass and therefore the use of at detection limit concentrations resulted in release rates for the fraction which skewed the calculated release rate. Typically, the calculated release rate was greater than humidity cell rate for this reason. Sample 00-361C(310-320) (anorthosite with 0.18% S) showed increasing calculated nickel concentrations compared to the ASTM cell which were a result of decreasing pH and increasing nickel release from the coarsest fraction. Calculated copper and zinc release rates were slightly greater than the ASTM cell.

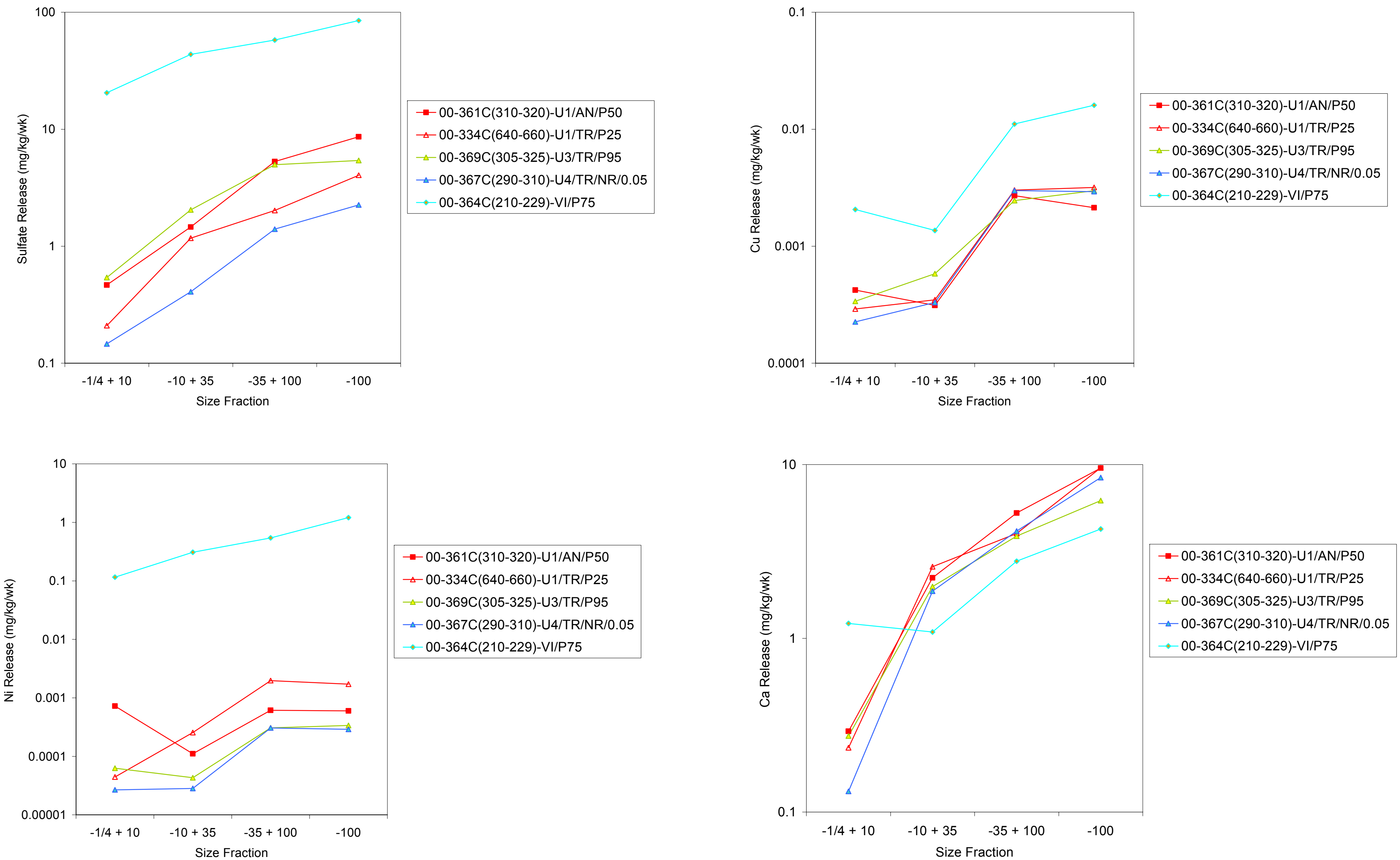


Figure 6-7: Relationships Between Average Release Rates and Particle Sizes

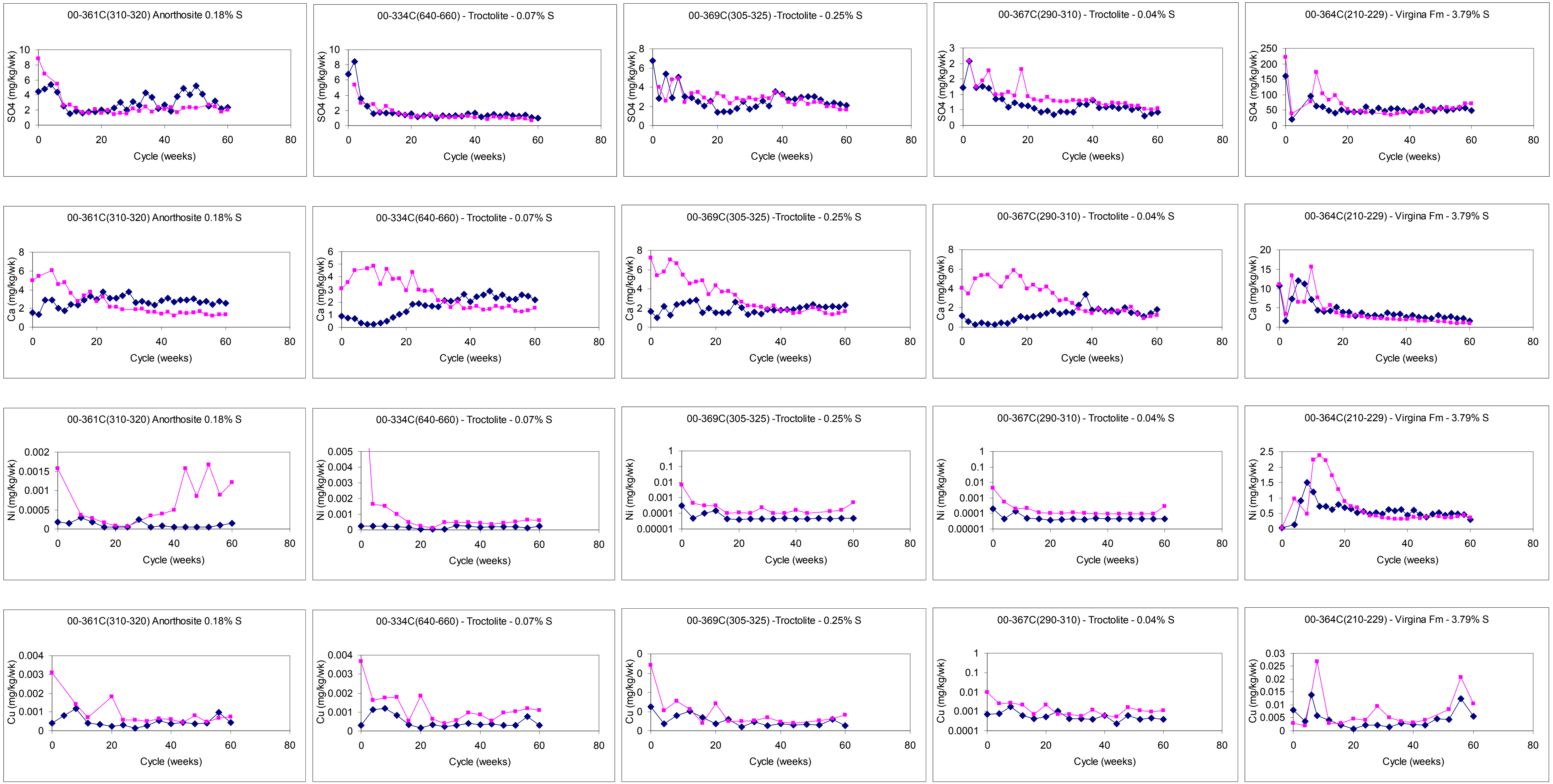


Figure 6-8: Comparison of Rates Observed in ASTM Humidity Cells (squares) with Rates Indicated by Combined Individual Size Fractions (diamonds).

The Virginia Formation sample for which leachates from the ASTM cell and size fractions were all acidic showed strong similarity for calculated and humidity cell release rates after 20 weeks. All rock weathering components also tracked closely. The calculated nickel release peaked at a higher level (2.4 mg/kg/week) than the humidity cell (1.5 mg/kg/week) but after 26 weeks nickel leaching tracked closely. Cobalt showed a similar effect. Copper release possibly showed a subdued initial peak after which both calculated and humidity cell copper release increased. Calculated zinc release peaked initially then decreased. The ASTM cell zinc release for this sample increased and peaked at 56 weeks.

Based on review of the size fraction data, it is concluded that the weathering behavior of the whole samples can be accounted for by the performance of the individual fractions and that the size fractions react mainly in response to the decrease in particle size and corresponding increase in surface area. Segregation based on particle size would result in concentration of leachable surface area into the finer particle sizes. Coarse material would be expected to leach to a lesser degree (on a mass basis).

6.4.6 Waste Classification Criteria

Potential Classification Criteria

The following potential classification criteria were indicated by the testwork:

- Sulfur content to separate rock based on ARD potential and severity of ARD potential.
- Copper/Sulfur Ratio to refine the sulfur criteria.
- Ultramafic rock as a potential means to isolate rock with greater potential for nickel leaching.
- Particle size segregation.

Operational Classification Criteria

Waste management planning as described in RS43 (PolyMet 2007c) is proceeding on the basis of using sulfur criteria linked to copper content for primary segregation. Segregation based on rock type and particle size was not considered practical under operational conditions.

6.5 Application of Results to Subaqueous Disposal

6.5.1 Implications of Results to Solute Build-Up and Dissolution

There are three considerations for subaqueous disposal:

- The simple dissolution of primary minerals and secondary (weathering) minerals. The latter are formed subaerially prior to subaqueous disposal and may affect water chemistry if the waste rocks are highly reactive and the time between exposure and disposal resulted in extensive build-up of weathering products.

- Oxidation of sulfide minerals by oxidants contained in secondary minerals.
- Oxidation of sulfide minerals by dissolved oxygen.

6.5.2 Reaction Rates

Dissolution of Secondary Minerals

Dissolution of secondary minerals formed by weathering prior to subaqueous disposal can be assumed to occur at the ideal solubility of the secondary mineral under the disposal conditions. The disposal conditions may be substantially different from the conditions of formation resulting in higher or lower solubility. Backfill in a flooded open pit, for example, may see the development of chemically reducing conditions and contact with inflowing groundwater. The latter may have partial pressures of carbon dioxide above atmospheric conditions which will affect the dissolution of minerals occurring as carbonates. The development of reducing conditions can affect the mobility of elements stored as sorbed components of ferric hydroxides and manganese oxides. For reduction to occur, a reducing agent (such as organic matter) needs to be present.

The rate at which the secondary mineral dissolves can be estimated from the ideal solubility and the rate at which contact water is replaced. In other words, the contact water assumes the ideal solubility of the mineral as long as the mineral has not completely dissolved, and the loading is the concentration multiplied by the flow.

Oxidation of Sulfide Minerals from Oxidants Contained in Secondary Minerals

Dissolution of ferric iron salts (for example, ferric sulfate) become a source of dissolved ferric iron:

$$Fe_2(SO_4)_3 \rightarrow 2Fe^{3+} + 3SO_4^{2-}$$

The ferric iron produced can then oxidize sulfide minerals contained in the waste:

$$FeS_2 + 8H_2O + 14Fe^{3+} \rightarrow SO_4^{2-} + 15Fe^{2+} + 8H^+$$

The rate at which this process occurs is controlled by the rate at which ferric iron can oxidize the sulfide mineral. This process indicates that it is inadvisable to place highly oxidized waste underwater because it can result in acidification of the water, release of metals in salts and additional oxidation of sulfide minerals contained in the waste. The effect can be mitigated by adding a buffering agent before flooding to increase pH and precipitate ferric iron as hydroxide:

$$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$$

Oxidation of Sulfide Minerals by Dissolved Oxygen

Dissolved oxygen in water can oxidize sulfide minerals by the same reaction as gaseous oxygen:

$FeS_2 + 7/2H_2O + 15/4O_2(aq) \rightarrow 2SO_4^{2-} + Fe(OH)_3 + 4H^+$

The rate at which the reaction occurs is limited by the low solubility of oxygen in water and the rate at which oxygenated water contacts the sulfide minerals. Lapakko (1994c) demonstrated in laboratory tests that highly reactive Virginia Formation (5% sulfur as pyrrhotite) in contact with a small volume of water reacted as rapidly as exposed rock probably because oxygen was not limited and the rock did not contain any buffering capacity.

In a situation where flowing water saturated with oxygen at 10 mg/L contacts pyrite, assuming that all the oxygen is consumed, results in a sulfate concentration of 16 mg/L and an alkalinity demand of 20 mg HCO_3/L. This low sulfate and low alkalinity demand demonstrates why acidification of subaqueous potentially acid generating waste does not occur (MEND 2001). Disposal of reactive wastes typically occurs in stagnant facilities where oxygen supply is limited, and the wastes often contain some carbonate minerals that can consume the small amount of acid produced by oxidation of sulfides.

6.5.3 Conclusions

The main factor when considering subaqueous disposal of sulfide waste rocks is the degree to which the wastes are already oxidized. Dissolution of weathering products is the primary factor affecting pore water chemistry which can be important if the waste is acidic (SENES 1996). If the waste rock is not oxidized, oxidation under saturated conditions is very slow and will not result in acidic conditions. Pore water chemistry will be controlled by the dissolution of primary minerals and release of metals from slowly oxidizing sulfide minerals controlled by the pH of the water in contact with the waste rock.

If acidic oxidation products are present, they can be neutralized by addition of lime prior to flooding.

7 Water Chemistry Database

7.1 Objective

As described in Section 2.2.2, one of the fundamental limitations of the empirical method is that direct scale-up of laboratory test results to full-scale conditions often results in prediction of elevated dissolved metal concentrations because the calculation takes loads indicated by well-flushed laboratory tests and dissolves them in small volumes of water. This does not account for the solubility of secondary minerals which form as a result of weathering of primary minerals or the solubility of the primary minerals themselves. This effect can be evaluated for known major primary and secondary minerals by considering their ideal equilibrium solubility using thermodynamic data. However, for many trace elements, solubility is controlled by small amounts of secondary minerals that cannot be identified directly and must be inferred by evaluation of water chemistry data, or by sorption processes (co-precipitation and adsorption).

Water chemistry databases make use of the concept of Geo-Environmental Models or Analogs (Plumlee and Nash 1995) because it is reasonable to assume that contaminant solubilities are controlled by secondary minerals that form in comparable geological and environmental settings. A large database containing data from testwork and full scale monitoring allows solubility relationships to be developed and applied to water quality predictions for the current project. Day and Rees (2006) provide an example of the application of this approach to water chemistry prediction to a porphyry copper mine.

The primary need for the database was to identify data from comparable mineralogical settings because mineral solubility is controlled by the availability of ions to form secondary minerals. Also, because it is expected that the majority of NorthMet waste rock will leach under non-acidic conditions, the search was targeted to mines where ARD is not being released. The solubility of metals under acidic conditions is known to be high so the search for sites with data on ARD composition was limited.

Data was sought from a number of sources including:

- Minnesota MDNR.
- USGS (Geoff Plumlee).
- SRK Files.
- Environment Canada (Robert McCandless).
- Other consultants.

Appendix H.1 tabulates 96 mines compiled as part of a broad search for information on low level leaching of nickel.

7.2 Sources of Data

7.2.1 Historical Duluth Complex Testwork Data

All historical Duluth Complex testwork data generated by the MDNR for other sites has been included in the database. These data were obtained from other nearby Duluth Complex intrusions. The data have been included in the database because the bulk and trace mineralogy of the Duluth Complex is relatively homogeneous and believed to be consistent with NorthMet.

7.2.2 NorthMet Project

The MDNR's kinetic test data for the Dunka Road Project (which is now called the NorthMet Project) and PolyMet's kinetic test data have been included in the database.

7.2.3 Dunka Pit Stockpile Monitoring Data

As described in Section 3.2.4, the Duluth Complex waste rock stockpiles at the Dunka Pit are of uncertain composition (Eger 2006). The value of the data in terms of understanding weathering of rock of known composition is therefore limited. The data were included in the database but were not used for interpretations.

7.2.4 USX Bulk Sample Pit, AMAX, Teck Cominco, INCO Bulk Sample Sites

A number of bulk sampling programs have been completed primarily in the nearby Babbitt Deposit. US Steel excavated a test pit in the NorthMet Deposit. As described in Section 3.2.1, AMAX's underground bulk sampling resulted in construction of four waste rock test piles. These data were included in the database because the waste rock is known to be similar to the NorthMet Deposit and the composition of the test piles is known.

No suitable data were identified from other bulk sample sites.

7.2.5 Other Sites in Similar Geological Settings

The USGS has classified the Duluth Complex Deposits as part of "Deposits related to mafic-ultramafic rocks in unstable areas". Its classification is 5a in the USGS System (Cox and Singer 1986) and it is included in the same group as the Noril'sk Deposits in Russia. Eckstrand and Hulbert (2006) call this group "Rift- and continental flood basalt-associated mafic sills and dyke-like bodies" and include other similar deposits (Jinchuan, China; Muskox, Nunavut, Canada and Crystal Lake intrusion, Ontario, Canada). The Noril'sk and Jinchuan Deposits are mined but no information could be found on waste rock drainage geochemistry.

7.2.6 Other Sites in Ultramafic Settings

In addition to the rift association, Eckstrand and Hulbert (2006) identified five other mafic and ultramafic deposit types which host nickel, copper and platinum group elements. These include:

- A meteorite-impact mafic melt sheet that contains basal sulfide ores (Sudbury, Ontario)
- Komatiitic (magnesium-rich) volcanic flows and related sill-like intrusions (Thompson, Manitoba; Raglan and Marbridge, Quebec; Langmuir, Ontario; Kambalda and Agnew, Australia; Pechenga, Russia; Shangani, Trojan, and Hunter's Road, Zimbabwe).
- Other mafic/ultramafic intrusions (Voisey's Bay, Labrador; Lynn Lake, Manitoba; Giant Mascot, British Columbia; Kotalahti, Finland; Råna, Norway; Selebi-Phikwe, Botswana).
- Reef-type or stratiform PGE deposits, which occur in well-layered mafic/ultramafic intrusions (Merensky Reef and UG-2 chromitite layer of the Bushveld Complex, South Africa; J-M Reef of the Stillwater Complex, Montana; Main sulfide zone in the Great Dyke, Zimbabwe).
- Magmatic breccia type, which occur in stock-like or layered mafic/ultramafic intrusions (Platreef deposits of the northern Bushveld Complex, South Africa; Lac des Iles deposit and Marathon deposit, Ontario).

SRK sought information from many of these mines and in some cases made direct contact with the mines. No direct results for waste rock drainage were identified.

Diamond mines have recently been opened in northern Canada and drainage chemistry data are available for waste kimberlite which is a nickel-rich ultramafic rock type with sulfide content close to the concentrations in the NorthMet Deposit. However, kimberlite contains carbonate minerals and was therefore considered inappropriate as an analogue.

7.2.7 Other Sites with Pyrrhotite as Dominant Sulfide

Numerous other deposit types contain pyrrhotite as the dominant sulfide (including volcanogenic and stratiform massive sulfides). These sites were not pursued as sources of data because there are many differences in host rock mineralogy and they are not natural analogues to the deposits in the Duluth Complex.

7.2.8 Other Sites with Reactive Iron Sulfides

For the same reason as described in Section 7.2.7, mines in which pyrite is present as the dominant sulfide mineral were not included.

7.3 QA/QC of Database

The database is provided on the CD attached to this report.

The compiled database contains 28,700 data records of which roughly 5,000 are from the current NorthMet laboratory test program and the balance are data generated by the MDNR since the 1980s. QA/QC of NorthMet data is described in Section 5.2.5 of this report. The quality of the data transmitted to SRK by the MDNR was not evaluated because the MDNR has been involved in compiling and maintaining the database.

7.4 Interpretation of Database

7.4.1 Relationships among Parameters

The database was primarily evaluated for relationships between ion concentrations and pH. Appendix H.2 provides charts showing pH vs element and ion concentrations.

Table 7-1 provides conclusions on the distribution of contaminant concentrations with respect to pH. The main components occurring at elevated concentrations in leachates of all types, in addition to the major ions were sulfate, cobalt, copper, nickel and zinc. These components have been analyzed in the majority of leachates and the distribution with respect to pH is well defined and consistently shown by various data sources (Figure 7-1). The upper bound to the relationships is mainly defined by the AMAX test piles. At higher pHs, the MDNR's long term Dunka reactor experiments and Babbitt Deposit experiments provide some indication of metal solubility. Generally concentrations in leachates obtained from laboratory experiments were lower than indicated under field conditions. This indicates that the release of these elements is a function of pH but that the high liquid to solid ratio in the tests dilutes the reaction products. Concentrations of these parameters increase as pH decreases.

Other components tended to occur at trace concentrations and have only been analyzed in leachates from PolyMet's laboratory tests. As a result, the distribution with respect to pH is not well known. The lack of analyses of acidic leachates from Duluth Complex rocks limits the understanding of low pH solubility of elements such as antimony, arsenic, barium, beryllium, boron, chromium, mercury, molybdenum, selenium, silver and thallium. The data show however that many of these elements are more soluble under alkaline conditions than acidic conditions (Figure 7-1). Because several components occur as oxyanions this finding is consistent with expected chemical behavior.

7.4.2 Evaluation of Geochemical Controls on Metal Solubility

Thermodynamic Controls

Solubility controls on metal concentrations were evaluated using Geochemist's Workbench. The thermodynamic database was updated to provide data for two nickel silicates (Nepouite and Ni-Kerolite) provided by Schmiermund (2006) and obtained from Golightly (1981). Selected leachate results were input into the model and the resulting saturation indices obtained were used to determine whether any minerals could be controlling the solution chemistry. The samples were selected as pH transects through the data scatter at various pH concentrations. Data for Duluth Complex rocks and Virginia Formation were assessed separately. Saturation indices were plotted on the graph as data point labels. An example for nickel from the Duluth Complex is provided in Figure 7-2.

Table 7-1: Distribution of Components with Respect to pH and Maximum Concentrations Indicated at Characteristic pHs

Parameter	Description
Alkalinity	Concentrations increase as pH increases
SO_4	Concentrations increase as pH decreases. Highest concentrations at full scale
Al	Envelope concentration minimum between 5 and 6.
Sb	Upper envelope increases as pH increases.
As	Upper envelope increases as pH increases. No data for Duluth Complex at low pH.
Ba	Upper envelope increases as pH increases. No data for Duluth Complex at low pH.
Be	Mostly undetected
B	Upper envelope increases as pH increases. No data for Duluth Complex at low pH.
Cd	Mostly undetected
Cr	Upper envelope increases as pH increases. No data for Duluth Complex at low pH.
Co	Upper envelope Increases as pH decreases.
Cu	Upper envelope Increases as pH decreases.
Fe	Upper envelope concentration minimum between 5 and 6.
Pb	No pH relationship
Mn	Upper envelope increases as pH decreases but unusual clusters for AMAX test piles.
Hg	Mostly undetected
Mo	No pH relationship
Ni	Upper envelope Increases as pH decreases.
Se	Upper envelope increases as pH increases. No data for Duluth Complex at low pH.
Ag	Mostly undetected
Tl	Mostly undetected
Zn	Upper envelope increases as pH increases.

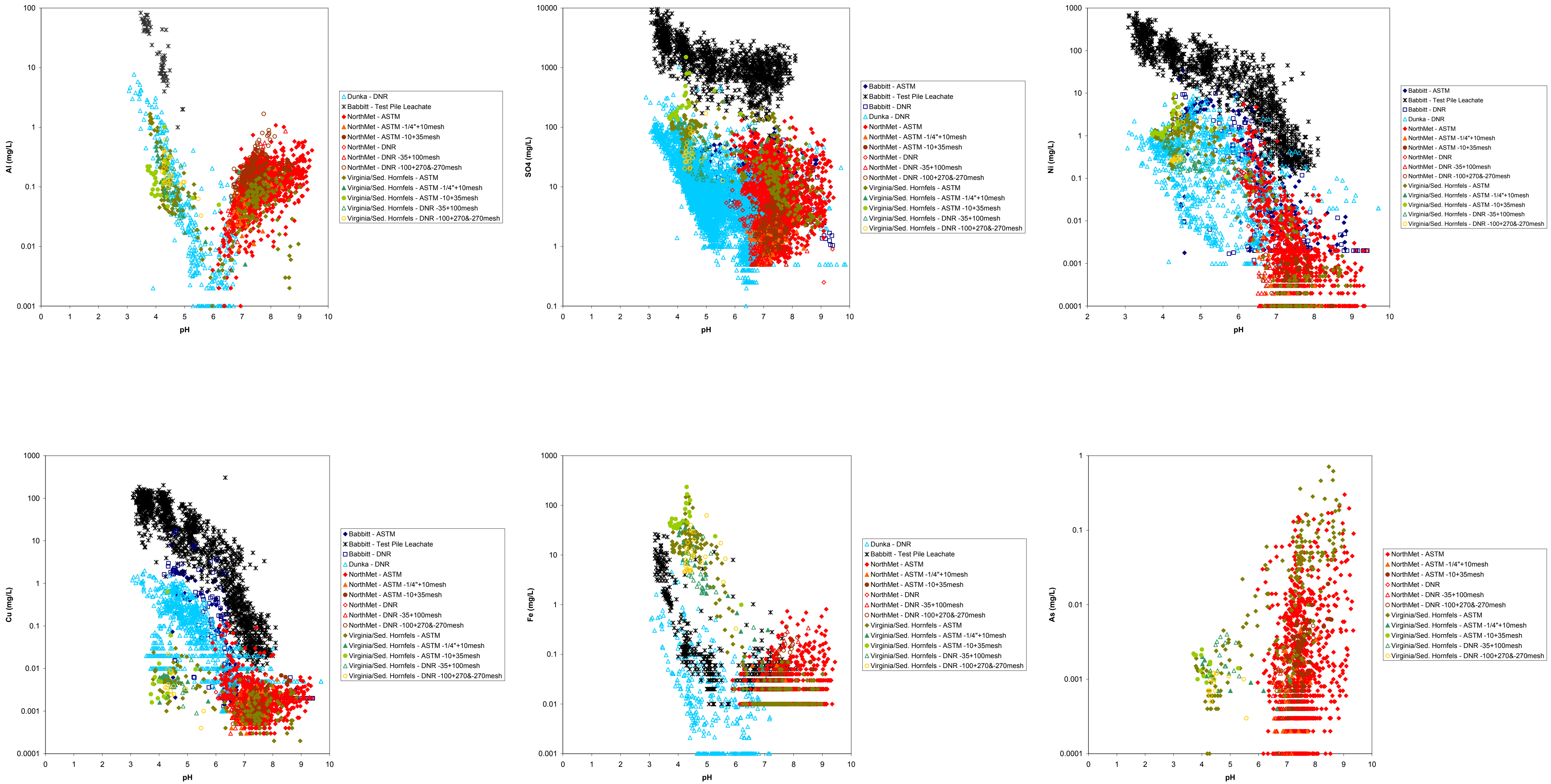


Figure 7-1: Examples of Component Distributions in the Water Chemistry Database

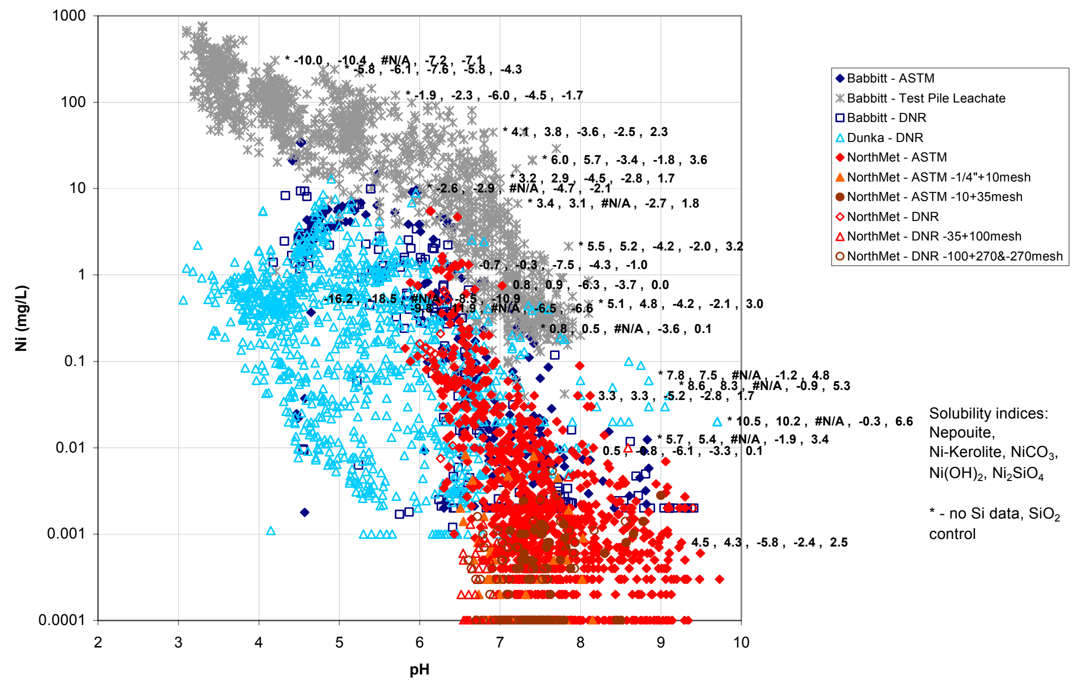


Figure 7-2: Assessment of Solubility for Nickel. Labels show saturation indices for minerals shown in the legend at selected data points.

The data for the AMAX stockpiles did not include silica analyses which were needed to evaluate the solubility of silicates. To simulate silica concentrations, quartz was added as a soluble phase.

Major ion chemistry showed that solubility controls included gypsum, calcite, dolomite, gibbsite and ferrihydrite.

Nickel concentrations lower than the edge of the data scatter (i.e. lower concentrations than the edge for a given nickel concentration) at pHs greater than about 6 tended to be undersaturated with respect to the nickel silicates (nepouite, Ni-kerolite, Ni_2SiO_4). For nickel concentrations near or above the edge, nickel concentrations were over-saturated with respect to the silicates but undersaturated with respect to nickel hydroxide and nickel carbonate.

At pH lower than 6, nickel minerals are highly soluble and no solubility controls were found.

Copper concentrations at pHs greater than 6 for Duluth Complex samples appeared to be controlled by tenorite and malachite. Concentrations were undersaturated with respect to dioptase the only copper silicate in the thermodynamic database. For the Virginia Formation, tenorite appeared to the control.

Zinc solubility for both Duluth Complex and Virginia Formation was predicted to be controlled by silicates ($ZnSiO_3$ and willemite) but not carbonates, hydroxides or oxides. Similarly, cobalt concentrations may be controlled by Co_2SiO_4.

The nickel, zinc and cobalt data therefore indicate a relationship with pH that may be explained by the formation and dissolution of silicates. The strong relationships between metal concentrations and pH provide a reasonable empirical basis for definition of metal solubility controls.

Copper data are consistent with dissolution of well known secondary copper minerals.

Relationships with Source Rock Characteristics

Relationships with source rock characteristics would have been considered if the database included data from a wide range of mine sites. This was not the case, and therefore this was not investigated.

Empirical Relationships

The well-defined upper metal concentration limits indicate that empirical relationships between pH and metal concentrations could be developed for use in predictions.

Selection of Solubility Controls

For the purpose of constraining subsequent water quality predictions, the upper limit of the data scatter for two pHs for each parameter were identified. For non-acidic drainage, a pH value of 8 was selected based on the expectation that drainage chemistry for Category 2 rock will be dominated by alkalinity from the weathering of silicates and relatively low water to rock ratios resulting in formation of secondary carbonate minerals (See Section 6.1.2 and Figure 6-2). For acidic drainage, a pH value of 3.5 was selected to nominally represent strongly acidic conditions. This effectively results in selection of the highest component concentrations in the database.

Maximum observed concentrations at the two pH levels are shown in Table 7-2.

Table 7-2: Maximum Concentrations Indicated at Characteristic pHs and Possible Controlling Minerals

			Maximum Concentrations			
Parameter	**Unit**	**Possible Controlling Minerals**	**At pH 8**	**Source**	**At pH 3.5**	**Source**
Alkalinity	mg/L	Calcium and magnesium carbonates	72.5	NorthMet MDNR Reactor	0	By definition
SO_4	mg/L	Gypsum	2150	AMAX Pile	9600	AMAX Pile
Al	mg/L	Kaolinite, gibbsite	1.68	NorthMet MDNR Reactor	83	AMAX Pile
Sb	mg/L	Fe oxides	0.003	NorthMet MDNR Reactor	0.00001	NorthMet MDNR Reactor
As	mg/L	Fe oxides	0.71	NorthMet HCT	0.71	NorthMet HCT
Ba	mg/L	Barite	0.19	NorthMet MDNR Reactor	0.19	NorthMet MDNR Reactor
Be	mg/L	Fe oxides	0.0002	NorthMet MDNR Reactors and HCTs	0.0023	NorthMet HCT
B	mg/L	Unknown	0.76	NorthMet HCT	0.76	NorthMet HCT
Cd	mg/L	Fe oxides	0.00018	NorthMet HCT	0.0149	NorthMet HCT
Cr	mg/L	Fe oxides	0.0015	NorthMet HCT	0.0015	
Co	mg/L	Fe oxides, cobalt silicates	0.052	AMAX Pile	44	AMAX Pile
Cu	mg/L	Tenorite, malachite	0.092	AMAX Pile	202	AMAX Pile
Fe	mg/L	Fe oxides	0.81	NorthMet HCT	235	NorthMet HCT
Pb	mg/L	Fe oxides	0.0528	NorthMet HCT	0.0528	NorthMet HCT
Mn	mg/L	Mn Oxides	0.75	AMAX Pile	47	AMAX Pile
Hg	ng/L	Fe oxides	6	Low Level Analyses	6	Low Level Analyses
Mo	mg/L	Fe oxides	0.0051	NorthMet HCT	0.0051	NorthMet HCT
Ni	mg/L	Nickel silicates	0.86	AMAX Pile	762	AMAX Pile
Se	mg/L	Fe oxides	0.0029	NorthMet HCT	0.0029	NorthMet HCT
Ag	mg/L	Fe oxides	0.0007	NorthMet HCT	0.0007	NorthMet HCT
Tl	mg/L	Fe oxides	0.00002	NorthMet HCT	0.00006	NorthMet HCT
Zn	mg/L	Zinc silicates	0.09	AMAX Pile	26	AMAX Pile

Mercury

Mercury concentrations were not determined in the MDNR's historical work but characterization work has been completed as part of the overall mass balance for mercury at the site as reported in RS66 (Barr 2007c). This work primarily focused on the ability of geological materials (rock and tailings) to remove mercury from rainfall in the region which typically contains 10 ng/L compared to the Lake Superior basin water quality standard of 1.3 ng/L. Laboratory experiments performed by NTS using Virginia precipitation in contact with Duluth Complex rock showed that mercury concentrations decreased from 12 ng/L to between 1.9 and 3.2 ng/L over 36 days. The control test (no rock) over the same period showed a decrease to 7 ng/L. The results indicate that the rock has the ability to remove mercury from solution. As shown in Table 5-9, mercury concentrations in leachates from waste rock samples were about 6 ng/L. The results imply that the mercury concentrations observed in leachates are indicative of equilibrium concentrations. Table 7-2 shows a source term mercury concentration of 6 ng/L.

8 Stockpile Water Chemistry Modeling

8.1 Objective

The primary intended objective of waste rock characterization was to result in a high level classification of rock into "non-reactive" and "reactive" categories as defined in Minnesota Rules. A "non-reactive" waste is defined as a material that will have leachate that meets the appropriate water quality discharge limits and therefore does not require treatment for discharge to the environment. A "reactive" waste is defined as generating unacceptable water chemistry which could exceed water quality discharge limits.

A secondary objective was the separation of reactive wastes into categories that would define the extent of containment needed to limit leakage from the disposal facilities. For example, waste rock predicted to generate non-acidic water but with unacceptable drainage chemistry would be a low reactivity rock.

This chapter of RS42 presents the evaluation of classification approaches in terms of modeled drainage chemistry.

8.2 Inputs to Water Quality Model

8.2.1 Waste Quantities and Scheduling

Waste Rock Quantities by Potential Classification Categories

In RS78, PolyMet (2007d) provided annual waste rock quantities from the block model and mine plan based on the three sulfur categories indicated in Section 6.4. Sulfur and element content for each category were calculated for components containing sufficient data in the block model. Total tonnages and characteristics for all waste rock produced to Year 20 are shown in Table 8-1.

Table 8-1: Summary of Average Characteristics for Each Category through Life of Mine

Category	Type	Mass US tons	Total S %	Cu %	Ni %	Co mg/kg	As mg/kg	Ba mg/kg	Cr mg/kg	Mn mg/kg	Pb mg/kg	Sb mg/kg	Zn mg/kg
All	All	394,081,962	0.15	0.04	0.02	52	6	67	97	1207	5	4	104
1/2	Waste	327,073,193	0.08	0.03	0.02	52	6	63	97	1224	5	4	100
3	Waste	14,755,777	0.22	0.06	0.03	51	5	59	91	1244	5	4	102
4	Waste	8,892,706	2.38	0.02	0.01	30	34	280	156	601	15	4	285
3	Lean Ore	41,470,125	0.23	0.09	0.04	60	6	60	93	1245	5	4	102
4	Lean Ore	1,890,162	0.88	0.11	0.04	61	6	70	103	1065	5	4	98

Category 1/2 is the largest waste rock component and has an average sulfur content of 0.08%. Annual characteristics indicated that average sulfur concentrations are expected to vary from 0.01% to 0.10%. These concentrations are a result of mixing of rock containing 0.01% to 0.31% sulfur and indicate that the average composition is well below the threshold used to define this category. Category 3 waste rock has average sulfur concentration of 0.22% varying from 0.16% to 0.28% between the criteria of 0.12% and 0.6%. Copper and nickel concentrations are higher than Category 1/2 but concentrations of other elements were comparable. Category 4 waste rock is dominated by Virginia Formation and therefore has an average sulfur concentration of 2.38% with annual averages varying from 0.8% to 2.8%. The effect of Virginia Formation is apparent in the lower copper and nickel content but higher arsenic, lead and zinc content compared to Category 1/2 and 3.

Lean Ore

Two lean ore categories are defined equivalent to the waste rock categories 3 and 4. Category 3 Lean Ore is expected to have similar characteristics to Category 3 waste rock with the exception of higher copper content. Category 4 Lean Ore is quite different from Category 4 waste rock because it consists of Duluth Complex rock containing 0.6% surface rather than Virginia Formation. This is also reflected in the copper and nickel content.

Virginia Formation

Category 4 waste rock is not specifically Virginia Formation but it is dominated but this rock type.

8.2.2 Hydrological Inputs

Annual average infiltration into waste rock was calculated by Barr (2007a) as described in RS21 for Years 1, 5, 10, 15 and 20. Inflow calculations account for progressive reclamation efforts including the placement of evapo-transpiration covers.

Barr (2007) provided two flow scenarios (“low” and “high”). Water quality compliance will be determined by concentrations, therefore all modeling was performed using the low flow scenario because this would result in the highest concentrations.

8.2.3 Physical Inputs

For scale-up calculations, it was necessary to describe the relationship between the particle size distribution used in the humidity cells and the particle size of waste rock, and the proportion of the rock expected to be contacted by infiltration.

All calculations assumed that the rates indicated by humidity cells are equivalent to 20% of the run-of-mine rock mass. In other words, the rate observed in the laboratory from 1 ton of rock is assumed to be seen from 5 tons under field conditions. This reflects the much coarser nature of run-of-mine rock (ROM) compared to the rock crushed to pass a ¼” sieve for humidity cell testing.

The range of possible values is 0 to 100%. Choice of 100% as the factor would require that all ROM rock is finer than ¼".

The proportion of rock assumed to be contacted by infiltration was 50%. The range of possible values is 0 to 100%. Use of 100% as the value would assume that all rock is contacted by precipitation which would ignore channeling effects.

8.2.4 Chemical Inputs

The chemical inputs into the calculations are rates of weathering and rate reductions to reflect temperature. Weathering rates were calculated as follows:

- Average rates (in mg/kg/week) were calculated for each humidity cell test using the period when sulfate release had stabilized.
- The average rates were then grouped according to the numeric geological units (numbered 1 to 6, sedimentary hornfels and Virginia Formation), major rock types (anorthositic, troctolite and ultramafic) and numeric waste rock category (1/2, 3, 4) (as described in Section 6.4.3). No separation was maintained between waste rock and lean ore tests because kinetic test results indicated a continuum regardless of metal content. Lean ore is effectively treated as waste rock.
- The 95th percentile rate for each unit, rock type and category grouping (a total of 28 individual rates) were then calculated. These are groups for which it was predicted more than 1 million tons of rock would be produced. This conservatively assumes that all rock in any particular grouping will function as indicated by the sample containing the highest sulfur concentrations.
- The tonnages of each unit and rock type combination were used to obtain weighed averages for overall rates for each category. The tonnages used are shown in Figure 4-1. A summary of rates is shown in Table 8-2.

Calculations for Category 3 and 4 required the use of acidic rates. For Category 3 rock, none of the test work resulted in acidic pHs. In order to calculate rates under acidic conditions, the MDNR's results for the Dunka Pit (Engstrom 2006a) were reviewed to determine the factor by which release rates increased for this type of rock when leachates become fully acidic. The typical factor was 10 indicating that rates tended to increase by an order of magnitude. This factor was applied to the rates calculated under non-acidic conditions for Category 3 rock. This does not mean that concentrations would only increase by an order of magnitude for acidic conditions because the concentrations calculated are evaluated with respect to the general solubility limits indicated in Table 7-2. For example, nickel concentrations can increase by nearly three orders of magnitude because nickel becomes highly soluble as pH decreases. The same approach was used for Category 3 lean ore.

For Category 4 waste rock, the acidic weathering rates indicated for Virginia Formation and Sedimentary Hornfels were used directly. For Category 4 Lean Ore (which is mainly intrusive rock), the non-acidic rates were scaled using the same approach as Category 3.

The Arrhenius equation indicates that all chemical reactions proceed slower under lower temperatures with the difference in rates determined by the activation energy of the reaction. This finding applies to oxidation of sulfide minerals (SRK and MESH 2007). For pyrrhotite, the range of activation energies is 50 to 60 KJ/mol (Nicholson and Scharer 1998). For NorthMet average site temperature of 2.4^{o}C (Hoyt Lakes), the rate reduction from 20^{o}C (the low end of the laboratory environment) is 0.2 to 0.3 for the range of activation energies. A value of 0.3 would therefore conservatively apply for the NorthMet site. This approach can only be used for low sulfur rock of Category 1/2 because the assumption is that Category 3 and 4 will oxidize rapidly generating excess heat. Category 1/2 rates were therefore reduced by a factor of 0.3, but the rates for Category 3 and 4 were not adjusted.

All rock is assumed to weather at the same rate without limit to the supply of oxygen. Decrease in oxygen availability was not considered, which is conservative. Oxygen limitation could be a factor in Category 3 and 4 waste rock and lean ore piles when oxidation accelerates. It may also be a factor when the waste rock is reclaimed.

Table 8-2: Weighted Averages of 95th Percentile Rates Indicated by Humidity Cells (mg/kg/week)

Category	Acidity (pH=8.3)	Alkalinity	F	Cl	SO_4	Al	As	Ba
2	1.3	7.9	0.027	0.11	2.3	0.087	0.0044	0.0088
3 (non-acidic)	1.4	9.5	0.024	0.14	11	0.052	0.0068	0.0081
4 (non-acidic)	1.4	15	0.03	0.11	11	0.063	0.0044	0.0075
4 (Virginia, acidic)	24	0.88	0.034	0.11	50	0.37	0.00071	0.0052
Ore	1.4	5.2	0.041	0.11	23	0.017	0.0014	0.0059

Category	B	Cd	Ca	Cr	Co	Cu	Fe	Pb
2	0.0039	0.00002	2.2	0.00011	0.000053	0.00085	0.015	0.000063
3 (non-acidic)	0.0054	0.000028	4.7	0.00011	0.0059	0.0084	0.011	0.000069
4 (non-acidic)	0.016	0.000021	3.4	0.00013	0.000086	0.00078	0.03	0.000059
4 (Virginia, acidic)	0.021	0.0032	3.5	0.00012	0.039	0.0048	9.5	0.0011
Ore	0.011	0.000022	7.3	0.0001	0.0028	0.0053	0.0074	0.000076

Category	Mg	Mn	Mo	Ni	Se	Ag	Tl	Zn
2	0.44	0.00096	0.000027	0.00024	0.00011	0.000025	0.00001	0.0013
3 (non-acidic)	0.82	0.023	0.000043	0.07	0.0002	0.000031	0.00001	0.0040
4 (non-acidic)	0.31	0.0033	0.00014	0.0009	0.00042	0.000096	0.00001	0.00069
4 (Virginia, acidic)	3.9	0.12	0.000026	0.56	0.0006	0.000029	0.000012	0.60
Ore	1.5	0.022	0.000034	0.057	0.00012	0.000025	0.00001	0.0021

The delay to onset of acidic conditions for Category 3 and 4 was an input used to semi-quantitatively determine when leachate from the piles would be acidic. For Category 3, the delay was assumed to be 5 years based on the AMAX stock pile data. For Category 4, the rock was assumed to become acidic immediately upon placement.

All rates were assumed to be constant. In reality, depletion of rock components will result in decreasing rates. However, the laboratory results did not provide a basis to predict changes in rates as a function of time and it is conservative from a prediction standpoint to hold rates constant. Total metal content of the rock (Table 8-1) provides a basis to determine when components might run out, in which case the rate would decrease to “zero”. For the majority of components of interest, depletion would take centuries and therefore was not a factor in the predictions.

The effect of leaching of explosives residues was based on the explosives recipe provided PolyMet. The overall mixture of emulsion, oxidizer and ANFO (ammonium nitrate and fuel oil) will contain 67% ammonium nitrate. Explosive use will be 0.33 lbs/ton, or 3720 lbs/blast hole. PolyMet have estimated that explosives losses will occur mainly from spillage at the point of loading the blast holes, and that the estimated spillage is 2 lbs/hole, or 0.05% of total explosives use. For safety reasons, PolyMet are committed to re-firing or explosives recovery for blast holes that do not detonate and therefore losses from this source were assumed to be negligible.

8.3 Evaluation of the Effect of Segregation Criteria on Water Quality

These sections of the report discuss the differences in predicted chemistry resulting from the proposed waste rock segregation scheme.

8.3.1 Waste Rock

Effect of Segregation Criteria on Water Quality

Examples of predictions are illustrated in Figure 8-1. Tabulated modeling results are attached in Appendix I.

Sulfate concentrations for all stockpiles were predicted to increase due to increases in mass that are not matched by increasing footprint (i.e. the piles grow vertically rather than laterally). The delayed effect of ARD starting for Category 3 waste rock is shown by the initially slow increase in sulfate, copper and nickel to Year 5. Both Category 3 and Category 4 piles show rapid increases in sulfate reaching a maximum value shown as constrained by maximum observed sulfate concentrations from stockpiles. The Category 3 stockpile shows the 5 year delay until ARD is allowed to develop within the piles.

Although Category 3 rock contains greater nickel concentrations than Category 4 rock (Table 8-1), Category 4 rock is dominated by Virginia Formation which has been shown to leach nickel under laboratory conditions (Table 8-2) and as a result there is no predicted difference between Category 3 and 4 stockpile drainage chemistry.

Recommended Criteria

The predictions indicate that the main benefit of segregation is in producing a large volume of waste rock that has a low potential for ARD (Category 2) from rock that is likely to generate ARD (Categories 3 and 4). The predictions imply that the chemistry of water draining from Category 3 and 4 waste rock will not be different. This reflects the use of common solubility constraints at acidic pHs for both waste categories. In reality, Category 4 waste rock is mainly Virginia Formation rock and will contain higher sulfur concentrations than Category 3. Segregation into these categories is probably beneficial but not readily quantified with the data available.

8.3.2 Lean Ore

Effect of Segregation Criteria on Water Quality

The effect of segregating Lean Ore into Categories 3 and 4 is shown in Figure 8-1. The predicted difference in water chemistry effect is negligible. The segregation results in a small quantity of intrusive Category 4 rock which is continually blended into the ore feed to the plant. This pile will not exist at the end of mine life. The majority of lean ore is classified as Category 3.

Recommended Criteria

Segregation of Lean ore into Categories 3 and 4 is expected to provide an operational benefit in terms of limiting the need to treat ARD though the Category 3 Lean Ore pile drainage will require treatment to address metal leaching.

8.3.3 Deferred Ore

The deferred ore category no longer exists.

8.3.4 Virginia Formation

Effect of Segregation Criteria on Water Quality

Category 4 waste rock is 92% Virginia Formation rock as shown by the sulfur content and distinctive trace element characteristics.

Recommended Criteria

The sulfur criterion of 0.6% between Category 3 and 4 waste rock effectively segregates Virginia Formation rock into Category 4 waste rock because the quantity of waste intrusive rocks containing sulfur concentrations greater than 0.6% is negligible.

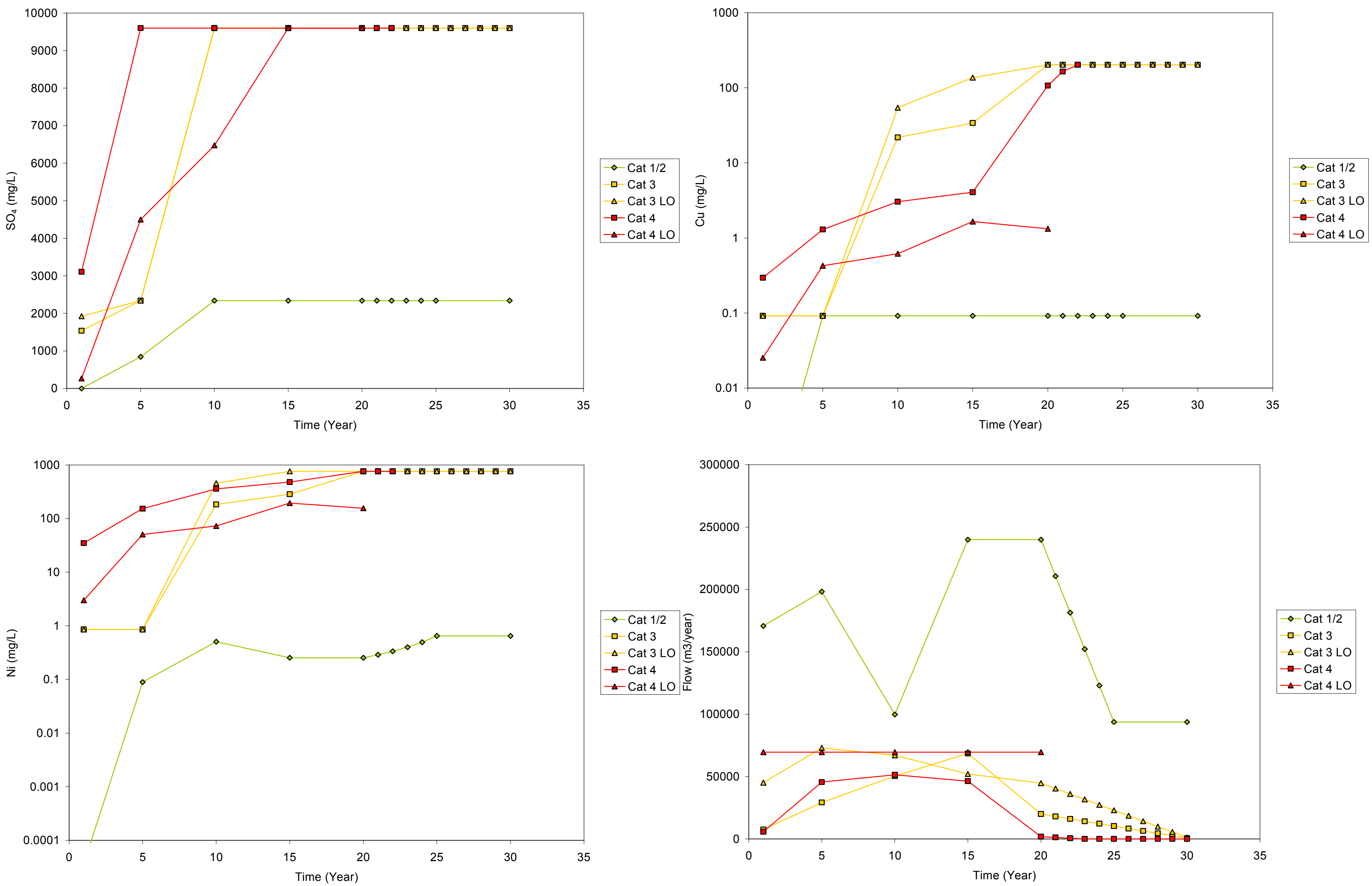


Figure 8-1: Examples of Predicted Chemistry for Waste Rock.

8.4 Water Quality Predictions

This section was originally intended to describe predicted drainage chemistry for the actual waste management. However, project planning has advanced using the proposed categories described above. Section 8.4 provides discussion on Category 1 (non-reactive waste rock) and sensitivity of predictions.

8.4.1 Non-Reactive Waste Rock

Prediction of Water Chemistry with Time

Non-reactive waste rock (Category 1) is defined as rock that will have effluent chemistry below water quality objectives and therefore the drainage is suitable for direct discharge to the environment without treatment. Category 2 was originally intended to satisfy this objective but predictions for Category 2 waste indicated that concentrations can be expected to exceed hardness-based water quality objectives for at least copper and nickel (0.03 and 0.17 mg/L, respectively at highest level of hardness acceptable for use in the calculations), and sulfate (250 mg/L). The Category 2 waste rock is not considered non-reactive by these results.

Consideration was given to a further segregation in Category 2 based on metal and/or sulfur content. As shown in Figure 6-4, average leaching rates are broadly related to metal and sulfur content, but at the low end of the sulfur and metal content of the rock, data are scattered and the ability to develop a significant relationship does not exist. It was concluded that definition of a non-reactive waste rock category based on bulk rock characteristics would not be reliable.

Disposal configuration was considered as a method to produce acceptable drainage quality. Because the calculation of water chemistry is driven by the rate of dissolution and the length of flow path (all other factors considered fixed), the sensitivity of rates used in the metal leaching calculations and the effect of low path length to the chemistry predictions were evaluated.

Decrease in flow path length was considered as an approach that could reduce concentrations primarily to determine if Category 2 type-rock could be used for construction purposes (e.g. road fill). The effect of relatively thin layers on overall water chemistry was evaluated by calculating concentrations for thicknesses of 10, 20 and 30 feet. The calculation also included estimation of hardness using calcium and magnesium concentrations so that the appropriate water chemistry objective could be calculated.

Results of the calculation are shown in Table 8-3. As shown, copper concentrations were predicted to be consistently marginally above the discharge limit. As the thickness decreases, copper concentrations decrease but the hardness is also expected to decrease which further lowers the limit as hardness decreases below 400 mg $CaCO_3$/L.

Table 8-3: Calculated Water Chemistry for Category 2 Rock in Thin Layers

Thickness	Standard or Prediction	Hardness	F	SO_4	Co	Cu	Mn	Ni	Zn
Feet		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10	Standard		2	250	0.005	0.021	0.05	0.12	0.27
	Prediction	259	0.9	81	0.002	**0.030**	0.03	0.01	0.047
20	Standard		2	250	0.005	0.030	0.05	0.17	0.39
	Prediction	519	1.9	163	0.004	**0.060**	**0.07**	0.02	0.09
30	Standard		2	250	0.005	0.030	0.05	0.17	0.39
	Prediction	778	**2.8**	244	**0.006**	**0.090**	**0.10**	0.03	0.09

Notes:
1. Bold indicates calculated concentration exceeds the potential discharge limit.

These calculations indicate that the concept of “non-reactive” waste rock cannot be achieved because drainage from waste rock could exceed water quality discharge limits (primarily copper).

Evaluation of Closure Alternatives

Closure alternatives were not evaluated because the concept of non-reactive waste rock has not been advanced.

Sensitivity Analysis

No sensitivity calculations were completed because the concept of non-reactive waste rock has not been advanced.

8.4.2 Reactive Waste Rock

Prediction of Water Chemistry with Time

Waste rock Categories 2, 3 and 4 are considered “reactive” by the definition of predicted drainage chemistry not meeting water quality discharge limits. Chemistry predictions were discussed in Section 8.3.1.

Evaluation of Closure Alternatives

The predictions described above incorporate the closure concepts described in the Detailed Project Description (PolyMet 2007a).

Sensitivity Analysis

The water chemistry predictions are sensitive in a linear fashion to all inputs. If an input factor is increased or reduced by a factor of 50%, the increase or decrease in loading released changes by the same factor. However, many predictions are capped by solubility limits so that changes in inputs do not affect the final prediction. Therefore, the predictions are controlled by the choice of solubility limits which is determined by the water chemistry database. The current predictions use maximum observed concentrations for a given pH and are therefore considered conservative. Use of lower solubility limits would lower the predicted concentrations.

Predictions of drainage chemistry from Category 2 rock are susceptible to the assumption that the overall conditions within the waste rock will remain non-acidic and the composition will reflect rock classified as Category 2 in the block model. Under operational conditions, these assumptions may be affected by the accidental inclusion of small amounts of Category 3 and 4 rock that could become localized sources of acidic water and leaching metals. The effect of these inclusions could be to contribute to metal leaching and lowering of pH resulting in higher concentrations of metals in the drainage. Category 3 and 4 rock could become incorporated into Category 2 rock by a number of routes which could include waste heterogeneity (i.e. small-scale inclusions of Category 3 and 4 rock in Category 2 rock) and operational errors. The latter are factors such as mistakes at the operating face and dumping location. These errors will be minimized by management practices but some level of operational mishaps can be expected.

The ability of Category 2 rock to absorb small quantities of Category 3 and 4 waste rock depends on the generation of excess alkalinity by weathering of silicates. The criteria used to produce Category 2 waste rock are based on an estimate of the critical level at which alkalinity generated by silicate weathering will balance acid produced by sulfide oxidation. All rock below this critical level is assumed to perpetually generate excess alkalinity by silicate weathering. The excess alkalinity then becomes available to neutralize acidity produced by inclusions of Category 3 and 4 rock.

Table 8-4 calculates the ratio of leachate alkalinity from Category 2 rock to acidity from Category 3 and 4 rock in order to achieve ratios of 2 and 1 for mixed alkalinity and acidity. The ratio of 1 indicates an exact balance whereas a ratio of 2 indicates twice much overall alkalinity as acidity. Various levels of alkalinity are shown compared to two levels of acidity. Actual alkalinity is expected to be about 75 mg $CaCO_3$/L from the water chemistry database, whereas acidity is shown for two values (1000 and 5000 mg $CaCO_3$/L) representing the behavior of rock with different levels of sulfur (eg. Category 3 and 4 waste rock). For the expected alkalinity, the tolerable proportion of Category 3 or 4 rock to maintain an alkalinity to acidity rate of 2 is between 1 and 4%.

Table 8-4: Calculation of Category 2 Waste Rock Stockpile Sensitivity to Proportion of Category 3 and 4 Rock Contributing Acidity

Alkalinity from Category 2 Rock	Acidity from Category 3 or 4 Rock	Proportion of Category 3 or 4 Required to Result in Indicated Alkalinity/Acidity Ratio	
mg$CaCO_3$/L	mg$CaCO_3$/L	2	1
50	1000	2%	5%
75	1000	4%	7%
100	1000	5%	9%
150	1000	7%	13%
50	5000	0%	1%
75	5000	1%	1%
100	5000	1%	2%
150	5000	1%	3%

Review of selected drill hole data throughout the deposit indicates that in most cases Category 2 rock occurs separately from Category 3 and 4 rock and is therefore amenable to segregation at a mining scale (Appendix C.2). The ability to maintain non-acidic drainage and therefore limit metal leaching will depend on the implementation of management systems that can ensure errors in placement of rock are limited to a few percent.

8.4.3 Lean Ore

Prediction of Water Chemistry with Time

Chemistry predictions were discussed in Section 8.3.1 and shown in Figure 8.1.

Evaluation of Closure Alternatives

The predictions described above incorporate the closure concepts described in the Detailed Project Description (PolyMet 2007a).

Sensitivity Analysis

Predictions of drainage chemistry for Lean Ore stockpiles are subject to the same sensitivities as all waste rock predictions.

Accidental placement of rock of other categories in the Lean Ore piles is unimportant in terms of drainage chemistry compared to Category 2 waste rock because collection systems are being designed to capture acidic drainage.

8.4.4 Virginia Formation

Prediction of Water Chemistry with Time

Chemistry predictions for Category 4 waste rock were discussed in Section 8.3.1 and shown in Figure 8.1.

Evaluation of Closure Alternatives

The predictions described above incorporate the closure concepts described in the Detailed Project Description (PolyMet 2007a).

Sensitivity Analysis

Predictions of drainage chemistry for Category 4 waste rock are subject to the same sensitivities as all waste rock predictions.

Accidental placement of rock other Categories 2 and 3 in the Category 4 piles are unimportant compared to Category 2 waste rock because collection systems are being designed to capture acidic drainage.

9 Water Chemistry for Subaqueous Disposal Option

9.1 Literature Review

As described in Section 2.2.3, the two principal geochemical issues associated with subaqueous disposal are dissolution of oxidation products formed prior to inundation with water, and continued reaction of the wastes once submerged. SENES (1996) reviewed flooding of pit walls and backfill wastes. Results of that review are summarized below.

SENES (1996) documented over 60 in-pit disposal sites in the U.S. and Canada. This included flooding of pit walls to address wall reactivity, and in-pit disposal of waste rock and tailings. Backfilled pits were identified as being "wet" (i.e. free water following backfilling), "combined" (i.e. backfilling with a cap or cover on the waste) and "dry" (i.e. no water cover) disposal of waste. The latter is a common approach when the open pit becomes part of the waste rock disposal area. Eight sites were listed as disposing of reactive waste rock in open pits resulting in a wet cover. Details on the individual sites were limited but include information for three sites:

- Collins "B", Saskatchewan. This uranium mine disposed of low sulfur (0.05%) rock in a pit. The constituents of concern in the waste rock were arsenic, nickel, uranium, lead-210 and radium-226. Interpretation of the effect of the backfilling on pit water chemistry was complicated by the discharge of waste rock drainage to the open pit.

- Owl Creek, Ontario. At this gold mine, slightly oxidized waste rock exposed for just over a year after ARD was first detected containing several percent sulfur was disposed into a flooding open pit. Limestone was added to the waste during backfilling to offset the effects of leaching of acid salts. Flooding of the waste occurred rapidly. The addition of limestone resulted in pH neutral conditions in the pit water with nickel concentrations between 0.09 and 0.12 mg/L, and copper between 0.01 and 0.06 mg/L.

- Solbec, Quebec. Waste rock was backfilled to a small open pit. No information was available on water chemistry in the pit after flooding.

SENES (1996) conclusions included:

- Pit disposal of reactive waste is becoming common practice;

- Several examples demonstrated that backfilling has resulted in environmental improvements by eliminating or limiting management of contaminant leaching problems.

- Wet covers are the most common approach in Canada. In the US, dry covers are more typical.

- The technology for in-pit disposal is reasonably well developed. The geochemistry, hydrogeology etc. can be determined and models to assess contaminant release and transport are well developed. The design of engineered controls can be reasonably assessed.

MEND (2001) added one additional case history. The Whistle Mine in Sudbury, Ontario was being backfilled with waste rock and final closure was to include a cover.

The Flambeau Mine (Wisconsin) backfilled two types of rock into the open pit at closure (Hill and Benson 2001). Type I rock contained less than 1% sulfur and was not predicted to be acid generating. Limestone was added to Type II rock because it was predicted to be potentially acid generating. Rock types were described as schist. Kuipers et al. (2006) indicate that water in the submerged backfill contained up to 12 mg/L iron, up to 37 mg/L manganese and 1700 mg/L sulfate. No other chemical data were provided.

Literature on waste rock backfilling indicates that it is common approach. Management plans appear to focus on controlling pH in the backfill during disposal to limit leaching effects from oxidation products formed prior to backfilling. Lime and/or limestone may be added to neutralize acidic products. The Flambeau Mine example showed that if a component of the waste rock has natural buffering capacity, addition of extra buffering material is not required.

Oxidation effects from oxygen dissolved in water have not been identified as a significant issue for long term water quality though there is considerable evidence in the literature that subaqueous disposal of reactive wastes significantly inhibits oxidation (MEND 2001).

9.2 Alternatives Considered

9.2.1 Disposal in Existing Pits

Disposal in nearby existing taconite pits is not considered in the Detailed Project Description (PolyMet 2007a). This alternative was not assessed.

9.2.2 Disposal in NorthMet Pits

RS31 (SRK 2007) provides a more detailed discussion of water quality predictions for the open pits. The following sections of RS42 are a summary.

The Detailed Project Description includes backfilling of the East Pit with Category 2 waste rock originating in the West Pit from Years 13 to 20 after East Pit is exhausted. Placement of Category 3 and 4 waste rock in the East Pit has not been evaluated at this time

Various options are presented in RS52 (Barr 2007b) for flooding of the East Pit so it reaches the discharge elevation in 20 years.

Category 2 waste rock would be hauled directly from the West Pit to the East Pit without a stockpiling phase. The backfill would be placed such that waste rock will be flooded very rapidly (within a year of being placed). This will be achieved by placement as lifts from the bottom of the pit rather than end-dumping from a higher elevation in the pit. This approach is being used to minimize exposure of the waste but also to provide access to the Virginia Formation pit walls for application of lime or limestone to limit leaching during filling of the pit. Initial predictions of pit water indicated that pore water chemistry would be elevated as a result of leaching of the oxidized Virginia Formation.

At closure, a wetland will be constructed on the surface of the East Pit backfill.

9.3 Non-Reactive Waste Rock

As described in Section 8.4.1, the concept of non-reactive waste rock has not been advanced for the project.

9.4 Reactive Waste Rock

9.4.1 Soluble Load Release

The literature review indicated that the primary factor considered when backfilling waste rock is the leaching of soluble oxidation products accumulated during weathering prior to subaqueous disposal. The accumulation of weathering products was estimated from the humidity cells by assuming that the weekly rate of release of weathering products accumulates in the rock until it is flushed. The load accumulated in the waste rock before it is inundated is therefore estimated from the time the rock is exposed multiplied by the weekly weathering rate. The calculation assumed that all this load is leached during flooding. RS31 explains in more detail the mechanics of the calculation but the exposure time is calculated by the difference between the time when the rock is flooded and the time when the rock was placed. This is very conservative calculation for metals because it assumes that all load produced is soluble and readily leachable. In fact, solubility constraints will limit leaching and some component of the load will not be leached. Development of reducing conditions in the backfill could be a factor allowing for dissolution of metals associated with ferric hydroxides. Because the closure plan includes construction of a wetland on the backfill, reducing conditions could locally develop in the backfill due to delivery of dissolved organic carbon to the backfill, but the Category 2 waste rock does not contain a reductant that could initiate sufficiently reducing conditions in the backfill to dissolve ferric hydroxides.

The calculation used is conservative but has not been refined. The load originating from the backfill (both the component briefly exposed above the water level and the flooding component) were found to be small compared to load leached from the Virginia Formation pit walls. The pit water predictions were used primarily to evaluate the effect of measures to limit the effect of the Virginia Formation.

9.4.2 Underwater Weathering

Because underwater weathering has not been documented as a significant effect for subaqueously disposed waste rock and the rate of oxidation under these conditions is likely to be very slow compared to leaching of the exposed high walls, this effect was not considered. Backfilled rock was assumed to not oxidize once flooded.

9.4.3 Prediction of Water Chemistry as a Function of Time

RS31 provides results of overall predictions for the East Pit during flooding. As indicated above, the rapid flooding of slowly weathering Category 2 rock with minimal exposure resulted in insignificant effects on the chemistry of backfill pore water quality.

9.5 Further Investigations

Under the current proposal provided in the Detailed Project Description, no additional studies of the effect of subaqueous disposal are recommended because the disposal of Category 2 rock in the East Pit has been predicted in RS31 to have a minor effect on overall loadings from the pit when compared to other sources. In the event that other disposal methods are proposed, or other categories of rock are considered for disposal, specific investigations should be considered.

10 Conclusions and Recommendations

An extensive geochemical characterization program has been completed for waste rock, lean ore and ore at the proposed NorthMet Project. These data and data obtained by the MDNR over nearly two decades of testing indicate the following:

- The concept of “non-reactive” waste rock cannot be defined when drainage from waste rock is required to meet stringent water quality discharge limits. Even thin waste rock placement containing low levels of sulfide mineralization may produce drainage chemistry exceeding the limit for copper (in particular) because the water quality standards are hardness based and result in low water quality discharge limits.

- Three categories of reactive waste rock have been defined using sulfur content as a primary criteria and copper to sulfur ratios as a secondary criterion.

- Category 2 waste rock has been defined as having low potential to generate acid rock drainage (ARD). This rock will have a sulfur content of less than 0.31% or 0.12% for lower and higher copper to sulfur ratios, respectively.

- The sulfur criteria for Category 2 were developed by considering threshold effects for consumption of acid by alkalinity generated from silicate weathering. The thresholds obtained are completely consistent with the MDNR’s long term testwork which shows that rock containing less than 0.41% sulfur did not generate ARD for 18 years.

- Category 3 waste rock has been defined as rock with potential to generate ARD but with a delay of several years. The sulfur content of this rock is greater than Category 2 and less than 0.6%. The category was developed primarily with reference to the field scale test work conduced on the Babbitt Deposit.

- Category 4 waste rock has been defined as rock with a potential to generate ARD immediately upon exposure. This waste rock has sulfur content above 0.6% and is dominated by the Virginia Formation metasediments located in the footwall of the Duluth Complex at NorthMet.

- Lean Ore has been divided into Categories 3 and 4. Category 2 does not exist for Lean Ore. Both Lean Ore categories are intrusive rock hence Category 4 lean ore has lower sulfur content than Category 4 waste rock.

- Conservative water quality predictions for three waste rock stockpiles and two lean ore stockpiles were developed by scaling-up laboratory weathering rates and considering solubility limits indicated by review of water chemistry database assembled testwork and field monitoring data obtained by MDNR and PolyMet.

- All chemistry predictions indicate that drainage from the waste rock and lean ore stockpiles will exceed water quality discharge limits for several parameters including sulfate, nickel and copper.

- Drainage chemistry for Category 2 waste rock is sensitive to the inclusion of Category 3 and 4 rock. If the proportion of these potentially ARD producing categories are included in the Category 2 rock, the main concern is that the overall drainage could be acidic and result in increased metal solubility. Segregation errors may occur during mining due to operational practicalities. A target error rate of less than 2% is recommended.
- Rapid subaqueous disposal of Category 2 rock in the East Pit after year 12 is not expected to have a significant effect on pit water chemistry compared to the effects of leaching of walls composed of Virginia Formation.

The findings of RS42 have been used to provide input chemistry to the prediction of drainage treatment (RS29, Barr (2007)) and the Waste Management Plan (RS43).

The ongoing waste rock, lean ore and ore characterization program currently consists of more than 100 individual tests. Substantial reduction in this test program is recommended. A few tests should be continued to support long term predictions.

This report **"1UP005.01 – RS53/RS42 Waste Rock Characteristics/Waste Water Quality Modeling – Waste Rock and Lean Ore - DRAFT"**, has been prepared by SRK Consulting (Canada) Inc.

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Appendices

Appendix A

Waste Rock and Lean Ore Characterization Plan

Waste Rock and Lean Ore Geochemical Characterization Plan NorthMet Project, Minnesota

Prepared for

PolyMet Mining Corporation

Prepared by

SRK Consulting
Engineers and Scientists

May 2006

Waste Rock and Lean Ore Geochemical Characterization Plan NorthMet Project, Minnesota

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1 Introduction

1.1 Background

PolyMet Mining (PolyMet) is proposing to develop the NorthMet Project (Dunka Road Project of US Steel) near Babbitt, Minnesota. As a part of the Minnesota Department of Natural Resources (MDNR) "Permit to Mine" process a complete "mine waste characterization" will be required (Minnesota Rules Chapter 6132.1000). This document describes the plan developed for selection and testing of waste rock samples for the NorthMet Project, and the context for interpretation of the results.

The issues associated with waste rock at the NorthMet are expected to include acid rock drainage (ARD) and leaching of some heavy metals. The latter in particular are expected to include nickel and cobalt both of which do not require acidic conditions to be mobilized at elevated concentrations.

The specific objectives of this program include:

- Refinement of preliminary waste rock management criteria developed by PolyMet and MDNR.
- Development of mass-loading rates for input into water quality predictions for impact assessment and mitigation design.

1.2 Geological Setting

The NorthMet Deposit is located in the intrusive Duluth Complex of northern Minnesota. Disseminated copper-nickel-iron sulfides (chalcopyrite, cubanite, pentlandite and pyrrhotite) with associated platinum group element (PGE) mineralization will be extracted from several igneous stratigraphic horizons.

In the vicinity of the NorthMet deposit, the Duluth Complex intruded and assimilated the Virginia Formation, which consists of argillite and greywacke with minor interbeds of siltstone, graphitic argillite, chert, and carbonate. This formation is the stratigraphic footwall of the NorthMet deposit, but also occurs as xenoliths ("inclusions") within the deposit.

1.3 Agency Consultation and Design Process

This document was developed in consultation with staff from the Minnesota Department of Natural Resources (MDNR). The consultation included the following steps:

- December, 2004. PolyMet submitted a draft "Work Plan for Geochemical Characterization of Rock and Concentrator Flotation Tailings". The plan was presented to MDNR representatives.
- January 31 and February 1, 2005. Meetings were held by teleconference between SRK and MDNR representatives to further discuss the variables potentially affecting water chemistry from waste stockpiles.

- March 17, 2005. MDNR requested additional information on the tonnages of the major units and rock types, and the distribution of sulfur and minerals.
- March 28, 2005. PolyMet provided the requested information.
- April 12, 2005. MDNR provided a sample selection matrix. This matrix was accepted by PolyMet and is the basis for the selection of samples described in this document.
- May 15, 2005. MDNR provided a design for specific testwork.
- May 17, 2005. MDNR provided a design for specific testwork.
- June 6, 2005. A draft of this sampling plan was submitted to MDNR.
- June 15, 2005. MDNR provided comments on the draft plan.
- June 22, 2005. SRK provided responses and discussion of the MDNR comments in a letter to MDNR which were discussed during a teleconference on June 27, 2005.
- July 5, 2005. SRK provided results of candidate samples selected for kinetic testing to in a memorandum to MDNR.
- July 13, 2005. MDNR provided comments on the July 5, 2005 SRK memorandum.
- July 15, 2005. SRK provided clarification on sample selection in a memorandum to MDNR.
- July 20, 2005. MDNR notified SRK and PolyMet that kinetic testing on the majority of waste rock samples could be initiated. It was recognized that analysis of a few candidate samples was ongoing.
- August 4, 2005. MDNR Provided recommendations for lean ore characterization.
- August 29, 2005. As requested by SRK, MDNR provided additional rationale for the recommendations on lean ore sampling selection.
- September 14, 2005. Lean ore sample selection was further discussed during a conference call which were provided the basis for completion of this plan.

The plan was fully implemented in October 2005.

This document has been prepared to conclude the design process and seek MDNR approval of PolyMet's plans to respond to the waste rock characterization component of requirements under Minnesota Rules 6132.1000.

1.4 Organization of this Document

This document describes:

- Section 2. Design basis for the program.
- Section 3. Sample selection. This section describes the methods used to select samples from the NorthMet Project drill hole database.

- Section 4. Analytical methods. This section describes methods used to analyse solids and leachates.
- Section 5. Use of the results in the context of water chemistry predictions.

1.5 Acknowledgements

The following individuals cooperated in the preparation of this plan:

- John Borovsky, Barr Engineering Company.
- Stephen Day, SRK Consulting.
- Paul Eger, MDNR.
- Jennifer Engstrom, MDNR.
- Steve Geerts, PolyMet.
- Don Hunter, PolyMet.
- Kim Lapakko, MDNR.
- Richard Patelke, PolyMet.
- Jim Scott, PolyMet.

1.6 Analytical Laboratues

The following laboratories are performing the procedures described in this document (contact names for each laboratory are shown):

- ALS Chemex, North Vancouver, British Columbia – solids analysis listed in Section 4.1.1 (Bill Anslow).
- Optical – PolyMet (Richard Patelke).
- Sub-Optical Lab – McSwiggen and Associates (Pete McSwiggen).
- Canadian Environmental and Metallurgical Inc (CEMI), North Vancouver, British Columbia - kinetic testing (Rik Vos).
- Cantest Inc.. Vancouver, British Columbia - Kinetic test leachate analysis (Richard Jornitz).

2 Characterization Design

2.1 Background

Sample selection for this project was based on the December 2004 PolyMet geologic and assay database (assembled by PolyMet) and the February 2005 block model by Dr. Phil Hellman of Hellman & Schofield. Ultimately, the rock characterization data from these tests will be linked to the mine plan through this database and block model. Current and anticipated future geochemical data collection from drilling is described in documents submitted to MDNR by PolyMet on August 23, 2004 and September 15, 2004.

2.2 Design Basis

Based on discussions between SRK and MDNR on January 31 and February 1, 2005, the following critical variables were identified that potentially could affect drainage quality from waste rock stockpiles:

- Sulfur content.
- Sulfide mineral type.
- Rock type.
- Fragment particle size.

Other important variables include, mineral content, mineral grain size, mineral chemistry, and mode of mineral occurrence.

Sulfur content is considered the primary factor affecting the potential for acid generation and metal mobility based on existing research conducted by MDNR. At higher sulfur concentrations, it appears that acid generation starts earlier and results in lower pHs resulting in increased metal leaching. At lower sulfur concentrations, acid generation is not expected to occur, but sulfur content is correlated with metal content and is therefore expected to be related to metal release.

Sulfide mineral type can be important in terms of rate of reaction and metal release. For example, it is well know that pyrrhotite is more reactive than pyrite. Chalcopyrite and pentlandite are sources of copper and nickel, respectively in drainage. However, since the dominant sulfide mineral in the waste rock appears to be pyrrhotite (based on distribution of metal content) and the commodity sulfide minerals (chalcopyrite, pentlandite and cubanite) are expected to be present at low concentrations, sulfide mineral type was not considered as a primary variable for sample selection. As described below, concentrations of copper, nickel, cobalt and zinc were used as secondary factors for sample selection which is expected to capture variations in sulfide mineralogy. Lean ore characterization is considered separately. All samples are being characterized to evaluate assumptions about the mineralogical occurrence of the important metals.

All rock types in the Duluth Complex are variants of troctolite and to a lesser extent ultramafic rocks. Carbonate minerals are absent or occur at very low concentrations in this rock type. Therefore, the variation in silicate content of these rocks is considered to be an important variable controlling drainage pH.

MDNR also considered that igneous layer in the intrusive complex may be a significant variable. because the reactivity of the minerals may be different in each of the layers. SRK and PolyMet did not agree with this position based on evidence from MDNR's past testwork. Nonetheless, this variable has been carried through the sampling design.

Finally fragment particle size is an important factor because it controls exposure of the reactive minerals and the overall surface area available for reaction.

2.3 Sampling Matrix for Waste Rock

A sampling matrix for waste rock characterization (Table 1) was developed by MDNR, SRK and PolyMet through a series of discussions and exchange of relevant data. Table 1 shows how the main variables have been translated to a sampling design. The table also provides estimates of the tonnages of each major rock type within each unit. Reading from left to right, the columns in the table show the following:

- Unit. This refers to the stratigraphic igneous layers in the complex (number 1 to 7). Unit 20 refers to the footwall of the deposit composed of Virginia Formation and localized igneous intrusions
- Rock Type. This refers to a generalized rock description in the associated unit.
- Estimated Rock Tonnages. These tonnages indicate the estimated amounts of each rock type within each layer and therefore their relative importance. The categories were developed by MDNR and PolyMet to indicate rock with sulfur less than 0.05%[1] ("non-reactive"), sulfur greater than 0.05% but not likely ore grade ("reactive"), and rock with marginal ore grade (lean ore).

Selection of samples for each unit and rock type combination was based on sulfur concentrations in order to develop correlations between reactivity and bulk characteristics such as sulfur and metal content. This provides a basis for water chemistry predictions using bulk characteristics, prediction of waste management criteria (based on sulfur content and metal content) and ultimately for the selection of easily-measured parameters that can be used for waste management during mining (see Section 5.2 below, for additional discussion).

[1] Note that the non-reactive classification is a temporary criterion which will be refined by this testwork program.

Table 1: Matrix for Sample Selection in Waste Rock Types

Unit	Rock Type	Non-Reactive	Reactive	Approximate sulfur contents																				Reactive Rock
				Non-reactive[1]			Reactive[1]									Lean Ore[1]								P size
		M. tons	M. tons	NR1	NR2	NR3	P10	P25	P50	P75	P80	P85	P90	P95	P100	P10	P25	P50	P75	P80	P85	P90	P95	
1	Anorthositic	0.57	0.99				0.08	***0.1***	***0.15***	***0.29***				***1.09***	1.09	0.11	0.26	***0.36***	***0.93***				***1.95***	***4***
1	Gabbroic	0	0.68				0.06	0.07	0.07	0.08				0.19	0.5	0.09	0.1	0.18	0.37				0.5	
1	Sedimentary hornfels	0	1.6				***0.08***	***0.35***	***0.69***	***2.2***	2.32	***2.81***	3.38	3.5	3.78	0.34	1.37	***1.58***	1.76				***4.91***	
1	Troctolitic	17.2	40.1	***0.01***	***0.03***	***0.05***	0.06	**0.07**	***0.1***	0.18	***0.21***	0.26	***0.34***	***0.62***	***1.97***	0.08	***0.15***	***0.24***	0.42	0.49	***0.55***	0.68	***0.98***	***4***
1	Ultramafic	0.21	1.1				0.07	***0.08***	0.1	0.13	***0.2****	***0.3****	***0.5****	***0.8****	1.35	0.07	0.09	***0.14***	***0.33***	0.55	***0.56***	0.65	***0.81***	
1	Vein	0.055	0.022				0	0	0	0				0										
2	Anorthositic	2.4	0.56	***0.01***	***0.03***	***0.05***	0.06	0.06	0.08	0.11				0.19		0.09	0.12	0.17	0.21				0.25	
2	Basalt inclusions	0.28	0													0	0	0	0				0	
2	Gabbroic	0	0.082				0	0	0	0				0										
2	Troctolitic	16.9	9.7	***0.01***	***0.03***	***0.05***	0.06	0.06	0.07	0.09	0.09	0.1	0.11	0.12	0.25	0.05	0.07	0.12	0.18	0.2	***0.22***	0.26	***0.32***	
2	Ultramafic	0.38	0.25	***0.03***	***0.04***	***0.05***	0	0	0	0				0		0.04	***0.05***	0.07	0.12	***0.14***	0.16	0.19	***0.23***	
3	Anorthositic	9.4	1.2	***0.01***	***0.03***	***0.05***	0.07	0.08	0.08	0.12				0.14		0.06	0.08	0.12	0.27				0.38	
3	Fault-Breccia	0	0.055				0	0	0	0				0										
3	Gabbroic	0.2	0.72				0.09	0.15	0.18	0.27				0.29		0	0	0	0				0	
3	Noritic	0.11	0																					
3	Sedimentary hornfels	0.38	0.46				0.12	1.42	1.67	1.97				2.22		1.66	1.77	1.85	2.43				3.26	
3	Troctolitic (augite)	41.2	12.5	***0.01***	***0.03***	***0.05***	0.06	0.06	***0.08***	0.1	0.11	***0.12***	0.14	***0.19***	0.36	0.05	0.13	0.19	***0.32***	0.35	0.45	0.48	***0.52***	***4***
3	Ultramafic	0.24	0.071				0	0	0	0				0		0	0	0	0				0	
4	Anorthositic	0.16	0.055				0	0	0	0				0										
4	Sedimentary hornfels	0	0.055				0	0	0	0				0										
4	Troctolitic	7	2.2	***0.01***	***0.03***	***0.05***	0.06	***0.07***	0.09	***0.18***	0.19	0.19	***0.48***	***0.92***	1.53	0.09	0.15	0.22	0.47				***1.52***	***4***
4	Vein	0.055	0																					
5	Troctolitic	2.5	2	***0.01***		***0.05***	0.07	0.09	0.11	0.16				0.22	0.22	0.12	0.17	0.26	0.37				***0.45***	
6	Chlorite	0.16	0													0	0	0	0				0	
6	Fault-Breccia	0.055	0.055				0	0	0	0				0										
6	Troctolitic	6.8	0.59	***0.02***	***0.04***		0	0	0	0				0		0.01	0.01	0.03	0.07				***0.19***	
6	Ultramafic	0	0.11				0	0	0	0				0										
7	Ultramafic	0.082	0													0	0	0	0				0	
20	Troctolitic	0	0.27				3.18	3.45	3.76	4.3				4.31										
20	Virginia	0	10.4				0.59	***1.25***	2.98	***4.15***	4.49	4.85	5.07	***6.06***	7.45	0	0	0	0				0	***4***

Notes:
1. Non-reactive rock categories (lower, medium and higher sulfur contents).
2. Sulfur percentiles for reactive rock types calculated by PolyMet are shown. "*" indicates approximate percentiles.
3. Grey – sampling plan.
4. Bold and italic – samples obtained.
5. Bold border – duplicate cell in operation.

Separate sulfur ranges were defined for the “non-reactive” and “reactive” categories. Within the non-reactive category, three sulfur concentrations were selected to represent the lowest possible sulfur concentration in the rock type (typically 0.01%), the upper limit to this category (0.05%) and an intermediate (0.03%). The need for samples was identified for relatively abundant rock types contributing more than 1,000,000 tons (ie more than 1% of the rock mass). For the reactive category, sample selections were based on sulfur concentration percentiles calculated by Polymet. Again, rock types contributing more than 1,000,000 tons were identified for testing.

Sulfide mineral variability was considered by preferring samples with higher concentrations of Ni and Co, Cu and Zn.

The search for suitable samples included all candidate sulfur values indicated in grey shading Table 1.

2.4 Characterization of Lean Ore

Lean ore is defined as rock containing grades of commodity minerals below that at which processing can currently be justified, but may eventually be processed if project economics improve. In terms of sulfur content, lean ore mainly overlaps the “reactive” waste rock category and also some to degree the non-reactive catagory but contains higher nickel and copper concentrations than waste rock. Therefore, the main difference between lean ore and waste rock is expected to be in the mineralogical occurrence of sulfur. In waste rock, sulfur occurs mainly as iron sulfide but in lean ore the commodity minerals pentlandite, chalcopyrite and cubanite are expected to be more important. This has important implications for drainage chemistry. In particular, oxidation and leaching of pentlandite is expected to release more nickel than pyrrhotite due to the higher Ni/Fe ratio in pentlandite. This limits the co-precipitation of nickel with iron oxhydroxides during oxidation.

The overall approach to selection of samples was similar to that of waste rock.

3 Sampling

3.1 Methods

3.1.1 Sample Selection for Non-Reactive and Reactive Waste Types

Samples were selected from the NorthMet Project drill hole database. The following sequence was used to select samples:

1. The database was reduced to rock core. Only diamond drill holes were considered because this method of drilling results in the best characterised samples by eliminating mixing of intervals and allowing accurate logging.
2. Separate datasets were created for "waste rock" (non-reactive and reactive) and "lean ore".
3. Due to ease of recovery from the core archives, core obtained by PolyMet drilling was preferred. In cases where suitable samples could not be found from this source, US Steel drillholes were considered.
4. To select samples, 20-foot moving-averages for consistent rock types were calculated for all parameters. This interval was selected to reduce the potential for characterizing small-scale local heterogeneity, and provide a sample width that relates to mining scale. The wider interval also ensured that sufficient sample is available for all the different tests. In practice, the need to obtain samples with specific unit, rock type and ulphur combinations resulted in sampling intervals of 5 to 20 feet. In three cases, sample intervals from two different locations had to be selected to yield sufficient material for testing.
5. Within each rock type and unit combination, samples were identified based on a ulphur range straddling the desired concentrations. The range was calculated as between the midpoint concentration to the two nearest ulphur concentrations. For example, a target concentration of 0.03% between 0.01% and 0.05% could be selected from intervals with ulphur concentrations between 0.02% and 0.04% (with a preference for 0.03%). This approach was necessary to provide candidate samples in all ranges and incorporate the need to target higher metal concentrations for tests.
6. If more than one candidate interval was identified, the interval with the highest nickel and cobalt concentrations was selected with a primary focus on nickel content. If several samples could still be chosen, copper and zinc concentrations were considered. This approach resulted in selection of samples with nickel concentrations approaching the highest values in the database. For example, the highest nickel concentration in a non-reactive sample is 0.043% compared to a maximum value of 0.043% in the database. Similarly, the highest reactive nickel concentration in the database is 0.042%, and the highest sample is 0.038%.

The sample lists (Table 2 and 3) were re-generated several times due to limitations of core availability. The first pass attempted to use PolyMet core only. Subsequent lists included US Steel core.

Lean ore sample selection was performed in two passes. The first pass targeted samples containing ulphur concentrations at the P95 level. The second pass selected samples for the remaining samples. To ensure that delays did not occur in the second pass, a large number of intervals were selected to ensure that at least one sample would be available for each target ulphur concentration.

3.1.2 Core Recovery

Samples were recovered from archived core boxes by PolyMet personnel. Since the core had previously halved for initial analysis, the remaining half core was quartered for this sampling.

All required intervals were sampled on a continuous basis and placed in plastic bags for shipment to the analytical laboratory.

3.2 Sample List

The resulting lists of waste rock samples and lean ore samples shipped to the laboratory are shown in Tables 2 and 3.

Table 2: List of Non-Reactive and Reactive Samples Selected

Unit	Rock Type	S Percentile – Non-Reactive and Reactive Waste Rock[1]	Selected Interval				Weighted Average Characteristics Calculated from Drill Hole Database				
			DDH	From	To	Length	S	Ni	Co	Cu	Zn
				Feet	Feet	Feet	%	%	mg/kg	%	mg/kg
1	Anorthositic	P25	99-320C	830	850	20	0.12	0.015	35.8	0.035	72
1	Anorthositic	P50	00-361C	310	320	10	0.16	0.018	36.0	0.013	51
1	Anorthositic	P75	00-361C	345	350	5	0.33	0.026	53.0	0.038	68
1	Anorthositic	P95	00-343C	240	250	10	0.67	0.020	38.0	0.069	69
1	Sedimentary Hornfels	P10	26030	1047	1052	5	0.17	0.006	10.0	0.006	34
1	Sedimentary Hornfels	P25	26061	1218	1233	15	0.43	0.011	19.3	0.012	193
1	Sedimentary Hornfels	P50	00-340C	990	995	10	0.62	0.012	24.0	0.031	148
1	Sedimentary Hornfels	P75	00-340C	965	974.5	15	1.49	0.015	23.7	0.031	249
1	Sedimentary Hornfels	P85	26043	1501	1506	5	2.76	0.024	36.0	0.037	344
1	Sedimentary Hornfels	P85(a)	26027	740	745	5	2.59	0.035	67.0	0.051	48
1	Troctolitic	NR1	26029	815	825	10					
1	Troctolitic	NR2	00-340C	595	615	20	0.03	0.025	49.8	0.013	71
1	Troctolitic	NR3	00-334C	580	600	20	0.05	0.024	52.0	0.024	83
1	Troctolitic	P25	00-334C	640	660	20	0.08	0.038	63.8	0.024	102
1	Troctolitic	P50	00-347C	795	815	20	0.09	0.034	70.8	0.035	94
1	Troctolitic	P80	00-350C	580	600	20	0.22	0.027	55.5	0.041	115
1	Troctolitic	P90	00-327C	225	245	20	0.44	0.015	50.5	0.032	73
1	Troctolitic	P95	00-371C	435	440	5	0.65	0.014	32.0	0.036	54
1	Troctolitic	P100	00-340C	765	780	15	1.72	0.022	78.0	0.064	69
1	Ultramafic	P25	00-357C	335	340	5	0.08	0.015	35.0	0.026	68
1	Ultramafic	P80	00-326C	680	685	5	0.21	0.016	33.0	0.085	82
1	Ultramafic	P85	00-357C	535	540	5	0.26	0.026	34.0	0.095	62
1	Ultramafic	P90	99-318C	725	735	10	0.44	0.011	23.0	0.032	45
1	Ultramafic	P95	99-317C	460	470	10	1.10	0.018	33.0	0.056	86
2	Anorthositic	NR1	00-366C	185	205	20	0.01	0.018	35.0	0.008	47
2	Anorthositic	NR2	00-366C	230	240	10	0.02	0.014	32.0	0.011	51
2	Anorthositic	NR3	99-320C	165	175	10	0.04	0.023	46.0	0.012	63
2	Troctolitic	NR1	99-318C	250	270	20	0.02	0.022	42.3	0.011	64
2	Troctolitic	NR2	00-373C	95	115	20	0.03	0.036	64.0	0.019	84
2	Troctolitic	NR3	00-373C	75	95	20	0.05	0.031	55.3	0.020	75
2	Troctolitic	P50	00-357C	110	130	20	0.07	0.024	53.5	0.029	88
2	Troctolitic	P80	99-320C	315	330	15	0.09	0.017	39.3	0.026	65
2	Troctolitic	P95	00-369C	335	345	10	0.16	0.021	43.0	0.046	68
2	Ultramafic	NR1	00-368C	460	465	5	0.03	0.042	70.0	0.033	98
2	Ultramafic	NR2	26055	940	945	5	0.04	0.037	69.0	0.025	88
2	Ultramafic	NR3	26098	145	148.5	3.5	0.05	0.037	76.0	0.014	112

Table 2: List of Non-Reactive and Reactive Samples Selected (Cont'd).

Unit	Rock Type	S Percentile – Non-Reactive and Reactive Waste Rock[1]	Selected Interval				Weighted Average Characteristics Calculated from Drill Hole Database				
			DDH	From	To	Length	S	Ni	Co	Cu	Zn
				Feet	Feet	Feet	%	%	mg/kg	%	mg/kg
2	Ultramafic	NR3(a)	00-337C	105	110	5	0.05	0.043	71.0	0.023	116
3	Anorthositic	NR1	00-334C	30	50	20	0.01	0.022	47.0	0.009	64
3	Anorthositic	NR2	00-368C	125	145	20	0.03	0.016	38.0	0.015	62
3	Anorthositic	NR3	00-368C	20	40	20	0.04	0.010	25.8	0.022	47
3	Troctolitic	NR1	00-366C	35	55	20	0.01	0.019	45.3	0.005	50
3	Troctolitic	NR2	00-334C	110	130	20	0.03	0.028	57.3	0.012	73
3	Troctolitic	NR3	00-347C	155	175	20	0.04	0.015	49.5	0.015	67
3	Troctolitic	P50	00-347C	280	300	20	0.08	0.018	45.3	0.035	61
3	Troctolitic	P85	00-326C	60	70	10	0.12	0.031	51.0	0.034	91
3	Troctolitic	P95	00-369C	305	325	20	0.27	0.030	51.5	0.037	57
4	Troctolitic	NR1	00-367C	50	65	15	0.02	0.015	38.7	0.010	59
4	Troctolitic	NR2	00-367C	260	280	20	0.04	0.024	53.8	0.018	78
4	Troctolitic	NR3	00-367C	290	310	20	0.04	0.021	41.3	0.018	64
4	Troctolitic	P25	00-370C	20	30	10	0.07	0.010	37.0	0.016	67
4	Troctolitic	P75	00-369C	20	30	10	0.14	0.021	39.0	0.043	60
4	Troctolitic	P90	00-367C	170	175	5	0.48	0.023	45.0	0.034	54
4	Troctolitic	P95	00-367C	395	400	5	0.92	0.028	76.0	0.080	96
5	Troctolitic	NR1	26064	44	54	10	0.01	0.035	62.0	0.009	58
5	Troctolitic	NR3	26064	264	269	5	0.04	0.017	42.0	0.005	56
5	Troctolitic	NR3(a)	26064	146	156	10	0.05	0.032	67.0	0.031	78
6	Troctolitic	NR1	26056	110	125	15	0.02	0.034	66.7	0.025	85
6	Troctolitic	NR2	26056	135	153	18	0.04	0.037	62.7	0.032	89
20	Virginia	P25	00-361C	737	749	15	1.91	0.015	22.3	0.039	225
20	Virginia	P75	00-364C	210	229	19	4.11	0.018	26.8	0.017	872
20	Virginia	P90	00-337C	510	520	10	5.12	0.016	29.5	0.019	492

Notes:

1. Designation (a) indicates that the sample will be mixed with the previous sample in the list to make a composite for testing.

Table 3: List of Lean Ore Samples Selected

Unit	Rock Type	S Percentile	Selected Interval				Weighted Average Characteristics Calculated from Drill Hole Database				
			DDH	From	To	Length	S	Ni	Co	Cu	Zn
				Feet	Feet	Feet	%	%	mg/kg	%	mg/kg
1	Anorthositic	P50	99-320C	400	405	5	0.32	0.06	63	0.07	68
1	Anorthositic	P75	00-331C	255	260	5	0.95	0.05	38	0.16	42
1	Anorthositic	P95	26027	616	626	10	2.31	0.054	77.0	0.144	75
1	Sedimentary Hornfels	P50	26058	704	715	11	1.59	0.04	40	0.08	175
1	Sedimentary Hornfels	P95	26062	993	998	5	5.49	0.049	81.0	0.153	166
1	Sedimentary Hornfels	P95	26026	565	568	3	3.83	0.033	70.0	0.074	88
1	Troctolitic	P25	00-326C	250	265	15	0.15	0.04	49	0.07	73
1	Troctolitic	P50	00-340C	910	925	15	0.33	0.04	50	0.15	77
1	Troctolitic	P85	00-331C	190	210	20	0.54	0.04	41	0.17	43
1	Troctolitic	P95	00-340C	725	745	20	1.06	0.045	116.0	0.114	95
1	Ultramafic	P50	00-326C	495	505	10	0.14	0.06	91	0.06	128
1	Ultramafic	P75	00-344C	630	635	5	0.33	0.05	54	0.13	82
1	Ultramafic	P85	00-330C	275	280	5	0.60	0.06	123	0.10	86
1	Ultramafic	P95	00-344C	515	520	5	1.10	0.057	72.0	0.090	130
2	Troctolitic	P85	99-318C	325	330	5	0.21	0.05	63	0.14	90
2	Troctolitic	P95	00-340C	380	385	5	0.30	0.04	56	0.13	84
2	Ultramafic	P80	00-326C	225	235	10	0.13	0.06	87	0.10	122
2	Ultramafic	P95	00-361C	240	245	5	0.20	0.085	103.0	0.017	130
3	Troctolitic	P75	00-367C	495	500	5	0.28	0.05	52	0.16	58
3	Troctolitic	P95	26049	358	362	4	0.55	0.058	73.0	0.151	60
3	Troctolitic	P95	26030	291	296	5	0.50	0.055	78.0	0.149	104
4	Troctolitic	P95	00-367C	400	405	5	1.52	0.031	79.0	0.116	86
5	Troctolitic	P95	26056	302	312	10	0.45	0.04	50	0.11	67
6	Troctolitic	P95	26142	360	365	5	0.15	0.043	50.0	0.109	80

4 Sample Preparation and Analysis

4.1 Solids Characterization

4.1.1 Sample Preparation

Samples were shipped to Canadian Environmental and Metallurgical Inc (CEMI) as whole core pieces. The following procedures were used for sample preparation:

- Upon arrival, each sample was weighed and its weight recorded. Specific gravity was determined.
- Each sample was crushed to pass a 0.25 inch screen.
- A 3 kg split of crushed sample was split and saved for humidity cell testing. This provides sufficient sample for duplicate kinetic testing if needed
- A 200 g split was used for solids characterization
- A 50 g split was saved for additional archive and petrographic analysis

4.1.2 Chemical Analysis

A split of each sample was submitted for an extensive suite of analysis, as follows:

- Acid base accounting (total S, carbonate, paste pH). Sulfur as sulfate is not needed because previous work shows that sulfur occurs exclusively as sulfide. Carbonate rather than neutralization potential is being determined because neutralization potential determinations on rocks containing reactive silicates are ambiguous and do not reflect field capacity to neutralize acid. Carbonate indicates the field reactive component of acid neutralization potential.
- 27 elements by ICP scan following four-acid (nitric-hydrochloric-perchloric-hydrofluoric) digestion (near total) (0.5 g).
- 34 elements by ICP scan following aqua regia (nitiric-hydrochloric acid) digestion (0.5 g).
- Whole rock oxides (0.5 g).

These methods were selected to provide continuity with the earlier work and will therefore allow the samples selected to be compared with the existing project database.

Method detection limits are provided in Appendix A.

In addition, 200 g of all samples were split into four size fractions (-100+270 mesh, -35+100 mesh, -10+35 mesh and -0.25”+10 mesh) for analysis of total S and 27 elements by four acid digestion.

Chemical analysis of all samples was completed prior to implementation of kinetic testing.

4.1.3 Optical Analysis

Two pieces of typical core from each interval sampled were taken for preparation of polished thin sections to confirm the rock type and quantify reactive minerals. Optical mineralogy reports will indicate mineral types, mineral abundance, grain sizes and mineral occurrence.

4.1.4 Sub-Optical Analysis

Sub-optical analysis included determination of the trace element content of major minerals on selected samples using microprobe analyses.

4.2 Kinetic Test Methods

4.2.1 Humidity Cell

Humidity cell testing is being performed using ASTM Procedure D 5744 – 96 (Reapproved 2001). This procedure was selected for the following reasons:

- Similar procedures have been in use under different names since the late 1980s (e.g. MEND 1991). The results can therefore be evaluated in the context of more than a decade of experience using the procedure.
- It is a standard procedure approved by the ASTM and is therefore defensible as a method.

The ASTM procedure provides some options for varying the test procedure. Appendix B provides a detailed listing of the requirement of the ASTM procedure, options chosen and any variances from the ASTM procedure

4.2.2 MDNR Reactor

To evaluate size fraction effects, four size fractions (-100 mesh, -35+100 mesh, -10+35 mesh and -0.25”+10 mesh) from five samples are being tested using a procedure referred to as the “MDNR Reactor” experiment. The two smallest size fractions are being tested in a specifically designed apparatus designed by MDNR (Appendix C) to contain 75 g. The two coarser fractions are being tested in cells with the same configuration as ASTM Procedure D 5744–96. Details of the construction of the smaller MDNR reactors as provided by MDNR are attached in Appendix C.

For the small reactors, a weekly volume of 200 mL is being used. For the larger samples, the leachate volume is 300 mL.

4.2.3 Leachate Analysis

Leachates from kinetic tests are being analyzed for the parameters indicated in Table 4 every four weeks beginning on the first rinsing cycle (week 0). Every four weeks on weeks 2, 6, 10 etc. the leachates are analysed for a higher level scan to evaluate trends in major elements. Based on experience, testing of non-reactive rock samples with very low sulfur concentrations is expected to result in very dilute leachates containing low concentrations of the metals of interest. Back-calculation of metal concentrations from other testwork performed by DNR indicates that nickel and cobalt concentrations could be as low as 0.0002 mg/L (200 ng/L) and 0.00001 (10 ng/L), respectively. Quantification of these low metal concentrations is needed to provide reasonably constrained estimates of metals concentrations in waste rock seepage.

A number of different approaches are available to quantify low levels of metals:

- The routine leachate analysis will achieve a detection level of 0.0001 mg/L (100 ng/L). Should concentrations be undetected, detection limits of 50 ng/L can be obtained with additional processing effort using the same routine method.
- Specialist methods can achieve lower detection limits. These are non-routine (for example, evaporation to increase concentrations) and will need to be developed as the need arises. In order to generate a 10 times decrease in detection limit, the samples would need to be concentrated at 1east 10 times. A composite leachate sample would be prepared from several cycles.
- Existing testwork demonstrates that good correlations exist between cobalt and nickel concentrations in leachates. Detectable nickel concentrations can be used to estimate cobalt concentrations if this relationship can be demonstrated.
- The particle size experiments provide a larger surface area and provide greater likelihood that lower concentrations will be detected.
- In the event of undetectable low levels, detection limit values would be used in subsequent calculations. A scale-up methodology will be agreed upon with MDNR to translate non-detectable concentrations to waste rock seepage concentrations. Section 5.2 provides discussion of possible scale-up approaches.

Table 4: List of Parameters for Humidity Cell Leachate Analyses. Concentrations in mg/L except where indicated

Parameter	Limit	Parameter	Limit
pH (standard units)	-	Acidity	1
Conductivity (µS/cm)	1	Alkalinity	1
Chloride	0.2	Sulfate	0.5
Fluoride	0.05	Total Inorganic Carbon	1
ORP (mV)	-		
Dissolved Elements			
Aluminum	0.001	Molybdenum	0.00005
Antimony	0.0001	Nickel	0.0001 (0.00005)[1]
Arsenic	0.0001	Potassium	0.02
Barium	0.0001	Selenium	0.0002
Beryllium	0.0002	Silicon	0.05
Bismuth	0.0002	Silver	0.00005
Boron	0.005	Sodium	0.01
Cadmium	0.00004	Strontium	0.0001
Calcium	0.01	Tellurium	0.0002
Chromium	0.0002	Thallium	0.00002
Cobalt	0.0001 (0.00005)[1]	Thorium	0.0001
Copper	0.0001	Tin	0.0001
Iron	0.01	Titanium	0.0002
Lead	0.00005	Uranium	0.00005
Lithium	0.0002	Vanadium	0.0002
Magnesium	0.005	Zinc	0.001
Manganese	0.00005		

Notes:

1. Low detection limits are available for cobalt and nickel as shown.

4.3 Quality Assurance/Quality Control

To summarize, QA/QC includes the following components:

- Roughly 10% of all solids analyses are performed in duplicate.
- Roughly 10% of all cell and reactor tests are run as duplicates.
- A blank cell and reactor containing no sample is being operated to check for contamination of leachates by construction materials.
- Individual leachate results are reviewed.
- Ion balances on leachate results are reviewed. In general, imbalances of ±10% are considered acceptable. Re-analysis if requested depending on the nature of the imbalance.
- Data trends in kinetic test leachates are analysed to check for anomalies.

5 Analytical Results for Samples Selected

Table 5 compares analytical results for all samples selected with concentrations calculated from individual intervals in the database. This table reflects the final sample selection following review of data to locate potential replacements, and replacement of one sample. The final three columns indicate the difference between calculated and analytical results using:

$$\% \text{ Difference} = \frac{\text{Target- Actual} \times 100\%}{\text{Target}}$$

Sulfur results showed the greatest percentage differences for samples in the non-reactive category. However, these differences reflect small absolute differences (0.01 to 0.02%) resulting from analytical variability near the detection limit. One sample was replaced in this category because it had 0.05% sulphur compared to target of 0.01%.

A few samples in the reactive class had differences between 50% and 100%. Review of the database indicated no suitable replacements.

One sample in the lean ore class showed a difference of 50%.

Based on these results, MDNR, SRK and PolyMet agreed that the sample selections mostly provided good coverage with respect to the targeted sample ranges indicated in Table 2 and that set up of kinetic tests could proceed.

Table 5: Comparison of Weighted Sample Characteristics Used for Sample Selection with Analytical Results for Interval Composites

Percentiles for Sulfur Contents

Unit	Rock Type	Parameter		Non-reactive			Reactive									Lean Ore							
				NR1	NR2	NR3	P10	P25	P50	P75	P80	P85	P90	P95	P100	P10	P25	P50	P75	P80	P85	P90	P95
1	Anorthositic	Target	Total S, %				0.08	0.1	0.15	0.29				1.09	1.09	0.11	0.26	0.36	0.93				1.95
		Test Material	Total S, %					0.09	0.18	0.05				0.68				0.18	0.86				1.83
	Sedimentary hornfels	Target	Total S, %				0.08	0.35	0.69	2.2	2.32	2.81	3.38	3.5	3.78	0.34	1.37	1.58	1.76				4.91
		Test Material	Total S, %				0.24	0.44	0.55	1.74		2.47						1.46					4.46
	Troctolitic	Target	Total S, %	0.01	0.03	0.05	0.06	0.07	0.1	0.18	0.21	0.26	0.34	0.62	1.97	0.08	0.15	0.24	0.42	0.49	0.55	0.68	0.98
		Test Material	Total S, %	0.02	0.04	0.06			0.07		0.19		0.44	0.88	1.68		0.08	0.36			0.42		0.91
	Ultramafic	Target	Total S, %				0.07	0.08	0.1	0.13	0.2	0.3	0.5	0.8	1.35	0.07	0.09	0.14	0.33	0.55	0.56	0.65	0.81
		Test Material	Total S, %					0.08			0.3	0.2	0.72	1.24				0.16	0.34		0.75		1.2
2	Anorthositic	Target	Total S, %	0.01	0.03	0.05	0.06	0.06	0.08	0.11				0.19		0.09	0.12	0.17	0.21				0.25
		Test Material	Total S, %	0.02	0.02	0.03																	
	Troctolitic	Target	Total S, %	0.01	0.03	0.05	0.06	0.06	0.07	0.09	0.09	0.1	0.11	0.12	0.25	0.05	0.07	0.12	0.18	0.2	0.22	0.26	0.32
		Test Material	Total S, %	0.04	0.04	0.06			0.08		0.07			0.18							0.17		0.15
	Ultramafic	Target	Total S, %	0.03	0.04	0.05	0	0	0	0				0		0.04	0.05	0.07	0.12	0.14	0.16	0.19	0.23
		Test Material	Total S, %	0.06	0.06	0.1														0.12			0.06
3	Anorthositic	Target	Total S, %	0.01	0.03	0.05	0.07	0.08	0.08	0.12				0.14		0.06	0.08	0.12	0.27				0.38
		Test Material	Total S, %	0.02	0.04	0.04																	
	Troctolitic (augite)	Target	Total S, %	0.01	0.03	0.05	0.06	0.06	0.08	0.1	0.11	0.12	0.14	0.19	0.36	0.05	0.13	0.19	0.32	0.35	0.45	0.48	0.52
		Test Material	Total S, %	0.02	0.04	0.06			0.06			0.14		0.25					0.28				0.59
4	Troctolitic	Target	Total S, %	0.01	0.03	0.05	0.06	0.07	0.09	0.18	0.19	0.19	0.48	0.92	1.53	0.09	0.15	0.22	0.47				1.52
		Test Material	Total S, %	0.03	0.04	0.04		0.08		0.21			0.51	0.77									1.37
5	Troctolitic	Target	Total S, %	0.01		0.05	0.07	0.09	0.11	0.16				0.22	0.22	0.12	0.17	0.26	0.37				0.45
		Test Material	Total S, %	0.02		0.06												0.23					0.32
6	Troctolitic	Target	Total S, %	0.02	0.04		0	0	0	0				0		0.01	0.01	0.03	0.07				0.19
		Test Material	Total S, %	0.04	0.05																		
20	Virginia	Target	Total S, %				0.59	1.25	2.98	4.15	4.49	4.85	5.07	6.06	7.45	0	0	0	0				0
		Test Material	Total S, %					2		3.79			5.68										

Deviations

Unit	Rock Type	Parameter		Non-reactive			Reactive									Lean Ore							
				NR1	NR2	NR3	P10	P25	P50	P75	P80	P85	P90	P95	P100	P10	P25	P50	P75	P80	P85	P90	P95
1	Anorthositic	Target	Total S, %																				
		Test Material	Total S, %					-10%	20%	-83%				-38%				-50%	-8%				-6%
	Sedimentary hornfels	Target	Total S, %																				
		Test Material	Total S, %				200%	26%	-20%	-21%		-12%						-8%					-9%
	Troctolitic	Target	Total S, %																				
		Test Material	Total S, %	100%	33%	20%			-30%		-10%		29%	42%	-15%		-47%	50%			-24%		-7%
	Ultramafic	Target	Total S, %																				
		Test Material	Total S, %					0%			50%	-33%	44%	55%				14%	3%		34%		48%
2	Anorthositic	Target	Total S, %																				
		Test Material	Total S, %	100%	-33%	-40%																	
	Troctolitic	Target	Total S, %																				
		Test Material	Total S, %	300%	33%	20%			14%		-22%			50%							-23%		-53%
	Ultramafic	Target	Total S, %																				
		Test Material	Total S, %	100%	50%															-14%			-74%
3	Anorthositic	Target	Total S, %																				
		Test Material	Total S, %	100%	33%	-20%																	
	Troctolitic (augite)	Target	Total S, %																				
		Test Material	Total S, %	100%	33%	20%			-25%			17%		32%					-13%				13%
4	Troctolitic	Target	Total S, %																				
		Test Material	Total S, %	200%	33%	-20%		14%		17%			6%	-16%									-10%
5	Troctolitic	Target	Total S, %																				
		Test Material	Total S, %	100%		20%												-12%					-29%
6	Troctolitic	Target	Total S, %																				
		Test Material	Total S, %	100%	25%																		
20	Virginia	Target	Total S, %																				
		Test Material	Total S, %					60%		-9%			12%										

Notes
Target sulfur levels for samples tested in humidity cells (selected by DNR).

Notes:
Greater than 100% deviation for non-reactive samples and between 50% and 100% deviation for reactive and lean ore samples.
Greater than 100% deviation for reactive and lean ore samples.

6 Implementation Schedule

The majority of waste rock testwork and some lean ore test work was implemented beginning August 8, 2005 following approval by MDNR on July 20, 2005. The balance of lean ore testwork was started on October 28, 2005. Based on the agreement between PolyMet and MDNR that 26 weeks will provide sufficient data for initial analysis, and allowing 8 weeks for reporting and quality assurance evaluations of metals results, the timing of 26 weeks of available data is as follows:

- Waste Rock –Early April, 2006.
- Lean Ore – Late June, 2006.

Based on these time frames, waste rock data will be reported in mid-May and lean ore in early August. These reports will contain recommendations for modifications to the test program. Termination of testwork will consider the following factors:

- Observation of stable trends for all monitored parameters. Stable is defined as a either flat or steady decrease in metal release.
- Demonstration that results for tests are similar and results can be grouped. Selected tests represent the groups of tests will be continued to demonstrate stability of trends.
- Similarity of results with previous DNR testwork.

It is recognized based on MDNR long term experience with kinetic testing of waste rock from other locations in the Duluth Complex that the pH of initial leachates may be elevated compared to long term pH, and that this may result in under-estimation of metal release. This factor will be considered when selecting samples for continuation.

7 Use of Data for Water Quality Predictions

7.1 Purpose of this Section

This section of the plan describes how the data obtained from kinetic tests are used as inputs into prediction of water chemistry for the NorthMet Project. Section 5.2 describes how water quality predictions fit into the overall mine planning process. Section 5.3 provides discussion on scaling up data obtained from small lab experiments to full scale site stockpiles and waste dumps.

7.2 General Context to Water Quality Predictions in Mine Planning

The ultimate objectives of geochemical characterization are to obtain data that can be used as inputs to:

1. Waste management planning (for example, is the rock/tailings acid generating and/or metal leaching?); and

2. Impact assessment (what concentrations of metals and other components might leach from rock/tailings?).

Figure 1 illustrates the general flow of data collection to achieve the above objectives. The bulk geological and geochemical characteristics (indicated by the geological and lithogeochemical models) are interpreted in the context of release rates and geochemical waste classification criteria, and are input into waste scheduling. The resulting waste composition allows release rate information to be used in scale-up calculations, which in turn are used to develop water chemistry predictions.

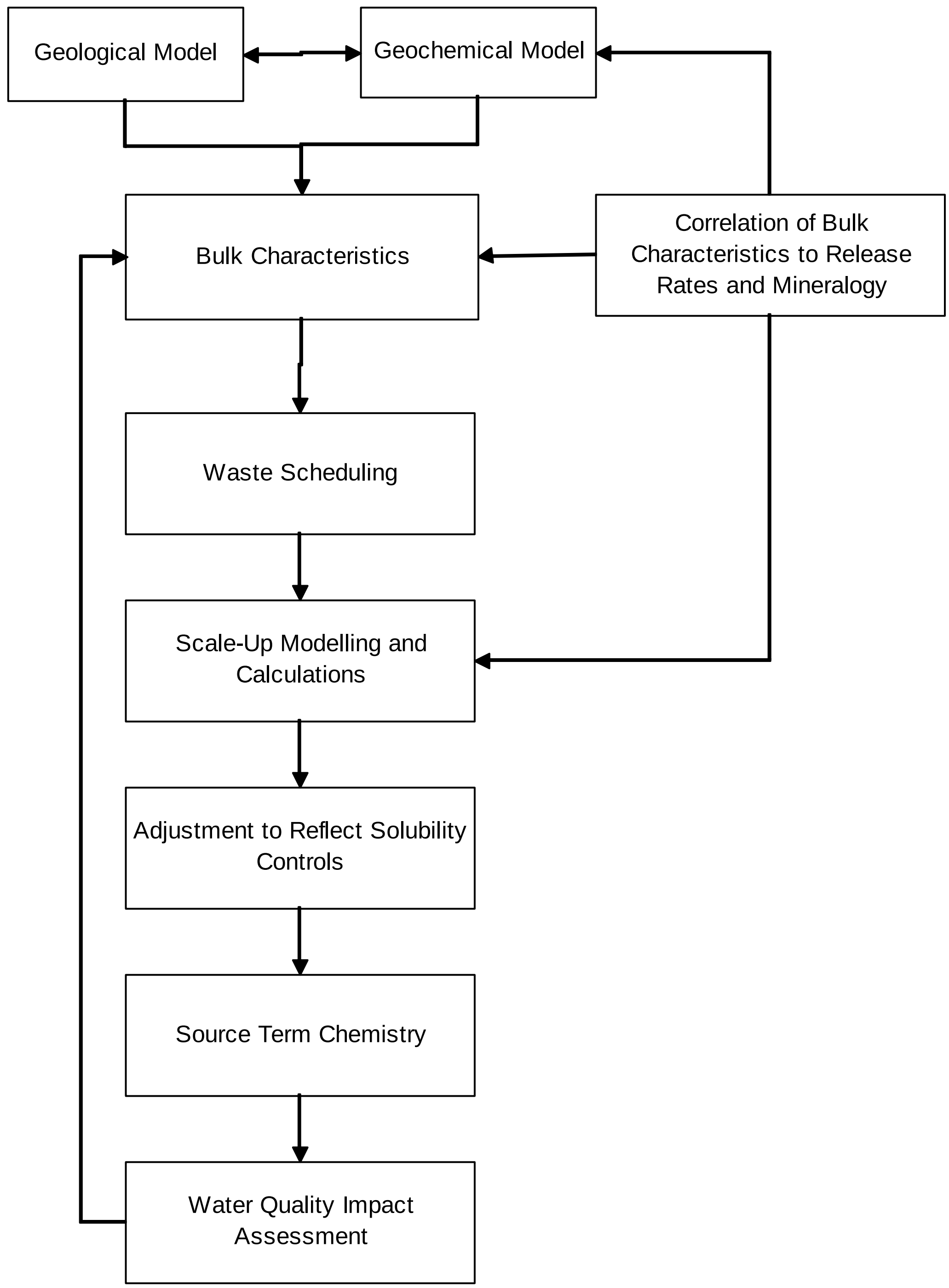

Figure 1: Flow of Information for Water Quality Predictions During Mine Planning

The overall components of geochemical characterization therefore include:

1. Bulk characterization of the rock mass using geological and/or geochemical variables that can be used to predict the waste characteristics for the purpose of waste management planning.
2. Correlation of the characteristics used for bulk characterization with relevant ML/ARD (metal leaching/acid rock drainage) variables and development of criteria based on that correlation (e.g. correlate sulfur content with acid generation and correlate metal leaching rates with bulk metal content).
3. Prediction of contaminant release rates on a mass basis from rock and tailings under various disposal scenarios.
4. Determination of water quality controls (e.g. solubility limits, attenuation effects etc.) for prediction of source term concentrations for individual facilities. Data obtained for this component will be used to adjust water quality predictions obtained from scale-up of laboratory kinetic tests.

All four components are relevant to both objectives and the process is iterative. For example, the last component may indicate parameters that should be used for classification of waste leading to requirements for waste modeling in the first component (Figure 1).

7.3 Approach to Developing Water Quality Predictions

A number of general approaches are available to obtain water quality predictions. These include:

- Theoretical (“First Principals”);
- Site comparisons; and
- Empirical

Discussion of each of these approaches is provided in the following sections.

7.3.1 Theoretical Approach

The theoretical approach involves working from first principals with reaction kinetics and thermodynamics for the processes involved in sulfide oxidation, acid neutralization and metal leaching and attenuation (MEND 2000). There are a number of limitations to this approach which include the difficulty of modeling processes for site-specific conditions. For example, sulfide mineral reactivity can vary widely due to differences in mineral type, occurrence, crystallinity and trace element content. To address these limitations, practitioners typically introduce site-specific calibrations for some processes resulting in predictions that contain empirical aspects. These calibrations may involve actual measurements of oxygen consumption rates, heat generation and seepage chemistry, most of which require that a waste rock dump exists. The ability to make predictions for completely new facilities is therefore limited using purely theoretical approaches (MEND 1995) and should not be pursued further for the NorthMet Project

7.3.2 Site Comparisons

Site comparisons are based on the assumption that mineralogy has a strong influence on water quality, and therefore that comparison of mineral deposits with similar mineralogy is a legitimate approach to making water quality predictions for facilities in the same geological setting.

For example, Caruccio and Ferm (1974) first proposed that paleo-environment is an important factor in determining water quality for coal mines because coal seams formed in salt water environments have higher initial sulfur content and are therefore more prone to generation of acid due to the formation of pyrite during lithification.

Recently, Red Chris Development Co. (2005) compiled data for six porphyry copper mine sites in western Canada and found strong similarities between geographically scattered sites despite variations in host rock geology and climate (for example Figure 2). Porphyry deposits form by interaction of hot water with volcanic or plutonic rocks typically in a sub-volcanic environment. The similarities in drainage chemistry reflected the relatively simple sulfide mineralogy of these deposits and the formation of common alumino-silicate alteration minerals.

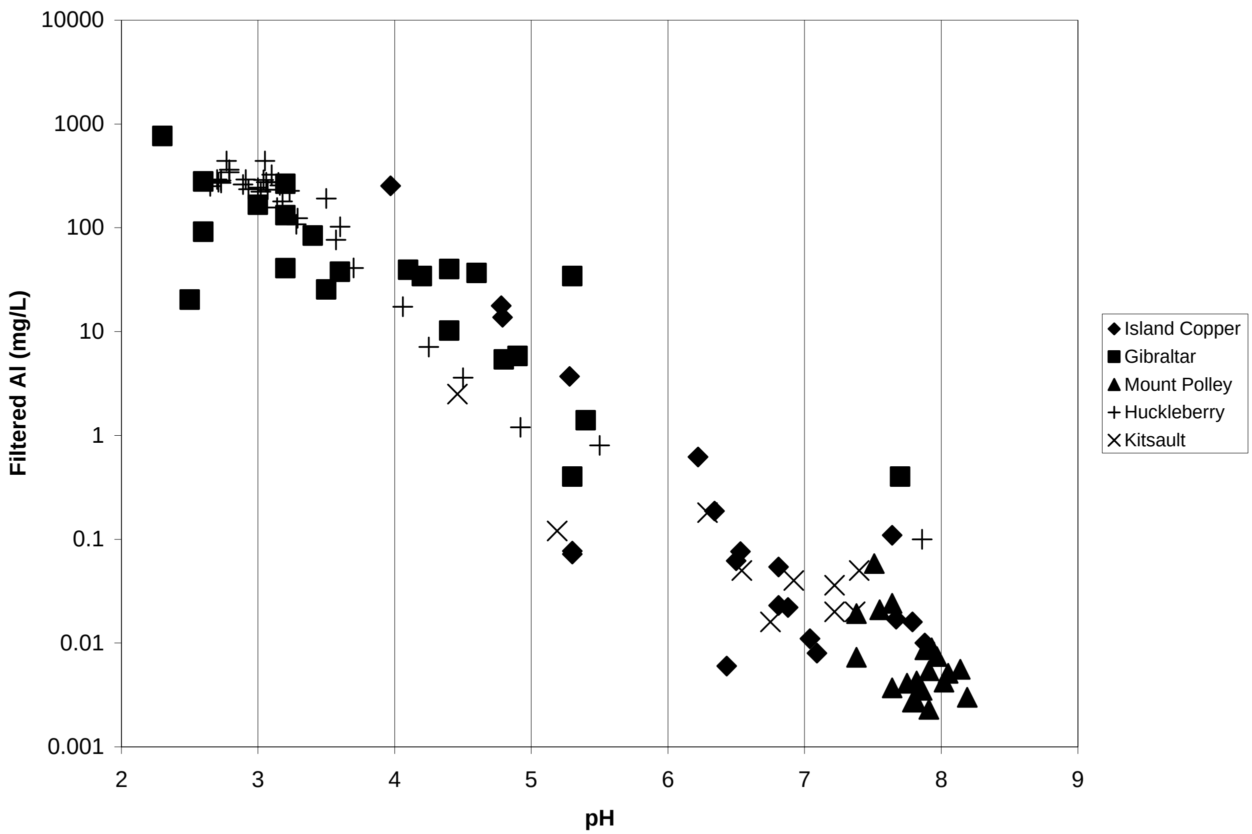

Figure 2: Strong Correlation between Aluminum Concentrations and pH for Porphyry Copper Deposits in Western Canada (Red Chris Development Co. 2004)

A limitation of these comparisons is that geographical proximity does not always guarantee geological similarity because ore forming processes can vary over short lateral and vertical distances, especially as a result of interaction with different rock types. An example of this limitation is seen at the Mount Washington mine site on Vancouver Island where two nearby pits have strongly acidic copper-bearing and non-acidic arsenic-bearing drainages (SRK 2000). The host rock geology is clearly different though for the two pits.

Based on the experience with site comparisons, there are a number of reasons to indicate that mineral deposits within the Duluth Complex can be compared including:

- Uniform, troctolitic to ultramafic composition of the mineralization and metamorphosed siliclastic footwall rocks (Virginia Formation);
- Relatively simple iron sulfide mineralogy; and
- Magmatic rather than hydrothermal mineral deposit formation.

The latter is particularly important because the ore-forming process in the NorthMet Deposit and nearby occurrences have not altered the associated primary silicate minerals. It is concluded therefore that the water quality data collected from nearby full-scale facilities (such as the Dunka Pit Duluth Complex waste rock dumps) and testwork should be factored into the water quality predictions for the NorthMet Project.

7.3.3 The Empirical Method

Introduction

The Empirical Method is also sometimes referred to as “scale-up calculations” because it involves translation of results from small laboratory or field tests to full-scale facilities. The attraction of this approach is that it involves the use of site-specific laboratory and field data, and does not rely on theoretical calculations. The results are transparent and easily explained. However, a significant issue is that the resulting concentrations are typically excessively conservative. This may be attractive for environmental assessment purposes but the resulting predictions may unreasonably over-predict the need for mitigation measures to address potential water quality impacts. A necessary component of the Empirical Method is the adjustment of resulting predictions to reflect basic geochemical controls and experience from other sites.

There are three main steps in the method:

1. Design of a laboratory program to collect rate information;
2. Calculation of concentrations based on rock mixtures, scale-up factors, and hydrological considerations; and
3. Adjustment of calculated concentrations to reflect geochemical constraints indicated by testwork, thermodynamic constraints and experience.

Additional description of these steps is provided in the following sections.

Laboratory Program

The laboratory program is designed to obtain weathering rates, typically expressed as mass of component released per mass of rock per week. Rates are obtained for all rock types and a range of the characteristics for each rock type. Generally, the objective is to obtain rates that can be correlated with bulk characteristics of the rock so that overall rates can be calculated for mixtures. Examples of strong correlations of sulfur content with sulfate release are common and include MDNR's humidity cell data (Figure 3). When good correlations are established, the data can be interpolated between points. For example, in Figure 3, although no rate was specifically measured at a sulfur concentration of 0.9%, it is reasonable to use the overall trend to interpolate a rate. Figure 3 also shows that since the correlation indicates no sulfate release if no sulfur is present, it is also reasonable to extrapolate between 0 and 0.2% sulfur.

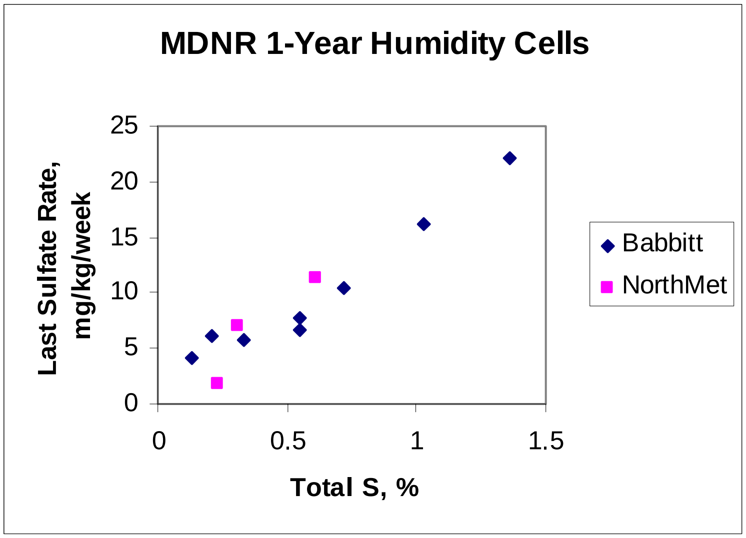

Figure 3: Correlation of Sulfur Content and Sulfate Release for MDNR ASTM Procedure Humidity Cells.

Calculation of Concentrations Using Scale-Up Factors

The purpose of the scale-up calculation is to convert laboratory measured generation rates (R) (for example in mg/kg/week) to seepage concentrations (C) (in mg/L). The scale-up calculations need to consider the rock type mixture, temperature effects, grain size, rock mass, flow path development, and water volume. Pore water concentrations are calculated for each rock type, then mixed according to the proportion of rock types indicated by the mine planners.

Temperature should be considered because oxidation rates decrease as temperatures decreases and vice versa. This correction is typically applied based on the average annual site temperature, and can be calculated using the Arrhenius equation. This equation provides a good approximation of actual rate decrease observed in laboratory experiments. The laboratory rate (R) is therefore adjusted using a constant factor (k_T) to obtain the adjusted rate (R_a):

$R_a = R.k_T$

This correction should be applied cautiously for reactive materials because the sulfide oxidation reaction is exothermic and will offset cooler site conditions.

The next step is to consider particle size effects. There are two issues to consider:

- Oxidation is a surface area phenomenon. A larger surface area provides a greater reactive surface area, and
- Reactive minerals encapsulated in large rock types do not oxidize at the same rate as exposed reactive particles because oxygen must diffuse through a solid rather than a gas.

Figure 4 illustrates the relationship between particle size and surface area for particles occurring as cubes. The graph shows that below a particle size of 0.1 cm, the available surface area increases exponentially. For larger particles, the area contribution is insignificant. Therefore, a standard humidity cell containing -¼” (0.6 cm) material provides a good representation of the surface area of a rock mixture containing much larger particles. For example, in a typical rock mixture containing 5% by weight finer than this size, the particles finer than 0.6 cm can account for 95% of the surface area.

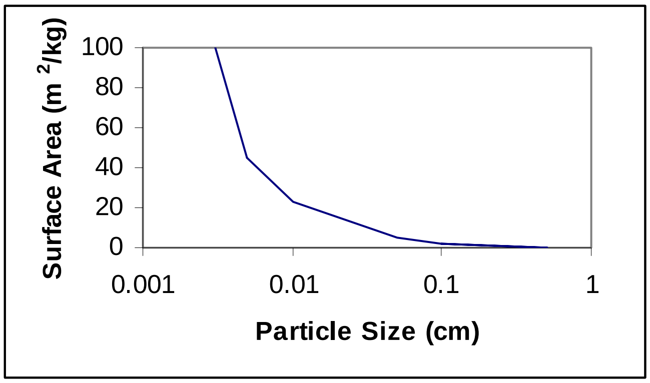

Figure 4: Particle Surface Area as a Function of Particle Size for Cubic Particles

The correction for particle size then becomes a ratio of the fine-grained reactive mass (M_r) to the total mass (M):

$R_a = R.k_T.(M_r/M)$.

The scale up of rate to full scale is then obtained by multiplying by M to obtain:

$R_a' = R.k_T.M_r$ (in mg/week).

R_a' is the scale-up of laboratory rate to field rate for total mass; however, it represents production rather than release because humidity cells are designed to be fully flushed. Under field conditions, the entire rock mass is not flushed due to flow path development. For thin waste rock dumps, flushing is likely to be relatively thorough but as the flow path length increases the degree of flushing decreases (eg Morin 1991; Morin and Hutt 1997). Simple calculations for long flow paths indicate that the proportion flushed may be as low as 20% (Day and Harpley 1992). R_a' can therefore be converted to leached mass (L) by multiplying by a flushed proportion (k_f):

$L = R.k_T.M_r.\ k_f$ (mg/week).

This leached loading can then converted to a concentration (C) by dividing by the volume of infiltrating water (Q):

$C = R.k_T.M_r.k_f/Q$ (mg/L).

The application of this method to calculation of actual concentrations is illustrated by the following example.

Adjustment of Calculated Concentrations – Example Calculation

Example Dataset

As noted previously, calculation of concentrations using the empirical method often results in unusually high concentrations and it is therefore necessary to evaluate the individual concentrations with consideration of chemical principals and experience from other sites. In order to explain the approach, a recently released dataset from the environmental assessment of a porphyry copper project is used (Red Chris Development Company 2004). For that project, fourteen ASTM-style humidity cells were operated on several rock types which included mineralized quartz diorite and andesitic volcanics and unmineralized siltstones. The resulting calculated average rates from two tests representing a range of conditions are provided in Table 6. The calculation applies to non-acidic drainage.

As an example calculation, concentrations were calculated using an input infiltration rate of 240 mm/year acting on a waste rock dump 50 m high. No temperature correction was applied (k_T), but it was assumed that the bulk of the surface area is contained in 10% of the waste rock and that 20% of the rock is actually flushed.

Evaluation and Adjustment of Major Parameters

The first step in evaluation of the calculated scale-up concentrations is to examine the major parameters (sulfate, calcium, magnesium, etc). An appropriate approach is to enter the data into a thermodynamic equilibrium model (such as MINTEQ, PHREEQE). These models can assist with identifying concentrations that are not supportable thermodynamically. For example, when dissolving common salt in a container of water, only a finite amount can be dissolved after which any additional salt remains as solid in the bottom of the container. The water is said to be saturated with respect to salt, and the resulting sodium and chloride concentrations in solution can be no greater than when the salt stops dissolving. The reverse is not always true though. It is possible for a solution to be over-saturated with respect to a solid during evaporation. In this case, the energy required to start forming (or nucleating) the first crystals is not available. The thermodynamic models must therefore be used cautiously.

Table 6: Example of Empirical (Scale-up) Calculation of Waste Rock Seepage Chemistry for pH Neutral Drainage Using Humidity Cell Data (from Red Chris Development Co. 2004)

Parameter	Unit	Typical Release for Specific Cells Rates		Calculated Concentrations		P_{95} Concentrations at Other Porphyry Mine Sites (pH>6)
		Major Parameters Low	Major Parameters High	Low	High	
		mg/kg/wk	mg/kg/wk	mg/L	mg/L	mg/L
SO_4		4	73	1633	26978	1526
Mo		0.0004	0.017	0.2	6	0.3
Cu		0.0003	0.0015	0.1	1	2
Pb		0.00005	0.0002	0.018	0.08	0.0002
Zn		0.0004	0.0051	0.2	1.9	0.7
Ni		0.00005	0.0013	0.017	0.50	0.07
Co		0.0001	0.0005	0.020	0.19	0.167
Mn		0.007	0.067	3	25	4
Fe		0.01	0.06	5	23	0.1
As		0.0002	0.0005	0.08	0.20	0.01
Cd		0.0000	0.0001	0.004	0.03	0.002
Ca		3.4	8.8	1254	3252	727
Mg		1.9	1.3	689	477	101
Al		0.040	0.094	15	35	0.1
Na		0.9	32	322	11772	53
K		1.1	0.7	397	275	37
Se		0.0002	0.0089	0.08	3.3	0.2
Si		0.28	0.62	104	229	34
Infiltration	mm/a			240	240	
Density	t/m^3			1.7	1.7	
k_T	-			1	1	
k_f	-			0.2	0.2	
M_r/M	-			0.1	0.1	
Dump Height	m			50	50	

In the case of this dataset, the initial evaluation would allow the following example incompatibilities to be assessed:

- Sulfate and calcium concentrations are much higher in the “high” case than would be expected based on the solubility of gypsum. Since gypsum is well known to form readily, the calcium and sulfate concentrations could be adjusted to reflect precipitation of gypsum.
- Aluminum is not soluble at these levels at neutral pH and could be adjusted to reflect the solubility of basic aluminum sulfates.
- Iron may be present at these concentrations but not under well-oxygenated conditions as would be present in a coarse waste rock pile. Iron hydroxides would be expected to form significantly lowering dissolved iron concentrations.
- Alkalinity was not calculated but can be estimated by assuming a carbonate mineral is present.

Downward adjustment of sulfate obviously impacts the charge balance of the water probably leaving a positive imbalance due to the high sodium and potassium concentrations. While this can be rectified by adding another anion (like chloride), the source of that anion needs to be justified (ie. chloride may not be present in the rock).

In summary, the result of the empirical calculation is a set of concentrations for major ions that typically exceed expected values. This indicates that some products of the weathering reactions remain stored in the rock and are not leached by infiltrating processes. This fact can be applied to adjustment of minor and trace parameters.

Evaluation and Adjustment of Minor and Trace Parameters

Evaluation of these parameters is treated separately because they occur at concentrations that are not a major component of the ion balance and with some exceptions occur at concentrations below limits implied by saturation controls. Copper and manganese concentrations in Table 5 are expected to be close to saturation limits for their carbonates and oxides at neutral pH and can therefore be adjusted to reflect the solubility of these minerals.

Other elements, including for example, lead, zinc, nickel cobalt, cadmium and selenium are predicted to be released at concentrations which seem to be “high” based on experience. In some cases, the concentrations are result of scaling up of detection limit values (for example, arsenic and lead). To refine the predictions for the project in the example, a database of seepage chemistry for other similar porphyry copper mine sites was evaluated. The 95th percentile concentrations from the database are shown in Table 7. Comparison of these concentrations to the calculated concentrations indicated that the calculated low-end lead, arsenic, cadmium and selenium concentrations are higher than the database concentrations, and all calculated high end concentrations are greater than the database concentrations. In other words, the empirical calculation is most likely over-estimating the concentrations of the main trace parameters.

The explanation for this effect is probably that these elements are being released as part of weathering processes but remain stored in the rock. The expected retention of iron represents a sink for these elements through sorption processes. Pyrite is the dominant source of iron, and is likely also the source for many trace elements. The ratio of iron to other metals is very high and represents a significant source of sorptive capacity. Since this process is pH dependent, it is expected that metal concentrations would be negatively correlated with pH. An example of this type of relationship used as part of this example is shown in Figure 5. Data for two sites show that nickel concentrations are strongly related to pH. For example, between pH 4 and 7.5, the data from Huckleberry Mine shows a negative correlation with pH. Likewise, the Island Copper Mine dataset shows a good correlation throughout the pH range.

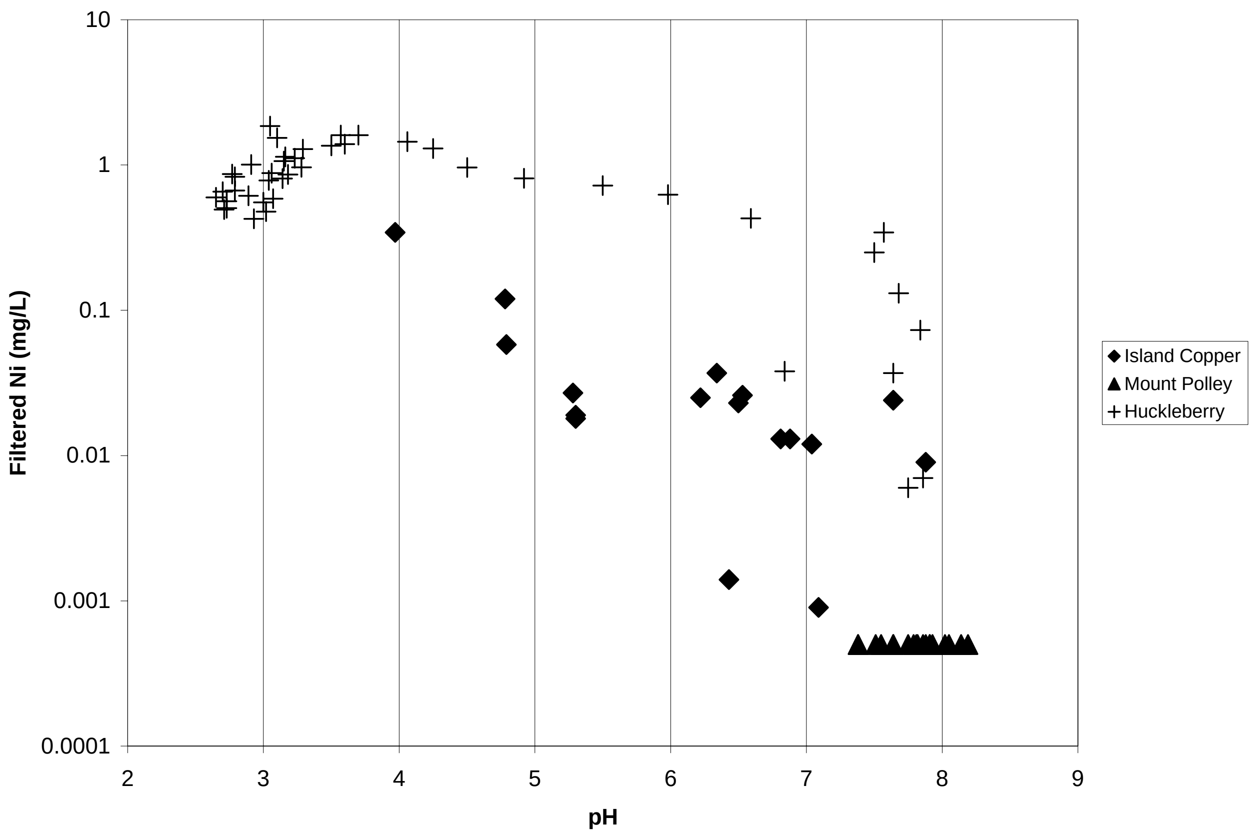

Figure 5: Example of Relationship Between Nickel Concentrations and pH (Red Chris Development Company 2004).

Example of Combined Empirical and Site Comparison Approach in Alaska

Water quality predictions waste rock and dry stack tailings for the recently permitted Pogo Project in Alaska were obtained using a combination of empirically-calculated concentrations scaled-up from humidity cells adjusted to reflect concentrations observed in groundwater, surface water, leach columns, meteoric water extraction procedures and seepage from a pile of waste rock from underground development.

Documentation from the project can be obtained from:

http://www.dnr.state.ak.us/mlw/mining/largemine/pogo/

7.3.4 Implementation for the NorthMet Project

The proposed overall approach is comparable to the combined empirical and site comparisons approach described in the example above. The initial empirical calculation will be based on interpolation and extrapolation of humidity cell results with adjustments for major parameters based on thermodynamic equilibrium calculations and reference to concentrations measured in test pile and waste rock pile drainage.

Scale-up of low concentrations of nickel and cobalt in the non-reactive rock category (sulfur less than 0.05%) is expected to require additional data since the majority of testwork to date has been focused on "reactive" rock containing higher concentrations of sulfur. Since drainage from non-reactive materials is expected to be non-acidic, reliable relationships that indicate correlations between metal concentrations and pH (for example, as shown in Figure 3 and see also Norecol Dames & Moore 1996) may be used to predict metal concentrations. The limitation of the current dataset is that nickel can be expected to be very mobile under non-acidic conditions when the metal to iron ratio is high (for example, if pentlandite is present). A distinctive water quality dataset is needed for low sulfur rock piles. The following approaches may be considered:

- Sampling of seepage from existing Duluth Complex waste rock piles or rock exposures known to contain low concentrations of sulfur.
- Evaluation of oxide coatings to understand the attenuation of metals and comparison with loads leached from humidity cells. Generally speaking, sulfate is conservative in slowly reactive humidity cells, therefore if the nickel to sulfur ratio is lower in the leachate than the sulfide minerals, then nickel is being attenuated (assuming that nickel originates from oxidation of sulfides). Likewise, comparison of iron and nickel release with iron and nickel ratios in sulfides and oxides coatings will indicate how nickel is attenuated relative to iron.

7.4 Conclusions

An empirical scale-up approach is proposed to translate weathering rates observed in humidity cells to full-scale concentrations. The resulting predicted concentrations will be evaluated and adjusted based on solubility constraints and data from existing monitoring. The incorporation data from past or existing waste rock facilities (AMAX test piles, Dunka Pit waste rock) ensures that the predictions are consistent with large scale operational experience. Additional testing may be designed to evaluate mobility and attenuation of metals such as nickel and cobalt.

8 References

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Appendix A

Parameter Lists and Detection Limits for Analysis of Solids

ALS/CHEMEX METHOD CODE	ITEM	UINTS	CHEMEX DETECTION LIMIT
ME-ICP61 (four acid)	CU%	%	0.001
ME-ICP61 (four acid)	NI%	%	0.001
S-IR08 (LECO SULFUR)	S%TOT	%	0.01
ME-ICP61 (four acid)	S%ICP	%	0.01
PGM-ICP23 (30 GRAM)	PT_PPB	PPB	5
PGM-ICP23 (30 GRAM)	PD_PPB	PPB	1
PGM-ICP23 (30 GRAM)	AU_PPB	PPB	1
ME-ICP61 (four acid)	CO_PPM	PPM	1
ME-ICP61 (four acid)	AG_PPM	PPM	0.5
ME-ICP61 (four acid)	ZN_PPM	PPM	2
ME-ICP61 (four acid)	CD_PPM	PPM	0.5
ME-ICP61 (four acid)	MO_PPM	PPM	1
ME-ICP61 (four acid)	PB_PPM	PPM	2
ME-ICP61 (four acid)	AS_PPM	PPM	5
ME-ICP61 (four acid)	CR_PPM	PPM	1
ME-ICP61 (four acid)	V_PPM	PPM	1
ME-ICP61 (four acid)	TI%	%	0.01
ME-ICP61 (four acid)	AL%	%	0.01
ME-ICP61 (four acid)	CA%	%	0.01
ME-ICP61 (four acid)	FE%	%	0.01
ME-ICP61 (four acid)	K%	%	0.01
ME-ICP61 (four acid)	NA%	%	0.01
ME-ICP61 (four acid)	MG%	%	0.01
ME-ICP61 (four acid)	MN_PPM	PPM	5
ME-ICP61 (four acid)	P_PPM	PPM	10
ME-ICP61 (four acid)	BA_PPM	PPM	10
ME-ICP61 (four acid)	BE_PPM	PPM	0.5
ME-ICP61 (four acid)	BI_PPM	PPM	2
ME-ICP61 (four acid)	SB_PPM	PPM	5
ME-ICP61 (four acid)	SR_PPM	PPM	1
ME-ICP61 (four acid)	W_PPM	PPM	10

ALS/CHEMEX METHOD CODE	ITEM	UINTS	CHEMEX DETECTION LIMIT
ME-ICP41 (Aqua regia digestion)	CU%	%	0.001
ME-ICP41 (Aqua regia digestion)	NI%	%	0.001
ME-ICP41 (Aqua regia digestion)	S%ICP	%	0.01
ME-ICP41 (Aqua regia digestion)	CO_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	AG_PPM	PPM	0.2
ME-ICP41 (Aqua regia digestion)	ZN_PPM	PPM	2
ME-ICP41 (Aqua regia digestion)	CD_PPM	PPM	0.5
ME-ICP41 (Aqua regia digestion)	MO_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	PB_PPM	PPM	2
ME-ICP41 (Aqua regia digestion)	AS_PPM	PPM	2
ME-ICP41 (Aqua regia digestion)	CR_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	V_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	TI%	%	0.01
ME-ICP41 (Aqua regia digestion)	AL%	%	0.01
ME-ICP41 (Aqua regia digestion)	CA%	%	0.01
ME-ICP41 (Aqua regia digestion)	FE%	%	0.01
ME-ICP41 (Aqua regia digestion)	K%	%	0.01
ME-ICP41 (Aqua regia digestion)	NA%	%	0.01
ME-ICP41 (Aqua regia digestion)	MG%	%	0.01
ME-ICP41 (Aqua regia digestion)	MN_PPM	PPM	5
ME-ICP41 (Aqua regia digestion)	P_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	B_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	BA_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	BE_PPM	PPM	0.5
ME-ICP41 (Aqua regia digestion)	BI_PPM	PPM	2
ME-ICP41 (Aqua regia digestion)	GA_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	HG_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	LA_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	SB_PPM	PPM	2
ME-ICP41 (Aqua regia digestion)	SC_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	SR_PPM	PPM	1
ME-ICP41 (Aqua regia digestion)	W_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	TL_PPM	PPM	10
ME-ICP41 (Aqua regia digestion)	U_PPM	PPM	10

ALS/CHEMEX METHOD CODE	ITEM	UINTS	CHEMEX DETECTION LIMIT
ME-ICP06--whole rock geochemisrty by ICP-AES	SIO2	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	AL203	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	TIO2	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	FE2O3	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	CAO	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	MGO	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	MNO	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	NA2O	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	K2O	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	P2O5	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	BAO	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	SRO	%	0.01
ME-ICP06--whole rock geochemisrty by ICP-AES	LOI	%	0.01

Appendix B

Options and Variance in ASTM Humidity Cell Procedure

9. Sample Preparation

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
9.1	Air dry as-received bulk samples of solid material to prevent the additional oxidation of reactive minerals or compounds. If air drying is not practicable, oven dry the solid material at a maximum temperature of 50 ± 2°C for 24 h, or until a constant weight is reached.	Samples were air-dried at room temperature (~ 20 °C).	
9.1.1	If exploration-generated or run-of-mine solid material samples are not readily available, archived dried and crushed samples from geological exploratory or development drilling programs may be used for preliminary evaluations of ore and waste rock from new operations; this is provided that the available solid material samples are not significantly finer than 95 % passing a No. 12 (1.7-mm) sieve. Document the sample drying and preparation procedures used during the drill sampling program in order to interpret the results properly. Evaluate the effects of drying temperature on metals volatilization (for example, mercury in cinnabar vaporizes at temperatures exceeding 80 to 90°C) and mineral morphology and chemistry modifications (for example, on heating at temperatures exceeding 100°C, chalcocite changes crystal form and is oxidized subsequently from Cu_2S to CuO, $CuSO_4$, and SO_2). Especially ensure that the effects of particle size distribution changes resulting from the more finely crushed sample are considered in the interpretation (this is, the potential for increased liberation of acid-producing and acid-consuming minerals with an attendant increase in mineral surface area).	NA	
9.1.2	In mining waste evaluations, the particle size for mill tailings will be significantly finer (commonly less than 150 µm/100 mesh) than the particle size distributions from ore and waste rock. Pilot plant tailings should be used if mill tailings are not available.	NA	
9.2	Screen the air-dried bulk samples through a 6.3-mm (¼-in.) screen in accordance with Test Method E 276. Crush any oversize material so that 100 % passes the screen.	ASTM	

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
Note 7	Caution: Recent accelerated weathering studies of run-of mine waste rock from metal mines demonstrate that crushing a bulk sample so it passes a 6.3-mm (¼-in.) screen may change the character of the sample by artificially increasing liberation and consequent surface areas of acid-producing and acid-consuming minerals contained in the + 6.3-mm (¼-in.) material. A suggestion for avoiding this problem is to segregate the - 6.3-mm (¼-in.) fraction by screening rather than crushing, and to test that fraction according to the protocol and equipment described in this text. The + 6.3-mm (¼-in.) material can be tested separately (for example, Brodie, et al (10) describe a large-scale humidity cell test that would accommodate – 75-mm material). Samples from the drill core and cuttings also present material sizing problems, which must be considered when interpreting drill core and cuttings accelerated data. The drill core must be crushed to -6.3-mm (¼-in.) to fit the cell described in this test method. The resulting size distribution from crushing will differ from that of run-of-mine due to differences in fracture patterns inherent to blasting practices that produce run-of-mine material. By contrast, drill cuttings size fractions are commonly less than 6.3-mm (¼-in.) due to the rotary-percussive nature of obtaining the sample.	NA	

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
9.3	Mix and divide the bulk sample to obtain a representative test unit with a weight in the range of 8 to 10 kg, using a riffle splitter with 1-in. (2.54-cm) chutes. Divide the test unit into eight nominal 1-kg specimens. Seal each test specimen in a moisture-barrier bag.	Samples mixed by riffle splitter, but different sample weights were available (see column at the right).	All material available for each sample was mixed by the riffle splitter (0.552 kg – 10.54 kg). The test unit was divided into the following amounts: Samples received June 06, 2005 (lean ore): 150 – 200 g for Chemex Assay; Reject for archive, screen assay, etc. Samples received May 20, 2005 (waste rock): 200 g for Chemex Assay, 50 g of crushed archive, 100 g for screen assay, store rejects for HC
Note 8	The dried sample should be mixed through the riffle splitter at least once before making any splits; recombine the splits resulting from the sample mixing exercise by pouring individual splits either over each other or through the splitter again. Once the actual split is made, it is wise to re-mix it (according to the above procedure) prior to making the next split.		Samples were mixed through the riffle splitter once.
9.4	Select one test specimen at random, and determine the moisture content by weighing and drying to constant weight at 80 ±5°C.		Determined at 20 °C
9.4.1	Crush the dried test specimen so that at least 95 % passes a 1.7-mm (10-mesh) screen, in accordance with Test Method E 276.		See 9.3
9.4.2	Divide the crushed test specimen in half twice, using a riffle splitter with 6.35-mm (¼-in.) chutes, and select a ¼ subsample at random.		See 9.3
9.4.3	Transfer the selected subsample to a ring and puck grinding mill and grind to a nominal of 95 % passing a 150-µm (100-mesh) screen, in accordance with Test Method E 276. Use the subsample for chemical and mineralogical characterization of the test unit.		See 9.3

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
9.5	Select one test specimen at random, and determine the particle size distribution in accordance with Test Method E 276.		100 g were removed after 9.3 for screen assays: -1/4" + 10 mesh, -10 mesh + 35 mesh, -35 mesh + 100 mesh, -270 mesh; each size was weighed and submitted to Chemex for Total S (S-IR08) and four acid digestion (ME-ICP61).
9.6	Select one test specimen at random for use in the accelerated test method. Divide the test specimen into four nominal 250-g subsamples using the riffle splitter with 25.4-mm (1-in.) chutes, and label and store in vapor-barrier bags until it is time to load the humidity cells.	See 9.3 - variance column	
9.7	Reserve the remaining test specimens for replicated testing or to resolve disputed results.	See 9.3 - variance column	

10. Apparatus Assembly

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
10.1	The humidity cells are table-mounted at a height sufficient to accommodate the placement of both the humidifier and one Erlenmeyer flask for effluent collection from the bottom of each cell. During the water-saturated and dry-air portions of each weekly cycle, feed air is metered to the bottom of each cell at the selected rate (1 to 10L/min). Feed air for the three-day dry–air portion is routed first through a desiccant column and then to each of the cells through a dry-air manifold. Feed air for the water-saturated air portion is routed through a water-filled humidifier by means of aeration stones or gas dispersion fritted cylinders/disks, and then to each humidity cell lid air exit port to prevent the short circuiting of air through cells containing more permeable solid material samples. A separatory funnel rack is mounted on the table that holds the cells if the weekly water leach is applied dropwise (drip trickle). Multiple separatory funnels (one for each cell) are held in the rack during the drip trickle leach that is performed on the seventh day of each weekly cycle. The separatory funnel can be used to meter the required water volume slowly down the sides of the cell wall until the sample is flooded if the weekly leach is to be a flooded leach.	Humidity cells are constructed of acrylic tubing with an inside diameter of four inches and an overall height of twelve inches, with an acrylic base plate. The base plate is glued to the tube and threaded with a nylon hose adapter to which a length of tubing is attached to allow for leachate drainage into a collection container. A perforated PVC support plate is positioned inside the cell, one inch above the base plate and covered with six layers of nylon mesh. A nylon adapter is threaded into the side of the cell between the support plate and the base plate and a length of tubing was connected from the side adapter to the humidifier to facilitate the inflow of humid air to the cell. A dry air line is also connected to each cell. Each cell is covered with a removable acrylic lid.	Approximately 16 cells per humidifier Flood leaching: peristaltic pump using a peristaltic pump Temperature: 20 ± 2°C. Feed air rate to be determined.

11. Procedure

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
11.1	Cell Loading:		
11.1.1	If more than one humidity cell is used at one time, label each with a sequential number, and use the same number for the matching collection vessel (Erlenmeyer flask).	ASTM	
11.1.2	Weigh each humidity cell (without its lid) and each collection vessel; record the tare weights of each to the nearest 0.1 g.	ASTM	
11.1.3	Cut the filter media (such as 12-oz/yd^2 polypropylene described in 6.11) to the humidity cell's inside diameter dimensions so that it fits snugly yet lies flat on the perforated support.		PVC perforated disk & nylon mesh
11.1.4	Re-weigh the humidity cell, and record the resulting tare to the nearest 0.1 g; the original cell tare (11.1.2) minus the new cell tare is the weight of the filter media.	ASTM	
11.1.5	Transfer the contents from each of the four bags containing the 250-g samples (9.6) into the humidity cell. Prior to the transfer, mix the contents of each bag by gentle rolling to eliminate possible stratification that may have occurred during sample storage.	ASTM	
11.1.6	Re-weigh the loaded cell, and record the weight to the nearest 0.1 g; the loaded cell weight minus the combined cell and filter-media tare weight is the weight of the sample charge.	ASTM	
11.2	First Leach:		

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
11.2.1	The first leach (whether drip trickle or flooded), designated as the Week 0 leach, initiates the 20-week long humidity cell test and establishes the starting or initial characteristics of the leachate. Either a 500-mL or 1-L volume of water may be used for the weekly leachates, depending on the weekly pore volume desired or the quantity of solution required for analytical purposes; however, once a weekly volume has been selected, that weekly volume must remain constant throughout the 20-week testing period. A centrifuged cell culture of *Thiobacillus ferrooxidans* may be used in the first leach in order to ensure that optimum conditions for accelerates weathering are present at the beginning of the test.	500 mL Flood Leach	
Note 9	In the testing of mining wastes, cation (including metals and trace metals) and anion loadings are commonly high in the Week 0 leachate due to the dissolution of pre-existing soluble oxidation salts present in the sample prior to sample collection. The average number of weekly accelerated weathering cycles required to flush these pre-existing salts ranges from 3 to 5 weeks. Oxidation products observed during these 3 to 5 weeks are principally from the pre-existing salts, while those products observed after this period are considered to be solely a function of the accelerated weathering procedure. A method for estimating the amount of pre-existing oxidation salts present in a solid material sample is described by Sobek, et al (6). A comparison of estimated salt storage data obtained using this method with the first thee weeks of humidity cell effluent loadings from three different samples is describes by White and Jeffers (7).	NA	
11.2.2	Fill a separatory funnel with for each cell with de-ionized water using a volumetric flask. If the leach is to be performed using the drip trickle method, set each separatory funnel above its corresponding cell, and adjust the drip rate (approximately 3 to 4 L/min) so that the solid material sample is wetted thoroughly but not flooded.	NA	
11.2.3	A minimum of 2 to 3 h is commonly required to complete the drip trickle leach.	NA	

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
11.2.4	If the leach is to be performed by flooding, the separatory funnel can be used to meter the selected water volume slowly down the sides of the cell wall until the sample is flooded. This application method reduces hydraulic agitation of the sample surface commonly caused by pouring liquid from an open-mouthed vessel. Alternatively, flooding may be accomplished by any application apparatus (for example, a peristaltic pump) that supplies the selected volume of leachant at a reasonable rate without causing agitation and suspension of the finer fractions contained in the sample charge.	ASTM	
11.2.4.1	Allow the flooded cell to sit for a period of 1 h before draining the leachate into the Erlenmeyer collection flask. The 1-h leach time commences after all of the leachant has been placed in the cell. The solid material sample should be saturated and covered with leachant to a depth sufficient to maintain sample saturation. In testing mining wastes, the observed depth of leachant cover from a 500-mL flooded leach performed in 10.2-cm (4.0-in.) ID cells is approximately 2.5 cm (1.0 in.).	ASTM	
11.2.5	The following is performed once the leaching process has been completed: to reduce the effects of evaporation, and to prevent the contamination of each cell by airborne contaminants, place the lids on their corresponding cells and let the cells complete the leachate draining process for the remainder of the leaching day and overnight.	ASTM	
11.2.6	Disconnect the cells on the day following the leach, and weigh and record the weight of each cell and Erlenmeyer collection flask. Set each filled collection flask aside for leachate analyses. (Measurements of pH and Eh and sample preservation procedures must be performed as soon as possible after leachate collection.) Return each cell, replace the filled collection flasks with clean, tared Erlenmeyer flasks, hook up all connections, and begin the dry-air cycle.	ASTM	
11.3	Dry-Air Cycle:		

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
11.3.1	The commencement of the three-day dry-air period marks the beginning of each new weekly cycle of the accelerated weathering humidity cell test; the first full-week cycle after the first leaching is designated Week 1; subsequent weeks (commencing with the second dry-air period) are designated as Week 2, Week 3 … . Week n, etc.	ASTM	
11.3.2	To perform the dry-air cycle, feed air is metered to the humidity cell array with a flowmeter (see 6.3) set at a target rate in the range of 1 to 10 L/min per cell, depending on the objectives of the testing. The air flow rate must be checked daily and adjusted to the target value ± 0.5 L/min.	ASTM	
11.3.3	Feed air from the flowmeter is routed first through a desiccant column and then to each of the sells through a dry-air manifold. Air exiting the desiccant column should have a relative humidity of less than 10 % as measured with a hygrometer (see 6.23).	ASTM	
11.3.4	To maintain similar positive air pressure through the cells, attach a water-bubbling vessel to each humidity cell air exit port coming out of the humidity cell lid; a 50-mL Erlenmeyer flask with a rubber stopper containing a vent and air inlet tube serves as a simple and efficient bubbler.	ASTM	
11.3.5	The dry air is passed through each humidity cell for three days. Air flow rates from each of the cells should be checked each day, recorded, and adjusted, if necessary. See also Note 10.	ASTM	
11.4	Wet-Air Cycle:		
11.4.1	The three-day wet-air period commences on the fourth day of each weekly cycle.	ASTM	
11.4.2	To perform the wet-air cycle of the method, feed air is routed through a water-filled humidifier via aeration stones or gas dispersion fritted cylinders/disks and then to each humidity cell.	ASTM	
11.4.3	The water temperature in the humidifier is maintained at 30 ± 2°C to ensure that the sparged air maintains a relative humidity of approximately 95 % as measured with a hygrometer (see 6.23) from one of the humidifier exit lines. Air flow rates to each of the cells should be checked each day, recorded, and adjusted, if necessary.	ASTM	

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
Note 10	It is good practice to measure the air flow rates and relative humidity of the air exiting each humidity cell during each day of the three-day dry- and wet-air periods; the measurements should be taken at the same time each day from the humidity cell air exit port; these measurements can be accomplished by installing a quick-disconnect fitting in the tubing that connects the air exit port to the bubbler.	NA	
Note 11	Coals spoils in eastern states are commonly saturated; Caruccio (10) has suggested the following geographic control alternative to the dry-air versus saturated-air scheduling: (1) Eastern States Samples – Six days of saturated air (versus three days dry/three days wet); and (2) Western States Samples – Three days dry/three days wet.	NA	
11.5	Subsequent Weekly Leaches:		
11.5.1	A second leach with water is performed on the day following the end of the three-day wet-air period (that is, day seven of the first weekly cycle). This leach marks the end of the first weekly cycle and is designated as the Week 1 leach.	ASTM	
11.5.2	Subsequent leaches are designates as Week2, Week 3 … Week n, and they mark the end of the weekly cycle for that numbered week. Perform each weekly leach as described in 11.2.2 – 11.2.5. Weekly weighing of the test cells is optional.	ASTM	No weekly weighing of the cells.
11.6	It is recommended that the weekly accelerated weathering cycles described in 11.2, 11.3, 11.4 and 11.5 be performed for a minimum of 20 weeks.	ASTM	
Note 12	Additional weeks of accelerated weathering may be required to demonstrate the nature of the material, depending on the chemical composition of the solid material. For some metal mining wastes, researchers have shown that as much as 60 to 120 weeks of accelerated weathering data may be required to demonstrate the complete weathering characteristics of a particular sample (7, 12). The criteria for ending the testing may be site specific and should be agreed before initiating the testing.	ASTM	
11.7	Leachate Analyses:		

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
11.7.1	Analyze the leachates for specific constituents or properties, or use them for biological testing procedures as desired, using (1) appropriate ASTM test methods or (2) methods accepted for the site where disposal will occur. Where no appropriate ASTM test method exists, other test methods may be used and recorded in the report, provided that they are sufficiently sensitive to assess potential water quality impacts at the proposed disposal site. Suggested minimum weekly analyses should include pH, Eh, conductivity, and selected metals could be analyzed less frequently (for example, at Weeks 0, 1, 2, 4, 8, 12, 16, and 20), especially if changes in leachate chemistry are slow. Whether visible phase separation during storage of the leachates occurs or not, appropriate mixing should be used to ensure the homogeneity of the leachates prior to their use in such analyses.	At the end of weekly cycle the volume of leachate collected is recorded. The leachate is filtered through a Gelman magnetic filter funnel fitted with a membrane filter with pore size of 0.45 microns and analyzed for the parameters listed in Table 2 of the RFP. Filtered leachate samples will be submitted to ALS Environmental/Cantest Ltd. for dissolved metals analysis as requested in Table 4 of the Waste Rock and Lean Ore Geochemical Characterization Plan. Conductivity, Eh, and pH are measured in the CEMI laboratory using standard procedures. An aliquot of filtered leachate is titrated with standardized sulphuric acid to pH 4.5 to calculate total alkalinity. Standardized sodium hydroxide is used to titrate an aliquot of leachate to pH 4.5 and to pH 8.3 to calculate total acidity. Analysis frequency: pH, cond, Eh every cycle; SO4, Cl, F, alkalinity, TIC, acidity cycle 0, 2, 4, 6 etc.; ICP-MS including Hg and Si cycle 0, 4, 8, 12, etc., ICP-ES including Si cycle 2, 6, 10, 14, etc.	
11.7.2	Table 1 is an example of a spreadsheet format used for recording 20 weeks of leachate analytical data.	ASTM	
11.7.3	Fig. 5 is an example of a method used to plot the temporal variation (by week) of leachate pH, sulfate load, and cumulative sulfate load from 21 weeks of accelerated load and release rates).	ASTM	
11.8	Weathered Solid Material Analyses:		

Section	**ASTM Procedure Description**	**Description of CEMI Procedure** **NA – Not applicable to this Project** **ASTM – ASTM Procedure Followed**	**CEMI Variance from ASTM**
11.8.1	Weigh the humidity cell after collection of the final effluent and completion of a three-day dry-air period.	ASTM	
11.8.2	Transfer the weathered residue and filter media to a clean drying pan, and dry to constant weight at 50 ± 5°C. Record the final weight.	ASTM	
Note 13	Perform any gross sample examination (for example, sample texture and weathering product mineralogic characterization) desired for the weathered residues prior to pulverization. To facilitate such an examination, empty the humidity cell contains into a clean drying pan carefully by pushing gently on the bottom of the perforated plate with a wooden dowel until the sample exits the cell mouth. The perforate plate is accessed through the humidity cell drain port.	NA	
11.8.3	Identify and mark the top versus bottom portions of the sample for gross sampling purposes. Formations of cemented lumps of sample termed “ferricrete” that result from the accelerated weathering process arte common in iron-sulfide-mineral rich samples. Depending on the sample mineralogy, the degree of “ferricrete” cementation may vary vertically within the sample, and the investigator may wish to segregate the sample into upper, middle, and lower thirds to document and characterize such changes.	Procedure to be determined	
11.8.4	After drying to constant weight and prior to splitting, use an instrument such as a rolling pin to break up cemented lumps in the sample (if the cemented lumps cannot be sufficiently reduced to pass through the chutes of a riffle splitter, remove, record, and weigh separately):	ASTM	
11.8.4.1	Split the sample into halves using a riffle splitter with 2.54-cm (1-in.) chutes, and reserve one half to determine the particle size distribution in accordance with Test Method E 276.		Repeat same screen assay method as for pre-test characterization (s.9.5)
11.8.4.2	Split the remaining half sample into two quarters using a riffle splitter with 2.54-cm (1-in.) chutes, and submit one quarter for mineralogical characterization; pulverize the other quarter in either a ring-and-puck or disk-pulverizing machine to 95 % passing a 150-µm (100-mesh) screen in accordance with Test Method E 276.	Procedure to be determined	

Section	ASTM Procedure Description	Description of CEMI Procedure NA – Not applicable to this Project ASTM – ASTM Procedure Followed	CEMI Variance from ASTM
11.8.5	Mix the pulverized residue in a blender or on a rolling cloth. Use the prepared residue for chemical characterization and for comparison with the pre-weathered solid material sample.	Procedure to be determined	

Appendix C

Design of MDNR Reactor

Day, Stephen

From: Kim Lapakko [kim.lapakko@dnr.state.mn.us]
Sent: Tuesday, May 17, 2005 9:55 AM
To: Stephen Day
Cc: Dave Antonson; Jennifer Engstrom; Paul Eger
Subject: RE: Small reactor

Attachments: MN DNR psize methods 050517.doc

MN DNR psize
nethods 050517.do.

Steve,

Attached is a description of the reactors, masses, and rinse volumes used for various size fractions of Duluth Complex rock in our particle size experiment. As indicated in the attachment, I won't have access to the trace metal data from that experiment until tomorrow. I will need to examine this to help evaluate the expected metal concentrations in drainage relative to detection limits. I'm not sure it will give us as much as hoped because the sulfur contents of the samples typically were on the order of 0.9% to 1.3%. This may make extrapolation by more than an order of magnitude tenuous. It will be another pertinent piece of information.

Kim

>>> "Stephen Day" <sday@srk.com> 5/17/2005 11:18:50 AM >>>
Dave

A design drawing should be fine along with description of the procedure.

The main question is what do you do to scale-up the sample mass as the particle size increases? I want to copy your procedure exactly.

Thanks
Steve.

-----Original Message-----
From: Kim Lapakko [mailto:kim.lapakko@dnr.state.mn.us]
Sent: Tuesday, May 17, 2005 8:38 AM
To: Stephen Day
Cc: Dave Antonson
Subject: Small reactor

Steve,

Dave Antonson will email a figure depicting our small reactor, along with some design details (perforated plate, adehesive, filter). He could also send a reactor. Please contact him directly, with an address to send it, if you think that would be helpful.

Kim

17 May 2005

Steve,

In our particle size tests we used a small reactor and 75-g mass for particle sizes of –270, +270/-100, and +100/-35 mesh. We used the ASTM cell and 1000-g mass for +35/-10, +10/-0.25 inch, and +0.25/-0.75 inch particle sizes. For rinse volumes, we used 200 mL for the 75-g samples and 300 mL for the 1000-g samples. The 300-mL rinse volume was determined as the quantity of water, rounded up to the nearest 100 mL, required to submerge the solids.

I won't have access to the metal release data for the particle size experiment until tomorrow. As mentioned on the phone, sulfate release rates appear to vary linearly with surface area. It seems likely that nickel release rates will vary similarly, and I'll look into this further tomorrow. Hopefully this information will shed some light on the maximum particle size question.

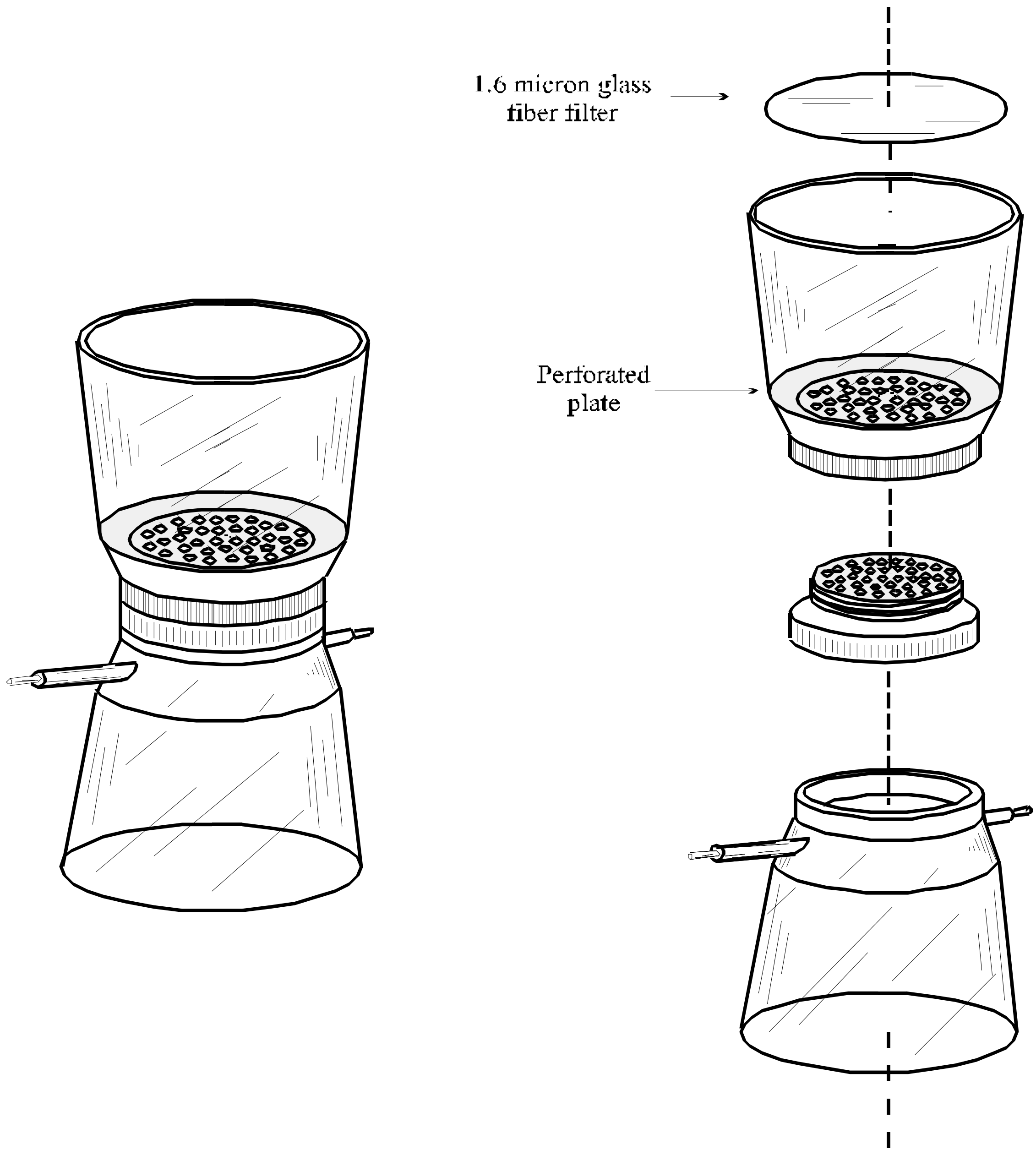
Day, Stephen

From: Dave Antonson [dave.antonson@dnr.state.mn.us]
Sent: Tuesday, May 17, 2005 11:53 AM
To: Kim Lapakko
Subject: reactor

Attachments: small reactor.doc

small reactor.doc
(271 KB)

see if this makes any sense. you can edit it if you want. if it seems adequate you can forward it to steve. maybe he doesn't need a sample of the base.


1.6 micron glass fiber filter
Perforated plate

The reactors were purchased from Millipore Corporation (1-800-645-5476). They are 47 mm Sterifil aseptic systems. You will need the 250 ml receiver flask, 250 ml funnel (top), silicone o-rings, and the filter holder base and support screen.

The perforated acrylic plastic base was purchased as flat stock and fabricated to fit the top funnel. The plates are 1/8” thick, 2 1/4” in diameter and tapered to fit into the reactor top. Approximately sixteen 1/16” holes were drilled in the plate. The plate was glued into the reactor using acrylic solvent cement purchased from United States Plastics (1-800-537-9724). Catalog # 44629 for 5 oz. tube. The acrylic flat stock was also purchased from United States Plastics.

After the plate is glued into the top of the reactor there should be approximately a 3/8” gap between the bottom of the perforated plate and the top of the support screen of the filter unit.

The filter that rests on the perforated plate is a 55 mm Whatman GF/A glass microfibre filter (catalog # 1820 055).

Note: Before adding the solids to the filter you should wet the filter slightly with distilled water so no solids escape around the filter.

Appendix B

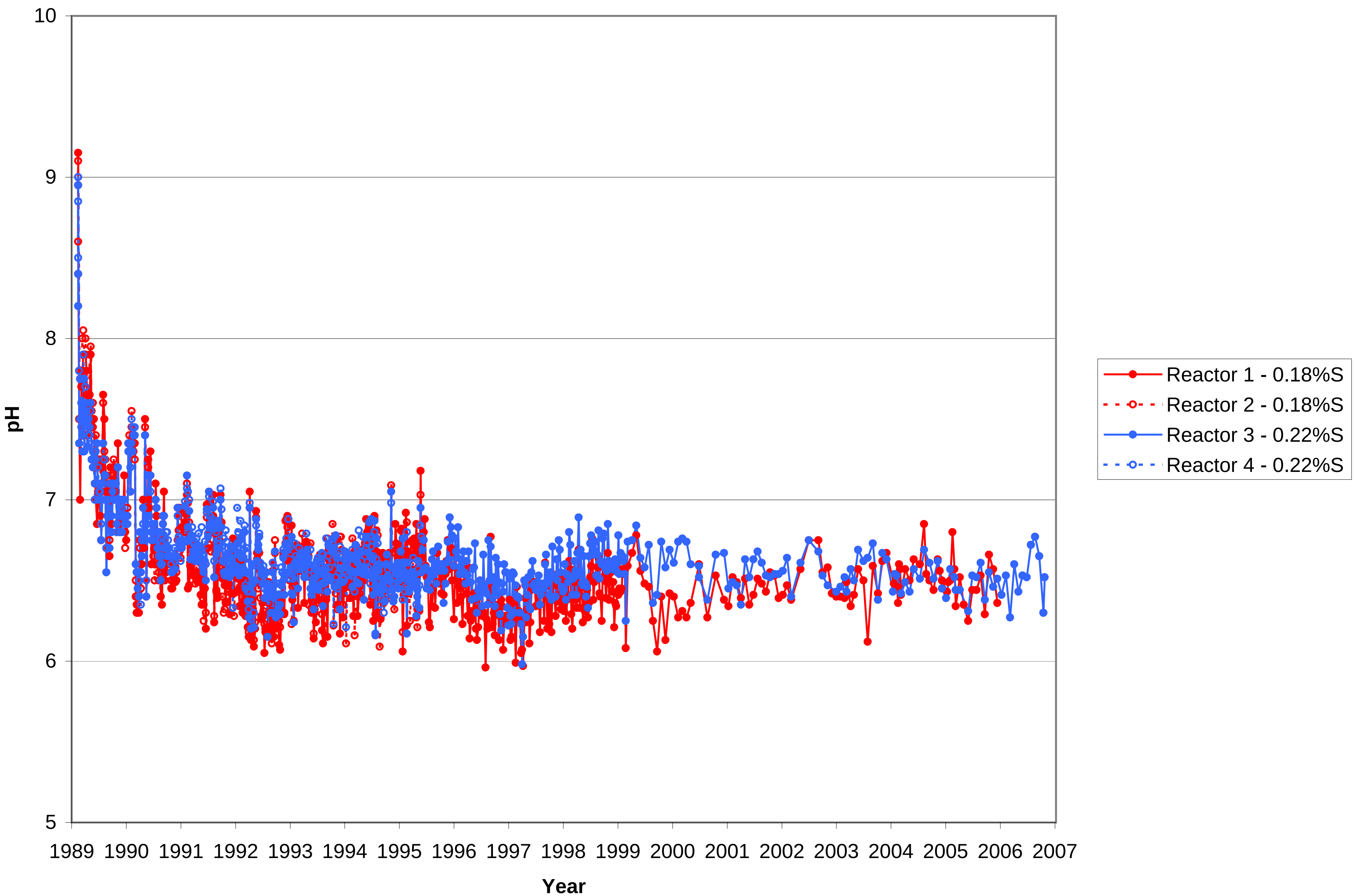
Charts of MDNR Testwork

Appendix B.1

Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Appendix B.1
Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Chart B.1.1



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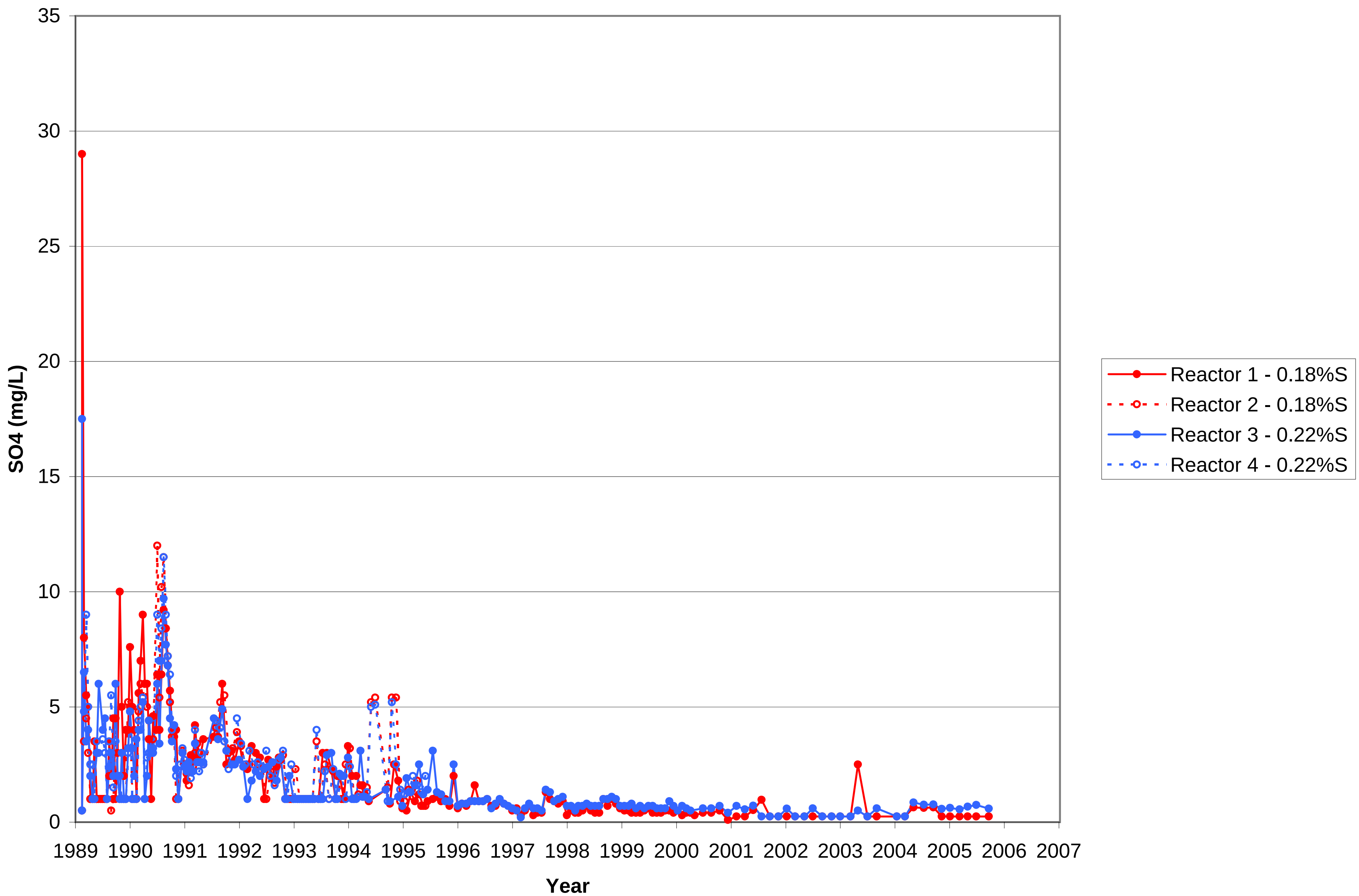
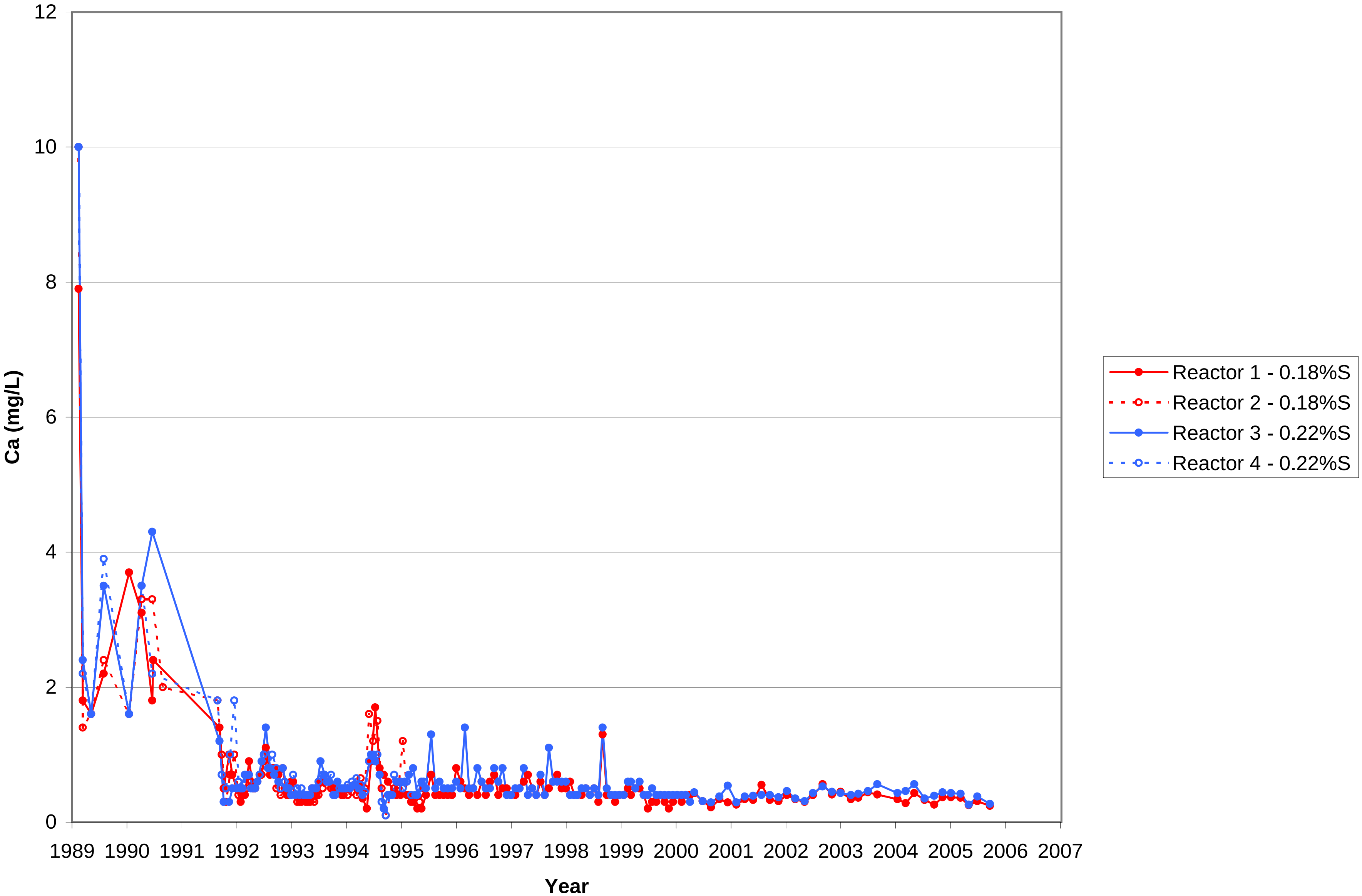

35
30
25
20
15
10
5
0
SO4 (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 1 - 0.18%S
Reactor 2 - 0.18%S
Reactor 3 - 0.22%S
Reactor 4 - 0.22%S

Appendix B.1
Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Chart B.1.3



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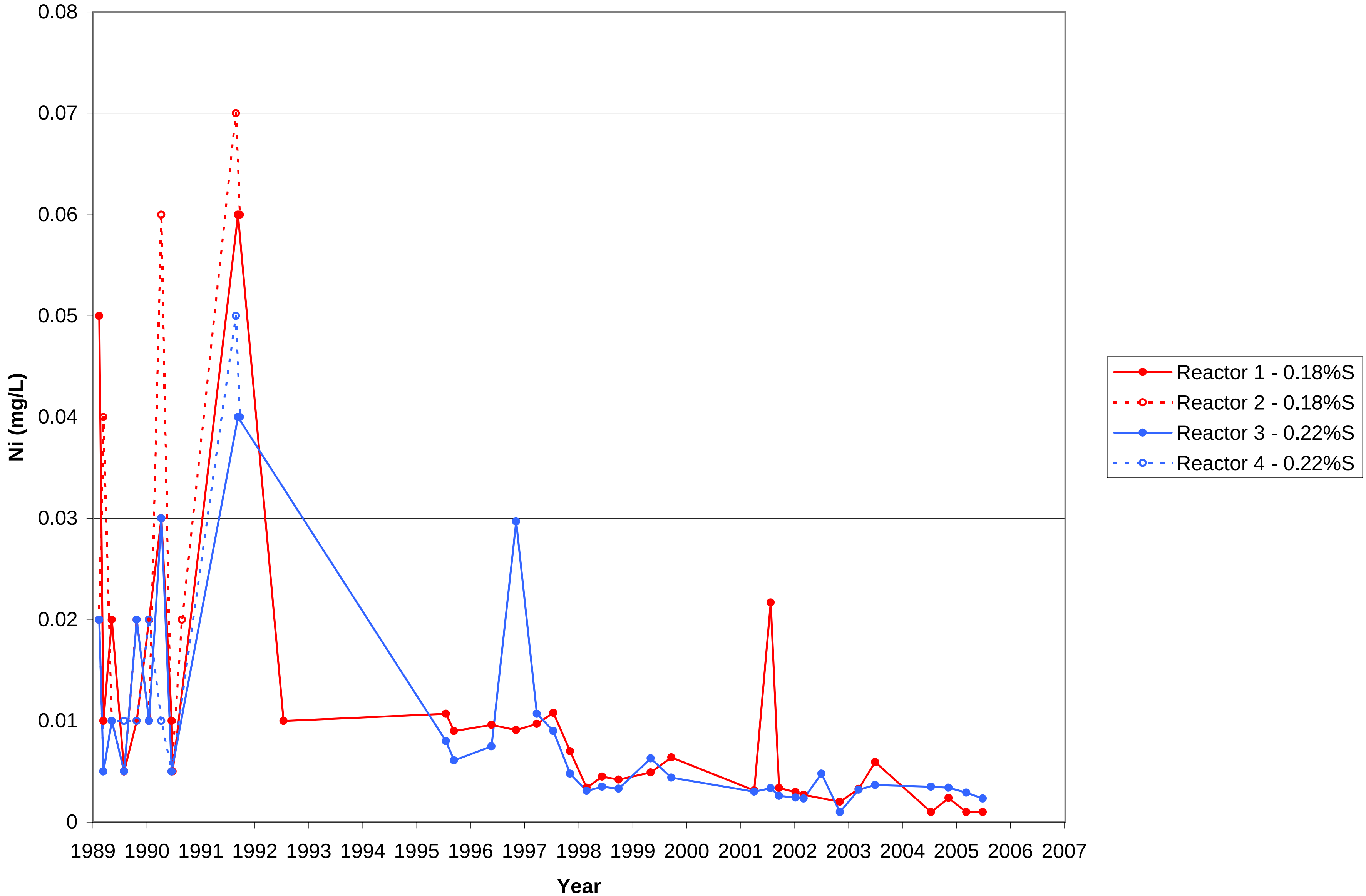
Appendix B.1
Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Chart B.1.4



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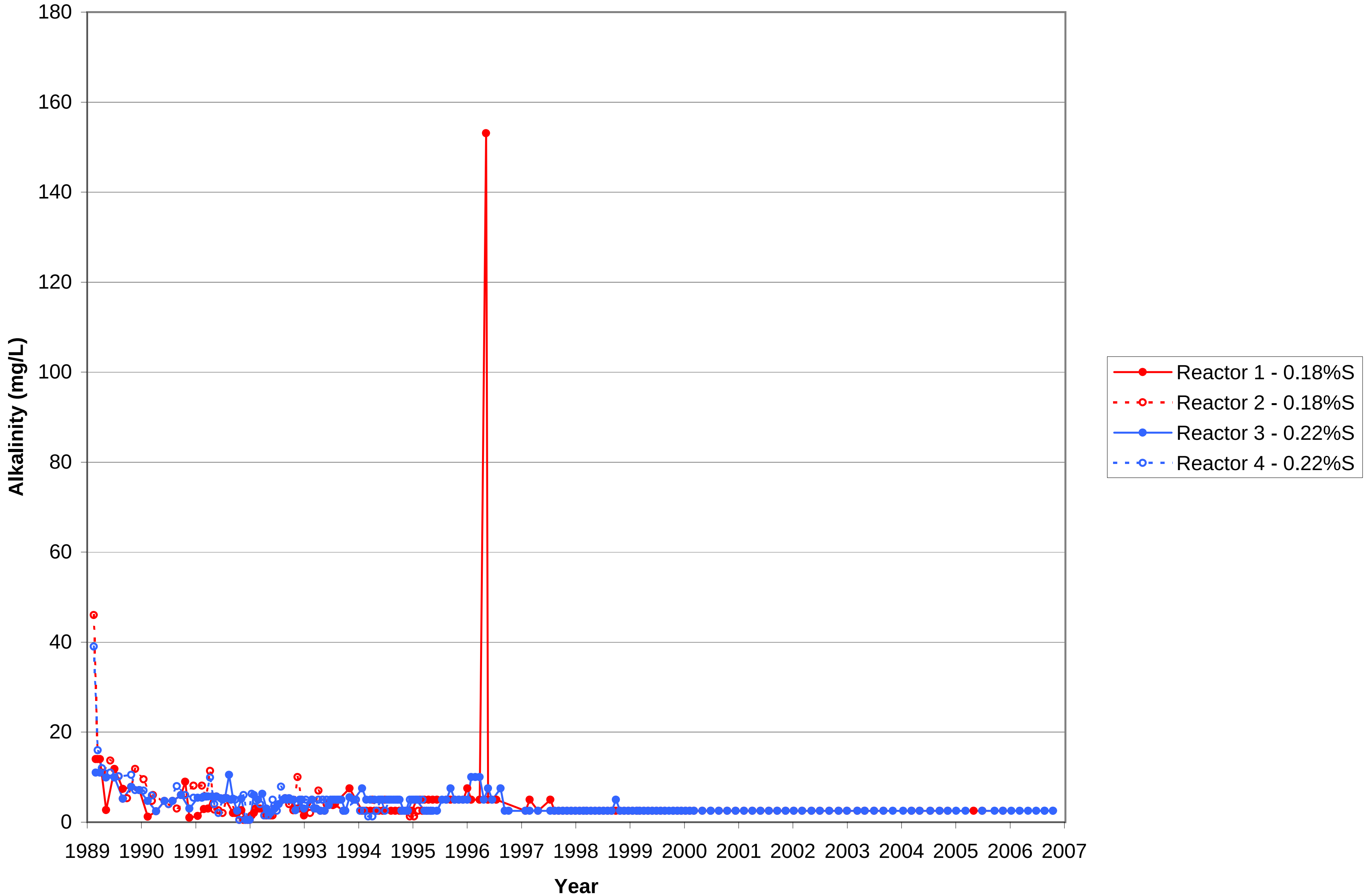
Appendix B.1
Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Chart B.1.5



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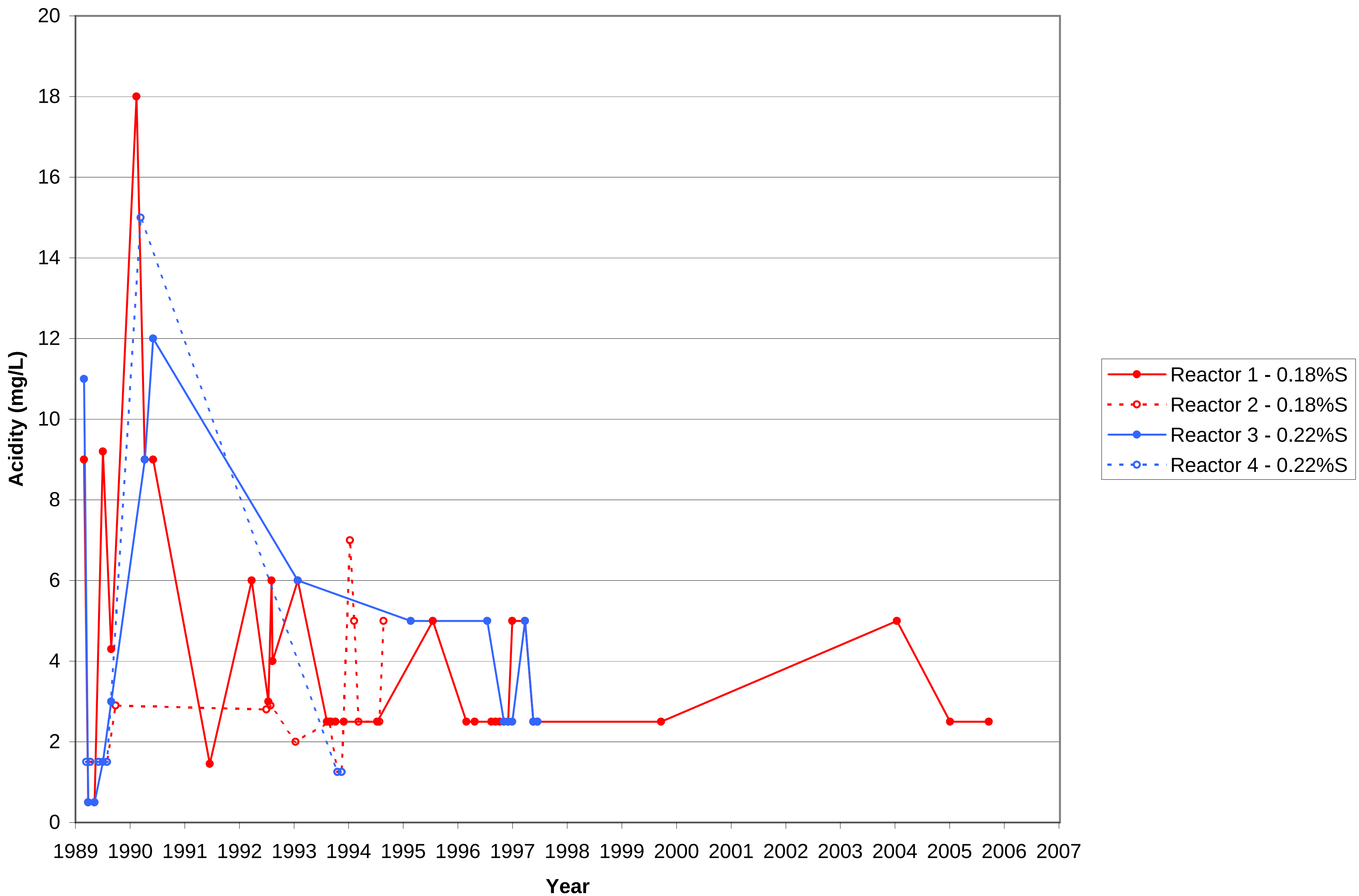
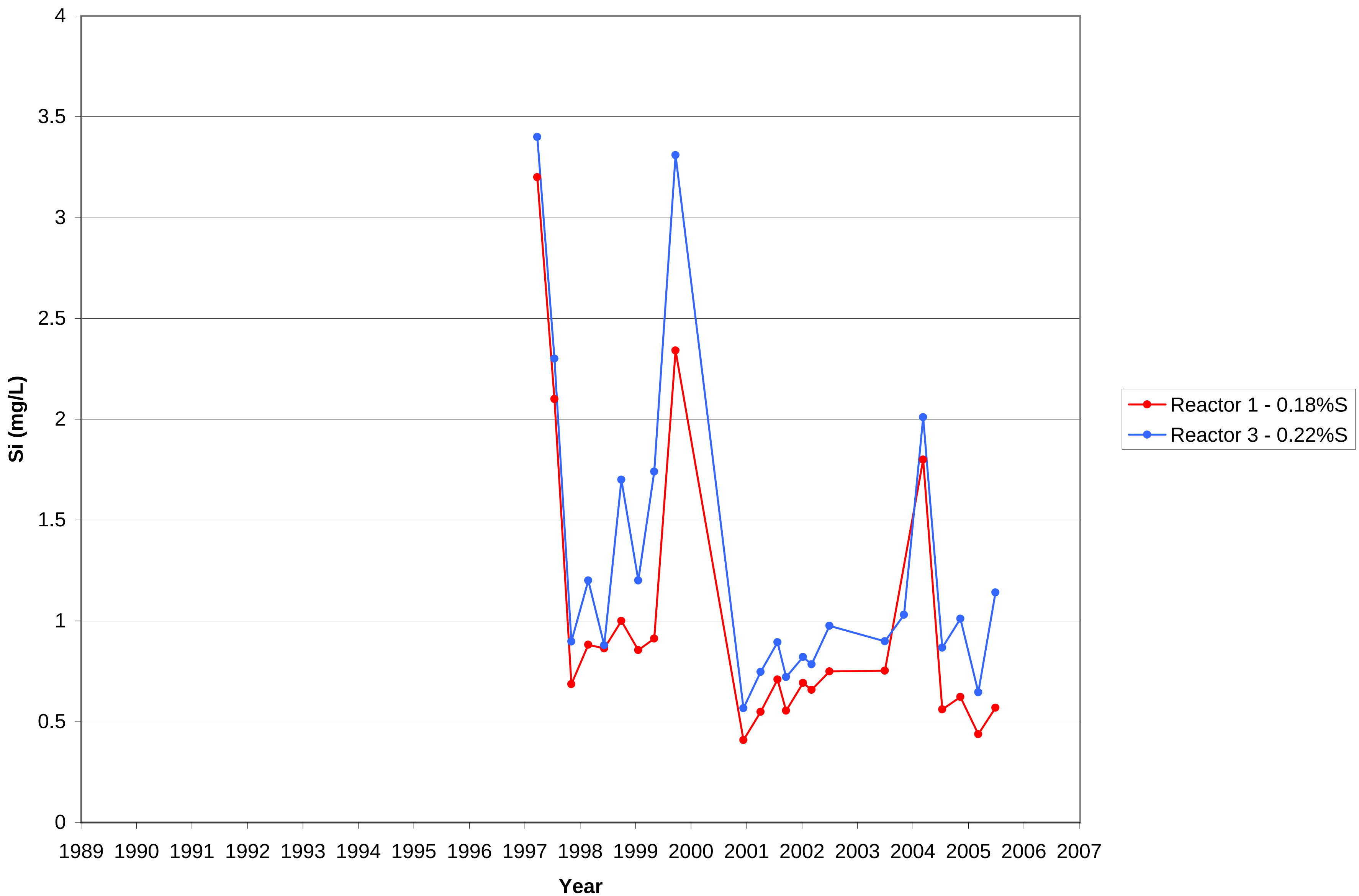

Acidity (mg/L)
0
2
4
6
8
10
12
14
16
18
20
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 1 - 0.18%S
Reactor 2 - 0.18%S
Reactor 3 - 0.22%S
Reactor 4 - 0.22%S



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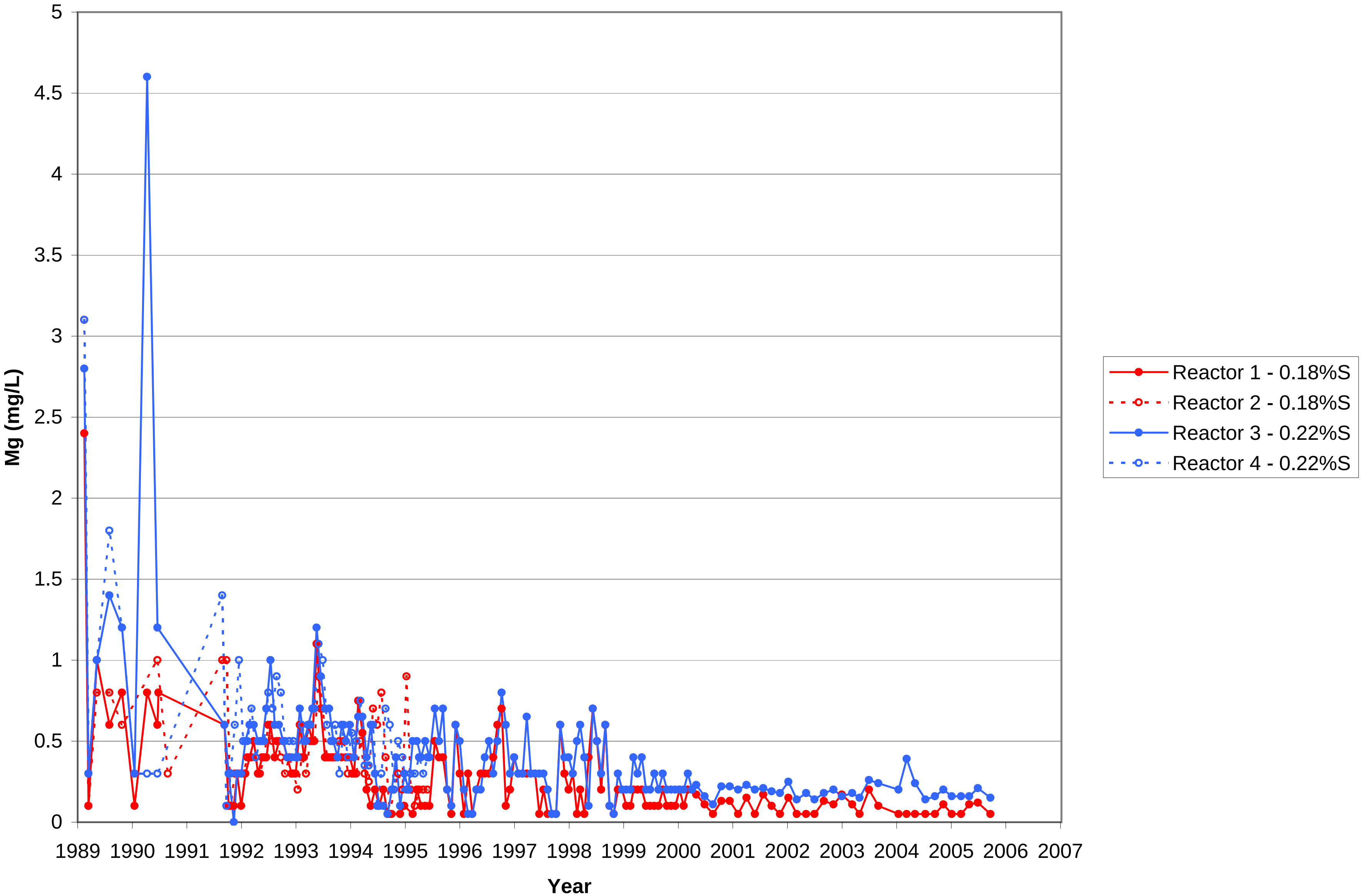
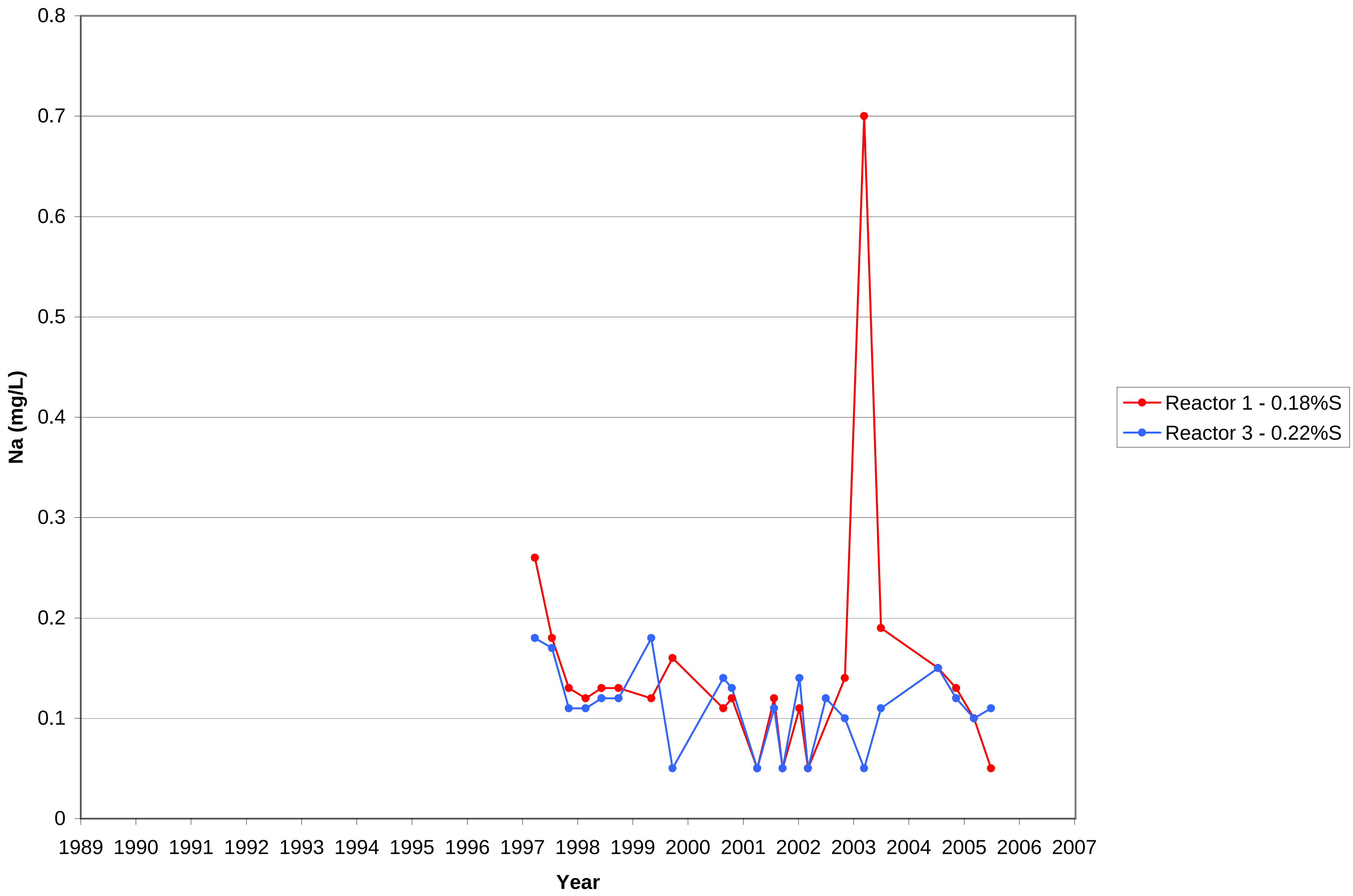

Mg (mg/L)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 1 - 0.18%S
Reactor 2 - 0.18%S
Reactor 3 - 0.22%S
Reactor 4 - 0.22%S



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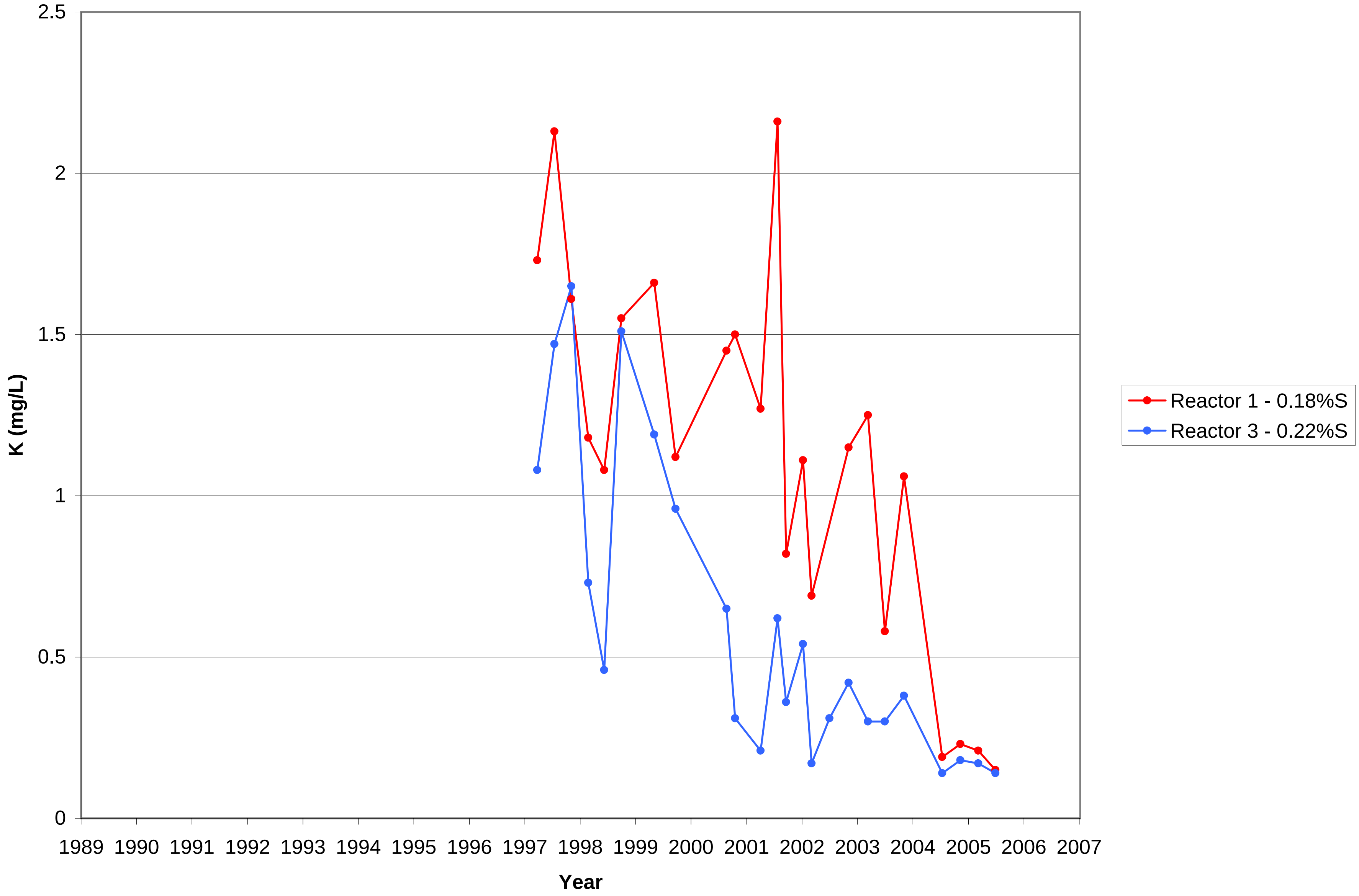
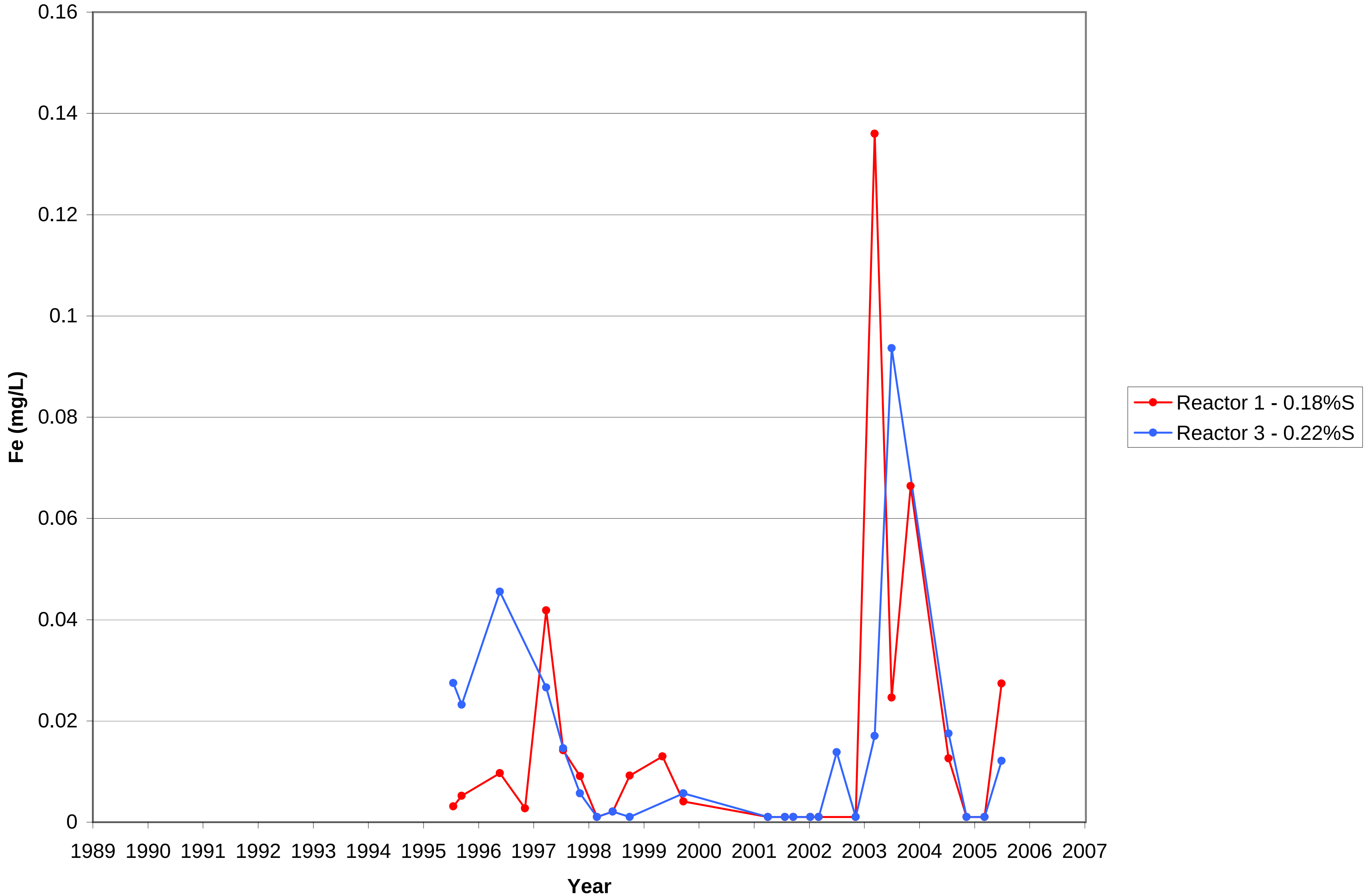
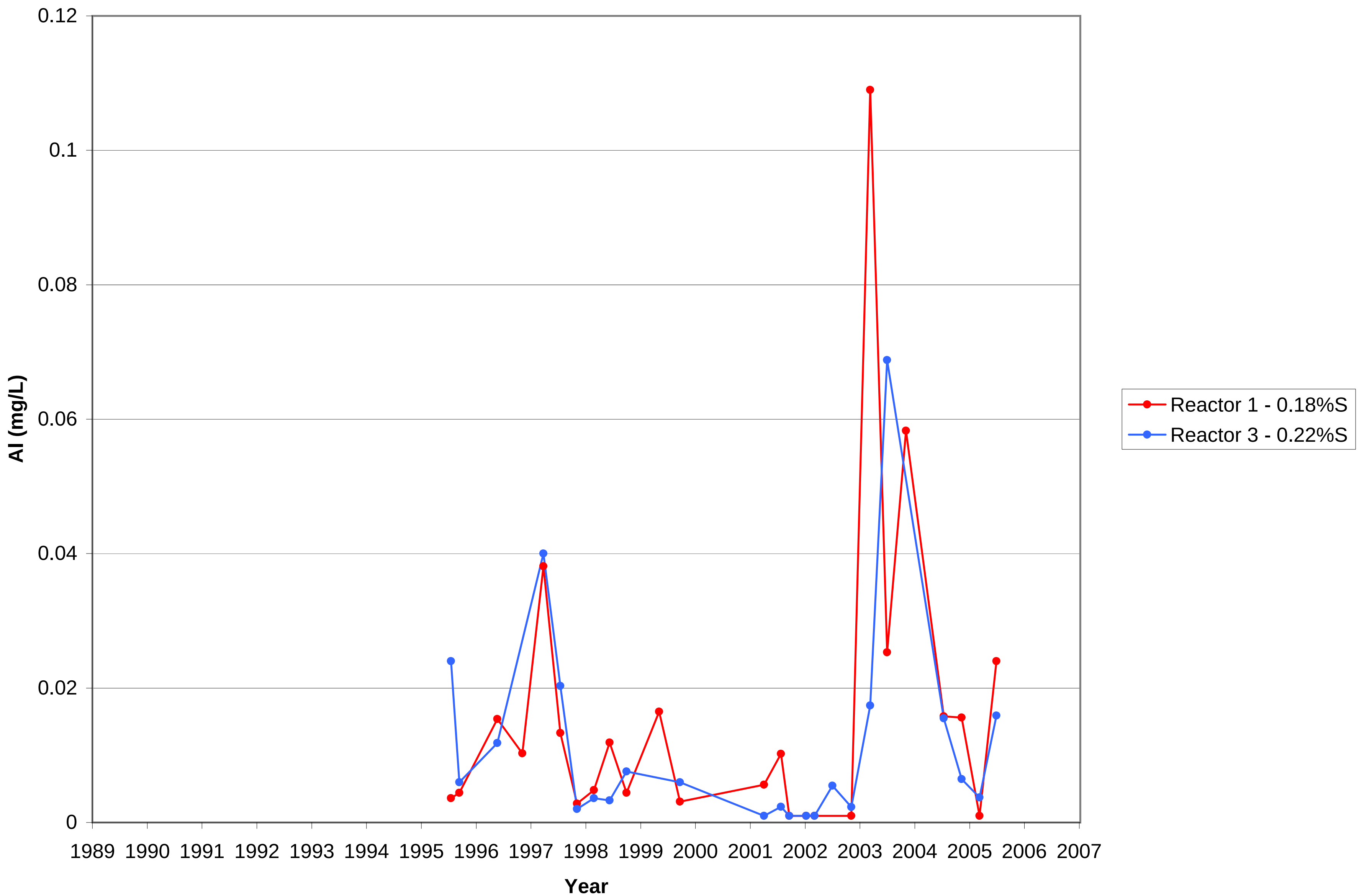
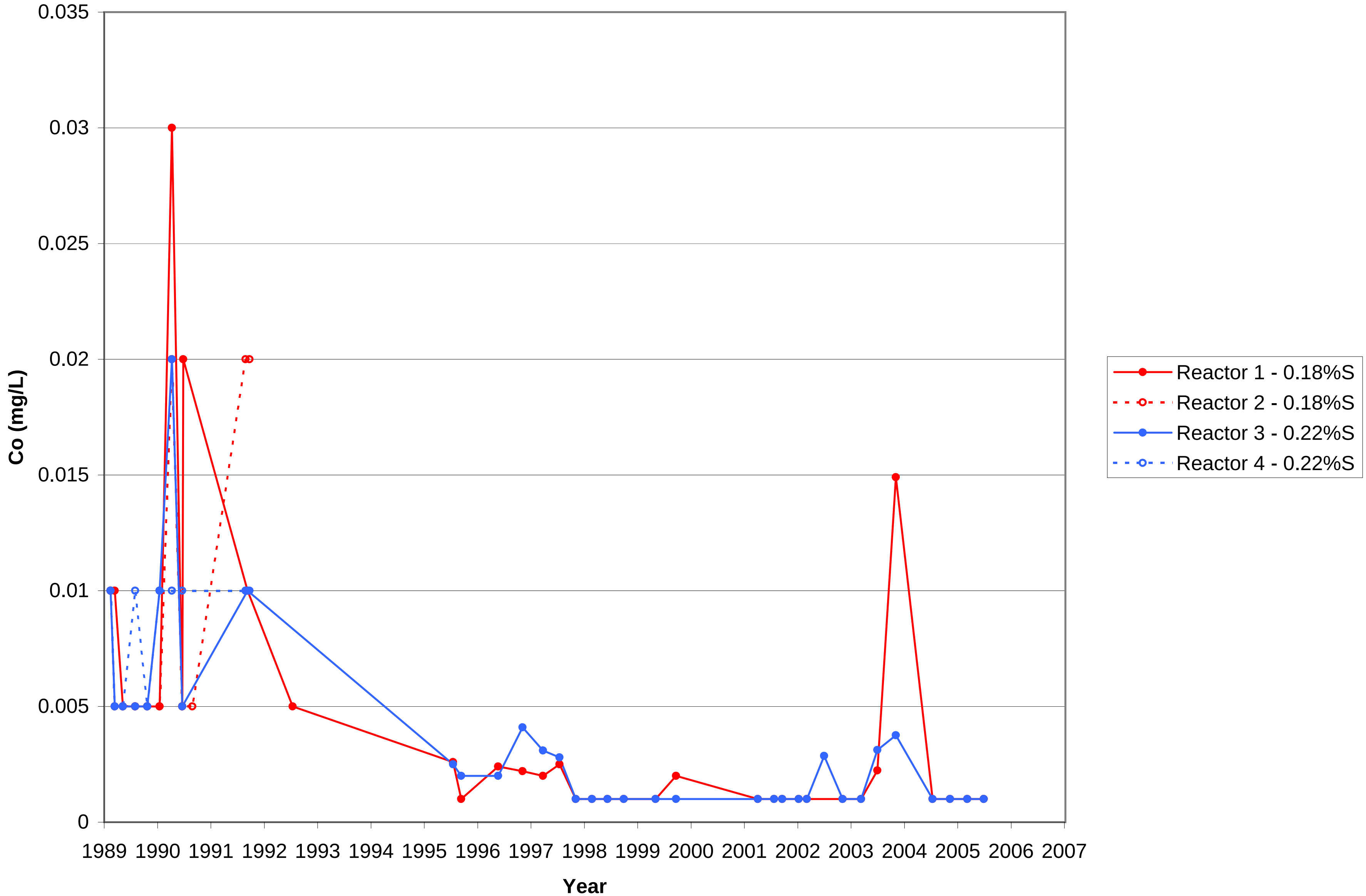
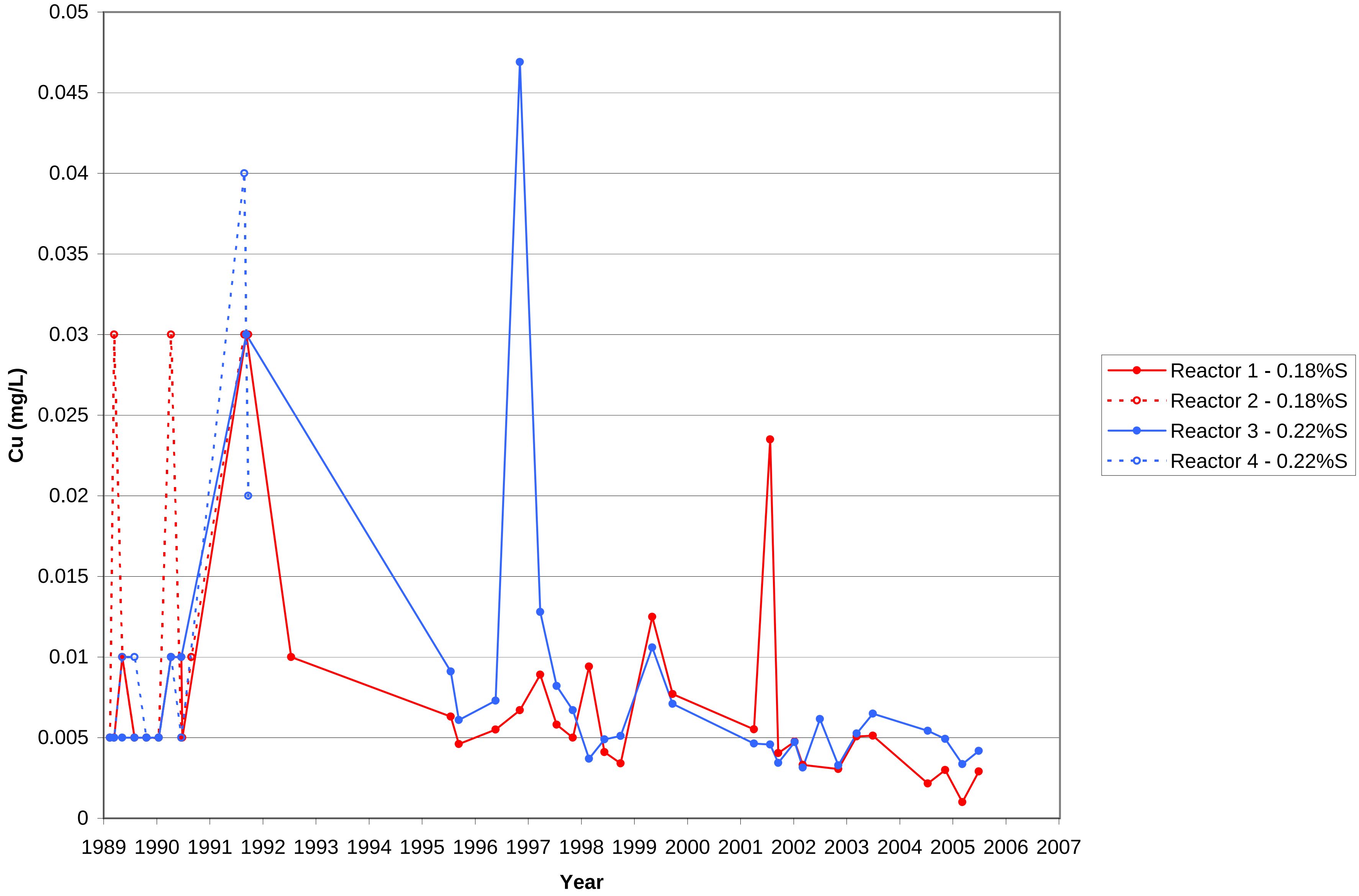

2.5
2
1.5
1
0.5
0
K (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 1 - 0.18%S
Reactor 3 - 0.22%S


0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Fe (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 1 - 0.18%S
Reactor 3 - 0.22%S



Minnesota Department of Natural Resources


0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Co (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 1 - 0.18%S
Reactor 2 - 0.18%S
Reactor 3 - 0.22%S
Reactor 4 - 0.22%S



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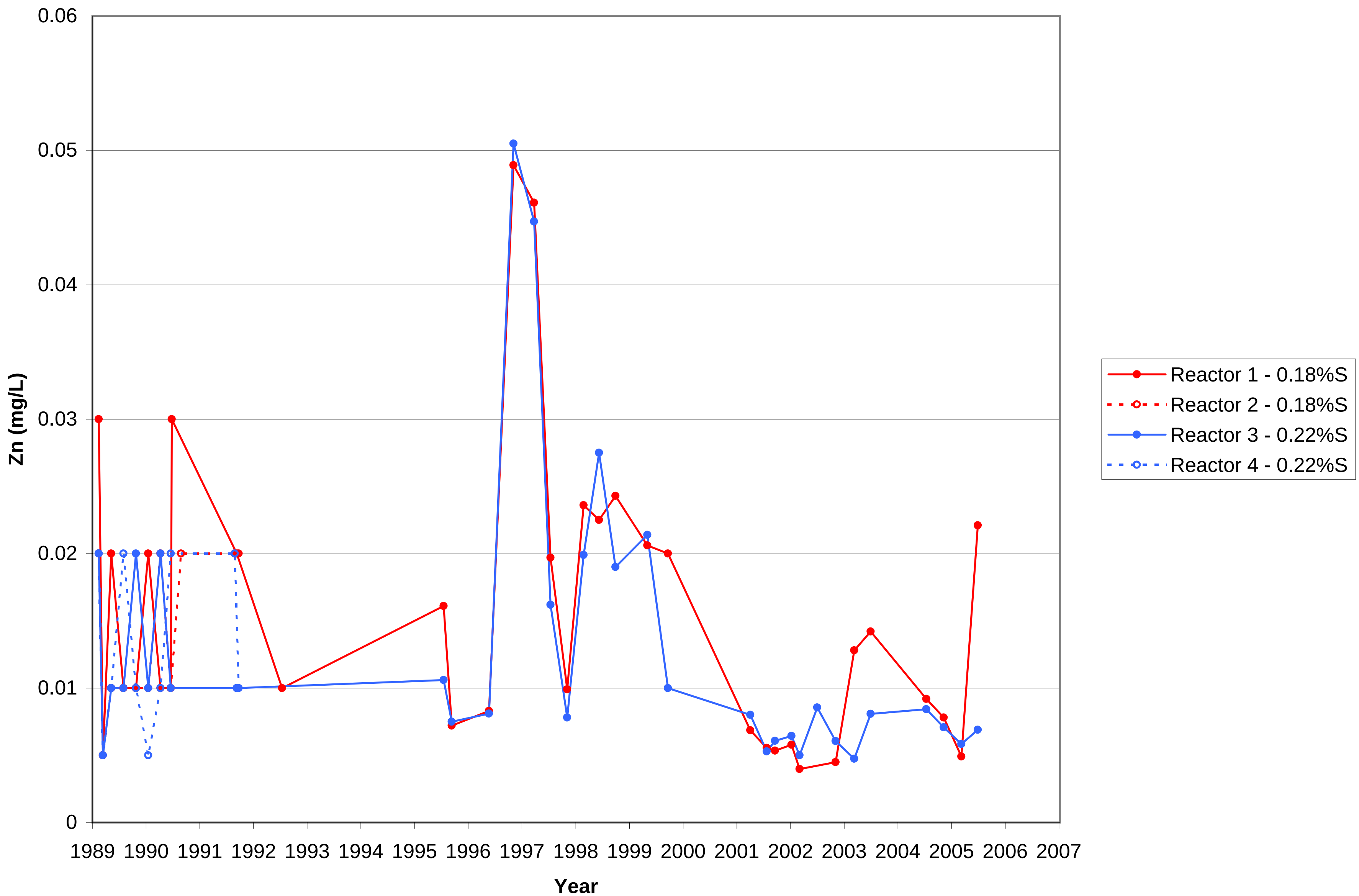
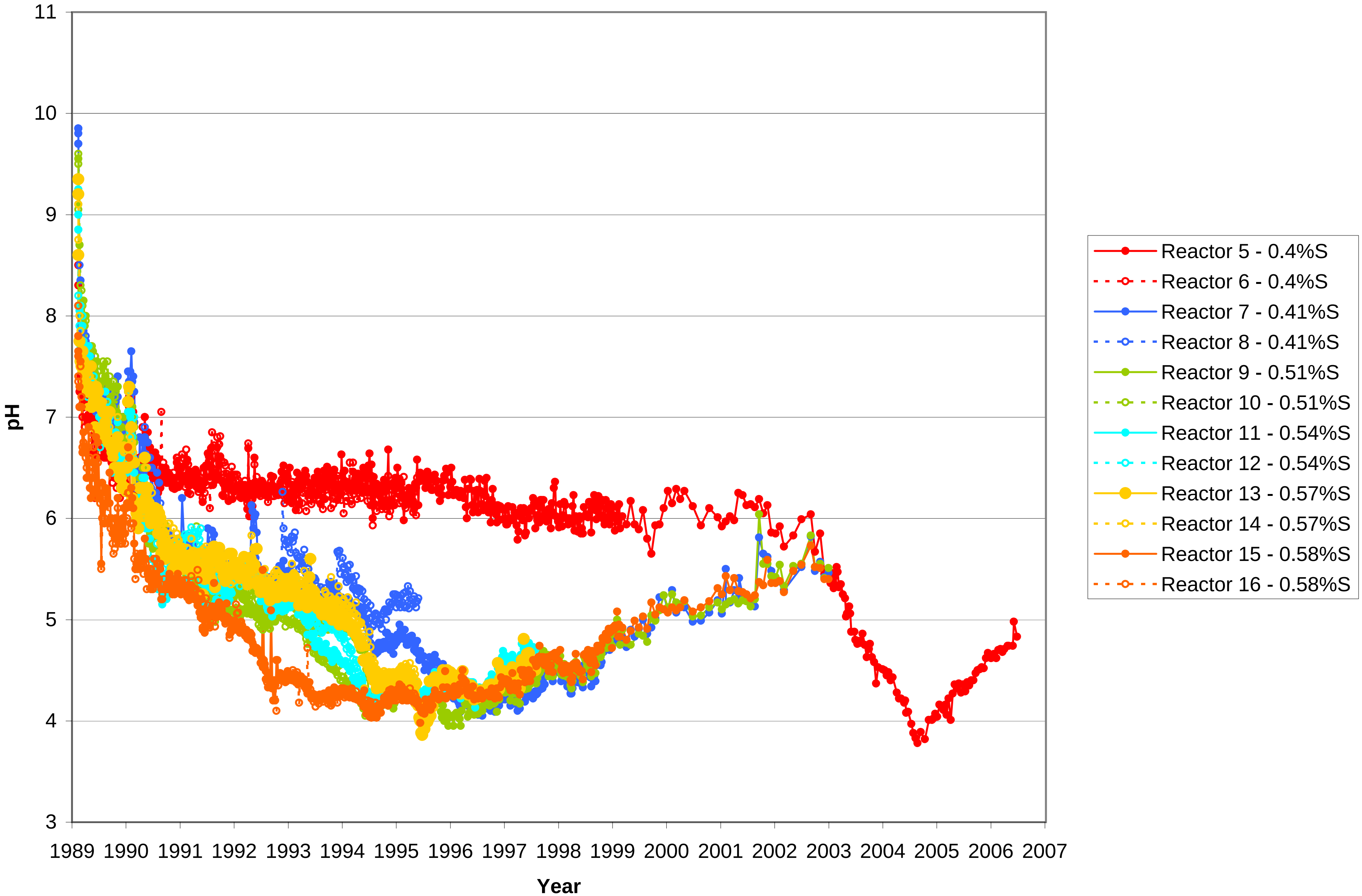
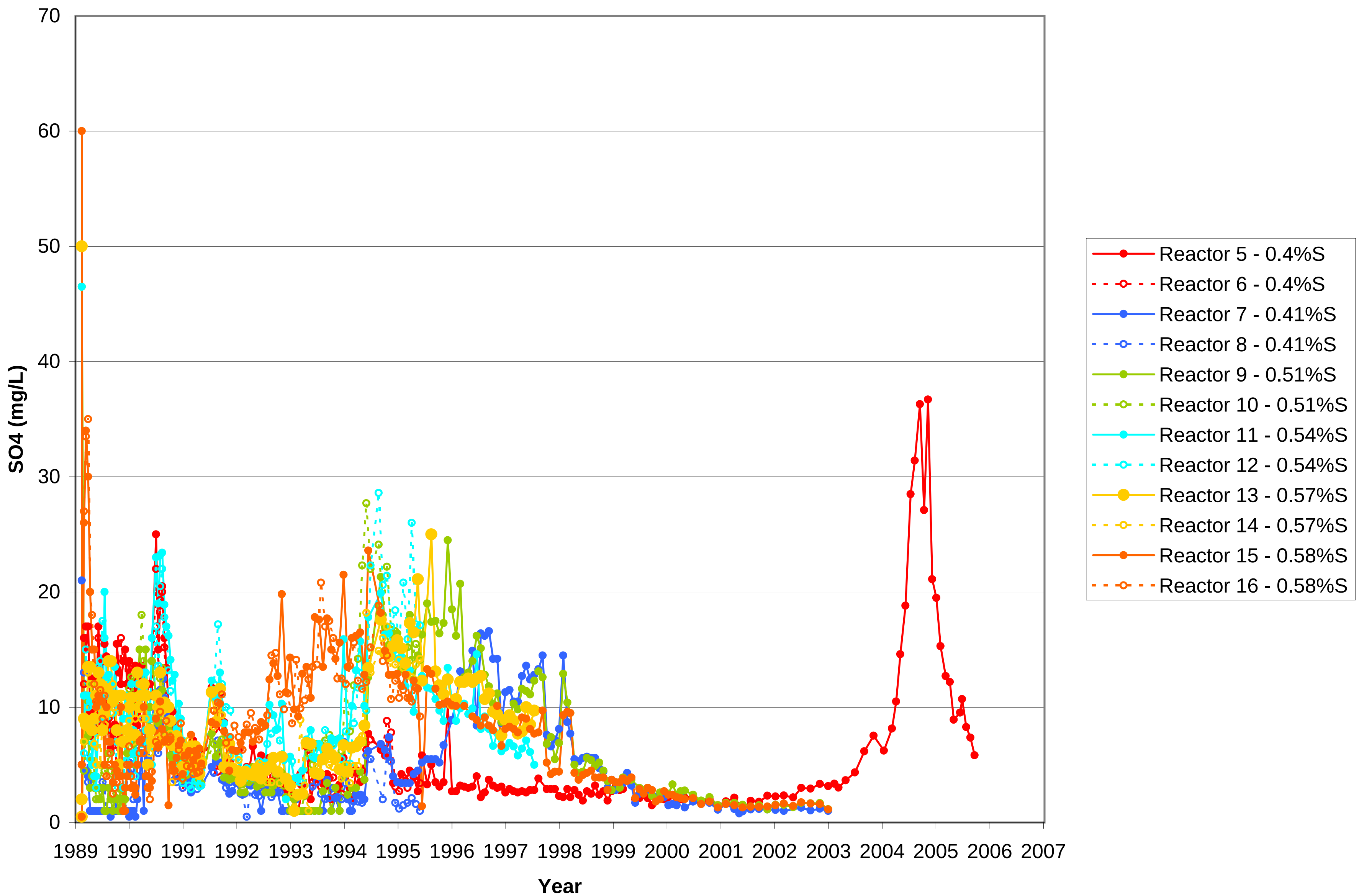
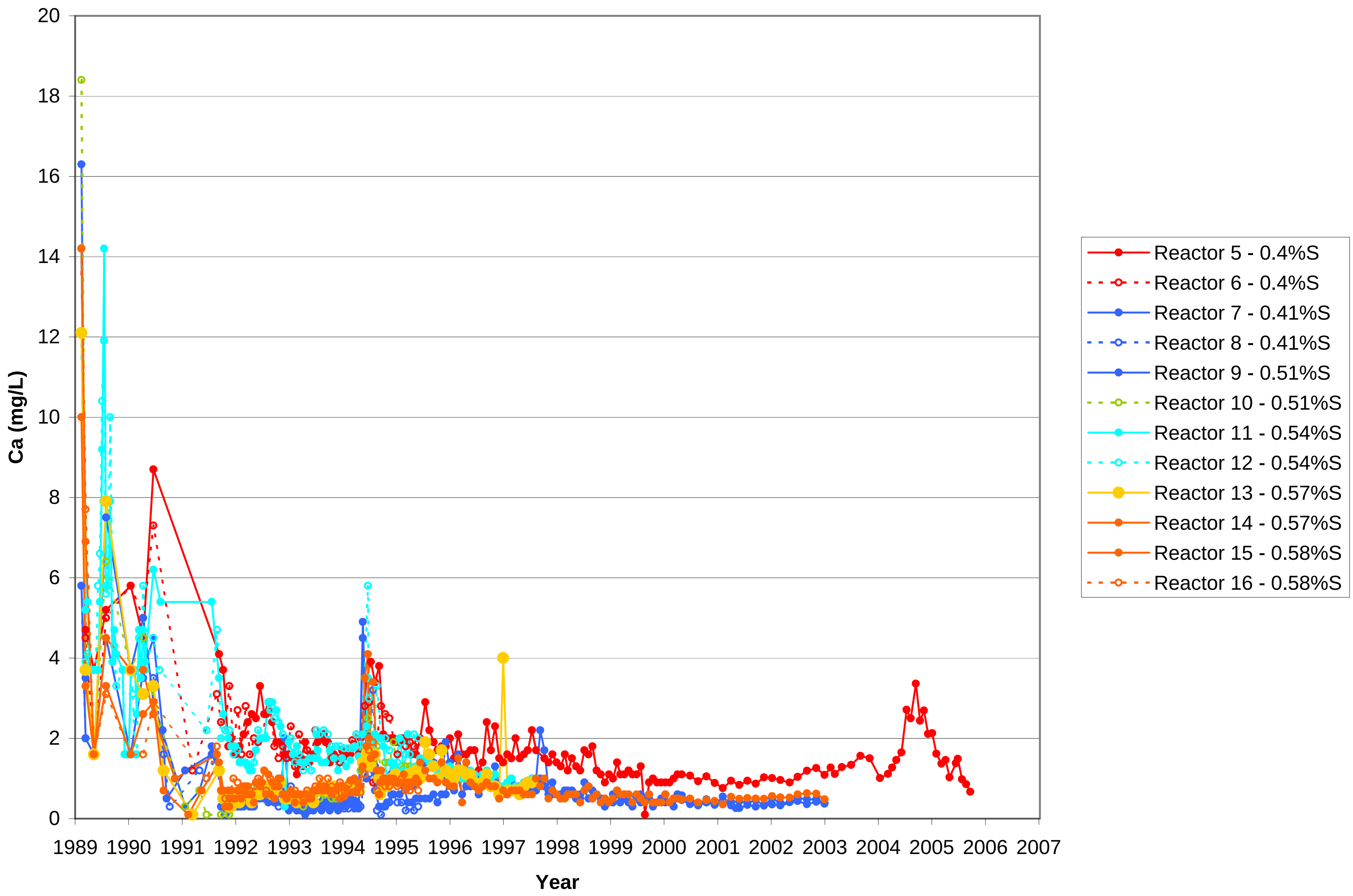
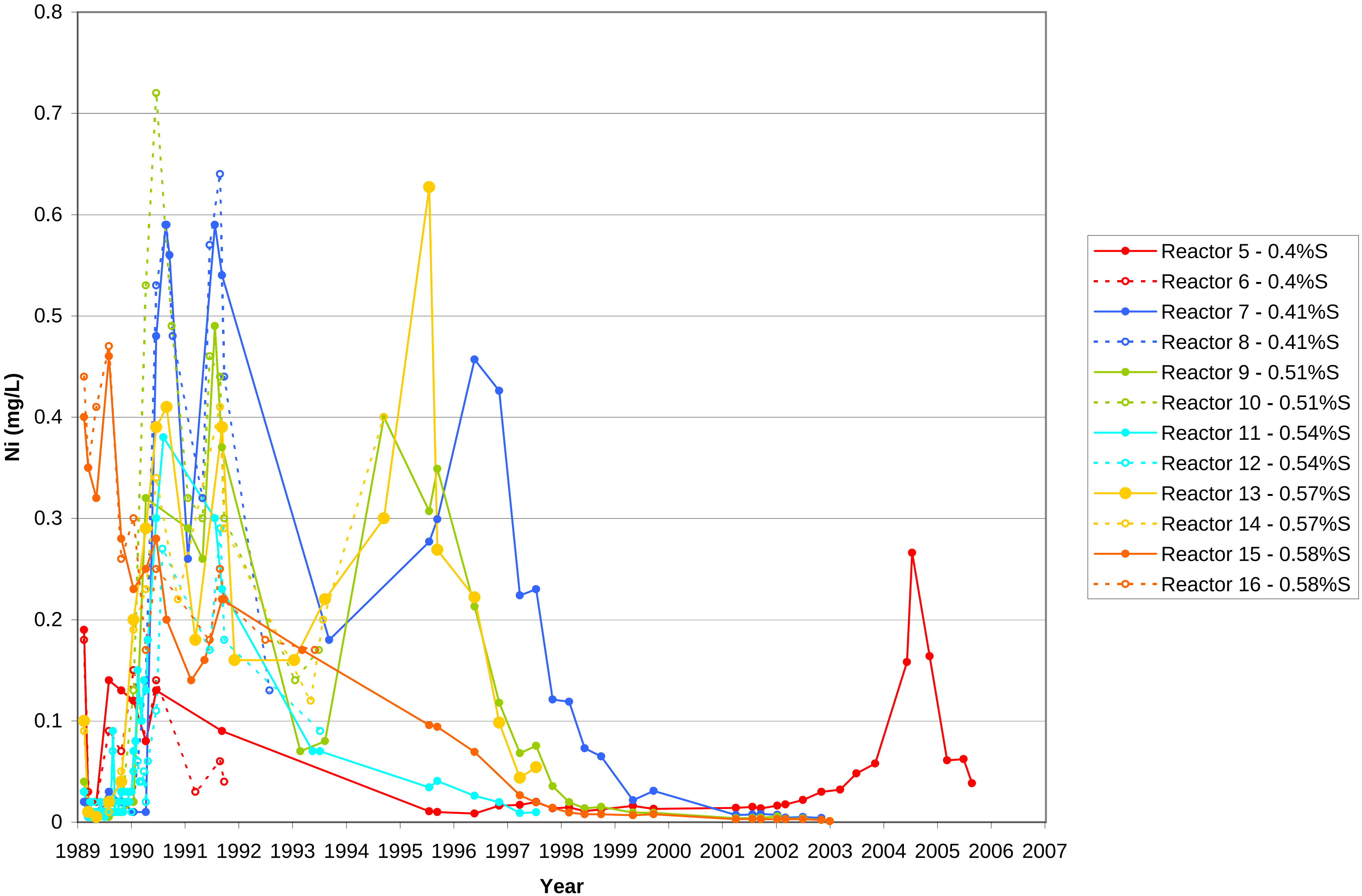
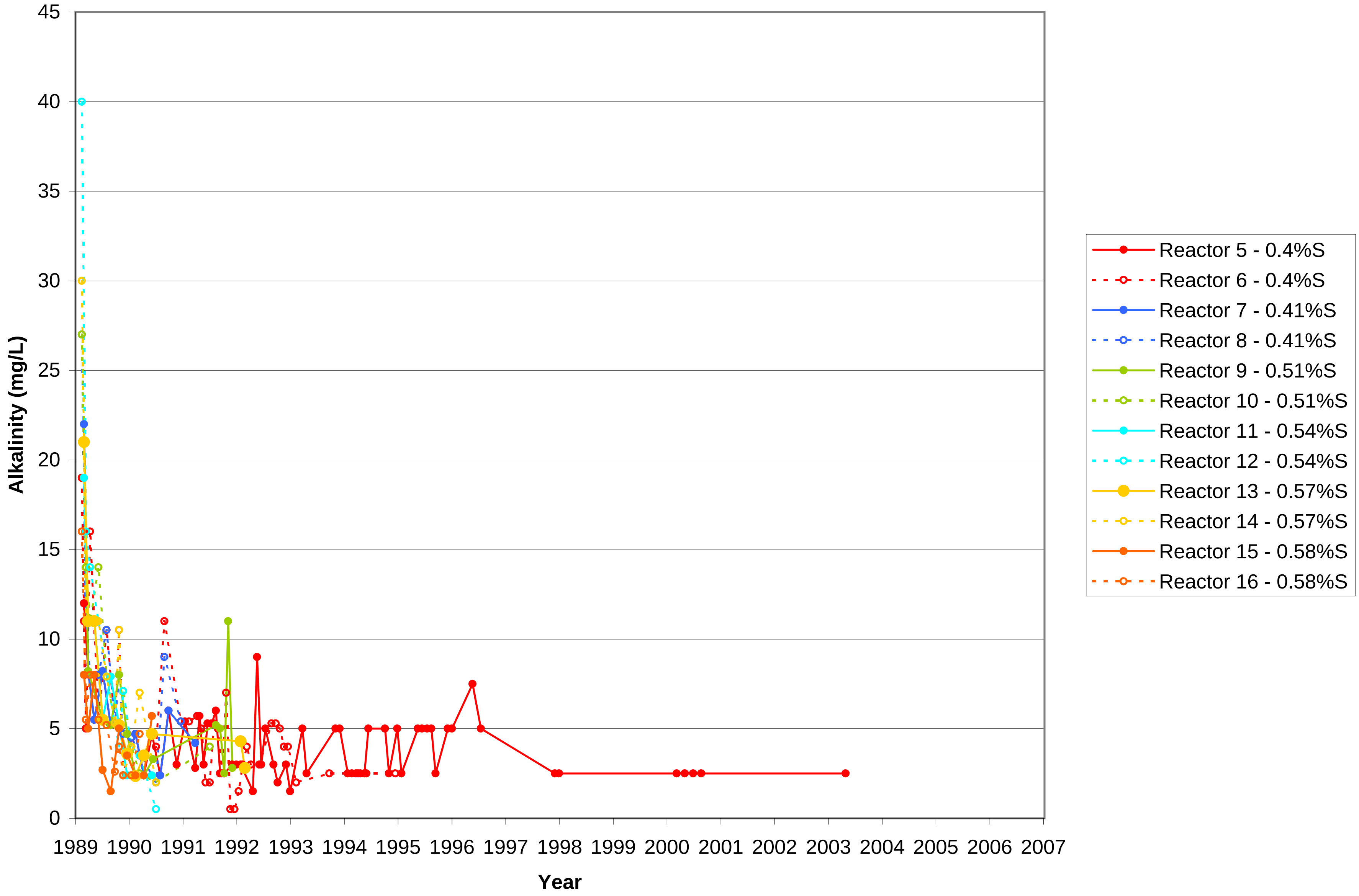

0.06
0.05
0.04
0.03
0.02
0.01
0
Zn (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 1 - 0.18%S
Reactor 2 - 0.18%S
Reactor 3 - 0.22%S
Reactor 4 - 0.22%S

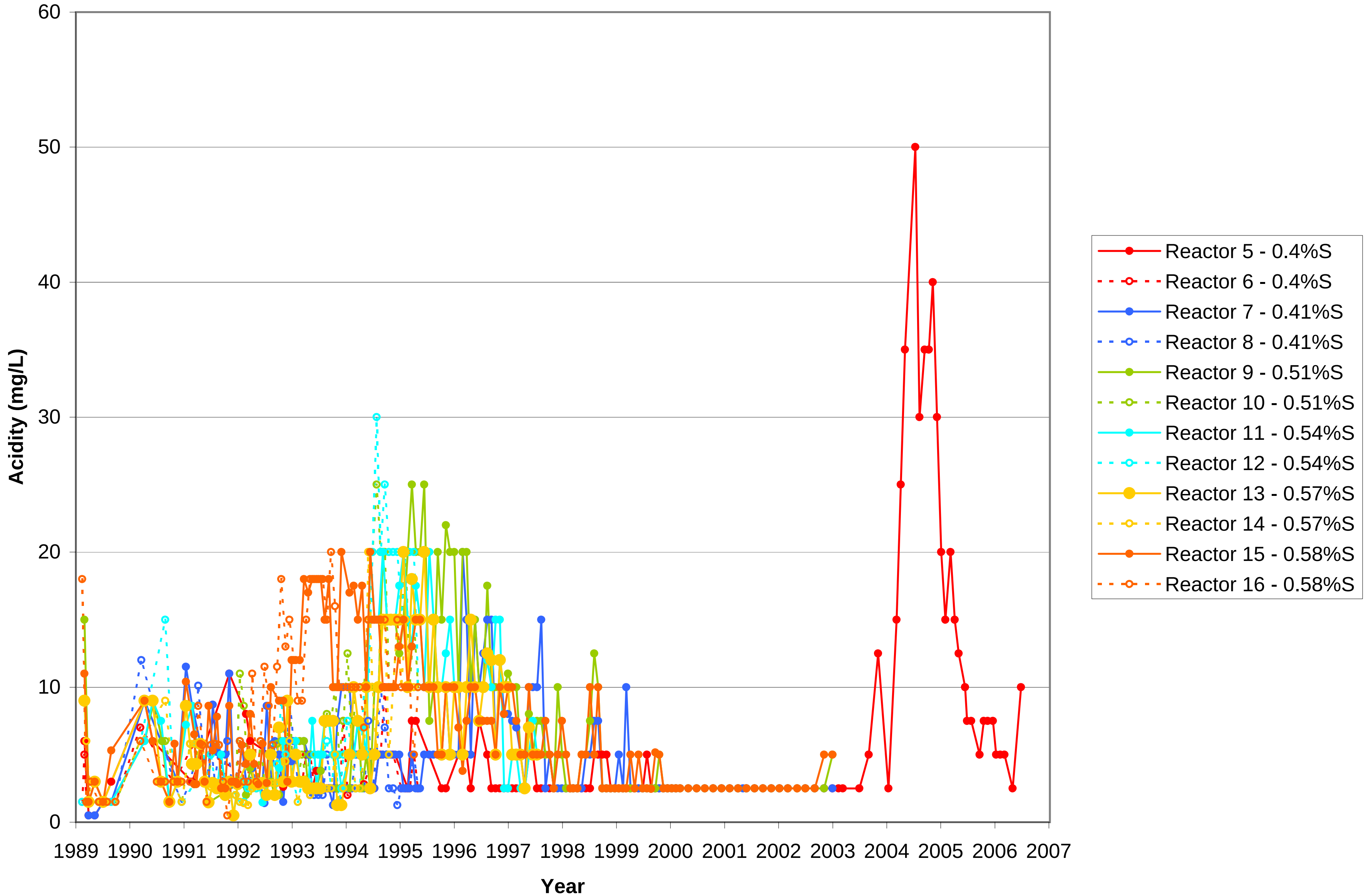

11
10
9
8
7
6
5
4
3
pH
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S

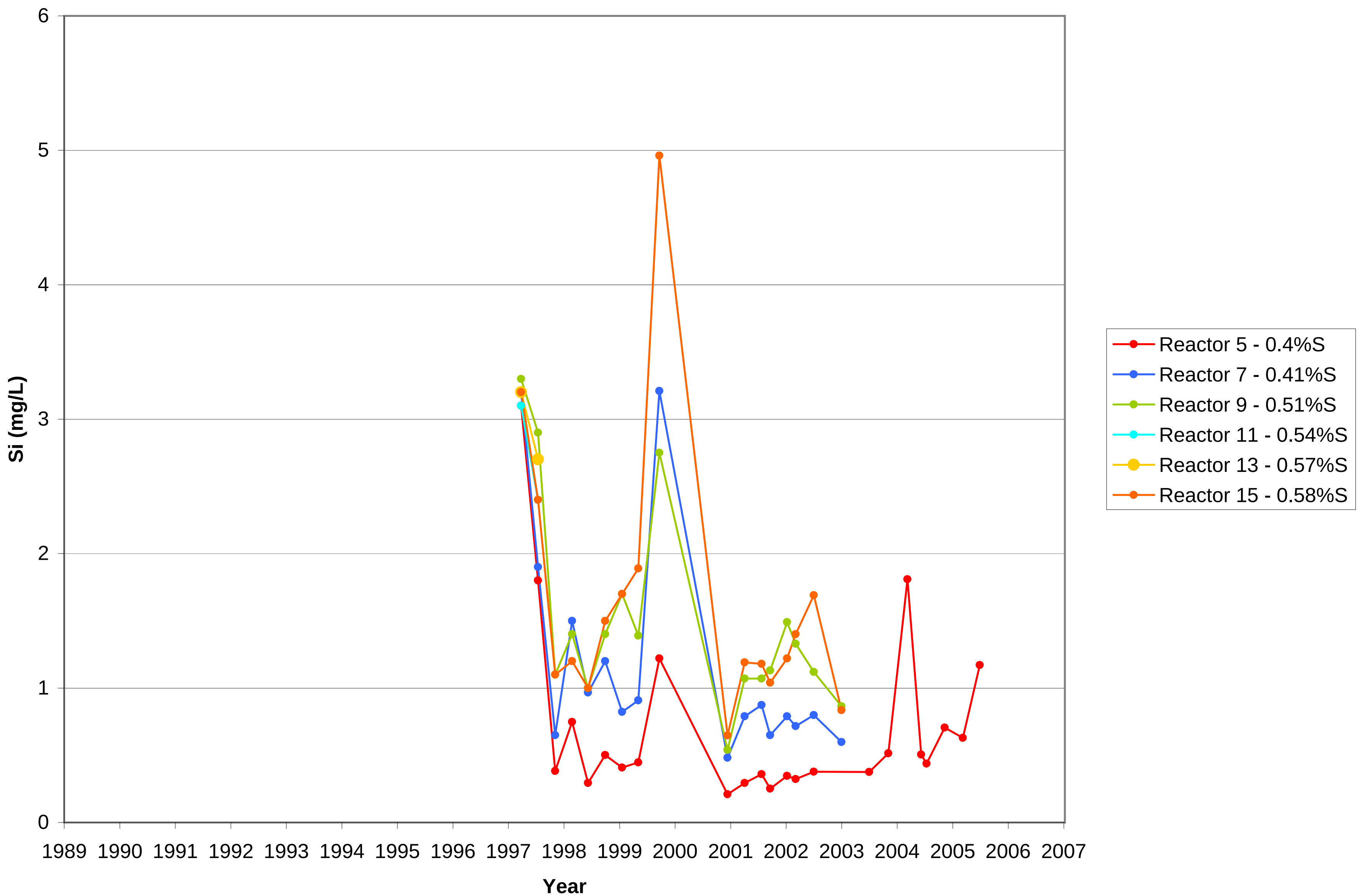

70
60
50
40
30
20
10
0
SO4 (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S

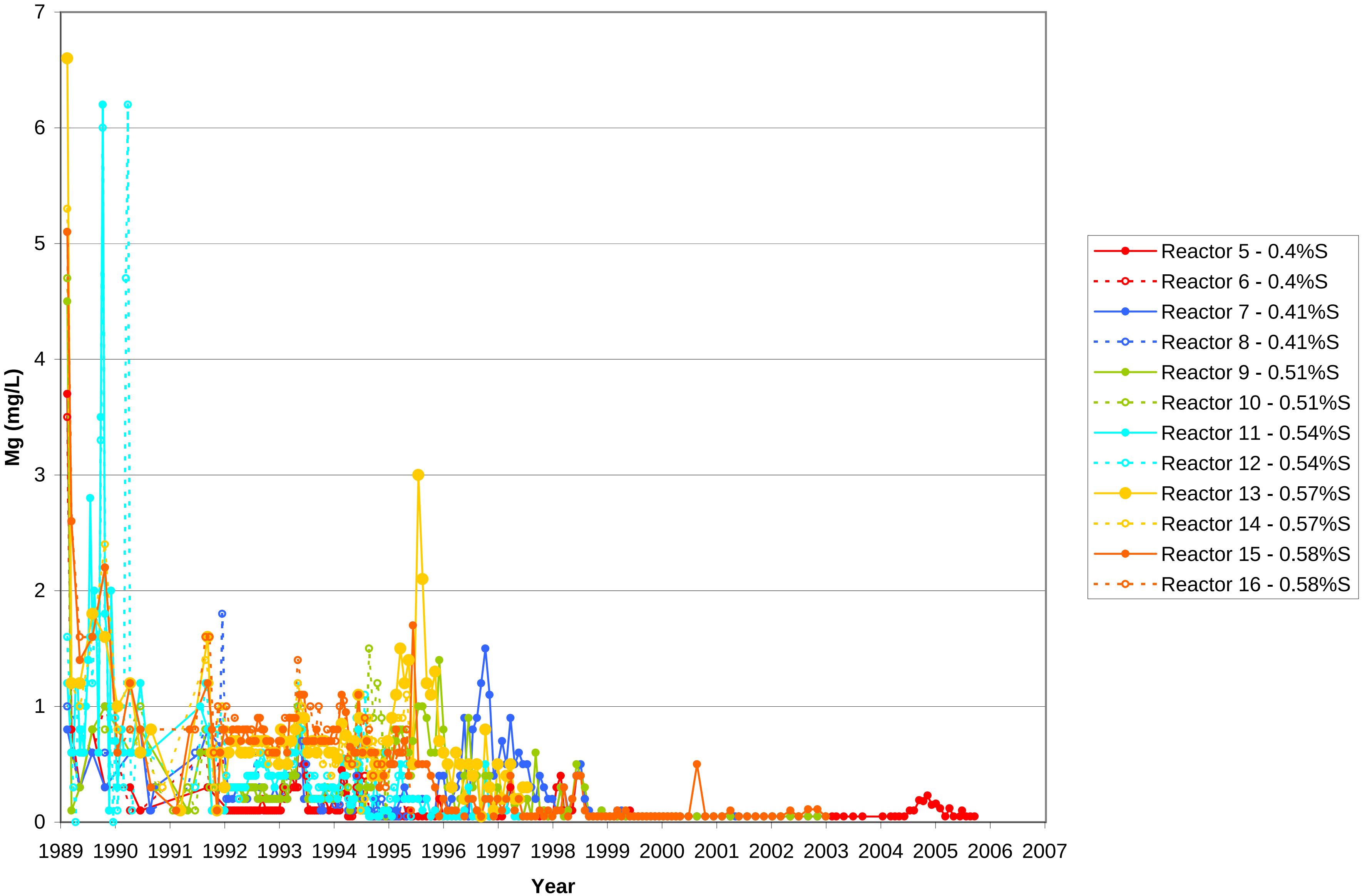

Ca (mg/L)
0
2
4
6
8
10
12
14
16
18
20
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S

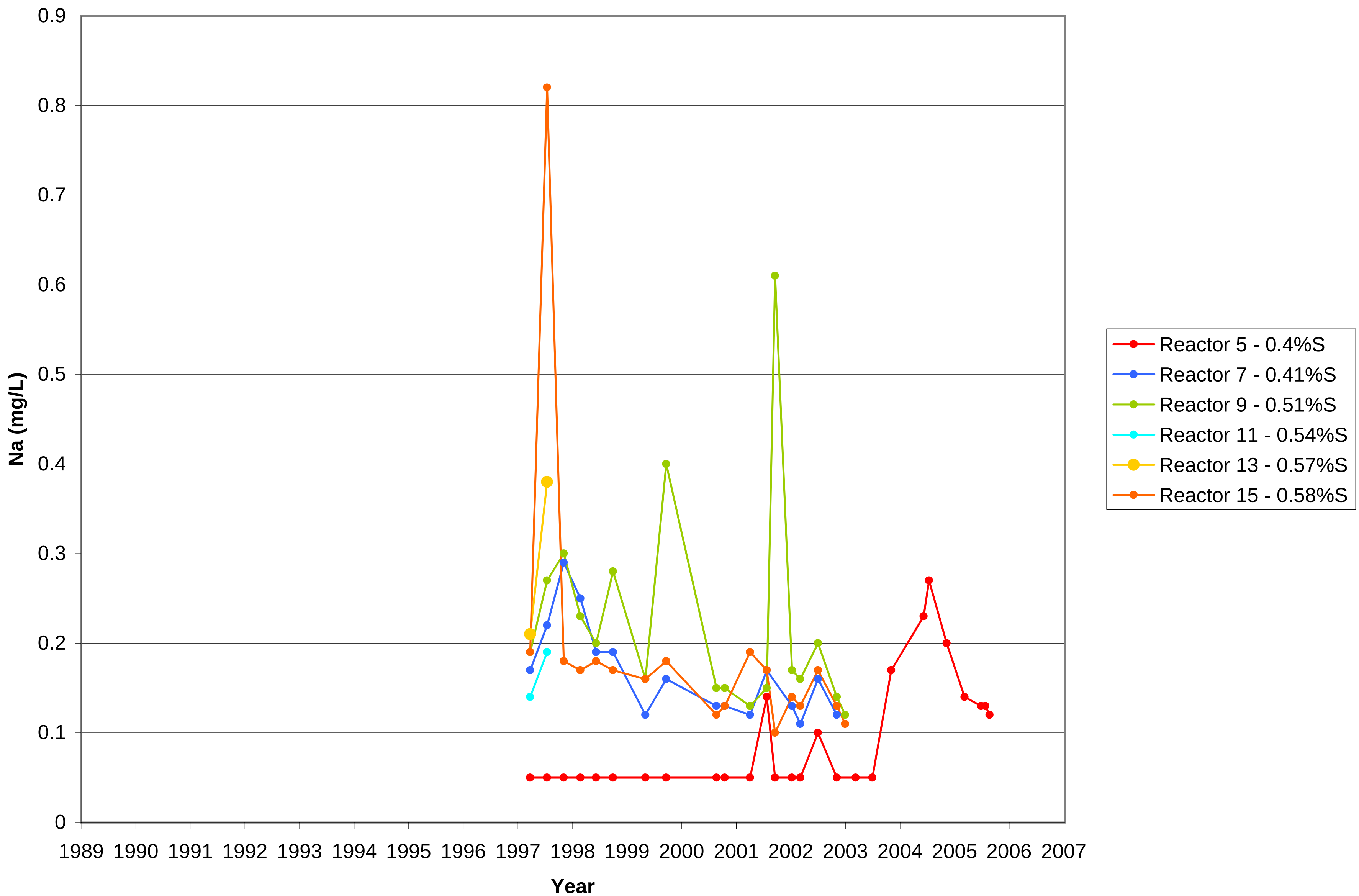

Ni (mg/L)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S


Alkalinity (mg/L)
45
40
35
30
25
20
15
10
5
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S


60
50
40
30
20
10
0
Acidity (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S


Si (mg/L)
0
1
2
3
4
5
6
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 7 - 0.41%S
Reactor 9 - 0.51%S
Reactor 11 - 0.54%S
Reactor 13 - 0.57%S
Reactor 15 - 0.58%S


Mg (mg/L)
0
1
2
3
4
5
6
7
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S



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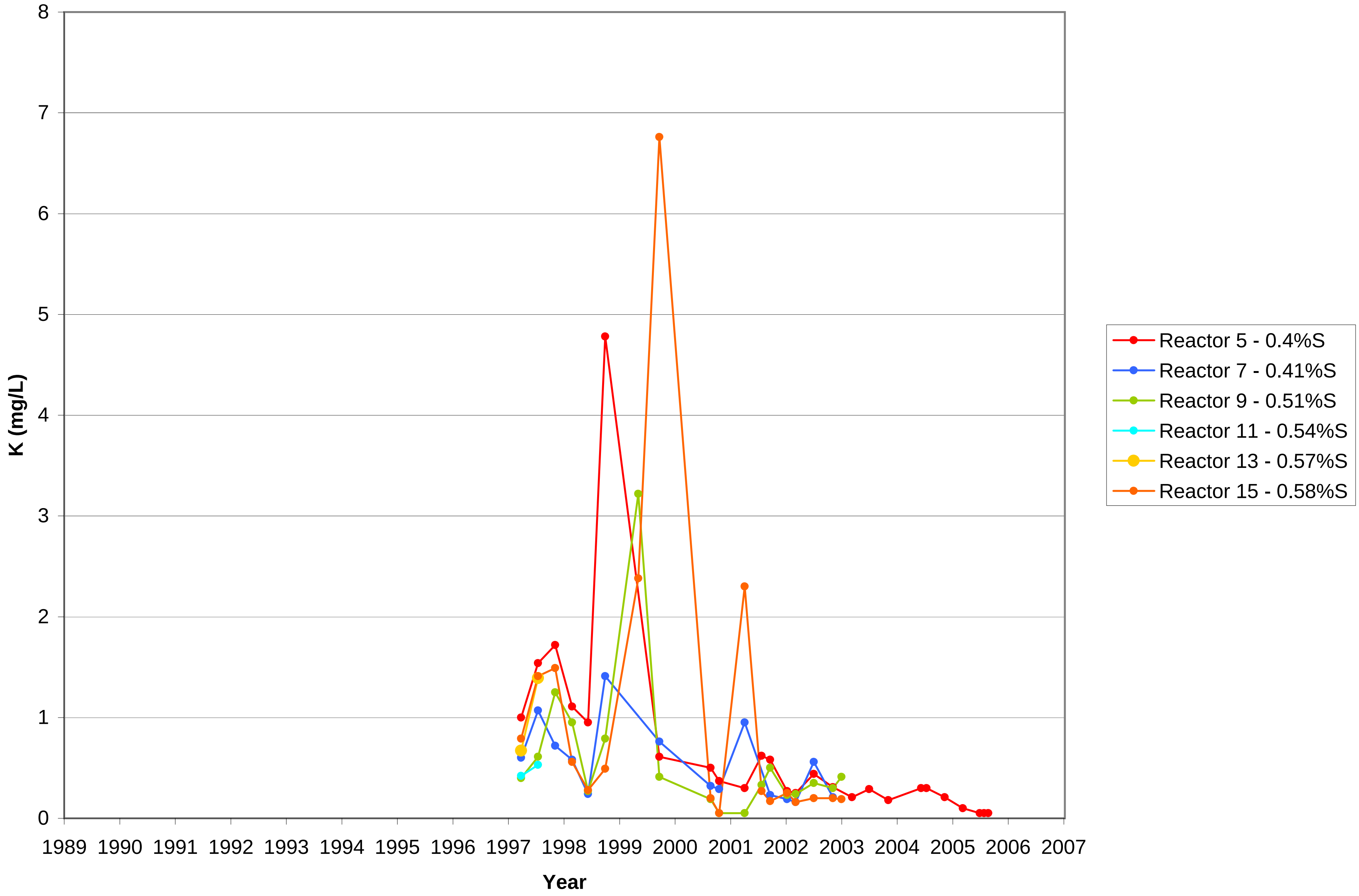
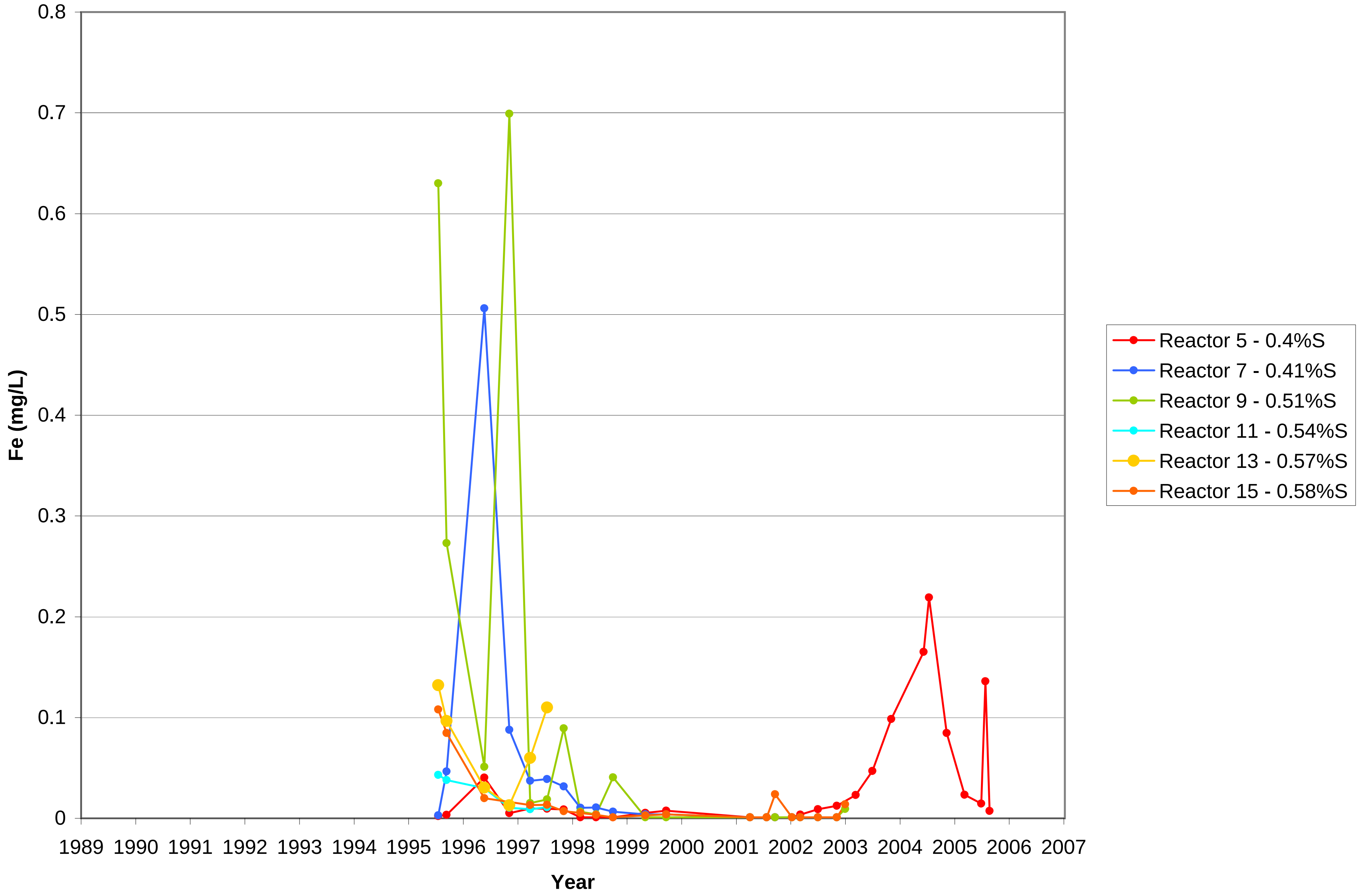
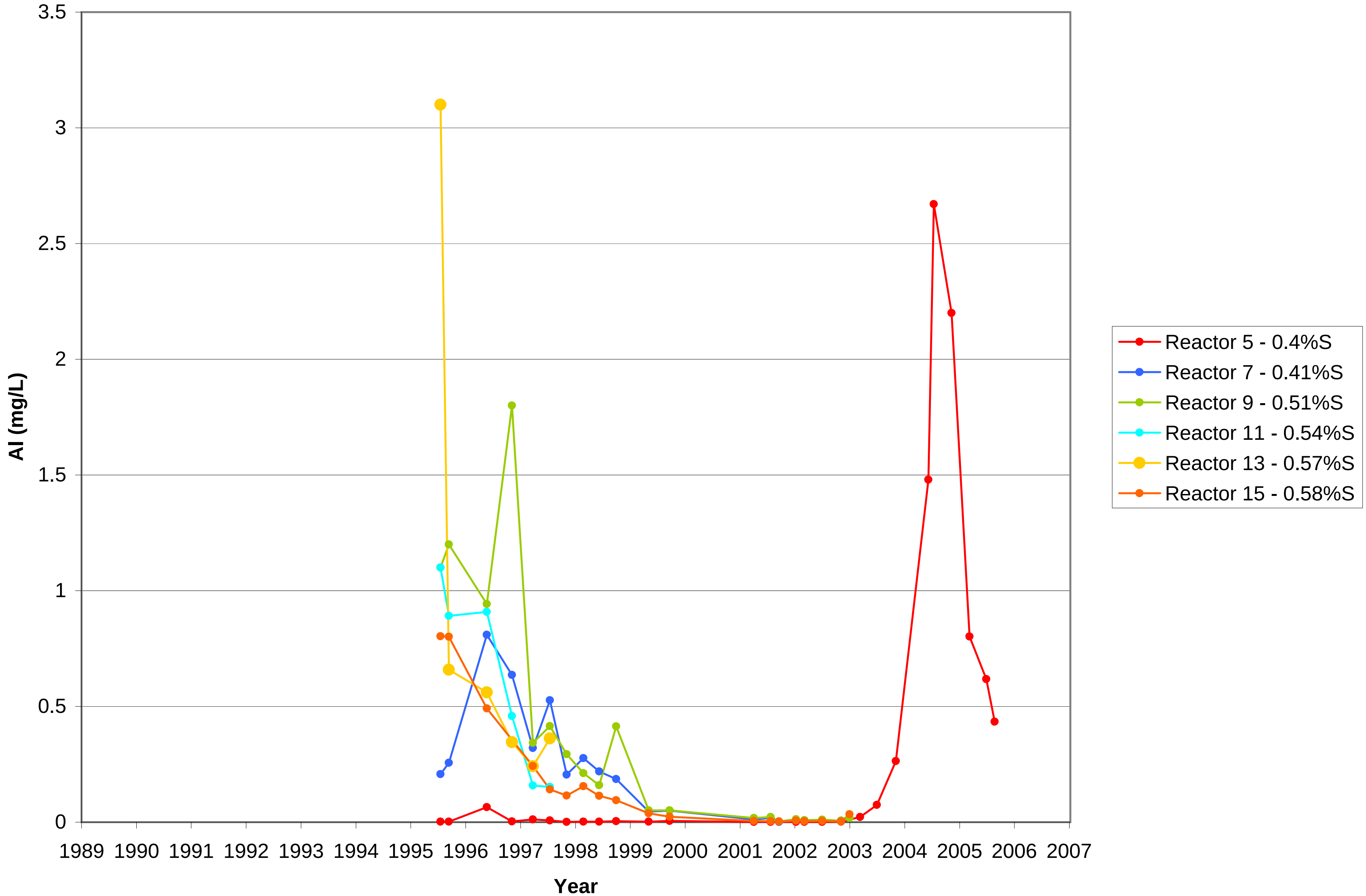
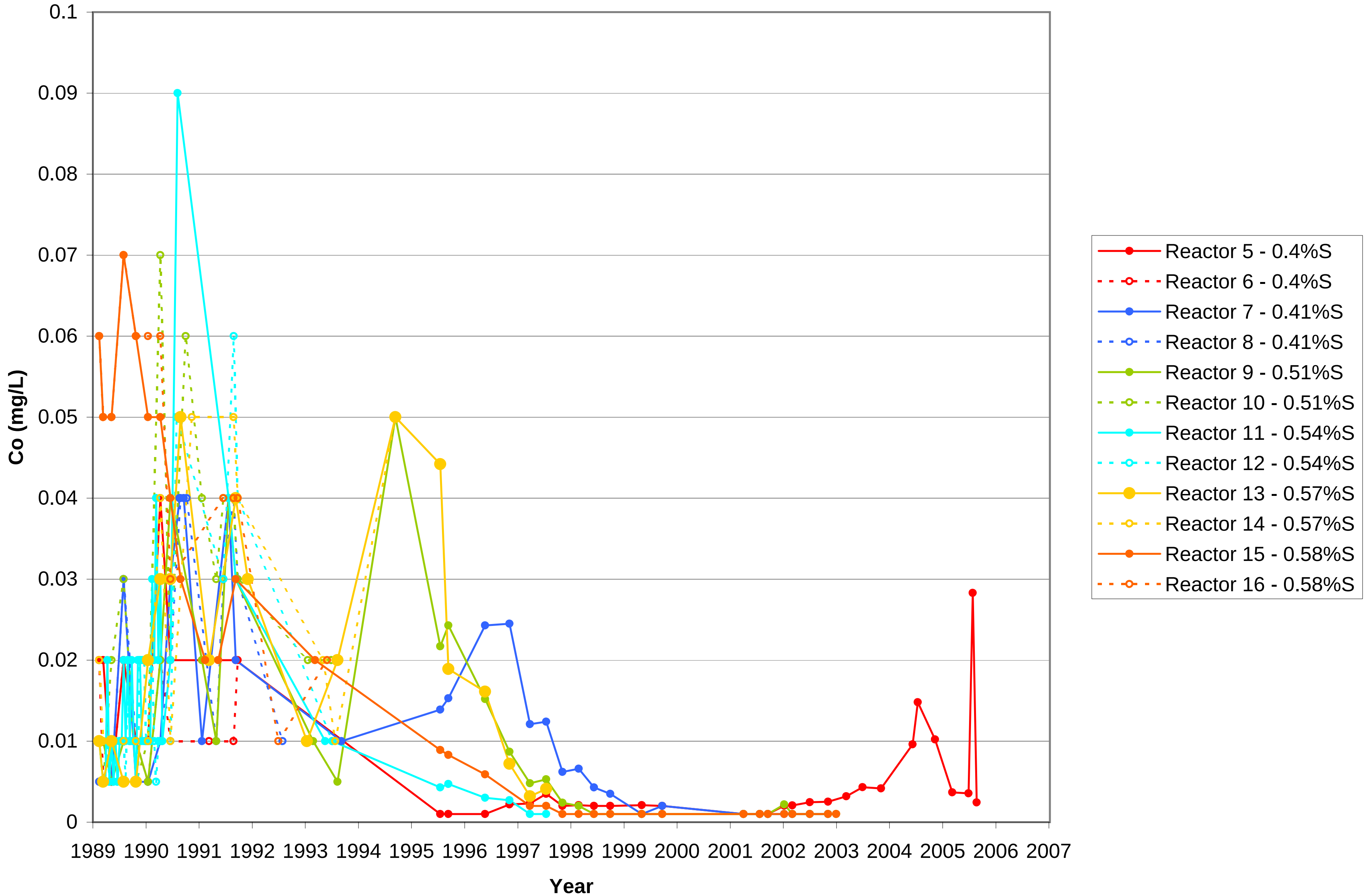
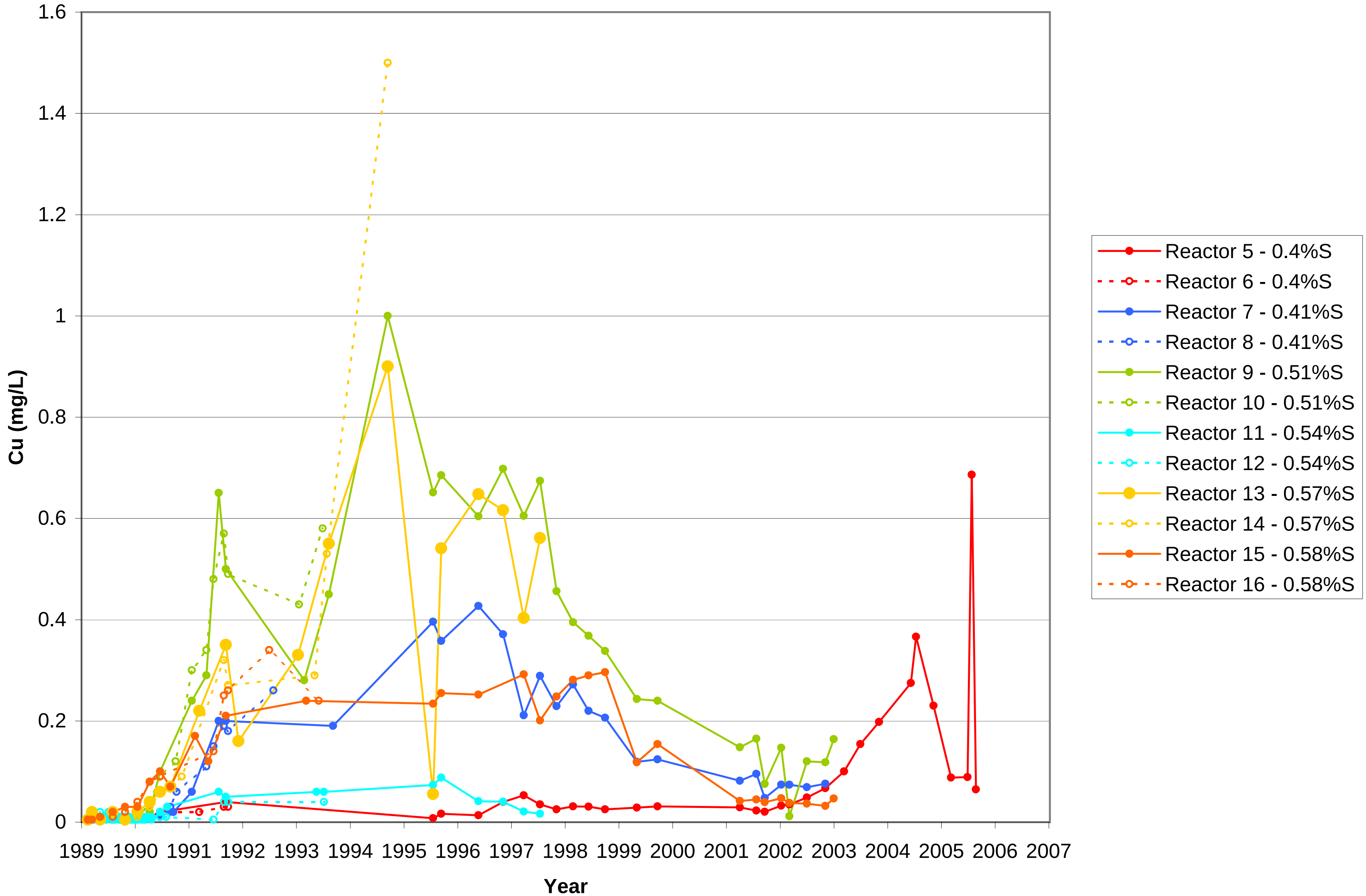
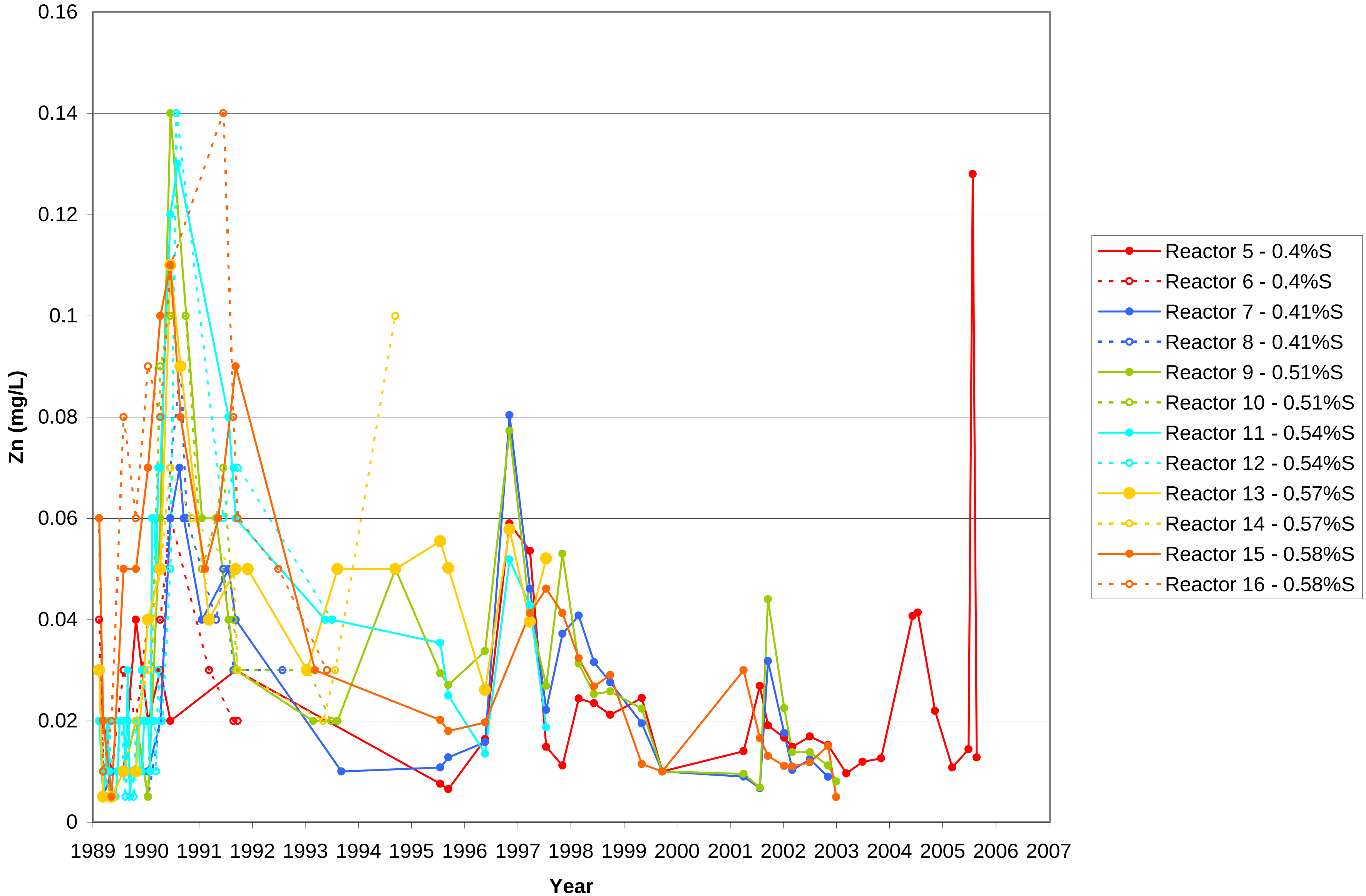

8
7
6
5
4
3
2
1
0
K (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 7 - 0.41%S
Reactor 9 - 0.51%S
Reactor 11 - 0.54%S
Reactor 13 - 0.57%S
Reactor 15 - 0.58%S


0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fe (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 7 - 0.41%S
Reactor 9 - 0.51%S
Reactor 11 - 0.54%S
Reactor 13 - 0.57%S
Reactor 15 - 0.58%S


3.5
3
2.5
2
1.5
1
0.5
0
Al (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 7 - 0.41%S
Reactor 9 - 0.51%S
Reactor 11 - 0.54%S
Reactor 13 - 0.57%S
Reactor 15 - 0.58%S

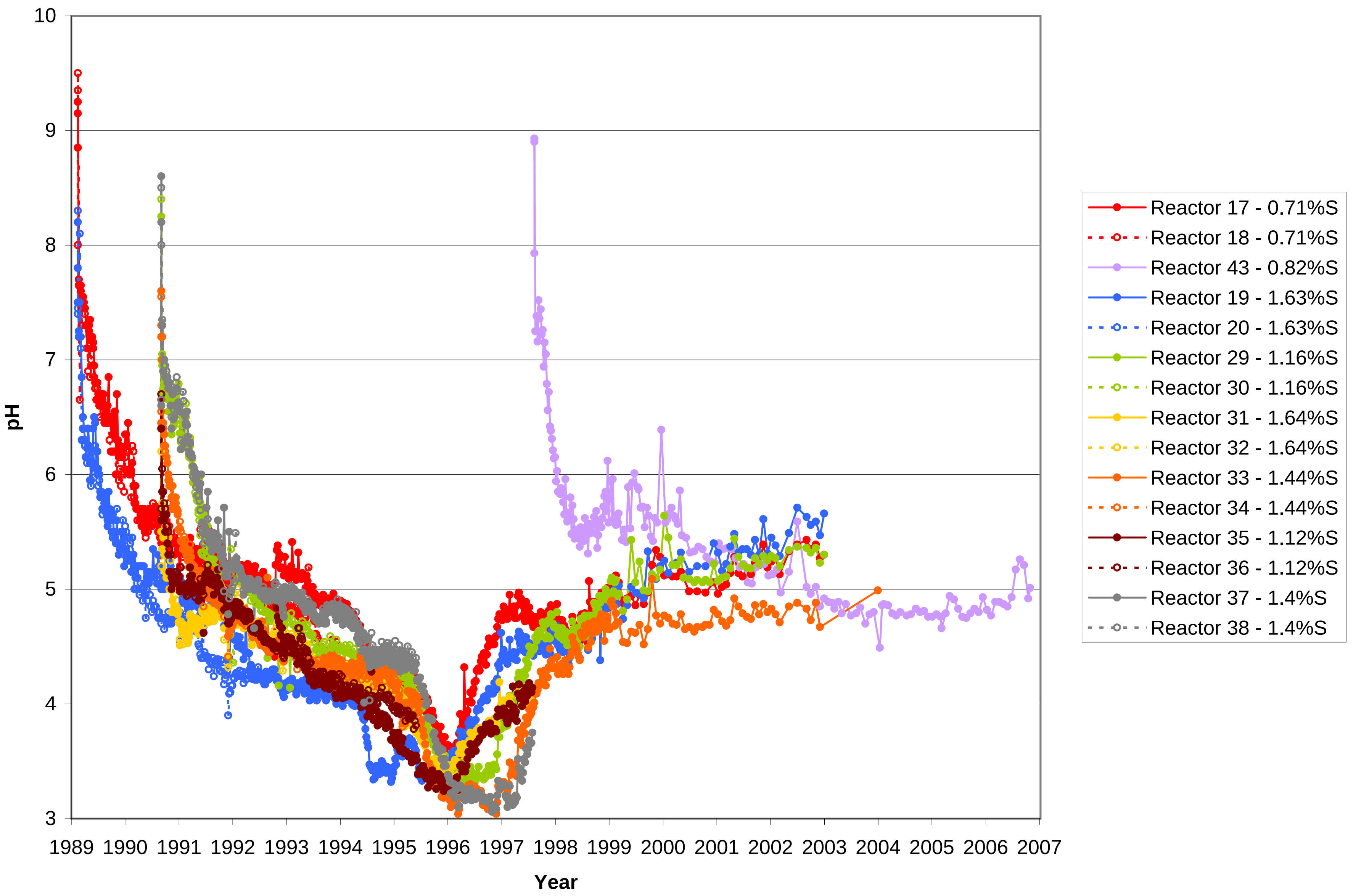

0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Co (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S


Cu (mg/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S


0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Zn (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 5 - 0.4%S
Reactor 6 - 0.4%S
Reactor 7 - 0.41%S
Reactor 8 - 0.41%S
Reactor 9 - 0.51%S
Reactor 10 - 0.51%S
Reactor 11 - 0.54%S
Reactor 12 - 0.54%S
Reactor 13 - 0.57%S
Reactor 14 - 0.57%S
Reactor 15 - 0.58%S
Reactor 16 - 0.58%S

Appendix B.1
Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Chart B.1.31



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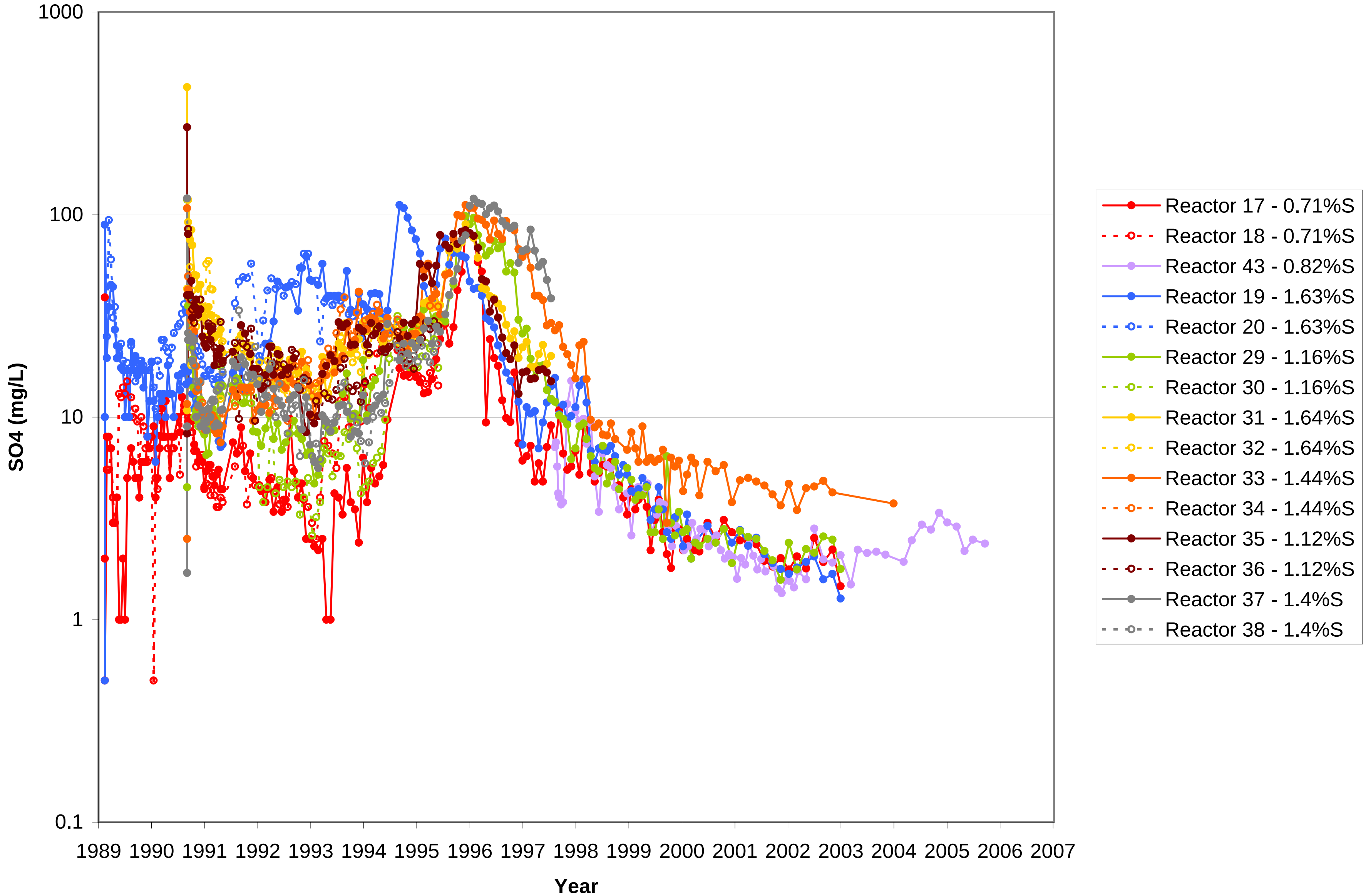
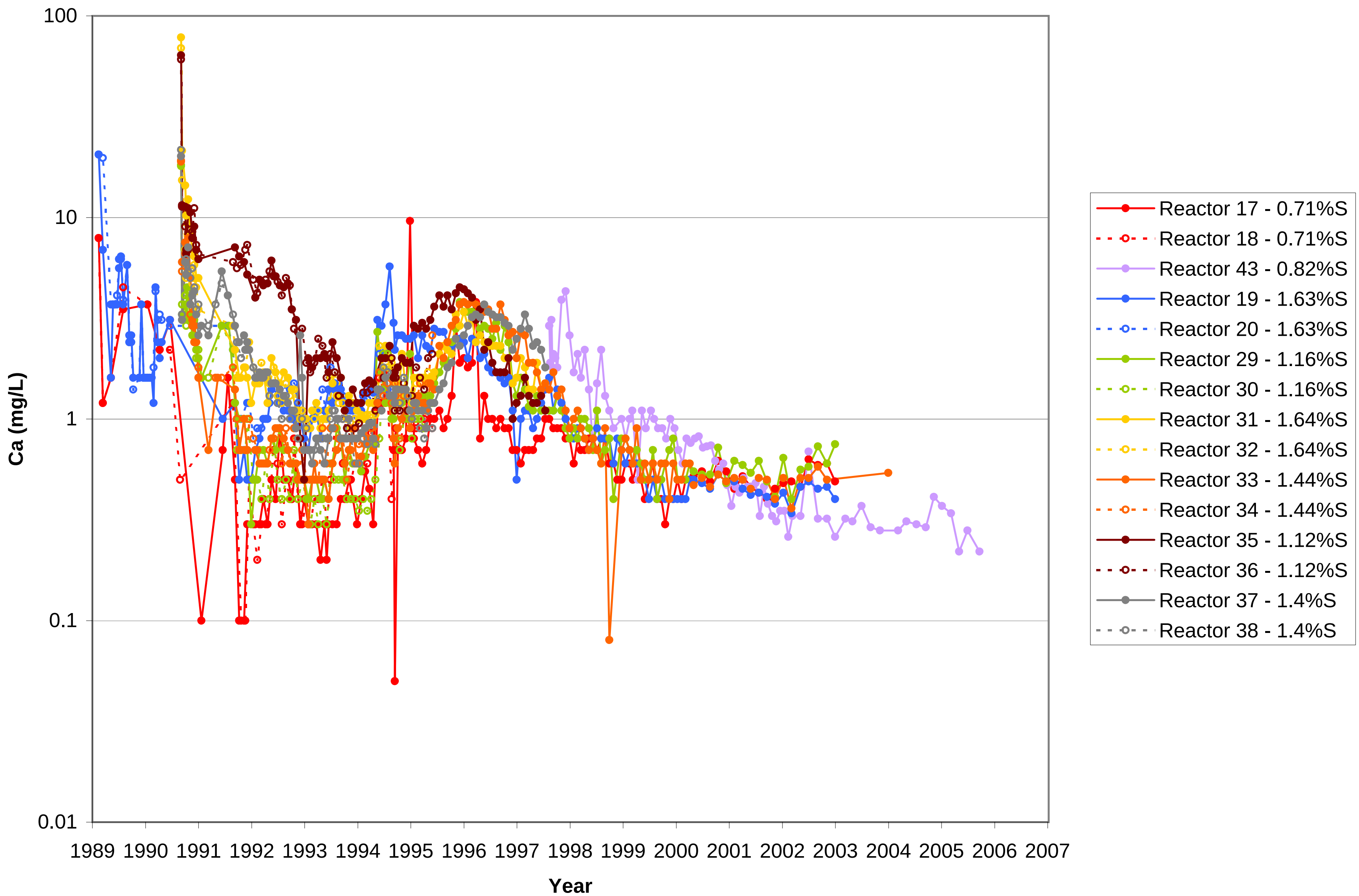
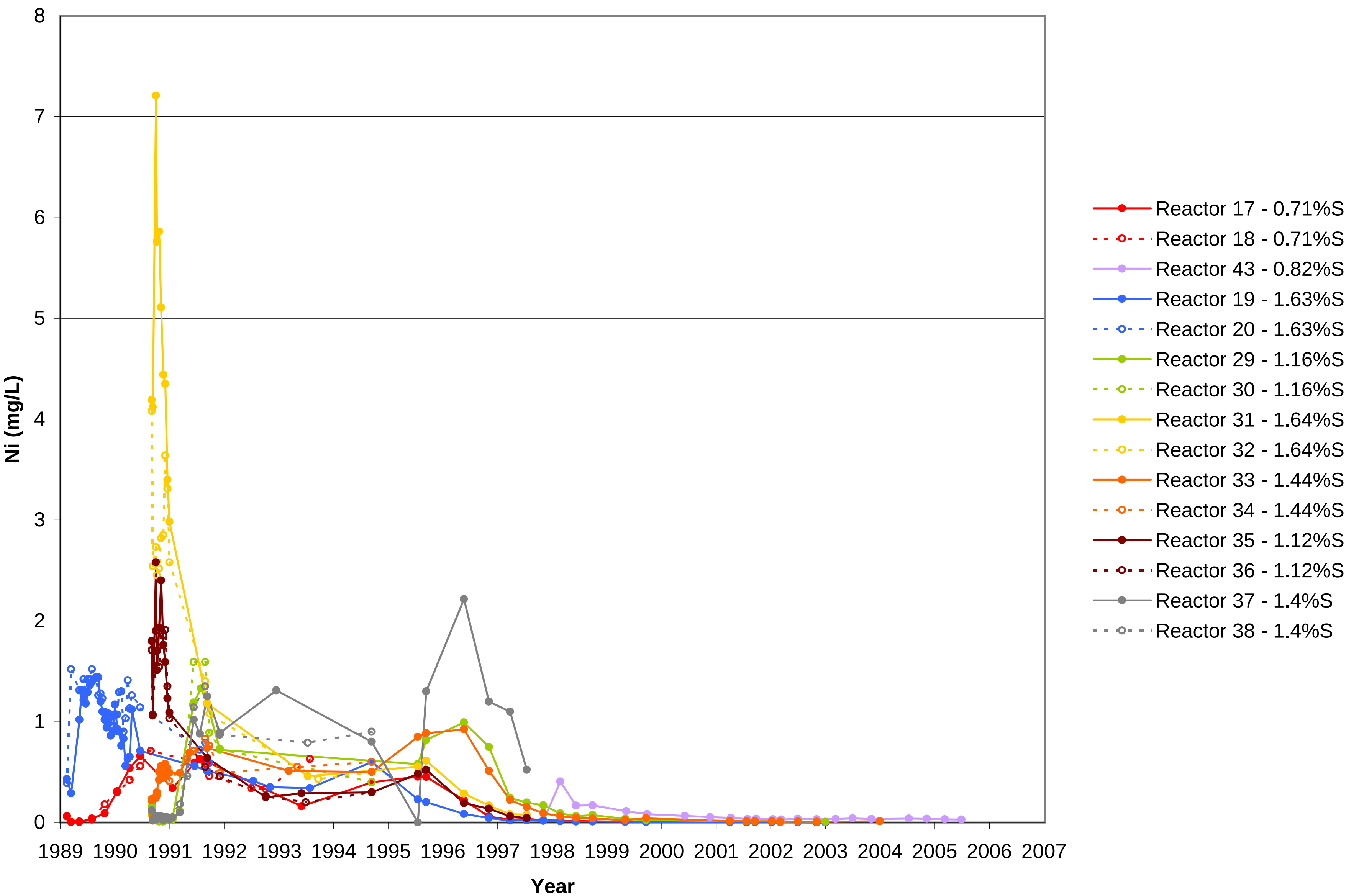
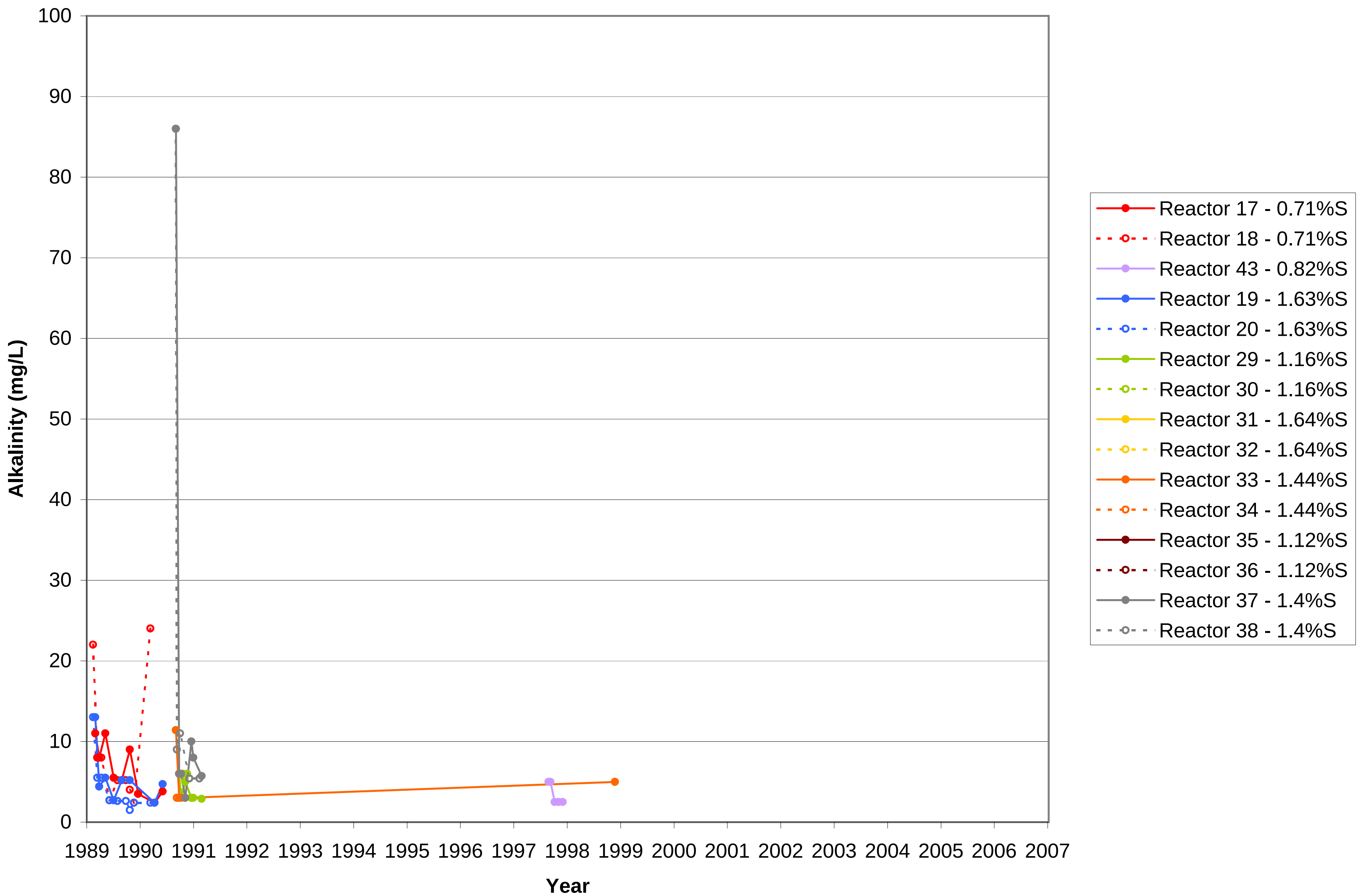
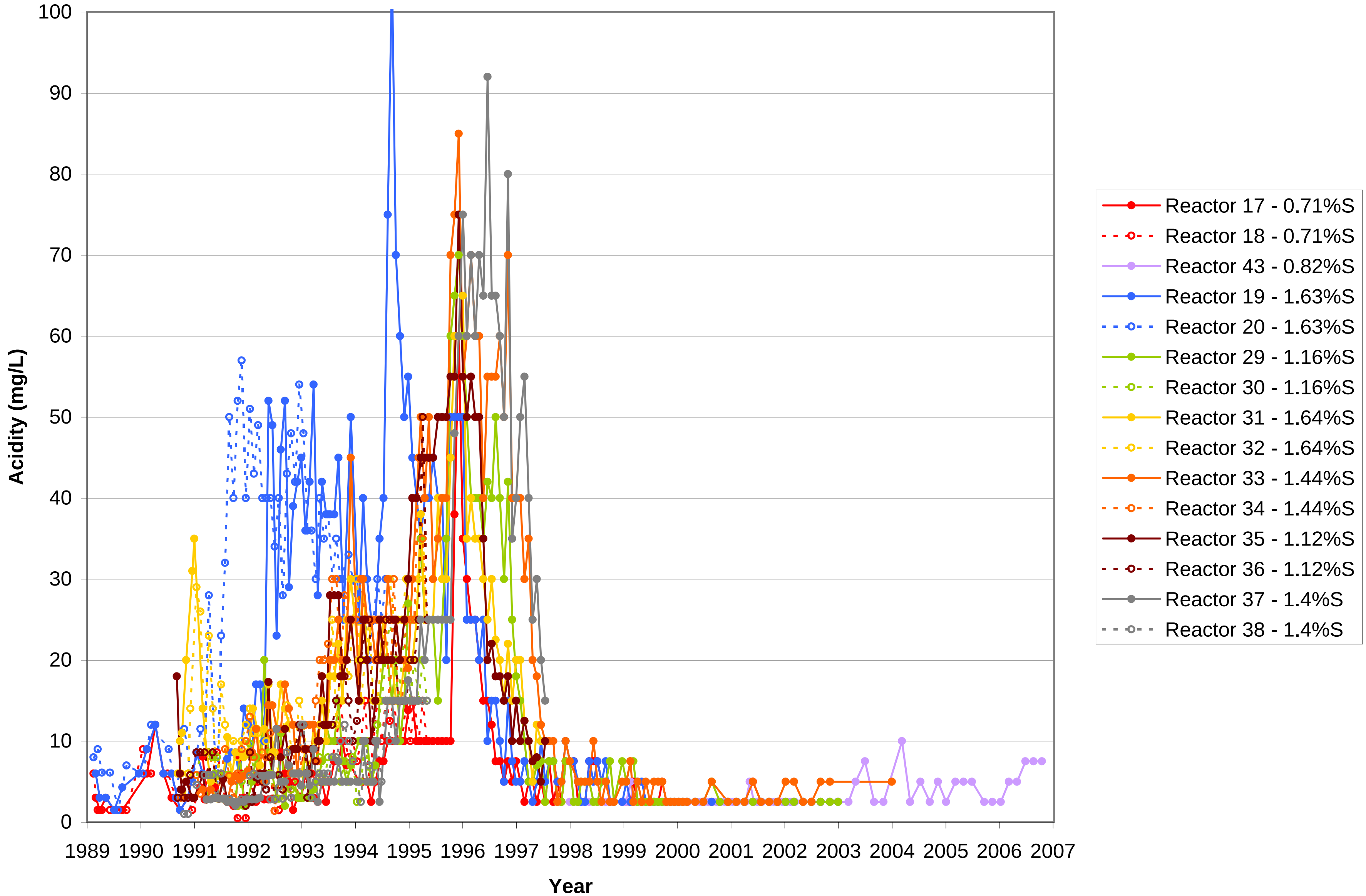
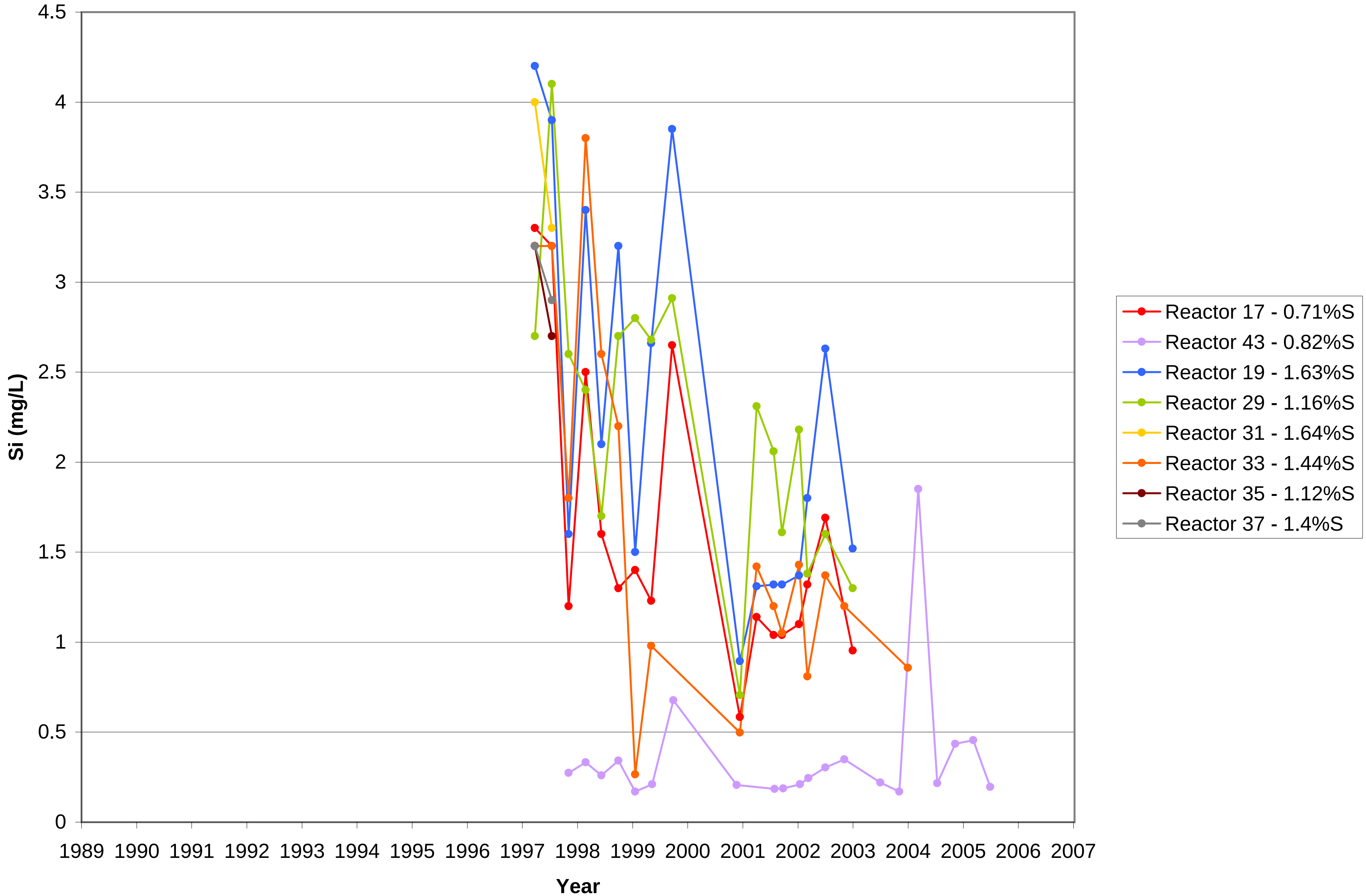

1000
100
10
1
0.1
SO4 (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S

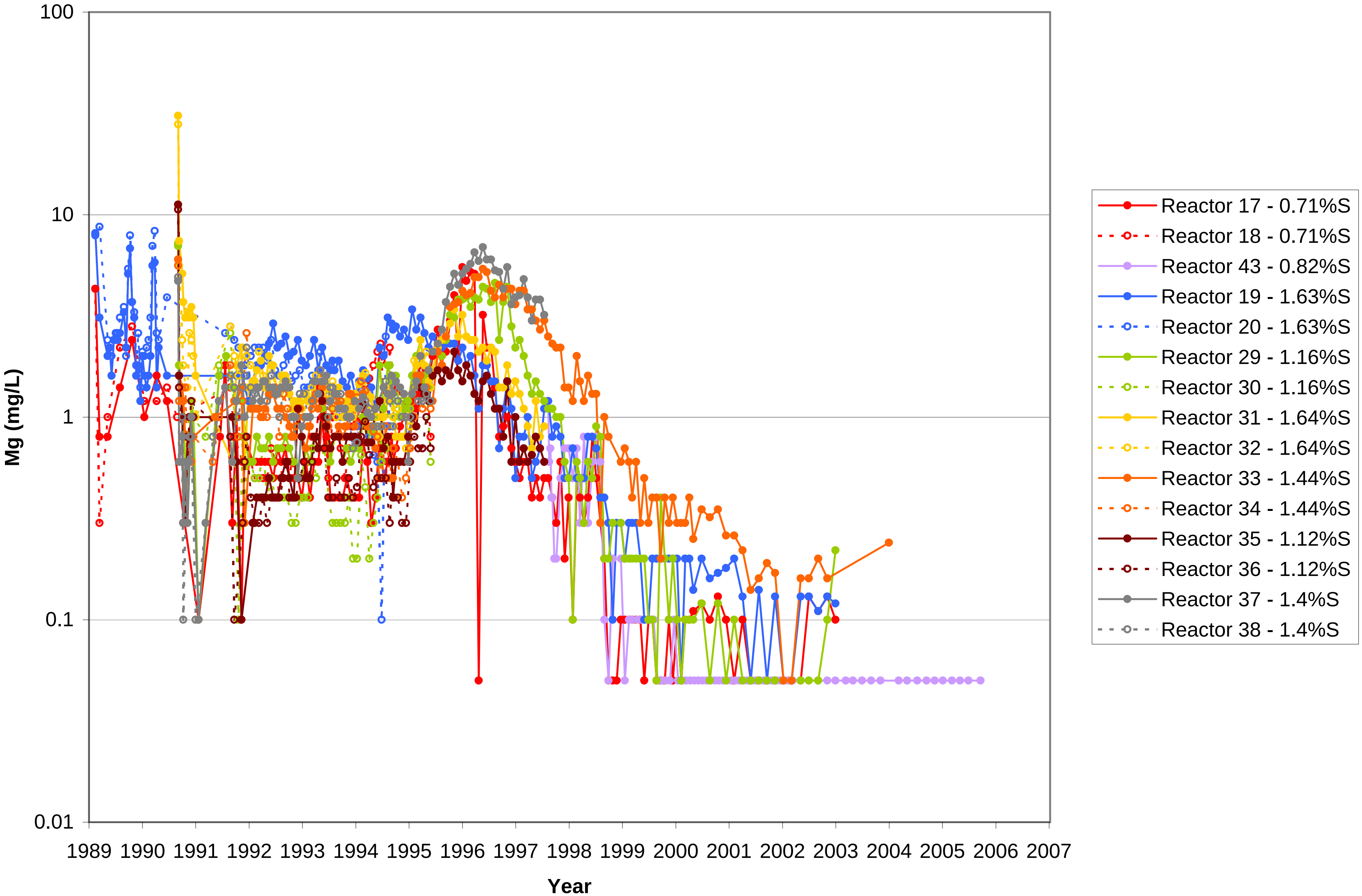

100
10
1
0.1
0.01
Ca (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S

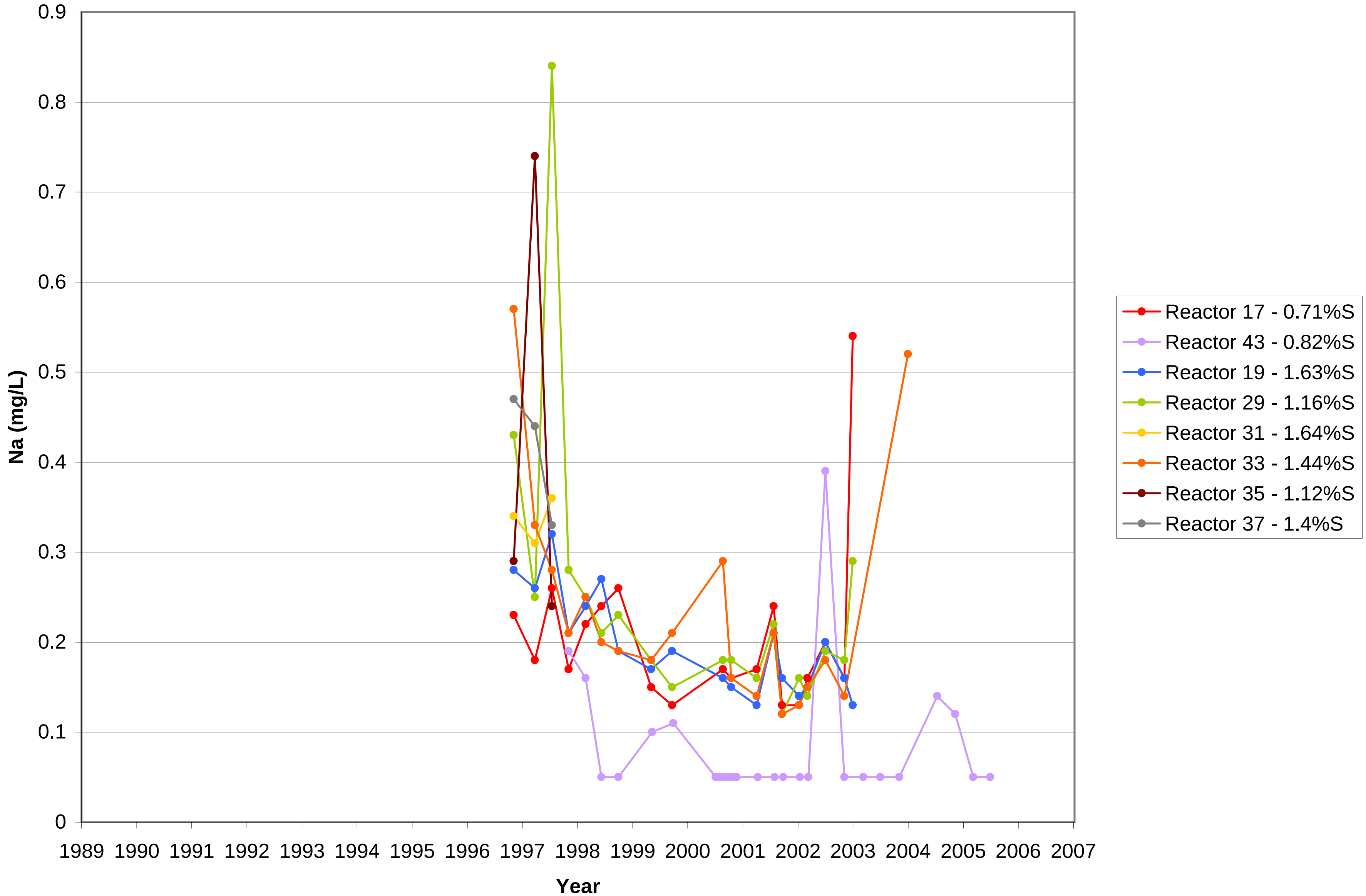

8
7
6
5
4
3
2
1
0
Ni (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S

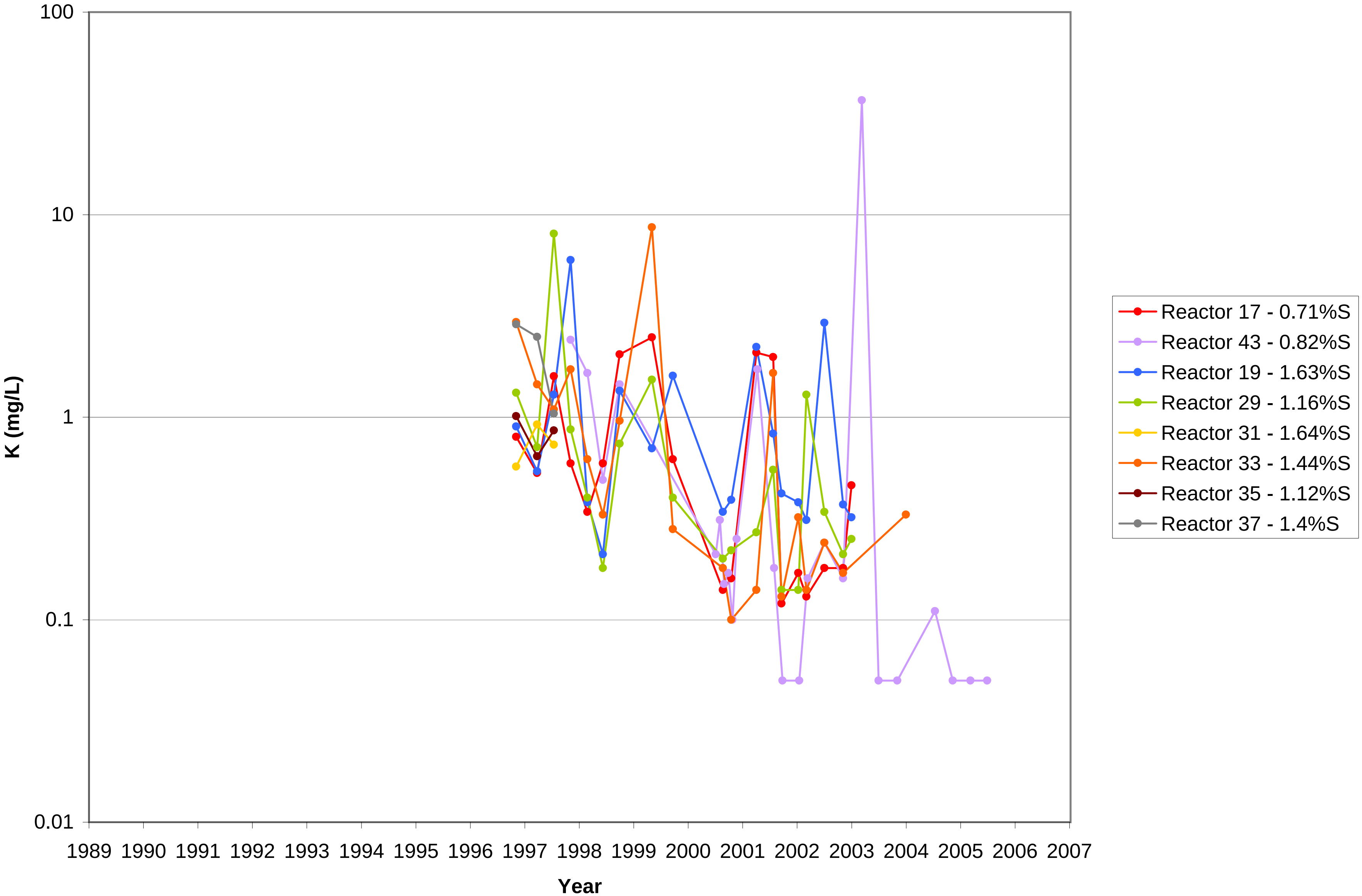

100
90
80
70
60
50
40
30
20
10
0
Alkalinity (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S

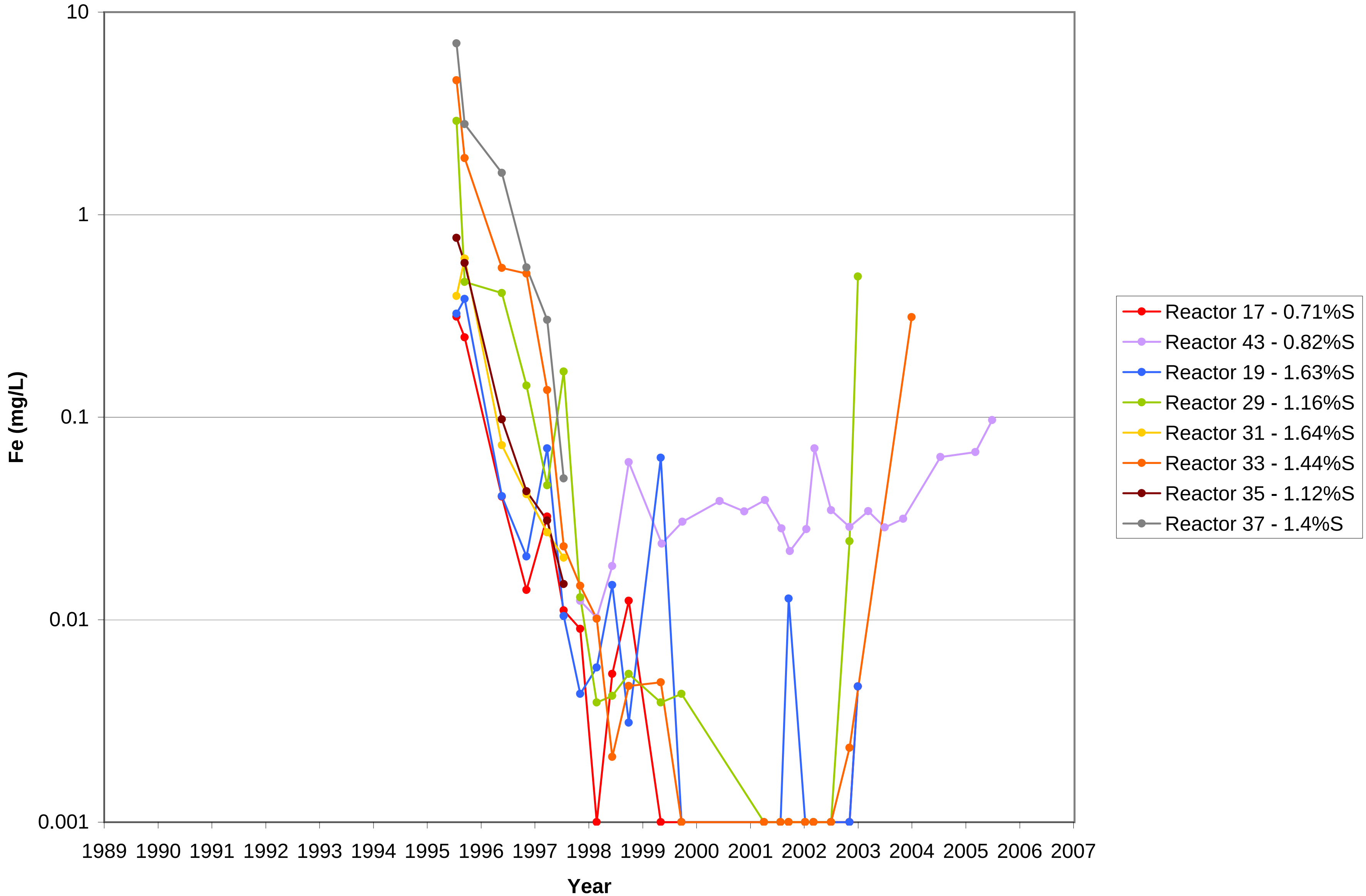

100
90
80
70
60
50
40
30
20
10
0
Acidity (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S

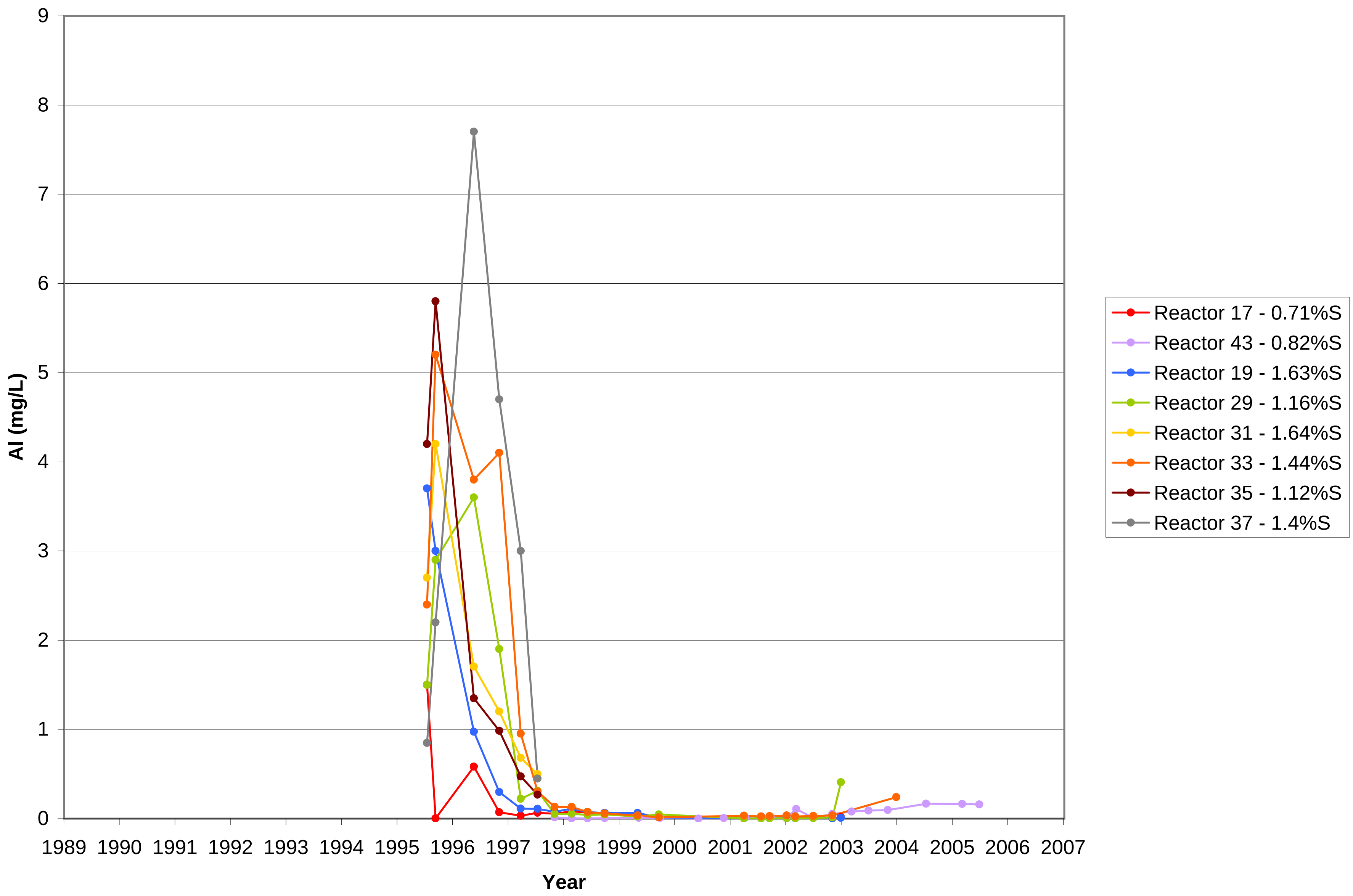

4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Si (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 17 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 29 - 1.16%S
Reactor 31 - 1.64%S
Reactor 33 - 1.44%S
Reactor 35 - 1.12%S
Reactor 37 - 1.4%S


100
10
1
0.1
0.01
Mg (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S


0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Na (mg/L)
1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Year
Reactor 17 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 29 - 1.16%S
Reactor 31 - 1.64%S
Reactor 33 - 1.44%S
Reactor 35 - 1.12%S
Reactor 37 - 1.4%S


100
10
1
0.1
0.01
K (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 29 - 1.16%S
Reactor 31 - 1.64%S
Reactor 33 - 1.44%S
Reactor 35 - 1.12%S
Reactor 37 - 1.4%S


10
1
0.1
0.01
0.001
Fe (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 29 - 1.16%S
Reactor 31 - 1.64%S
Reactor 33 - 1.44%S
Reactor 35 - 1.12%S
Reactor 37 - 1.4%S


9
8
7
6
5
4
3
2
1
0
Al (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 29 - 1.16%S
Reactor 31 - 1.64%S
Reactor 33 - 1.44%S
Reactor 35 - 1.12%S
Reactor 37 - 1.4%S

Appendix B.1
Charts for MDNR Dunka Pit Blast Hole Reactor Tests

Chart B.1.43

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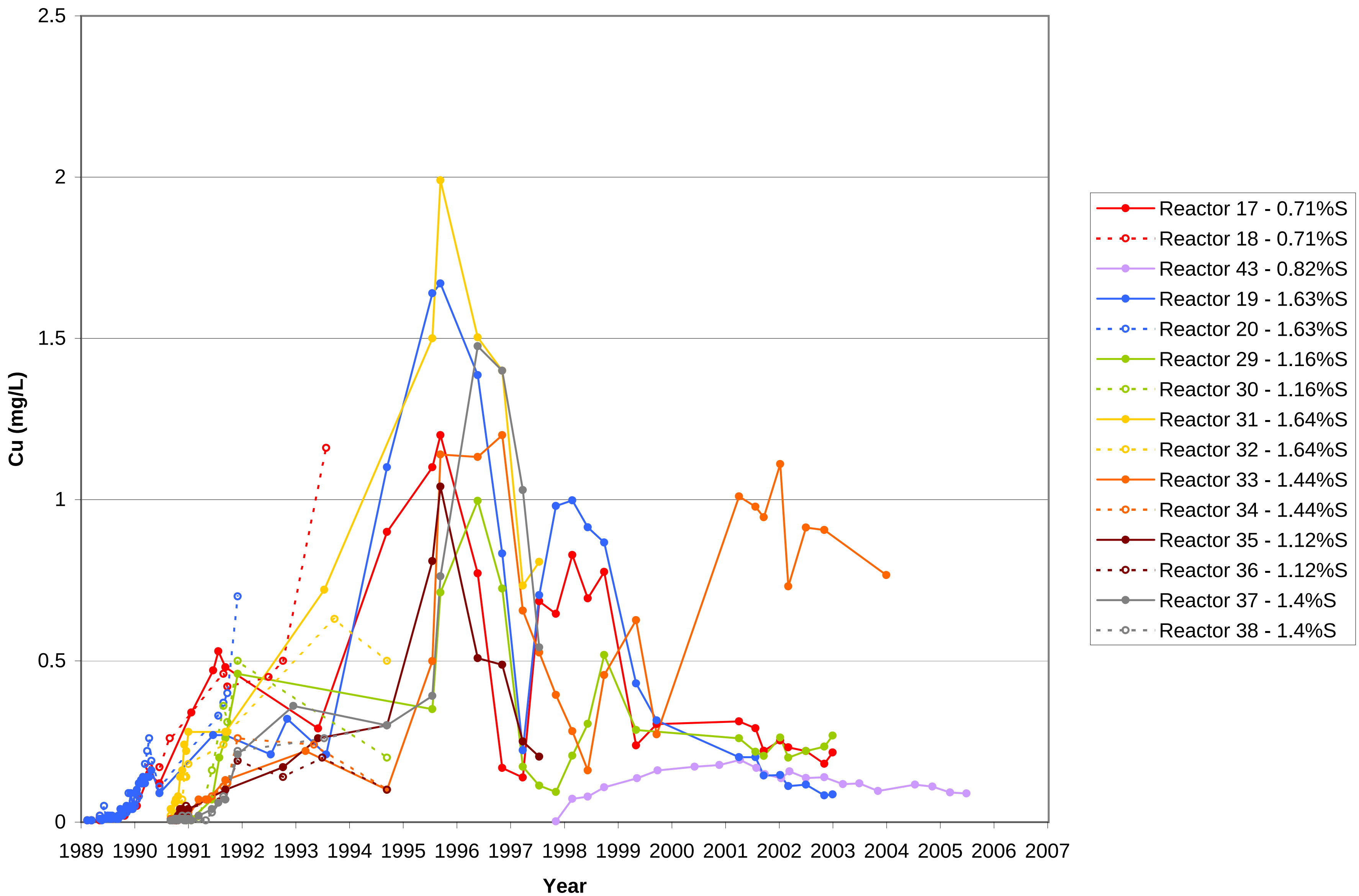
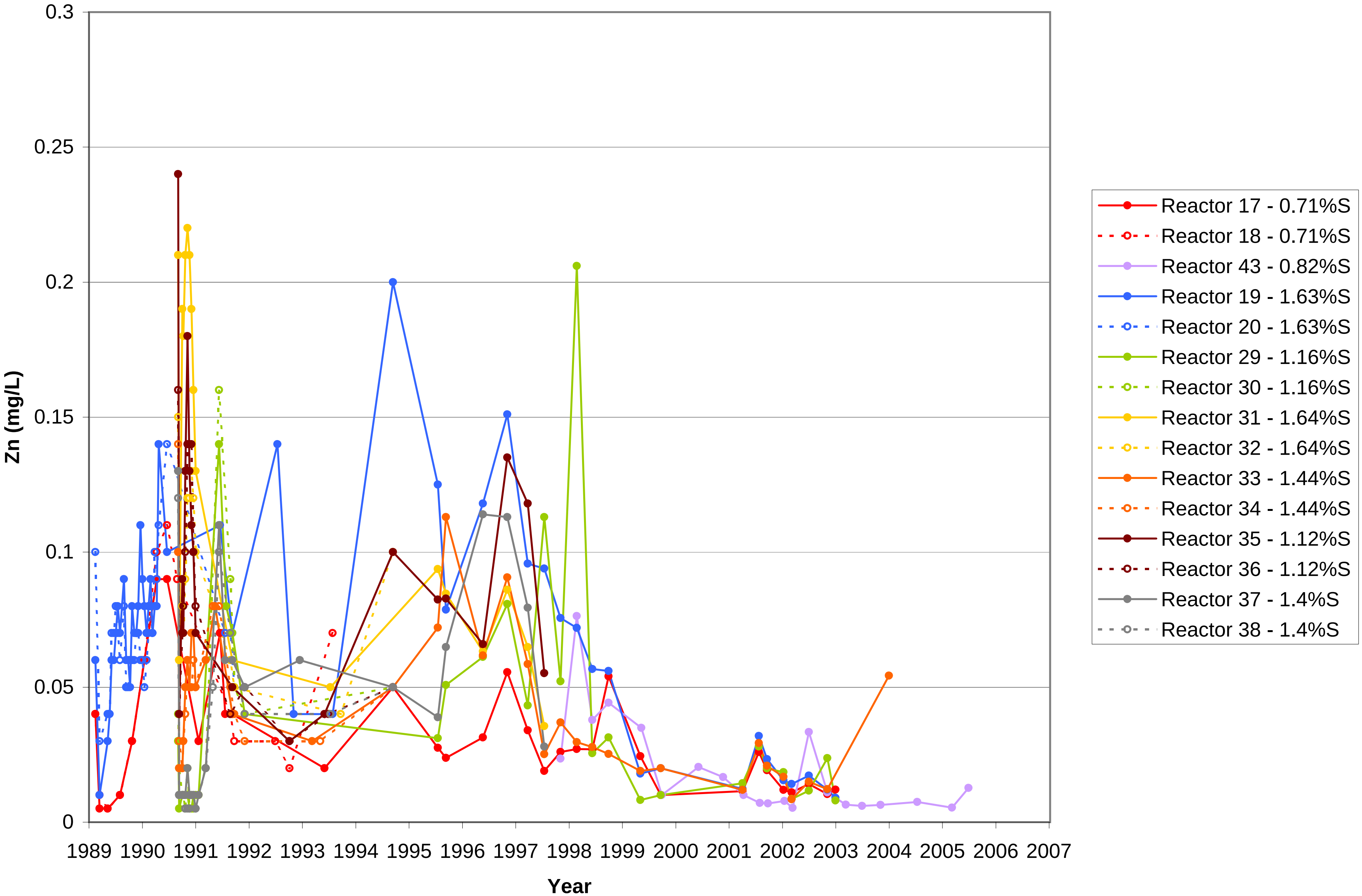
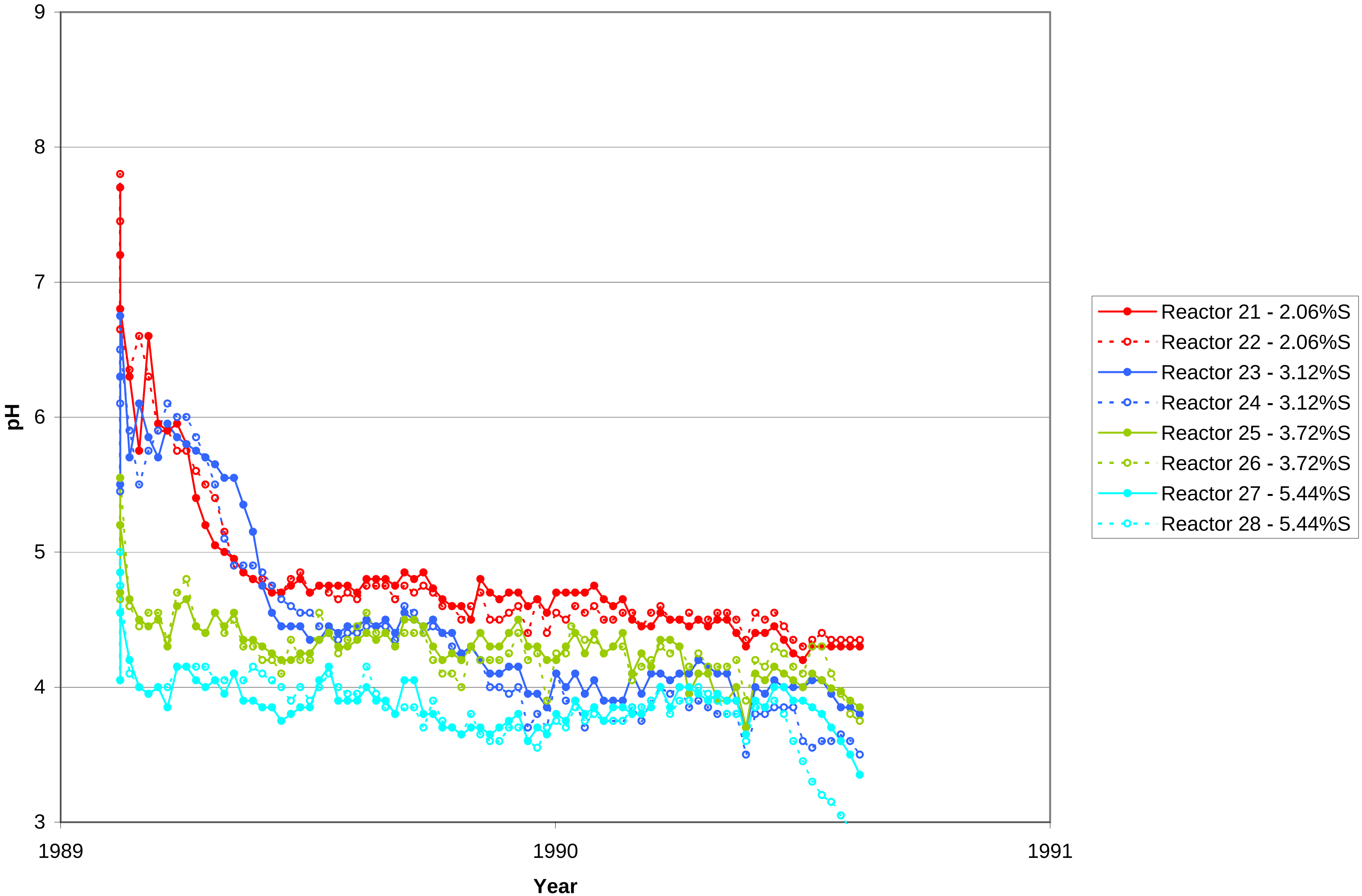

2.5
2
1.5
1
0.5
0
Cu (mg/L)
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S


Zn (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0.3
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 17 - 0.71%S
Reactor 18 - 0.71%S
Reactor 43 - 0.82%S
Reactor 19 - 1.63%S
Reactor 20 - 1.63%S
Reactor 29 - 1.16%S
Reactor 30 - 1.16%S
Reactor 31 - 1.64%S
Reactor 32 - 1.64%S
Reactor 33 - 1.44%S
Reactor 34 - 1.44%S
Reactor 35 - 1.12%S
Reactor 36 - 1.12%S
Reactor 37 - 1.4%S
Reactor 38 - 1.4%S


9
8
7
6
5
4
3
pH
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

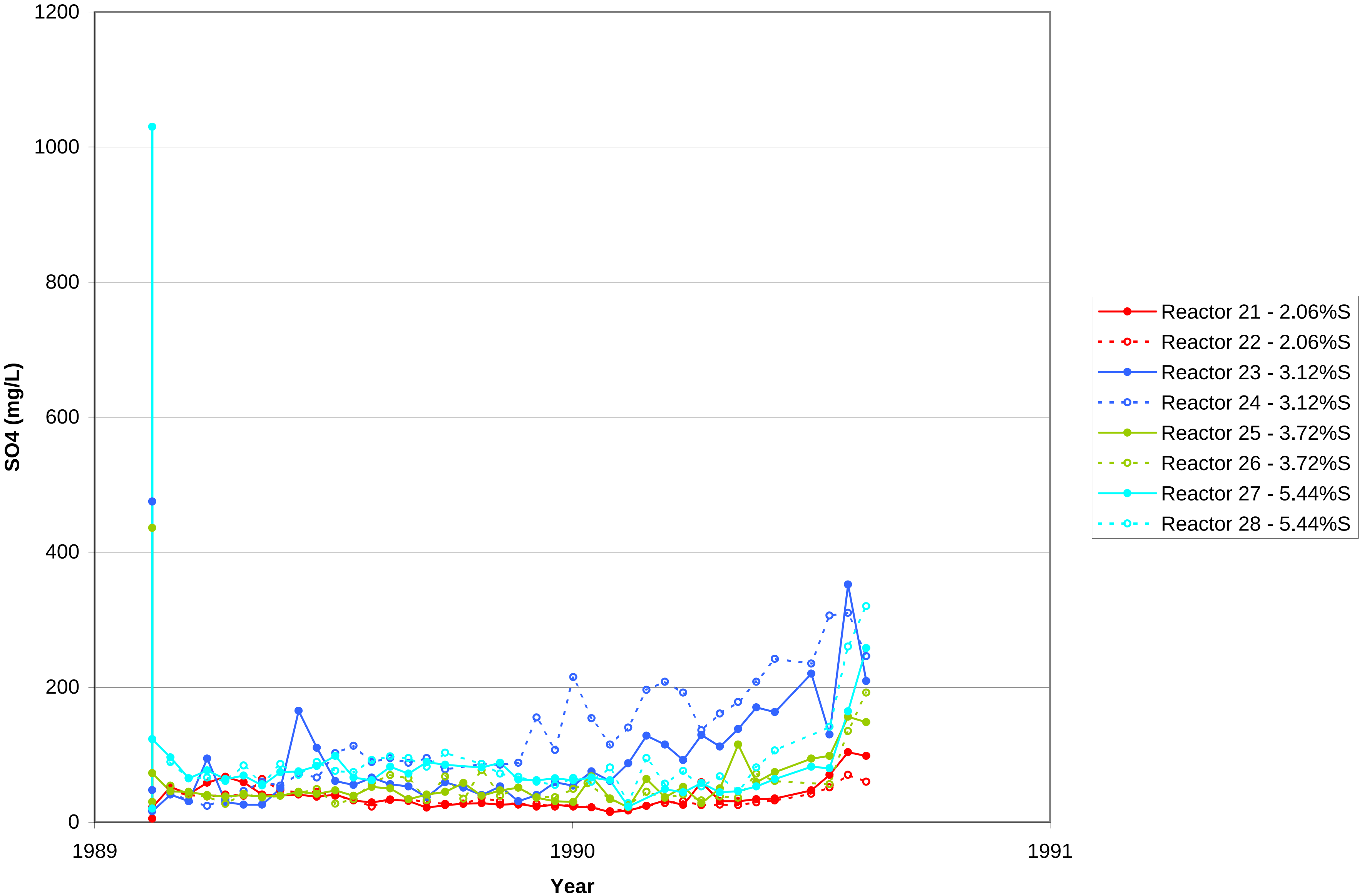
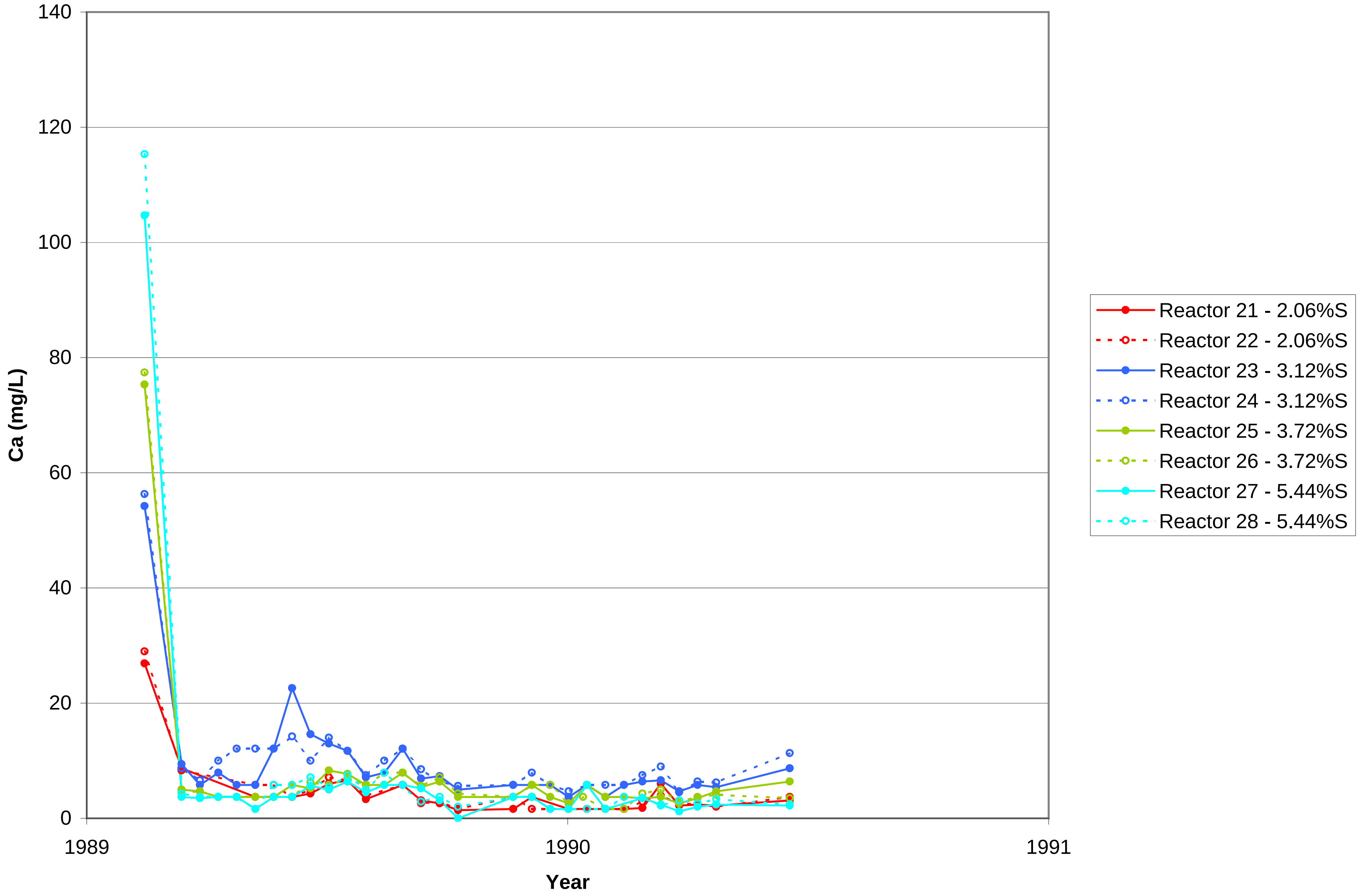
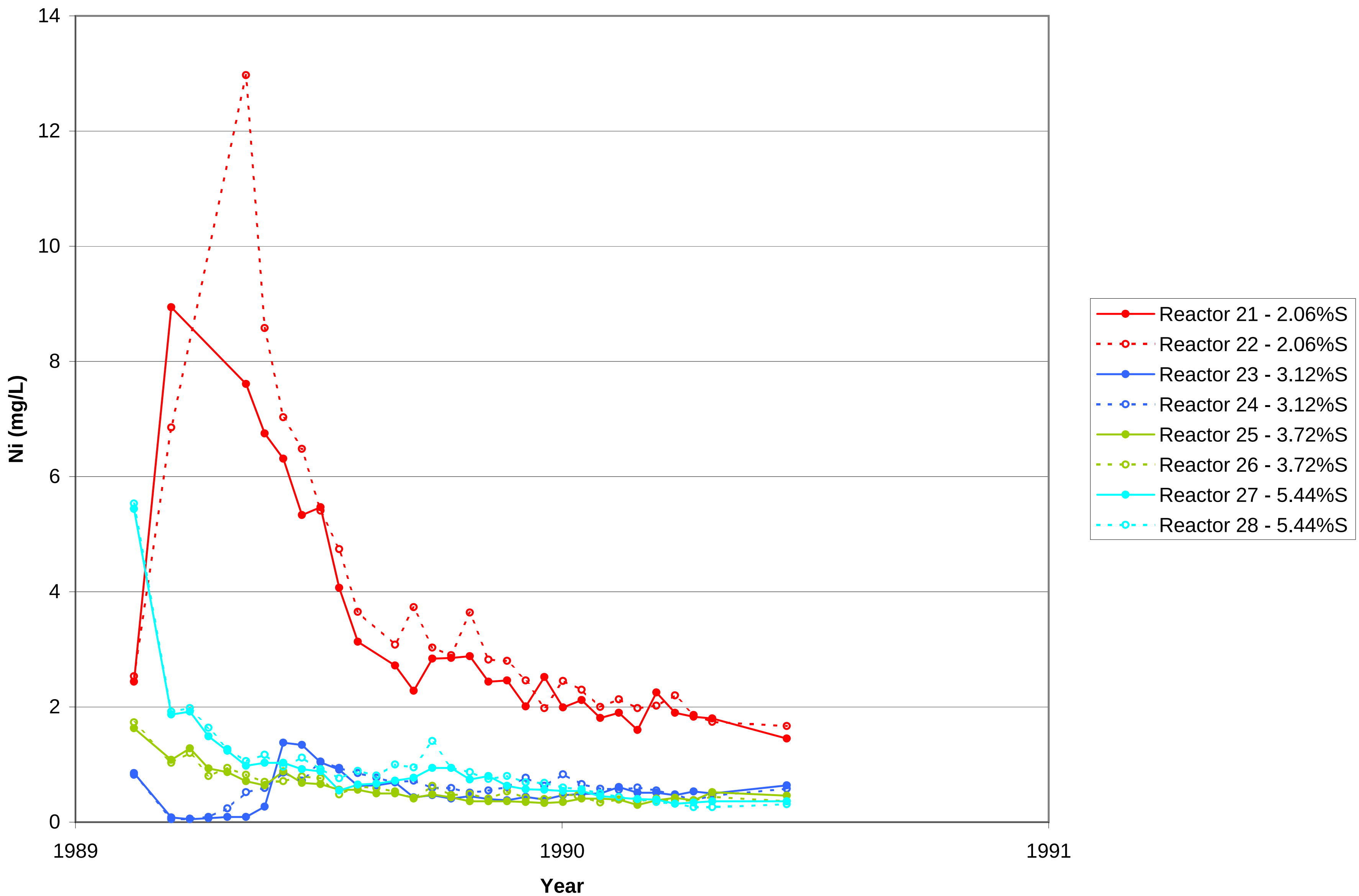
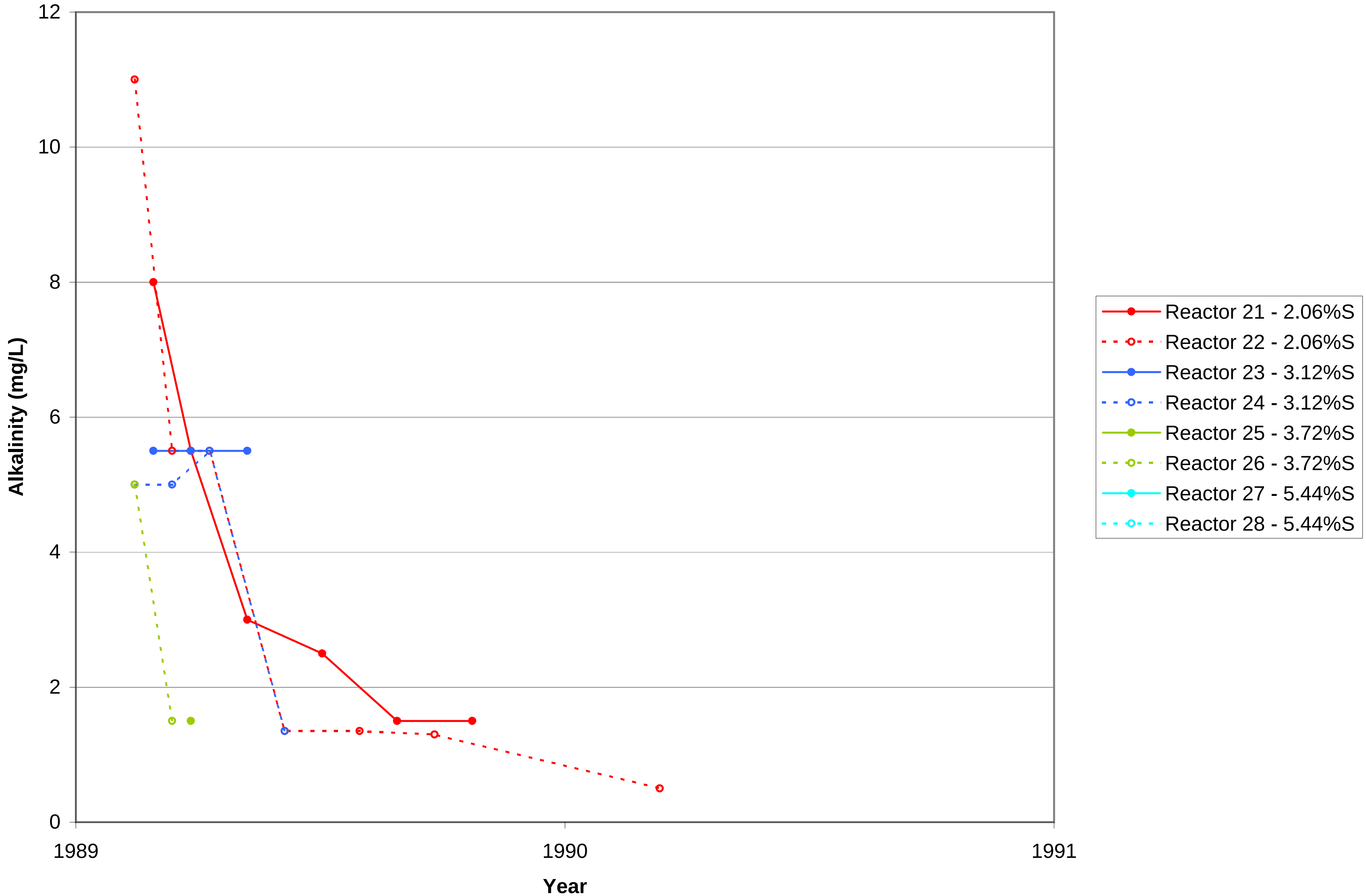
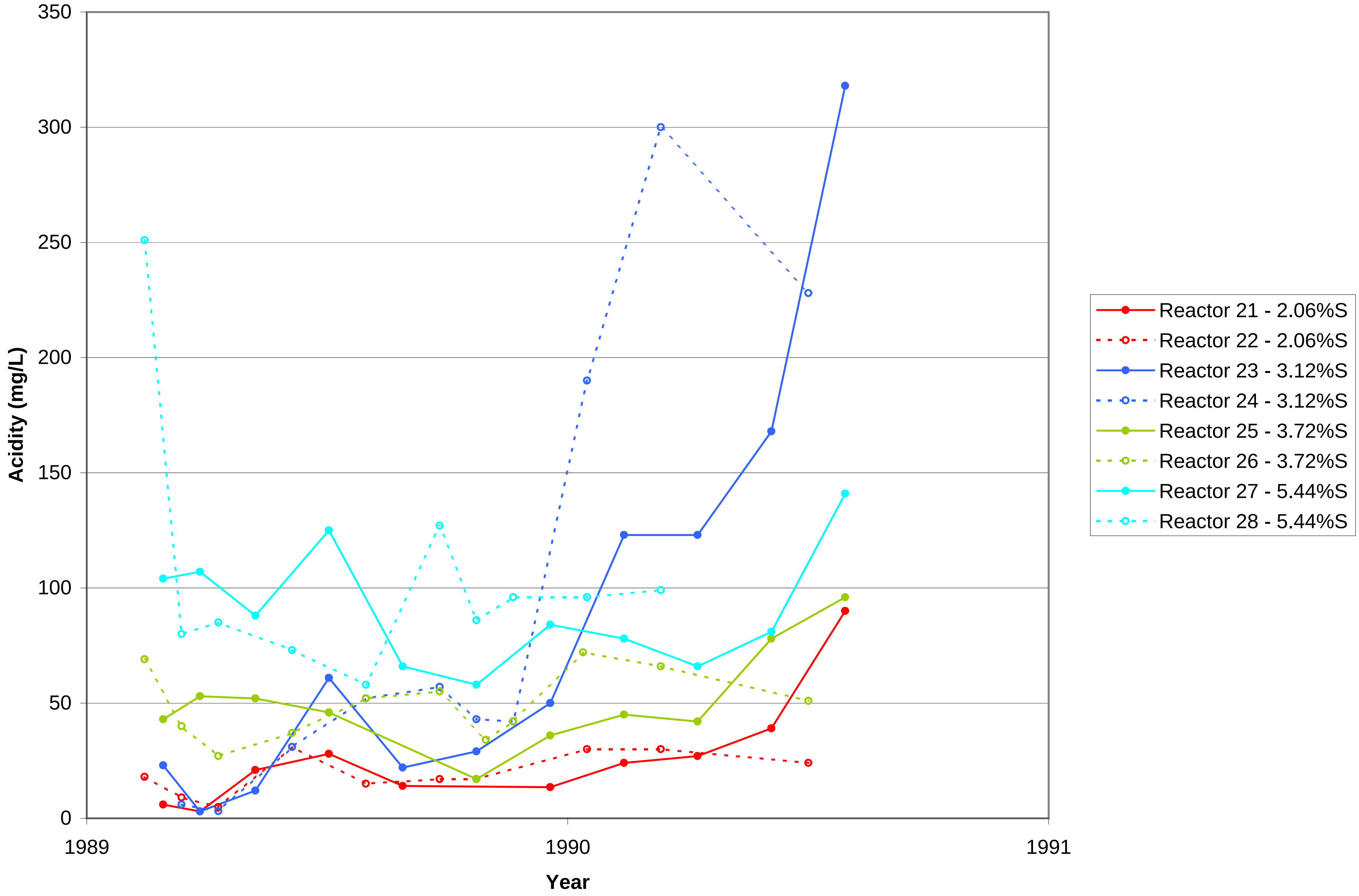

1200
1000
800
600
400
200
0
SO4 (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

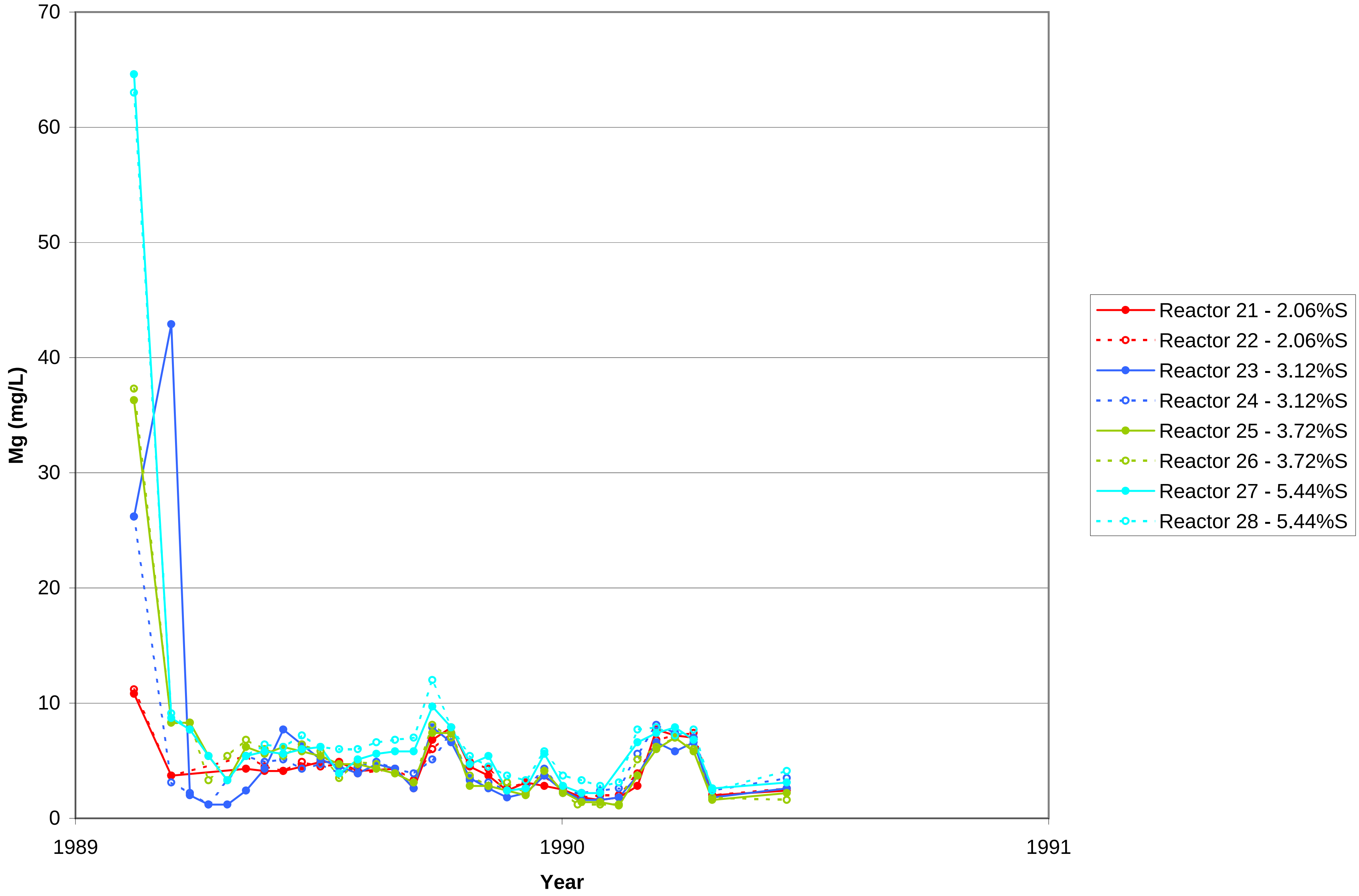
Chart B.1.48

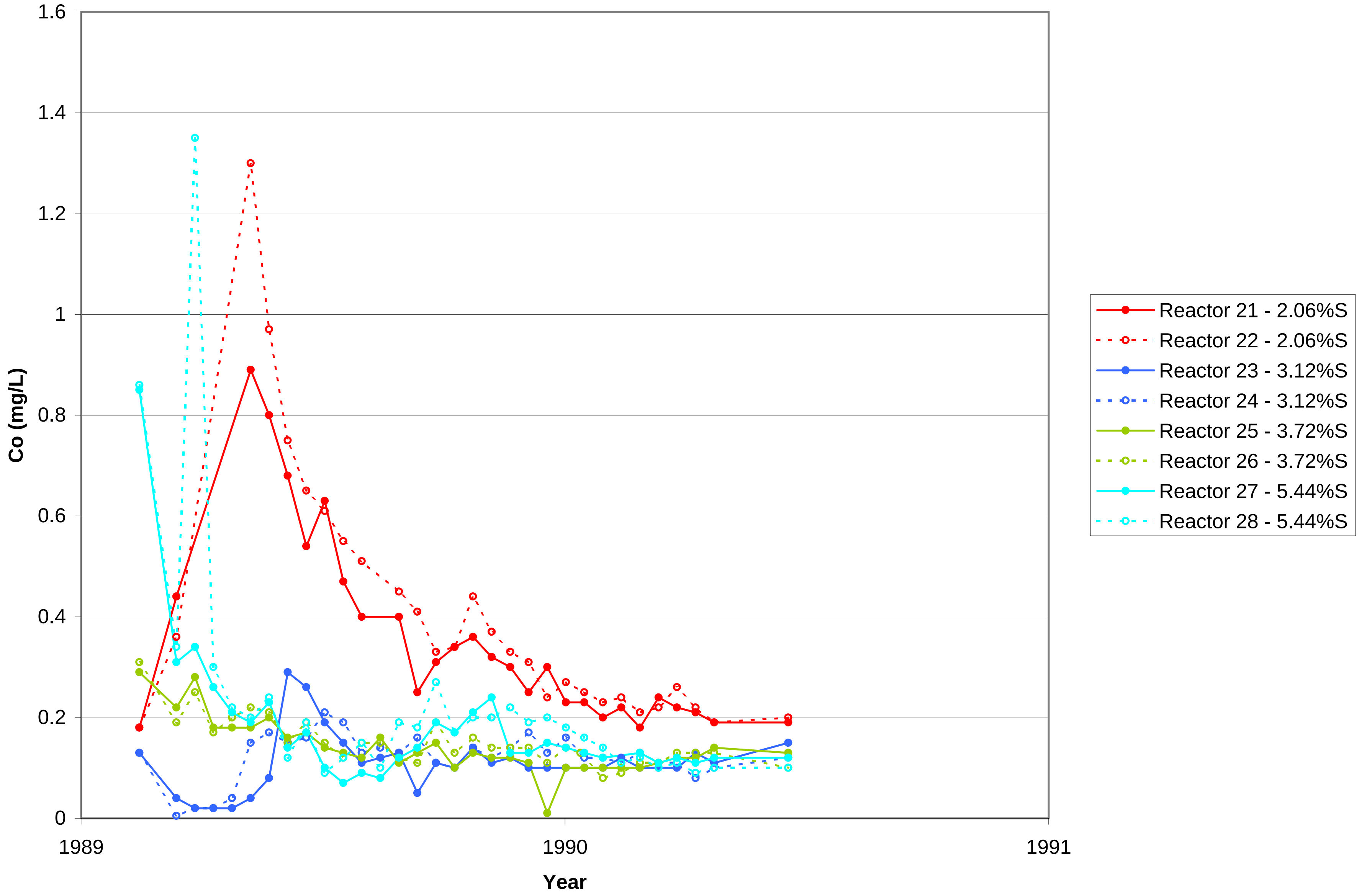

140
120
100
80
60
40
20
0
Ca (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

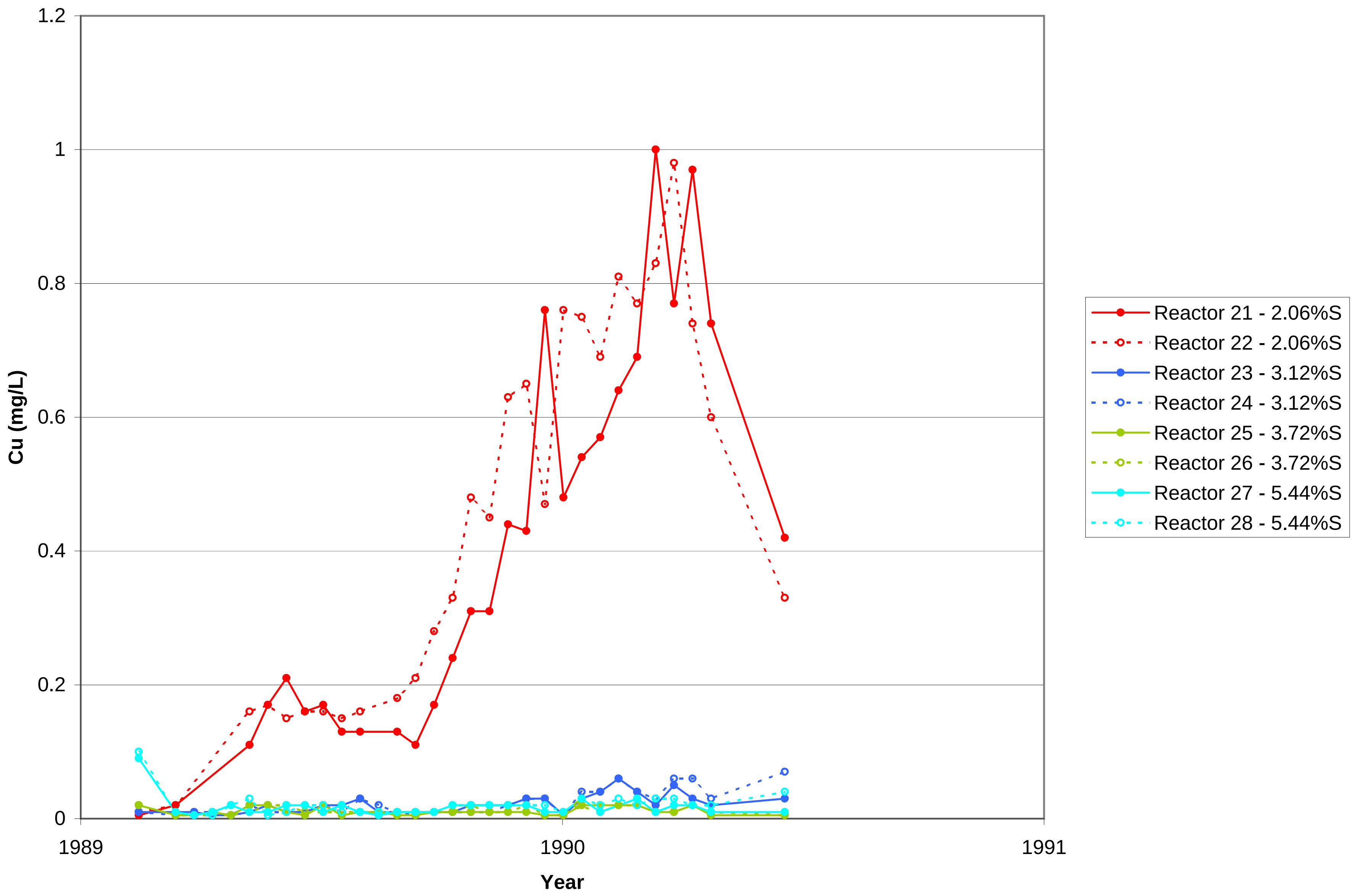

14
12
10
8
6
4
2
0
Ni (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

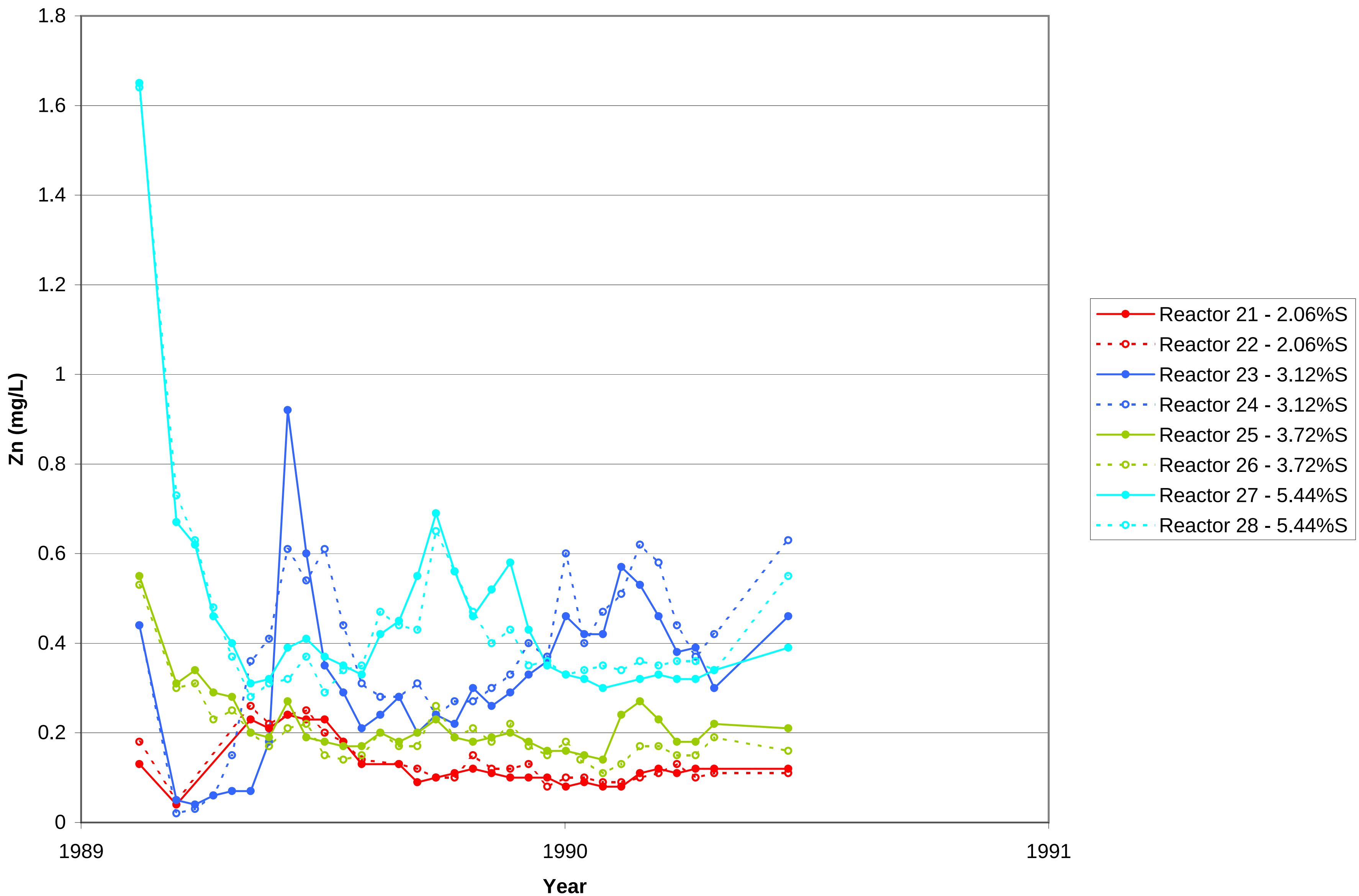

12
10
8
6
4
2
0
Alkalinity (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

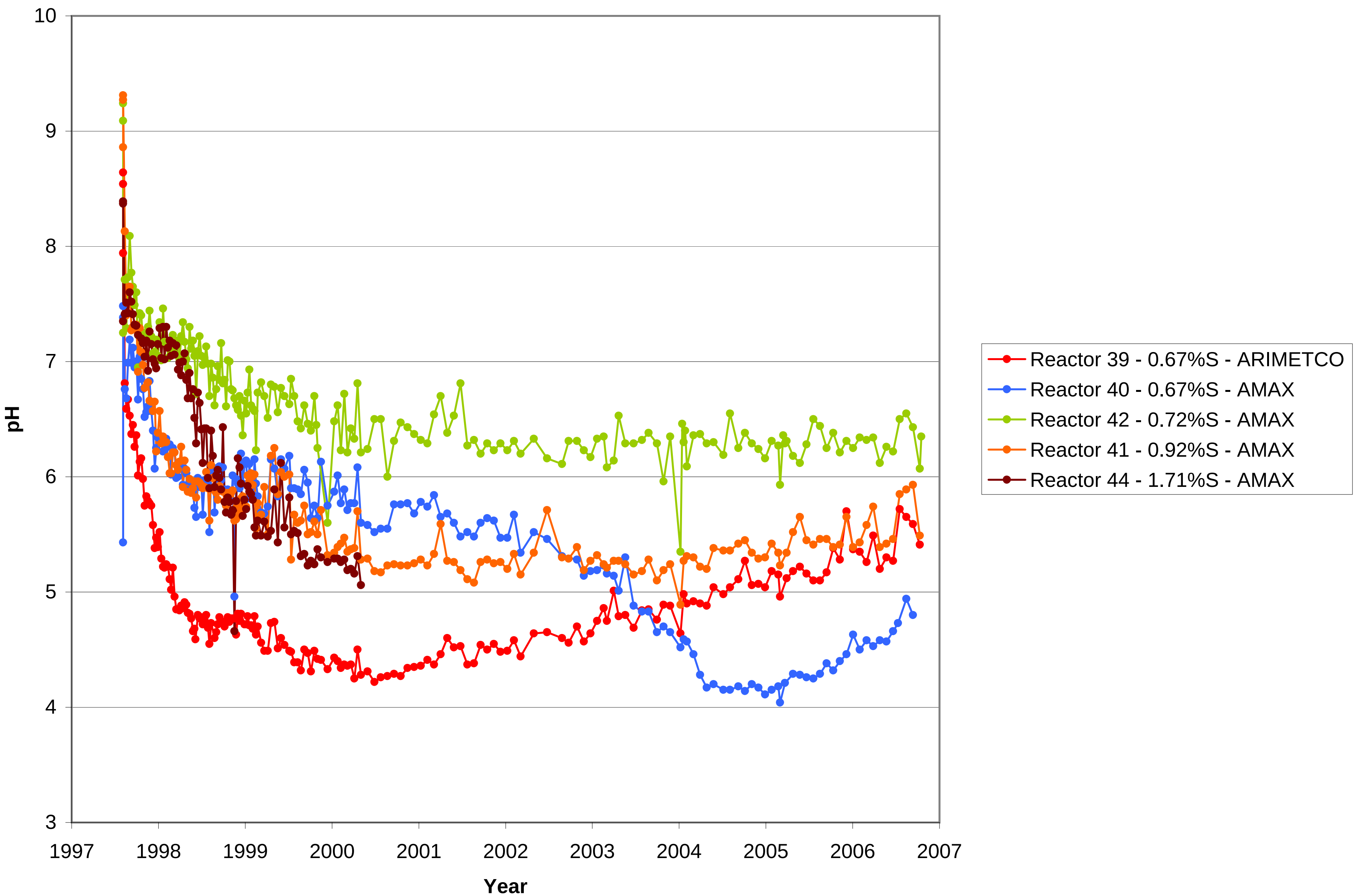

350
300
250
200
150
100
50
0
Acidity (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

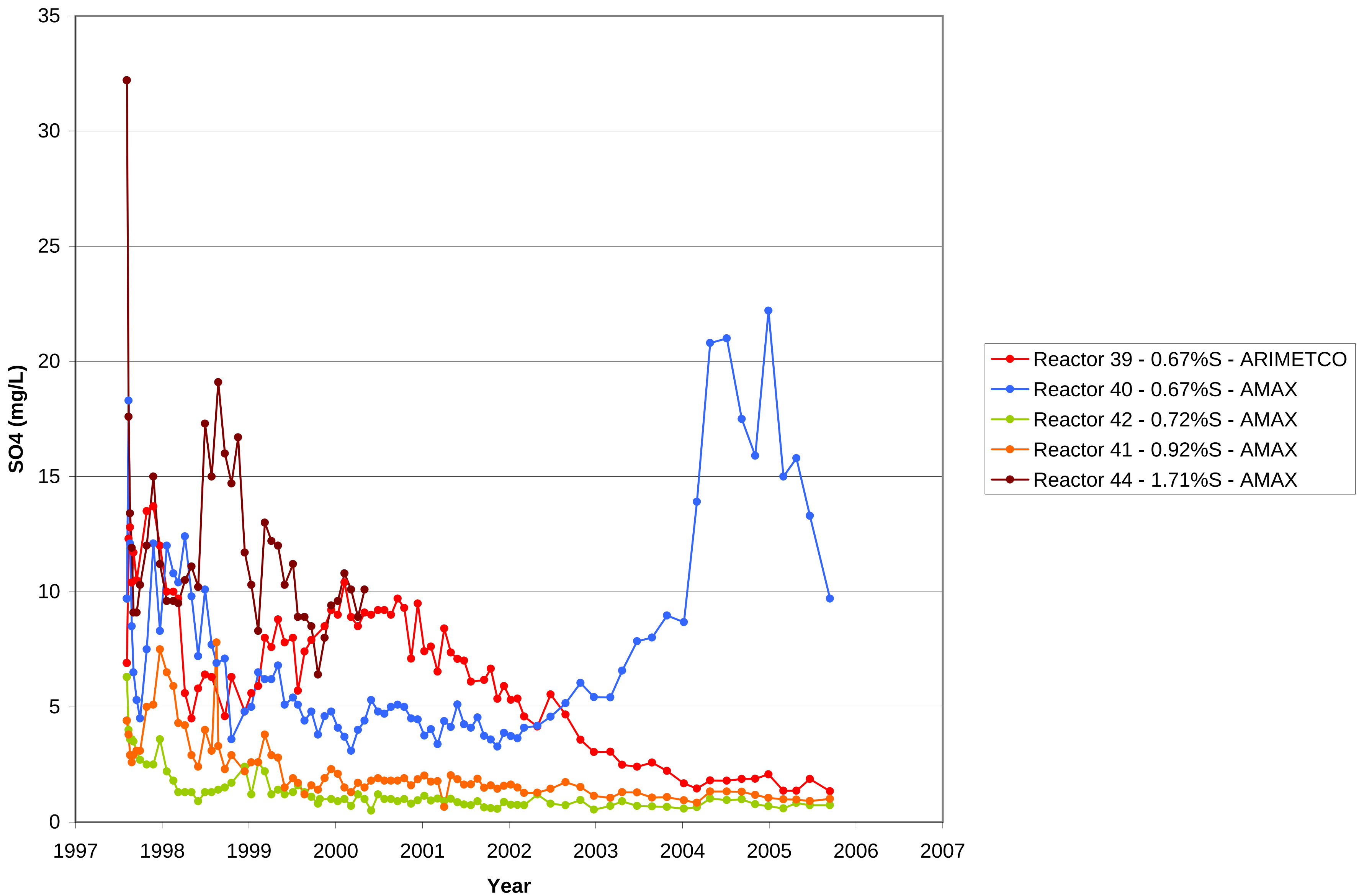

70
60
50
40
30
20
10
0
Mg (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S

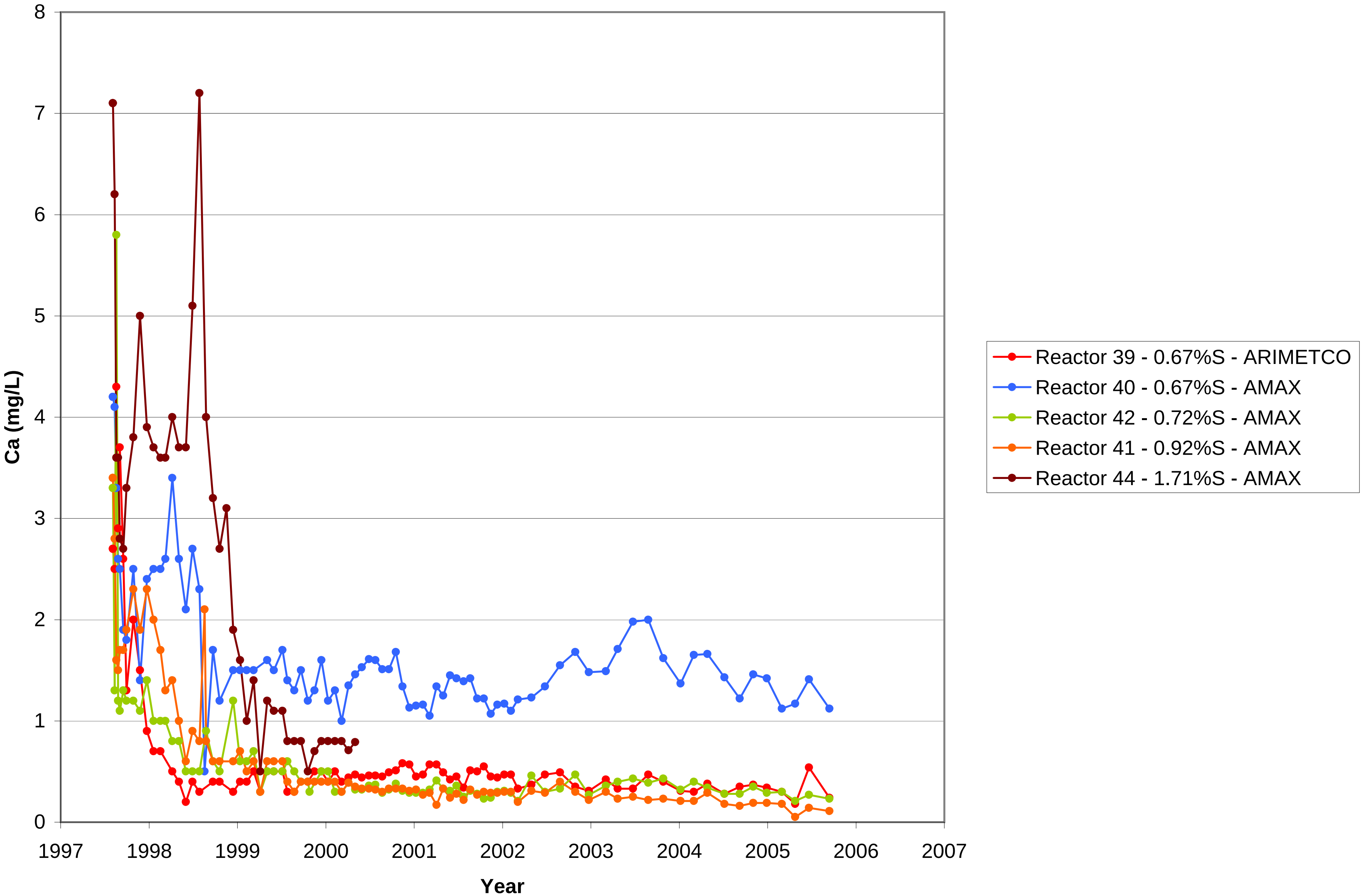

1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Co (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S


1.2
1
0.8
0.6
0.4
0.2
0
Cu (mg/L)
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S


Zn (mg/L)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1989
1990
1991
Year
Reactor 21 - 2.06%S
Reactor 22 - 2.06%S
Reactor 23 - 3.12%S
Reactor 24 - 3.12%S
Reactor 25 - 3.72%S
Reactor 26 - 3.72%S
Reactor 27 - 5.44%S
Reactor 28 - 5.44%S


10
9
8
7
6
5
4
3
pH
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX


35
30
25
20
15
10
5
0
SO4 (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX



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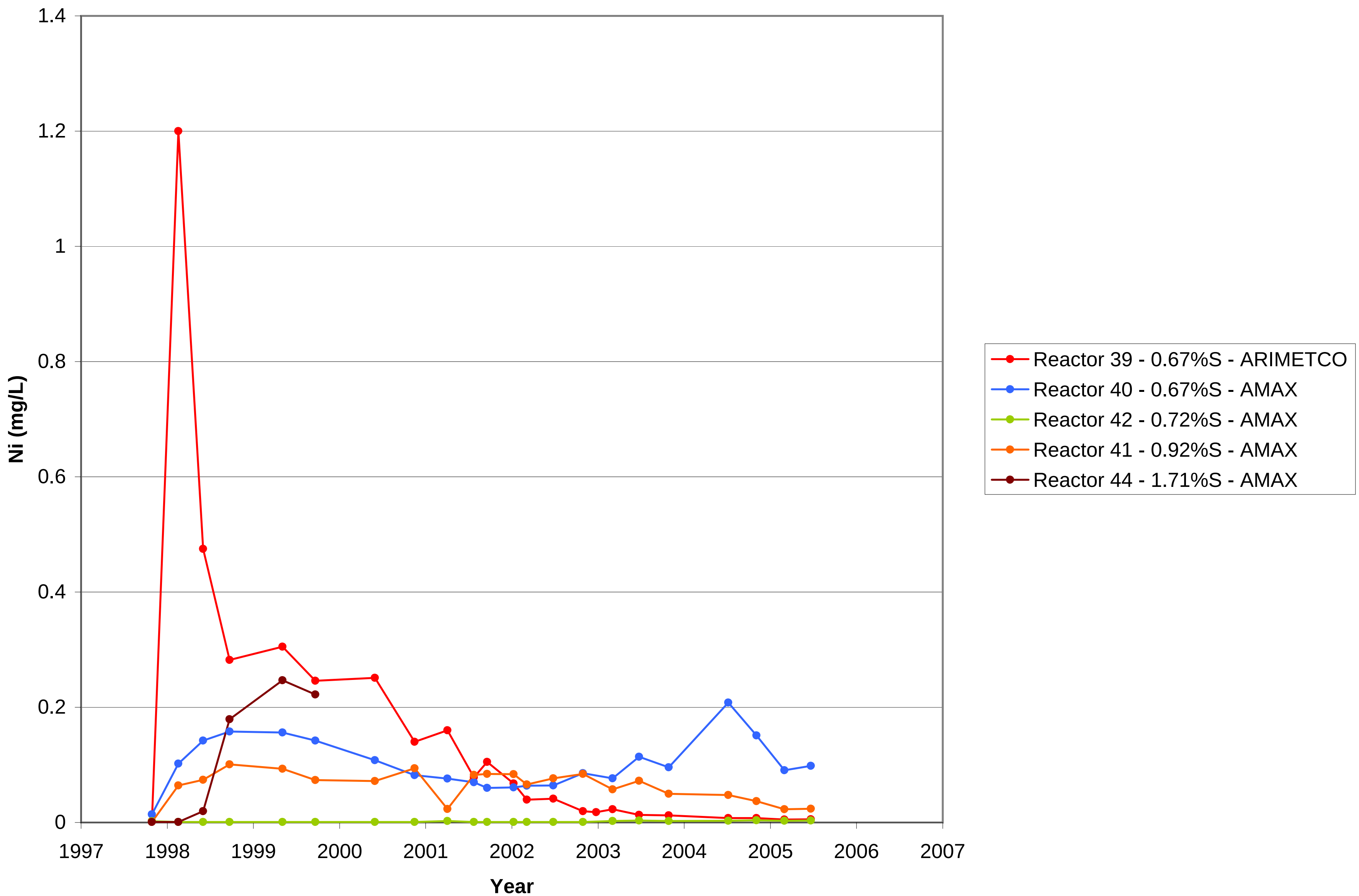
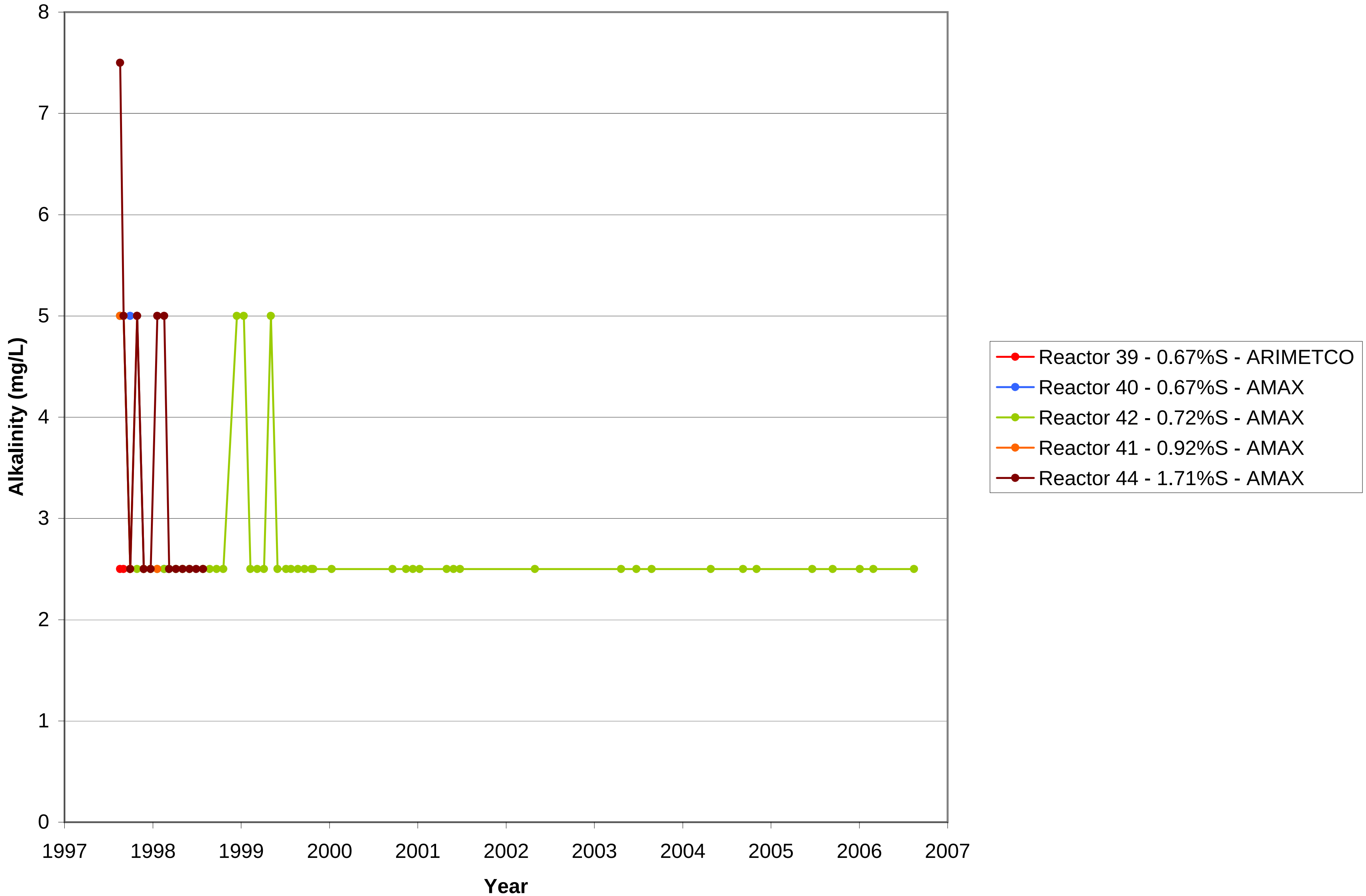
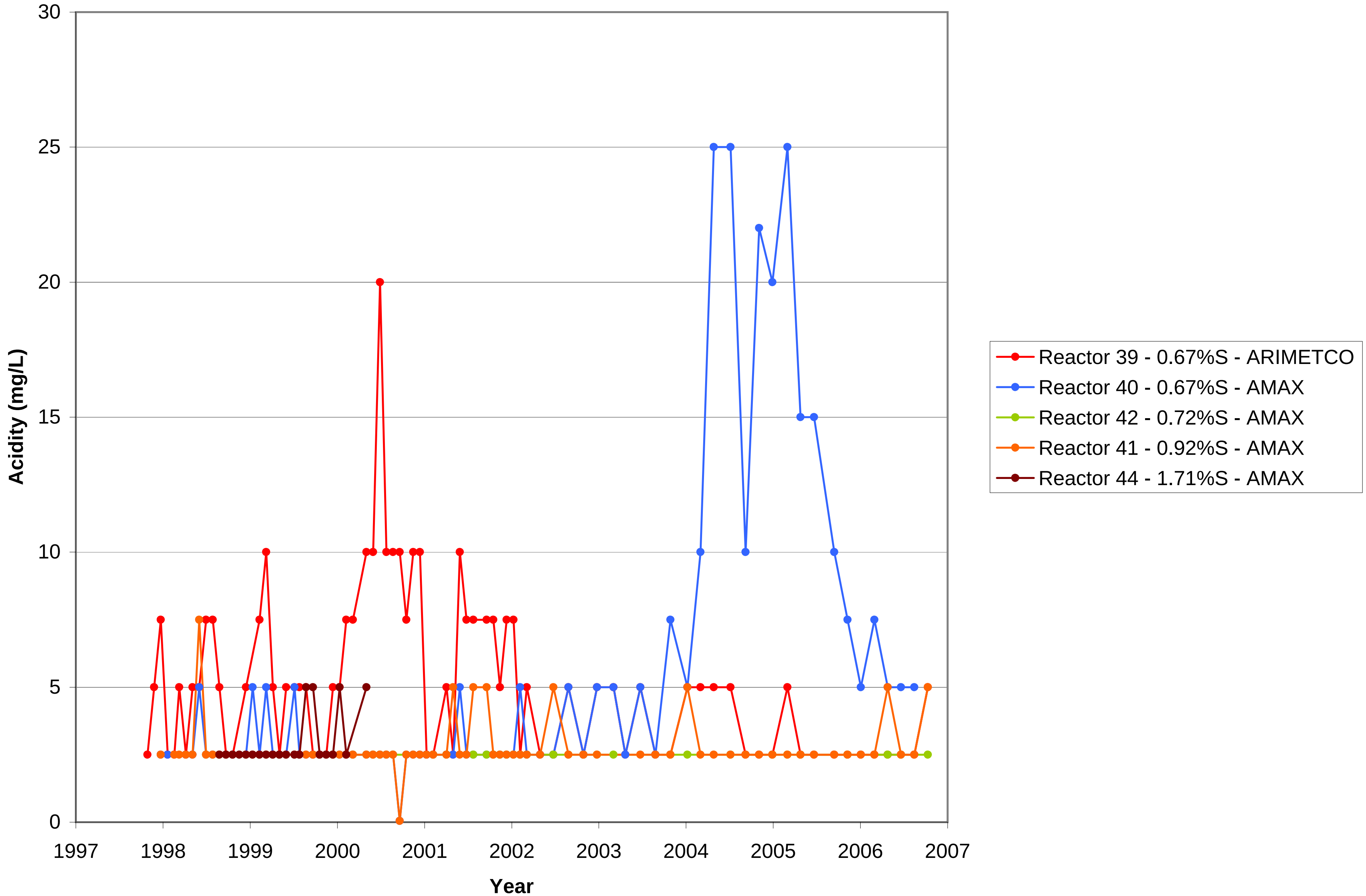
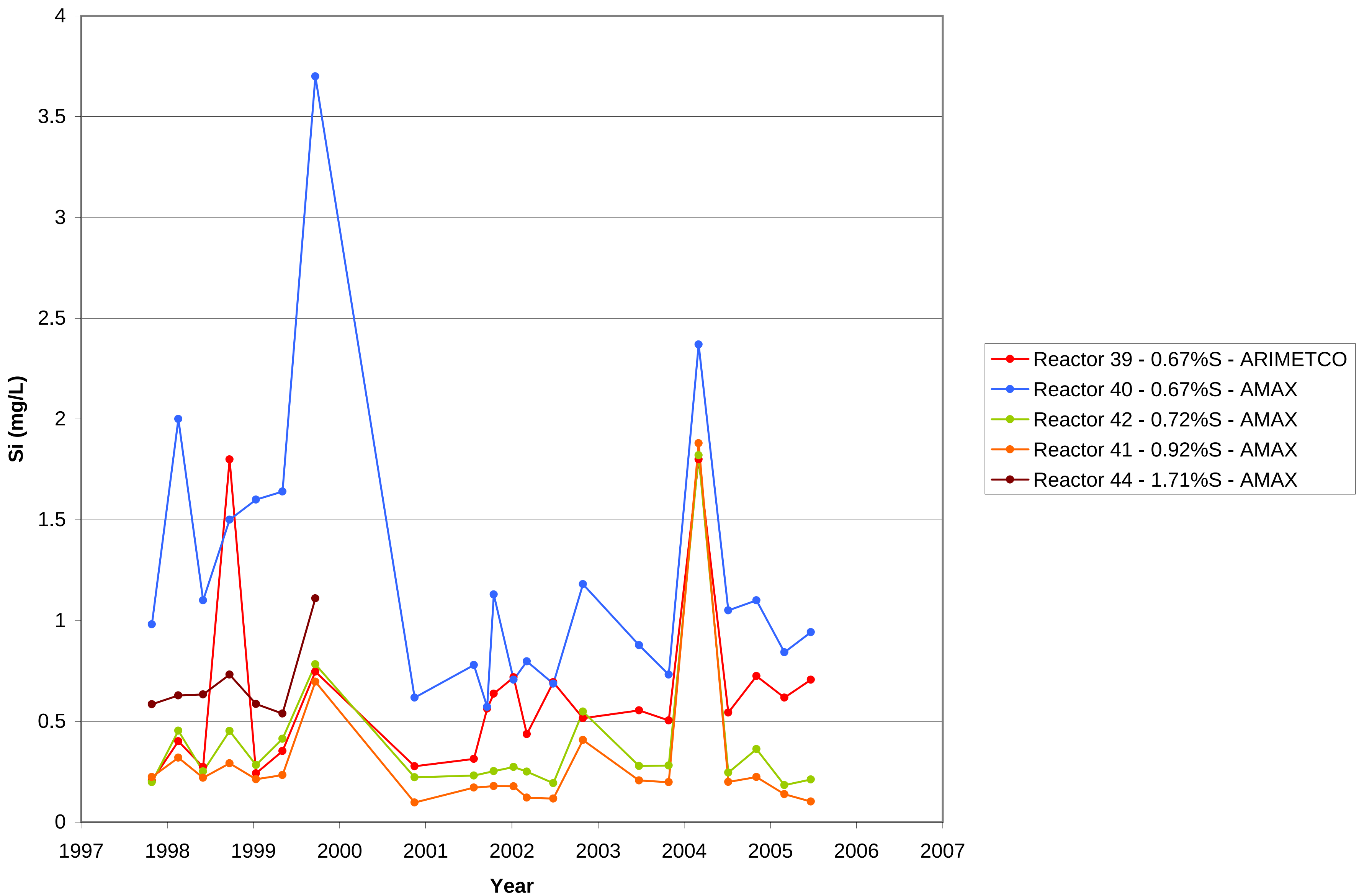
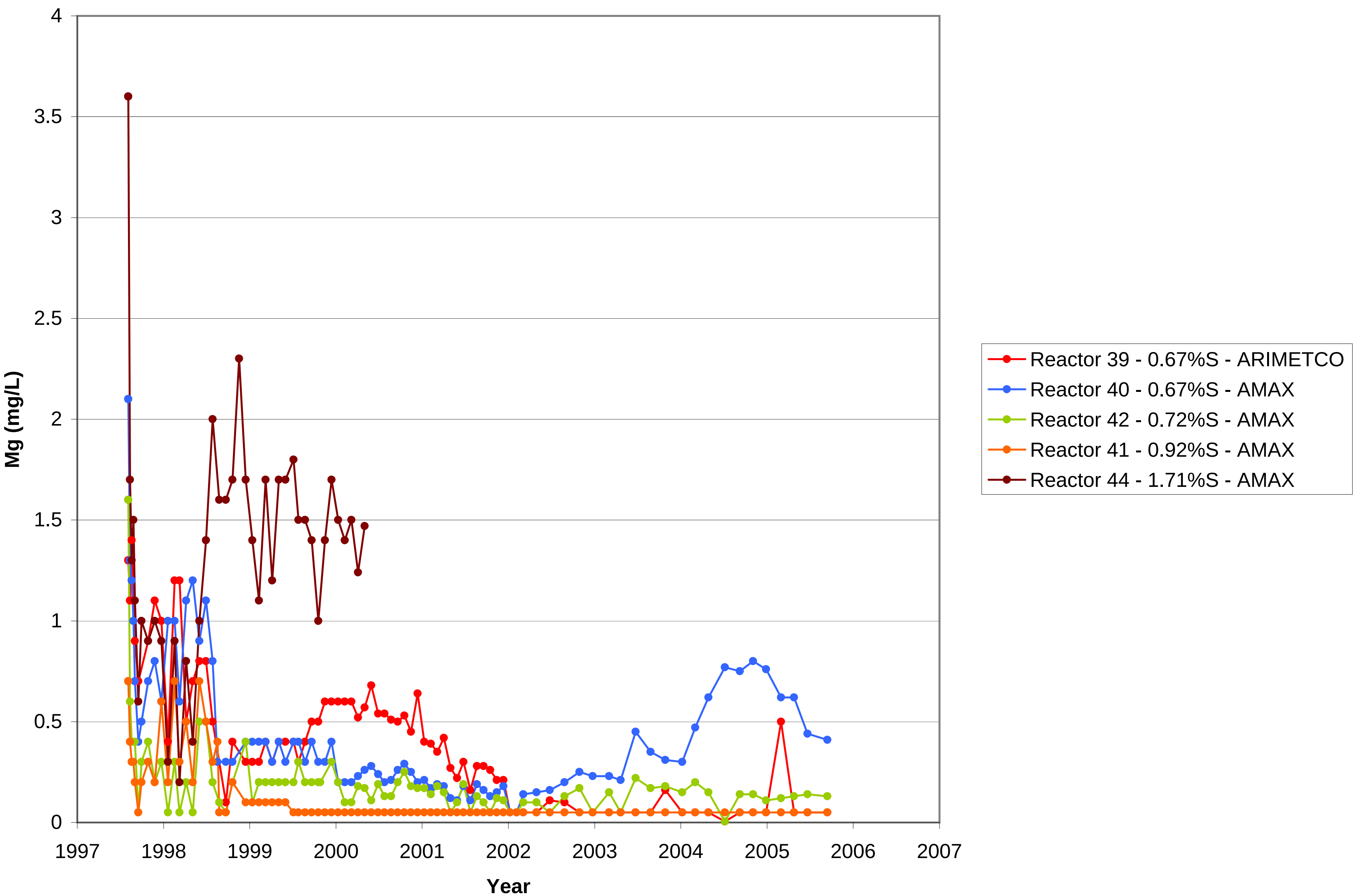
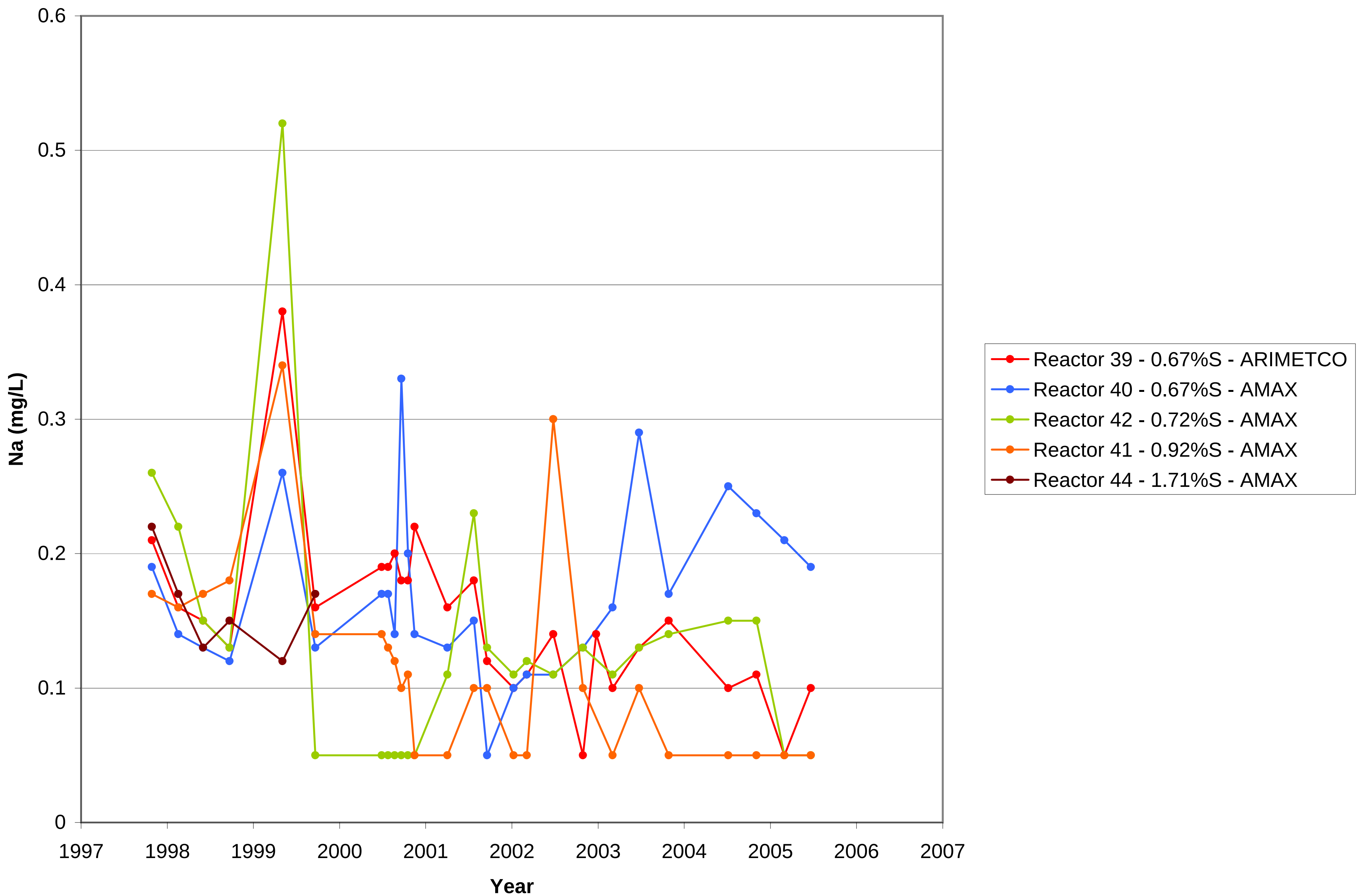

1.4
1.2
1
0.8
0.6
0.4
0.2
0
Ni (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

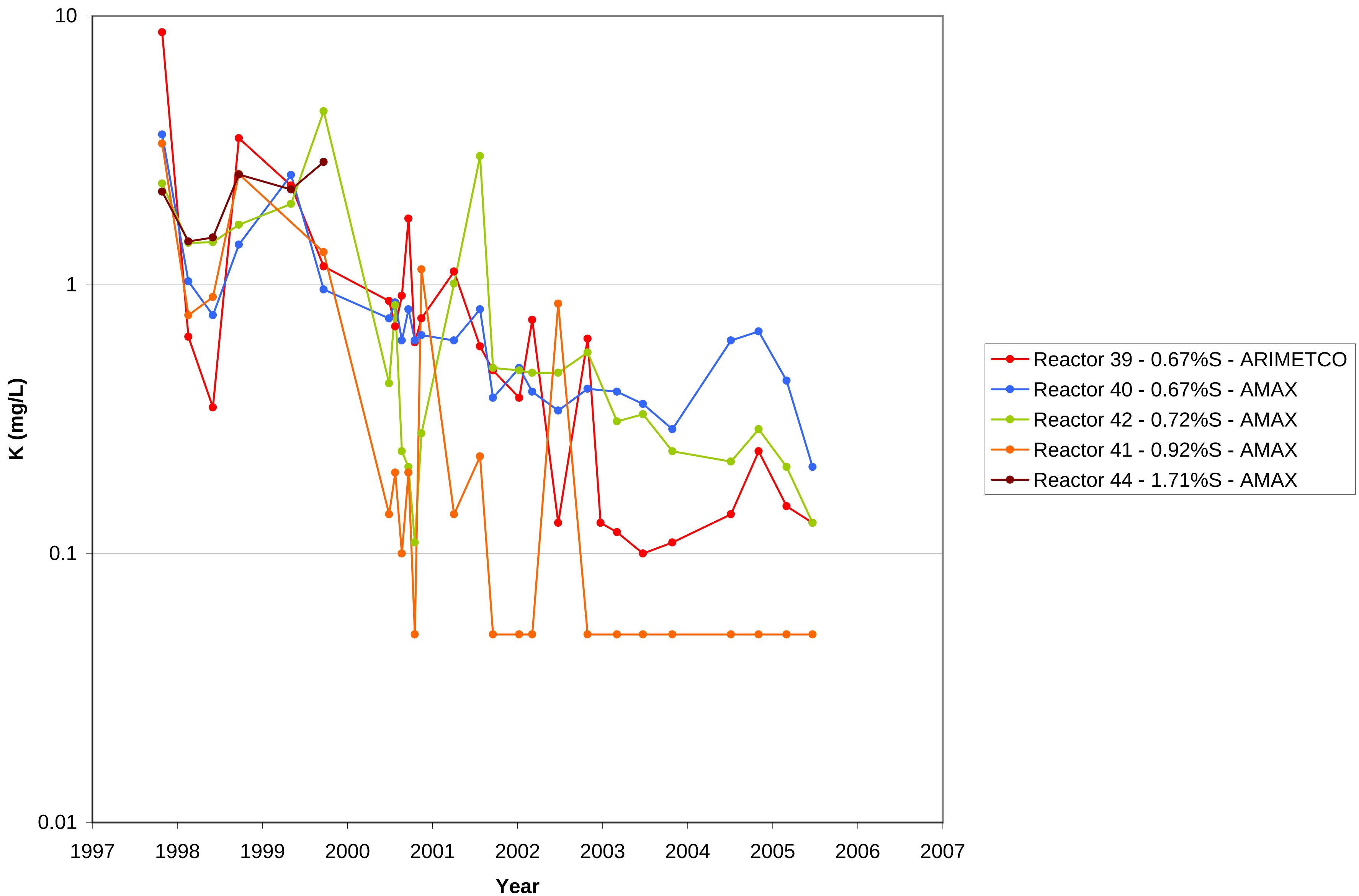

8
7
6
5
4
3
2
1
0
Alkalinity (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

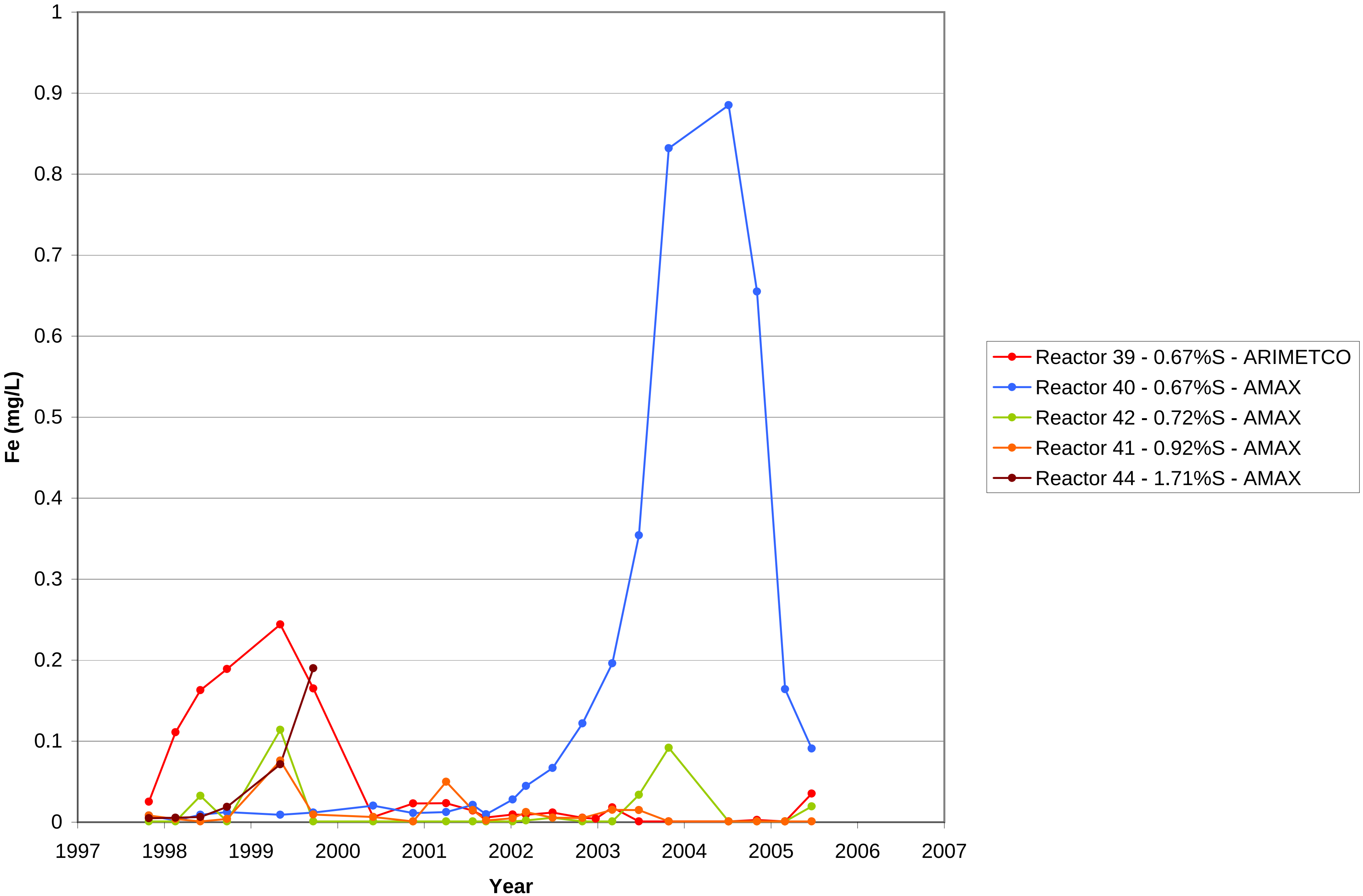

Acidity (mg/L)
30
25
20
15
10
5
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

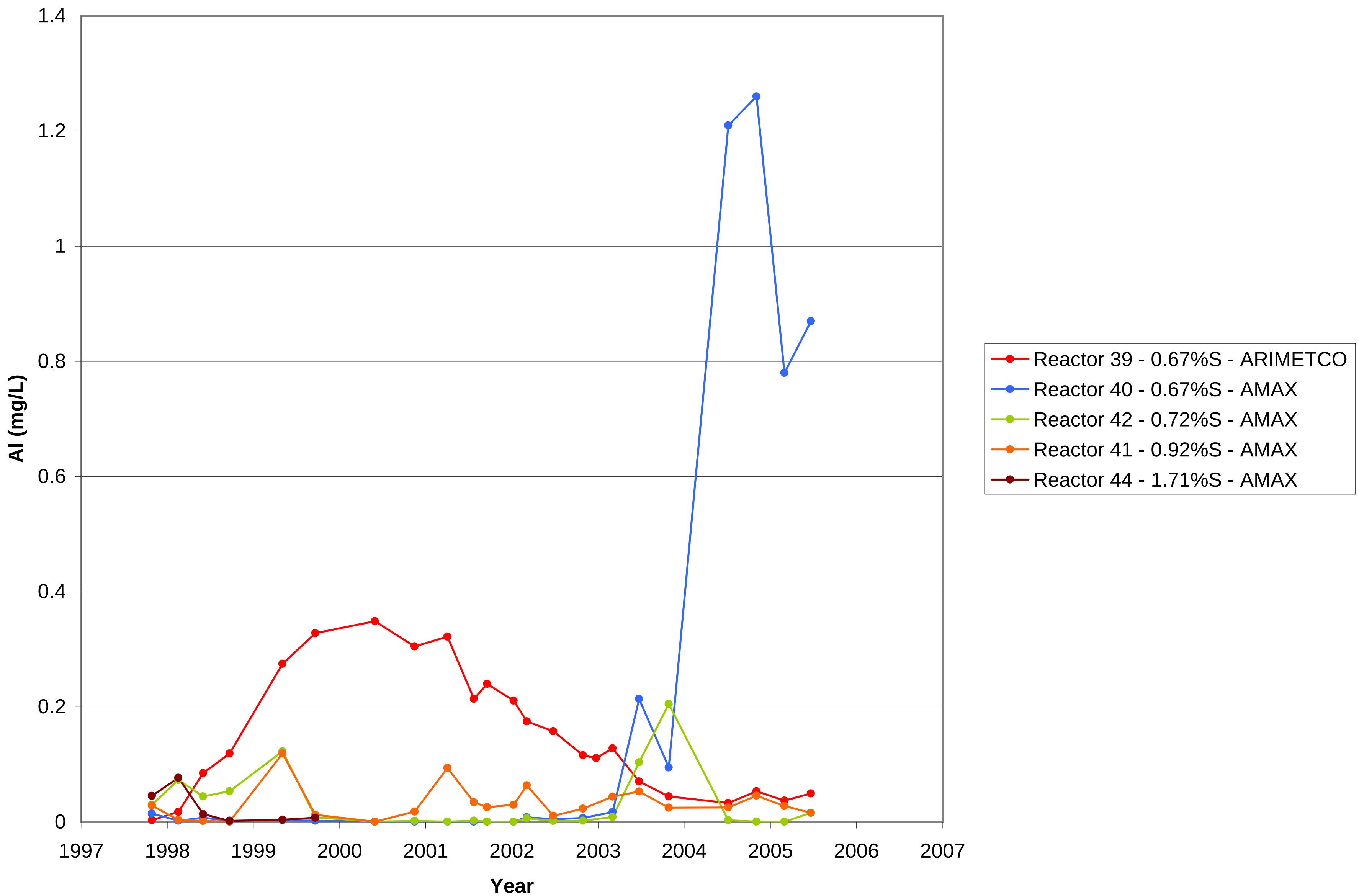

4
3.5
3
2.5
2
1.5
1
0.5
0
Si (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

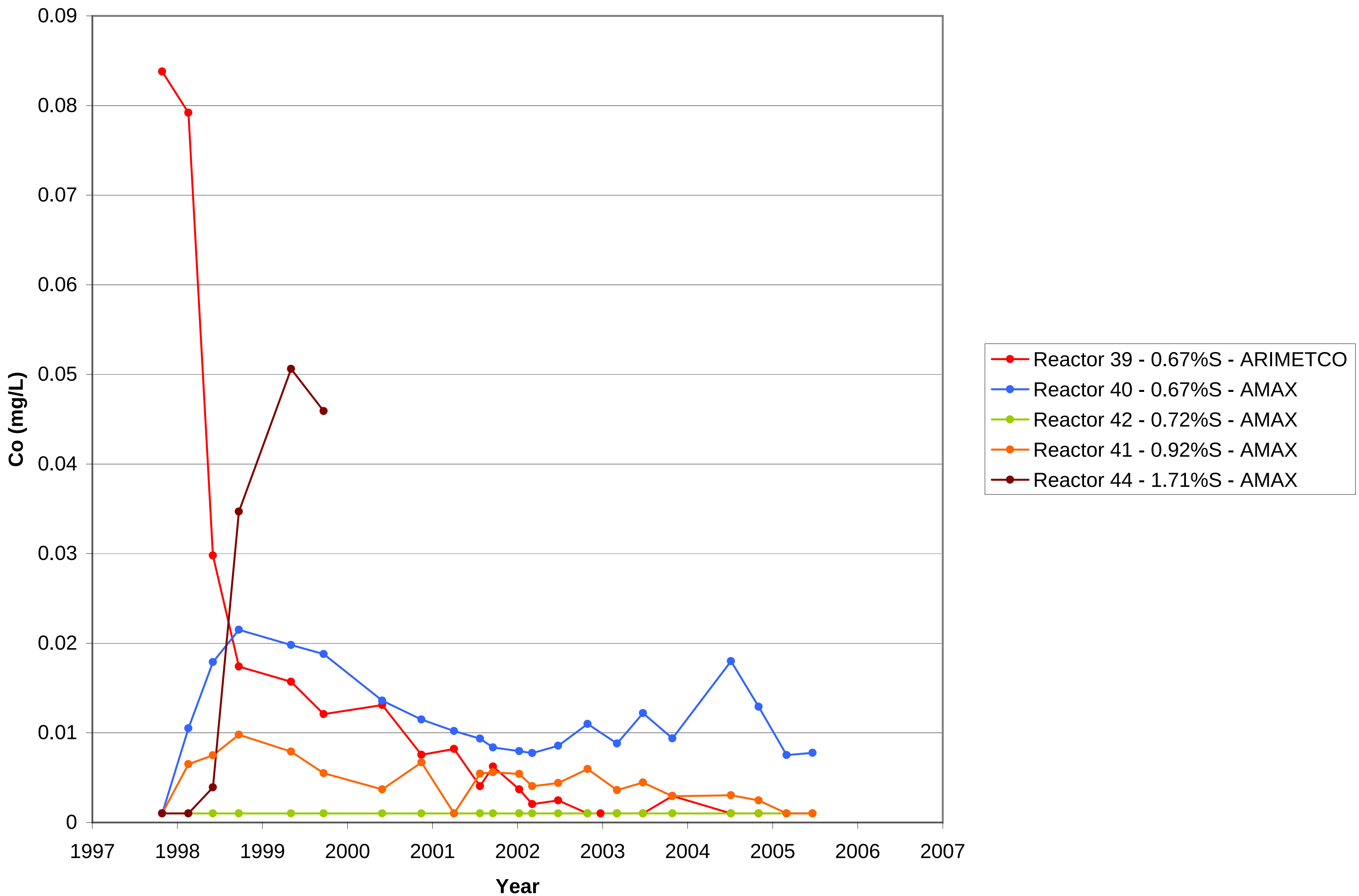

4
3.5
3
2.5
2
1.5
1
0.5
0
Mg (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

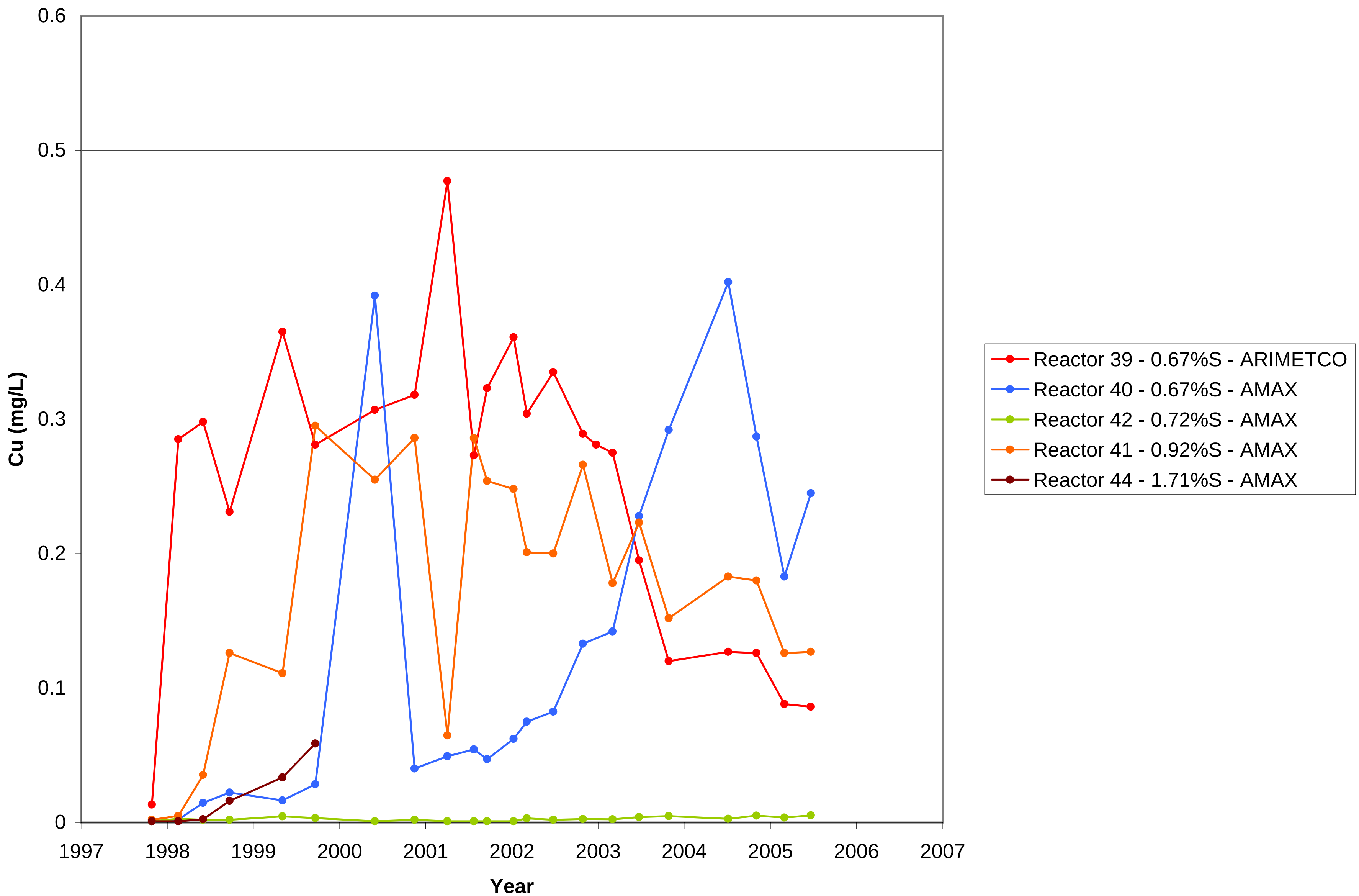

0.6
0.5
0.4
0.3
0.2
0.1
0
Na (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

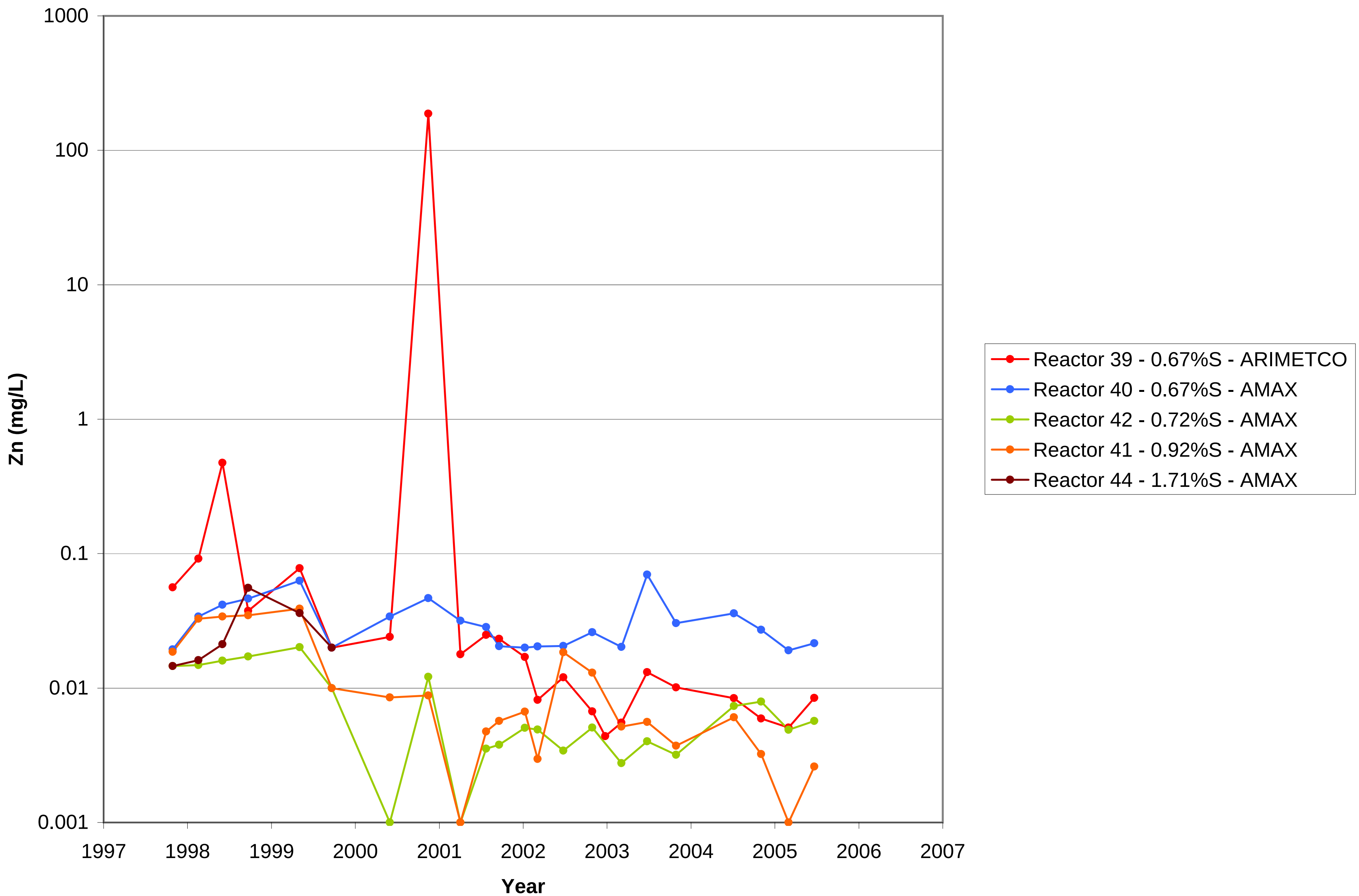

10
1
0.1
0.01
K (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Fe (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX


1.4
1.2
1
0.8
0.6
0.4
0.2
0
Al (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

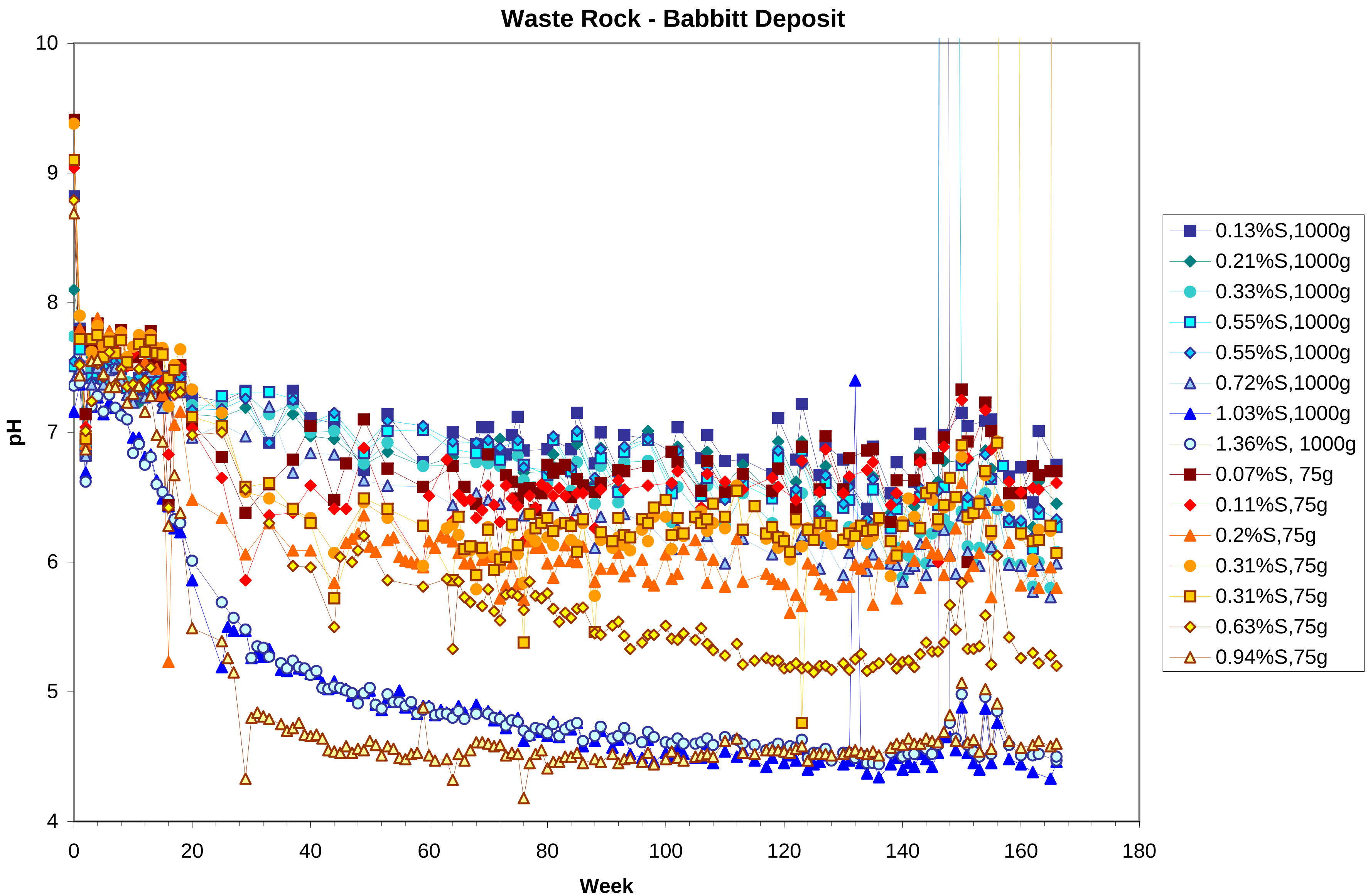

0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Co (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

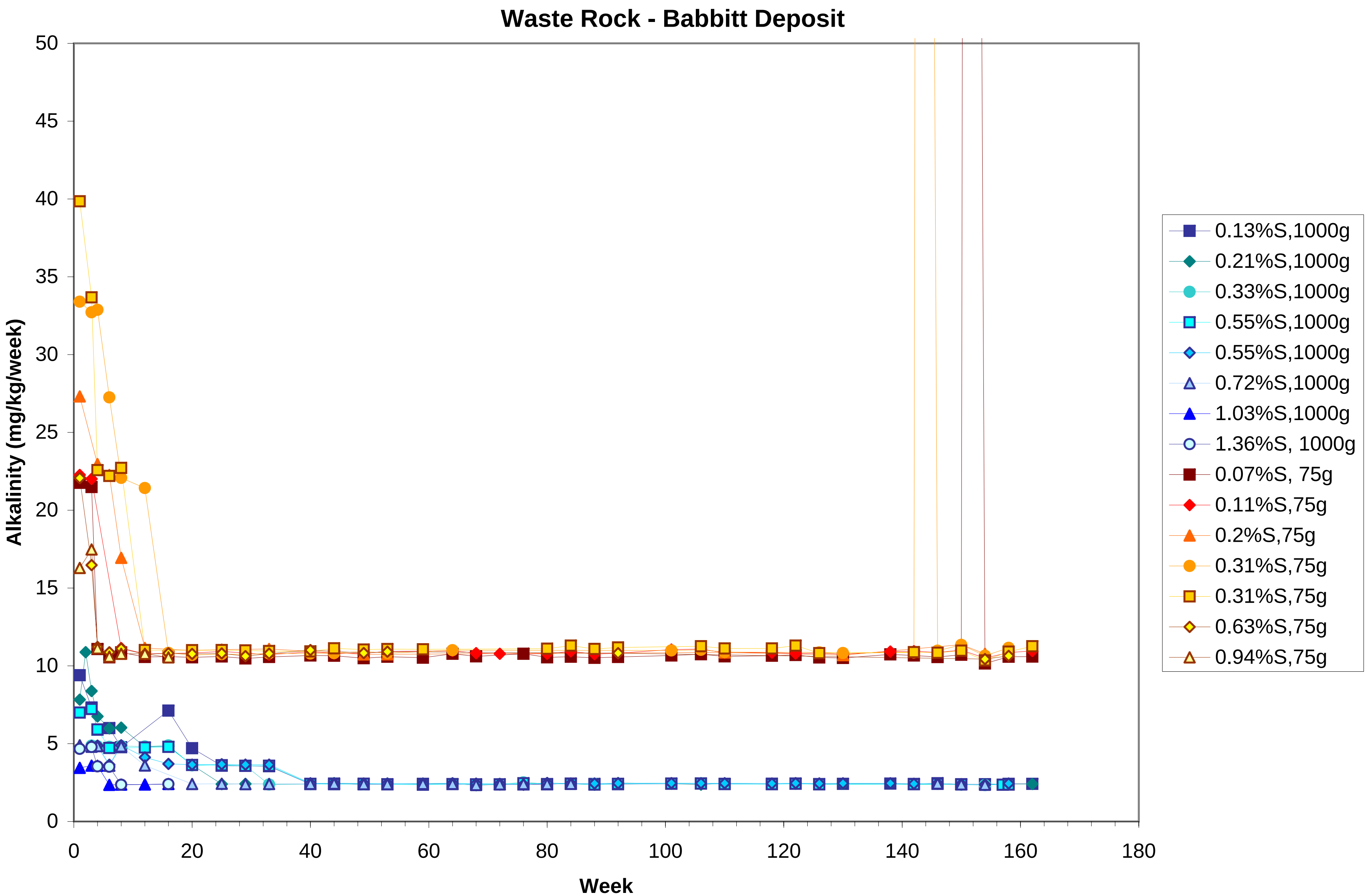

0.6
0.5
0.4
0.3
0.2
0.1
0
Cu (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

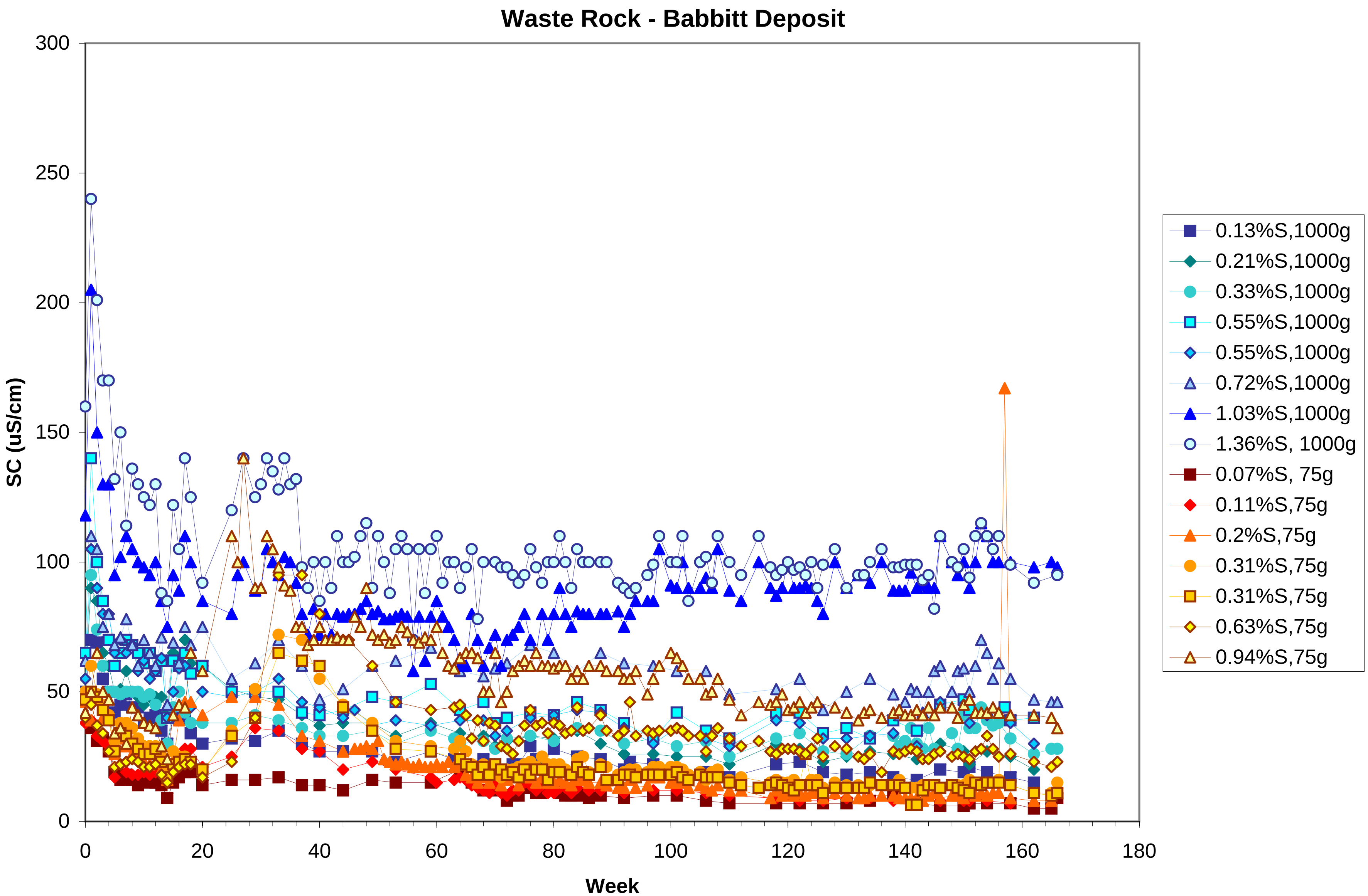

1000
100
10
1
0.1
0.01
0.001
Zn (mg/L)
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Year
Reactor 39 - 0.67%S - ARIMETCO
Reactor 40 - 0.67%S - AMAX
Reactor 42 - 0.72%S - AMAX
Reactor 41 - 0.92%S - AMAX
Reactor 44 - 1.71%S - AMAX

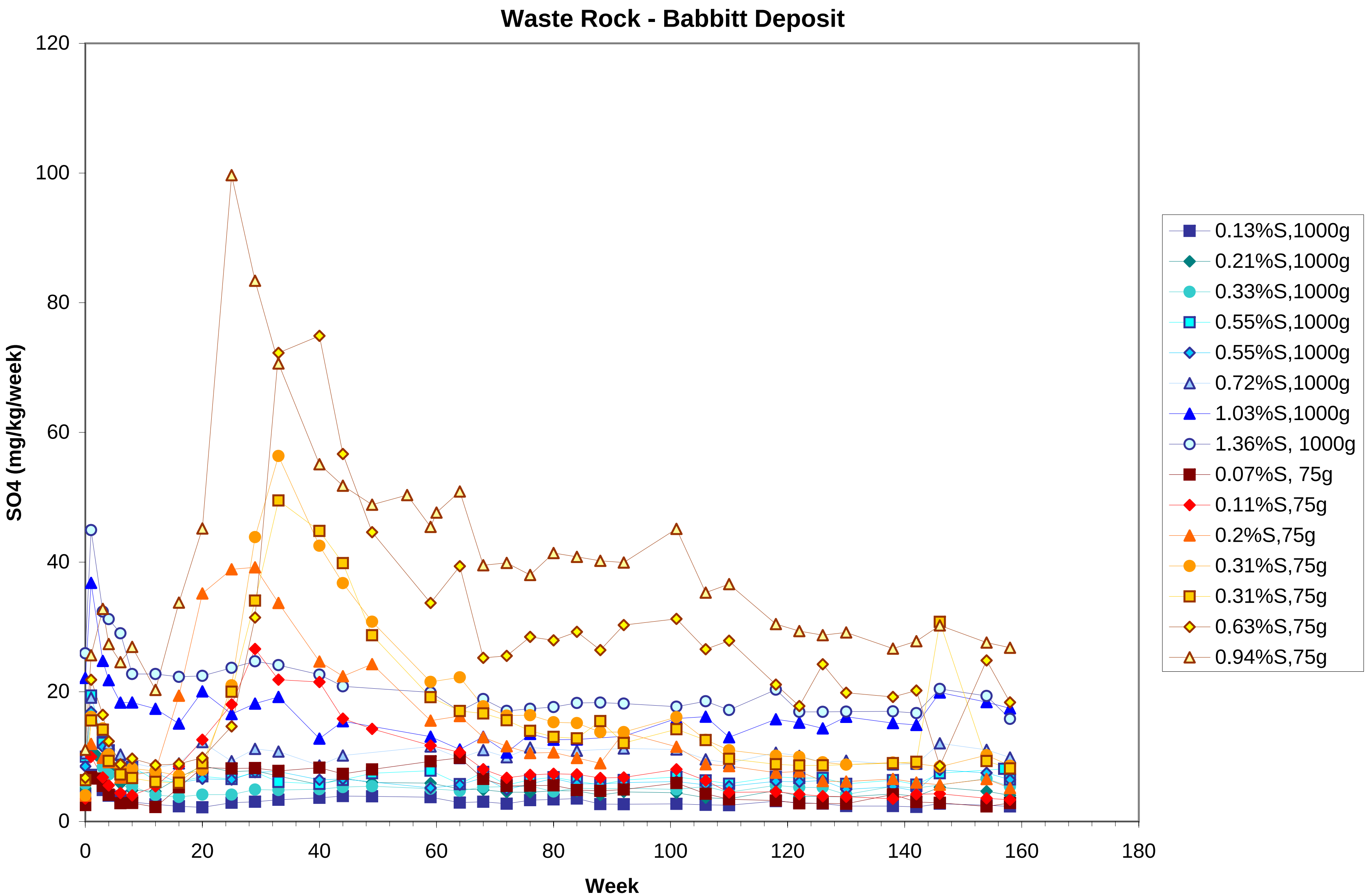
Appendix B.2

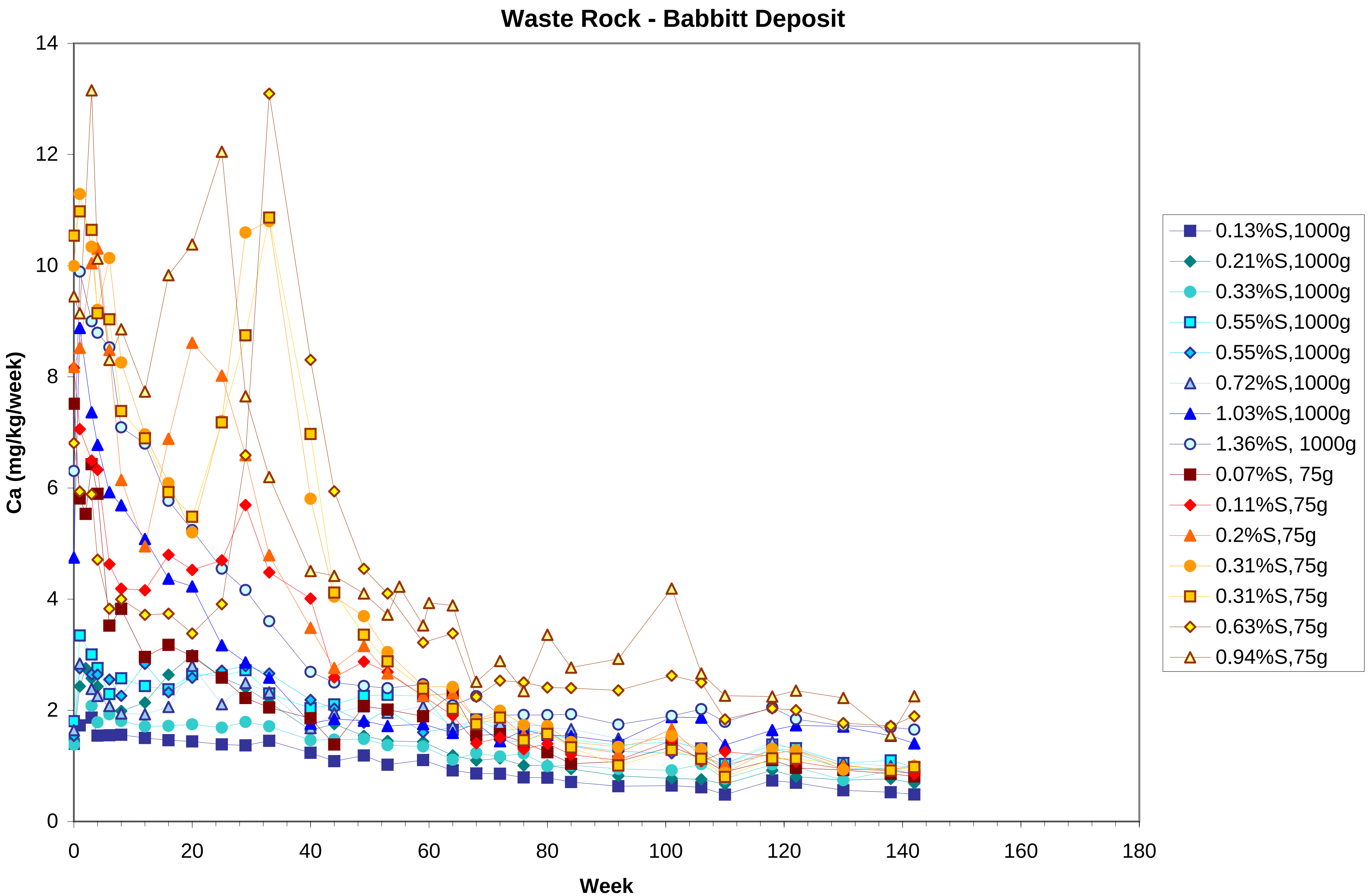
Charts for MDNR Babbit Deposit Kinetic Tests

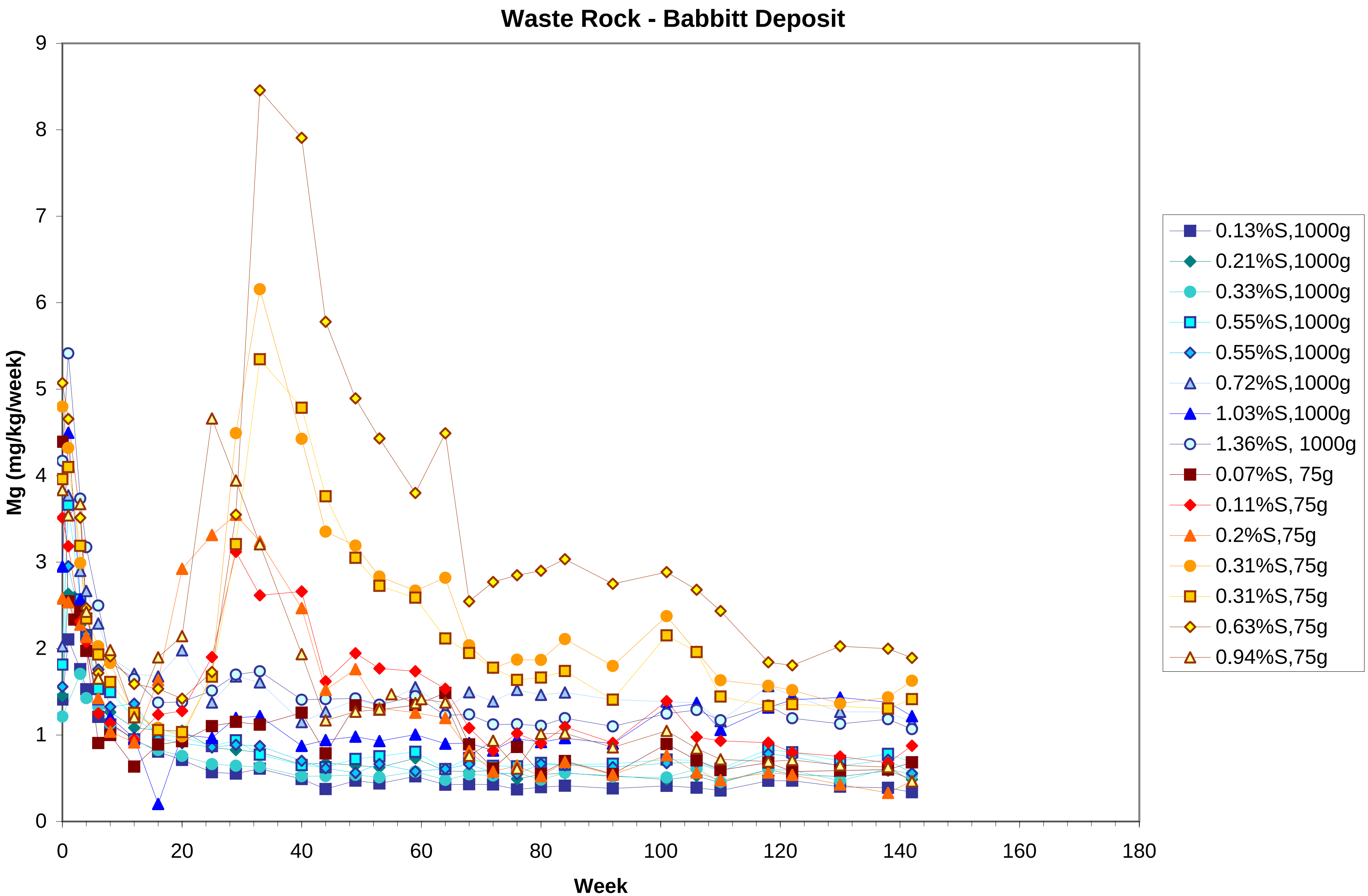

Waste Rock - Babbitt Deposit
pH
Week
10
9
8
7
6
5
4
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

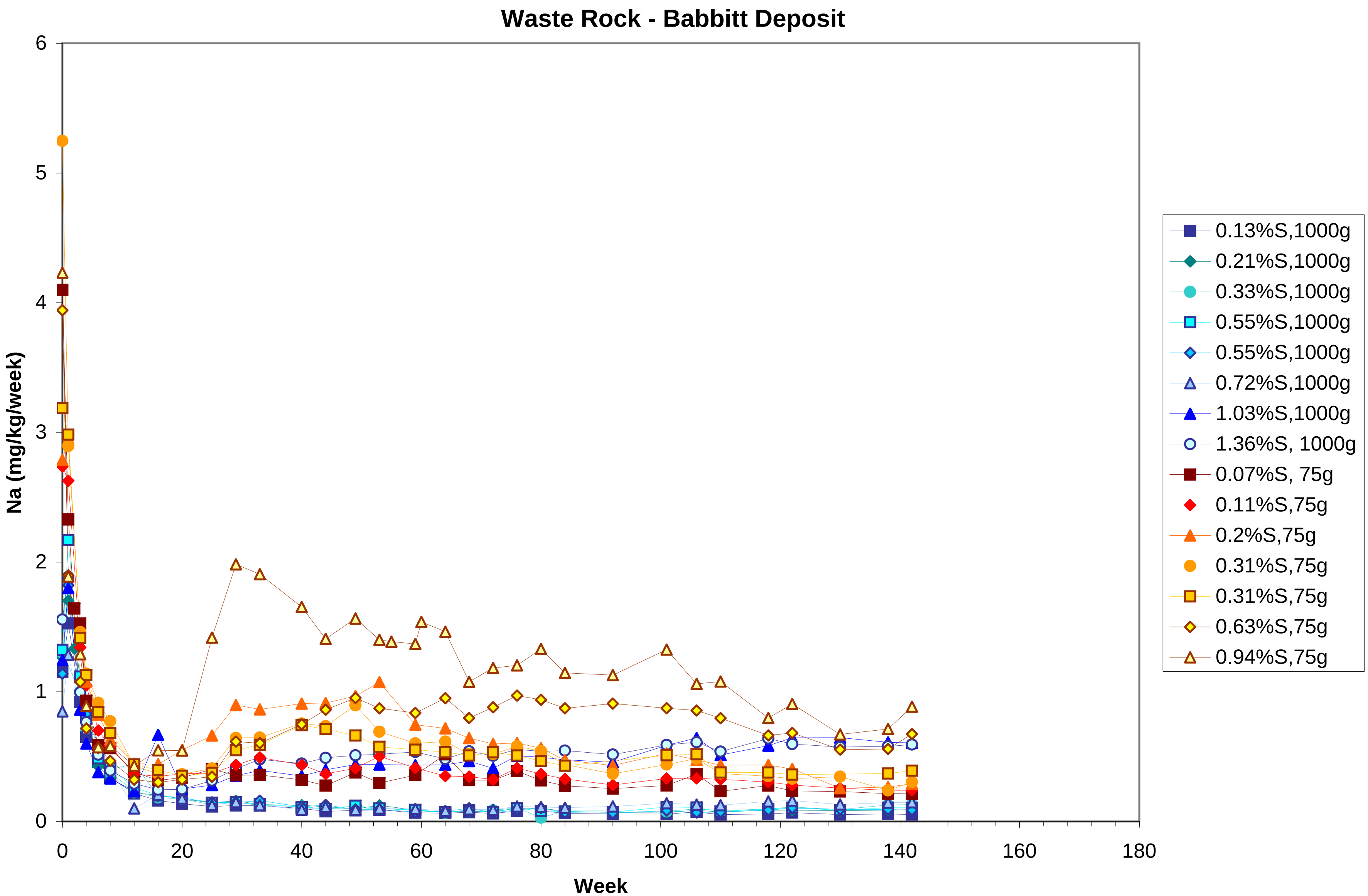

Waste Rock - Babbitt Deposit
Alkalinity (mg/kg/week)
50
45
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
Week
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

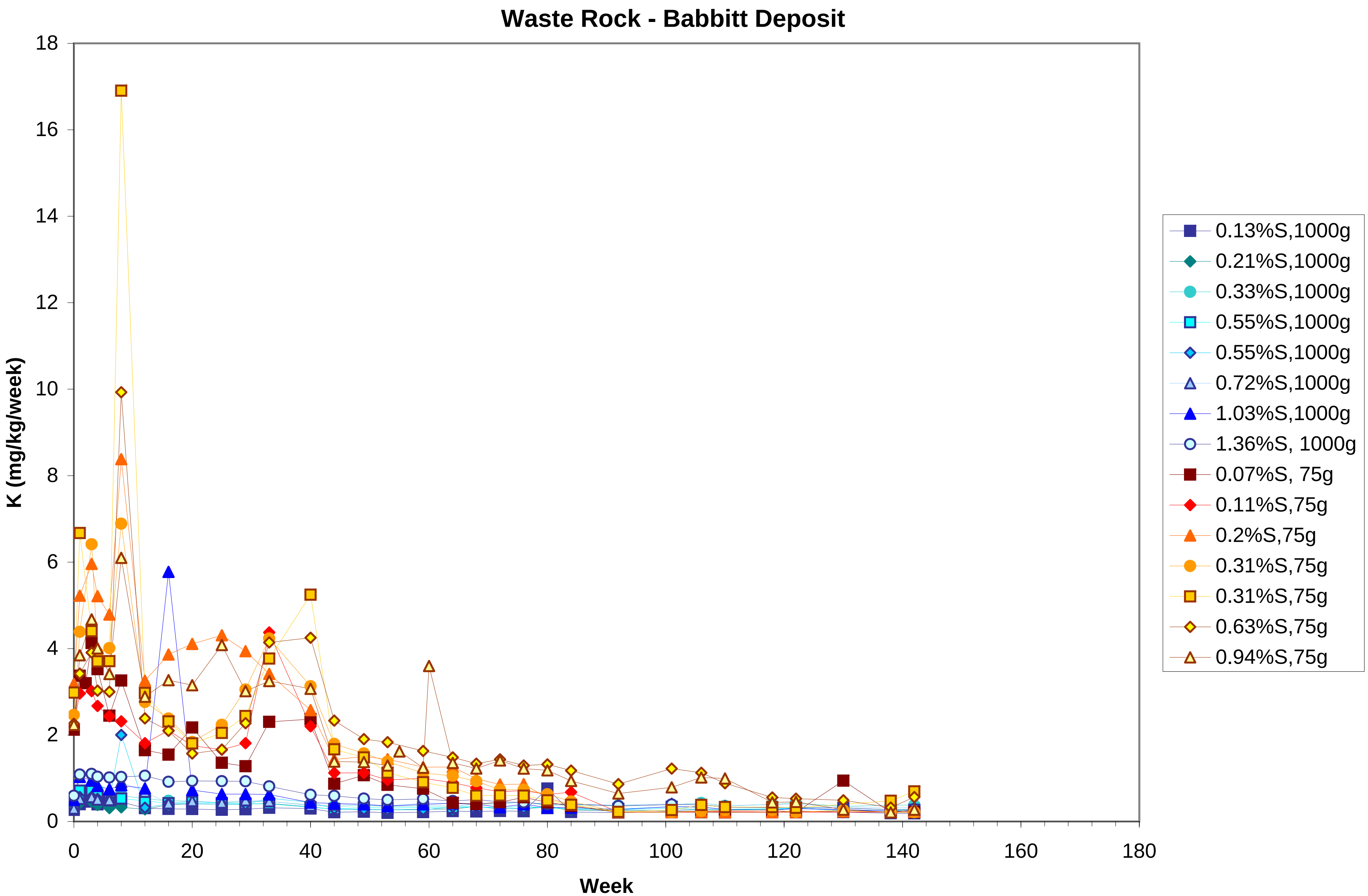

Waste Rock - Babbitt Deposit
SC (uS/cm)
300
250
200
150
100
50
0
0
20
40
60
80
100
120
140
160
180
Week
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

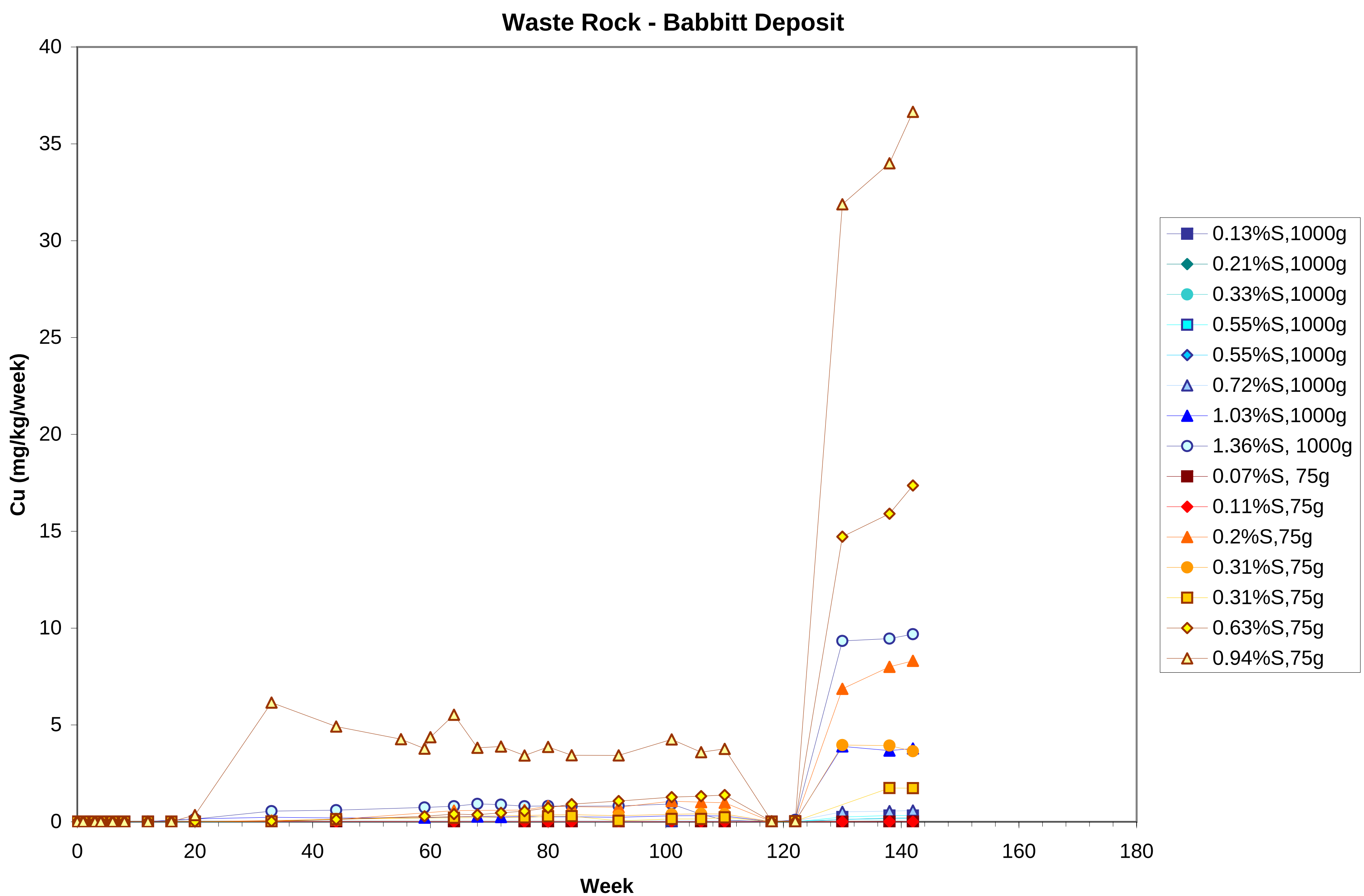

Waste Rock - Babbitt Deposit
SO4 (mg/kg/week)
Week
0
20
40
60
80
100
120
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

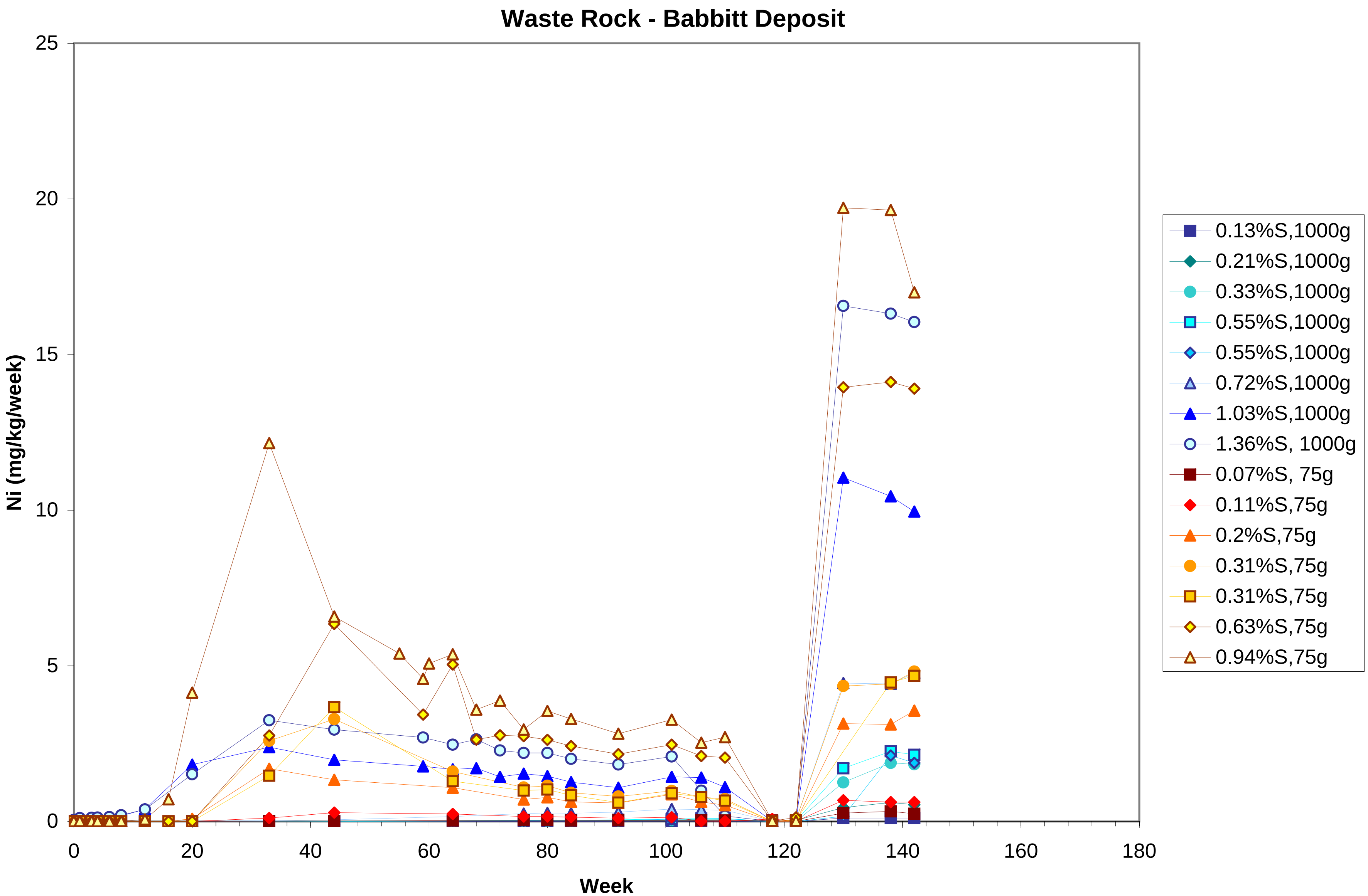

Waste Rock - Babbitt Deposit
Ca (mg/kg/week)
Week
0
2
4
6
8
10
12
14
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

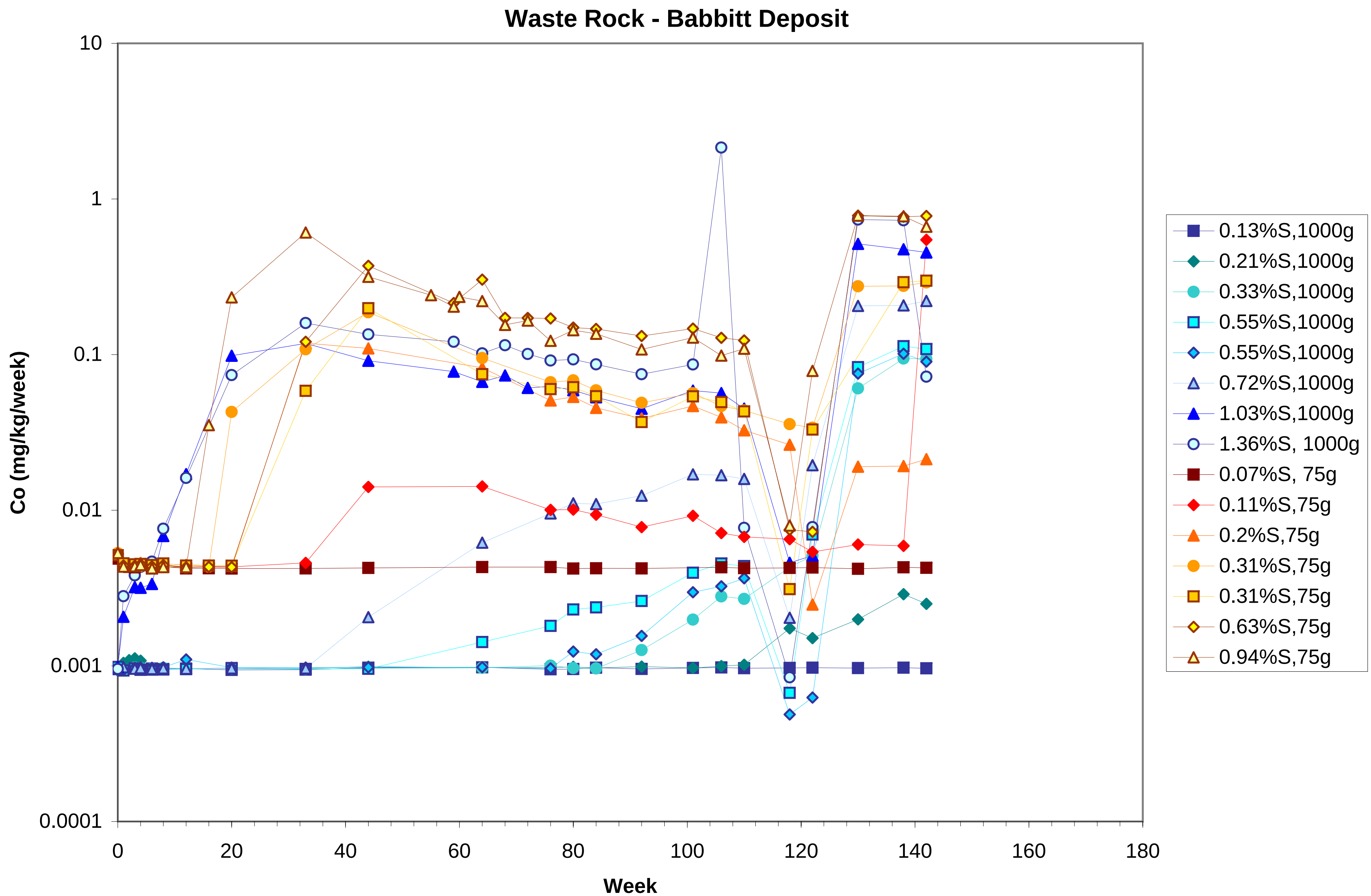

Waste Rock - Babbitt Deposit
Mg (mg/kg/week)
Week
0
1
2
3
4
5
6
7
8
9
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

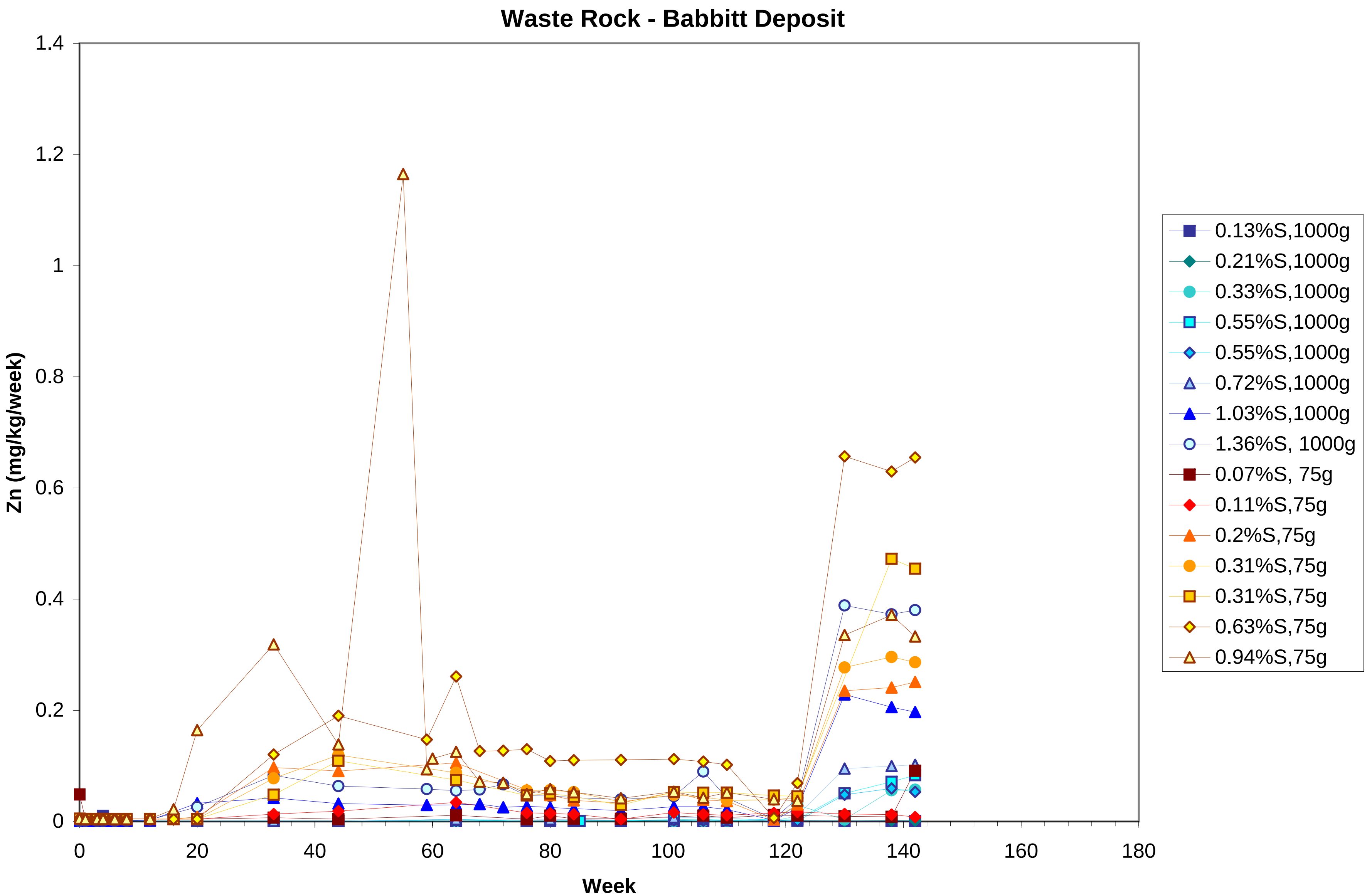

Waste Rock - Babbitt Deposit
Na (mg/kg/week)
Week
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g


Waste Rock - Babbitt Deposit
K (mg/kg/week)
Week
0
2
4
6
8
10
12
14
16
18
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g


Waste Rock - Babbitt Deposit
Cu (mg/kg/week)
Week
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

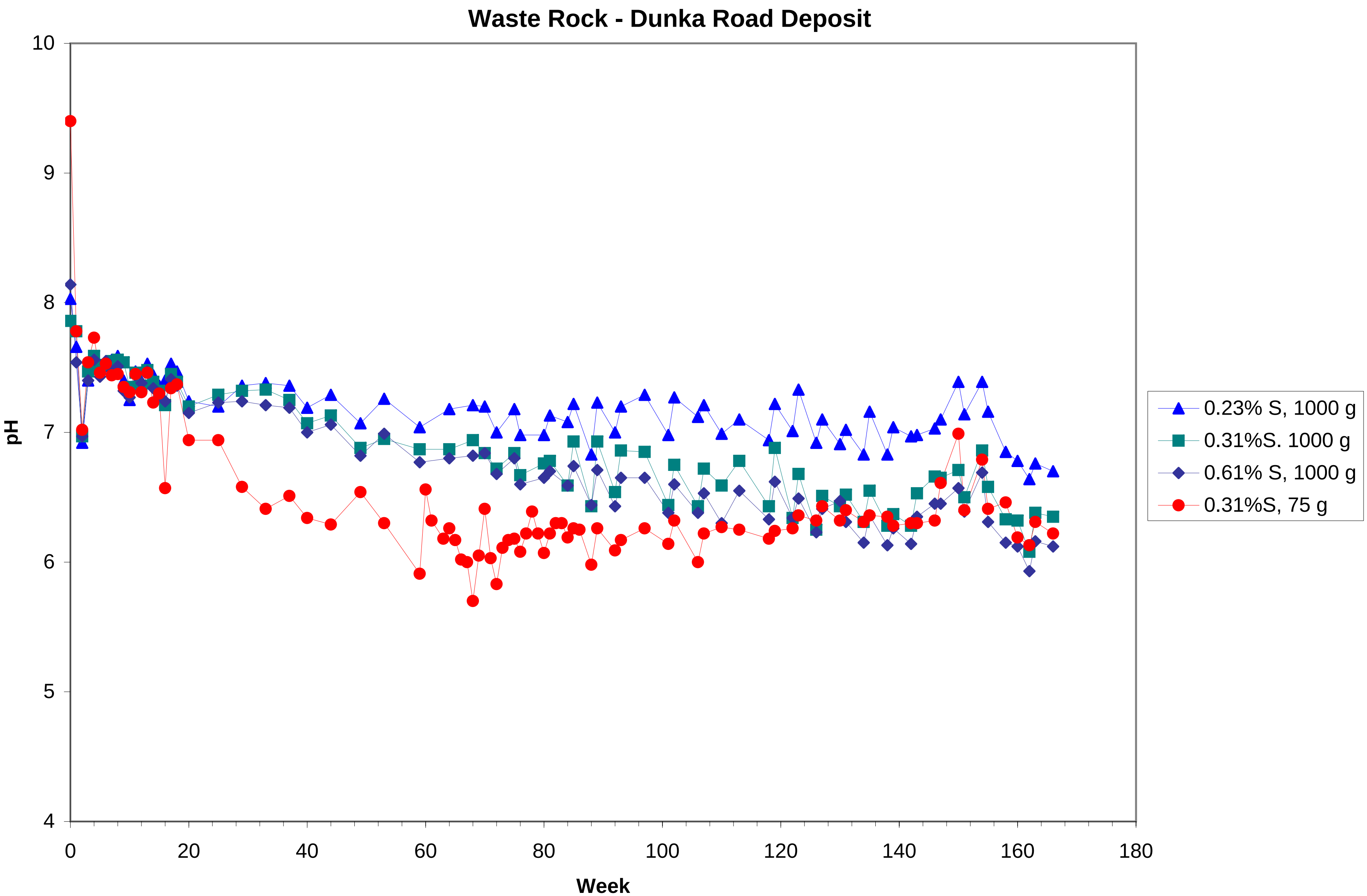

Waste Rock - Babbitt Deposit
Ni (mg/kg/week)
Week
0
5
10
15
20
25
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

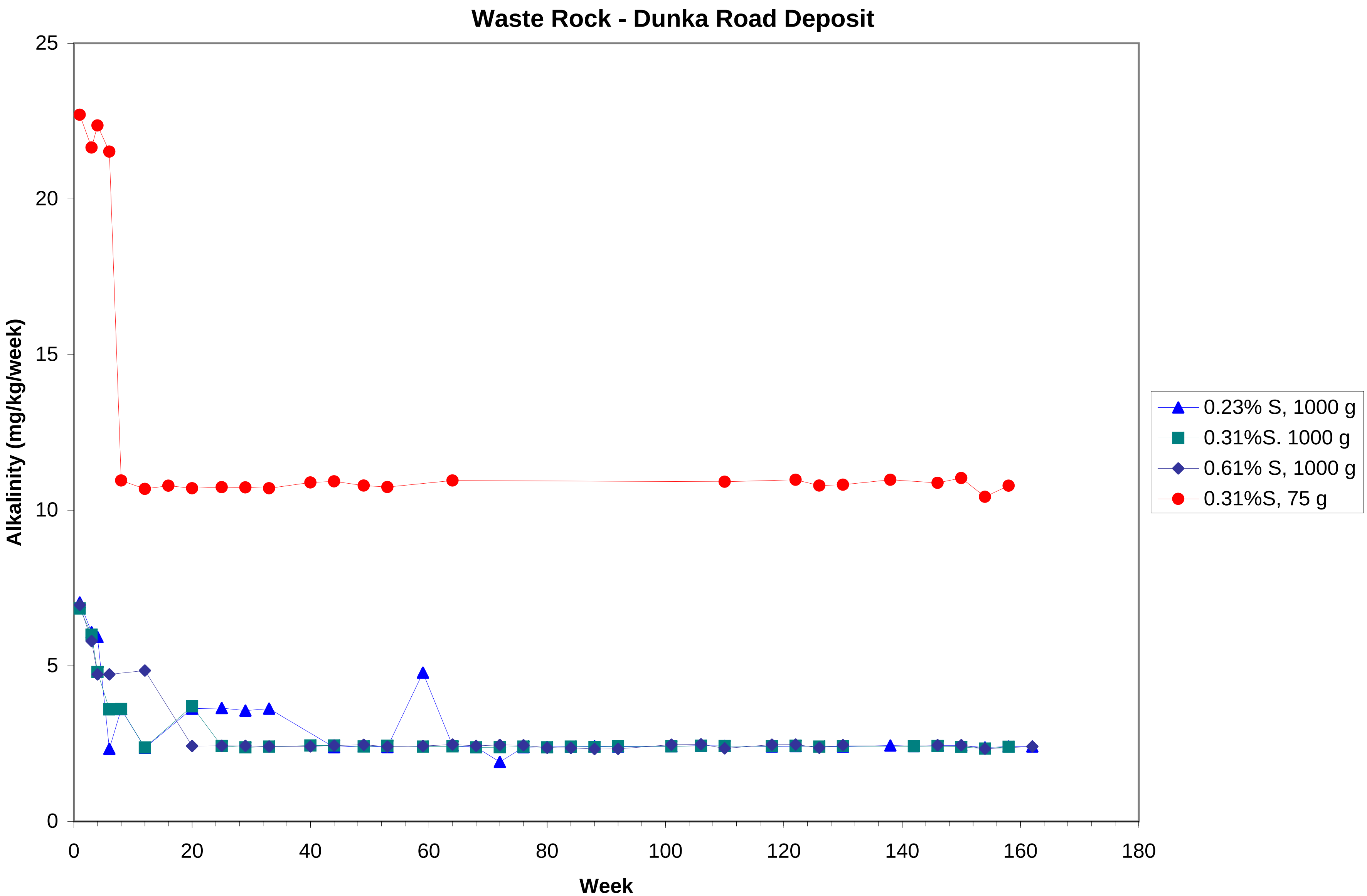

Waste Rock - Babbitt Deposit
Co (mg/kg/week)
10
1
0.1
0.01
0.001
0.0001
0
20
40
60
80
100
120
140
160
180
Week
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

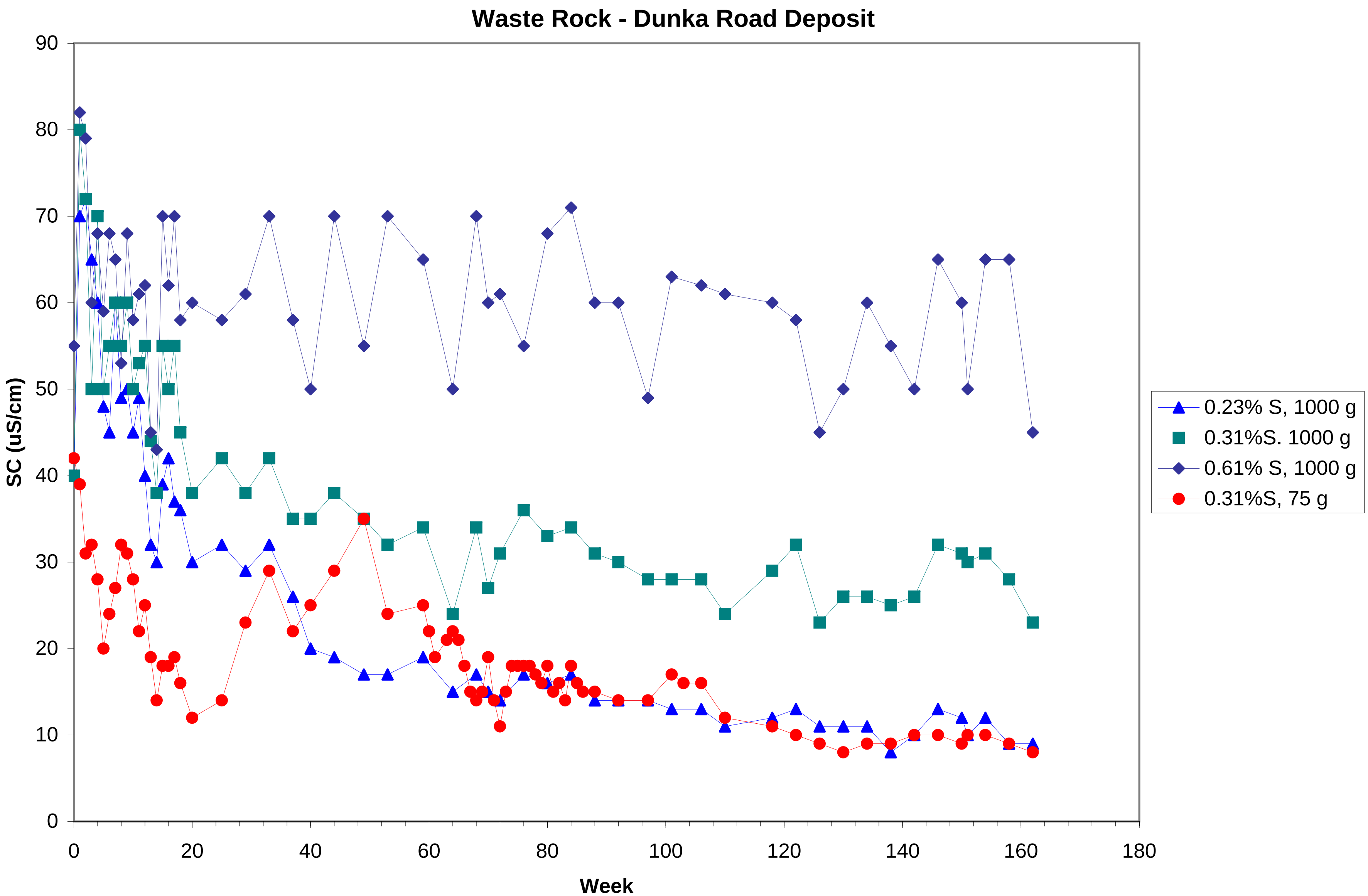

Waste Rock - Babbitt Deposit
Zn (mg/kg/week)
Week
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
120
140
160
180
0.13%S,1000g
0.21%S,1000g
0.33%S,1000g
0.55%S,1000g
0.55%S,1000g
0.72%S,1000g
1.03%S,1000g
1.36%S, 1000g
0.07%S, 75g
0.11%S,75g
0.2%S,75g
0.31%S,75g
0.31%S,75g
0.63%S,75g
0.94%S,75g

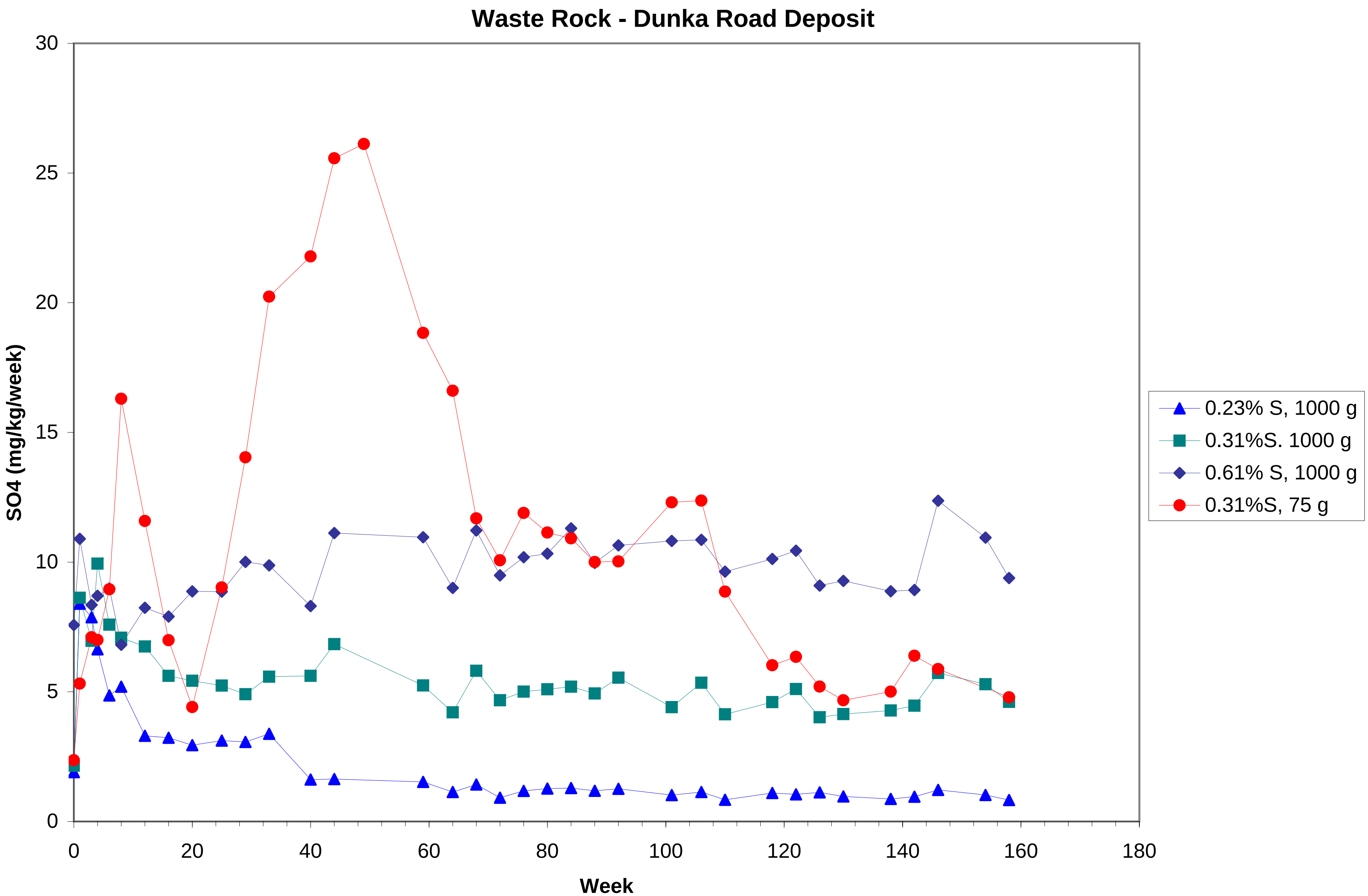
Appendix B.3

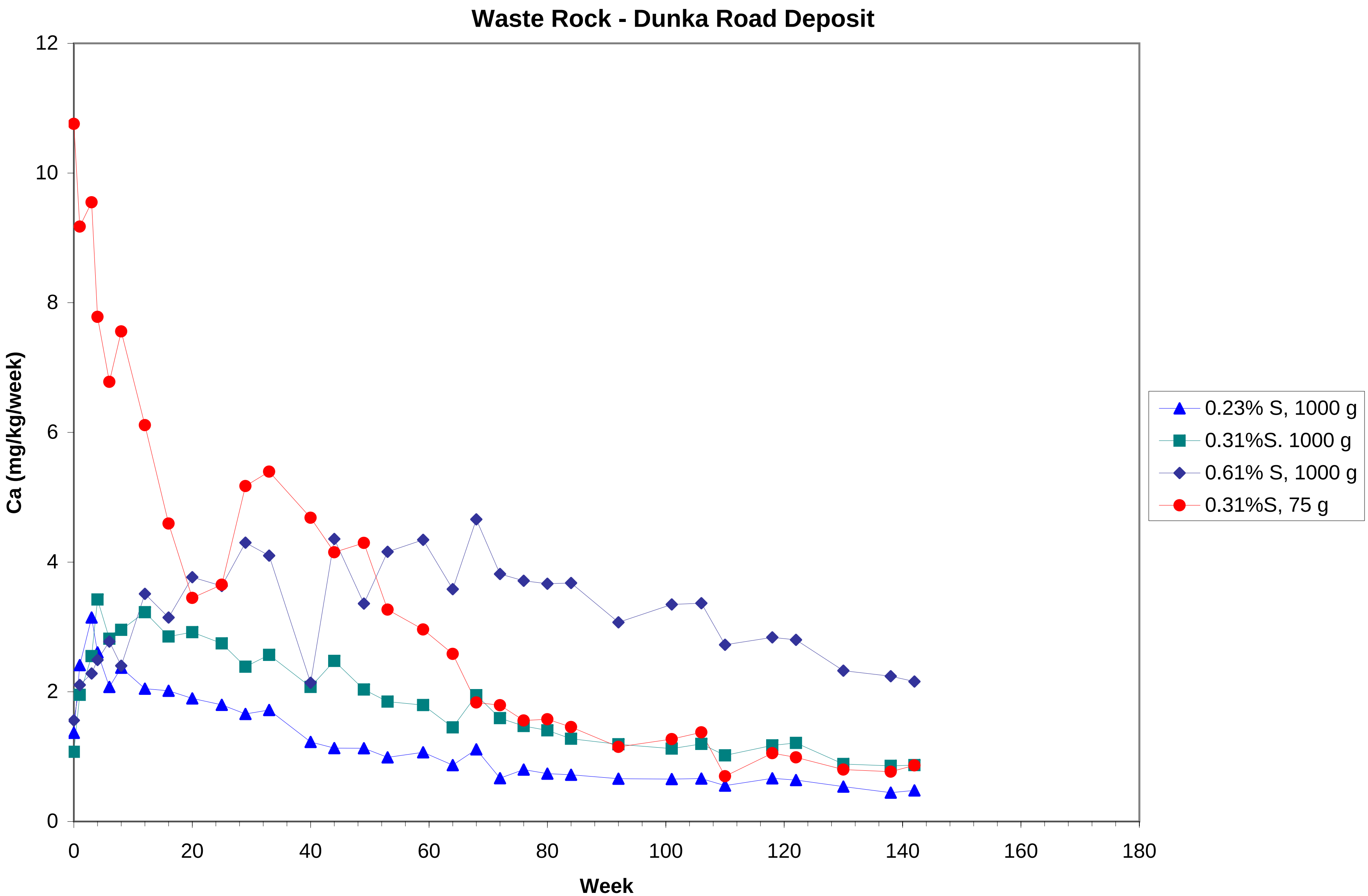
Charts for MDNR Dunka Road (NorthMet) Deposit Kinetic Tests

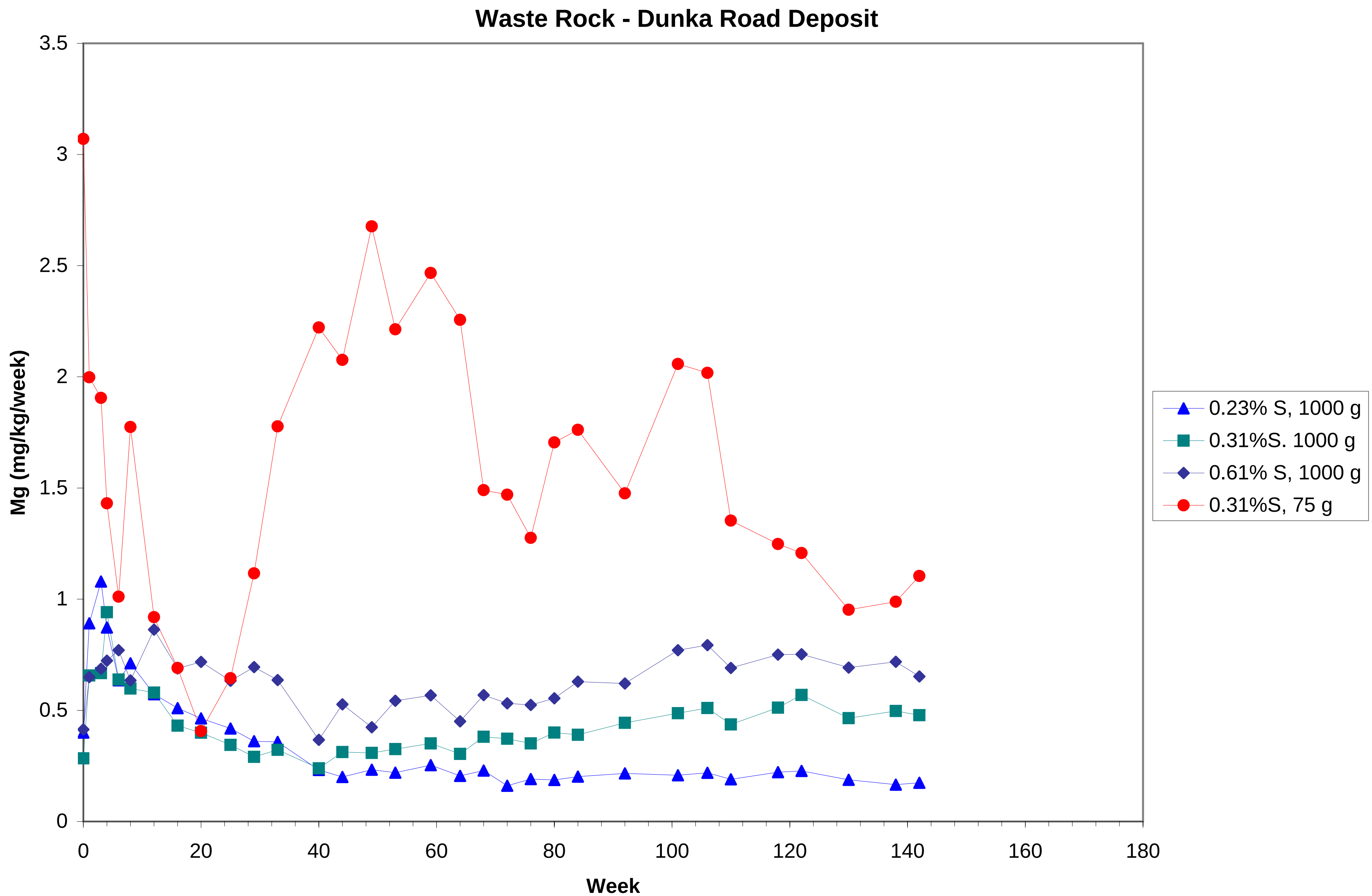

Waste Rock - Dunka Road Deposit
pH
Week
10
9
8
7
6
5
4
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

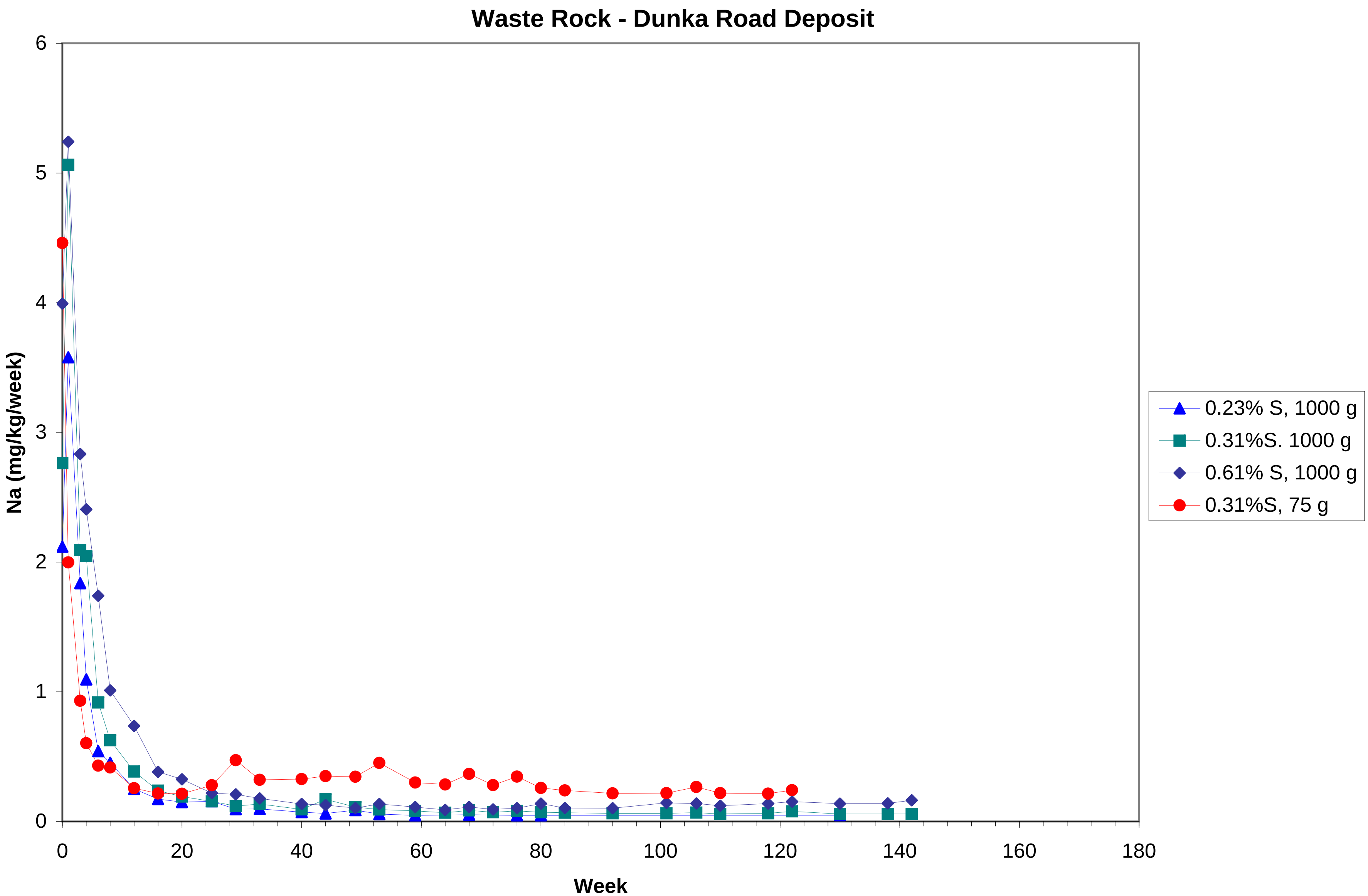

Waste Rock - Dunka Road Deposit
Alkalinity (mg/kg/week)
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
Week
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

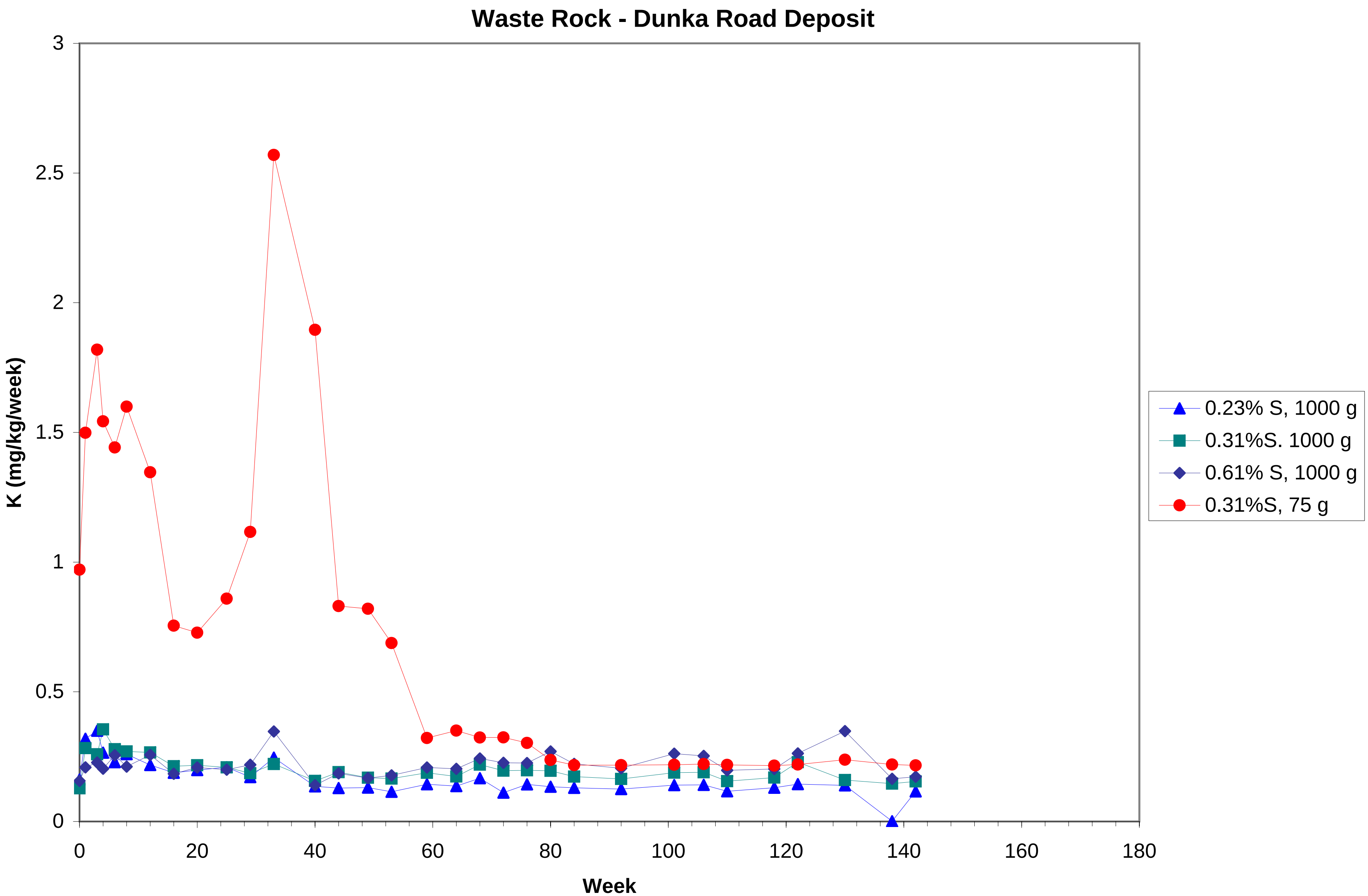

Waste Rock - Dunka Road Deposit
SC (uS/cm)
Week
0
10
20
30
40
50
60
70
80
90
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

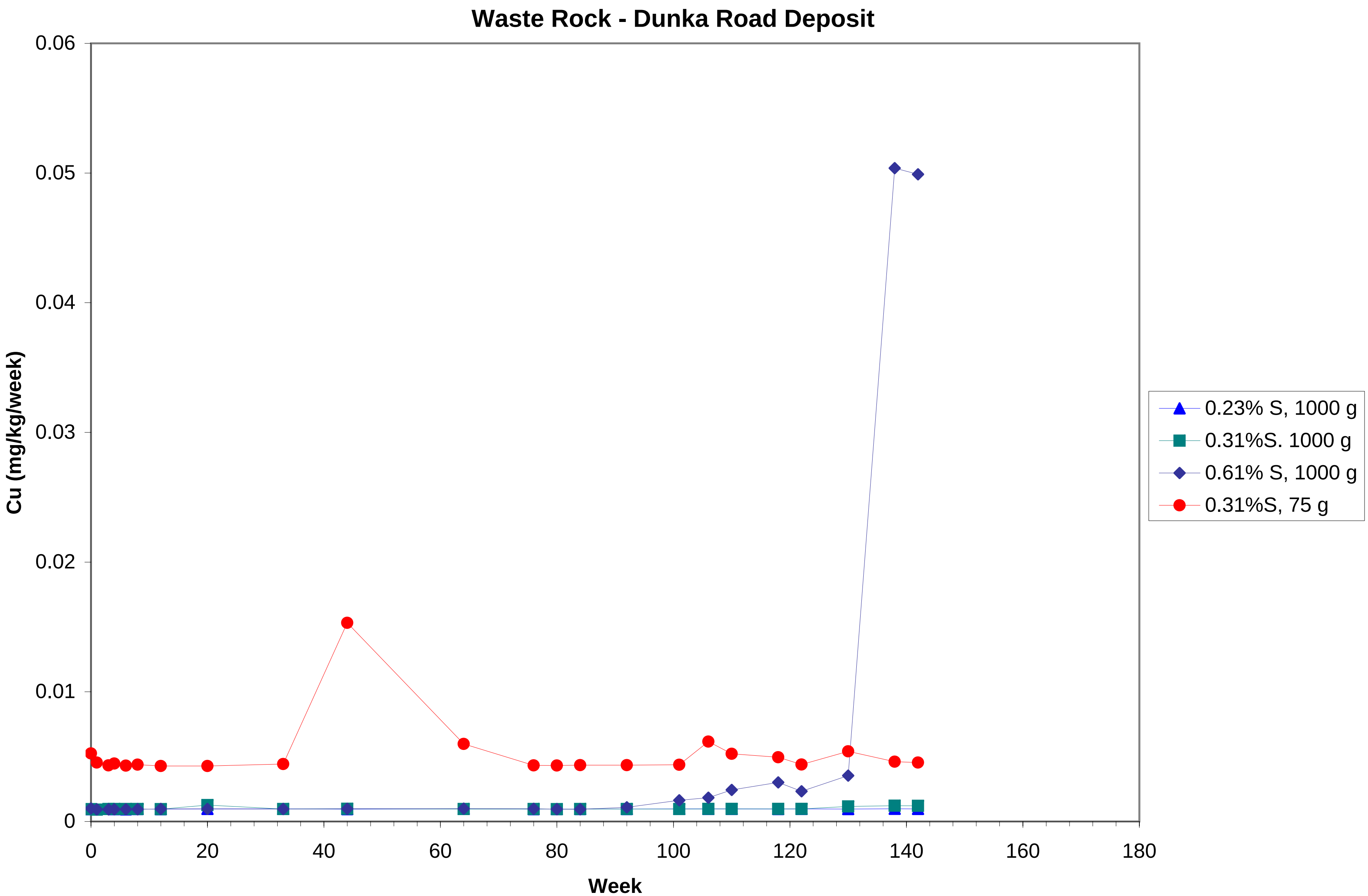

Waste Rock - Dunka Road Deposit
SO4 (mg/kg/week)
Week
0
5
10
15
20
25
30
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

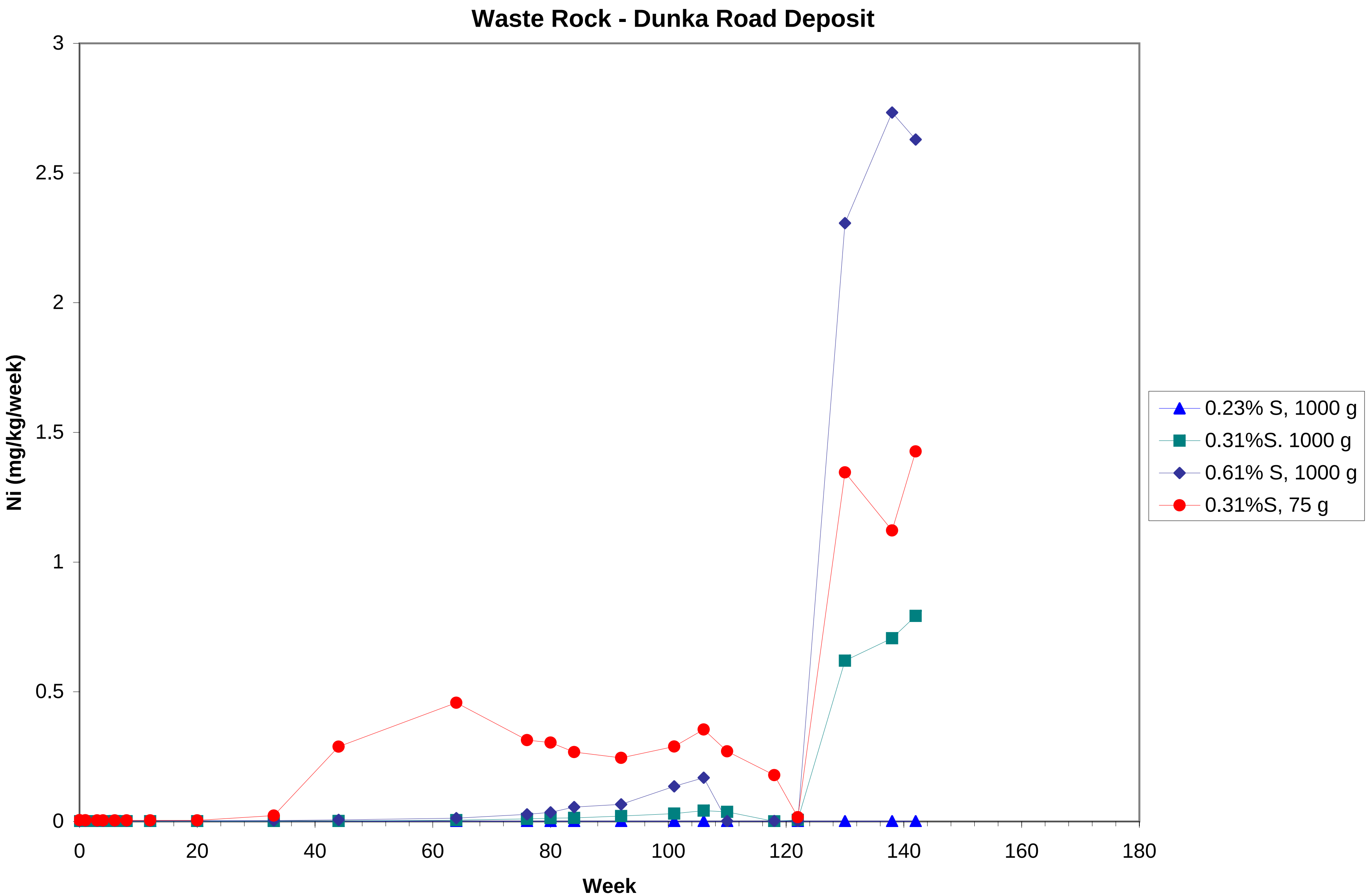

Waste Rock - Dunka Road Deposit
Ca (mg/kg/week)
Week
0
2
4
6
8
10
12
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

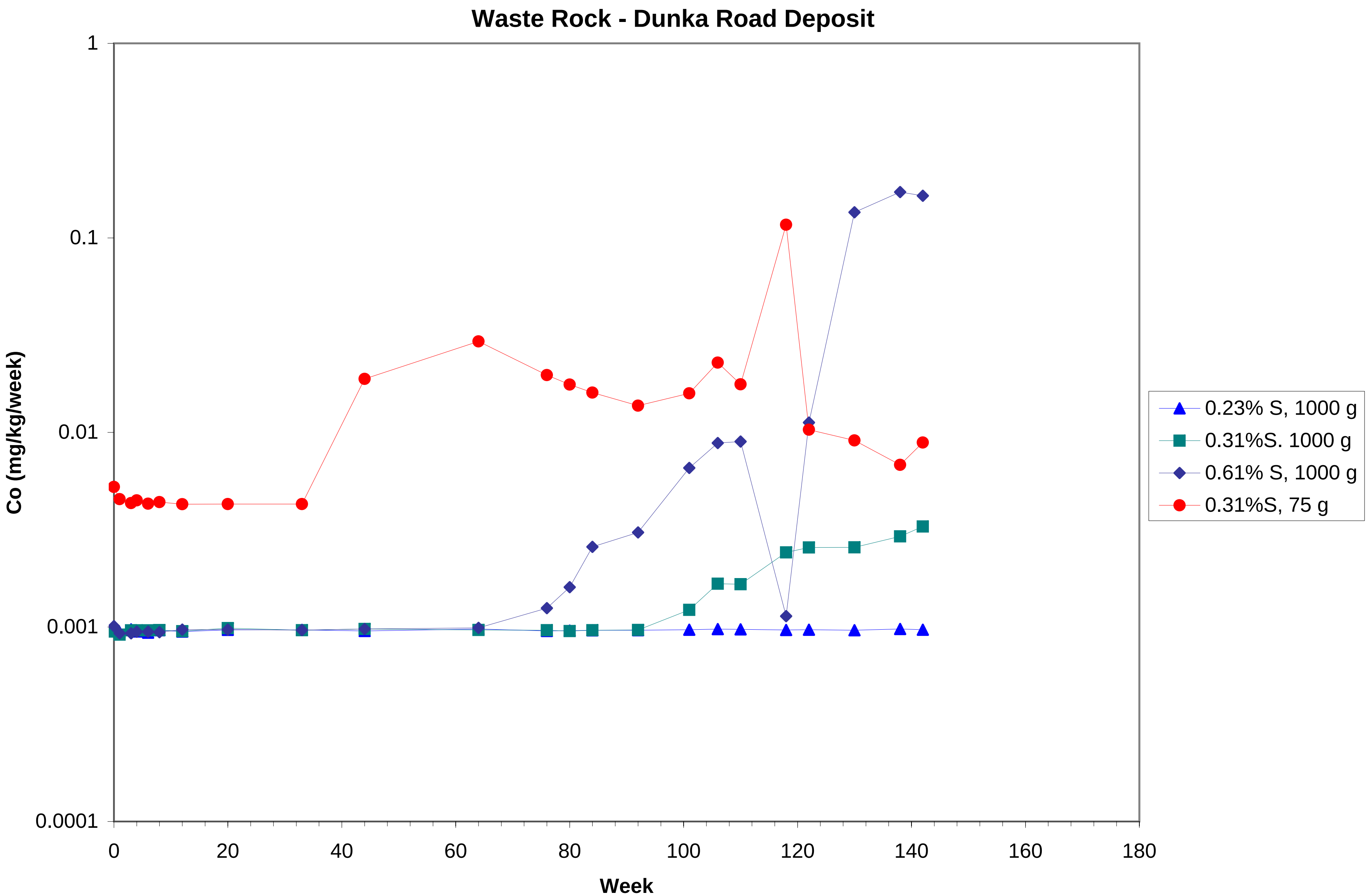

Waste Rock - Dunka Road Deposit
Mg (mg/kg/week)
Week
0
0.5
1
1.5
2
2.5
3
3.5
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

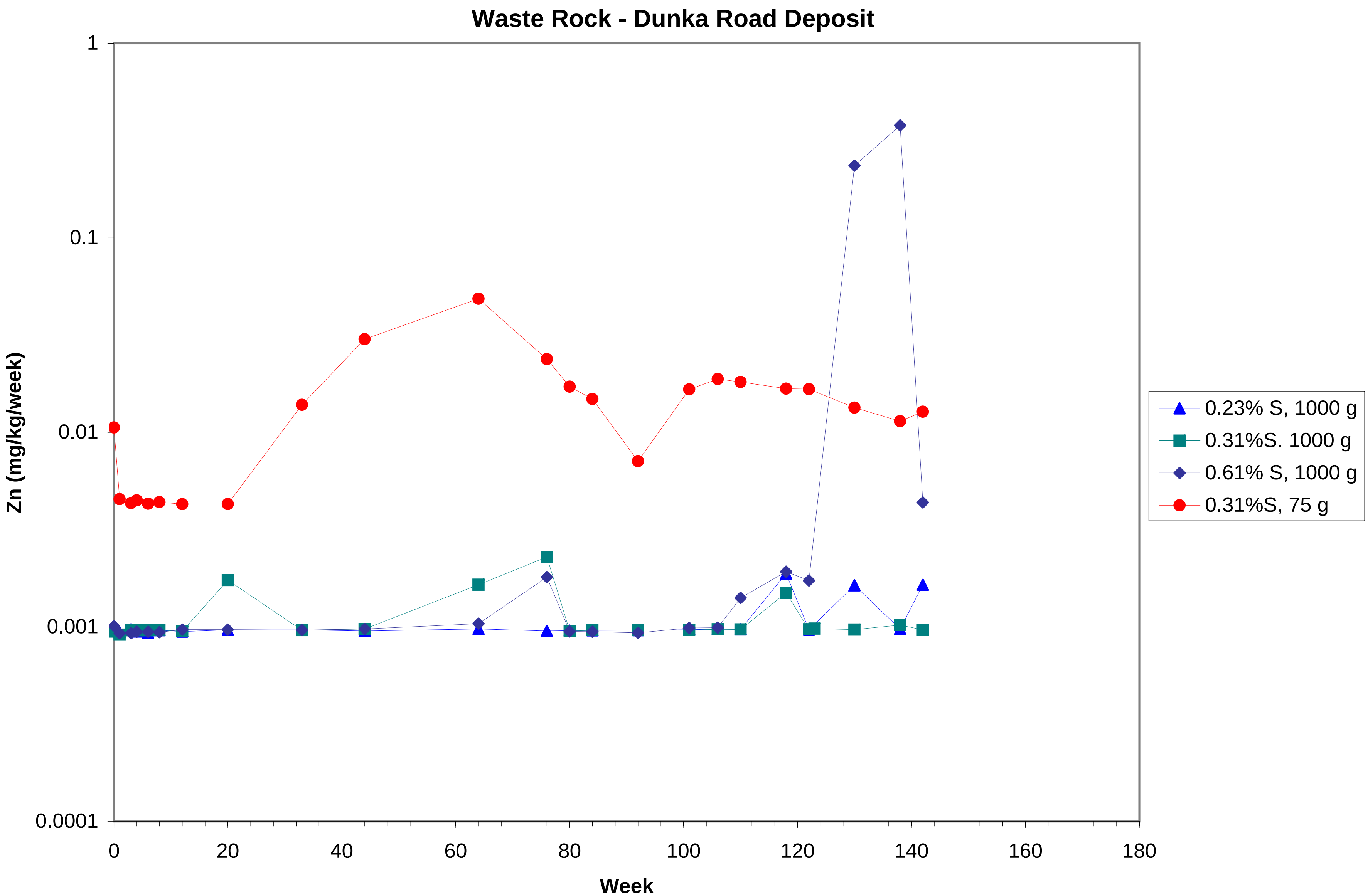

Waste Rock - Dunka Road Deposit
Na (mg/kg/week)
Week
0
1
2
3
4
5
6
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g


Waste Rock - Dunka Road Deposit
K (mg/kg/week)
Week
0
0.5
1
1.5
2
2.5
3
0
20
40
60
80
100
120
140
160
180
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g


Waste Rock - Dunka Road Deposit
0.06
0.05
0.04
0.03
0.02
0.01
0
Cu (mg/kg/week)
0
20
40
60
80
100
120
140
160
180
Week
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g


Waste Rock - Dunka Road Deposit
Ni (mg/kg/week)
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
160
180
Week
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g


Waste Rock - Dunka Road Deposit
Co (mg/kg/week)
1
0.1
0.01
0.001
0.0001
0
20
40
60
80
100
120
140
160
180
Week
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g


Waste Rock - Dunka Road Deposit
Zn (mg/kg/week)
1
0.1
0.01
0.001
0.0001
0
20
40
60
80
100
120
140
160
180
Week
0.23% S, 1000 g
0.31%S. 1000 g
0.61% S, 1000 g
0.31%S, 75 g

Appendix C

Bulk Characteristics of Rock Sample

Appendix C.1

Distribution of Sulfur, Copper, Nickel, Cobalt and Zinc by Rock Type and Unit

Table 1-A PolyMet 20 Year Sulfur - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

LEAN		Sampled				Adjm1	Adjm2	Adjusted			Sulfur (%S)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	15	90	0.59%	1,650,543	0	0	90	0.40%	1,125,191	0.09	0.58	1.95	0.11	0.26	0.36	0.93	1.95
	GABBROIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	0.09	0.25	0.50	0.09	0.10	0.18	0.37	0.50
	NORITIC	4	19	0.12%	339,278	0	0	19	0.08%	231,289	0.39	1.11	1.55	0.00	0.00	0.00	0.00	0.00
	SEDIMENTARY HORNFELS	19	81	0.53%	1,476,319	0	0	81	0.36%	1,006,421	0.12	1.74	4.91	0.34	1.37	1.58	1.76	4.91
	TROCTOLITIC	579	3,142	20.58%	57,613,131	0	0	3,142	14.03%	39,275,413	0.01	0.34	2.43	0.08	0.15	0.24	0.42	0.98
	ULTRAMAFIC	44	212	1.39%	3,887,946	0	0	212	0.95%	2,650,450	0.03	0.31	2.64	0.07	0.09	0.14	0.33	0.81
2	ANORTHOSITIC	5	23	0.15%	421,806	0	0	23	0.10%	287,549	0.09	0.17	0.25	0.09	0.12	0.17	0.21	0.25
	BASALT INCLUSION	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	112	576	3.77%	10,563,477	0	0	576	2.57%	7,201,222	0.03	0.14	0.85	0.05	0.07	0.12	0.18	0.32
	ULTRAMAFIC	35	167	1.09%	3,053,505	0	0	167	0.74%	2,081,603	0.03	0.09	0.28	0.04	0.05	0.07	0.12	0.23
3	ANORTHOSITIC	10	49	0.32%	898,629	0	0	49	0.22%	612,604	0.06	0.16	0.38	0.06	0.08	0.12	0.27	0.38
	GABBROIC	1	6	0.04%	110,036	0	0	6	0.03%	75,013	0.49	0.49	0.49	0.00	0.00	0.00	0.00	0.00
	SEDIMENTARY HORNFELS	7	33	0.22%	605,199	0	0	33	0.15%	412,570	1.66	2.14	3.26	1.66	1.77	1.85	2.43	3.26
	TROCTOLITIC	33	160	1.05%	2,934,299	0	0	160	0.71%	2,000,339	0.01	0.23	0.54	0.05	0.13	0.19	0.32	0.52
	ULTRAMAFIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	0.08	0.09	0.10	0.00	0.00	0.00	0.00	0.00
4	TROCTOLITIC	9	47	0.30%	852,781	0	0	47	0.21%	581,349	0.09	0.40	1.52	0.09	0.15	0.22	0.47	1.52
5	TROCTOLITIC	14	103	0.67%	1,888,955	0	0	103	0.46%	1,287,718	0.09	0.26	0.45	0.12	0.17	0.26	0.37	0.45
6	ANORTHOSITIC	1	3	0.02%	55,018	0	0	3	0.01%	37,506	0.15	0.15	0.15	0.00	0.00	0.00	0.00	0.00
	CHLORITE	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.12	0.12	0.12	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	6	30	0.20%	550,181	0	0	30	0.13%	375,064	0.01	0.06	0.19	0.01	0.01	0.03	0.07	0.19
7	ULTRAMAFIC	4	21	0.14%	385,127	0	0	21	0.09%	262,545	0.01	0.06	0.10	0.00	0.00	0.00	0.00	0.00
20	VIRGINIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	3.20	3.20	3.20	0.00	0.00	0.00	0.00	0.00
		Total	**4,810**	**32%**	**88,203,200**			**4,810**	**21%**	**60,128,950**	**0.01**	**0.35**	**4.91**	**0.07**	**0.12**	**0.21**	**0.39**	**1.19**

Table 1-A PolyMet 20 Year Sulfur - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

NON		Sampled				Adjm1	Adjm2	Adjusted			Sulfur (%S)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	10	50	0.33%	916,969	0	2	52	0.23%	652,483	0.03	0.04	0.05	0.04	0.04	0.04	0.05	0.05
	TROCTOLITIC	278	1,382	9.05%	25,345,009	0	167	1,549	6.91%	19,360,964	0.01	0.04	0.05	0.02	0.03	0.04	0.05	0.05
	ULTRAMAFIC	3	14	0.09%	256,751	0	5	19	0.09%	240,414	0.03	0.04	0.05	0.00	0.00	0.00	0.00	0.00
	VEIN	2	5	0.03%	91,697	0	0	5	0.02%	62,511	0.01	0.03	0.04	0.00	0.00	0.00	0.00	0.00
2	ANORTHOSITIC	30	145	0.95%	2,659,209	0	3	148	0.66%	1,853,204	0.01	0.02	0.05	0.01	0.01	0.02	0.04	0.05
	BASALT INCLUSION	4	17	0.11%	311,769	0	0	17	0.08%	212,536	0.01	0.03	0.05	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	208	1,030	6.74%	18,880,381	0	643	1,673	7.47%	20,914,771	0.01	0.04	0.05	0.02	0.03	0.04	0.05	0.05
	ULTRAMAFIC	5	24	0.15%	430,975	0	8	32	0.14%	396,821	0.03	0.04	0.05	0.03	0.03	0.04	0.05	0.05
3	ANORTHOSITIC	58	289	1.89%	5,300,078	0	571	860	3.84%	10,756,215	0.01	0.03	0.05	0.01	0.03	0.04	0.04	0.05
	GABBROIC	1	6	0.04%	110,036	0	12	18	0.08%	230,494	0.05	0.05	0.05	0.00	0.00	0.00	0.00	0.00
	NORITIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00
	SEDIMENTARY HORNFELS	7	35	0.23%	641,878	0	0	35	0.16%	437,574	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.02
	TROCTOLITIC	251	1,245	8.15%	22,823,346	0	2,467	3,712	16.57%	46,403,621	0.01	0.03	0.05	0.01	0.01	0.03	0.04	0.05
	ULTRAMAFIC	5	22	0.14%	403,466	0	0	22	0.10%	275,047	0.01	0.03	0.05	0.01	0.01	0.01	0.05	0.05
4	ANORTHOSITIC	3	15	0.10%	275,091	0	0	15	0.07%	187,532	0.02	0.03	0.04	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	88	439	2.87%	8,045,482	0	197	636	2.84%	7,952,644	0.01	0.03	0.05	0.02	0.03	0.03	0.04	0.05
	VEIN	1	3	0.02%	55,018	0	2	5	0.02%	62,511	0.03	0.03	0.03	0.00	0.00	0.00	0.00	0.00
5	TROCTOLITIC	15	75	0.49%	1,366,283	0	152	226	1.01%	2,828,593	0.01	0.02	0.05	0.01	0.01	0.02	0.03	0.05
6	CHLORITE	3	15	0.10%	275,091	0	0	15	0.07%	187,532	0.02	0.03	0.04	0.00	0.00	0.00	0.00	0.00
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	34	161	1.05%	2,952,639	0	457	618	2.76%	7,729,311	0.01	0.02	0.05	0.01	0.01	0.02	0.03	0.05
7	ULTRAMAFIC	1	5	0.03%	91,697	0	19	24	0.11%	300,051	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
		Total	**4,990**	**33%**	**91,507,955**			**9,697**	**43%**	**121,232,360**	**0.01**	**0.03**	**0.05**	**0.01**	**0.02**	**0.04**	**0.04**	**0.05**

Table 1-A PolyMet 20 Year Sulfur - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

REACT		Sampled				Adjm1	Adjm2	Adjusted			Sulfur (%S)							
Unit	**Rock Type**	**#**	**Ft**	**%**	**Tons**	**Ft**	**Ft**	**Ft**	**%**	**Tons**	**Min**	**Avg**	**Max**	**P10**	**P25**	**P50**	**P75**	**P95**
1	ANORTHOSITIC	18	87	0.57%	1,595,525	0	4	91	0.41%	1,135,320	0.08	0.25	1.09	0.08	0.10	0.15	0.29	1.09
	GABBROIC	12	60	0.39%	1,100,362	0	2	62	0.28%	775,131	0.06	0.08	0.19	0.06	0.07	0.07	0.08	0.19
	NORITIC	6	30	0.19%	541,011	0	6	35	0.16%	437,574	0.07	0.87	2.70	0.07	0.31	0.60	1.18	2.70
	SEDIMENTARY HORNFELS	26	120	0.79%	2,204,392	0	20	140	0.63%	1,752,797	0.06	1.20	3.78	0.08	0.35	0.69	2.20	3.50
	TROCTOLITIC	638	3,230	21.15%	59,232,497	0	389	3,619	16.16%	45,247,497	0.06	0.18	1.97	0.06	0.07	0.10	0.18	0.62
	ULTRAMAFIC	15	73	0.48%	1,338,774	0	27	100	0.45%	1,253,589	0.07	0.32	1.35	0.07	0.08	0.10	0.13	1.35
	VEIN	1	2	0.01%	36,679	0	0	2	0.01%	25,004	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00
2	ANORTHOSITIC	7	35	0.23%	632,708	0	1	35	0.16%	440,935	0.06	0.09	0.19	0.06	0.06	0.08	0.11	0.19
	GABBROIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.18	0.18	0.18	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	120	593	3.88%	10,875,246	0	371	964	4.30%	12,047,071	0.06	0.08	0.25	0.06	0.06	0.07	0.09	0.12
	ULTRAMAFIC	3	15	0.10%	275,091	0	5	20	0.09%	253,290	0.09	0.14	0.21	0.00	0.00	0.00	0.00	0.00
3	ANORTHOSITIC	8	37	0.24%	678,557	0	73	110	0.49%	1,377,093	0.07	0.10	0.14	0.07	0.08	0.08	0.12	0.14
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00
	GABBROIC	5	22	0.14%	394,296	0	45	66	0.29%	825,936	0.09	0.20	0.29	0.09	0.15	0.18	0.27	0.29
	SEDIMENTARY HORNFELS	9	42	0.28%	770,254	0	0	42	0.19%	525,089	0.12	1.58	2.22	0.12	1.42	1.67	1.97	2.22
	TROCTOLITIC	78	380	2.49%	6,959,791	0	752	1,132	5.05%	14,150,401	0.06	0.09	0.36	0.06	0.06	0.08	0.10	0.19
	ULTRAMAFIC	2	7	0.04%	119,206	0	0	7	0.03%	81,264	0.06	0.07	0.07	0.00	0.00	0.00	0.00	0.00
4	ANORTHOSITIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.39	0.39	0.39	0.00	0.00	0.00	0.00	0.00
	SEDIMENTARY HORNFELS	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.20	0.20	0.20	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	28	138	0.90%	2,530,833	0	62	200	0.89%	2,501,630	0.06	0.20	1.53	0.06	0.07	0.09	0.18	0.92
5	TROCTOLITIC	13	61	0.40%	1,118,702	0	124	185	0.83%	2,316,029	0.06	0.12	0.22	0.07	0.09	0.11	0.16	0.22
6	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.07	0.07	0.07	0.00	0.00	0.00	0.00	0.00
	TROCTOLITIC	1	14	0.09%	256,751	0	40	54	0.24%	672,114	0.14	0.14	0.14	0.00	0.00	0.00	0.00	0.00
	ULTRAMAFIC	1	10	0.07%	183,394	0	0	10	0.04%	125,021	0.10	0.10	0.10	0.00	0.00	0.00	0.00	0.00
20	TROCTOLITIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	3.18	3.80	4.31	3.18	3.45	3.76	4.30	4.31
	VIRGINIA	93	465	3.05%	8,527,807	0	481	946	4.22%	11,820,755	0.26	2.87	7.45	0.59	1.25	2.98	4.15	6.06
		Total	**5,469**	**36%**	**100,288,845**			**7,870**	**35%**	**98,388,647**	**0.06**	**0.45**	**7.45**	**0.06**	**0.07**	**0.10**	**0.22**	**2.98**

Adjm1 = footage adjustment for Not Sampled footage where Class, Unit and Rock Type defined

Adjm2 = footage adjustment for Not Sampled footage where only Unit and Rock Type defined (Not Sampled footage distributed between NON and REACT via same ratio as Sampled)

Figure 1-C PolyMet 20 Year Copper - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

LEAN		Sampled				Adjm1	Adjm2	Adjusted			Copper (%CU)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	15	90	0.59%	1,650,543	0	0	90	0.40%	1,125,191	0.080	0.127	0.174	0.083	0.106	0.125	0.152	0.174
	GABBROIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	0.042	0.105	0.192	0.042	0.047	0.089	0.157	0.192
	NORITIC	4	19	0.12%	339,278	0	0	19	0.08%	231,289	0.087	0.121	0.144	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	19	81	0.53%	1,476,319	0	0	81	0.36%	1,006,421	0.069	0.121	0.256	0.072	0.092	0.106	0.146	0.256
	TROCTOLITIC	579	3,142	20.58%	57,613,131	0	0	3,142	14.03%	39,275,413	0.009	0.105	0.232	0.047	0.078	0.107	0.133	0.176
	ULTRAMAFIC	44	212	1.39%	3,887,946	0	0	212	0.95%	2,650,450	0.018	0.080	0.164	0.032	0.038	0.082	0.099	0.157
2	ANORTHOSITIC	5	23	0.15%	421,806	0	0	23	0.10%	287,549	0.051	0.092	0.127	0.051	0.075	0.094	0.113	0.127
	BASALT INCLUSION	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.097	0.097	0.097	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	112	576	3.77%	10,563,477	0	0	576	2.57%	7,201,222	0.013	0.069	0.202	0.021	0.034	0.059	0.103	0.140
	ULTRAMAFIC	35	167	1.09%	3,053,505	0	0	167	0.74%	2,081,603	0.011	0.039	0.117	0.016	0.020	0.030	0.048	0.102
3	ANORTHOSITIC	10	49	0.32%	898,629	0	0	49	0.22%	612,604	0.025	0.067	0.125	0.026	0.029	0.067	0.091	0.125
	GABBROIC	1	6	0.04%	110,036	0	0	6	0.03%	75,013	0.147	0.147	0.147	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	7	33	0.22%	605,199	0	0	33	0.15%	412,570	0.048	0.074	0.124	0.048	0.053	0.071	0.088	0.124
	TROCTOLITIC	33	160	1.05%	2,934,299	0	0	160	0.71%	2,000,339	0.007	0.095	0.236	0.029	0.069	0.097	0.128	0.176
	ULTRAMAFIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	0.048	0.064	0.079	0.000	0.000	0.000	0.000	0.000
4	TROCTOLITIC	9	47	0.30%	852,781	0	0	47	0.21%	581,349	0.060	0.102	0.139	0.060	0.088	0.103	0.116	0.139
5	TROCTOLITIC	14	103	0.67%	1,888,955	0	0	103	0.46%	1,287,718	0.049	0.098	0.156	0.061	0.078	0.104	0.111	0.156
6	ANORTHOSITIC	1	3	0.02%	55,018	0	0	3	0.01%	37,506	0.112	0.112	0.112	0.000	0.000	0.000	0.000	0.000
	CHLORITE	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.085	0.085	0.085	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	6	30	0.20%	550,181	0	0	30	0.13%	375,064	0.010	0.041	0.095	0.010	0.011	0.034	0.064	0.095
7	ULTRAMAFIC	4	21	0.14%	385,127	0	0	21	0.09%	262,545	0.007	0.059	0.136	0.000	0.000	0.000	0.000	0.000
20	VIRGINIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.120	0.120	0.120	0.000	0.000	0.000	0.000	0.000
		Total	**4,810**	**32%**	**88,203,200**			**4,810**	**21%**	**60,128,950**	**0.007**	**0.096**	**0.256**	**0.031**	**0.062**	**0.097**	**0.127**	**0.172**

Figure 1-C PolyMet 20 Year Copper - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

NON		Sampled				Adjm1	Adjm2	Adjusted			Copper (%CU)							
Unit	**Rock Type**	**#**	**Ft**	**%**	**Tons**	**Ft**	**Ft**	**Ft**	**%**	**Tons**	**Min**	**Avg**	**Max**	**P10**	**P25**	**P50**	**P75**	**P95**
1	ANORTHOSITIC	10	50	0.33%	916,969	0	2	52	0.23%	652,483	0.010	0.019	0.034	0.013	0.014	0.018	0.024	0.034
	TROCTOLITIC	278	1,382	9.05%	25,345,009	0	167	1,549	6.91%	19,360,964	0.006	0.018	0.047	0.011	0.013	0.016	0.020	0.031
	ULTRAMAFIC	3	14	0.09%	256,751	0	5	19	0.09%	240,414	0.015	0.027	0.035	0.000	0.000	0.000	0.000	0.000
	VEIN	2	5	0.03%	91,697	0	0	5	0.02%	62,511	0.003	0.010	0.016	0.000	0.000	0.000	0.000	0.000
2	ANORTHOSITIC	30	145	0.95%	2,659,209	0	3	148	0.66%	1,853,204	0.007	0.013	0.027	0.008	0.009	0.012	0.015	0.021
	BASALT INCLUSION	4	17	0.11%	311,769	0	0	17	0.08%	212,536	0.019	0.029	0.039	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	208	1,030	6.74%	18,880,381	0	643	1,673	7.47%	20,914,771	0.004	0.019	0.046	0.012	0.015	0.018	0.021	0.029
	ULTRAMAFIC	5	24	0.15%	430,975	0	8	32	0.14%	396,821	0.014	0.017	0.023	0.014	0.016	0.017	0.017	0.023
3	ANORTHOSITIC	58	289	1.89%	5,300,078	0	571	860	3.84%	10,756,215	0.005	0.016	0.032	0.008	0.012	0.018	0.021	0.024
	GABBROIC	1	6	0.04%	110,036	0	12	18	0.08%	230,494	0.024	0.024	0.024	0.000	0.000	0.000	0.000	0.000
	NORITIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	0.018	0.019	0.019	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	7	35	0.23%	641,878	0	0	35	0.16%	437,574	0.002	0.005	0.011	0.002	0.002	0.004	0.008	0.011
	TROCTOLITIC	251	1,245	8.15%	22,823,346	0	2,467	3,712	16.57%	46,403,621	0.001	0.014	0.033	0.005	0.010	0.013	0.018	0.026
	ULTRAMAFIC	5	22	0.14%	403,466	0	0	22	0.10%	275,047	0.003	0.010	0.022	0.003	0.004	0.006	0.015	0.022
4	ANORTHOSITIC	3	15	0.10%	275,091	0	0	15	0.07%	187,532	0.009	0.010	0.011	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	88	439	2.87%	8,045,482	0	197	636	2.84%	7,952,644	0.004	0.014	0.023	0.006	0.011	0.015	0.017	0.020
	VEIN	1	3	0.02%	55,018	0	2	5	0.02%	62,511	0.022	0.022	0.022	0.000	0.000	0.000	0.000	0.000
5	TROCTOLITIC	15	75	0.49%	1,366,283	0	152	226	1.01%	2,828,593	0.006	0.014	0.030	0.006	0.009	0.012	0.016	0.030
6	CHLORITE	3	15	0.10%	275,091	0	0	15	0.07%	187,532	0.020	0.022	0.025	0.000	0.000	0.000	0.000	0.000
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.016	0.016	0.016	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	34	161	1.05%	2,952,639	0	457	618	2.76%	7,729,311	0.006	0.018	0.045	0.007	0.007	0.021	0.025	0.045
7	ULTRAMAFIC	1	5	0.03%	91,697	0	19	24	0.11%	300,051	0.015	0.015	0.015	0.000	0.000	0.000	0.000	0.000
		Total	**4,990**	**33%**	**91,507,955**			**9,697**	**43%**	**121,232,360**	**0.001**	**0.016**	**0.047**	**0.008**	**0.012**	**0.016**	**0.020**	**0.028**

Figure 1-C PolyMet 20 Year Copper - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

REACT		Sampled				Adjm1	Adjm2	Adjusted			Copper (%CU)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	18	87	0.57%	1,595,525	0	4	91	0.41%	1,135,320	0.017	0.043	0.115	0.018	0.029	0.039	0.048	0.115
	GABBROIC	12	60	0.39%	1,100,362	0	2	62	0.28%	775,131	0.014	0.028	0.061	0.017	0.019	0.023	0.037	0.061
	NORITIC	6	30	0.19%	541,011	0	6	35	0.16%	437,574	0.013	0.040	0.084	0.013	0.019	0.023	0.079	0.084
	SEDIMENTARY HORNFELS	26	120	0.79%	2,204,392	0	20	140	0.63%	1,752,797	0.003	0.045	0.089	0.012	0.020	0.050	0.062	0.085
	TROCTOLITIC	638	3,230	21.15%	59,232,497	0	389	3,619	16.16%	45,247,497	0.006	0.039	0.111	0.016	0.022	0.033	0.052	0.082
	ULTRAMAFIC	15	73	0.48%	1,338,774	0	27	100	0.45%	1,253,589	0.020	0.042	0.064	0.027	0.031	0.037	0.058	0.064
	VEIN	1	2	0.01%	36,679	0	0	2	0.01%	25,004	0.043	0.043	0.043	0.000	0.000	0.000	0.000	0.000
2	ANORTHOSITIC	7	35	0.23%	632,708	0	1	35	0.16%	440,935	0.029	0.040	0.056	0.029	0.034	0.038	0.046	0.056
	GABBROIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.070	0.070	0.070	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	120	593	3.88%	10,875,246	0	371	964	4.30%	12,047,071	0.005	0.029	0.101	0.016	0.020	0.025	0.033	0.060
	ULTRAMAFIC	3	15	0.10%	275,091	0	5	20	0.09%	253,290	0.035	0.049	0.057	0.000	0.000	0.000	0.000	0.000
3	ANORTHOSITIC	8	37	0.24%	678,557	0	73	110	0.49%	1,377,093	0.017	0.039	0.081	0.017	0.018	0.028	0.051	0.081
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.013	0.013	0.013	0.000	0.000	0.000	0.000	0.000
	GABBROIC	5	22	0.14%	394,296	0	45	66	0.29%	825,936	0.022	0.056	0.109	0.022	0.038	0.053	0.056	0.109
	SEDIMENTARY HORNFELS	9	42	0.28%	770,254	0	0	42	0.19%	525,089	0.035	0.044	0.052	0.035	0.039	0.046	0.049	0.052
	TROCTOLITIC	78	380	2.49%	6,959,791	0	752	1,132	5.05%	14,150,401	0.011	0.035	0.077	0.018	0.022	0.031	0.041	0.065
	ULTRAMAFIC	2	7	0.04%	119,206	0	0	7	0.03%	81,264	0.025	0.030	0.035	0.000	0.000	0.000	0.000	0.000
4	ANORTHOSITIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.062	0.062	0.062	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.021	0.021	0.021	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	28	138	0.90%	2,530,833	0	62	200	0.89%	2,501,630	0.011	0.042	0.084	0.014	0.024	0.036	0.058	0.081
5	TROCTOLITIC	13	61	0.40%	1,118,702	0	124	185	0.83%	2,316,029	0.017	0.047	0.067	0.019	0.037	0.051	0.059	0.067
6	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.078	0.078	0.078	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	1	14	0.09%	256,751	0	40	54	0.24%	672,114	0.080	0.080	0.080	0.000	0.000	0.000	0.000	0.000
	ULTRAMAFIC	1	10	0.07%	183,394	0	0	10	0.04%	125,021	0.059	0.059	0.059	0.000	0.000	0.000	0.000	0.000
20	TROCTOLITIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	0.015	0.026	0.040	0.015	0.020	0.026	0.028	0.040
	VIRGINIA	93	465	3.05%	8,527,807	0	481	946	4.22%	11,820,755	0.009	0.023	0.096	0.011	0.014	0.019	0.028	0.050
		Total	**5,469**	**36%**	**100,288,845**			**7,870**	**35%**	**98,388,647**	**0.003**	**0.037**	**0.115**	**0.016**	**0.021**	**0.031**	**0.048**	**0.078**

Adjm1 = footage adjustment for Not Sampled footage where Class, Unit and Rock Type defined

Adjm2 = footage adjustment for Not Sampled footage where only Unit and Rock Type defined (Not Sampled footage distributed between NON and REACT via same ratio as Sampled)

Figure 1-B PolyMet 20 Year Nickel - Waste Rock

Monday, April 18, 2005

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

LEAN		Sampled				Adjm1	Adjm2	Adjusted			Nickel (%NI)							
Unit	**Rock Type**	**#**	**Ft**	**%**	**Tons**	**Ft**	**Ft**	**Ft**	**%**	**Tons**	**Min**	**Avg**	**Max**	**P10**	**P25**	**P50**	**P75**	**P95**
1	ANORTHOSITIC	15	90	0.59%	1,650,543	0	0	90	0.40%	1,125,191	0.025	0.042	0.055	0.032	0.038	0.040	0.048	0.055
	GABBROIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	0.026	0.038	0.045	0.026	0.037	0.037	0.044	0.045
	NORITIC	4	19	0.12%	339,278	0	0	19	0.08%	231,289	0.030	0.043	0.062	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	19	81	0.53%	1,476,319	0	0	81	0.36%	1,006,421	0.026	0.041	0.052	0.026	0.036	0.043	0.045	0.052
	TROCTOLITIC	579	3,142	20.58%	57,613,131	0	0	3,142	14.03%	39,275,413	0.016	0.043	0.086	0.031	0.036	0.042	0.049	0.062
	ULTRAMAFIC	44	212	1.39%	3,887,946	0	0	212	0.95%	2,650,450	0.033	0.051	0.079	0.038	0.043	0.049	0.060	0.068
2	ANORTHOSITIC	5	23	0.15%	421,806	0	0	23	0.10%	287,549	0.024	0.034	0.048	0.024	0.027	0.034	0.039	0.048
	BASALT INCLUSION	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.026	0.026	0.026	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	112	576	3.77%	10,563,477	0	0	576	2.57%	7,201,222	0.022	0.043	0.075	0.031	0.036	0.043	0.049	0.061
	ULTRAMAFIC	35	167	1.09%	3,053,505	0	0	167	0.74%	2,081,603	0.037	0.064	0.093	0.048	0.053	0.062	0.071	0.087
3	ANORTHOSITIC	10	49	0.32%	898,629	0	0	49	0.22%	612,604	0.010	0.031	0.045	0.022	0.023	0.033	0.040	0.045
	GABBROIC	1	6	0.04%	110,036	0	0	6	0.03%	75,013	0.028	0.028	0.028	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	7	33	0.22%	605,199	0	0	33	0.15%	412,570	0.035	0.042	0.049	0.035	0.040	0.042	0.045	0.049
	TROCTOLITIC	33	160	1.05%	2,934,299	0	0	160	0.71%	2,000,339	0.020	0.036	0.054	0.025	0.028	0.036	0.041	0.053
	ULTRAMAFIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	0.044	0.047	0.050	0.000	0.000	0.000	0.000	0.000
4	TROCTOLITIC	9	47	0.30%	852,781	0	0	47	0.21%	581,349	0.026	0.038	0.049	0.026	0.033	0.038	0.042	0.049
5	TROCTOLITIC	14	103	0.67%	1,888,955	0	0	103	0.46%	1,287,718	0.028	0.037	0.048	0.030	0.031	0.037	0.042	0.048
6	ANORTHOSITIC	1	3	0.02%	55,018	0	0	3	0.01%	37,506	0.034	0.034	0.034	0.000	0.000	0.000	0.000	0.000
	CHLORITE	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.044	0.044	0.044	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	6	30	0.20%	550,181	0	0	30	0.13%	375,064	0.022	0.038	0.049	0.022	0.027	0.044	0.045	0.049
7	ULTRAMAFIC	4	21	0.14%	385,127	0	0	21	0.09%	262,545	0.038	0.051	0.060	0.000	0.000	0.000	0.000	0.000
20	VIRGINIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.037	0.037	0.037	0.000	0.000	0.000	0.000	0.000
		Total	**4,810**	**32%**	**88,203,200**			**4,810**	**21%**	**60,128,950**	**0.010**	**0.043**	**0.093**	**0.031**	**0.036**	**0.042**	**0.050**	**0.065**

Figure 1-B PolyMet 20 Year Nickel - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

NON		Sampled				Adjm1	Adjm2	Adjusted			Nickel (%NI)							
Unit	**Rock Type**	**#**	**Ft**	**%**	**Tons**	**Ft**	**Ft**	**Ft**	**%**	**Tons**	**Min**	**Avg**	**Max**	**P10**	**P25**	**P50**	**P75**	**P95**
1	ANORTHOSITIC	10	50	0.33%	916,969	0	2	52	0.23%	652,483	0.020	0.026	0.031	0.022	0.024	0.026	0.028	0.031
	TROCTOLITIC	278	1,382	9.05%	25,345,009	0	167	1,549	6.91%	19,360,964	0.006	0.023	0.044	0.014	0.017	0.023	0.027	0.038
	ULTRAMAFIC	3	14	0.09%	256,751	0	5	19	0.09%	240,414	0.030	0.037	0.044	0.000	0.000	0.000	0.000	0.000
	VEIN	2	5	0.03%	91,697	0	0	5	0.02%	62,511	0.002	0.005	0.008	0.000	0.000	0.000	0.000	0.000
2	ANORTHOSITIC	30	145	0.95%	2,659,209	0	3	148	0.66%	1,853,204	0.009	0.017	0.031	0.011	0.012	0.017	0.019	0.030
	BASALT INCLUSION	4	17	0.11%	311,769	0	0	17	0.08%	212,536	0.010	0.014	0.018	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	208	1,030	6.74%	18,880,381	0	643	1,673	7.47%	20,914,771	0.007	0.025	0.042	0.015	0.018	0.024	0.030	0.038
	ULTRAMAFIC	5	24	0.15%	430,975	0	8	32	0.14%	396,821	0.025	0.035	0.043	0.025	0.031	0.037	0.037	0.043
3	ANORTHOSITIC	58	289	1.89%	5,300,078	0	571	860	3.84%	10,756,215	0.007	0.014	0.025	0.009	0.010	0.013	0.018	0.022
	GABBROIC	1	6	0.04%	110,036	0	12	18	0.08%	230,494	0.016	0.016	0.016	0.000	0.000	0.000	0.000	0.000
	NORITIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	0.010	0.013	0.016	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	7	35	0.23%	641,878	0	0	35	0.16%	437,574	0.003	0.006	0.008	0.003	0.004	0.006	0.008	0.008
	TROCTOLITIC	251	1,245	8.15%	22,823,346	0	2,467	3,712	16.57%	46,403,621	0.007	0.018	0.044	0.011	0.014	0.017	0.021	0.029
	ULTRAMAFIC	5	22	0.14%	403,466	0	0	22	0.10%	275,047	0.025	0.031	0.035	0.025	0.030	0.032	0.034	0.035
4	ANORTHOSITIC	3	15	0.10%	275,091	0	0	15	0.07%	187,532	0.014	0.016	0.018	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	88	439	2.87%	8,045,482	0	197	636	2.84%	7,952,644	0.007	0.018	0.037	0.014	0.015	0.018	0.020	0.025
	VEIN	1	3	0.02%	55,018	0	2	5	0.02%	62,511	0.005	0.005	0.005	0.000	0.000	0.000	0.000	0.000
5	TROCTOLITIC	15	75	0.49%	1,366,283	0	152	226	1.01%	2,828,593	0.018	0.022	0.029	0.018	0.020	0.022	0.024	0.029
6	CHLORITE	3	15	0.10%	275,091	0	0	15	0.07%	187,532	0.027	0.034	0.039	0.000	0.000	0.000	0.000	0.000
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.020	0.020	0.020	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	34	161	1.05%	2,952,639	0	457	618	2.76%	7,729,311	0.019	0.028	0.041	0.021	0.023	0.028	0.034	0.037
7	ULTRAMAFIC	1	5	0.03%	91,697	0	19	24	0.11%	300,051	0.044	0.044	0.044	0.000	0.000	0.000	0.000	0.000
		Total	**4,990**	**33%**	**91,507,955**			**9,697**	**43%**	**121,232,360**	**0.002**	**0.021**	**0.044**	**0.012**	**0.015**	**0.020**	**0.025**	**0.037**

Figure 1-B PolyMet 20 Year Nickel - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

REACT		Sampled				Adjm1	Adjm2	Adjusted			Nickel (%NI)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	18	87	0.57%	1,595,525	0	4	91	0.41%	1,135,320	0.008	0.021	0.033	0.012	0.018	0.021	0.025	0.033
	GABBROIC	12	60	0.39%	1,100,362	0	2	62	0.28%	775,131	0.018	0.026	0.038	0.018	0.021	0.024	0.035	0.038
	NORITIC	6	30	0.19%	541,011	0	6	35	0.16%	437,574	0.007	0.015	0.027	0.007	0.010	0.012	0.021	0.027
	SEDIMENTARY HORNFELS	26	120	0.79%	2,204,392	0	20	140	0.63%	1,752,797	0.001	0.016	0.041	0.006	0.008	0.018	0.023	0.033
	TROCTOLITIC	638	3,230	21.15%	59,232,497	0	389	3,619	16.16%	45,247,497	0.003	0.023	0.044	0.011	0.017	0.023	0.028	0.036
	ULTRAMAFIC	15	73	0.48%	1,338,774	0	27	100	0.45%	1,253,589	0.008	0.025	0.041	0.009	0.013	0.028	0.037	0.041
	VEIN	1	2	0.01%	36,679	0	0	2	0.01%	25,004	0.017	0.017	0.017	0.000	0.000	0.000	0.000	0.000
2	ANORTHOSITIC	7	35	0.23%	632,708	0	1	35	0.16%	440,935	0.016	0.026	0.035	0.016	0.022	0.026	0.029	0.035
	GABBROIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.023	0.023	0.023	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	120	593	3.88%	10,875,246	0	371	964	4.30%	12,047,071	0.010	0.026	0.046	0.015	0.019	0.024	0.033	0.042
	ULTRAMAFIC	3	15	0.10%	275,091	0	5	20	0.09%	253,290	0.020	0.030	0.039	0.000	0.000	0.000	0.000	0.000
3	ANORTHOSITIC	8	37	0.24%	678,557	0	73	110	0.49%	1,377,093	0.004	0.019	0.035	0.004	0.005	0.017	0.028	0.035
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.012	0.012	0.012	0.000	0.000	0.000	0.000	0.000
	GABBROIC	5	22	0.14%	394,296	0	45	66	0.29%	825,936	0.012	0.019	0.027	0.012	0.013	0.016	0.026	0.027
	SEDIMENTARY HORNFELS	9	42	0.28%	770,254	0	0	42	0.19%	525,089	0.012	0.030	0.038	0.012	0.028	0.031	0.034	0.038
	TROCTOLITIC	78	380	2.49%	6,959,791	0	752	1,132	5.05%	14,150,401	0.005	0.021	0.037	0.013	0.017	0.020	0.024	0.034
	ULTRAMAFIC	2	7	0.04%	119,206	0	0	7	0.03%	81,264	0.024	0.028	0.032	0.000	0.000	0.000	0.000	0.000
4	ANORTHOSITIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.029	0.029	0.029	0.000	0.000	0.000	0.000	0.000
	SEDIMENTARY HORNFELS	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.015	0.015	0.015	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	28	138	0.90%	2,530,833	0	62	200	0.89%	2,501,630	0.012	0.024	0.040	0.014	0.017	0.023	0.029	0.035
5	TROCTOLITIC	13	61	0.40%	1,118,702	0	124	185	0.83%	2,316,029	0.017	0.029	0.035	0.022	0.027	0.032	0.032	0.035
6	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	0.026	0.026	0.026	0.000	0.000	0.000	0.000	0.000
	TROCTOLITIC	1	14	0.09%	256,751	0	40	54	0.24%	672,114	0.034	0.034	0.034	0.000	0.000	0.000	0.000	0.000
	ULTRAMAFIC	1	10	0.07%	183,394	0	0	10	0.04%	125,021	0.034	0.034	0.034	0.000	0.000	0.000	0.000	0.000
20	TROCTOLITIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	0.012	0.019	0.025	0.012	0.016	0.019	0.023	0.025
	VIRGINIA	93	465	3.05%	8,527,807	0	481	946	4.22%	11,820,755	0.006	0.016	0.029	0.010	0.012	0.015	0.020	0.026
		Total	**5,469**	**36%**	**100,288,845**			**7,870**	**35%**	**98,388,647**	**0.001**	**0.022**	**0.046**	**0.011**	**0.017**	**0.022**	**0.028**	**0.037**

Adjm1 = footage adjustment for Not Sampled footage where Class, Unit and Rock Type defined

Adjm2 = footage adjustment for Not Sampled footage where only Unit and Rock Type defined (Not Sampled footage distributed between NON and REACT via same ratio as Sampled)

Figure 1-D PolyMet 20 Year Cobalt - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

LEAN		Sampled				Adjm1	Adjm2	Adjusted			Cobalt (PPM)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	15	90	0.59%	1,650,543	0	0	90	0.40%	1,125,191	24	52	94	41	43	49	59	94
	GABBROIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	38	52	71	38	40	53	59	71
	NORITIC	4	19	0.12%	339,278	0	0	19	0.08%	231,289	32	47	69	0	0	0	0	0
	SEDIMENTARY HORNFELS	19	81	0.53%	1,476,319	0	0	81	0.36%	1,006,421	32	55	76	33	39	52	70	76
	TROCTOLITIC	579	3,142	20.58%	57,613,131	0	0	3,142	14.03%	39,275,413	24	59	114	40	47	57	69	90
	ULTRAMAFIC	44	212	1.39%	3,887,946	0	0	212	0.95%	2,650,450	33	78	168	50	65	75	90	105
2	ANORTHOSITIC	5	23	0.15%	421,806	0	0	23	0.10%	287,549	34	51	70	34	46	48	55	70
	BASALT INCLUSION	1	5	0.03%	91,697	0	0	5	0.02%	62,511	28	28	28	0	0	0	0	0
	TROCTOLITIC	112	576	3.77%	10,563,477	0	0	576	2.57%	7,201,222	21	65	106	48	56	66	75	88
	ULTRAMAFIC	35	167	1.09%	3,053,505	0	0	167	0.74%	2,081,603	62	87	121	69	75	88	95	111
3	ANORTHOSITIC	10	49	0.32%	898,629	0	0	49	0.22%	612,604	19	44	69	31	36	43	49	69
	GABBROIC	1	6	0.04%	110,036	0	0	6	0.03%	75,013	40	40	40	0	0	0	0	0
	SEDIMENTARY HORNFELS	7	33	0.22%	605,199	0	0	33	0.15%	412,570	84	90	104	84	85	87	94	104
	TROCTOLITIC	33	160	1.05%	2,934,299	0	0	160	0.71%	2,000,339	12	50	92	29	38	51	61	79
	ULTRAMAFIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	98	101	103	0	0	0	0	0
4	TROCTOLITIC	9	47	0.30%	852,781	0	0	47	0.21%	581,349	39	55	79	39	49	51	62	79
5	TROCTOLITIC	14	103	0.67%	1,888,955	0	0	103	0.46%	1,287,718	36	49	60	42	47	50	55	60
6	ANORTHOSITIC	1	3	0.02%	55,018	0	0	3	0.01%	37,506	46	46	46	0	0	0	0	0
	CHLORITE	1	5	0.03%	91,697	0	0	5	0.02%	62,511	68	68	68	0	0	0	0	0
	TROCTOLITIC	6	30	0.20%	550,181	0	0	30	0.13%	375,064	46	67	92	46	61	64	75	92
7	ULTRAMAFIC	4	21	0.14%	385,127	0	0	21	0.09%	262,545	49	86	101	0	0	0	0	0
20	VIRGINIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	48	48	48	0	0	0	0	0
		Total	**4,810**	**32%**	**88,203,200**			**4,810**	**21%**	**60,128,950**	**12**	**61**	**168**	**40**	**48**	**59**	**72**	**94**

Figure 1-D PolyMet 20 Year Cobalt - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

NON		Sampled				Adjm1	Adjm2	Adjusted			Cobalt (PPM)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	10	50	0.33%	916,969	0	2	52	0.23%	652,483	36	46	56	40	40	45	49	56
	TROCTOLITIC	278	1,382	9.05%	25,345,009	0	167	1,549	6.91%	19,360,964	21	48	85	34	40	48	56	70
	ULTRAMAFIC	3	14	0.09%	256,751	0	5	19	0.09%	240,414	62	74	89	0	0	0	0	0
	VEIN	2	5	0.03%	91,697	0	0	5	0.02%	62,511	6	12	17	0	0	0	0	0
2	ANORTHOSITIC	30	145	0.95%	2,659,209	0	3	148	0.66%	1,853,204	21	34	54	23	24	34	36	53
	BASALT INCLUSION	4	17	0.11%	311,769	0	0	17	0.08%	212,536	15	27	36	0	0	0	0	0
	TROCTOLITIC	208	1,030	6.74%	18,880,381	0	643	1,673	7.47%	20,914,771	16	50	79	36	41	49	59	68
	ULTRAMAFIC	5	24	0.15%	430,975	0	8	32	0.14%	396,821	50	65	76	50	64	65	71	76
3	ANORTHOSITIC	58	289	1.89%	5,300,078	0	571	860	3.84%	10,756,215	20	35	57	24	28	36	41	49
	GABBROIC	1	6	0.04%	110,036	0	12	18	0.08%	230,494	39	39	39	0	0	0	0	0
	NORITIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	32	39	45	0	0	0	0	0
	SEDIMENTARY HORNFELS	7	35	0.23%	641,878	0	0	35	0.16%	437,574	10	23	34	10	15	23	28	34
	TROCTOLITIC	251	1,245	8.15%	22,823,346	0	2,467	3,712	16.57%	46,403,621	16	41	77	31	35	40	46	59
	ULTRAMAFIC	5	22	0.14%	403,466	0	0	22	0.10%	275,047	53	57	60	53	54	59	59	60
4	ANORTHOSITIC	3	15	0.10%	275,091	0	0	15	0.07%	187,532	31	35	39	0	0	0	0	0
	TROCTOLITIC	88	439	2.87%	8,045,482	0	197	636	2.84%	7,952,644	17	41	66	34	37	41	44	53
	VEIN	1	3	0.02%	55,018	0	2	5	0.02%	62,511	5	5	5	0	0	0	0	0
5	TROCTOLITIC	15	75	0.49%	1,366,283	0	152	226	1.01%	2,828,593	39	46	55	40	41	48	50	55
6	CHLORITE	3	15	0.10%	275,091	0	0	15	0.07%	187,532	51	62	70	0	0	0	0	0
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	42	42	42	0	0	0	0	0
	TROCTOLITIC	34	161	1.05%	2,952,639	0	457	618	2.76%	7,729,311	42	56	74	47	50	56	60	71
7	ULTRAMAFIC	1	5	0.03%	91,697	0	19	24	0.11%	300,051	86	86	86	0	0	0	0	0
		Total	**4,990**	**33%**	**91,507,955**			**9,697**	**43%**	**121,232,360**	**5**	**45**	**89**	**32**	**37**	**43**	**53**	**66**

Figure 1-D PolyMet 20 Year Cobalt - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

REACT		Sampled				Adjm1	Adjm2	Adjusted			Cobalt (PPM)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	18	87	0.57%	1,595,525	0	4	91	0.41%	1,135,320	34	46	61	34	39	45	54	61
	GABBROIC	12	60	0.39%	1,100,362	0	2	62	0.28%	775,131	36	52	66	40	45	48	62	66
	NORITIC	6	30	0.19%	541,011	0	6	35	0.16%	437,574	21	29	39	21	22	28	38	39
	SEDIMENTARY HORNFELS	26	120	0.79%	2,204,392	0	20	140	0.63%	1,752,797	2	29	71	9	13	23	46	71
	TROCTOLITIC	638	3,230	21.15%	59,232,497	0	389	3,619	16.16%	45,247,497	10	46	101	29	39	47	55	67
	ULTRAMAFIC	15	73	0.48%	1,338,774	0	27	100	0.45%	1,253,589	18	44	70	23	26	48	62	70
	VEIN	1	2	0.01%	36,679	0	0	2	0.01%	25,004	31	31	31	0	0	0	0	0
2	ANORTHOSITIC	7	35	0.23%	632,708	0	1	35	0.16%	440,935	38	46	52	38	41	49	50	52
	GABBROIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	41	41	41	0	0	0	0	0
	TROCTOLITIC	120	593	3.88%	10,875,246	0	371	964	4.30%	12,047,071	20	52	90	36	43	50	60	75
	ULTRAMAFIC	3	15	0.10%	275,091	0	5	20	0.09%	253,290	35	55	66	0	0	0	0	0
3	ANORTHOSITIC	8	37	0.24%	678,557	0	73	110	0.49%	1,377,093	18	44	81	18	25	46	52	81
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	29	29	29	0	0	0	0	0
	GABBROIC	5	22	0.14%	394,296	0	45	66	0.29%	825,936	29	35	42	29	30	35	39	42
	SEDIMENTARY HORNFELS	9	42	0.28%	770,254	0	0	42	0.19%	525,089	22	66	83	22	66	68	76	83
	TROCTOLITIC	78	380	2.49%	6,959,791	0	752	1,132	5.05%	14,150,401	23	44	85	35	39	43	49	60
	ULTRAMAFIC	2	7	0.04%	119,206	0	0	7	0.03%	81,264	47	66	85	0	0	0	0	0
4	ANORTHOSITIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	46	46	46	0	0	0	0	0
	SEDIMENTARY HORNFELS	1	5	0.03%	91,697	0	0	5	0.02%	62,511	26	26	26	0	0	0	0	0
	TROCTOLITIC	28	138	0.90%	2,530,833	0	62	200	0.89%	2,501,630	28	45	76	29	39	42	50	70
5	TROCTOLITIC	13	61	0.40%	1,118,702	0	124	185	0.83%	2,316,029	34	53	68	42	52	54	56	68
6	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	40	40	40	0	0	0	0	0
	TROCTOLITIC	1	14	0.09%	256,751	0	40	54	0.24%	672,114	42	42	42	0	0	0	0	0
	ULTRAMAFIC	1	10	0.07%	183,394	0	0	10	0.04%	125,021	59	59	59	0	0	0	0	0
20	TROCTOLITIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	22	28	33	22	25	29	32	33
	VIRGINIA	93	465	3.05%	8,527,807	0	481	946	4.22%	11,820,755	17	27	39	21	23	27	30	37
		Total	**5,469**	**36%**	**100,288,845**			**7,870**	**35%**	**98,388,647**	**2**	**45**	**101**	**25**	**36**	**45**	**54**	**69**

Adjm1 = footage adjustment for Not Sampled footage where Class, Unit and Rock Type defined

Adjm2 = footage adjustment for Not Sampled footage where only Unit and Rock Type defined (Not Sampled footage distributed between NON and REACT via same ratio as Sampled)

Figure 1-E PolyMet 20 Year Zinc - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

LEAN		Sampled				Adjm1	Adjm2	Adjusted			Zinc (PPM)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	15	90	0.59%	1,650,543	0	0	90	0.40%	1,125,191	32	69	99	56	58	74	76	99
	GABBROIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	48	78	102	48	54	92	96	102
	NORITIC	4	19	0.12%	339,278	0	0	19	0.08%	231,289	36	61	112	0	0	0	0	0
	SEDIMENTARY HORNFELS	19	81	0.53%	1,476,319	0	0	81	0.36%	1,006,421	38	73	236	38	46	54	88	236
	TROCTOLITIC	579	3,142	20.58%	57,613,131	0	0	3,142	14.03%	39,275,413	38	80	199	60	68	78	90	117
	ULTRAMAFIC	44	212	1.39%	3,887,946	0	0	212	0.95%	2,650,450	44	102	148	70	84	100	126	136
2	ANORTHOSITIC	5	23	0.15%	421,806	0	0	23	0.10%	287,549	60	72	88	60	64	70	78	88
	BASALT INCLUSION	1	5	0.03%	91,697	0	0	5	0.02%	62,511	30	30	30	0	0	0	0	0
	TROCTOLITIC	112	576	3.77%	10,563,477	0	0	576	2.57%	7,201,222	52	91	136	68	76	90	104	118
	ULTRAMAFIC	35	167	1.09%	3,053,505	0	0	167	0.74%	2,081,603	78	113	136	92	104	114	126	134
3	ANORTHOSITIC	10	49	0.32%	898,629	0	0	49	0.22%	612,604	42	56	80	44	44	54	62	80
	GABBROIC	1	6	0.04%	110,036	0	0	6	0.03%	75,013	66	66	66	0	0	0	0	0
	SEDIMENTARY HORNFELS	7	33	0.22%	605,199	0	0	33	0.15%	412,570	36	81	208	36	42	50	106	208
	TROCTOLITIC	33	160	1.05%	2,934,299	0	0	160	0.71%	2,000,339	12	64	118	36	48	64	86	102
	ULTRAMAFIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	108	109	110	0	0	0	0	0
4	TROCTOLITIC	9	47	0.30%	852,781	0	0	47	0.21%	581,349	52	70	90	52	56	78	80	90
5	TROCTOLITIC	14	103	0.67%	1,888,955	0	0	103	0.46%	1,287,718	56	65	74	56	60	66	70	74
6	ANORTHOSITIC	1	3	0.02%	55,018	0	0	3	0.01%	37,506	64	64	64	0	0	0	0	0
	CHLORITE	1	5	0.03%	91,697	0	0	5	0.02%	62,511	106	106	106	0	0	0	0	0
	TROCTOLITIC	6	30	0.20%	550,181	0	0	30	0.13%	375,064	60	79	104	60	64	80	92	104
7	ULTRAMAFIC	4	21	0.14%	385,127	0	0	21	0.09%	262,545	70	101	112	0	0	0	0	0
20	VIRGINIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	104	104	104	0	0	0	0	0
		Total	**4,810**	**32%**	**88,203,200**			**4,810**	**21%**	**60,128,950**	**12**	**82**	**236**	**56**	**68**	**79**	**96**	**122**

Figure 1-E PolyMet 20 Year Zinc - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

NON		Sampled				Adjm1	Adjm2	Adjusted			Zinc (PPM)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	10	50	0.33%	916,969	0	2	52	0.23%	652,483	50	71	90	60	60	68	86	90
	TROCTOLITIC	278	1,382	9.05%	25,345,009	0	167	1,549	6.91%	19,360,964	34	74	116	58	65	72	84	102
	ULTRAMAFIC	3	14	0.09%	256,751	0	5	19	0.09%	240,414	94	99	110	0	0	0	0	0
	VEIN	2	5	0.03%	91,697	0	0	5	0.02%	62,511	18	26	34	0	0	0	0	0
2	ANORTHOSITIC	30	145	0.95%	2,659,209	0	3	148	0.66%	1,853,204	44	58	92	46	48	56	68	78
	BASALT INCLUSION	4	17	0.11%	311,769	0	0	17	0.08%	212,536	14	28	44	0	0	0	0	0
	TROCTOLITIC	208	1,030	6.74%	18,880,381	0	643	1,673	7.47%	20,914,771	24	77	112	58	68	78	87	100
	ULTRAMAFIC	5	24	0.15%	430,975	0	8	32	0.14%	396,821	64	90	116	64	78	80	112	116
3	ANORTHOSITIC	58	289	1.89%	5,300,078	0	571	860	3.84%	10,756,215	36	54	80	44	50	54	58	64
	GABBROIC	1	6	0.04%	110,036	0	12	18	0.08%	230,494	74	74	74	0	0	0	0	0
	NORITIC	2	10	0.07%	183,394	0	0	10	0.04%	125,021	64	71	78	0	0	0	0	0
	SEDIMENTARY HORNFELS	7	35	0.23%	641,878	0	0	35	0.16%	437,574	20	40	62	20	28	42	48	62
	TROCTOLITIC	251	1,245	8.15%	22,823,346	0	2,467	3,712	16.57%	46,403,621	26	61	106	44	50	60	70	90
	ULTRAMAFIC	5	22	0.14%	403,466	0	0	22	0.10%	275,047	54	71	96	54	60	60	86	96
4	ANORTHOSITIC	3	15	0.10%	275,091	0	0	15	0.07%	187,532	40	55	64	0	0	0	0	0
	TROCTOLITIC	88	439	2.87%	8,045,482	0	197	636	2.84%	7,952,644	34	59	90	48	54	58	64	76
	VEIN	1	3	0.02%	55,018	0	2	5	0.02%	62,511	32	32	32	0	0	0	0	0
5	TROCTOLITIC	15	75	0.49%	1,366,283	0	152	226	1.01%	2,828,593	52	64	90	54	56	58	76	90
6	CHLORITE	3	15	0.10%	275,091	0	0	15	0.07%	187,532	76	87	94	0	0	0	0	0
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	68	68	68	0	0	0	0	0
	TROCTOLITIC	34	161	1.05%	2,952,639	0	457	618	2.76%	7,729,311	52	71	98	58	60	66	80	96
7	ULTRAMAFIC	1	5	0.03%	91,697	0	19	24	0.11%	300,051	112	112	112	0	0	0	0	0
		Total	**4,990**	**33%**	**91,507,955**			**9,697**	**43%**	**121,232,360**	**14**	**68**	**116**	**48**	**56**	**66**	**80**	**96**

Figure 1-E PolyMet 20 Year Zinc - Waste Rock

Total Waste Tons (based on 32,000 tpd and 1.2 SR) = 280,000,000

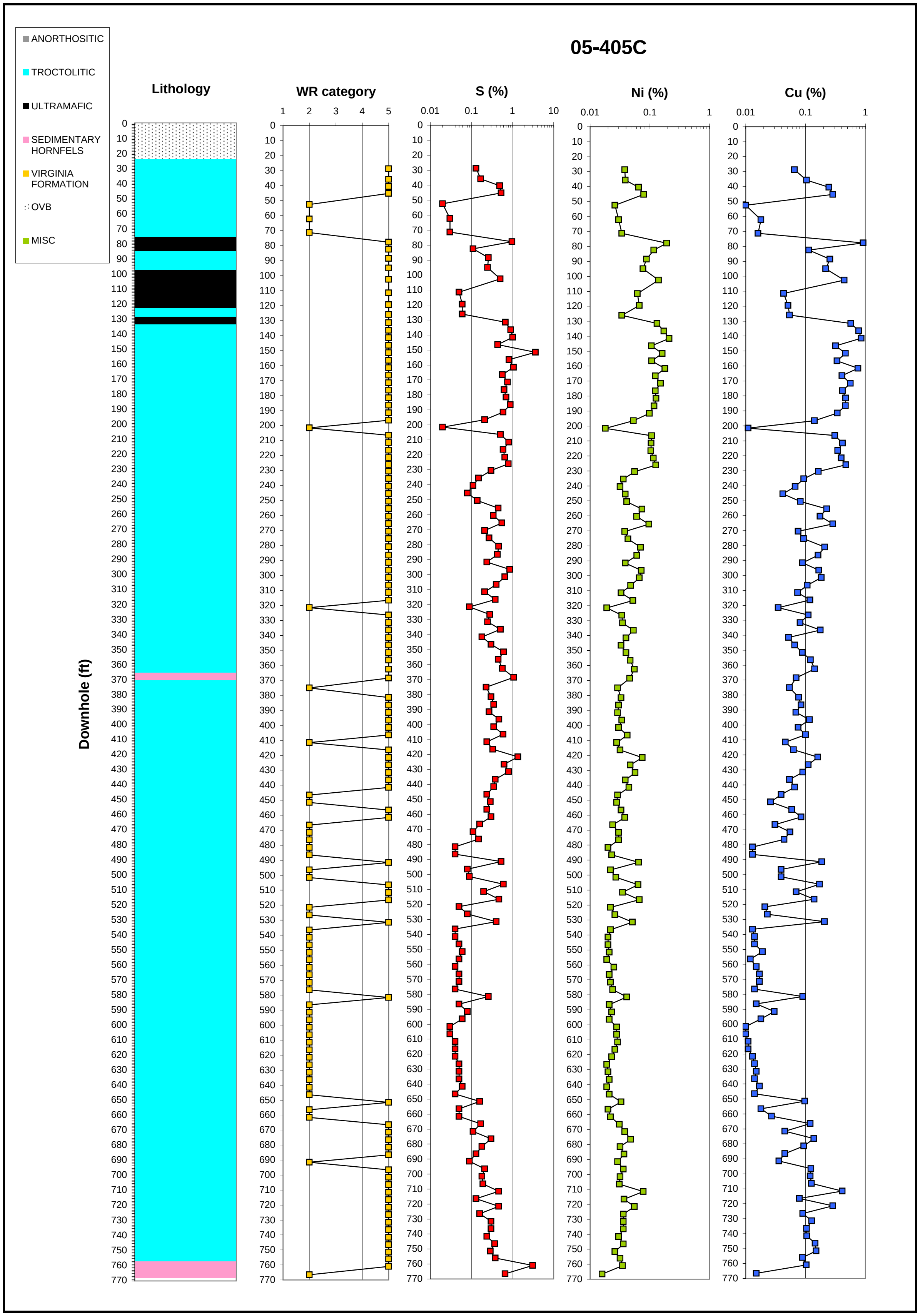
REACT		Sampled				Adjm1	Adjm2	Adjusted			Zinc (PPM)							
Unit	Rock Type	#	Ft	%	Tons	Ft	Ft	Ft	%	Tons	Min	Avg	Max	P10	P25	P50	P75	P95
1	ANORTHOSITIC	18	87	0.57%	1,595,525	0	4	91	0.41%	1,135,320	38	64	80	48	60	64	70	80
	GABBROIC	12	60	0.39%	1,100,362	0	2	62	0.28%	775,131	74	89	101	78	87	90	94	101
	NORITIC	6	30	0.19%	541,011	0	6	35	0.16%	437,574	18	58	150	18	20	50	70	150
	SEDIMENTARY HORNFELS	26	120	0.79%	2,204,392	0	20	140	0.63%	1,752,797	26	82	176	42	50	82	100	170
	TROCTOLITIC	638	3,230	21.15%	59,232,497	0	389	3,619	16.16%	45,247,497	20	76	164	57	66	74	86	103
	ULTRAMAFIC	15	73	0.48%	1,338,774	0	27	100	0.45%	1,253,589	38	95	178	50	70	92	102	178
	VEIN	1	2	0.01%	36,679	0	0	2	0.01%	25,004	62	62	62	0	0	0	0	0
2	ANORTHOSITIC	7	35	0.23%	632,708	0	1	35	0.16%	440,935	58	76	98	58	62	70	92	98
	GABBROIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	86	86	86	0	0	0	0	0
	TROCTOLITIC	120	593	3.88%	10,875,246	0	371	964	4.30%	12,047,071	44	82	122	62	72	80	94	106
	ULTRAMAFIC	3	15	0.10%	275,091	0	5	20	0.09%	253,290	58	86	110	0	0	0	0	0
3	ANORTHOSITIC	8	37	0.24%	678,557	0	73	110	0.49%	1,377,093	54	66	78	54	56	68	70	78
	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	16	16	16	0	0	0	0	0
	GABBROIC	5	22	0.14%	394,296	0	45	66	0.29%	825,936	50	61	72	50	56	62	66	72
	SEDIMENTARY HORNFELS	9	42	0.28%	770,254	0	0	42	0.19%	525,089	22	59	86	22	40	50	82	86
	TROCTOLITIC	78	380	2.49%	6,959,791	0	752	1,132	5.05%	14,150,401	30	67	100	46	56	68	80	96
	ULTRAMAFIC	2	7	0.04%	119,206	0	0	7	0.03%	81,264	96	122	148	0	0	0	0	0
4	ANORTHOSITIC	1	5	0.03%	91,697	0	0	5	0.02%	62,511	70	70	70	0	0	0	0	0
	SEDIMENTARY HORNFELS	1	5	0.03%	91,697	0	0	5	0.02%	62,511	116	116	116	0	0	0	0	0
	TROCTOLITIC	28	138	0.90%	2,530,833	0	62	200	0.89%	2,501,630	32	66	106	48	54	64	72	96
5	TROCTOLITIC	13	61	0.40%	1,118,702	0	124	185	0.83%	2,316,029	48	69	116	58	62	64	72	116
6	FAULT-BRECCIA	1	5	0.03%	91,697	0	0	5	0.02%	62,511	66	66	66	0	0	0	0	0
	TROCTOLITIC	1	14	0.09%	256,751	0	40	54	0.24%	672,114	67	67	67	0	0	0	0	0
	ULTRAMAFIC	1	10	0.07%	183,394	0	0	10	0.04%	125,021	90	90	90	0	0	0	0	0
20	TROCTOLITIC	5	25	0.16%	458,484	0	0	25	0.11%	312,553	134	338	526	134	217	405	410	526
	VIRGINIA	93	465	3.05%	8,527,807	0	481	946	4.22%	11,820,755	51	299	898	80	149	243	390	744
		Total	**5,469**	**36%**	**100,288,845**			**7,870**	**35%**	**98,388,647**	**16**	**96**	**898**	**54**	**66**	**76**	**90**	**204**

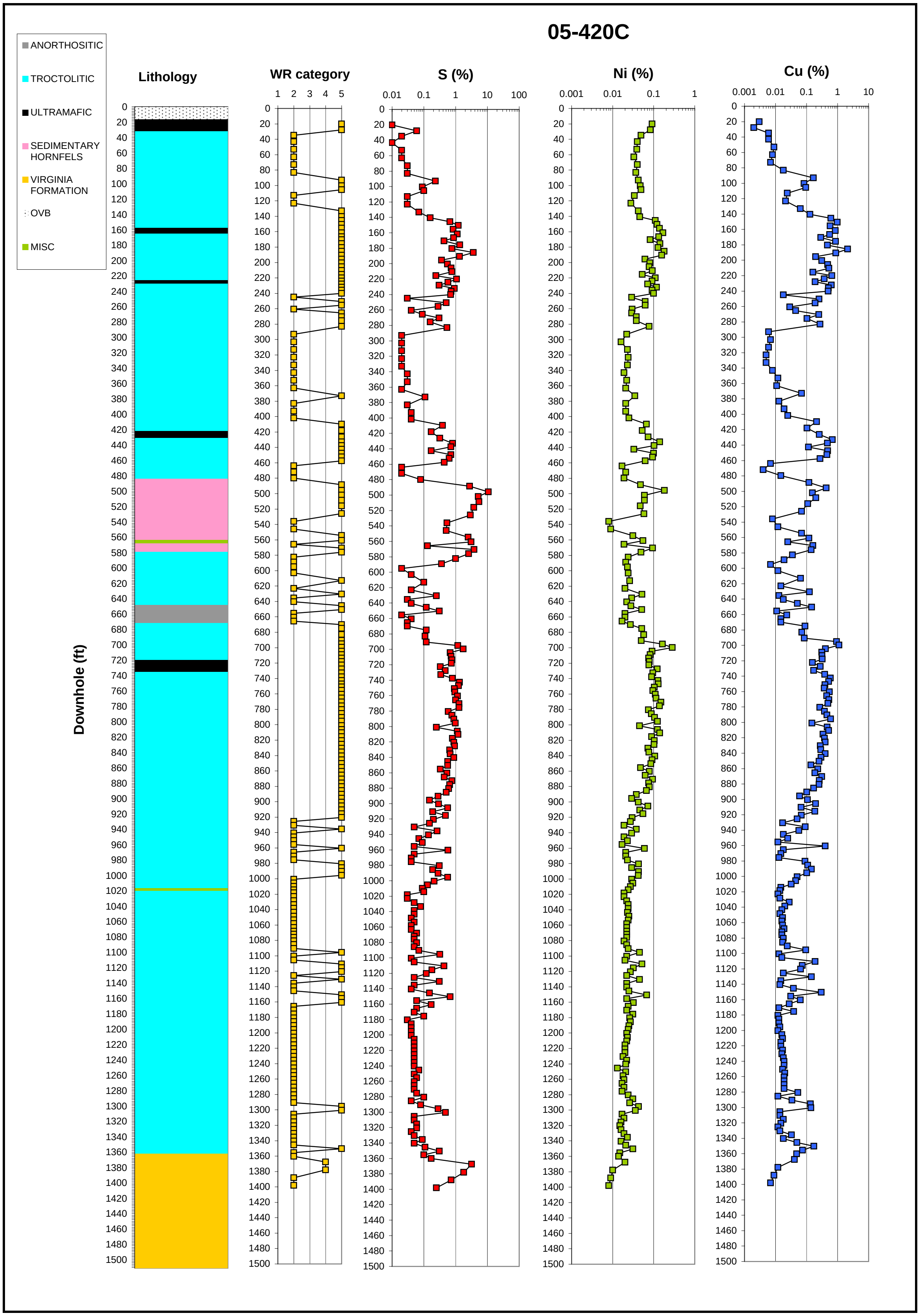
Adjm1 = footage adjustment for Not Sampled footage where Class, Unit and Rock Type defined

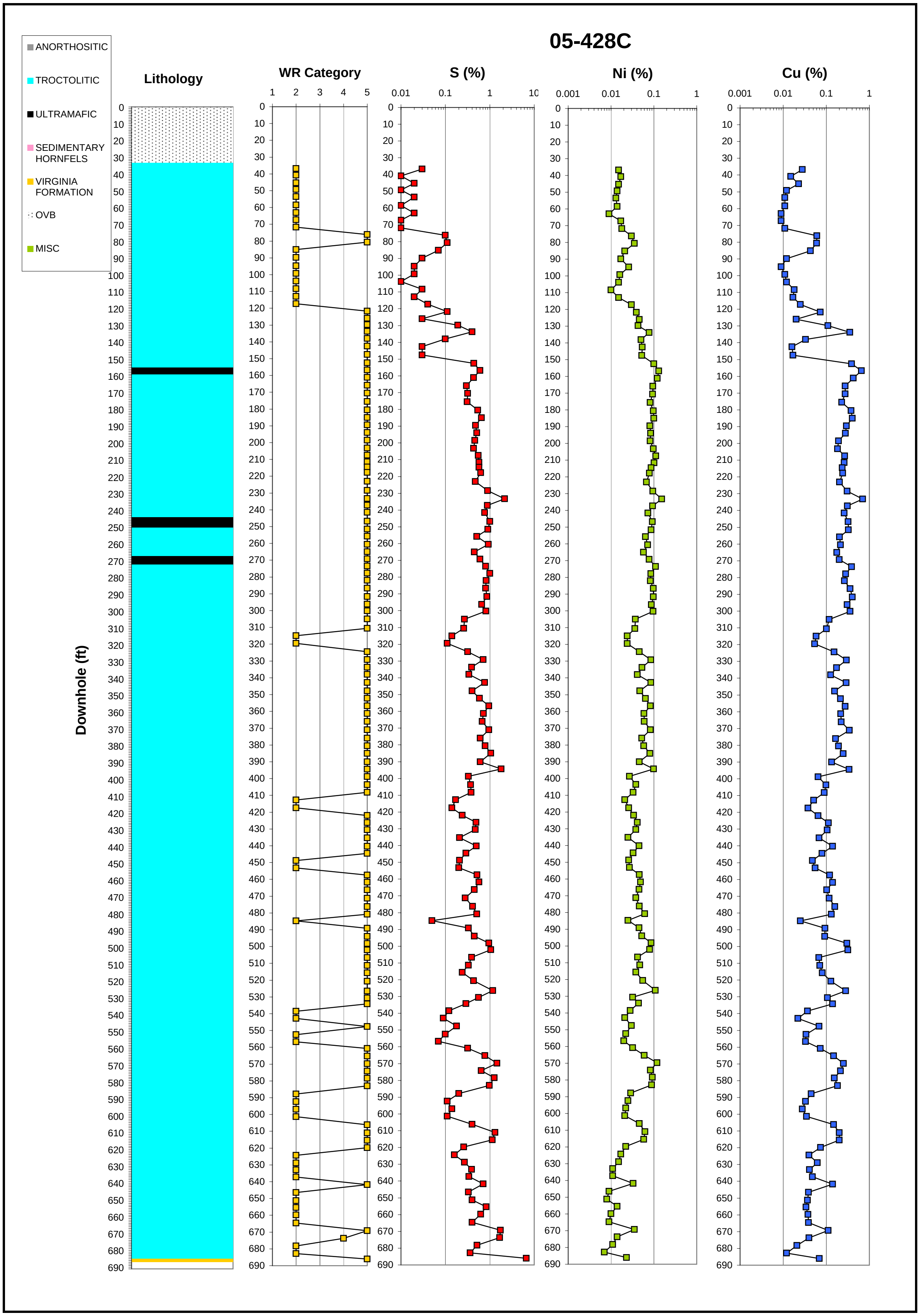
Adjm2 = footage adjustment for Not Sampled footage where only Unit and Rock Type defined (Not Sampled footage distributed between NON and REACT via same ratio as Sampled)

Appendix C.2

Downhole Plots


05-405C
ANORTHOSITIC
TROCTOLITIC
ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
Lithology
WR category
S (%)
Ni (%)
Cu (%)
Downhole (ft)


05-420C
ANORTHOSITIC
TROCTOLITIC
ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
Lithology
WR category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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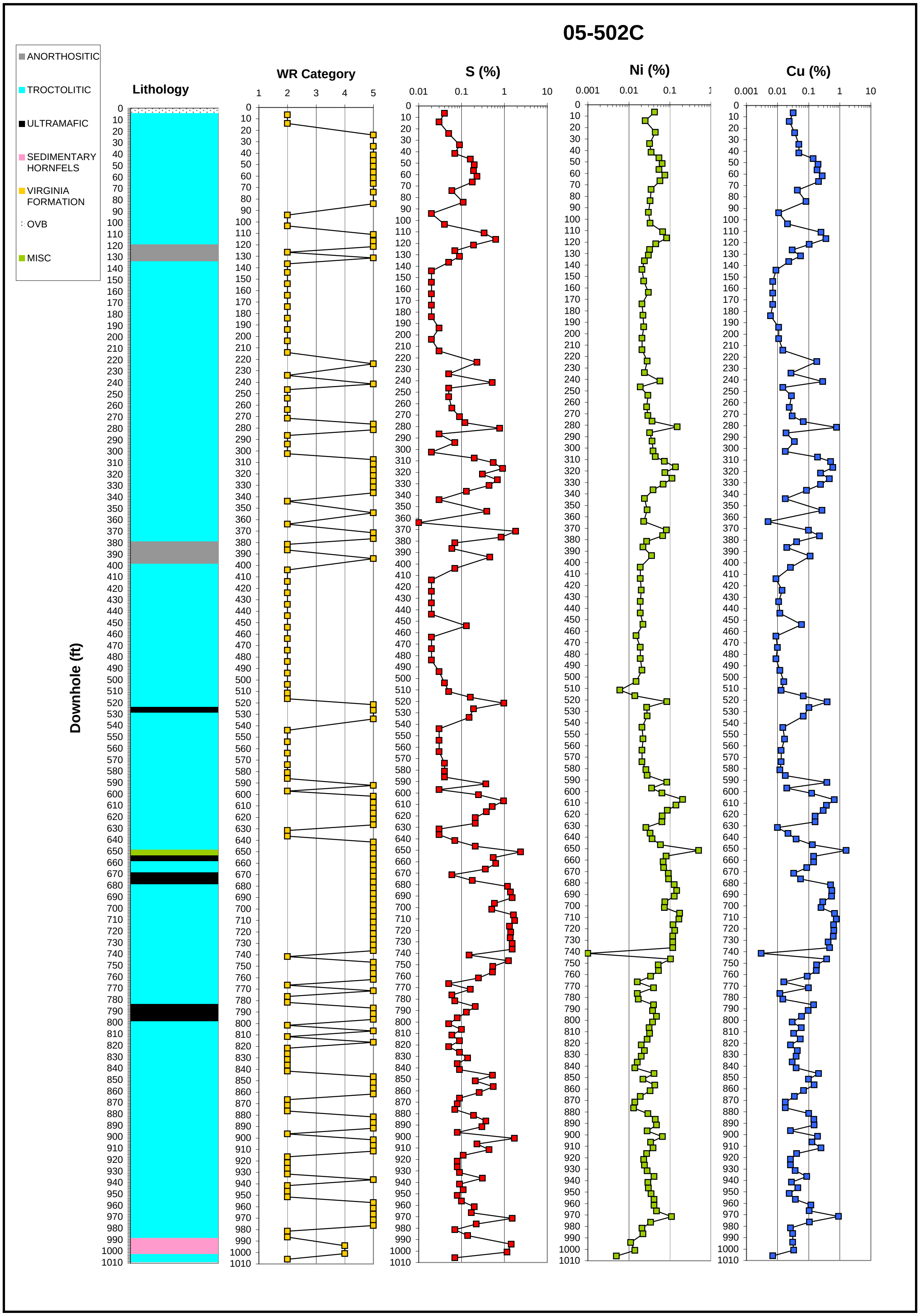
TROCTOLITIC
ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
Lithology
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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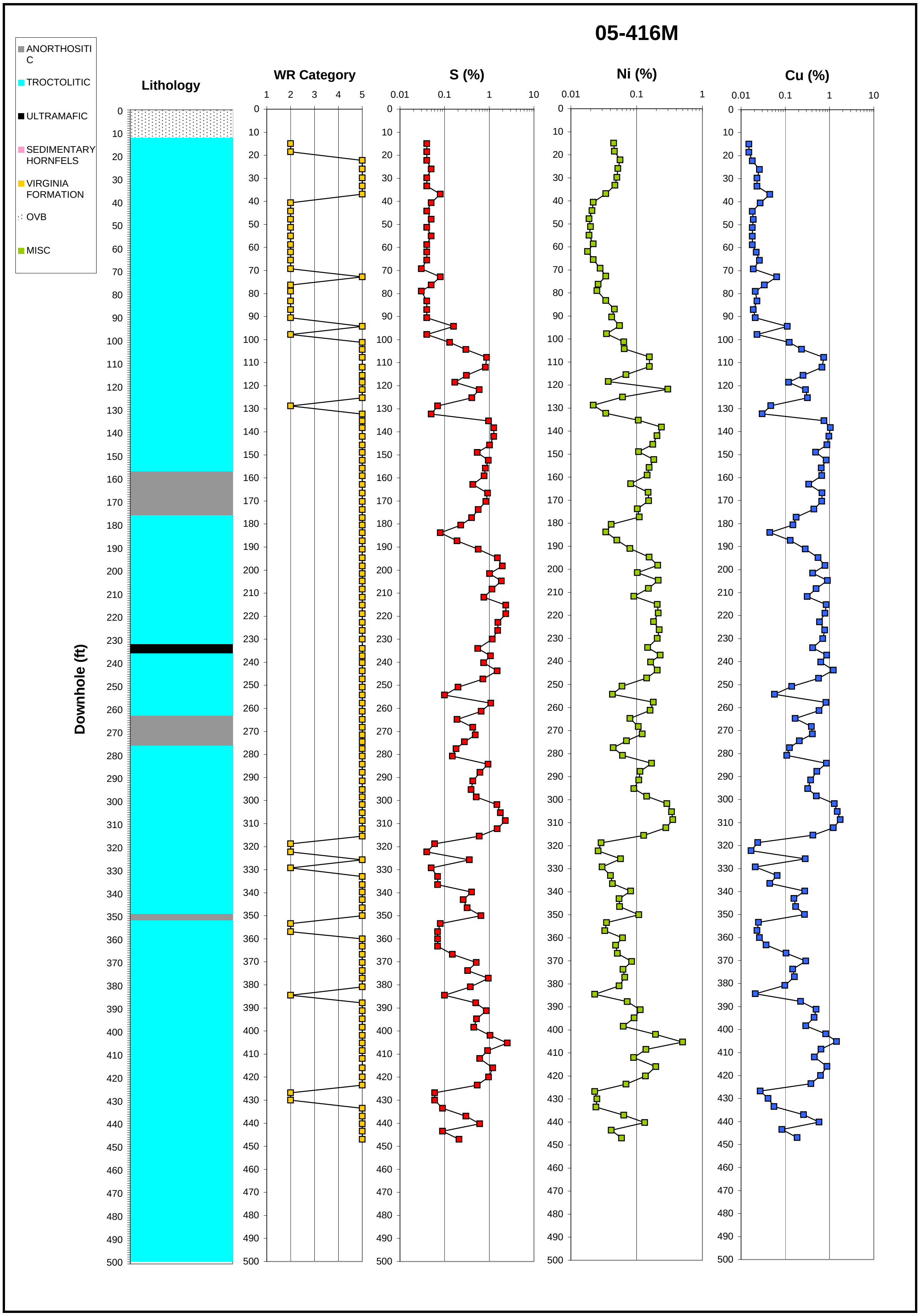
OVB
MISC
Lithology
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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ULTRAMAFIC
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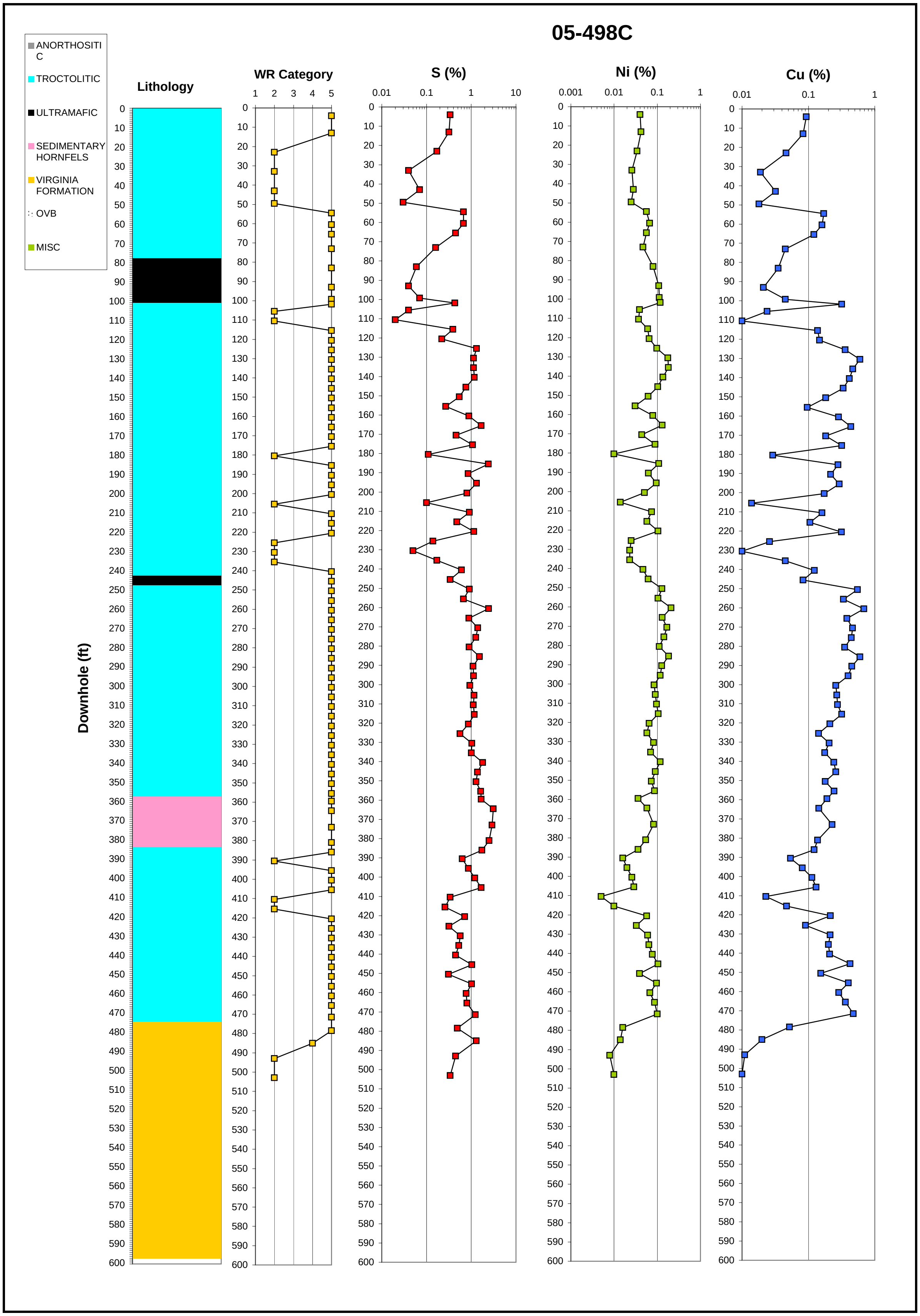
OVB
MISC
Lithology
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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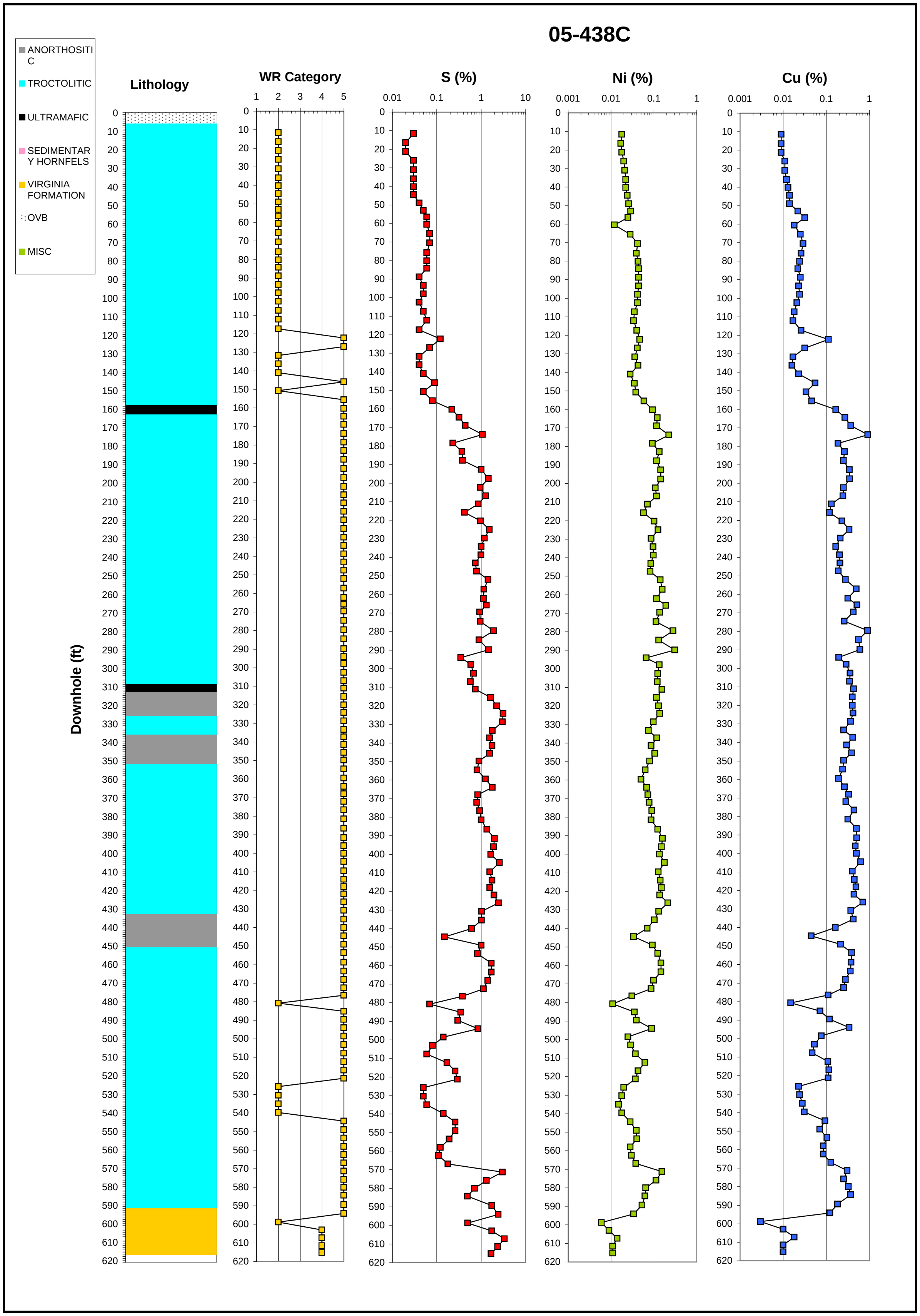
OVB
MISC
Lithology
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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ULTRAMAFIC
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OVB
MISC
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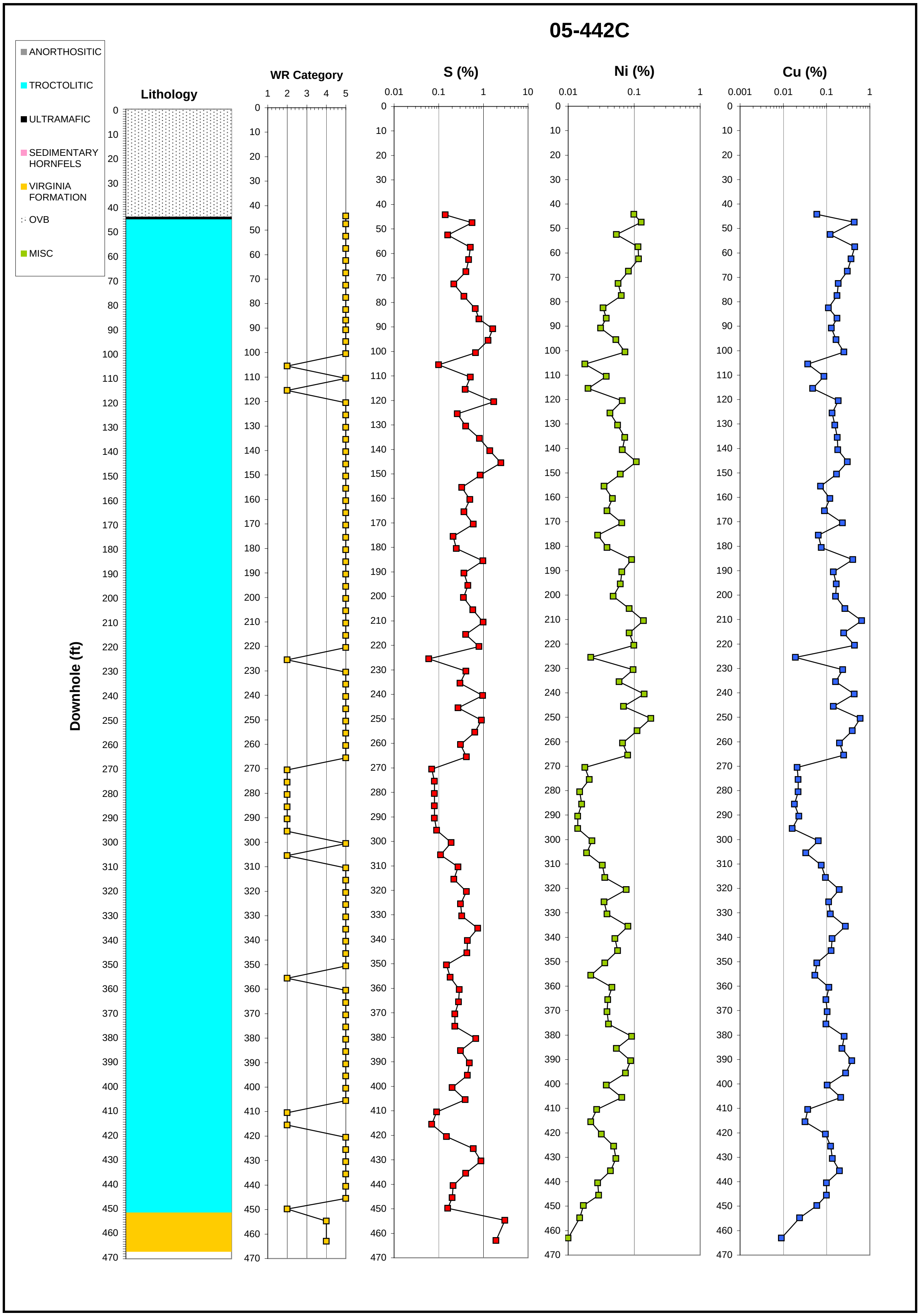
Ni (%)
Cu (%)
Downhole (ft)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ULTRAMAFIC
SEDIMENTARY HORNFELS
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OVB
MISC
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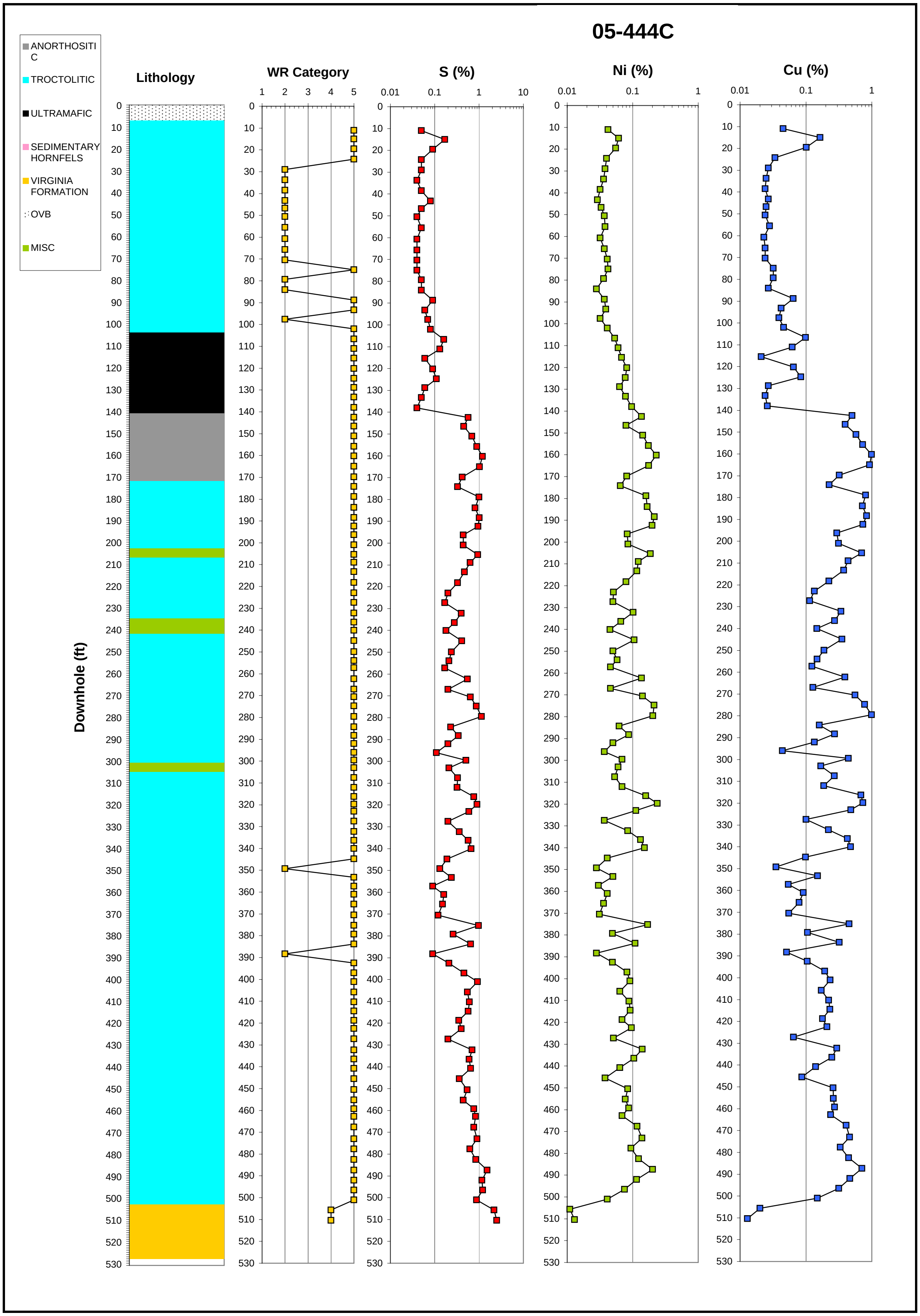
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
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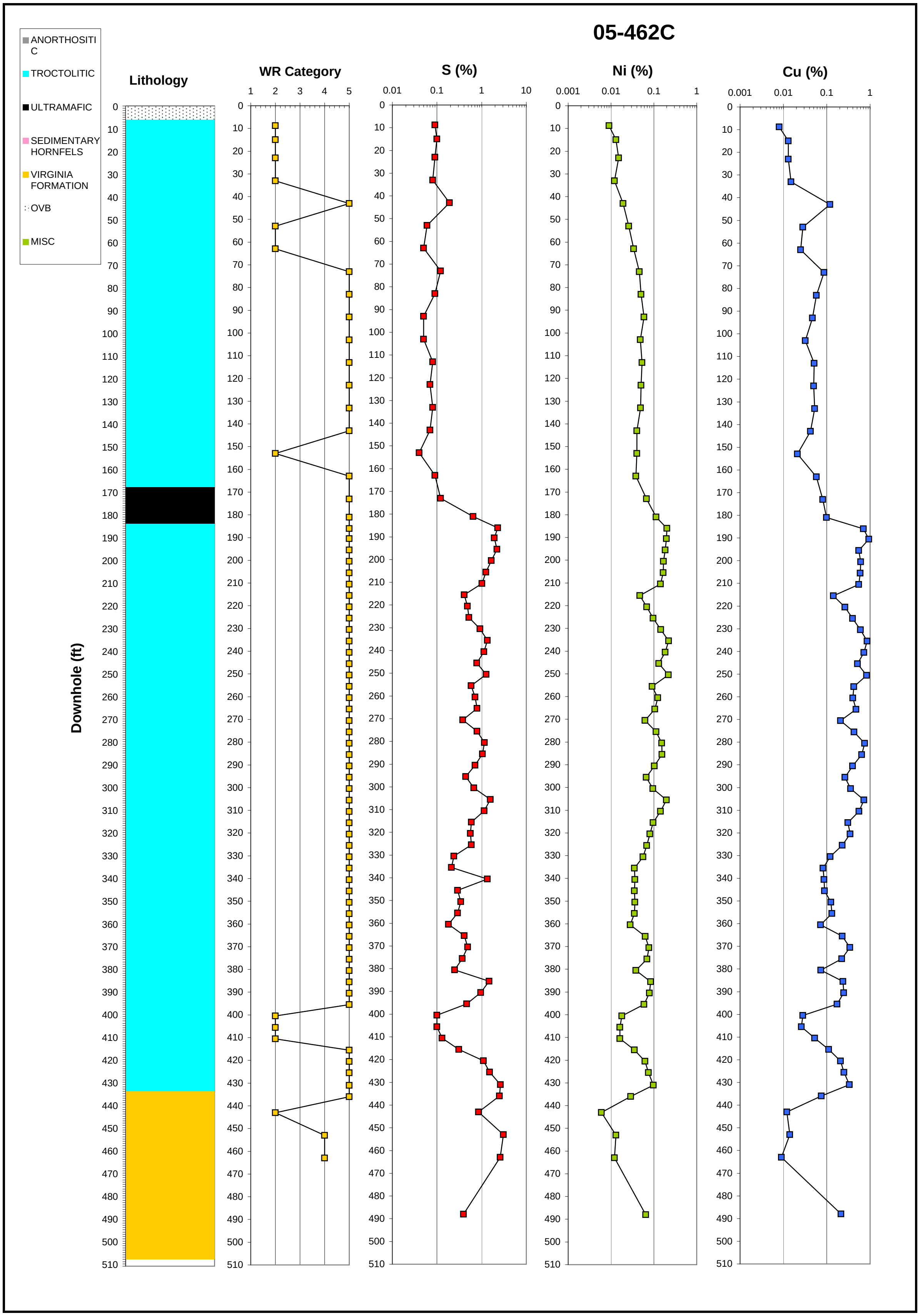
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
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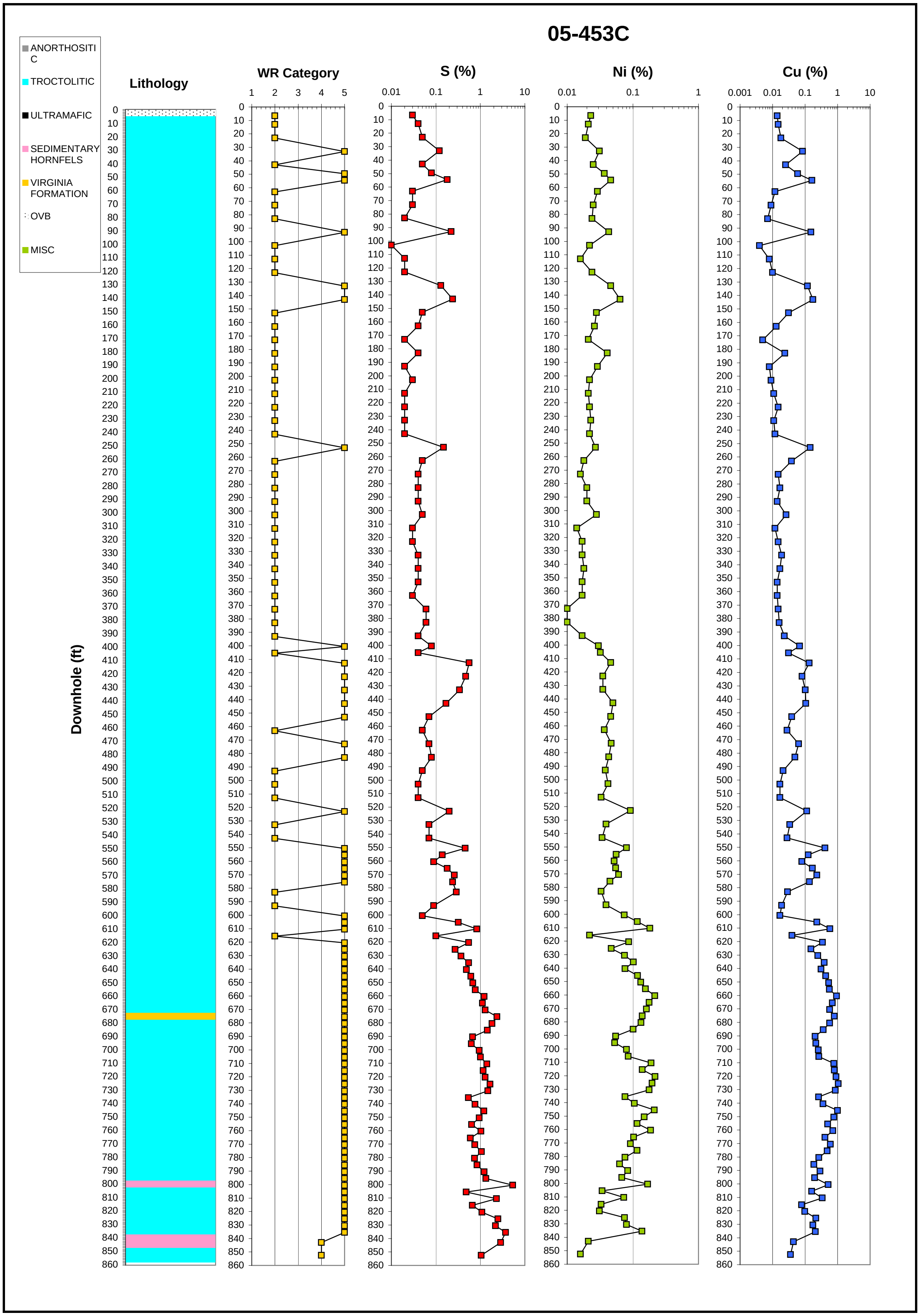
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)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TROCTOLITIC
ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
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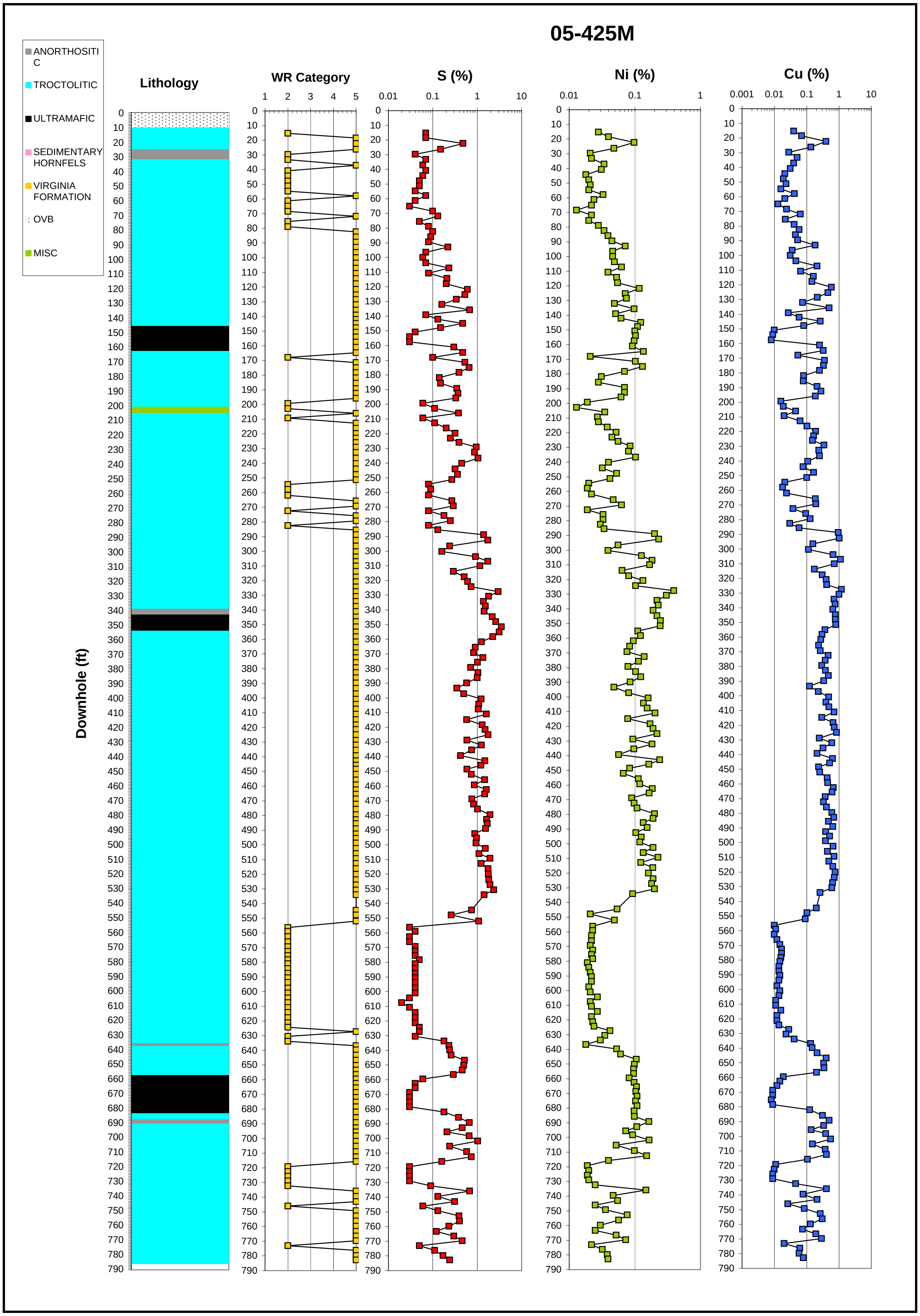
Ni (%)
Cu (%)
Downhole (ft)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TROCTOLITIC
ULTRAMAFIC
SEDIMENTARY HORNFELS
VIRGINIA FORMATION
OVB
MISC
Lithology
WR Category
S (%)
Ni (%)
Cu (%)
Downhole (ft)

Appendix D

Characterization of Rock Samples Used for Dissolution Testwork

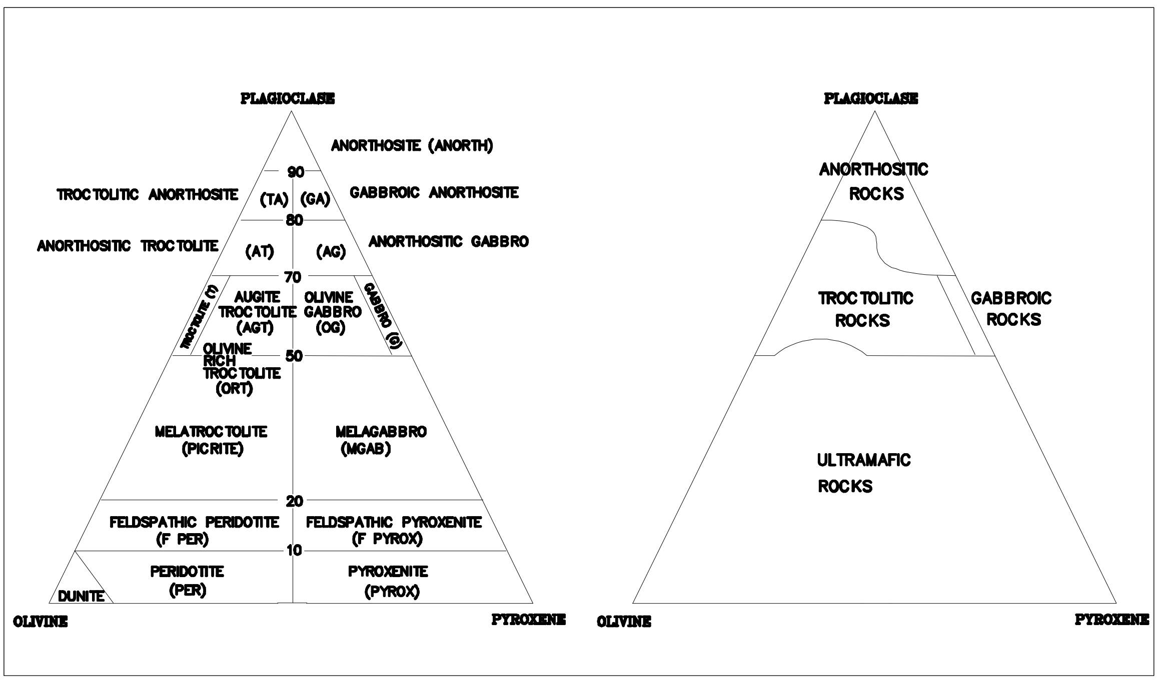
Appendix D.1

Optical Mineralogy Report

(Produced by PolyMet)

SUMMARY OF PETROGRAPHIC OBSERVATIONS
FOR WASTE ROCK CHARACTERIZATION

As part of Polymet's waste rock characterization, total of 91 intervals ranging from 5 to 20 feet in length were selected to represent a variety of rock types, sulfur/metals ranges, and stratigraphic units within the NorthMet Deposit. Petrographic observations were recorded from a representative polished thin-section from each of the intervals, including; mineral identification, estimated modal percents, crystal shape/grain size/textural characteristics, and the subsequent assigning of a rock name. It is important to note, however, that the rock name assigned to the polished thin-section (based on estimated modal percents of plagioclase, olivine and pyroxene) may not be the same as that assigned to the entire interval, due to a difference in just a few modal percent of any one of the three minerals and the fact that this was derived from a one-square inch representative of rock (see Phinney's diagram below). Approximately 90% of the petrographic-derived rock names do nevertheless match that assigned to the core interval. All data is included in an Excel spreadsheet.



Rock classification scheme (after Phinney, 1972)

In addition to the raw data presented in the accompanying Excel spreadsheet, a number of broad generalizations are included below:

- In general, approximately 90% of the rocks are classified as adcumulates, with plagioclase and olivine occurring as the two main cumulate phases. Pyroxenes often occur interstitially as ophitic or reactionary textures. Minor accessory minerals include; biotite, apatite and trace zircon, as interstitial or inclusions within the major silicate phases. Secondary silicates associated with alteration occur rarely and include; amphibole, carbonates (calcite), epidote, and potassium feldspar.

- Overall, the vast majority of rock (>90%) is unaltered. Where alteration is present, it ranges from weak to moderate, and is usually limited to microfractures (0.01-0.1mm wide) that cross-cut mineralogy. This pattern suggests that both fracturing and accompanying alteration of the rock occur as a result of the migration of late-stage deuteric fluids during the cooling phase. Alterations commonly observed include; chloritization/serpentinization of olivine, sericitization/saussuritization of plagioclase, and uralitization of pyroxenes. Less than 2% of the rock displays wide spread alteration, ranging from moderate to strongly altered, where most of the primary minerals have been replaced by secondary mineralization.

- Also observed in some of the more wide spread alteration, is anhedral aggregates and microveinlet in-fill, of pyrrhotite and chalcopyrite within microfractures that cross-cut altered silicate mineralogy. Inclusions of secondary sulfide mineralization, mostly occurring as tiny (<0.005mm), euhedral/subhedral grains, of chalcopyrite, pentlandite, and pyrrhotite, were observed in some altered mafic silicates (olivine and pyroxene). Minute amounts of copper-enriched sulfides including, bornite, covellite, digenite, and chalcocite, were also present in some of these zones. The locally remobilized and enriched sulfides associated with alteration, represent only a few percent of the total sulfide mineralization present.

- Approximately 95-98% of the sulfide mineralization (usually larger grain size, >0.1mm) are interstitial between cumulate silicate mineralogy (plagioclase and olivine). This also includes sulfides included in interstitial silicates such as pyroxenes and micas. The remaining 2-5% of sulfides occur as inclusions (generally <0.1mm) in silicates, microveinlets in microfractures, and as secondary remobilized scraps in altered silicates.

- The ratio of pyrrhotite to chalcopyrite varies depending on the stratigraphic unit. Within the basal unit 1, the pyrrhotite to chalcopyrite ratio increases noticeably toward the basal contact with the Virginia Formation and the contact with sedimentary inclusion. However, above unit 3 the amount of pyrrhotite present drops substantially.

- Oxide mineralogy is similar to that of sulfide mineralogy, where nearly 99% is interstitial to cumulate silicate mineralogy. The remaining percent or two is observed as inclusions in silicates, and as secondary magnetite as a result of serpentinization of olivine. The latter, occur as anhedral collections or in-fill in microfractures in or adjacent to altered olivine.

Unit	Rock Type	S Percentile	#	Sulfur Range			Selected Interval				Weighted Average Characteristics					Individual petrographic section footages	Individual petrographic section footages		Petrographic Section Observed	Petrographic Observations: Modal Percentages of Minerals																							Percent Check
				Low	From Table 1	High	DDH	From	To	Length	S	Ni	Co	Cu	Zn					Plagioclase	Olivine	K-spar	Quartz	Cordierite	OPX	CPX	Amphibole	Biotite	White Mica	Chlorite	Clay minerals	Serpentine	Uralite	Epidote	Apatite	Zircon	Rutile	Graphite	Carbonates	Vesuvianite/ Idocrase	Oxides	Sulfides	
				%	%	%		Feet	Feet	Feet	%	%	mg/kg	%	mg/kg																												
1	Anorthositic	P25	1	0.09	0.1	0.125	99-320C	830	850	20	0.12	0.015	35.8	0.035	72	833	841		833	78.0	15.0				1.0	4.0		0.5		tr					tr						1.5	tr	100
1	Anorthositic	P50	2	0.125	0.15	0.22	00-361C	310	320	10	0.16	0.018	36.0	0.013	51	311	316		311	75.0	20.0					3.0		1.0							rare						1.0	tr	100
1	Anorthositic	P75	3	0.22	0.29	0.36	00-361C	345	350	5	0.33	0.026	53.0	0.038	68	347	349		347	82.0	16.0				tr	2.0		tr	tr	tr					tr						tr	tr	100
1	Anorthositic	P95	4		1.09	1.09	00-343C	240	250	10	0.67	0.020	38.0	0.069	69	241	249		241	65.0	5.0				8.0	6.0		tr	tr	10.0	tr				1.5				tr		2.0	2.5	100
1	Sedimentary Hornfels	P10	5	0.08	0.08	0.215	26030	1047	1052	5	0.17	0.006	10.0	0.006	34	1048	1050		1050			10.0				48.0			10.0									1.0	25.0	5.0		1.0	100
1	Sedimentary Hornfels	P25	6	0.215	0.35	0.52	26061	1218	1233	15	0.43	0.011	19.3	0.012	193	1220	1231		1231			55.0		5.0				5.0	30.0									2.0			1.0	2.0	100
1	Sedimentary Hornfels	P50	7	0.52	0.69	1.445	00-340C	990	995	10	0.62	0.012	24.0	0.031	148	991	994		994			25.0	30.0			30.0		0.5		10.0		tr						1.0			2.0	1.5	100
1	Sedimentary Hornfels	P75	8	1.445	2.2	2.26	00-340C	965	974.5	15	1.49	0.015	23.7	0.031	249	966	972		966			10.0		65.0				10.0	tr		tr				tr			5.0			tr	10.0	100
1	Sedimentary Hornfels	P85	9	2.565	2.81	3.095	26043	1501	1506	5	2.76	0.024	36.0	0.037	344	1502	1505		1505	tr		25.0		45.0	20.0			2.0	tr		tr							3.0			1.0	4.0	100
1	Sedimentary Hornfels	P85(a)	9(a)	2.565	2.81	3.095	26027	740	745	5	2.59	0.035	67.0	0.051	48	741	744		741			30.0		40.0	20.0			2.0										1.0			3.0	4.0	100
1	Troctolitic	P1	10	0.01	0.01	0.02	00-368C	565	570	5	0.01	0.013	25.0	0.021	52	566	569		569	30.0						8.0		1.0	25.0	25.0	tr	5.0		5.0	tr						1.0	tr	100
1	Troctolitic	P1	10(a)	0.01	0.01	0.02	26098	247	255	8	0.01	0.015	24.0	0.006	37	248	254		248	52.0	38.0				1.0	5.0		1.0		tr		tr			tr						3.0	tr	100
1	Troctolitic	P1	10(b)	0.01	0.01	0.02	26029	815	825	10	0.01	0.014	30.0	0.007	43	816	824		824	68.0	24.0					6.0		0.5		tr	tr				tr						1.5	tr	100
1	Troctolitic	P1	10(c)	0.01	0.01	0.02	26017	433	443	10	0.01	0.016	32.0	0.011	46	435	442		435	68.0	28.0				1.0	2.5		0.5	tr	tr					tr						tr	tr	100
1	Troctolitic	P2	11	0.02	0.03	0.04	00-340C	595	615	20	0.03	0.025	49.8	0.013	71	596	613		596	60.0	10.0				1.0	25.0		1.0	tr	tr					1.0						2.0	tr	100
1	Troctolitic	P3	12	0.04	0.05	0.05	00-334C	580	600	20	0.05	0.024	52.0	0.024	83	589	598		598	58.0	32.0				tr	6.0		2.0							tr						2.0	tr	100
1	Troctolitic	P25	13	0.065	0.07	0.085	00-334C	640	660	20	0.08	0.038	63.8	0.024	102	642	657		642	55.0	30.0					6.0		2.0	tr	1.0		2.0			tr						4.0	tr	100
1	Troctolitic	P50	14	0.085	0.1	0.14	00-347C	795	815	20	0.09	0.034	70.8	0.035	94	798	812		798	55.0	35.0					6.0		2.0							tr						2.0	tr	100
1	Troctolitic	P80	15	0.195	0.21	0.235	00-350C	580	600	20	0.22	0.027	55.5	0.041	115	582	591		582	55.0	30.0				tr	8.0		2.0	tr	tr	tr	tr			tr						5.0	tr	100
1	Troctolitic	P90	16	0.3	0.34	0.48	00-327C	225	245	20	0.44	0.015	50.5	0.032	73	226	242		242	50.0	40.0				3.0	4.0		1.0	tr	tr	tr		tr		0.5				tr		1.0	0.5	100
1	Troctolitic	P95	17	0.48	0.62	1.295	00-371C	435	440	5	0.65	0.014	32.0	0.036	54	436	438		436	60.0			tr		32.0	1.0		tr	tr	tr					2.0	tr	tr				5.0	tr	100
1	Troctolitic	P100	18	1.295	1.97	1.97	00-340C	765	780	15	1.72	0.022	78.0	0.064	69	771	778		778	60.0	25.0					5.0		2.0	tr	tr	tr				tr						5.0	3.0	100
1	Ultramafic	P25	19	0.075	0.08	0.09	00-357C	335	340	5	0.08	0.015	35.0	0.026	68	337	338		338		3.0	25.0				12.0			3.0	25.0	3.0	5.0		12.0	2.0	tr			2.0		8.0	tr	100
1	Ultramafic	P80	20	0.165	0.2	0.25	00-326C	680	685	5	0.21	0.016	33.0	0.085	82	680	684		684	45.0	30.0					15.0		1.0	tr	tr		tr			1.0						3.0	5.0	100
1	Ultramafic	P85	21	0.25	0.3	0.4	00-357C	535	540	5	0.26	0.026	34.0	0.095	62	536	539		536	45.0	20.0				3.0	25.0		2.0	tr	1.0					1.0						3.0	tr	100
1	Ultramafic	P90	22	0.4	0.5	0.925	99-318C	725	735	10	0.44	0.011	23.0	0.032	45	728	735		735	55.0	20.0	8.0			15.0	tr		1.0	tr		tr				tr	rare					1.0	tr	100
1	Ultramafic	P95	23	0.925	1.35	1.35	99-317C	460	470	10	1.10	0.018	33.0	0.056	86	462	465		462	45.0	15.0				5.0	30.0		3.0	tr	tr					tr						2.0	tr	100
2	Anorthositic	P1	24	0.01	0.01	0.02	00-366C	185	205	20	0.01	0.018	35.0	0.008	47	187	204		187	88.0	3.0				1.0	5.0		tr							tr	tr					3.0	tr	100
2	Anorthositic	P2	25	0.02	0.03	0.04	00-366C	230	240	10	0.02	0.014	32.0	0.011	51	231	239		239	88.0	8.0				1.0	2.0		tr							tr						1.0	tr	100
2	Anorthositic	P3	26	0.04	0.05	0.05	99-320C	165	175	10	0.04	0.023	46.0	0.012	63	167	172		172	85.0	tr					12.0		tr			tr				1.0						2.0	tr	100
2	Troctolitic	P1	27	0.01	0.01	0.02	99-318C	250	270	20	0.02	0.022	42.3	0.011	64	257	267		267	60.0	34.0				tr	4.0		tr		tr		tr			tr						2.0	tr	100
2	Troctolitic	P2	28	0.02	0.03	0.04	00-373C	95	115	20	0.03	0.036	64.0	0.019	84	99	114		99	65.0	30.0				1.0	2.0		1.0	tr	tr		tr			tr						1.0	tr	100
2	Troctolitic	P3	29	0.04	0.05	0.05	00-373C	75	95	20	0.05	0.031	55.3	0.020	75	78	93		93	60.0	35.0				tr	3.0		0.5	tr	tr		tr			tr						1.5	tr	100
2	Troctolitic	P50	30	0.065	0.07	0.08	00-357C	110	130	20	0.07	0.024	53.5	0.029	88	112	126		112	54.0	40.0				tr	4.0		0.5							rare						1.5	tr	100
2	Troctolitic	P80	31	0.09	0.09	0.095	99-320C	315	330	15	0.09	0.017	39.3	0.026	65	319	328		319	65.0	26.0				tr	3.0		1.0		tr					tr						1.0	4.0	100
2	Troctolitic	P95	32	0.115	0.12	0.185	00-369C	335	345	10	0.16	0.021	43.0	0.046	68	336	341		341	60.0	35.0				tr	4.0		tr							tr						1.0	tr	100
2	Ultramafic	P1	33	0.03	0.03	0.035	00-368C	460	465	5	0.03	0.042	70.0	0.033	98	462	463		462	45.0	tr					3.0		1.0		20.0		30.0			tr						1.0	tr	100
2	Ultramafic	P2	34	0.035	0.04	0.045	26055	940	945	5	0.04	0.037	69.0	0.025	88	941	944		944	40.0	50.0				1.5	5.0		0.5	tr	tr		tr									3.0	tr	100
2	Ultramafic	P3	35	0.045	0.05	0.05	26098	145	148.5	3.5	0.05	0.037	76.0	0.014	112	146	148		148	43.0	55.0				tr	2.0		tr							tr						tr	tr	100
2	Ultramafic	P3(a)	35(a)	0.045	0.05	0.05	00-337C	105	110	5	0.05	0.043	71.0	0.023	116	106	108		106	40.0	50.0					5.0		1.0				2.0									2.0	tr	100
3	Anorthositic	P1	36	0.01	0.01	0.02	00-334C	30	50	20	0.01	0.022	47.0	0.009	64	31	50		31	82.0	15.0				tr	2.5		tr	tr	tr		tr							tr		0.5	tr	100
3	Anorthositic	P2	37	0.02	0.03	0.04	00-368C	125	145	20	0.03	0.016	38.0	0.015	62	132	143		132	72.0	20.0				1.0	4.0		1.0			tr										2.0	tr	100
3	Anorthositic	P3	38	0.04	0.05	0.05	00-368C	20	40	20	0.04	0.010	25.8	0.022	47	28	39		39	60.0	35.0				1.0	1.0		1.0		tr											2.0	tr	100
3	Troctolitic	P1	39	0.01	0.01	0.02	00-366C	35	55	20	0.01	0.019	45.3	0.005	50	37	47		37	65.0	35.0				tr	tr		tr							tr						tr	rare	100
3	Troctolitic	P2	40	0.02	0.03	0.04	00-334C	110	130	20	0.03	0.028	57.3	0.012	73	112	128		128	55.0	44.0					0.5		tr	tr	tr		tr									tr	tr	100
3	Troctolitic	P3	41	0.04	0.05	0.05	00-347C	155	175	20	0.04	0.015	49.5	0.015	67	157	174		157	70.0	25.0					2.5		0.5	tr	tr		tr									2.0	tr	100
3	Troctolitic	P50	42	0.07	0.08	0.09	00-347C	280	300	20	0.08	0.018	45.3	0.035	61	282	299		299	66.0	30.0				1.0	2.0		0.5							tr						0.5	tr	100
3	Troctolitic	P85	43	0.115	0.12	0.13	00-326C	60	70	10	0.12	0.031	51.0	0.034	91	61	66		66	60.0	38.0				tr	2.0		tr	tr	tr		tr							tr		tr	tr	100
3	Troctolitic	P95	44	0.165	0.19	0.275	00-369C	305	325	20	0.27	0.030	51.5	0.037	57	306	318		318	68.0	20.0				tr	2.0		tr	tr	8.0	tr	2.0			tr						tr	tr	100
4	Troctolitic	P1	45	0.01	0.01	0.02	00-367C	50	65	15	0.02	0.015	38.7	0.010	59	55	62		55	65.0	tr				tr	3.0		0.5	5.0	10.0	tr	15.0									1.5	rare	100
4	Troctolitic	P2	46	0.02	0.03	0.04	00-367C	260	280	20	0.04	0.024	53.8	0.018	78	269	279		269	45.0	45.0				tr	8.0		0.5	tr	tr		tr			tr						1.5	tr	100
4	Troctolitic	P3	47	0.04	0.05	0.05	00-367C	290	310	20	0.04	0.021	41.3	0.018	64	297	308		308	52.0					2.0	3.0		1.0	tr	40.0			1.0								1.0	tr	100
4	Troctolitic	P25	48	0.065	0.07	0.08	00-370C	20	30	10	0.07	0.010	37.0	0.016	67	22	27		22	52.0	26.0					8.0		0.5	tr	6.0	tr	6.0									1.5	tr	100
4	Troctolitic	P75	49	0.135	0.18	0.185	00-369C	20	30	10	0.14	0.021	39.0	0.043	60	22	29		29	65.0	20.0				1.0	3.0		1.0	tr	8.0	tr	1.0				tr					tr	1.0	100
4	Troctolitic	P90	50	0.335	0.48	0.7	00-367C	170	175	5	0.48	0.023	45.0	0.034	54	171	173		171	52.0	3.0	3.0				12.0	5.0	4.0	3.0	10.0											tr	8.0	100
4	Troctolitic	P95	51	0.7	0.92	1.225	00-367C	395	400	5	0.92	0.028	76.0	0.080	96	395	398		398	55.0	2.0				1.0	2.0		2.0	2.0	28.0	tr	2.0			tr						3.0	3.0	100
5	Troctolitic	P1	52	0.01	0.01	0.02	26064	44	54	10	0.01	0.035	62.0	0.009	58	45	53		45	74.0	24.0					2.0			tr	tr		tr			rare						tr	rare	100
5	Troctolitic	P3	53	0.04	0.05	0.05	26064	264	269	5	0.04	0.017	42.0	0.005	56	264	268		264	68.0	5.0				0.5	0.5		tr	1.0	24.0	tr	tr									0.5	0.5	100
5	Troctolitic	P3(a)	53(a)	0.04	0.05	0.05	26064	146	156	10	0.05	0.032	67.0	0.031	78	148	151		148	55.0	40.0				tr	2.0		tr	tr	2.0		1.0									tr	tr	100
6	Troctolitic	P1	54	0.02	0.02	0.03	26056	110	125	15	0.02	0.034	66.7	0.025	85	113	123		123	55.0	42.0					3.0		tr	tr	tr		tr			tr						tr	tr	100
6	Troctolitic	P2	55	0.03	0.04	0.04	26056	135	153	18	0.04	0.037	62.7	0.032	89	138	152		138	55.0	45.0					tr		tr		tr	tr										tr	tr	100
20	Virginia	P25	56	0.92	1.25	2.115	00-361C	737	749	15	1.91	0.015	22.3	0.039	225	739	748		739			10.0		70.0				5.0		2.0								10.0			tr	3.0	100
20	Virginia	P75	57	3.565	4.15	4.32	00-364C	210	229	19	4.11	0.018	26.8	0.017	872	211	228		211			65.0		25.0		tr		0.5	1.5							tr		2.0				6.0	100
20	Virginia	P90	58	4.96	5.07	5.565	00-337C	510	520	10	5.12	0.016	29.5	0.019	492	511	519		519					85.0	tr			2.0	tr									3.0				10.0	100

#	Rock Name	Oxides: Magnetite	Oxides: Ilmenite	Percent Check	Break-Down of Sulfide Mineralogy: Pyrite	Pyrrhotite	Chalcopyrite	Bornite	Digenite	Chalcocite	Covellite	Cubanite	Pentlandite	Violarite	PGMs	Silver	Mackinawite/ Valleriite	Sphalerite	Galena	Millerite	Enargite	Talnakhite	Percent Check
1	Anorthositic Troctolite	5.0	95.0	100		35.0	50.0						15.0	tr	rare			tr	rare				100
2	Anorthositic Troctolite	5.0	95.0	100		40.0	40.0	tr				10.0	10.0										100
3	Troctolitic Anorthosite	5.0	95.0	100		45.0	45.0	tr					5.0	rare			5.0	tr					100
4	Norite		100.0	100	tr	80.0	18.0						2.0					tr					100
5	Recrystallized/Granoblastic Calc-Silicate					tr	tr											95.0	5.0				100
6	Granoblastic cordierite biotite Graywacke	100.0		100		90.0	5.0						tr					5.0					100
7	Granoblastic Graywacke		100.0	100		95.0	5.0											tr	tr				100
8	Granoblastic cordierite biotite pyrrhotite Graywacke	tr	100.0	100		100.0	tr																100
9	Granoblastic cordierite Graywacke	100.0		100		100.0	tr																100
9(a)	Granoblastic cordierite Graywacke		100.0	100		90.0	5.0					1.0	1.0					3.0					100
10	Augite Troctolite	2.0	98.0	100		5.0	80.0			rare			15.0	tr				tr					100
10(a)	Augite Troctolite	60.0	40.0	100		55.0	20.0	tr				20.0	5.0					tr					100
10(b)	Augite Troctolite	20.0	80.0	100		60.0	40.0						tr				tr	tr					100
10(c)	Troctolite		100.0	100		60.0	35.0						5.0					tr					100
11	Olivine Gabbro	85.0	15.0	100		45.0	35.0					10.0	10.0	tr			tr						100
12	Augite Troctolite	5.0	95.0	100		30.0	25.0	tr				35.0	10.0					tr					100
13	Augite Troctolite	50.0	50.0	100		55.0	20.0					5.0	20.0				tr	tr					100
14	Augite Troctolite	tr	100.0	100		30.0	50.0					20.0	tr										100
15	Augite Troctolite	5.0	95.0	100		60.0	30.0	tr					10.0					tr				tr	100
16	MelaTroctolite (Picrite)/Troctolite	tr	100.0	100		65.0	35.0						tr	tr			tr						100
17	Norite	30.0	70.0	100		95.0	5.0					tr						tr	tr				100
18	Augite Troctolite	10.0	90.0	100		80.0	10.0			tr		4.0	6.0								tr		100
19	MelaTroctolite (Picrite)	10.0	90.0	100			60.0						40.0					tr	tr				100
20	MelaTroctolite (Picrite)	50.0	50.0	100		20.0	20.0	tr				35.0	25.0		rare		tr	tr					100
21	MelaGabbro		100.0	100		50.0	50.0						tr				tr						100
22	Basalt Inclusion	10.0	90.0	100		80.0	10.0					5.0	5.0				tr	tr					100
23	MelaGabbro	tr	100.0	100		10.0	85.0	5.0					tr		rare			tr					100
24	Gabbroic Anorthosite	1.0	99.0	100		45.0	40.0	tr			tr	10.0	5.0					rare					100
25	Troctolitic Anorthosite	40.0	60.0	100		5.0	90.0	tr					5.0				tr						100
26	Gabbroic Anorthosite	65.0	35.0	100		40.0	30.0					15.0	15.0										100
27	Troctolite	30.0	70.0	100		10.0	50.0	tr				25.0	15.0	tr				tr					100
28	Troctolite	30.0	70.0	100		30.0	60.0	tr			tr	5.0	5.0			rare							100
29	Troctolite	40.0	60.0	100		30.0	40.0	tr			tr	20.0	10.0	tr				tr					100
30	Troctolite	tr	100.0	100		40.0	45.0					10.0	5.0					tr				tr	100
31	Troctolite	10.0	90.0	100		20.0	35.0	tr			tr	30.0	15.0				tr	tr				tr	100
32	Troctolite	tr	100.0	100		60.0	20.0						15.0				5.0						100
33	Serpentinized MelaTroctolite (Picrite)	50.0	50.0	100			100.0					tr	tr										100
34	MelaTroctolite (Picrite)	5.0	95.0	100		30.0	40.0	tr	tr		tr	15.0	15.0										100
35	MelaTroctolite (Picrite)	2.0	98.0	100		30.0	45.0	tr				25.0	tr										100
35(a)	MelaTroctolite (Picrite)	5.0	95.0	100		35.0	40.0					15.0	10.0					tr					100
36	Troctolitic Anorthosite	35.0	65.0	100		45.0	45.0	tr					10.0										100
37	Anorthositic Troctolite	5.0	95.0	100		35.0	55.0						5.0				5.0	tr					100
38	Troctolite	tr	100.0	100		55.0	40.0	2.0					tr				3.0	rare					100
39	Troctolite	10.0	90.0	100		tr	75.0	15.0			10.0	tr	tr										100
40	Troctolite	30.0	70.0	100		45.0	40.0	tr				5.0	10.0										100
41	Troctolite/Anorthositic Troctolite	50.0	50.0	100		45.0	45.0	tr				5.0	5.0										100
42	Troctolite	tr	100.0	100		35.0	60.0					tr	tr				5.0						100
43	Troctolite	50.0	50.0	100		10.0	75.0	tr				10.0	5.0					tr					100
44	Troctolite	1.0	99.0	100		85.0	10.0										5.0						100
45	Serpentinized Troctolite	80.0	20.0	100			95.0	5.0					tr										100
46	Augite Troctolite	30.0	70.0	100		15.0	48.0	tr	tr		tr	30.0	5.0				tr	tr				2.0	100
47	Troctolite	50.0	50.0	100		5.0	80.0						15.0		rare								100
48	Augite Troctolite	tr	100.0	100		70.0	20.0	tr				2.0	3.0				5.0	tr					100
49	Troctolite	tr	100.0	100		35.0	25.0										40.0						100
50	Augite Troctolite		100.0	100		70.0	25.0						5.0					tr					100
51	Chloritic Troctolite	tr	100.0	100		tr	3.0			tr			95.0	2.0				tr					100
52	Anorthositic Troctolite	50.0	50.0	100			40.0	30.0			30.0		tr										100
53	Chloritic Troctolite	tr	100.0	100		25.0	50.0					tr	5.0	tr			20.0	tr					100
53(a)	Troctolite	5.0	95.0	100		5.0	65.0	10.0			10.0	5.0	5.0										100
54	Troctolite	45.0	55.0	100		tr	70.0	5.0	5.0		5.0	10.0	4.0					1.0					100
55	Troctolite	5.0	95.0	100		5.0	75.0	10.0	3.0		2.0		5.0		tr								100
56	Granoblastic graphitic cordierite Argillite	100.0		100		100.0	tr											tr					100
57	Granoblastic pyrrhotite Graywacke					98.0	tr											1.5	0.5				100
58	Bedded Granoblastic pyrrhotite cordierite Graywacke					98.0	tr											2.0					100

#	Rock Name	Silicates/Alteration Minerals/Phosphates/Carbonates — Plagioclase: crystal shape	Plagioclase: grain size	Plagioclase: texture	Olivine: crystal shape	Olivine: grain size	Olivine: texture	K-spar: crystal shape	K-spar: grain size	K-spar: texture
1	Anorthositic Troctolite	subhedral	1-10mm	adcum./sympl. Opx	anhedral	0.5-3mm	intercumulate			
2	Anorthositic Troctolite	subhedral	1-5mm	adcumulate	anhed/subhed	1-5mm oikos	poikilitic			
3	Troctolitic Anorthosite	subhedral	2-4mm	adcum./sympl. Opx	anhedral	1-4mm	adcumulate			
4	Norite	subhedral	2-8mm	adcumulate	anhedral	1-2mm	adcumulate			
5	Recrystallized/Granoblastic Calc-Silicate							anhedral	0.5-1mm	porphyroblastic
6	Granoblastic cordierite biotite Graywacke							anhedral	0.1-0.15mm	granoblastic
7	Granoblastic Graywacke							anhedral	0.01-0.1mm	granoblastic
8	Granoblastic cordierite biotite pyrrhotite Graywacke							subhed/anhed	1-2mm	granoblastic
9	Granoblastic cordierite Graywacke	subhedral	0.2-0.5mm	random grains				subhedral	2-5mm	poikilitic/wk foliated
9(a)	Granoblastic cordierite Graywacke							subhedral	0.1-0.5mm	granoblastic/porphy.
10	Augite Troctolite	subhedral	1-2mm	adcumulate						
10(a)	Augite Troctolite	subhedral	0.5-1.5mm	adcum./sympl. Opx	anhedral	1-2mm	adcumulate			
10(b)	Augite Troctolite	subhedral	1-10mm	adcum./sympl. Opx	anhedral	2-8mm	adcumulate			
10(c)	Troctolite	subhedral	1-5mm	adcum./sympl. Opx	anhedral	1-4mm	adcumulate			
11	Olivine Gabbro	subhedral	1cm	orthocum./sympl. Opx	anhedral	1-3mm	orthocumulate			
12	Augite Troctolite	subhedral	1-5mm	adcumulate	anhedral	1-2mm	adcum/intercum/sympl			
13	Augite Troctolite	subhedral	1-2mm	mesocumulate/wk zone	anhedral	0.1-1mm	adcumulate/subequant			
14	Augite Troctolite	subhedral	1mm	adcumulate	equant/subhed	0.1-0.5mm	adcumulate			
15	Augite Troctolite	subhedral	1-2mm	adcum./sympl. Opx	equant	0.2-0.4mm	adcumulate			
16	MelaTroctolite (Picrite)/Troctolite	subhedral	1-4mm	adcum./sympl. Opx	anhedral	1-10mm oikos	poikilitic			
17	Norite	subhedral	2-12mm	adcum./sympl. Opx						
18	Augite Troctolite	subhedral	1-2mm	adcum./sympl. Cpx	anhedral	1-3mm oikos	poikilitic/adcumulate			
19	MelaTroctolite (Picrite)				anhedral	3mm	poikilitic	anhedral	1-8mm	sauss. alt. of Plag.
20	MelaTroctolite (Picrite)	subhedral	1-4mm	adcumulate	anhedral	5-8mm	poikilitic/sympl. Cp.			
21	MelaGabbro	subhedral	1-3mm	adcumulate	anhedral	0.5-1mm	adcumulate			
22	Basalt Inclusion	subhedral	0.5-1mm	zoned	anhedral	5mm oikos	poikilitic	anhedral	3-5mm oikos	poikilitic
23	MelaGabbro	subhedral	0.5-6mm	adcum./sympl. Opx	anhedral	1cm oikos	poikilitic/adcumulate			
24	Gabbroic Anorthosite	subhedral	2-6mm	adcum./sympl. Opx	anhedral	5mm oikos	poikilitic			
25	Troctolitic Anorthosite	subhedral	2-6mm	adcum./sympl. Opx	anhedral	2-6mm	intercum./interst.			
26	Gabbroic Anorthosite	subhedral	1-5mm	adcumulate	anhedral	0.1-0.2mm	random/trace			
27	Troctolite	subhedral	1-8mm	adcum./sympl. Opx	anhedral	1-5mm	adcumulate			
28	Troctolite	subhedral	1-6mm	adcum./sympl. Opx	anhedral	4-6mm oikos	adcumulate/poikilitic			
29	Troctolite	subhedral	1-3mm	adcum./sympl. Opx	anhedral	4-5mm oikos	subpoik./adcum./sympl.			
30	Troctolite	subhedral	1-3mm	adcumulate	anhed/subhed	0.5-1mm	poikilitic/adcumulate			
31	Troctolite	subhedral	1-3mm	adcum./sympl. Opx	anhedral	1-3mm	adcumulate			
32	Troctolite	subhedral	1-3mm	adcum./sympl. Opx	anhedral	2-3cm oikos	poikilitic/adcumulate			
33	Serpentinized MelaTroctolite (Picrite)	subhedral	0.5-1mm	adcumulate	equant	0.3-0.5mm	adcumulate			
34	MelaTroctolite (Picrite)	subhedral	1-4mm	adcumulate	anhedral	2-5mm oikos	subpoik./adcum./sympl.			
35	MelaTroctolite (Picrite)	subhedral	1-2mm	adcumulate	anhedral	2-5mm	poikilitic/adcumulate			
35(a)	MelaTroctolite (Picrite)	subhedral	0.5-1mm	adcumulate	equant	0.1-0.5mm	adcumulate			
36	Troctolitic Anorthosite	subhedral	2-8mm	adcumulate	anhedral	6-8mm oikos	poikilitic			
37	Anorthositic Troctolite	subhedral	1-3mm	orthocumulate/zoned	anhedral	0.5-1cm oikos	poikilitic			
38	Troctolite	subhed/anhed	0.5-5mm	adcum./sympl. Opx	anhedral	3-4cm oikos	poikilitic/adcumulate			
39	Troctolite	subhedral	0.5-5mm	adcum./sympl. Opx	anhedral	3mm	poikilitic/adcumulate			
40	Troctolite	subhedral	1-5mm	adcumulate	anhedral	1-2cm oikos	poikilitic			
41	Troctolite/Anorthositic Troctolite	subhedral	1-3mm	adcumulate	anhedral	1-2cm oikos	poikilitic			
42	Troctolite	subhedral	1-5mm	adcumulate	anhedral	3-4cm oikos	poikilitic			
43	Troctolite	subhedral	1-4mm	adcum./sympl. Opx	anhedral	3-6cm oikos	adcumulate			
44	Troctolite	subhedral	1-4mm	adcum./sympl. Opx	anhedral	4-5mm oikos	poikilitic/adcumulate			
45	Serpentinized Troctolite	subhedral	1-5mm	adcumulate	anhedral	1-2mm	adcumulate/subpoikilitic			
46	Augite Troctolite	subhedral	2-8mm	adcumulate	anhedral	1-4mm	adcumulate			
47	Troctolite	subhedral	1-5mm	adcum./sympl. Opx						
48	Augite Troctolite	subhedral	0.5-2mm	adcumulate	anhedral	4cm oikos	adcumulate/subpoikilitic			
49	Troctolite	subhedral	1-4mm	adcumulate	anhedral	1-3mm	adcumulate			
50	Augite Troctolite	subhedral	1-3mm	orthocumulate/zoned	anhedral	0.5-1mm	cumulate	anhedral	2-6mm	massive/cavity in-fill
51	Chloritic Troctolite	anhedral	0.5-2.5mm	adcumulate	anhedral	0.05-1mm	adcumulate/altered			
52	Anorthositic Troctolite	subhedral	1-10mm	adcumulate	anhedral	1-4mm	adcumulate			
53	Chloritic Troctolite	subhedral	2-5mm	adcumulate	anhedral	1-4mm	adcumulate/altered			
53(a)	Troctolite	subhedral	2-6mm	adcumulate	anhedral	0.1-10mm	adcumulate			
54	Troctolite	subhedral	1-4mm	adcumulate	anhedral	1-3mm	adcumulate/sympl. Cp			
55	Troctolite	subhedral	0.5-2mm	adcumulate	subhed/equant	0.5-2mm	adcumulate			
56	Granoblastic graphitic cordierite Argillite							anhedral	0.1-0.5mm	granoblastic
57	Granoblastic pyrrhotite Graywacke							anhedral	0.1-0.4mm	granoblastic/porphy.
58	Bedded Granoblastic pyrrhotite cordierite Graywacke									

#	Silicates/Alteration Minerals/Phosphates/Carbonates																													
	Quartz			Cordierite			Opx			Cpx			Amphibole			Biotite			White Mica			Chlorite			Clay Minerals			Serpentine		
	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture
1							anhedral	0.1-0.3mm	sympl./rims Ol	subhedral	2-5mm ophites	ophitic/rims Olivine				subhedral	0.1-0.5mm	interst./rims Ox&Sulf				anhedral	<0.01mm	alt. of Olivine						
2										subhedral	1-2cm ophites	ophitic/rims Olivine				subhedral	0.1-0.2mm	interst./rims Ox&Sulf												
3							anhedral	0.1-0.5mm	sympl./rims Ol	subhedral	5mm ophites	ophitic/rims Olivine				subhedral	0.1-0.5mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.1-0.4mm	alt. of Olivine						
4							subhedral	1-3mm	invert. Pigeonite	subhedral	3-4mm ophites	ophitic				subhedral	0.1-0.5mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.2mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.			
5										anhedral	1-3mm ophites	poikiloblastic							anhedral	0.5-2mm	muscovite/poik.									
6				anhedral	0.1mm	granoblastic										subhedral	0.1-0.5mm	wk foliated	anhedral	0.01-0.05mm	sericitic alt. of Kspar									
7				anhedral	0.01-0.1mm	granoblastic				anhedral	0.1-0.3mm	poikiloblastic				subhedral	0.05-0.1mm	interstitial				anhedral	0.01-0.05mm	granoblastic				anhedral	<0.01mm	in-fill fractures
8				subhed/anhed	0.5-1mm	granoblastic										subhedral	0.1-2mm	granoblastic	subhedral	0.1-0.2mm	fibrous/radiating				anhedral	<0.01mm	brn clouding of Plag.			
9				anhedral	0.05-0.5mm	granoblastic	subhedral	0.1-0.2mm	granoblastic							subhedral	0.1-3mm	wk foliated	anhedral	<0.01mm	sericitic alt. of Plag.				anhedral	<0.01mm	brn clouding of Plag.			
9(a)				anhedral	0.1-0.3mm	granoblastic	anhedral	0.1-0.3mm	granoblastic							anhed/subhed	0.1-1mm	poikiloblast/rims sulf.												
10										subhedral	3-4mm ophites	ophitic				subhedral	0.1-1mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	0.01-0.05mm	alt. of Olivine
10(a)							anhedral	0.1-0.5mm	rim Ol/sympl. Plag/Mag	subhedral	1cm ophites	ophitic/sympl. Mag.				subhedral	0.5-2mm	interst./rims Ox&Sulf				anhedral	0.01-0.5mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
10(b)										subhedral	1.5-2cm ophite	ophitic/rims Ol/sympl.				subhedral	0.1-2mm	interst./rims Ox&Sulf				anhedral	<0.01mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.			
10(c)							anhedral	0.1-1mm	rim Ol/sympl. Plag	subhedral	3-5mm ophites	ophitic				subhedral	0.1-2mm	interst./rims Oxides	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.5mm	alt. of Olivine						
11							anhedral	0.1-0.5mm	sympl./rims Ol	subhedral	1.5cm	pegmatitic				subhedral	0.1-4mm	interst./rims Ox&Sulf	anhedral	0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine						
12							anhedral	0.05-0.1mm	sympl./rims Ol	subhedral	2-3cm ophites	ophitic/rims Olivine				subhedral	0.1-2.75mm	interst./rims Ox&Sulf												
13										subhedral	1cm ophites	ophitic				subhedral	0.1-2mm	poikilitic/rims Ox	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.2mm	alt. of Olivine				anhedral	0.01-0.1mm	alt. of Olivine
14										subhedral	3-5mm ophites	ophitic				subhedral	0.5-1mm	interst./rims Ox&Sulf												
15							anhedral	0.1-0.3mm	rim Ol/sympl. Plag	subhedral	3-5mm ophites	ophitic/sympl. Plag.				subhedral	0.1-0.8mm	interst./rims Oxides	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	<0.01mm	alt. of Olivine
16							anhedral	0.1-0.5mm	sympl./rims Ol	subhedral	1cm ophites	ophitic				subhedral	0.1-3mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.3mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.			
17	anhedral	3mm	cavity in-fill/zr & rutile				anhedral	1-6mm	rim Ol/sympl. Plag	subhedral	2-4mm ophites	ophitic/rims rem. Ol				subhedral	0.1-1.2mm	interst./incl.	anhedral	<0.01-0.8mm	ser. rad. alt. of Plag.	anhedral	0.01-0.05mm	alt. of Olivine						
18										subhedral	1cm ophites	ophitic				subhedral	0.1-3mm	interst./rims Sulf&Ox	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	<0.01mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.			
19										anhedral	1-6mm	interstitial							anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	<0.01mm	alt. of Olivine
20										subhedral	3-4mm ophites	subophitic				subhedral	0.1-2mm	interst./rims Sulf&Ox	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
21							anhedral	1-2mm	rims Olivine	subhedral	2-5mm ophites	ophitic				subhedral	0.1-1mm	interst./rims Ox&Sulf	subhedral	0.01-0.1mm	sericitic alt. of Plag.	anhedral	0.1-1mm	alt. of Olivine						
22							anhedral	4-5mm ophites	ophitic/invert. Pigeonite	subhedral	1-2mm ophites	ophitic				subhedral	0.1-1.5mm	poikilitic	anhedral	<0.01mm	sericitic alt. of Plag.				anhedral	<0.01mm	brn clouding of Plag.			
23							anhedral	0.1-1.5mm	rim Ol/sympl/invert. Pig.	subhedral	2-5mm ophites	ophitic				subhedral	0.1-1.2mm	interst./rims Sulf&Ox	subhedral	0.01-0.05mm	sericitic alt. of Plag.	anhedral	<0.01mm	alt. of Olivine						
24							anhedral	0.05-0.1mm	rim Ol/sympl. Plag/Mag	subhedral	1cm ophites	ophitic				subhedral	0.1-0.5mm	interst./rims Ox&Sulf												
25							anhedral	0.1-1mm	rim Ol/sympl. Plag/Mag	subhedral	1-2cm ophites	ophitic				subhedral	0.1-0.6mm	interst./rims Ox&Sulf												
26										subhedral	>3cm ophites	ophitic				subhedral	2mm oikos	poikilitic/rims Ox							anhedral	<0.01mm	brn clouding of Plag.			
27							anhedral	0.1-0.5mm	rim Ol/sympl. Plag/Ilm	subhedral	1-1.5cm ophite	ophitic/rims Olivine				subhedral	0.1-1mm	interst./incl. in Cpx				anhedral	<0.01mm	alt. of Ol./microfract.				anhedral	<0.01mm	alt. of Olivine
28							anhedral	0.1-1mm	rim Ol/sympl. Plag	subhedral	3-4mm ophites	ophitic/rims Olivine				subhedral	0.1-0.8mm	interst./rims Oxides	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
29							anhedral	0.05-0.1mm	rim Ol/sympl. Plag	subhedral	2cm ophites	ophitic/rims Olivine				subhedral	0.1-2mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	<0.01mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
30							subhedral	1mm	rim Ol/sympl. Ilm	subhedral	5mm ophites	ophitic				subhedral	0.2-1mm	interst./rims Ox&Sulf												
31							anhedral	0.1-0.2mm	rim Ol/sympl. Plag/Mag	subhedral	1-2cm ophites	ophitic/rims Olivine				subhedral	0.1-2mm	subpoik/rims Ox&Sulf				anhedral	0.01-0.05mm	alt. of Olivine						
32							anhedral	0.1mm	rim Ol/sympl. Plag	subhedral	1-2cm ophites	ophitic				subhedral	0.1-1mm	interst./incl. in Cpx												
33										subhedral	2-5mm ophites	ophitic				subhedral	0.1-1mm	interst./rims oxides				anhedral	0.01-0.3mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
34							anhedral	2-3mm ophites	rims Ol/ophitic	subhedral	5-8mm ophites	ophitic/rims Olivine				subhedral	0.1-1.5mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine				anhedral	0.01-0.02mm	alt. of Olivine
35							anhedral	0.5-1mm	rims Olivine	subhedral	2-3mm ophites	ophitic				subhedral	0.5-1mm	interst./rims Ox&Sulf												
35(a)										subhedral	5-10mm ophite	ophitic				subhedral	1-3mm oikos	poikilitic/rims Ox										anhedral	0.01-0.1mm	alt. of Olivine
36							anhedral	0.1-0.5mm	rim Ol/sympl. Mag	subhedral	1cm ophites	ophitic/rims Olivine				subhedral	0.1-0.8mm	interst./incl. in Cpx	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.3mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
37							anhedral	0.1-0.5mm	rim Ol/sympl. Plag/Mag	subhedral	1cm ophites	ophitic				subhedral	0.1-0.5mm	interst./rims Ox&Sulf							anhedral	<0.01mm	brn clouding of Plag.			
38							anhedral	0.1-1mm	rim Ol/sympl. Plag	subhedral	1cm ophites	ophitic				subhedral	0.1-1mm	interst./rims Ox&Sulf				anhedral	0.05-0.1mm	alt. of Olivine						
39							anhedral	0.1-0.5mm	rim Ol/sympl. Plag/Mag	subhedral	4-5mm ophites	ophitic				subhedral	0.1-0.5mm	interst./rims Ox&Sulf												
40										subhedral	3-5mm ophites	ophitic/rims Olivine				subhedral	0.1-0.4mm	interst./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.2mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
41										subhedral	1cm ophites	ophitic				subhedral	0.1-1mm	interst./rims Oxides	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.05mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
42							anhedral	1-2mm	rim Ol/sympl. Plag/Mag	subhedral	1-2cm ophites	ophitic				subhedral	0.5-1mm	interst./rims Ox&Sulf												
43							anhedral	0.1-0.8mm	rim Ol/sympl. Plag/Mag	subhedral	5mm ophites	ophitic/rims Olivine				subhedral	0.1-1mm	interst./rims Oxides	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
44							anhedral	0.05-0.2mm	rim Ol/sympl. Plag	subhedral	3-5mm ophites	ophitic/rims Olivine				subhedral	0.1-2mm	interst./rims Ox&Sulf	subhedral	0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	0.01-0.05mm	alt. of Olivine
45							anhedral	0.1-1mm	rim Ol/sympl. Mag	subhedral	1-2cm ophites	ophitic/rims Olivine				subhedral	0.1-0.5mm	interst./rims Ox	anhedral	<0.01-0.1mm	sericitic alt. of Plag.	anhedral	0.01-1mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	<0.01mm	alt. of Olivine
46							anhedral	0.1-0.2mm	rims Olivine	subhedral	1cm ophites	ophitic/rims Olivine				subhedral	0.1-1.5mm	interst./rims Ox	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
47							anhedral	0.05-0.1mm	rim Ol/sympl. Plag/Mag	subhedral	3mm ophites	ophitic				subhedral	0.1-1mm	interst./rims Oxides	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-2mm	alt. of Olivine						
48										subhedral	1-1.5cm ophite	ophitic/rims Olivine				subhedral	0.1-0.8mm	interst./rims Ox	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.3mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	<0.01mm	alt. of Olivine
49							anhedral	0.1-0.5mm	rim Ol/sympl. Plag	subhedral	0.5-1cm ophite	ophitic/rims Olivine				subhedral	0.1-5mm	interst./rims Ox&Sulf	subhedral	0.5mm	sericitic alt. of Plag.	anhedral	0.01mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	0.01mm	alt. of Olivine
50										subhedral	1-4mm	cumulate	subhedral	0.1-1mm	ural. Alt. pyroxene	subhedral	0.1-5mm	interst./incl. rims Sulf	anhed/subhed	0.01-0.5mm	ser/sauss alt of Plag	anhedral	0.01-0.1mm	radiat. alt. of Olivine						
51							anhedral	0.5-1mm	rims Olivine	anhedral	1-2mm	interstitial				subhedral	0.1-1mm	interst./rims Ox&Sulf	subhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.05mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	0.01mm	alt. of Olivine
52										subhedral	0.5-1cm ophite	ophitic/rims Olivine							anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	<0.01mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
53							anhed/subhed	0.1-0.5mm	rims Ol/ophitic	subhedral	1cm ophites	ophitic				subhedral	0.1-0.5mm	interst./rims Ox&Sulf	subhedral	0.01mm	sericitic alt. of Plag.	subhed/anhed	0.01-0.1mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.	anhedral	0.01mm	alt. of Olivine
53(a)							anhedral	0.05-0.2mm	rim Ol/sympl. Mag	subhedral	5mm ophites	ophitic/rims Olivine				subhedral	0.1-1mm	incl. Cpx/rims Ol	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.05mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
54										subhedral	5mm ophites	ophitic/rims Olivine				subhedral	4mm oikos	poik./rims Ox&Sulf	anhedral	<0.01mm	sericitic alt. of Plag.	anhedral	0.01-0.1mm	alt. of Olivine				anhedral	<0.01mm	alt. of Olivine
55										subhedral	1-2mm ophites	subophitic/rims Ol				subhedral	0.1-0.5mm	rims Ox&Sulf				anhedral	0.01-0.05mm	alt. of Olivine	anhedral	<0.01mm	brn clouding of Plag.			
56				anhedral	0.2-0.8mm	poikilobl./granoblastic										subhedral	0.1-0.3mm	random				anhedral	0.01-0.1mm	random						
57				anhedral	0.05-0.2mm	granoblastic				subhedral	0.1-2mm	porphyroblastic				subhedral	0.1-0.8mm	porphyroblastic	subhedral	0.1-0.4mm	muscovite									
58				anhedral	0.1-0.2mm	granoblastic/layered	anhedral	0.5mm	granoblastic							subhedral	1-3mm oikos	poikiloblastic/layered	subhedral	0.5mm oikos	poikiloblastic									

Silicates/Alteration Minerals/Phosphates/Carbonates

#	Uralite			Epidote			Apatite			Zircon		
	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture
1							euhedral	0.1-1.2mm	interst./incl			
2							euhedral	0.1mm	interst./incl			
3							euhedral	0.1-0.7mm	interst./incl			
4							euhedral	0.1-3mm	interst./incl			
5												
6												
7												
8							euhedral	0.5mm	incl. within Biot			
9												
9(a)												
10				anhedral	0.01-0.05mm	sauss. alt. of Plag.	euhedral	0.1-0.35mm	interst./incl			
10(a)							euhedral	0.1-0.5mm	interst./incl. Cpx/Biot.			
10(b)							euhedral	0.1-1mm	interst./incl			
10(c)							euhedral	0.1-0.5mm	incl. within Cpx/Biot			
11							euhedral	0.1-1mm	interst./incl			
12							euhedral	0.1-0.5mm	incl. within Cpx/Biot			
13							euhedral	0.1-0.5mm	interst./incl			
14							euhedral	0.2mm	interstitial			
15							euhedral	0.1-0.6mm	interst./incl			
16	anhedral	<0.01mm	alt. of Cpx				euhedral	0.2-2mm	interst./incl			
17							euhedral	0.1-2.2mm	interst./incl	subhedral	1.2mm	interstitial
18							euhedral	0.1-0.5mm	interstitial			
19				anhedral	0.1-1mm	sauss. alt. of Plag.	euhedral	0.1-2.5mm	interst./incl	euhedral	0.5mm	zoned, inclusions
20							euhedral	0.1-1mm	interst./incl			
21							euhedral	0.1-0.5mm	incl. within Cpx/Biot			
22							euhedral	0.1-1mm	interst./incl	subhedral	0.8mm	zoned, interstitial
23							euhedral	0.1-0.5mm	interst./incl			
24							subhedral	0.01-0.5mm	incl. within Cpx/Biot	subhedral	0.01-0.06mm	incl. in Plag.
25							euhedral	0.05-1mm	interstitial			
26							euhedral	0.1-1.5mm	interst./incl			
27							euhedral	0.05-0.3mm	interst./incl			
28							euhedral	0.1-0.8mm	interst./incl Cpx			
29							euhedral	0.1-0.2mm	interst./incl Cpx/Biot			
30							euhedral	0.1mm	incl. in Olivine			
31							euhedral	0.1-0.3mm	interstitial			
32							euhedral	0.1-0.3mm	interstitial			
33							euhedral	0.1-0.2mm	interst./incl			
34												
35							euhedral	0.5-2mm	incl. within Cpx/Biot			
35(a)												
36												
37												
38												
39							subhedral	0.1-0.3mm	interst./incl			
40												
41												
42							euhedral	0.5-1mm	interst./incl Ol.			
43												
44							euhedral	0.1-0.5mm	interstitial			
45												
46							euhedral	0.1-0.5mm	interst./incl Cpx/Biot			
47	anhedral	<0.01mm	alt. of Cpx									
48												
49										euhedral	0.05-0.1mm	clusters incl. in Plag.
50												
51							euhedral	0.1mm	interstitial			
52							euhedral	0.1mm	interst./incl			
53												
53(a)												
54							euhedral	0.05-0.15mm	interst./incl			
55												
56												
57										euhedral	0.01-0.1mm	random
58												

#	Rutile			Graphite			Carbonates			Vesuvianite/Idocrase		
	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture
1												
2												
3												
4							anhedral	0.1mm	sauss. alt. of Plag.			
5				anhedral	0.1-0.6mm	interstitial/random	anhedral	0.1-0.3mm	poikiloblastic	anhedral	1-2mm	porphyroblastic
6				subhedral	0.1-0.2mm	weakly lineated						
7				anhedral	0.05-0.1mm	granoblastic						
8				subhedral	0.1-0.2mm	interstitial						
9				subhedral	0.1-0.4mm	interstitial						
9(a)				subhedral	0.1-0.25mm	granobl./wk. lineated						
10												
10(a)												
10(b)												
10(c)												
11												
12												
13												
14												
15												
16							anhedral	0.01-0.1mm	sauss. alt. of Plag			
17	subhedral	0.05-0.4mm	interstitial									
18												
19							anhedral	2mm	sauss. alt. Plag.			
20												
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												
31												
32												
33												
34												
35												
35(a)												
36							anhedral	0.3mm	sauss. alt. Plag.			
37												
38												
39												
40												
41												
42												
43							anhedral	0.01-0.1mm	sauss. alt. Plag.			
44												
45												
46												
47												
48												
49												
50												
51												
52												
53												
53(a)												
54												
55												
56				anhedral	0.01-0.1mm	granoblastic						
57				subhedral	0.05-0.1mm	granoblastic						
58				subhedral	0.1-0.2mm	granoblastic						

Oxides/Sulfides

#	Magnetite			Ilmenite		
	crystal shape	grain size	texture	crystal shape	grain size	texture
1	anhedral	0.01-0.5mm	interst./incl./sympl.	anhed/euhed	0.01-4mm	interst./incl. in Plag
2	subhedral	0.1-0.5mm	interst.	subhedral	0.1-1mm	interst./incl.
3	anhedral	0.01-0.8mm	interst.	subhed/anhed	0.01-1.5mm	interst./incl./sympl.
4				subhed/anhed	0.01-4mm	interst./incl.
5						
6	anhedral	0.01-0.05mm	interst./random			
7				anhedral	0.05-0.1mm	subpoikiloblastic
8	subhedral	0.01-0.1mm	incl. in Po	anhed/subhed	0.01-0.1mm	interst./incl.
9	anhedral	0.01-0.1mm	equant/random grains			
9(a)				anhedral	0.01-0.1mm	granoblastic
10	anhedral	0.01-0.3mm	incl in Ilm/second. Alt	anhedral	0.01-3mm	interst./incl.
10(a)	anhedral	0.01-3.5mm	interst./sympl. Cpx	anhedral	0.01-2.5mm	interst./incl.
10(b)	anhedral	0.01-2mm	interst./sympl. Cpx	subhedral	0.01-4mm	interst./exsol. in Mag
10(c)				anhed/subhed	0.01-1.3mm	interst./incl.
11	anhedral	0.01-4mm	interst./incl.	anhed/subhed	0.01-1mm	interst./exsol. in Mag
12	anhedral	0.01-1.2mm	incl. in Ilm.	subhedral	0.01-4mm	interst./incl./sympl.
13	anhedral	0.01-3mm	poikilitic/incl.	anhedral	0.01-3mm	poikilitic/incl.
14	subhedral	0.1mm	interst./incl. in Ilm.	subhed/anhed	0.1-1mm	interst./incl.
15	anhedral	0.01-0.3mm	incl. in Ilm.	anhed/subhed	0.01-2.5mm	interst./incl. in Cpx
16	subhedral	0.01-0.1mm	exsol. lamell. In Ilm.	anhed/subhed	0.01-2mm	interst./incl.
17	anhedral	0.01-3.5mm	interst./subpoikilitic	anhed/subhed	0.01-2.5mm	interst./subpoikilitic
18	subhed/anhed	0.01-1mm	exsol. lamell. In Ilm.	anhed/subhed	0.01-5mm	interst./incl.
19	subhedral	0.5-2mm	incl. in Ilm.	anhed/subhed	0.5-13mm	interst./skeletal
20	anhedral	0.1-3.5mm	poikilitic/incl.	anhedral	0.01-2.2mm	interst./incl.
21				subhedral	<0.01-5mm	interst./incl. in Cpx
22	anhed/subhed	0.01-0.8mm	interst./incl.	subhed/anhed	0.01-1mm	prism./weak lineation
23	anhedral	0.01-0.05mm	incl. in Ilm.	subhed/anhed	0.01-1.5mm	interst./incl.
24	anhedral	0.01-0.2mm	interst./incl./sympl.	subhed/anhed	0.01-2.5mm	interst./incl. Plag/Cpx
25	anhedral	0.01-1mm	interst./sympl. Opx	anhed/subhed	0.01-2.5mm	interst./exsol. in Mag
26	anhedral	0.01-5mm	poikilitic/incl. in Ilm	anhedral	0.01-1.5mm	interstitial
27	anhedral	0.1-1mm	incl in Ilm/second. Alt	anhedral	0.01-2.5mm	interst./incl./sympl.
28	anhedral	0.01-0.9mm	incl in Ilm/second. Alt	anhedral	0.01-2mm	interst./incl.
29	anhedral	0.01-0.8mm	interst./incl. in Ilm.	subhedral	0.01-2mm	interst./incl. in Cpx
30	anhedral	0.01-1mm	exsol. lamell. In Ilm.	anhedral	0.01-2mm	interst./incl./sympl.
31	anhedral	0.01-1mm	interst./sympl. Opx	anhedral	0.01-2mm oiko	subpoikilitic/incl.
32	subhedral	0.01mm	exsol. Lamell. In Ilm.	subhed/anhed	0.01-3mm	interst./incl.
33	anhedral	1-2mm oikos	poikilitic	anhedral	0.01-2mm	interst./incl.
34	anhedral	0.01-0.2mm	incl in Ilm/second. Alt	anhedral	0.01-3mm oiko	subpoikilitic/incl.
35	anhedral	0.1mm	incl in Ilm/second. Alt	anhedral	0.5-1mm	interst./incl.
35(a)	anhedral	0.1-1mm	second./alt. Olivine	anhedral	1-4mm oikos	subpoik./interst./incl.
36	anhedral	0.01-0.8mm	incl in Ilm/second. Alt	anhed/subhed	0.01-0.8mm	interst./incl.
37	subhed/anhed	0.01-0.05mm	exsol. Ilm/sympl. Opx	anhedral	0.1-5mm	interst./incl.
38	anhedral	0.01mm	exsol. lamell. In Ilm.	anhedral	1cm oikos	poikilitic/interst.
39	subhedral	0.01-0.5mm	interst./incl.	anhed/subhed	0.01-1mm	interst./incl./sympl.
40	anhedral	0.1-2mm	incl. in Ilm.	anhedral	0.01-2.2mm	interst./incl.
41	anhedral	0.01-1mm	incl in Ilm/second. Alt	anhed/subhed	0.01-1.5mm	interst./incl.
42	anhed/subhed	0.01-0.05mm	exsol. Ilm/sympl. Opx	anhedral	0.5-1mm	interst./incl.
43	anhedral	0.01-1.8mm	incl in Ilm/second. Alt	anhedral	0.01-1mm	interst./incl.
44	anhedral	0.01-0.04mm	interst./incl. in Ilm.	subhed/anhed	0.01-1.5mm	interstitial
45	anhedral	0.01-3mm	interst./sympl. Opx	subhedral	0.01-0.5mm	interst./incl.
46	anhedral	0.01-1mm	interst./incl. in Ilm.	anhedral	0.01-2.5mm	interst./incl. in Cpx
47	anhedral	0.01-1.5mm	interst./sympl. Opx	anhedral	0.01-1.2mm	interst./incl.
48	anhedral	0.15mm	incl in Ilm/second. Alt	anhed/subhed	2-3mm oikos	poikilitic/interst.
49	anhedral	0.05-0.1mm	interst./incl.	anhedral	0.1-1mm	interst./incl.
50				anhed/subhed	0.01-0.4mm	interst./incl.
51	anhedral	0.02mm	interst./incl. in Ilm.	anhed/subhed	0.01-2.5mm	interst./incl.
52	anhed/subhed	0.01-1mm	incl in Ilm/second. Alt	anhedral	0.01-1mm	interstitial
53	subhedral	0.01-0.05mm	exsol. Lamell. In Ilm.	anhedral	0.1-1mm	interst./incl.
53(a)	anhedral	0.01-0.35mm	interst./incl./sympl.	anhedral	0.01-1.5mm	interst./incl.
54	anhedral	0.01-1.8mm	incl in Ilm/second. Alt	anhedral	0.01-1.5mm	interst./incl. in Cpx
55	anhedral	0.01-1mm	incl in Ilm/second. Alt	subhed/anhed	0.01-2mm	interst./exsol. in Mag
56	subhedral	0.01-0.2mm	random			
57						
58						

#	Oxides/Sulfides																										
	Pyrite			Pyrrhotite			Chalcopyrite			Bornite			Digenite			Chalcocite			Covellite			Cubanite			Pentlandite		
	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture
1				anhedral	0.01-0.2mm	incl. in Cp/alt. of Ol.	anhedral	0.01-0.1mm	interst./incl./microvein.																subhedral	0.01-0.1mm	incl. in Cp
2				anhedral	0.01-0.15mm	interst./incl.	anhedral	0.01-0.1mm	interst./incl.	anhedral	0.01-0.02mm	interst./incl./exsol. Cp										subhedral	0.01-0.025mm	laths within CP	subhed/anhed	0.01-0.05mm	interst./incl.
3				anhedral	0.04-0.2mm	interst./incl.	anhedral	0.01-0.2mm	interst./incl.	anhedral	0.01-0.15mm	exsol. Lamell. In Cp													subhedral	0.01-0.1mm	interst./incl. in Cp
4	euhedral	<0.01mm	second. alt.	anhedral	0.01-5mm	interst./incl.	anhedral	0.01-0.7mm	interst./incl. in Po																subhedral	0.8mm	interst./incl. in Cp
5				anhedral	0.01-0.02mm	interstitial/random	anhedral	0.01-0.02mm	interstitial/random																		
6				anhedral	0.01-0.2mm	interstitial	anhedral	0.01-0.1mm	interst./incl.																anhedral	<0.01mm	flame struct. In Po
7				anhedral	0.3-0.4mm	poikiloblastic	anhedral	0.01-0.05mm	incl. in Po																		
8				anhedral	0.01-0.5mm	incl./interst.	anhedral	0.01-0.1mm	incl. in Po																		
9				anhedral	0.01-0.8mm	incl./interst./granobl.	anhedral	0.01-0.1mm	incl. in Po																		
9(a)				anhedral	0.01-0.6mm	granoblastic	anhedral	0.01-0.1mm	incl. in Po													subhedral	0.01-0.12mm	laths within Cp	anhedral	0.01-0.08mm	flame struct. In Po
10				anhedral	0.01-0.02mm	incl. in alt. of Ol.	anhedral	0.01-0.6mm	interst./incl./microvein.							subhedral	<0.01mm	incl. in alt. of Ol.							subhedral	0.01-0.15mm	incl. in Cp
10(a)				anhedral	0.01-0.8mm	interst./incl.	anhedral	0.01-0.2mm	interst./incl./microvein.	anhedral	0.01-0.05mm	exsol. Lamell. In Cp										subhedral	0.01-0.4mm	laths within Cp	subhedral	0.01-0.2mm	incl. in Po/Cp
10(b)				anhedral	0.01-0.6mm	incl./interst.	anhed/subhed	0.01-0.7mm	interst./incl./microvein.																subhedral	0.1mm	interst./incl. in Cp
10(c)				anhedral	0.01-0.4mm	incl. in alt. of Ol.	anhedral	0.01-0.25mm	interst./incl. in Po																anhedral	0.01-0.1mm	incl. in Po
11				anhedral	0.01-1.5mm	interstitial	anhedral	0.01-0.3mm	interst./incl./microvein.													subhedral	0.01-0.1mm	laths within Cp	subhedral	0.01-0.2mm	interst./incl. in Cp
12				anhedral	0.01-0.4mm	interst./incl.	anhedral	0.01-0.15mm	interst/microvein/sympl	anhedral	<0.01mm	exsol. Lamell. In Cp										subhedral	0.01-0.3mm	laths within Cp/Po	subhedral	0.01-0.1mm	interst./incl. in Cp/Po
13				anhedral	0.01-0.15mm	interst./incl.	anhedral	0.01-0.1mm	interst./incl.													subhedral	0.01-0.05mm	laths within Cp	anhedral	0.01-0.1mm	incl. in Po/Cp
14				anhedral	0.01-0.2mm	interst./incl.	anhedral	0.01-0.1mm	interst./incl.													subhedral	0.01-0.1mm	laths within Cp	subhedral	0.01-0.04mm	interst./incl. in Cp/Cb
15				anhedral	0.01-0.1mm	interst./incl.	anhedral	0.01-0.05mm	interst./incl. in Po	anhedral	<0.01mm	exsol. in Cp/Tal													subhedral	0.01-0.05mm	incl. in Po
16				anhedral	0.01-0.3mm	interst./incl.	anhedral	0.01-0.2mm	interst./incl.																subhedral	0.01-0.05mm	interst./incl. in Cp/Po
17				anhedral	0.01-0.3mm	interst./incl. in alt. Ol.	anhedral	0.01-0.15mm	interst./incl. in Po													subhedral	0.01-0.1mm	laths within Cp			
18				anhedral	0.01-4mm	interst./incl. in alt. Ol.	subhedral	0.01-0.5mm	interst./incl. in Po							subhedral	0.1-0.2mm	incl. in Po, Cp & Cb				subhedral	0.1-0.3mm	laths within Cp	subhedral	0.1-1mm	interst./incl. in Cp
19							anhedral	<0.01-0.6mm	interst./incl.																anhedral	0.01-0.5mm	interst./incl. in Cp
20				anhedral	0.01-2.2mm	interst./incl.	anhedral	0.01-1mm	interst/microvein/sympl	anhedral	0.01-0.05mm	exsol. Lamell. In Cp										anhed/subhed	0.01-3mm	laths in Cp/microvein.	subhedral	0.01-3mm	incl. in Po/Cp
21				anhedral	0.01-0.2mm	interst./incl.	subhed/anhed	0.01-0.2mm	interst./incl./microvein.																anhedral	0.01mm	incl. in Cp
22				anhedral	0.01-0.35mm	interst./incl.	anhedral	0.01-0.05mm	incl. in Po													anhedral	0.01-0.1mm	laths within Cp	anhedral	0.01-0.1mm	incl. in Po
23				anhedral	0.01-0.1mm	interst./incl. in Cp	anhedral	0.01-0.3mm	interst./incl./microvein.	anhedral	0.01-0.1mm	exsol. Lamell. In Cp													anhedral	0.01-0.06mm	incl. in Cp
24				anhedral	0.01-0.25mm	interstitial	anhedral	0.01-0.15mm	interst./incl. in Po	anhedral	0.01-0.05mm	exsol. Lamell. In Cp							anhedral	0.02mm	Lamell. In Cp	subhedral	0.01-0.16mm	laths within Cp	subhedral	0.01-0.1mm	incl. in Cp/Po
25				anhedral	0.3mm	interstitial	anhedral	0.01-0.5mm	interst./incl.	subhedral	0.01-0.05mm	exsol. Lamell. In Cp													subhedral	0.1-0.2mm	interst./incl. in Cp
26				anhedral	0.1-0.6mm	interstitial	anhedral	0.01-0.6mm	interst./incl. in Po													subhedral	0.1-0.6mm	laths within Cp	subhedral	0.1-0.3mm	interst./incl. in Po/Cp
27				anhedral	0.01-0.2mm	interst./incl.	anhedral	0.01-0.2mm	interst./incl./microvein.	anhedral	0.02mm	exsol. Lamell. In Cp										subhedral	0.01-0.1mm	laths within Cp	subhedral	0.01-0.1mm	interst./incl. in Cp/Po
28				anhedral	0.01-0.15mm	interst./incl. in Cp	anhedral	0.01-0.2mm	interst./incl./microvein.	anhedral	0.01-0.03mm	exsol. Lamell. In Cp							anhedral	0.01-0.02mm	incl. in Bn/Cp/silic.	subhedral	0.01-0.2mm	laths within Cp	subhedral	0.01-0.5mm	interst./incl. in Po/Cp
29				anhedral	0.01-0.2mm	interst./incl.	anhedral	0.01-0.18mm	interst./incl./microvein.	subhedral	<0.01mm	exsol. Lamell. In Cp							anhedral	<0.01mm	incl. in Cp/silicates	subhed/anhed	0.01-0.2mm	laths within Cp	anhedral	0.01-0.1mm	incl. in Po/Cp
30				anhedral	0.01-0.3mm	interst./incl.	subhed/anhed	0.01-0.2mm	interst./incl.													subhedral	0.01-0.2mm	laths within Cp	subhedral	0.01-0.05mm	interst./incl. in Cp/Po
31				anhedral	0.01-1mm	interst./incl. in alt. Ol.	anhedral	0.01-0.5mm	interst./incl./microvein.	anhedral	0.01-0.02mm	exsol. Lamell. In Cp							anhedral	0.01-0.02mm	incl. in Cp/silicates	subhedral	0.01-1mm	laths within Cp	anhed/subhed	0.01-1.8mm	incl. in Po/Cp
32				anhedral	0.01-1mm	interstitial	anhedral	0.01-0.1mm	interst./incl./microvein.																subhedral	0.1-0.3mm	interst./incl. Po/Cp
33							anhedral	<0.01-0.3mm	interst./incl./microvein.													subhedral	0.01mm	laths within Cp	subhedral	0.01mm	incl. in Cp
34				anhedral	0.01-0.4mm	interstitial	anhedral	0.01-0.2mm	interst./incl./sympl. Ol.	anhedral	0.01-0.03mm	exsol. Lamell. In Cp	anhedral	0.01-0.05mm	Incl. in Plag./alt. Cov.				anhedral	0.01-0.02mm	incl. in Plag.	subhedral	0.01-0.1mm	laths within Cp	anhedral	0.01-0.2mm	incl. in Po
35				anhedral	0.01-0.2mm	interst./incl.	subhed/anhed	0.01-0.05mm	interst./incl.	anhedral	0.01mm	exsol. Lamell. In Cp										subhedral	0.1-0.05mm	laths within Cp	subhedral	0.1mm	interst./incl. in Cp/Po
35(a)				anhedral	0.01-0.15mm	interst./incl.	anhedral	0.01-0.2mm	interst./incl./microvein.													anhedral	0.01-0.1mm	laths within Cp	anhedral	0.01-0.1mm	incl. in Po/Cp
36				anhedral	0.01-0.25mm	interst./incl. in alt. Ol.	anhedral	0.01-0.2mm	interst./incl.	anhedral	0.01-0.02mm	exsol. Lamell. In Cp													subhedral	0.01-0.25mm	incl. in Po/Cp
37				anhedral	0.01-0.3mm	interst./incl.	anhedral	0.01-0.3mm	interst./incl.																subhedral	0.01-0.04mm	incl. in Cp
38				anhedral	0.01-0.2mm	interstitial	anhedral	0.01-0.2mm	interst./incl./microvein.	subhedral	0.01-0.02mm	exsol. Lamell. In Cp													subhedral	0.01mm	interst./incl. in Cp
39				anhedral	0.01mm	interst./incl.	anhedral	0.01-0.15mm	interst./incl.	subhedral	0.01-0.1mm	exsol. Lamell. In Cp							anhedral	0.01-0.02mm	interst./incl.	subhedral	0.01-0.02mm	laths within Cp	anhedral	0.01mm	incl. in Cp
40				anhedral	0.01-0.25mm	interst./incl. in alt. Ol.	anhedral	0.01-0.2mm	interst./incl./microvein.	anhedral	<0.01mm	exsol. Lamell. In Cp										anhedral	0.01-0.05mm	laths within Po/Cp	anhedral	0.01-0.1mm	incl. in Cp/Cb
41				anhedral	0.01-0.2mm	interst./incl. in alt. Ol.	anhedral	0.01-0.1mm	interst./incl.	anhedral	0.01-0.05mm	exsol. Lamell. In Cp										anhedral	0.01-0.1mm	laths within Cp	anhedral	0.01-0.03mm	incl. in Po/Cp
42				anhedral	0.1-0.5mm	interst./incl.	anhedral	0.01-0.2mm	interst./incl./microvein.													subhedral	0.1-0.2mm	laths within Cp	subhedral	0.01-0.02mm	incl. in Cp
43				anhedral	0.01-0.15mm	interst./incl. in alt. Ol.	anhedral	0.01-0.4mm	interst./incl./microvein.	anhedral	0.01-0.02mm	exsol. Lamell. In Cp										subhedral	0.05-0.2mm	laths within Cp	anhedral	0.01-0.04mm	incl. in Cp
44				anhedral	0.01-0.2mm	interst./incl. in alt. Ol.	anhedral	0.01-0.1mm	interst./incl.																		
45							anhedral	0.01-0.1mm	interst./incl.	anhedral	0.01-0.1mm	exsol. Lamell. In Cp													subhedral	0.01mm	incl. in Cp
46				anhedral	0.01-0.25mm	interst./incl. in Cp	anhedral	0.01-0.3mm	interst./incl./microvein.	anhedral	<0.01mm	exsol. Lamell. In Cp	anhedral	0.01mm	incl./in-fill fract				anhedral	<0.01mm	incl./in-fill fract	subhedral	0.01-0.5mm	laths within Cp	subhedral	0.01-0.15mm	incl. in Cp/Po
47				anhedral	<0.01mm	incl. in alt. Ol.	anhedral	0.01-0.2mm	interst./incl.																anhedral	0.01-0.05mm	incl. in Cp
48				anhedral	0.01-0.3mm	interst./incl./microvein.	anhedral	0.01-0.25mm	interst./incl. in Po	anhedral	<0.01mm	exsol. Lamell. In Cp										subhedral	0.01-0.1mm	laths within Cp	subhedral	0.01-0.1mm	interst./incl. in Cp
49				anhedral	0.1-0.2mm	interst./incl.	anhedral	0.1-0.2mm	interst./incl.																		
50				anhedral	0.01-0.3mm	interstitial	anhedral	0.01-0.3mm	interst./incl. in Po																anhedral	0.01-0.2mm	flame struct. In Po
51				anhedral	0.03mm	incl. in Ilm.	anhedral	0.01-0.1mm	incl. in Pn							anhedral	0.05mm	incl. in Cp							subhedral	0.01-3.5mm	interstitial
52							anhedral	0.01-0.05mm	interst./incl.	anhedral	0.01-0.05mm	exsol. Lamell. In Cp							anhedral	0.01-0.05mm	interst./incl.				subhedral	0.02mm	incl. in Cp
53				anhedral	0.01-0.1mm	interst./incl.	anhedral	<0.01-0.1mm	interst./incl.													subhedral	0.05mm	laths within Cp	subhed/anhed	0.01-0.1mm	Interst/flame struct Po
53(a)				anhedral	0.01-0.075mm	incl. in Cp	anhedral	0.01-0.2mm	interst./incl./microvein.	anhedral	0.01-0.1mm	exsol. Lamell. In Cp							anhedral	0.01-0.02mm	incl. in Plag.	subhedral	0.05-0.1mm	laths within Cp	anhedral	0.01-0.05mm	incl. in Cp
54				anhedral	0.01-0.05mm	interst./incl. in Cp	anhedral	0.01-0.2mm	interst./incl./microvein.	anhedral	0.01-0.15mm	exsol. Lamell. In Cp	anhedral	0.01-0.03mm	in-fill in fract.				anhedral	0.01-0.2mm	in-fill in fract.	subhedral	0.01-0.25mm	laths within Cp	anhed/subhed	0.01-0.1mm	incl. in Cp
55				anhedral	0.01-0.05mm	interst./incl.	anhedral	0.01-0.1mm	interst./incl./microvein.	subhed/anhed	0.01-0.05mm	exsol. Lamell. In Cp	anhedral	0.01-0.05mm	incl./in-fill fract				anhedral	0.01-0.05mm	incl./in-fill fract				anhed/subhed	0.01-0.02mm	interst./incl. in Cp
56				anhedral	0.01-0.2mm	granoblastic	anhedral	0.01-0.1mm	incl. in Po																		
57				anhedral	0.01-0.6mm	granoblastic	anhedral	0.01-0.05mm	incl. in Po/Sp																		
58				anhedral	0.01-0.5mm	layered/bedded	anhedral	0.01-0.05mm	incl. in Po/Sp																		

#	Oxides/Sulfides																										
	Violarite			PGMs			Silver			Mackinawite/Valleriite			Sphalerite			Galena			Millerite			Enargite			Talnakhite		
	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture	crystal shape	grain size	texture
1	anhedral	<0.01mm	oxidation of Pn	euhed./anhed.	0.02mm	incl. in Plag							anhedral	<0.01mm	exsol. lamell. in Cp	euhedral	0.025mm	incl. in Plag									
2																											
3	anhedral	<0.01mm	oxidation of Pn							anhedral	<0.01mm	incl. in Pn	subhedral	<0.01mm	exsol. lamell. in Cp												
4													anhedral	0.01-0.02mm	exsol. lamell. in Cp												
5													anhedral	0.01-0.4mm	porphyroblastic	subhedral	0.01-0.03mm	interstitial/random									
6													anhedral	0.01-0.04mm	exsol. lamell. in Cp												
7													anhedral	0.01-0.02mm	interstitial	subhedral	<0.01mm	interstitial/incl in Po									
8																											
9																											
9(a)													anhedral	0.01-0.1mm	granoblastic												
10	anhedral	<0.01mm	oxidation of Pn										anhedral	<0.01mm	exsol. lamell. in Cp												
10(a)													anhedral	0.01-0.1mm	exsol. lamell. in Cp												
10(b)										subhedral	0.01mm	incl. in Po/alt. of Ol.	subhedral	<0.01mm	exsol. lamell. in Cp												
10(c)													anhedral	<0.01mm	exsol. lamell. in Cp												
11	anhedral	<0.01mm	oxidation of Pn							anhedral	0.01-0.02mm	incl. in Pn,Cp & Cb															
12													anhedral	<0.01mm	exsol. lamell. in Cp												
13										anhedral	<0.01mm	blades in Po/Pn/Cp	anhed/subhed	0.01-0.15mm	exsol. lamell. in Cp												
14																											
15													anhedral	0.01mm	exsol. lamell. in Cp										anhedral	0.01-0.02mm	interst./incl.
16	anhedral	<0.01mm	oxidation of Pn							anhedral	0.01-0.02mm	incl. in alt. of Ol.															
17													anhedral	0.01-0.04mm	exsol in Cp/incl in alt	subhedral	0.01mm	incl. in alt.									
18																						anhedral	0.1mm	incl. in Po, Cp & Cb			
19													anhedral	<0.01mm	exsol. lamell. in Cp	euhedral	<0.01-0.04mm	incl. in alt. Plag.									
20				euhedral	<0.01mm	incl. in olivine				anhedral	<0.01mm	blades in Pn	anhedral	0.01-0.05mm	exsol. in Cp/Cb												
21										subhedral	<0.01mm	incl. in Po/alt. of Ol.															
22										anhedral	0.01-0.02mm	aggreg. in Po	anhedral	<0.01mm	exsol. lamell. in Cp												
23				anhedral	<0.01mm	incl. in Cp							anhed/subhed	<0.01mm	exsol. lamell. in Cp												
24													anhedral	<0.01mm	exsol. lamell. In Cp												
25										anhedral	0.01mm	incl. in Po															
26																											
27	anhedral	<0.01mm	oxidation of Pn										subhedral	<0.01mm	exsol. lamell. In Cp												
28							anhedral	0.02mm	vein in-fill																		
29	anhedral	<0.01mm	oxidation of Pn										anhedral	<0.01mm	exsol. lamell. in Cp												
30													subhedral	<0.01mm	exsol. lamell. in Cp										subhedral	0.1mm	incl. in silicates
31										anhedral	0.01-0.04mm	aggreg. in Po/Pn	anhedral	<0.01mm	exsol. lamell. in Cp										anhedral	0.01-0.2mm	incl. in silicates
32										subhedral	0.01-0.05mm	incl. in Po/alt. fract.															
33																											
34																											
35																											
35(a)													anhedral	<0.01mm	exsol. lamell. in Cp												
36																											
37										subhedral	0.01mm	radial blades	subhed/anhed	<0.01mm	exsol. lamell. in Cp												
38										subhedral	0.01-0.05mm	incl. in alt. fract. Ol.	anhedral	0.01mm	exsol. lamell. in Cp												
39																											
40																											
41																											
42										subhedral	0.01-0.02mm	blade-like fringe on Po															
43													anhedral	<0.01mm	exsol. lamell. in Cp												
44										anhedral	0.01mm	incl. in Po/alt. fract.															
45																											
46										anhedral	<0.01mm	incl. in Pn	anhedral	<0.01mm	exsol. lamell. in Cp										anhedral	0.02-0.2mm	interst./incl.
47				subhedral	0.02mm	incl. in alt. Ol.																					
48										anhedral	<0.01mm	incl. in alt. fract. Ol.	anhedral	<0.01mm	exsol. lamell. in Cp												
49										subhedral	0.01-0.1mm	second./incl. alt. Ol.															
50													anhedral	0.01-0.2mm	incl. in Cp/Po												
51	subhedral	0.01-0.02mm	oxidation of Pn										anhedral	0.01mm	exsol. lamell. in Cp												
52																											
53	anhedral	<0.01mm	oxidation of Pn							subhedral	<0.01-0.05mm	incl. in alt. fract. Ol.	anhedral	<0.01mm	exsol. lamell. in Cp												
53(a)																											
54													anhedral	0.01-0.15mm	exsol. Lamell. In Cp												
55				anhedral	<0.01mm	incl. in Cp																					
56													anhedral	0.01-0.1mm	random												
57													anhedral	0.01-0.1mm	random	anhedral	0.05-0.4mm	random									
58													anhedral	0.01-0.5mm	layered/bedded												

Abbreviations used in Petrographic Database spreadsheet

Abbreviation	
adcum	adcumulate
aggreg	aggregates
alt	alteration
anhed	anhedral crystal shape
Biot	biotite
Bn	bornite
brn	brown
Cb	cubanite
cm	centimeter
Cp	chalcopyrite
Cpx	clinopyroxene
Cv	covellite
euhed	euhedral crystal shape
exsol	exsolution
f-gr	fine-grained
fract	fractures
granobl	granoblastic
Ilm	ilmenite
incl	inclusion
intercum	intercumulate
interst	interstitial
invert	inverted
lamell	lamellae
Mag	magnetite
mesocum	mesocumulate
microfract	microfractures
microvein	microveining
mm	millimeter
oiko	oikocryst
Ol	olivine
Opx	orthopyroxene
orthocum	orthocumulate
Ox	oxide
Pig	pigeonite
Plag	plagioclase
Po	pyrrhotite
poik	poikilitic
porphyrobl	porphyroblastic
prism	prismatic
rem	remnant
sauss	saussuritization
second	secondary
ser	sericitic alteration
silic	silicates
Sp	sphalerite
struct	structure
subhed	subhedral crystal shape
subpoik	subpoikilitic
Sulf	sulfide
sympl	symplectic intergrowth texture
wk	weak

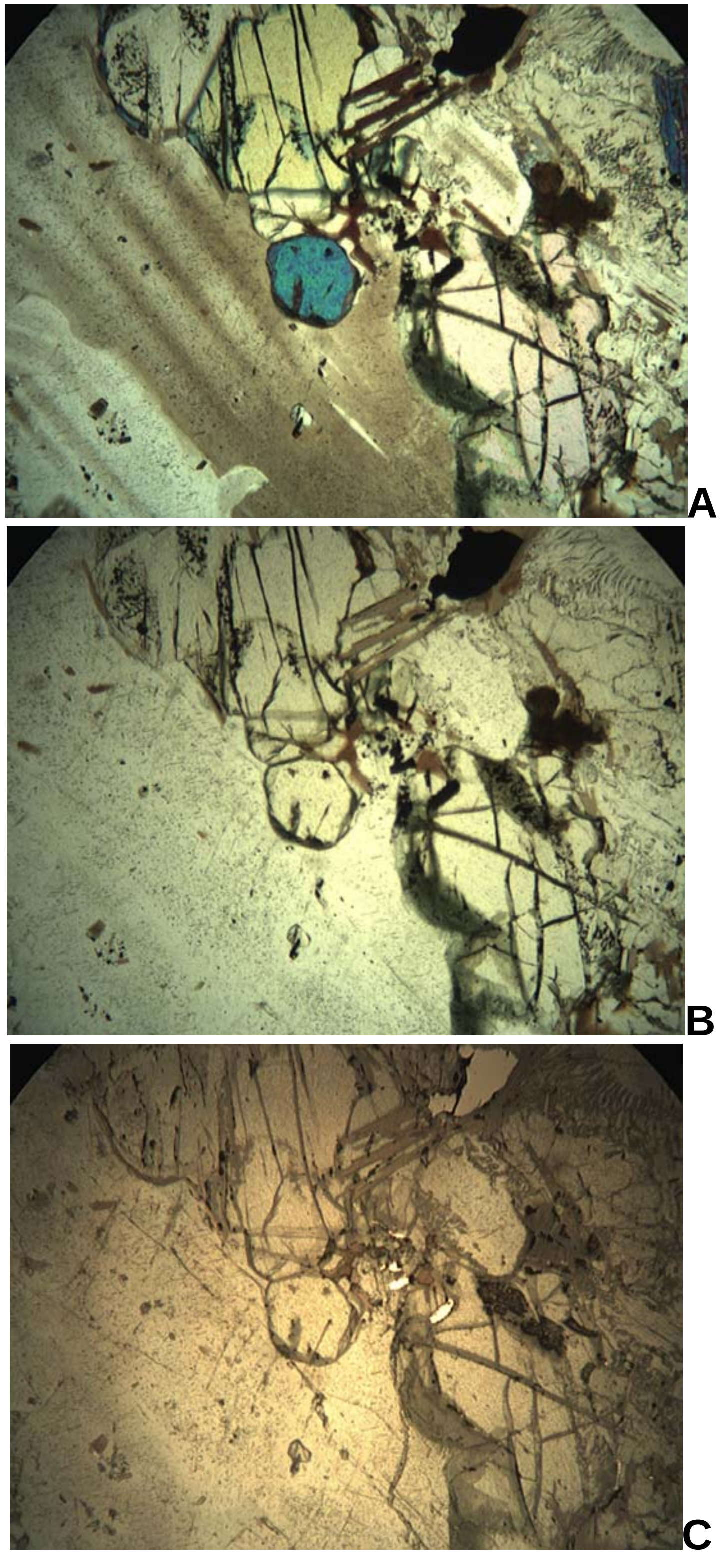
Drill Hole Number	From	To	Polymet Petrographic Footage	Vancouver Petrographic Number
99-320C	830	850	833	Z-131
99-320C	830	850	841	Z-132
00-361C	310	320	311	Z-75
00-361C	310	320	316	Z-76
00-361C	345	350	347	Z-77
00-361C	345	350	349	Z-78
00-343C	240	250	241	Z-59
00-343C	240	250	249	Z-60
26030	1047	1052	1048	Z-7
26030	1047	1052	1050	Z-8
26061	1218	1233	1220	Z-17
26061	1218	1233	1231	Z-18
00-340C	990	995	991	Z-57
00-340C	990	995	994	Z-58
00-340C	965	974.5	966	Z-55
00-340C	965	974.5	972	Z-56
26043	1501	1506	1502	Z-9
26043	1501	1506	1505	Z-10
26027	740	745	741	Z-3
26027	740	745	744	Z-4
00-368C	565	570	566	Z-105
00-368C	565	570	569	Z-106
26098	247	255	248	Z-27
26098	247	255	254	Z-28
26029	815	825	816	Z-5
26029	815	825	824	Z-6
26017	433	443	435	Z-1
26017	433	443	442	Z-2
00-340C	595	615	596	Z-51
00-340C	595	615	613	Z-52
00-334C	580	600	589	Z-43
00-334C	580	600	598	Z-44
00-334C	640	660	642	Z-45
00-334C	640	660	657	Z-46
00-347C	795	815	798	Z-65
00-347C	795	815	812	Z-66
00-350C	580	600	582	Z-67
00-350C	580	600	591	Z-68
00-327C	225	245	226	Z-37
00-327C	225	245	242	Z-38
00-371C	435	440	436	Z-115
00-371C	435	440	438	Z-116
00-340C	765	780	771	Z-53
00-340C	765	780	778	Z-54
00-357C	335	340	337	Z-71
00-357C	335	340	338	Z-72
00-326C	680	685	680	Z-35
00-326C	680	685	684	Z-36
00-357C	535	540	536	Z-73
00-357C	535	540	539	Z-74
99-318C	725	735	728	Z-125
99-318C	725	735	735	Z-126
99-317C	460	470	462	Z-121
99-317C	460	470	465	Z-122
00-366C	185	205	187	Z-85
00-366C	185	205	204	Z-86
00-366C	230	240	231	Z-87
00-366C	230	240	239	Z-88
99-320C	165	175	167	Z-127
99-320C	165	175	172	Z-128
99-318C	250	270	257	Z-123
99-318C	250	270	267	Z-124
00-373C	95	115	99	Z-119
00-373C	95	115	114	Z-120

Drill Hole Number	From	To	Polymet Petrographic Footage	Vancouver Petrographic Number	
00-373C	75	95	78	Z-117	
00-373C	75	95	93	Z-118	
00-357C	110	130	112	Z-69	
00-357C	110	130	126	Z-70	
99-320C	315	330	319	Z-129	
99-320C	315	330	328	Z-130	
00-369C	335	345	336	Z-111	
00-369C	335	345	341	Z-112	
00-368C	460	465	462	Z-103	
00-368C	460	465	463	Z-184	
26055	940	945	941	Z-11	
26055	940	945	944	Z-12	
26098	145	148.5	146	Z-25	
26098	145	148.5	148	Z-26	
00-337C	105	110	106	Z-47	
00-337C	105	110	108	Z-48	
00-334C	30	50	31	Z-39	
00-334C	30	50	50	Z-40	
00-368C	125	145	132	Z-101	
00-368C	125	145	143	Z-102	
00-368C	20	40	28	Z-99	Two slides
00-368C	20	40	39	Z-100	
00-366C	35	55	37	Z-83	
00-366C	35	55	47	Z-84	
00-334C	110	130	112	Z-41	
00-334C	110	130	128	Z-42	
00-347C	155	175	157	Z-61	
00-347C	155	175	174	Z-62	
00-347C	280	300	282	Z-63	
00-347C	280	300	299	Z-64	
00-326C	60	70	61	Z-33	
00-326C	60	70	66	Z-34	
00-369C	305	325	306	Z-109	
00-369C	305	325	318	Z-110	
00-367C	50	65	55	Z-89	
00-367C	50	65	62	Z-90	
00-367C	260	280	269	Z-93	
00-367C	260	280	279	Z-94	
00-367C	290	310	297	Z-95	
00-367C	290	310	308	Z-96	
00-370C	20	30	22	Z-113	
00-370C	20	30	27	Z-114	
00-369C	20	30	22	Z-107	
00-369C	20	30	29	Z-108	
00-367C	170	175	171	Z-91	
00-367C	170	175	173	Z-92	
00-367C	395	400	395	Z-97	
00-367C	395	400	398	Z-98	
26064	44	54	45	Z-19	
26064	44	54	53	Z-20	
26064	264	269	264	Z-23	
26064	264	269	268	Z-24	
26064	146	156	148	Z-21	
26064	146	156	151	Z-22	
26056	110	125	113	Z-13	
26056	110	125	123	Z-14	
26056	135	153	138	Z-15	
26056	135	153	152	Z-16	
00-361C	737	749	739	Z-79	
00-361C	737	749	748	Z-80	
00-364C	210	229	211	Z-81	
00-364C	210	229	228	Z-82	
00-337C	510	520	511	Z-49	
00-337C	510	520	519	Z-50	

Drill Hole Number	From	To	Polymet Petrographic Footage	Vancouver Petrographic Number	
26027	616	626	620	ON-3	
26027	616	626	624	ON-4	
26062	993	998	994	ON-11	
26062	993	998	996	ON-12	
26026	565	568	566	ON-1	
26026	565	568	567	ON-2	
00-340C	725	745	726	ON-19	
00-340C	725	745	744	ON-20	
00-344C	515	520	516	ON-21	
00-344C	515	520	518	ON-22	
00-340C	380	390	381	ON-17	
00-340C	380	390	389	ON-18	
00-361C	240	245	241	ON-23	
00-361C	240	245	244	ON-24	
26049	358	362	359	ON-7	
26049	358	362	361	ON-8	
26030	291	296	292	ON-5	
26030	291	296	295	ON-6	
00-367C	400	405	401	ON-25	
00-367C	400	405	404	ON-26	
26056	302	312	306	ON-9	
26056	302	312	311	ON-10	
26142	360	365	361	ON-15	
26142	360	365	364	ON-16	
26142	345	350	346	ON-13	Two slides
26142	345	350	349	ON-14	
99-320C	400	405	401	PM-1	
99-320C	400	405	404	PM-2	
00-331C	255	260	256	PM-3	
00-331C	255	260	259	PM-4	
26058	704	715	706	PM-5	
26058	704	715	712	PM-6	
00-326C	250	265	251	PM-7	
00-326C	250	265	261	PM-8	
00-340C	910	925	912	PM-9	
00-340C	910	925	922	PM-10	
00-331C	190	210	194	PM-11	
00-331C	190	210	206	PM-12	
00-326C	495	505	496	PM-13	
00-326C	495	505	504	PM-14	
00-344C	630	635	631	PM-15	
00-344C	630	635	634	PM-16	
00-330C	275	280	276	PM-17	
00-330C	275	280	279	PM-18	
99-318C	325	330	326	PM-19	
99-318C	325	330	329	PM-20	
00-326C	225	235	226	PM-21	
00-326C	225	235	234	PM-22	
26039	310	315	311	PM-23	
26039	310	315	314	PM-24	
00-367C	495	500	496	PM-25	
00-367C	495	500	499	PM-26	
26056	282	292	283	PM-27	
26056	282	292	291	PM-28	

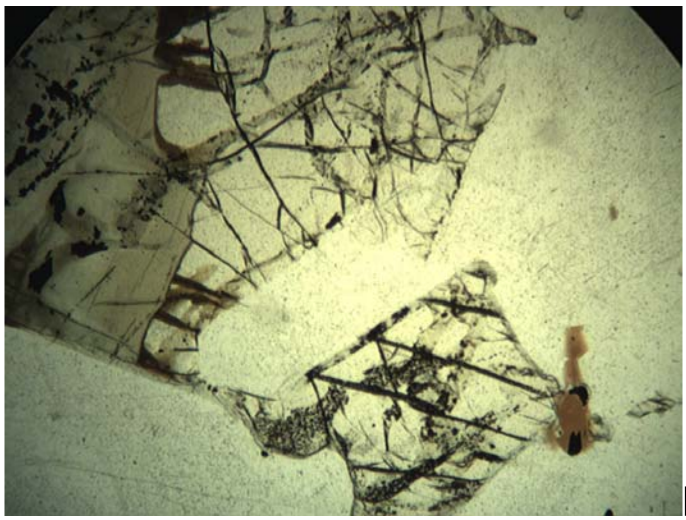
Appendix D.2

Photomicrographs

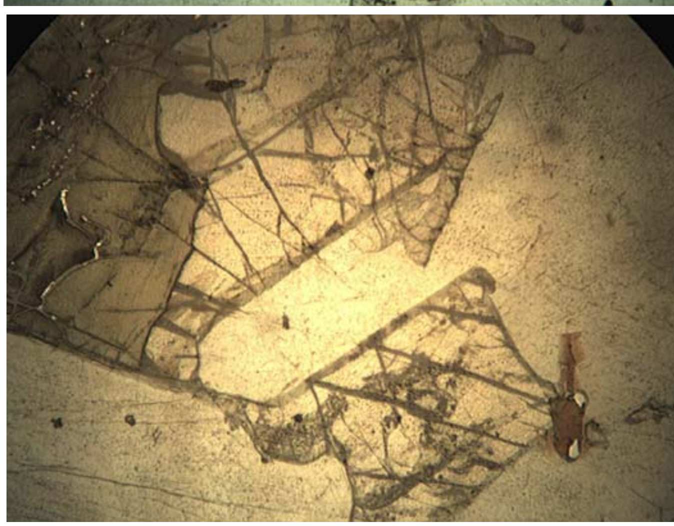


Humidity Cell Sample 99-320C (830-850)-1
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

A

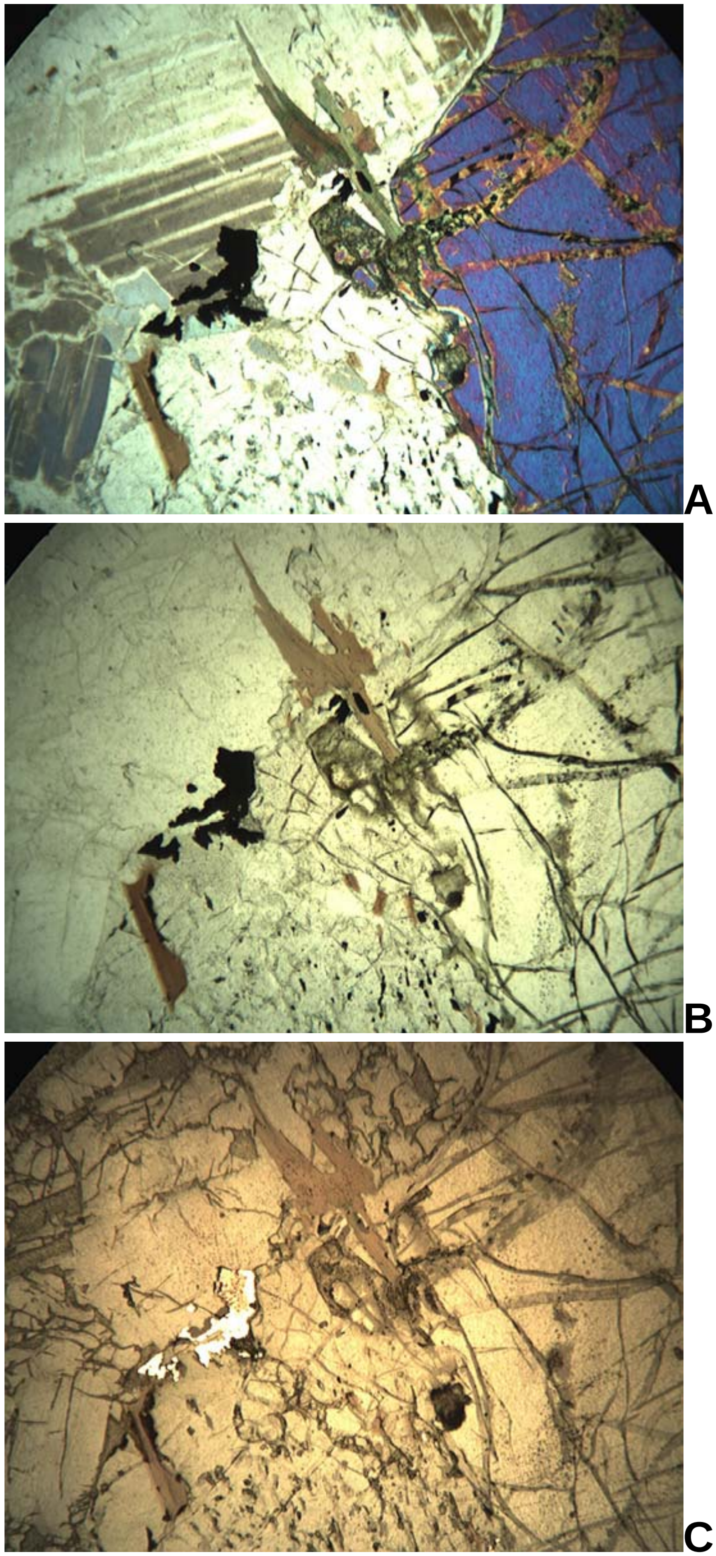


B

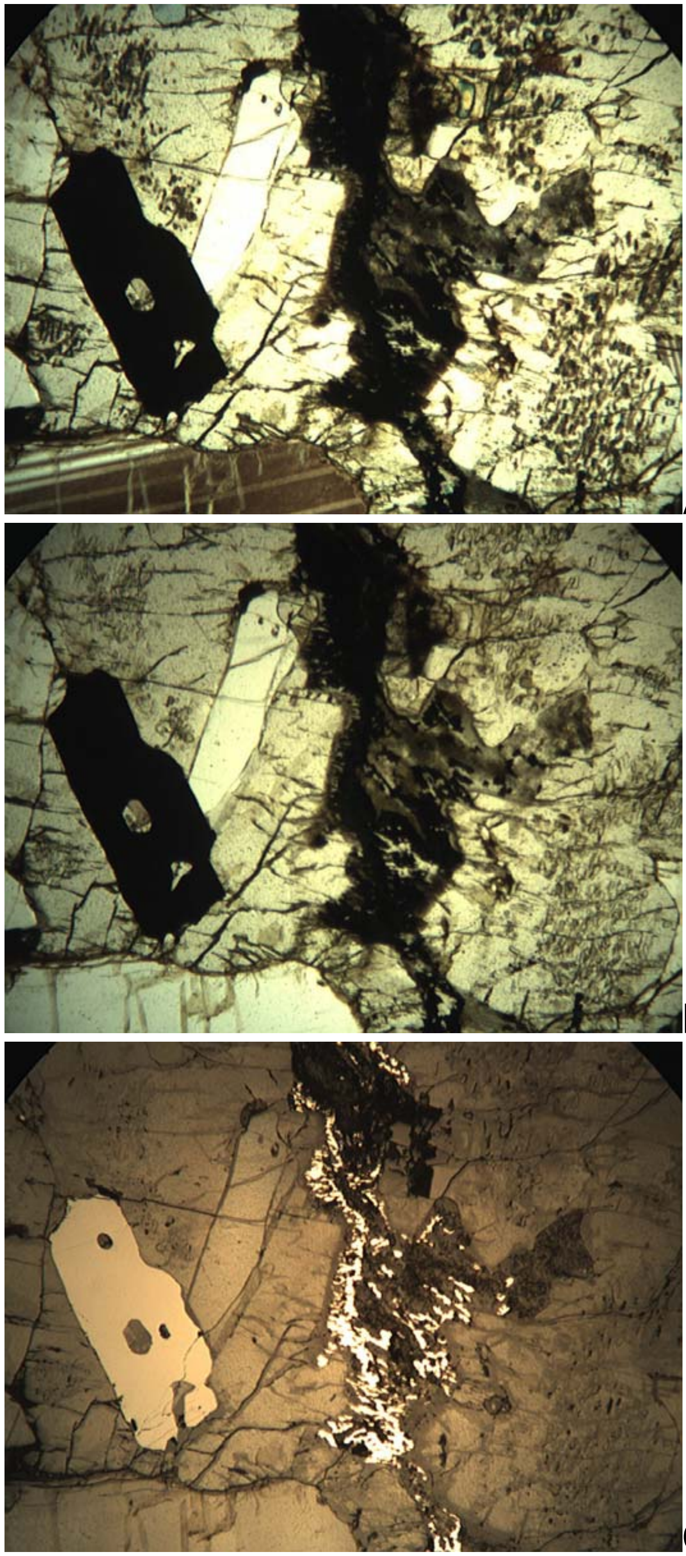


C

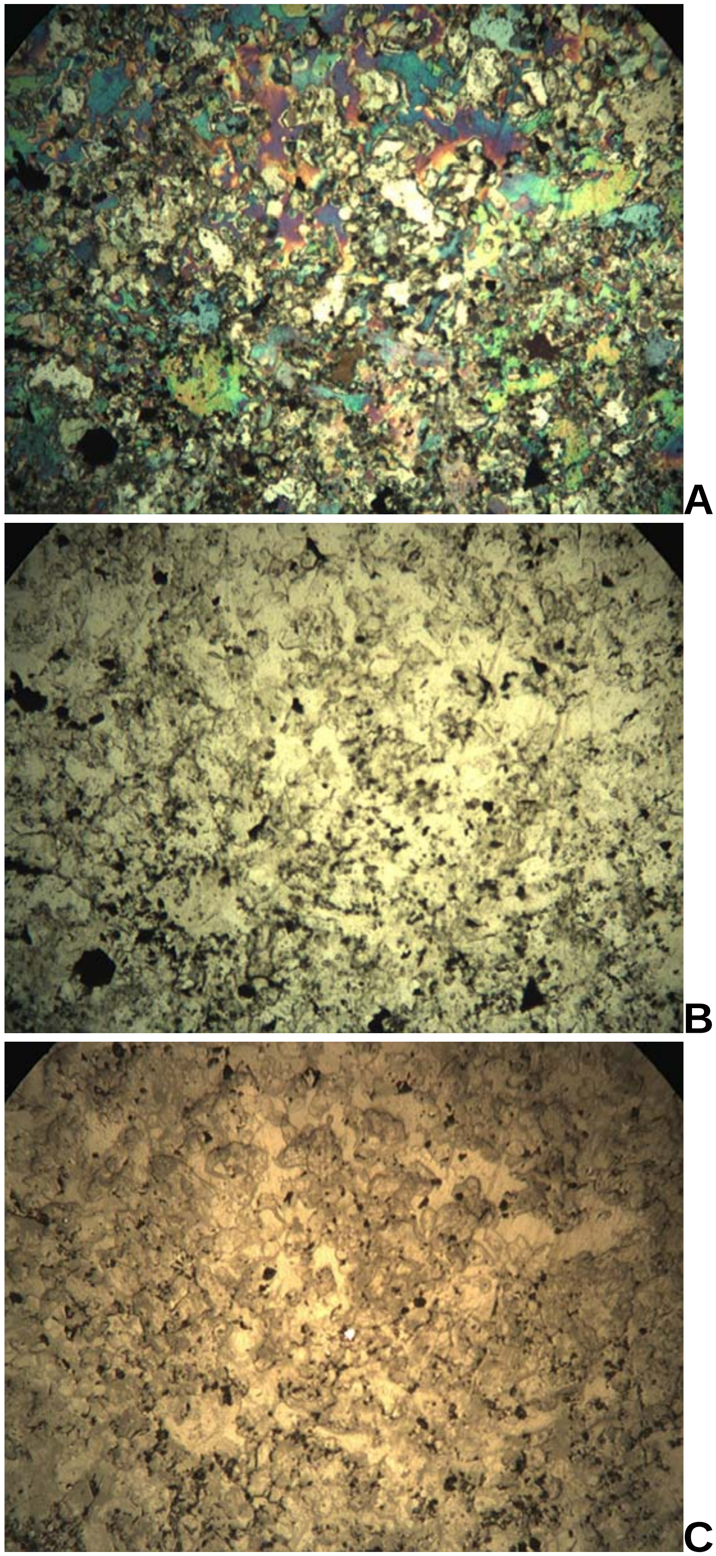
Humidity Cell Sample 00-361C (310-320)-2
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



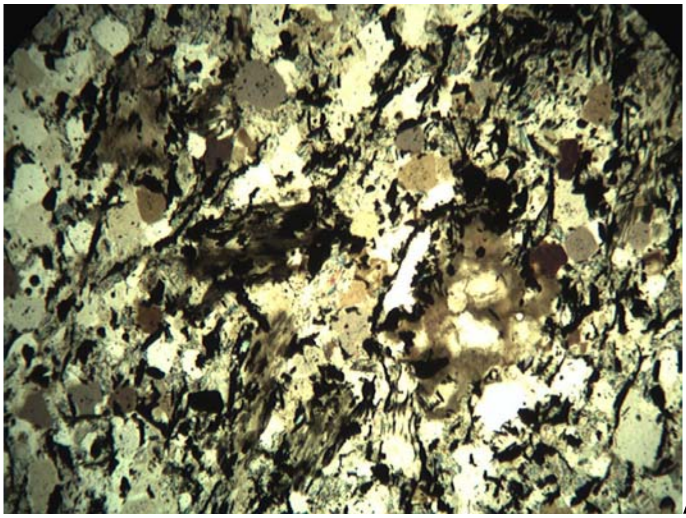
Humidity Cell Sample 00-361C (345-350)-3
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A
B
C

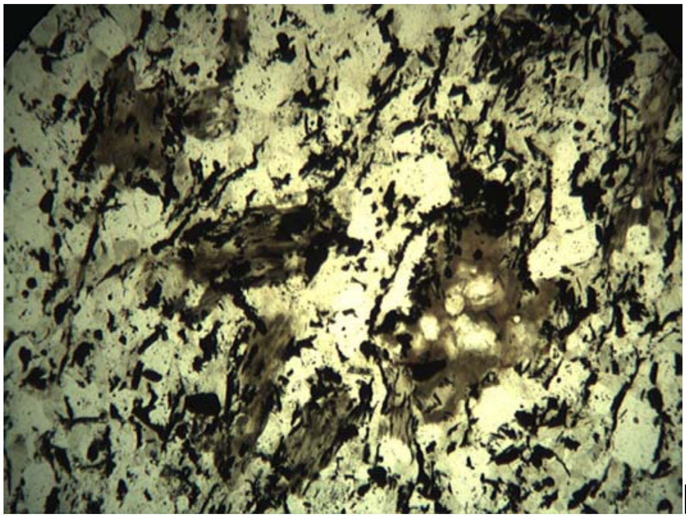
Humidity Cell Sample 00-343C (240-250)-4
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



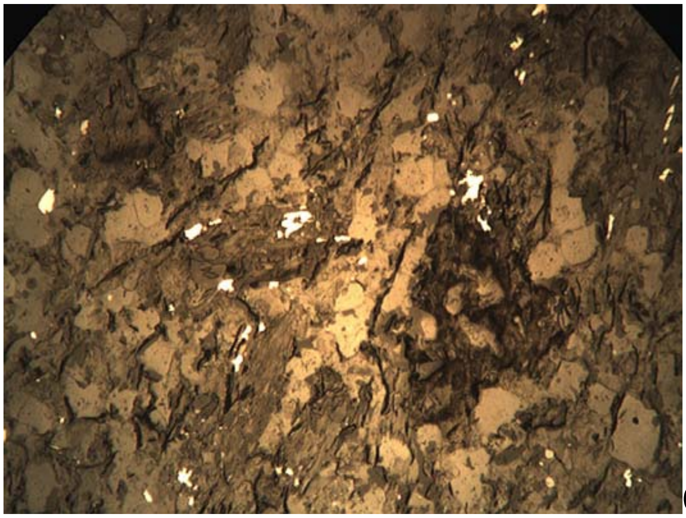
Humidity Cell Sample 26030 (1047-1052)-5
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

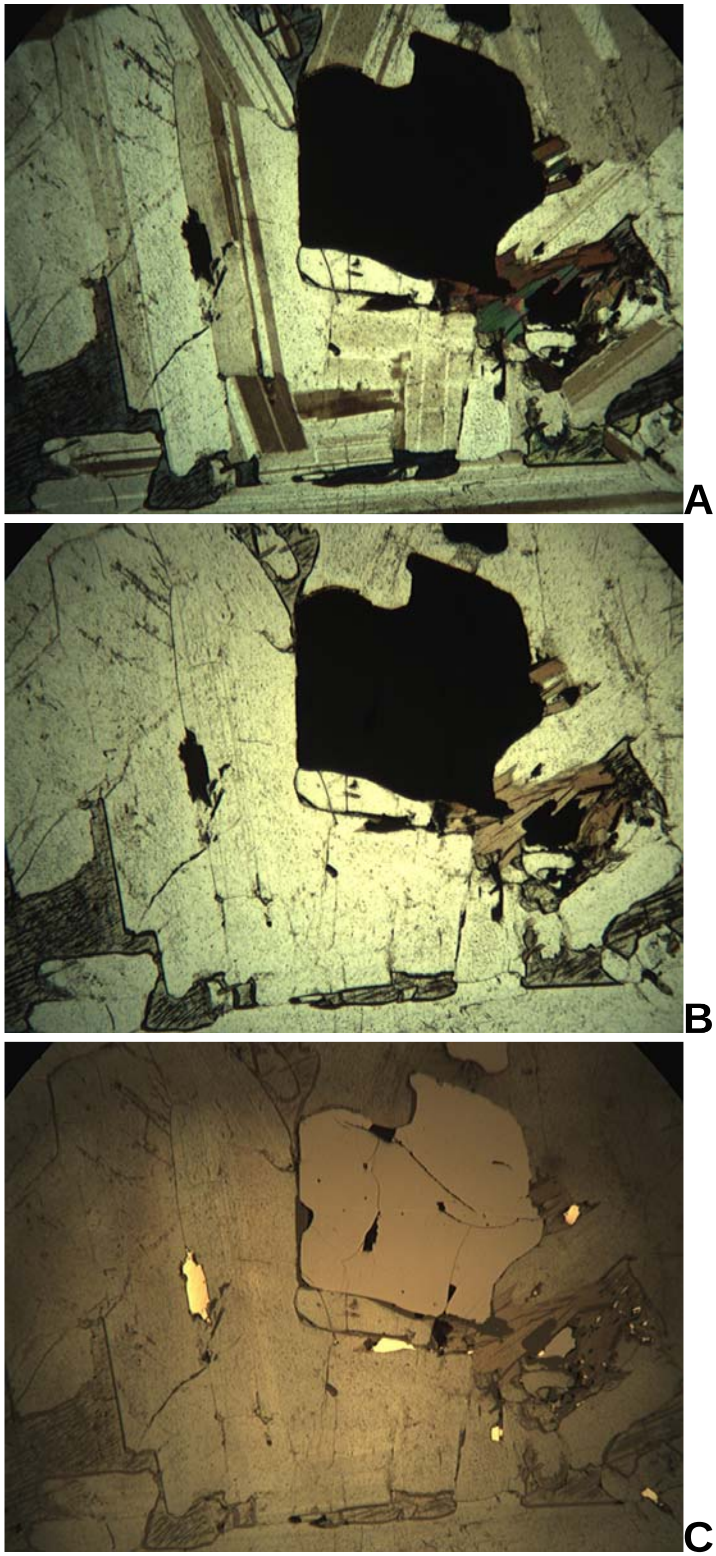


B

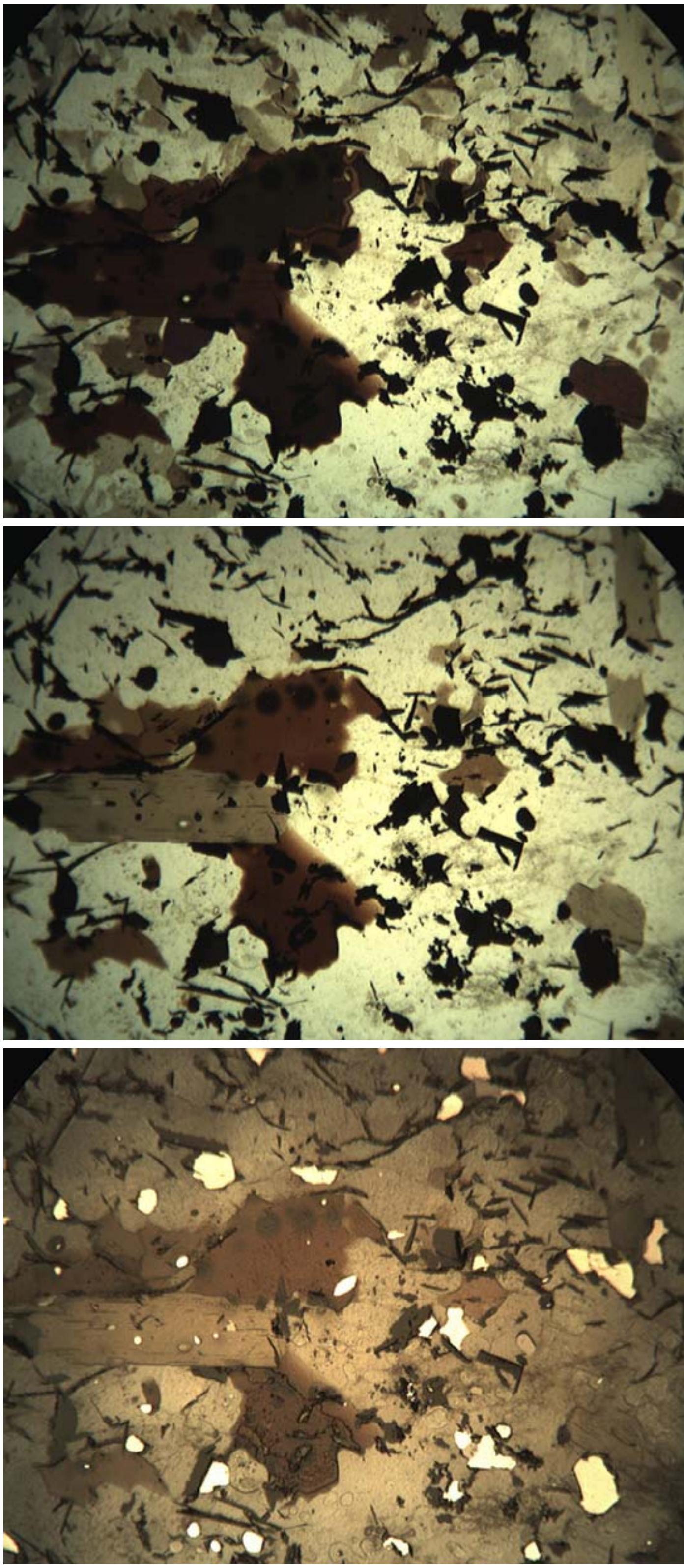


C

Humidity Cell Sample 26061 (1218-1233)-6
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



Humidity Cell Sample 00-340C (990-995)-7
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



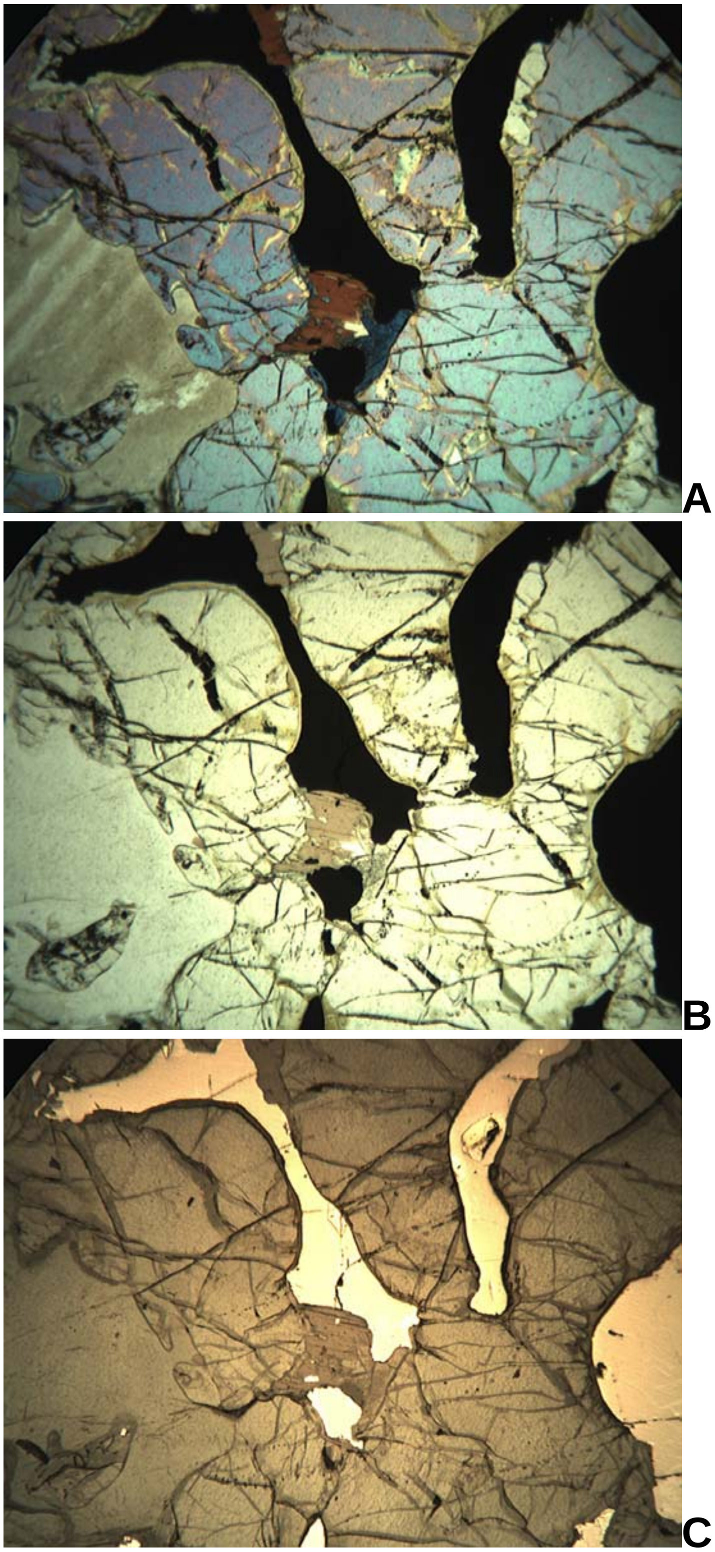
A

B

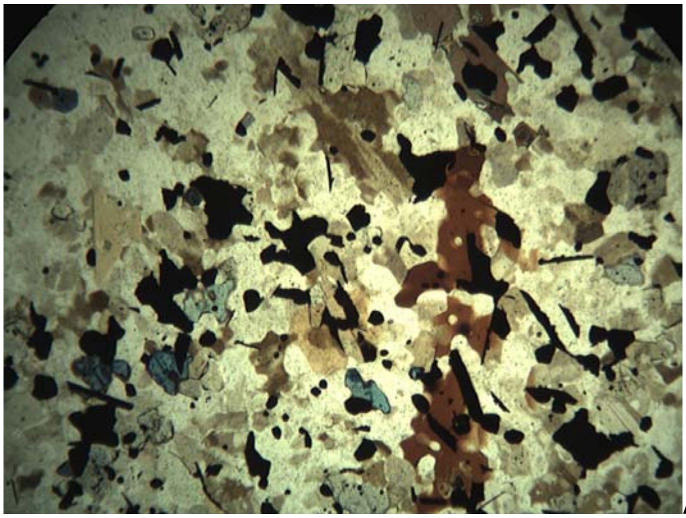
C

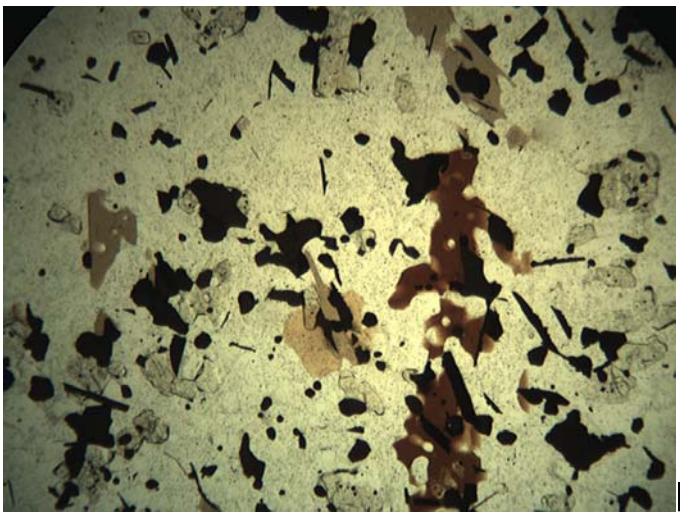
Humidity Cell Sample 00-340C (965-974.5)-8

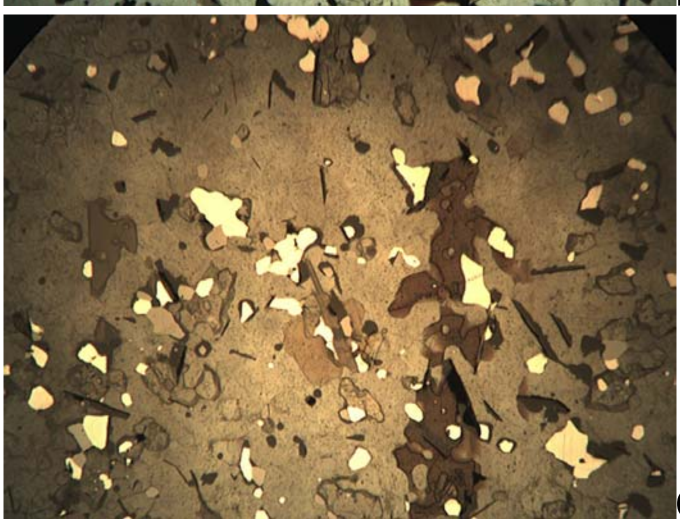
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



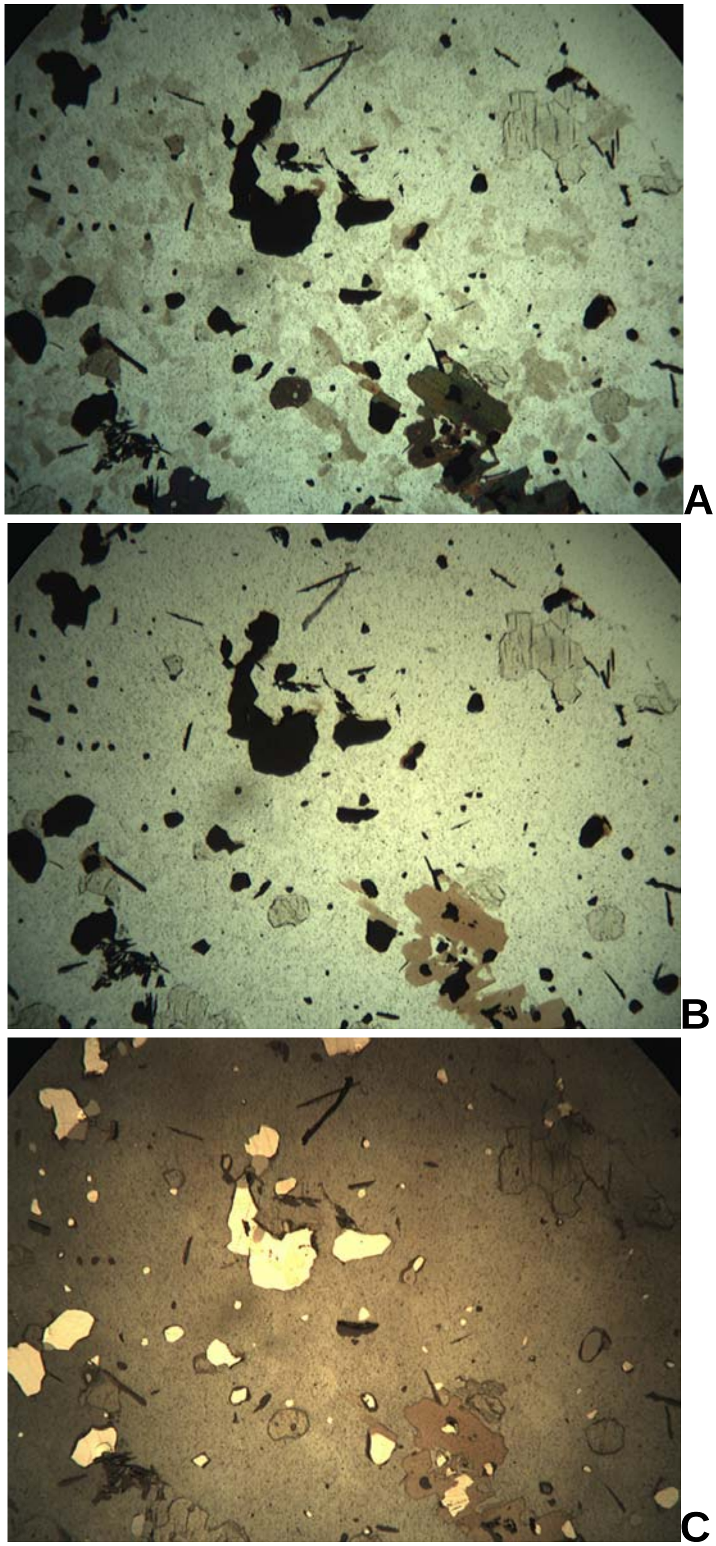
Humidity Cell Sample 00-340C (765-780)-10D
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A

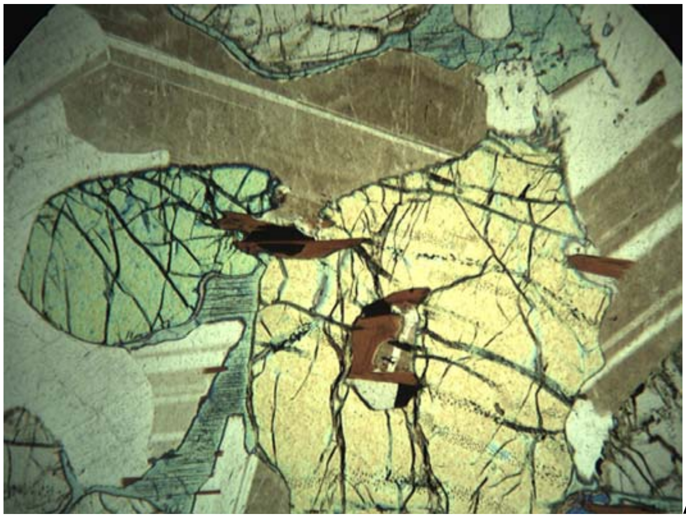

B


C

Humidity Cell Sample 26043 (1501-1506)-11a
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

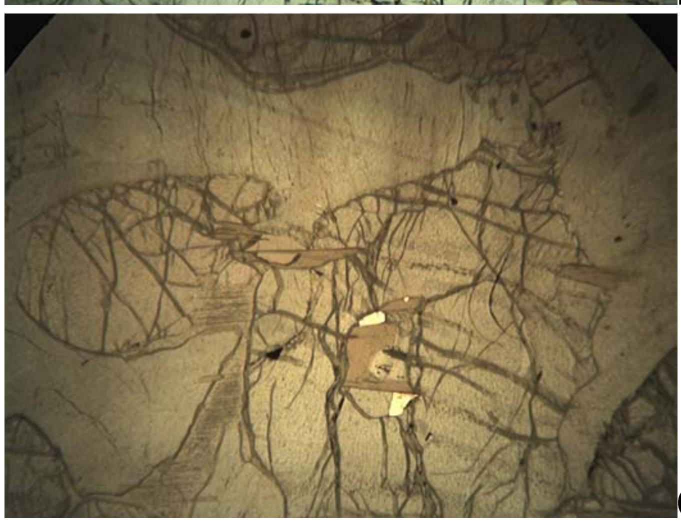


Humidity Cell Sample 26027 (740-745)-11b
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

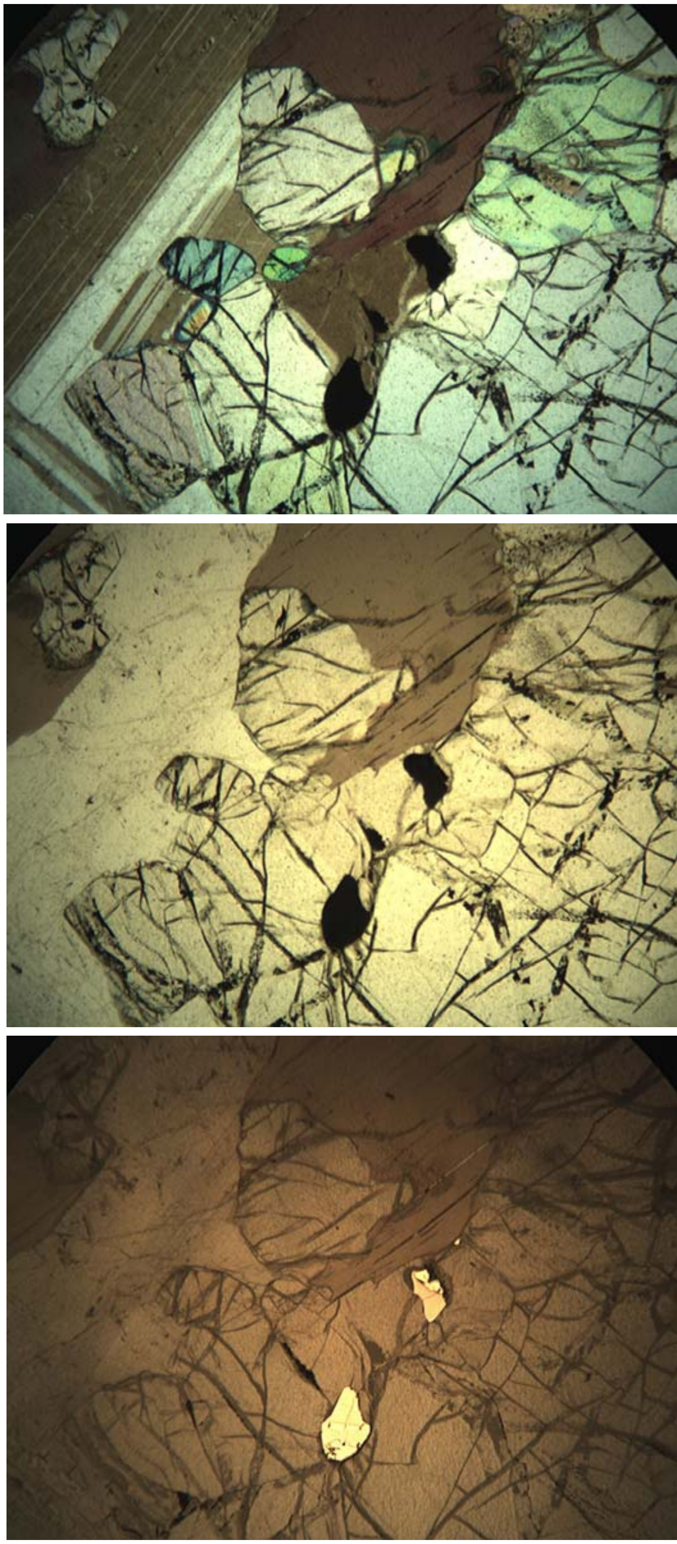
B



C

Humidity Cell Sample 00-340C (595-615)-13

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

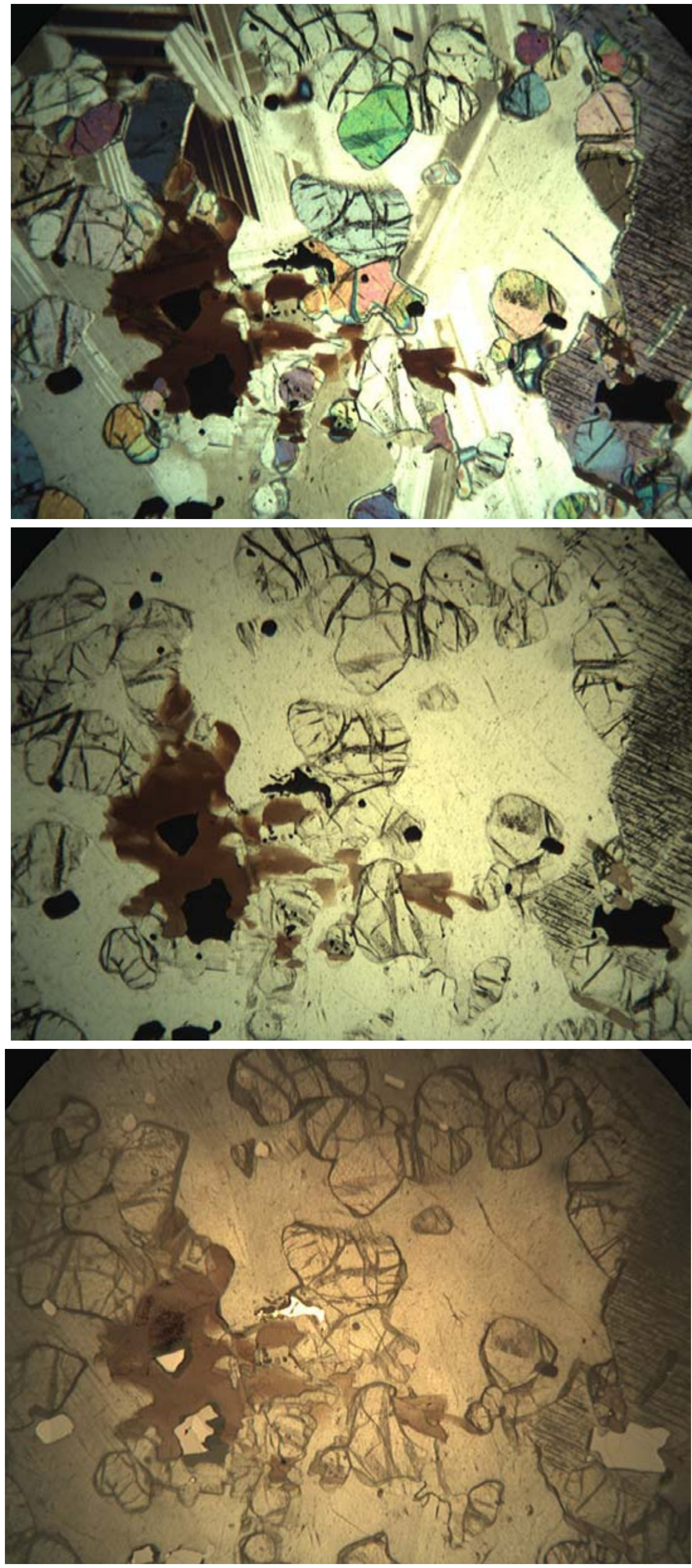

A
B
C

Humidity Cell Sample 00-334 (580-600)-14

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

A
B
C

Humidity Cell Sample 00-334 (640-660)-15
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



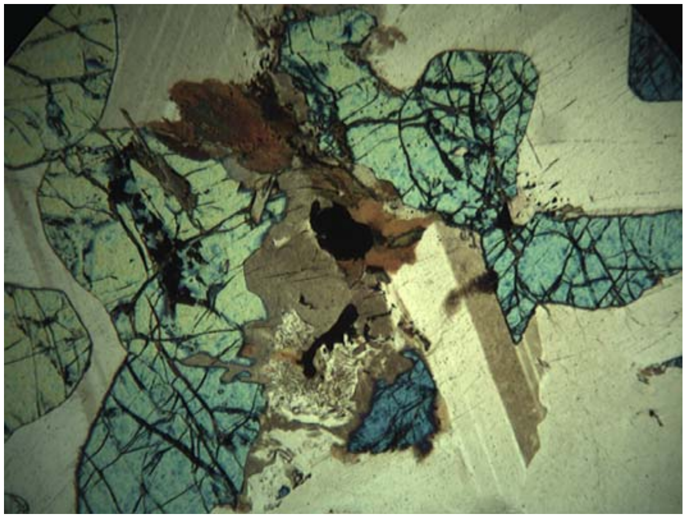
A

B

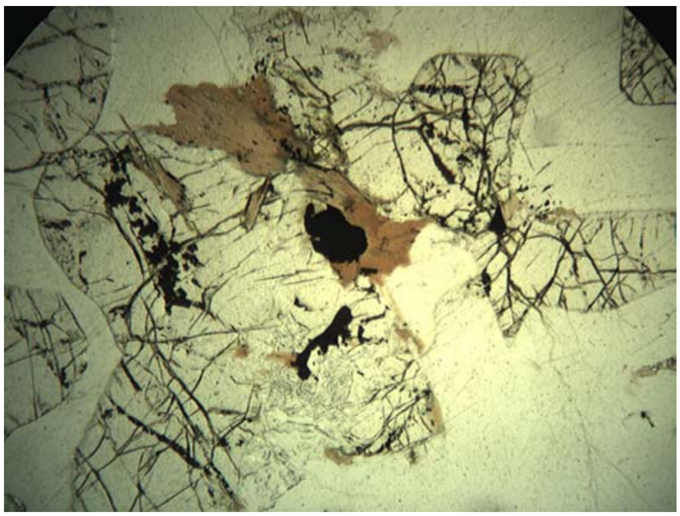
C

Humidity Cell Sample 00-347C (795-815)-16

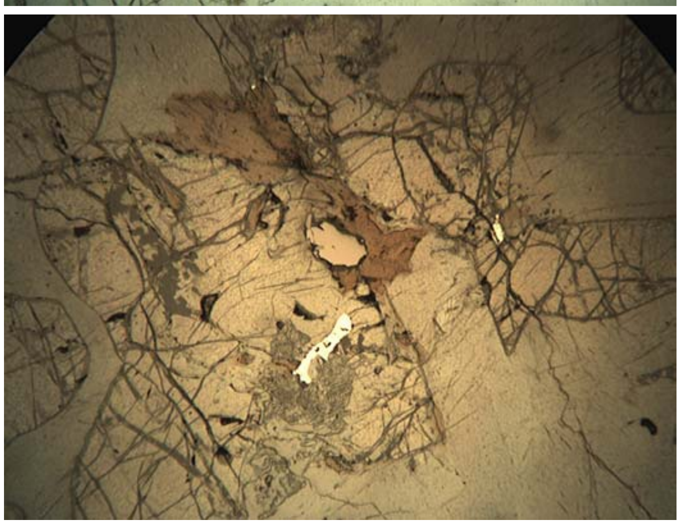
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

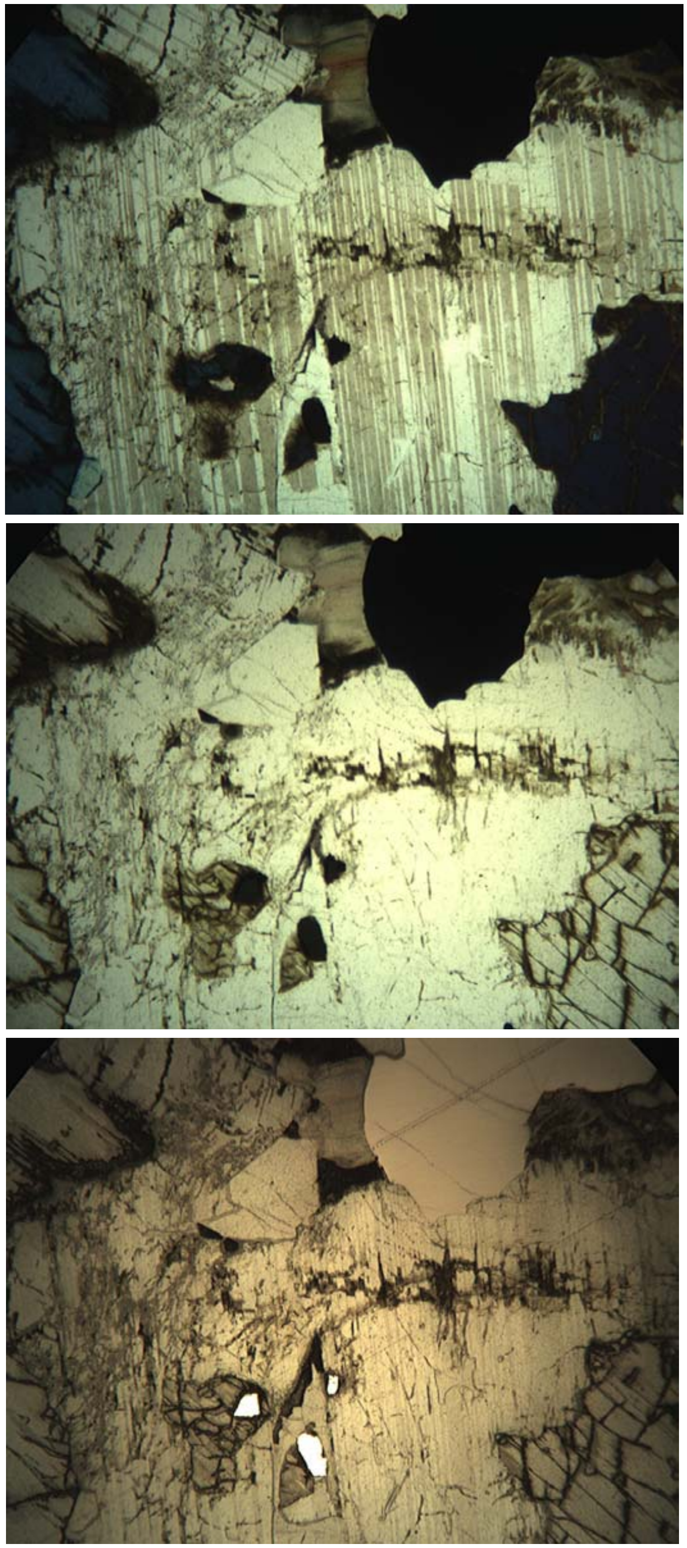


B



C

Humidity Cell Sample 00-327C (225-245) -18
A) **Cross** Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

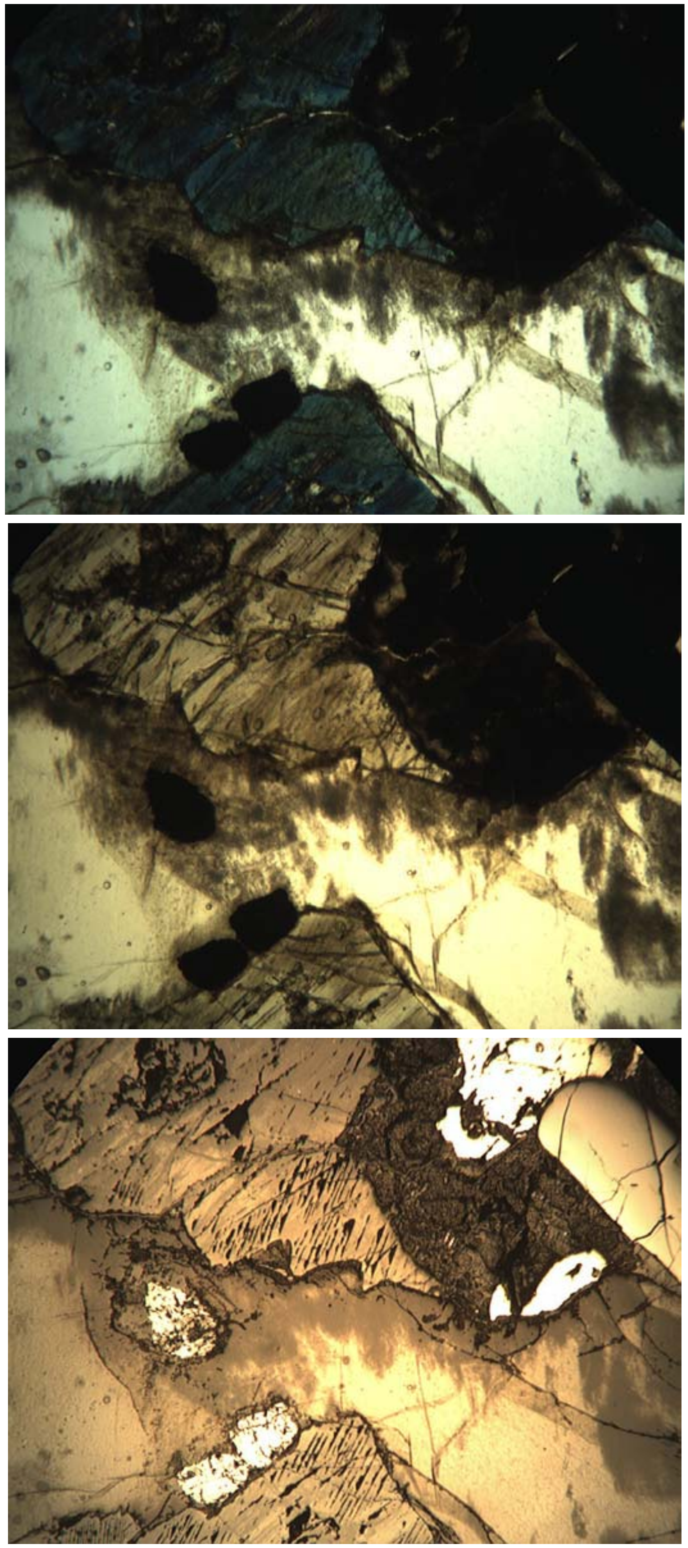


A

B

C

Humidity Cell Sample 00-371C (435-440) -19
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected **Light**, Field of View = ~2 mm



A

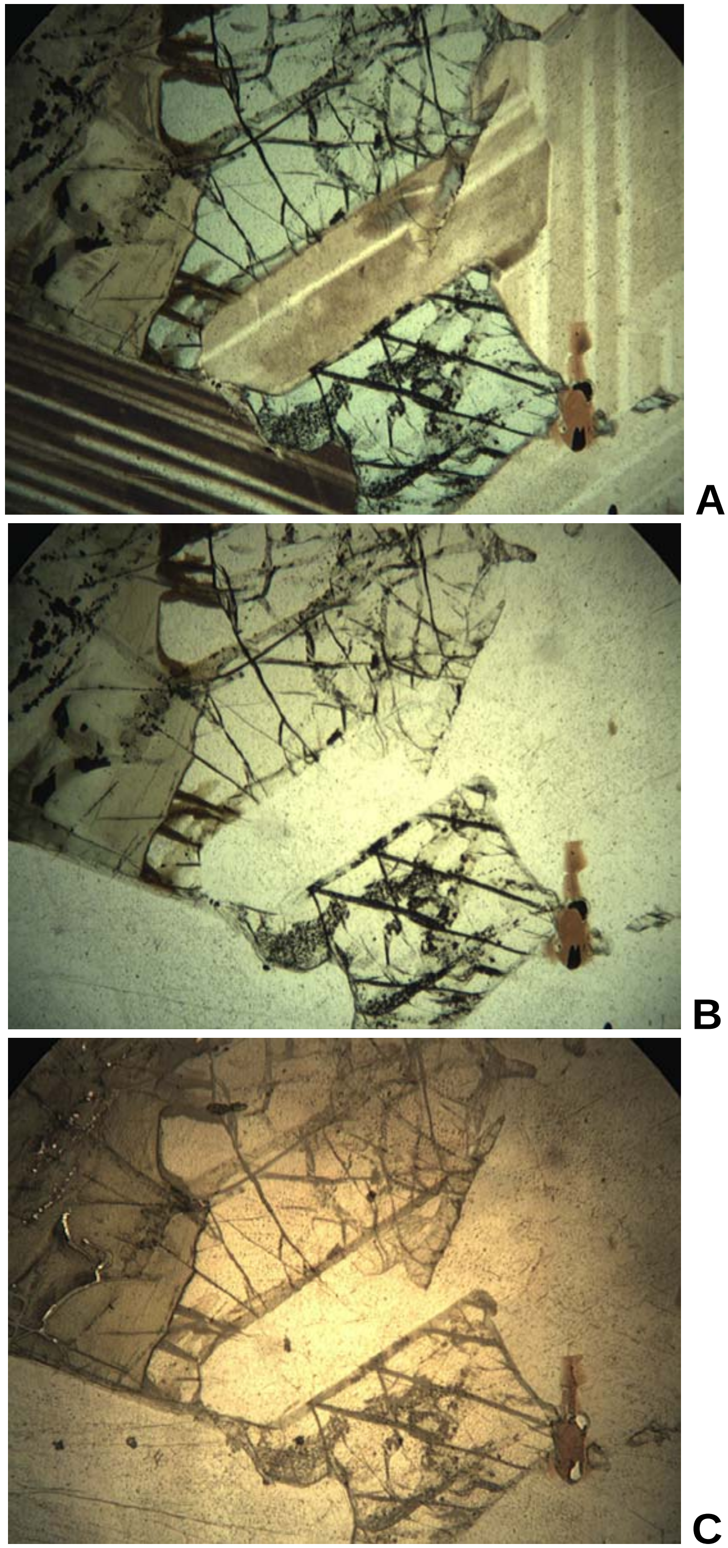
B

C

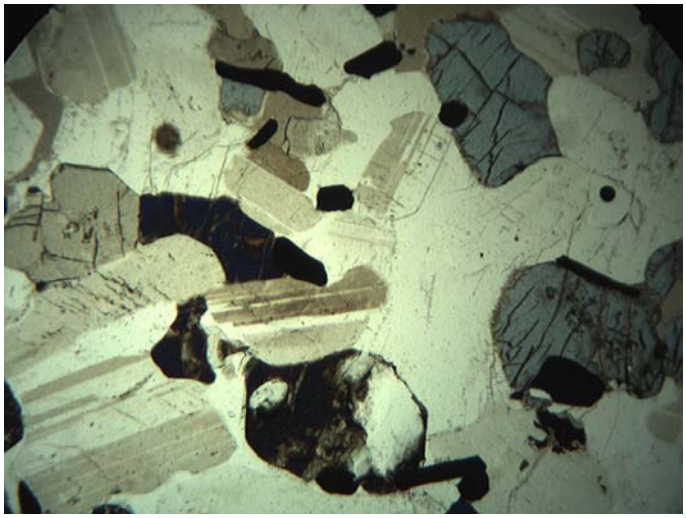
Humidity Cell Sample 00-357C (335-340) -21
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

A B C

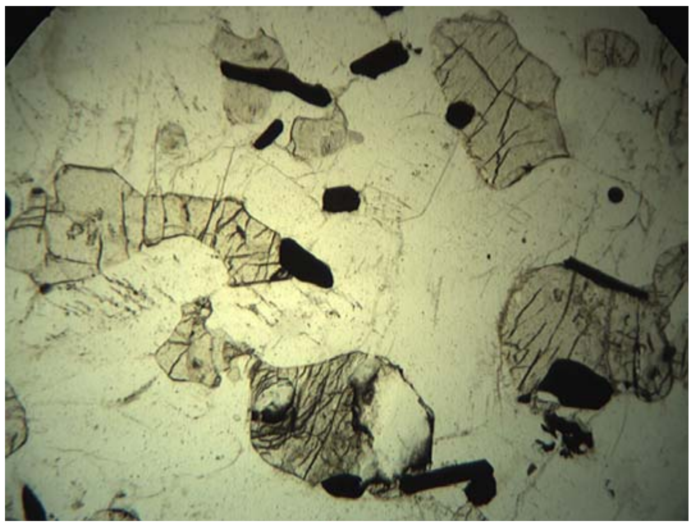
Humidity Cell Sample 00-326C (680-685) -22
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



Humidity Cell Sample 00-357C (535-540) -23
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

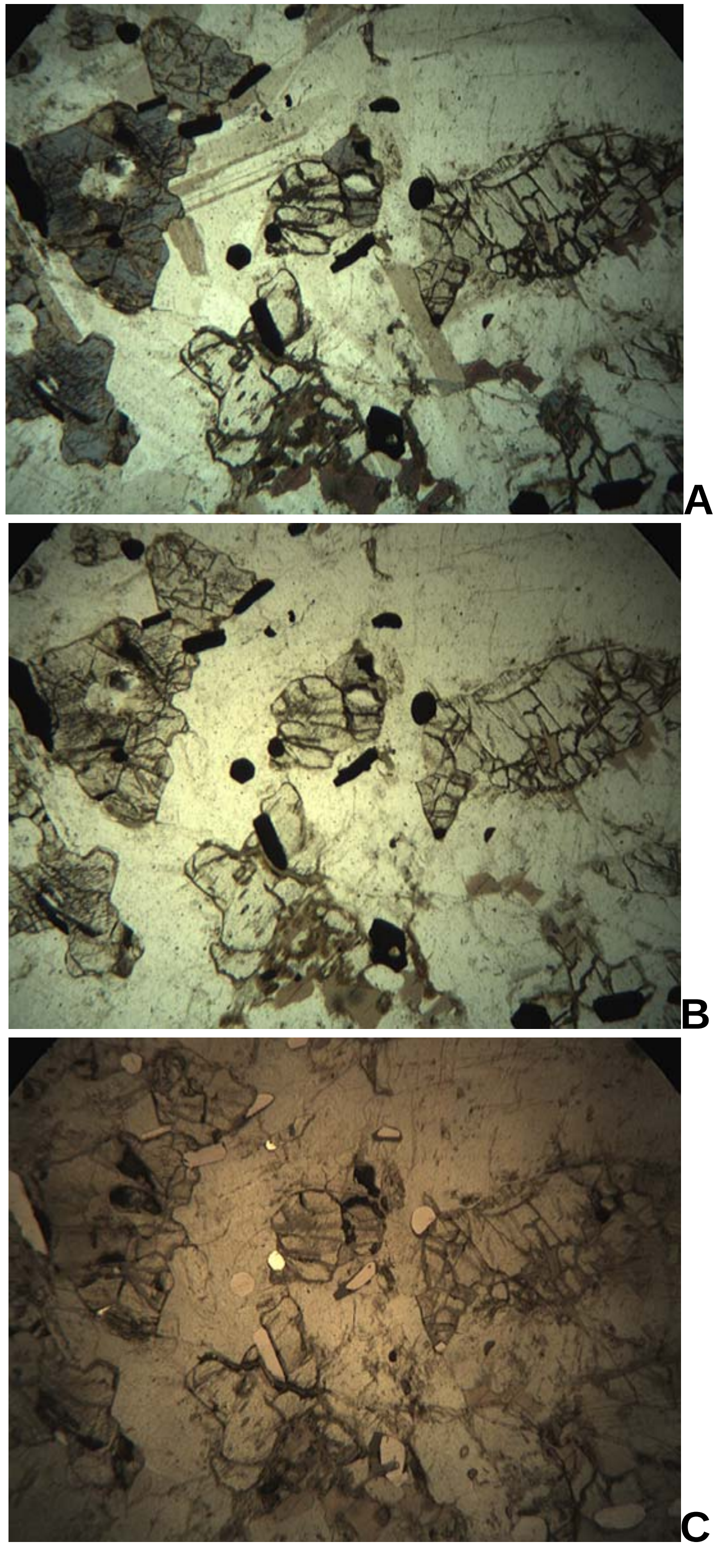


B

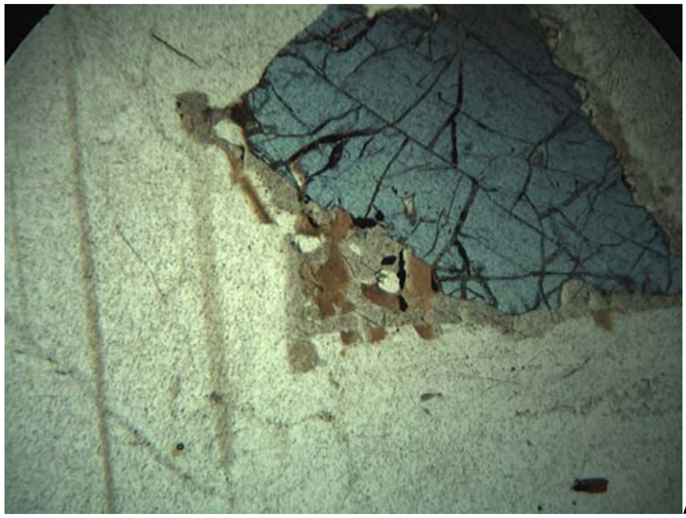
C

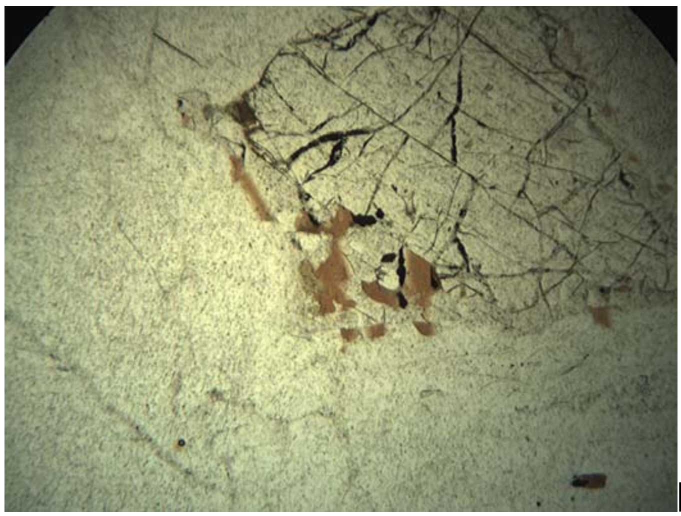
Humidity Cell Sample 99-318C (725-735) -24

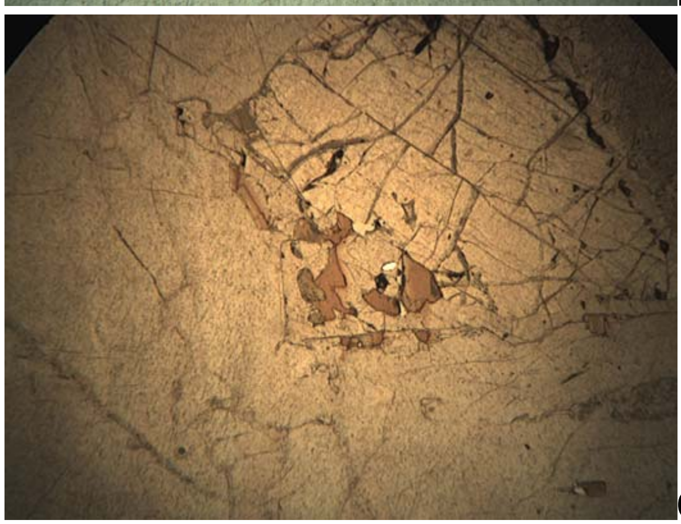
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



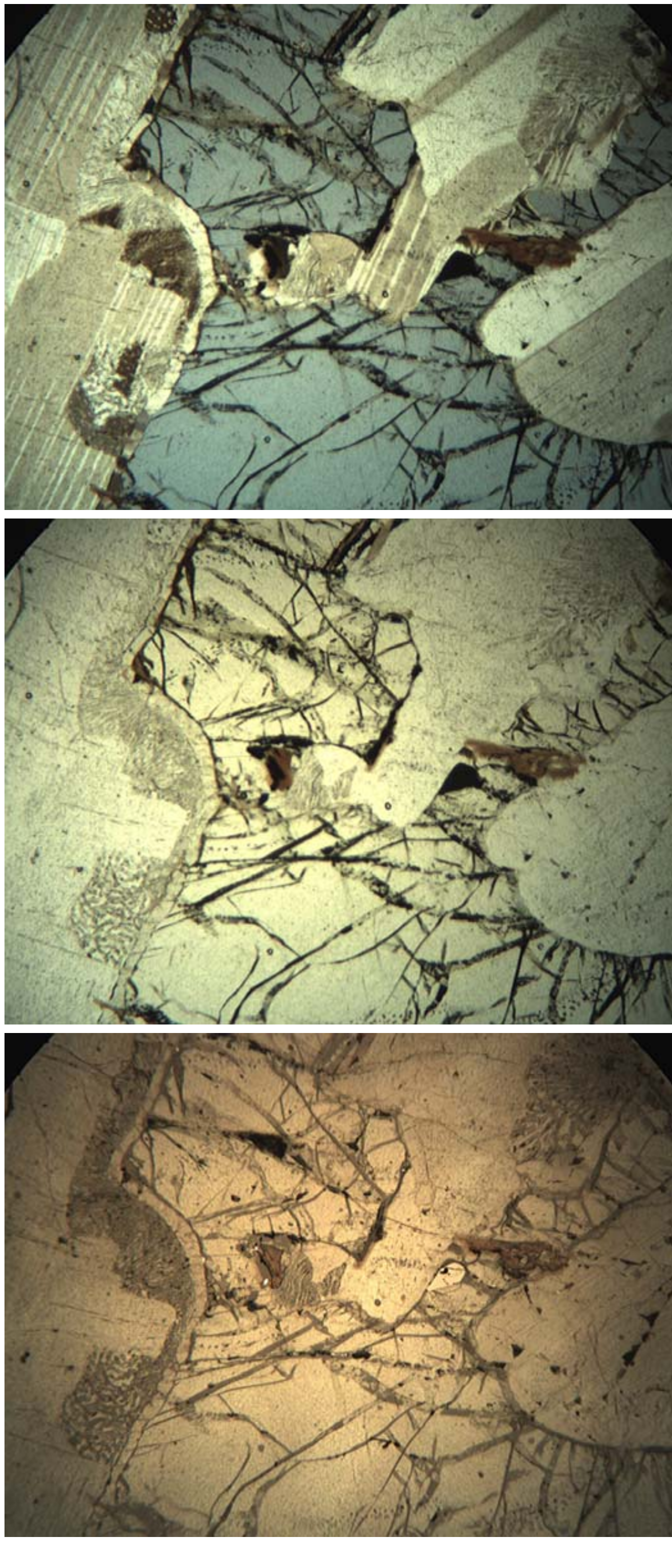
Humidity Cell Sample 99-317C (460-470) -25
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B


C

Humidity Cell Sample 00-366C (185-205) -26
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



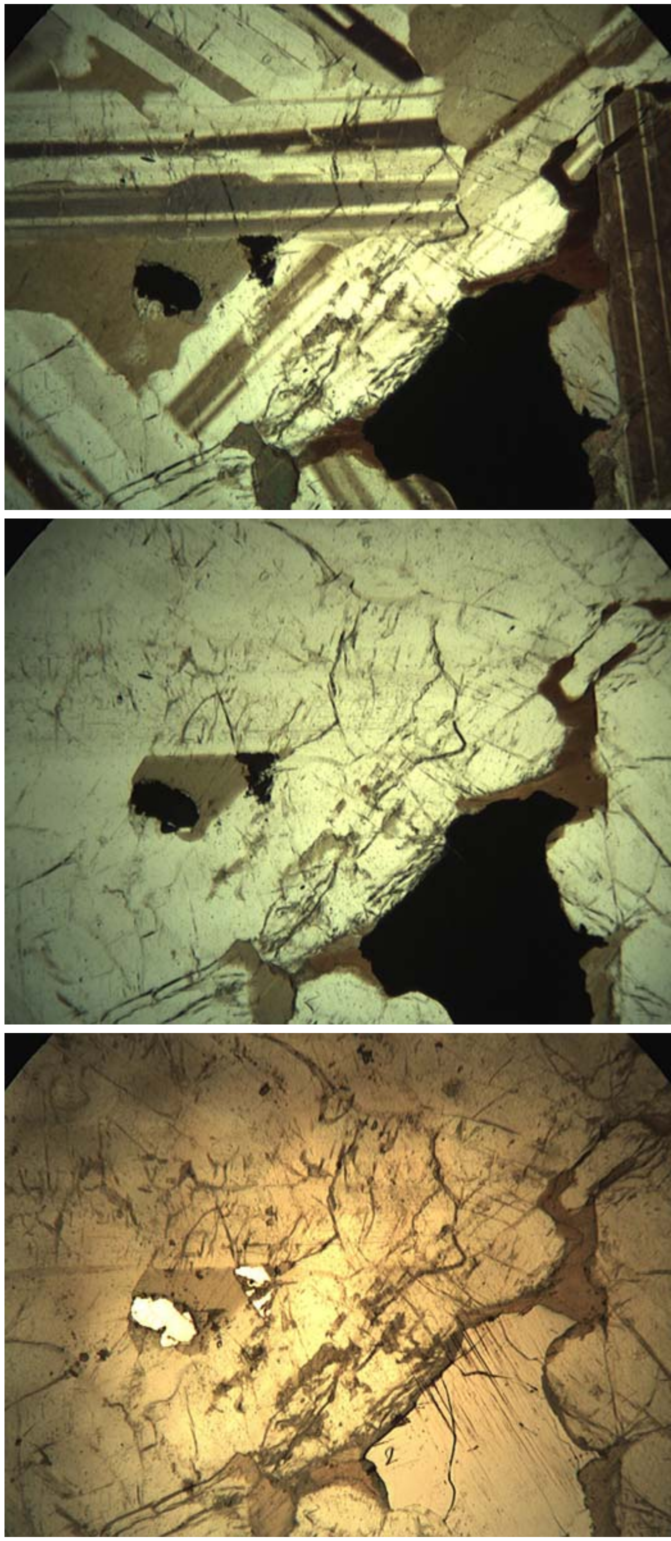
A

B

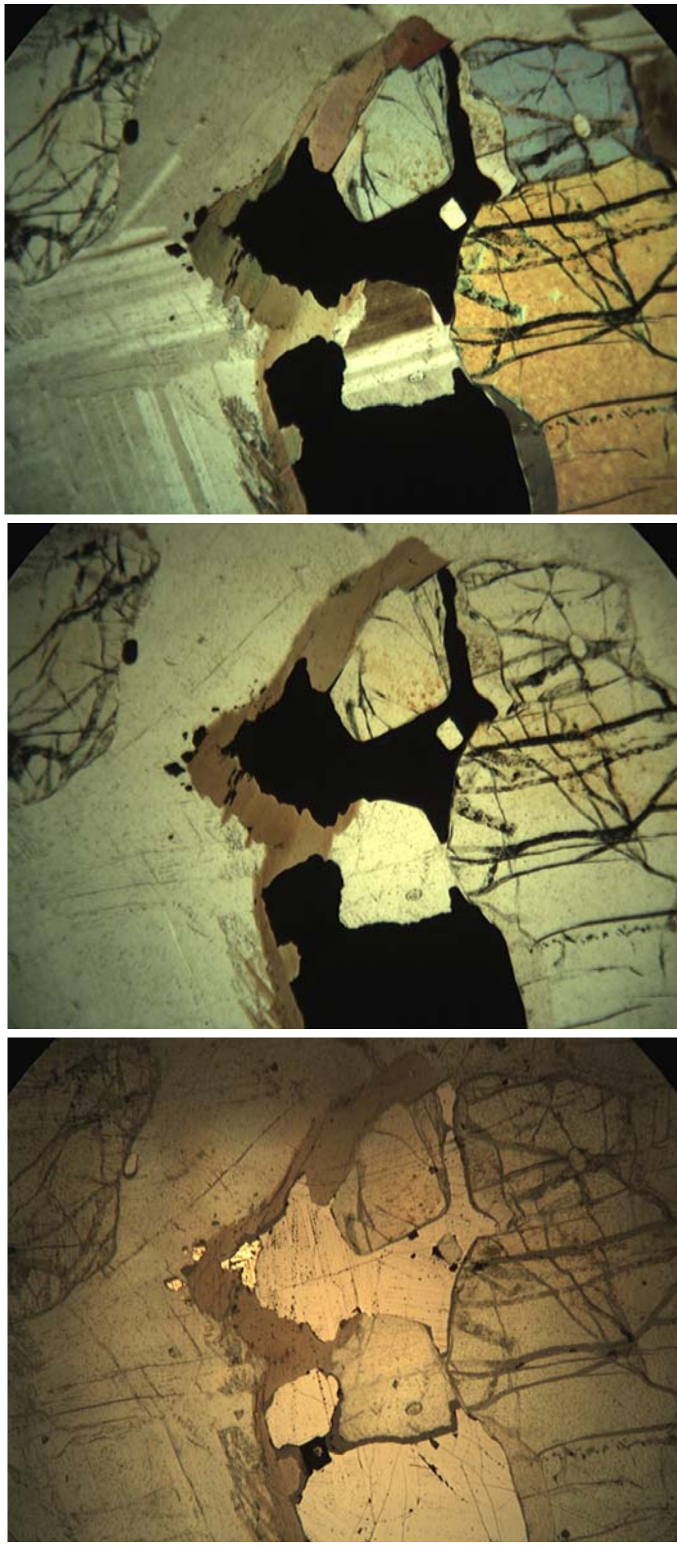
C

Humidity Cell Sample 00-366C (230-240) -27

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A
B
C

Humidity Cell Sample 99-320C (165-175) -28
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



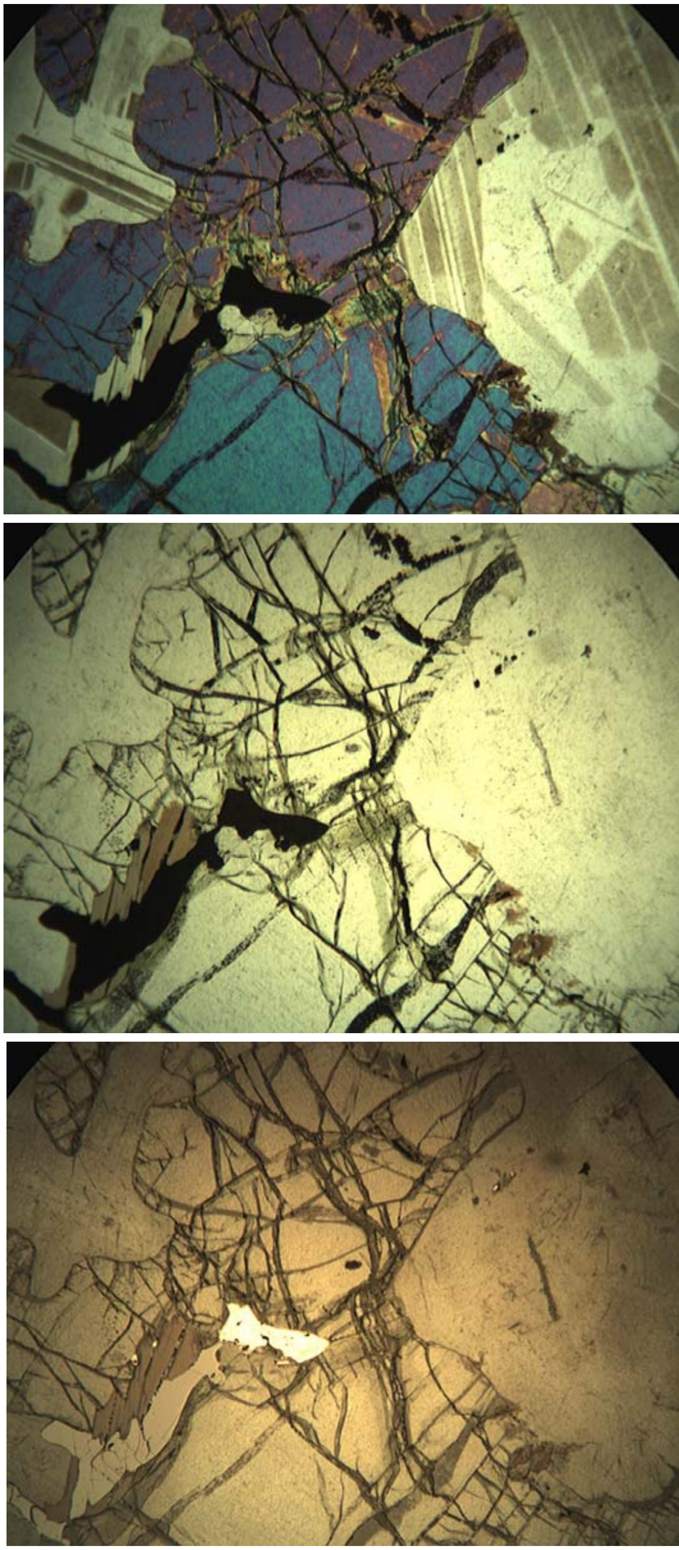
A

B

C

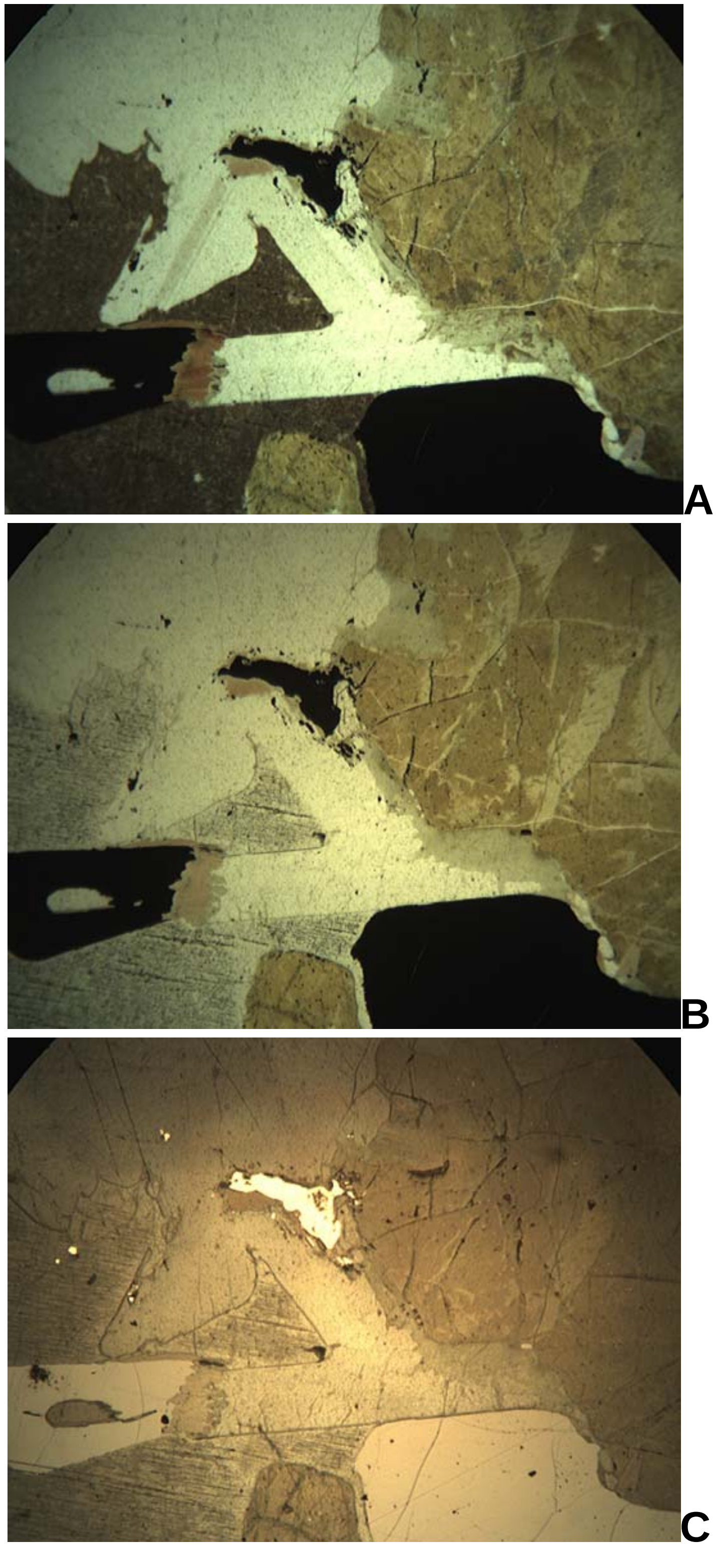
Humidity Cell Sample 99-318C (250-370) -29

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

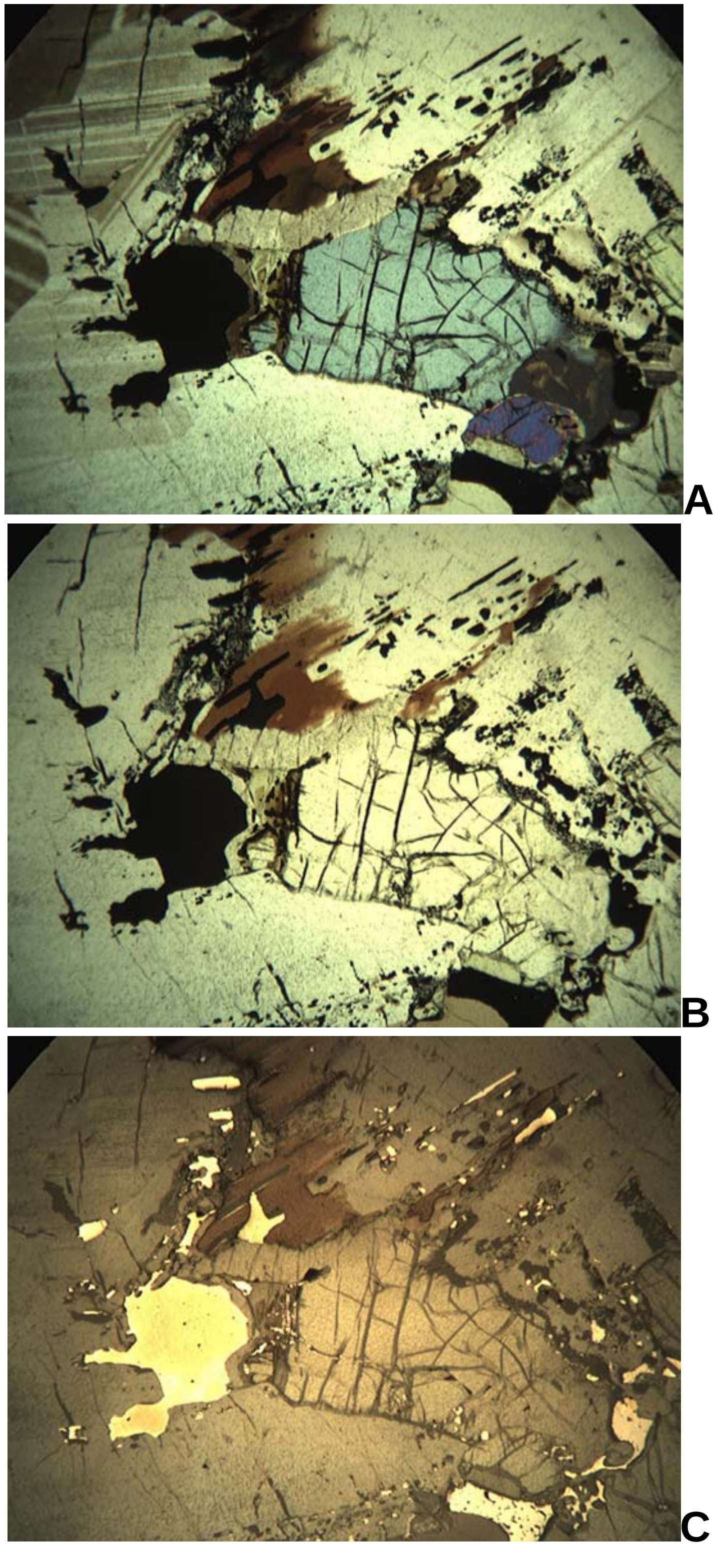


A
B
C

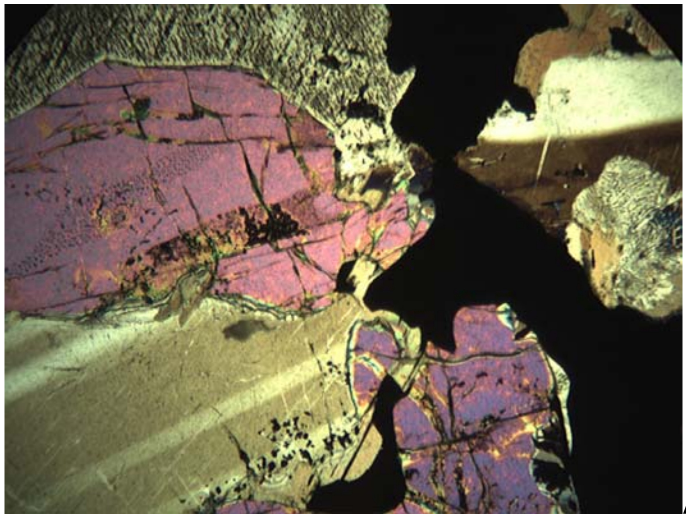
Humidity Cell Sample 00-373C (75-95) -31
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



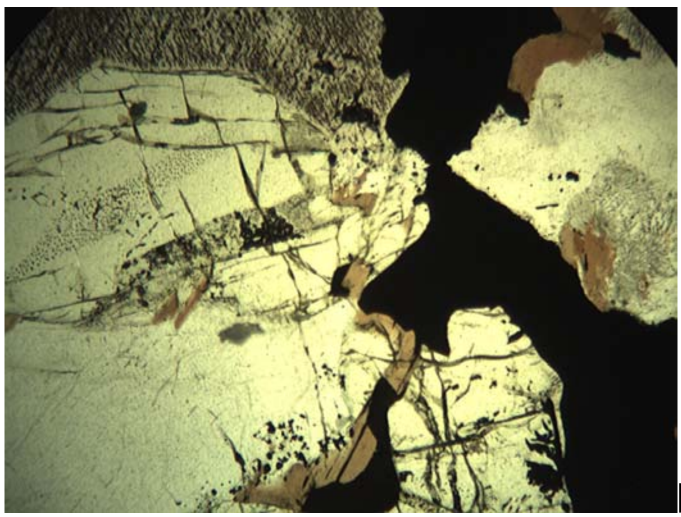
Humidity Cell Sample 00-357C (110-130) -32
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



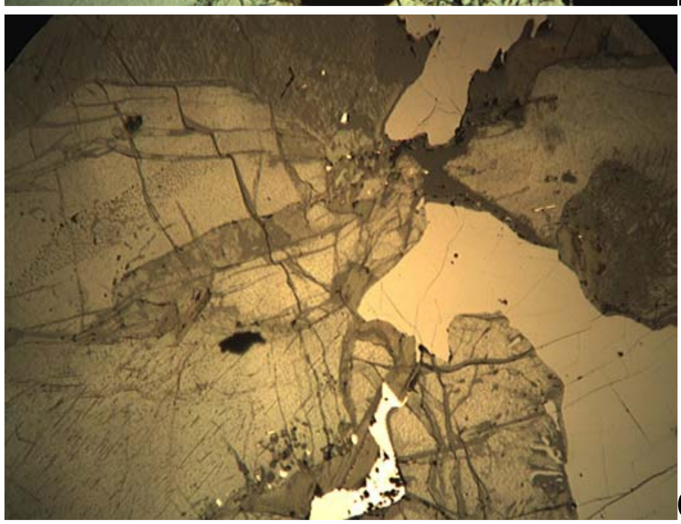
Humidity Cell Sample 99-320C (315-330) -33
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A



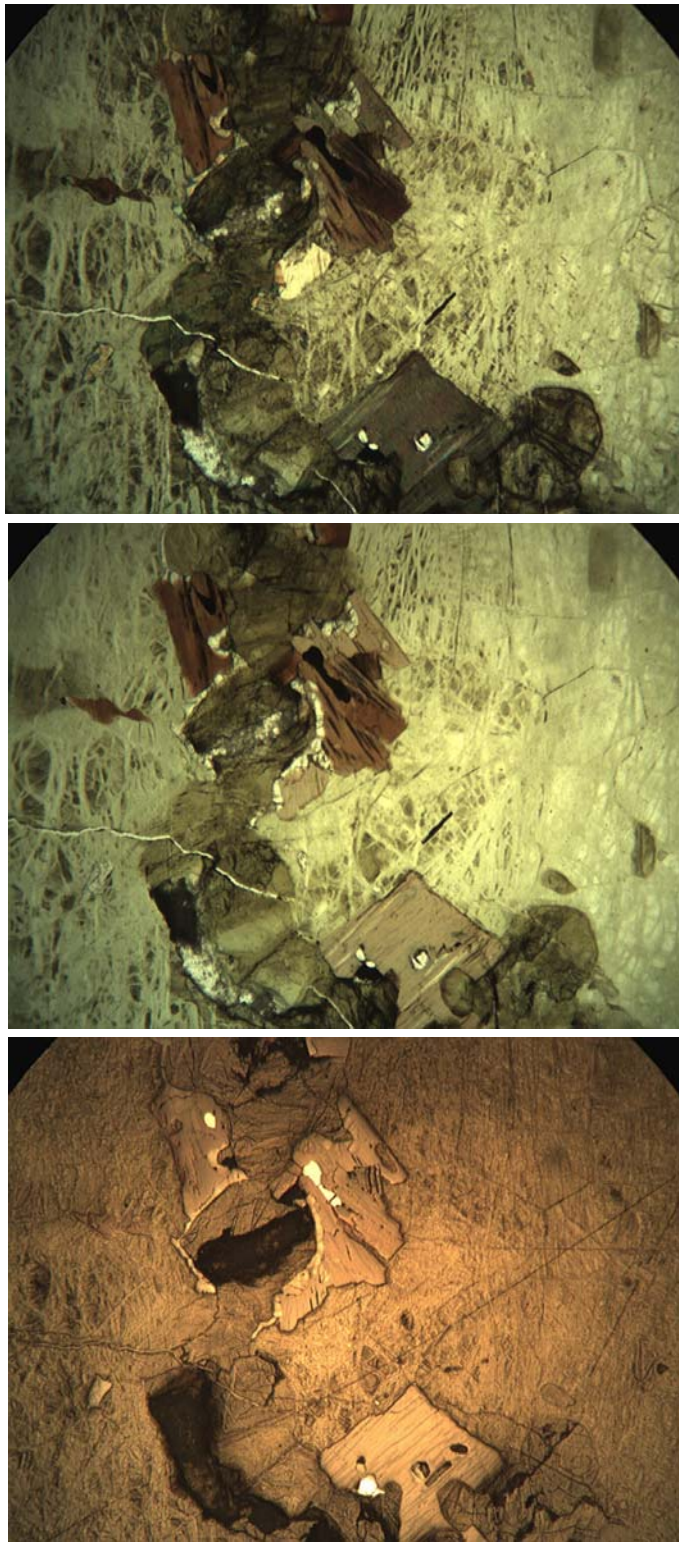
B



C

Humidity Cell Sample 00-369C (335-345) -34

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



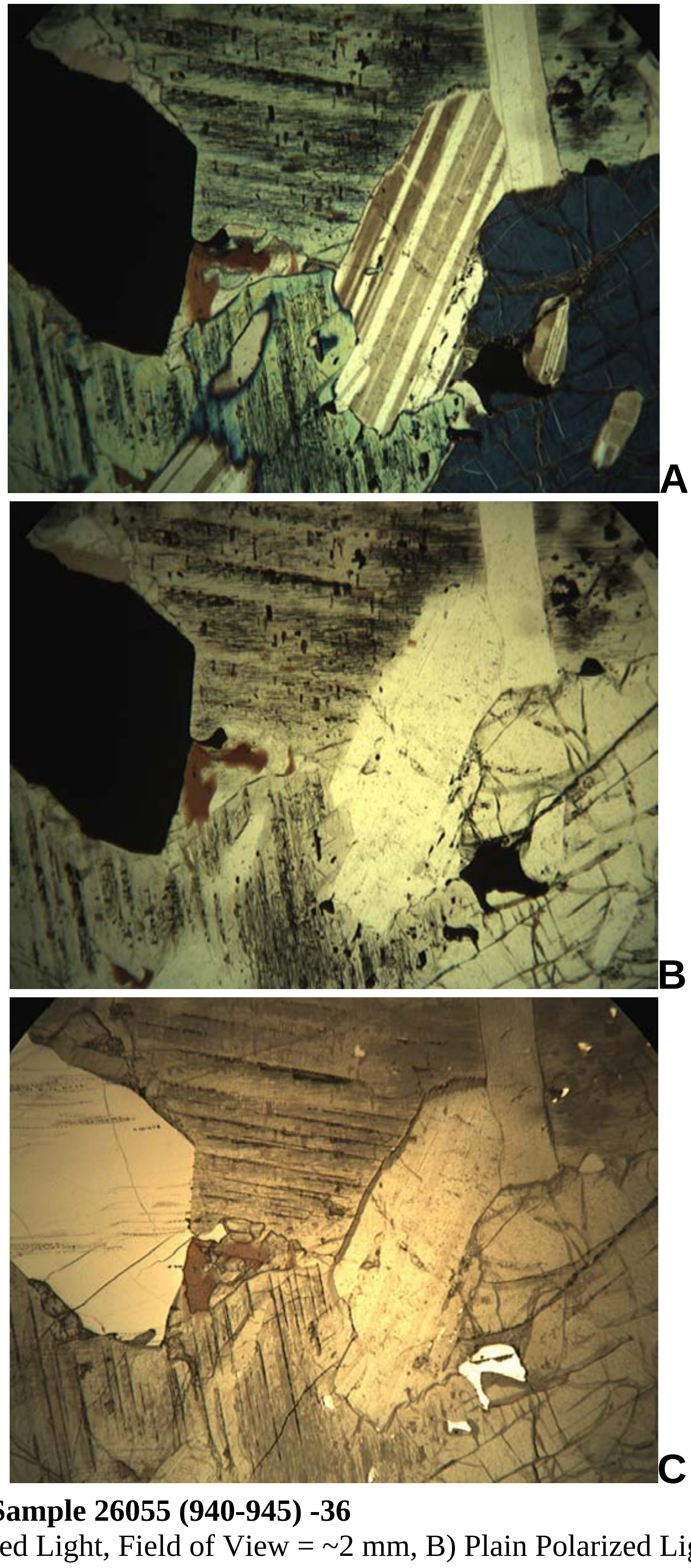
A

B

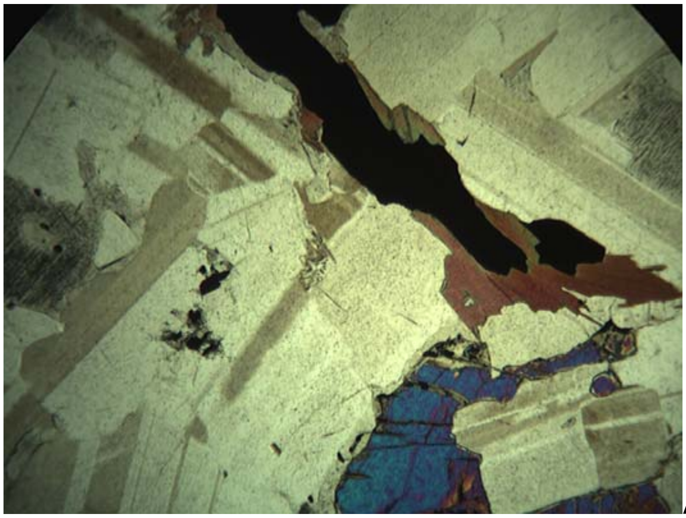
C

Humidity Cell Sample 00-368C (460-465) -35

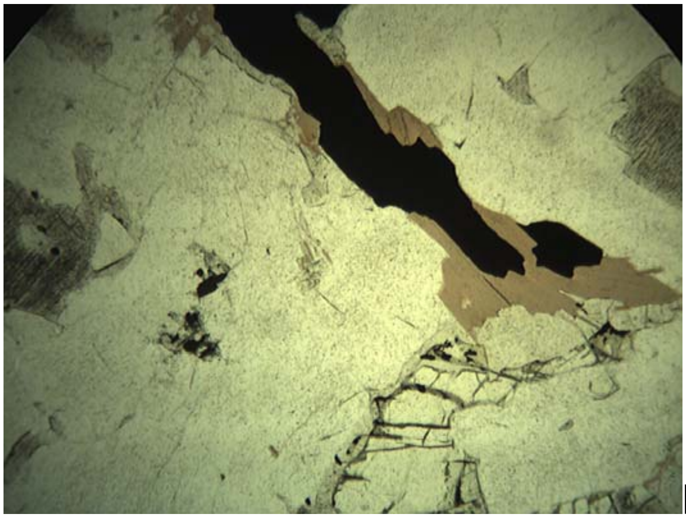
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



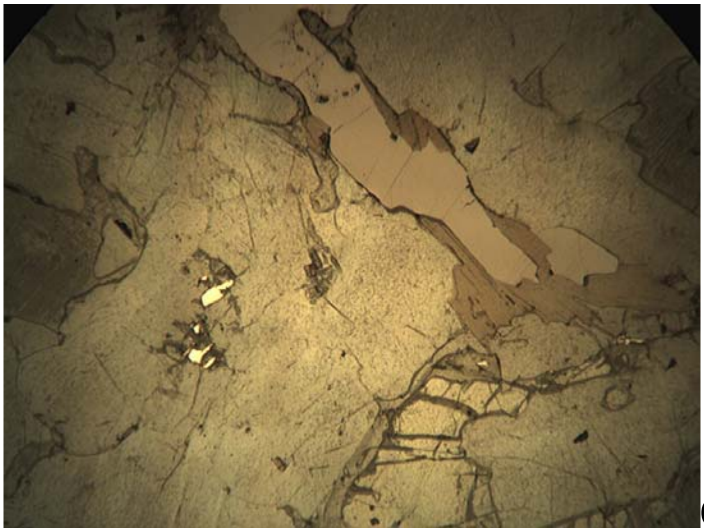
Humidity Cell Sample 26055 (940-945) -36
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

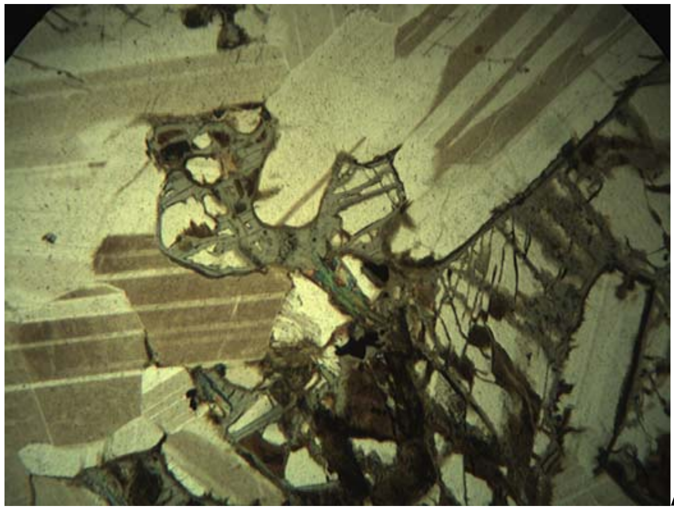


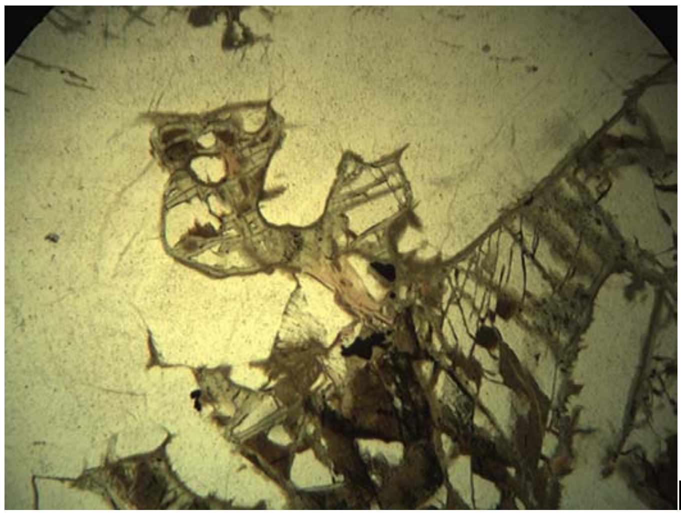
B

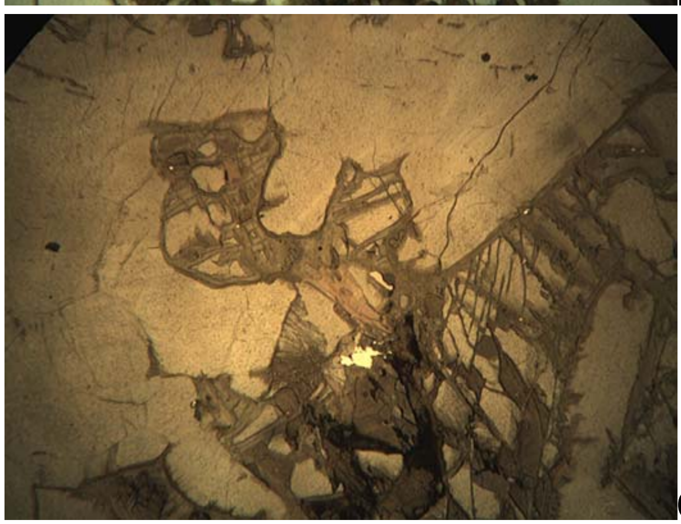


C

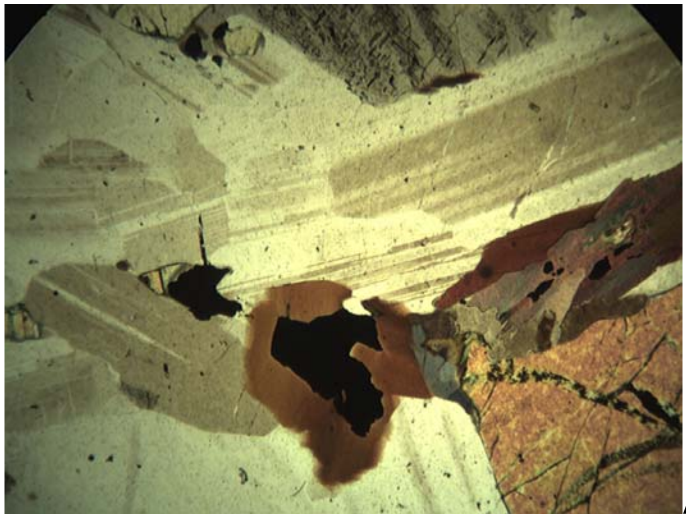
Humidity Cell Sample 00-368C (125-145) -37D
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

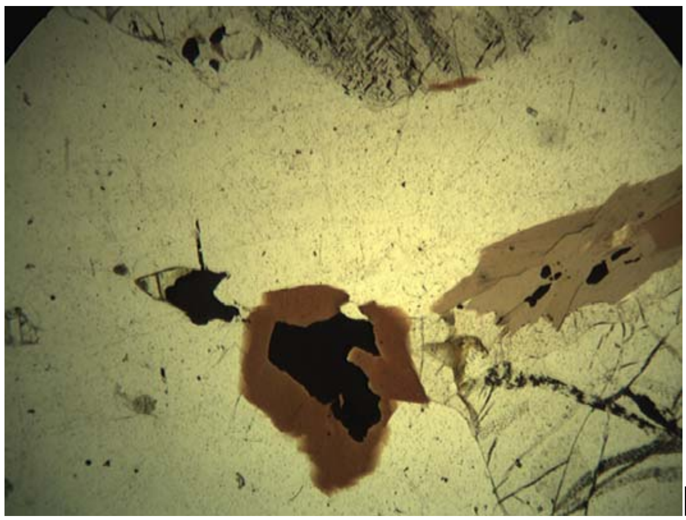

A

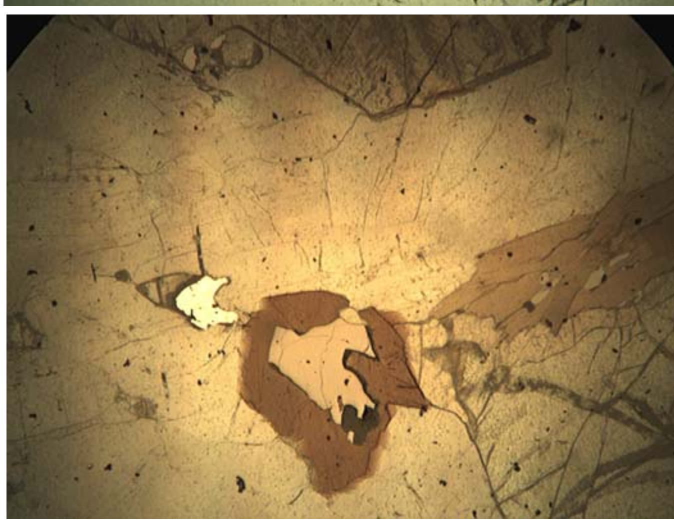

B


C

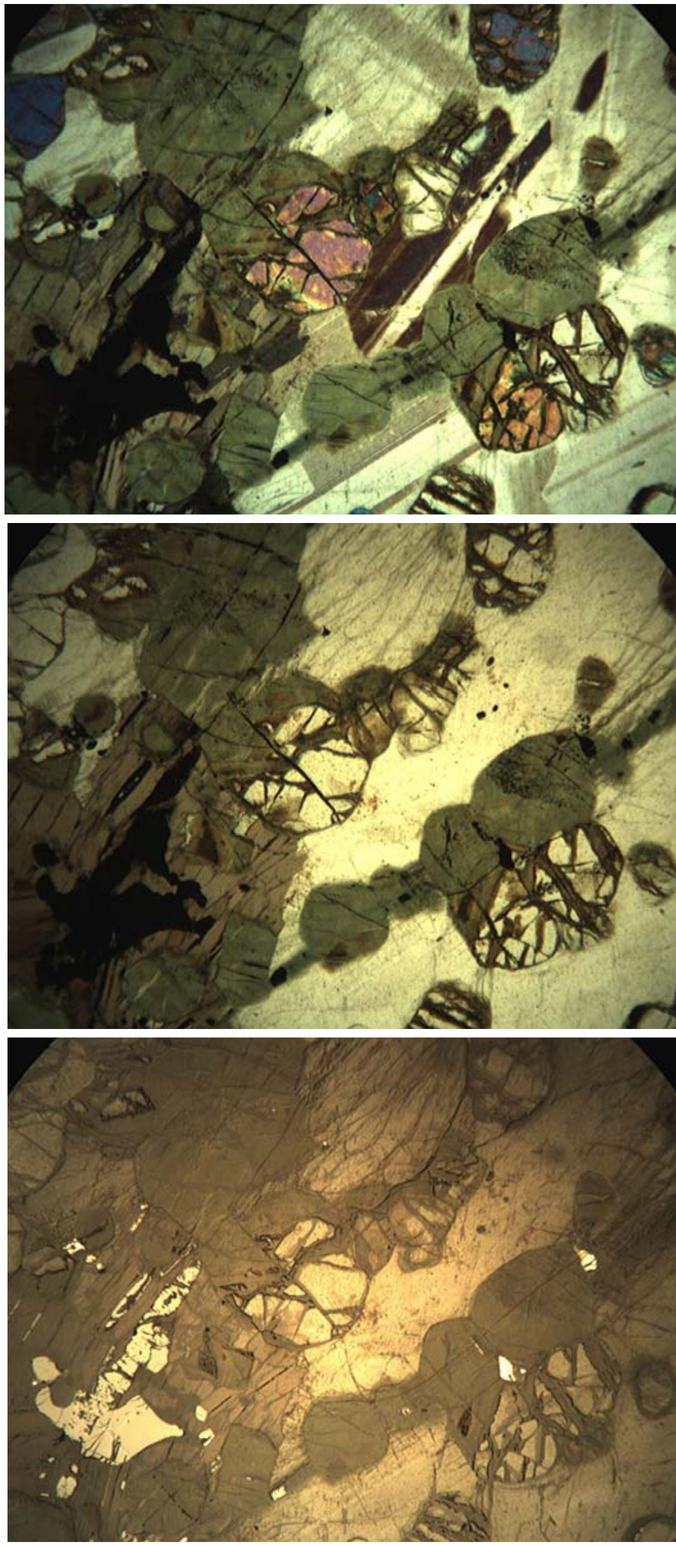
Humidity Cell Sample 00-369C (305-325) -38D
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B

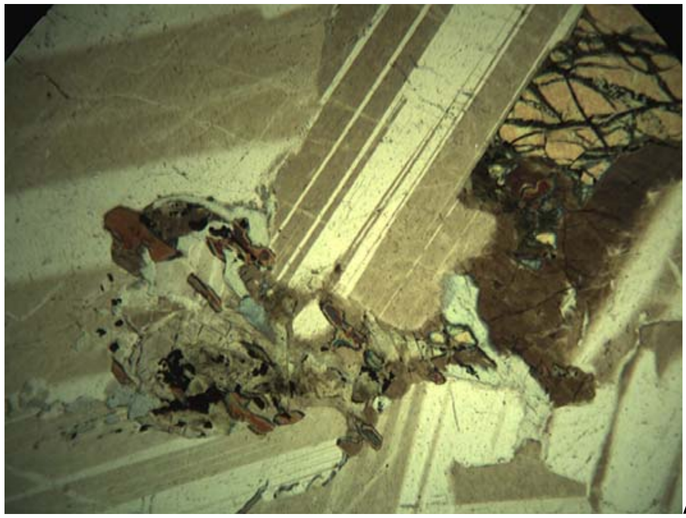

C

Humidity Cell Sample 26098 & 00-337 (145-148; 105-110) -39a
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

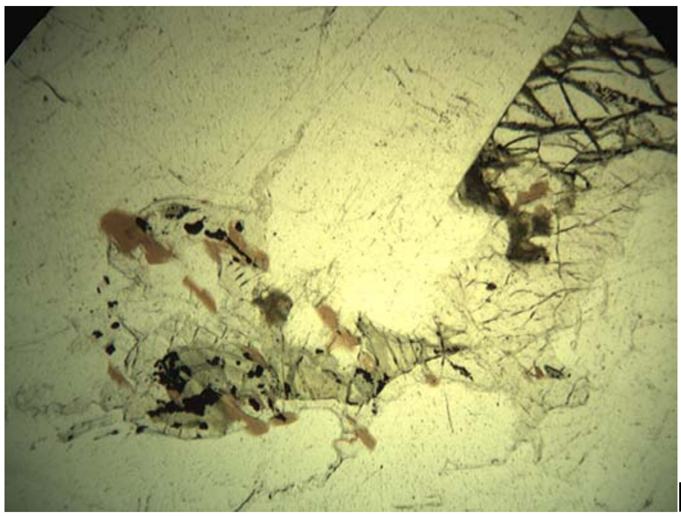


A B C

Humidity Cell Sample 26098 & 00-337 (145-148; 105-110) -39b
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

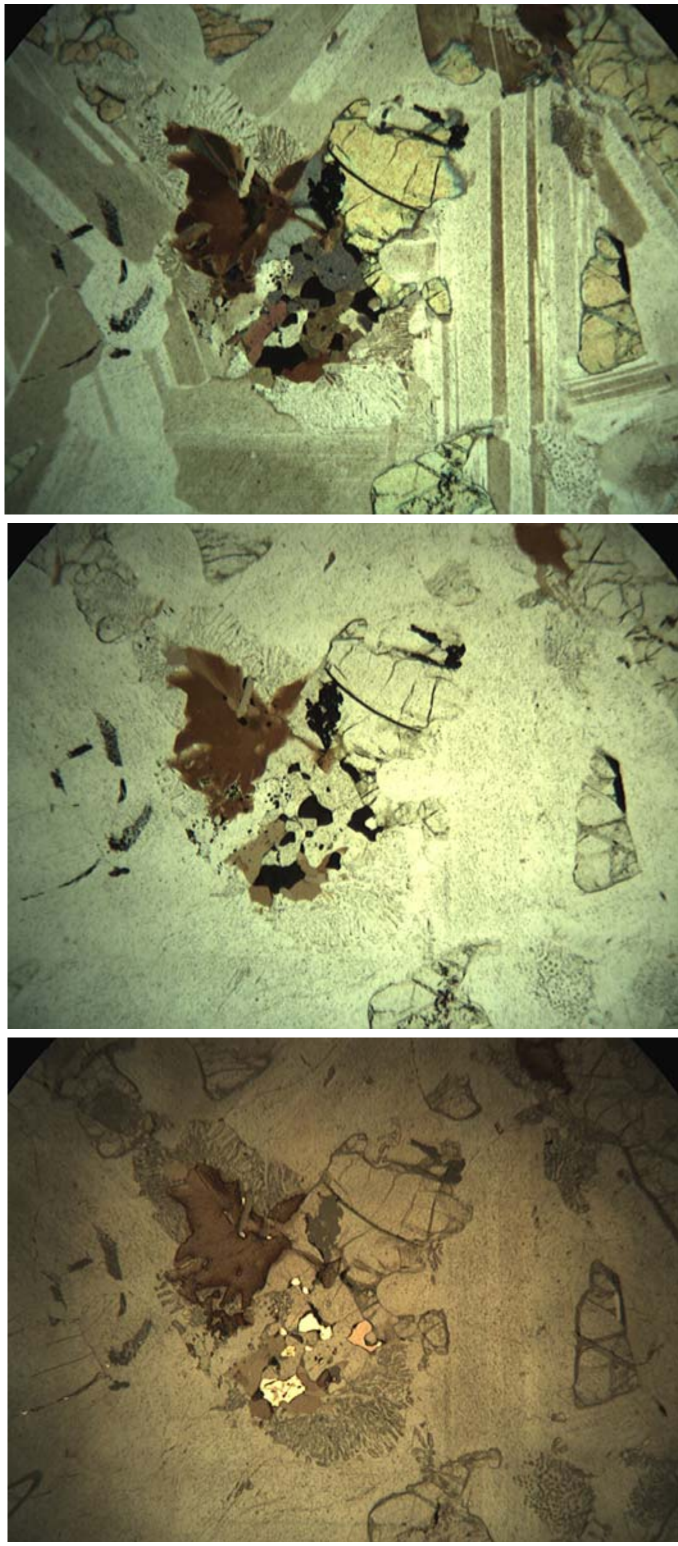


B

C

Humidity Cell Sample 00-334C (30-50) -40

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

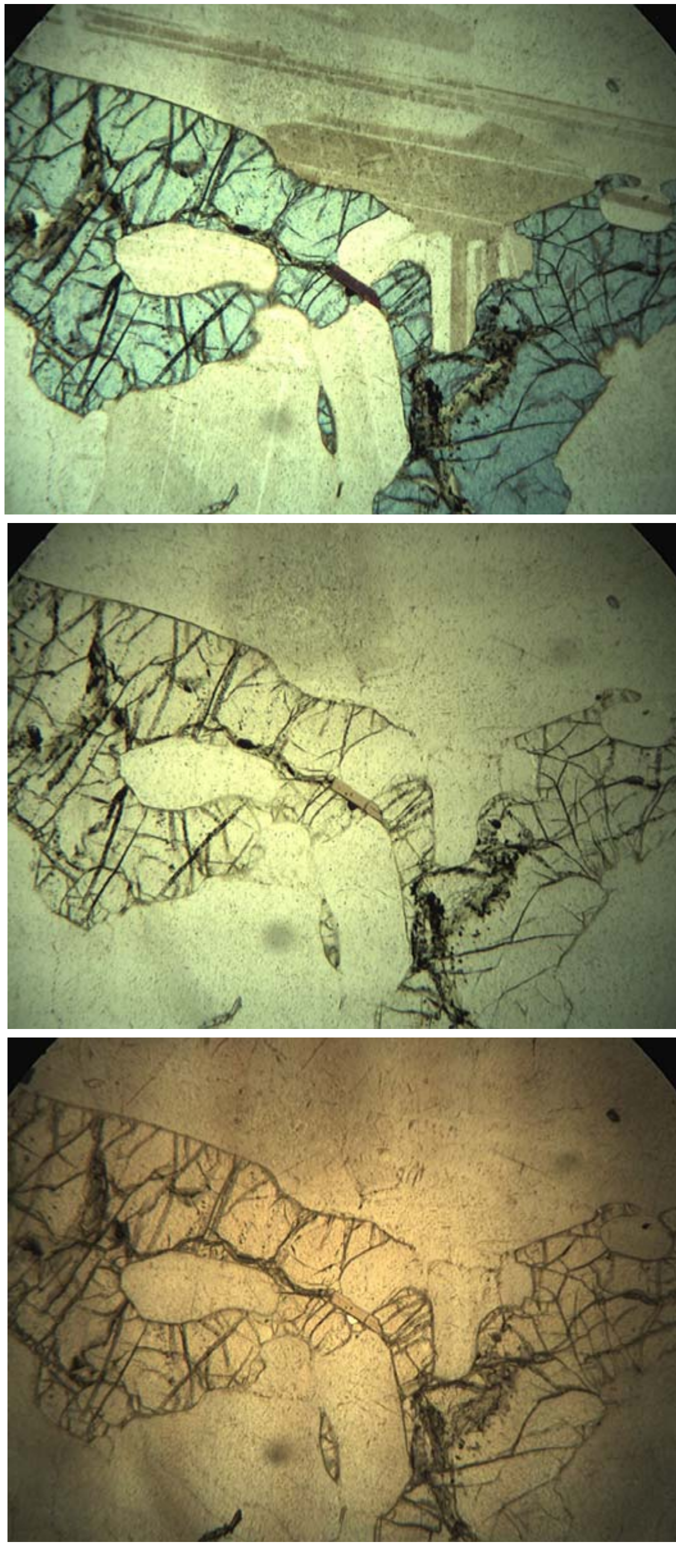


A

B

C

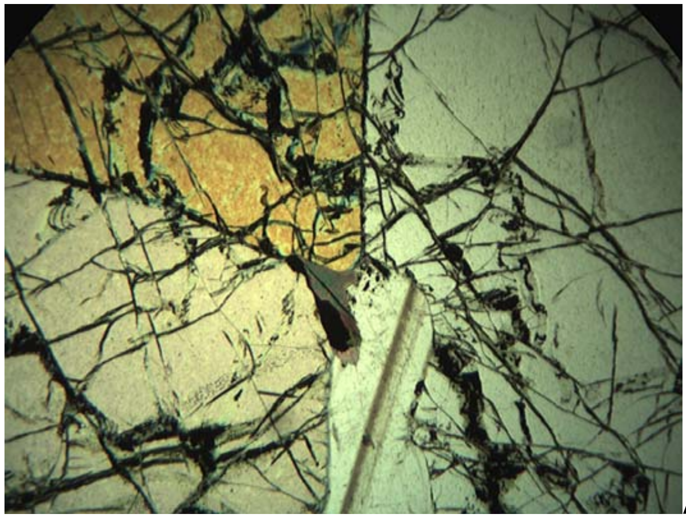
Humidity Cell Sample 00-368C (20-40) -42
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



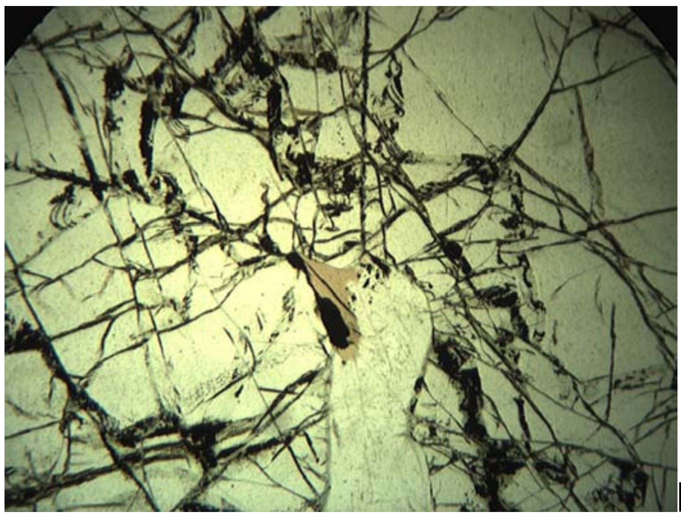
A B C

Humidity Cell Sample 00-366C (35-55) -43

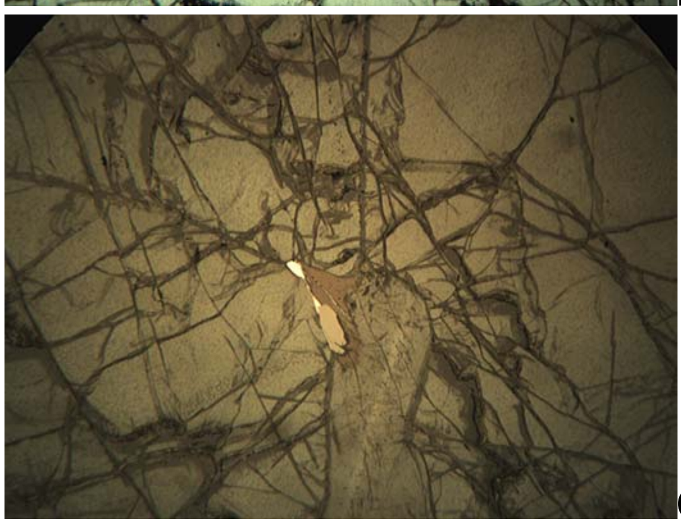
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A



B

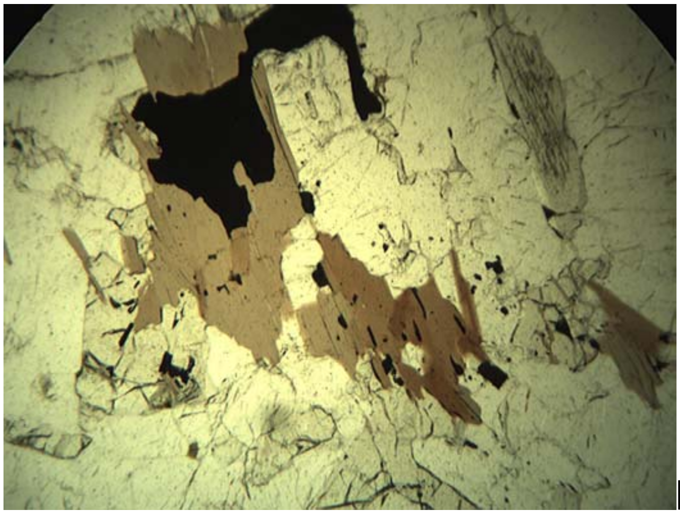


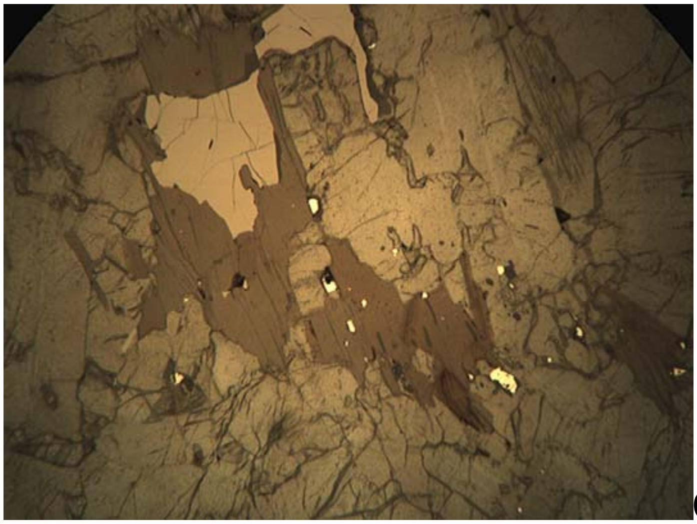
C

Humidity Cell Sample 00-334C (110-130) -44

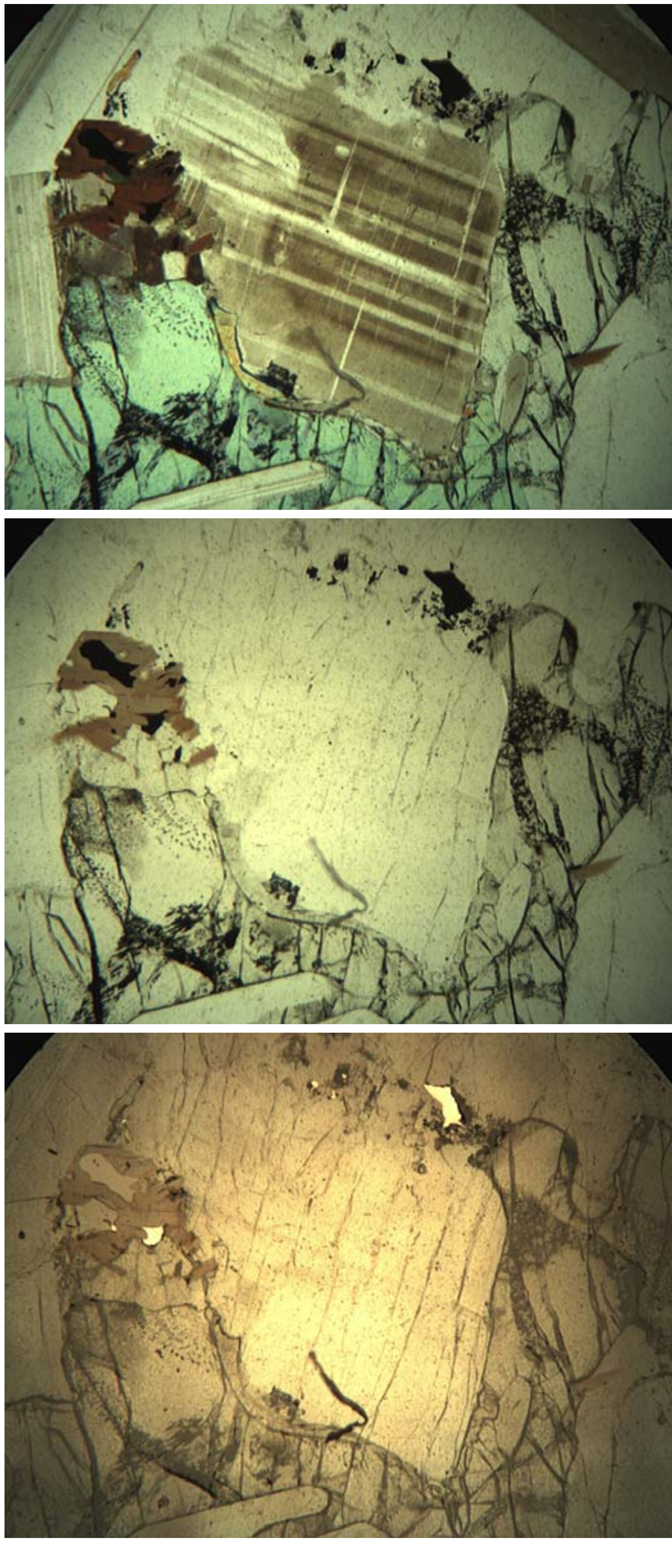
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B


C

Humidity Cell Sample 00-347C (155-175) -45
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



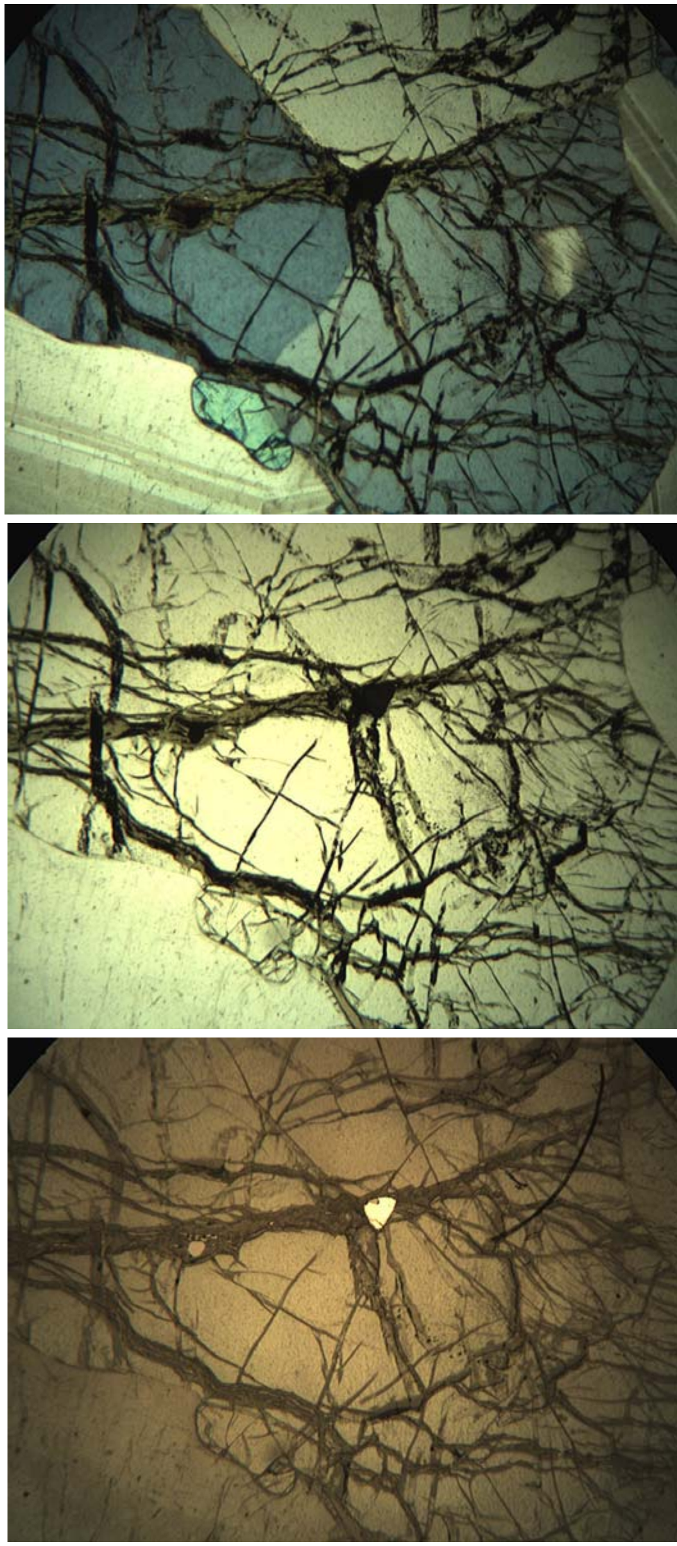
A

B

C

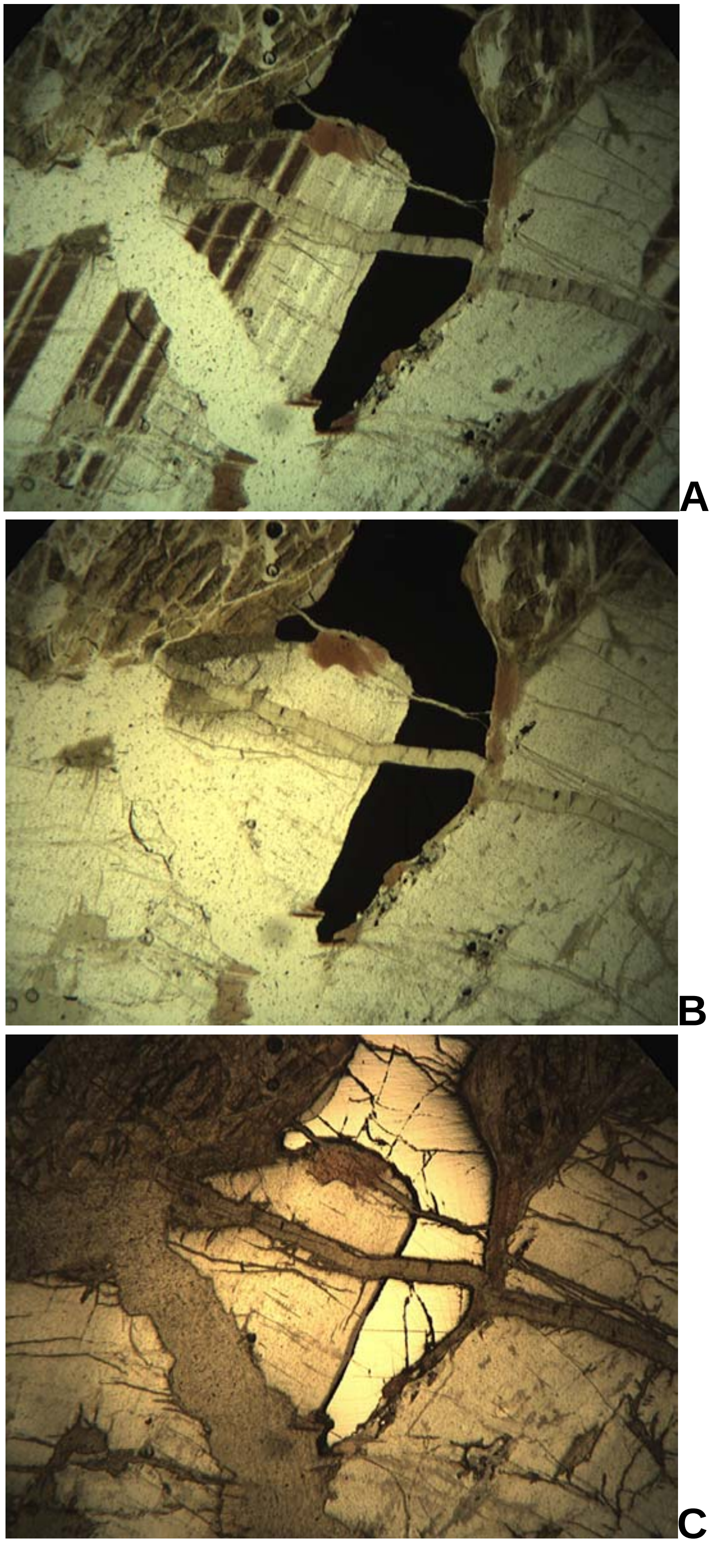
Humidity Cell Sample 00-347C (280-300) -46

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

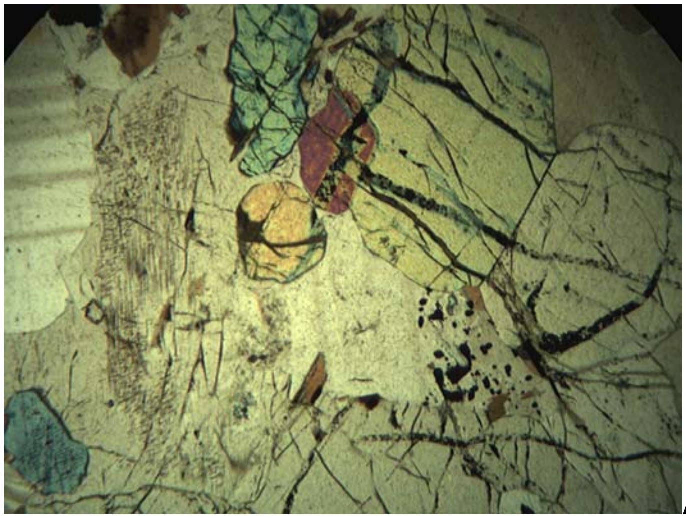


A B C

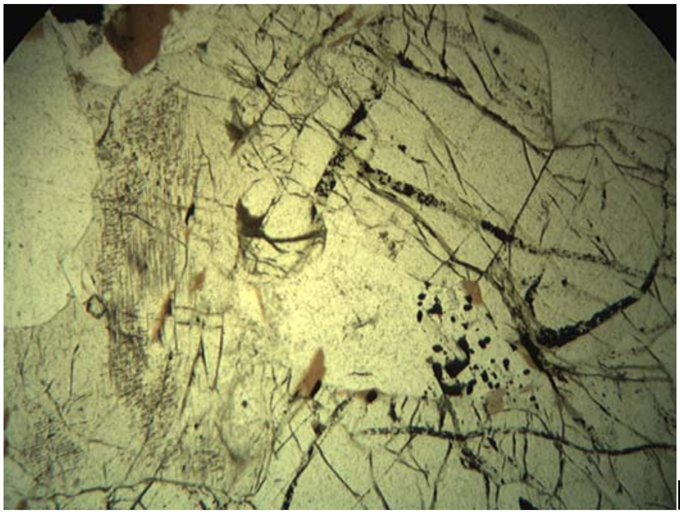
Humidity Cell Sample 00-326C (60-70)-47
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



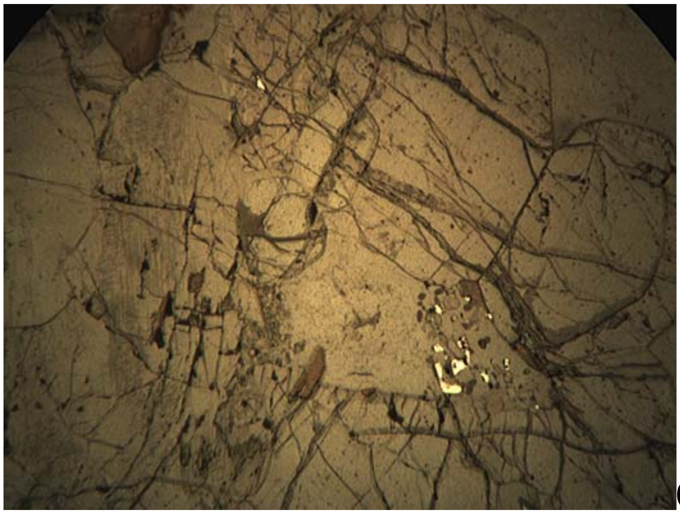
Humidity Cell Sample 00-367C (50-65)-49
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A



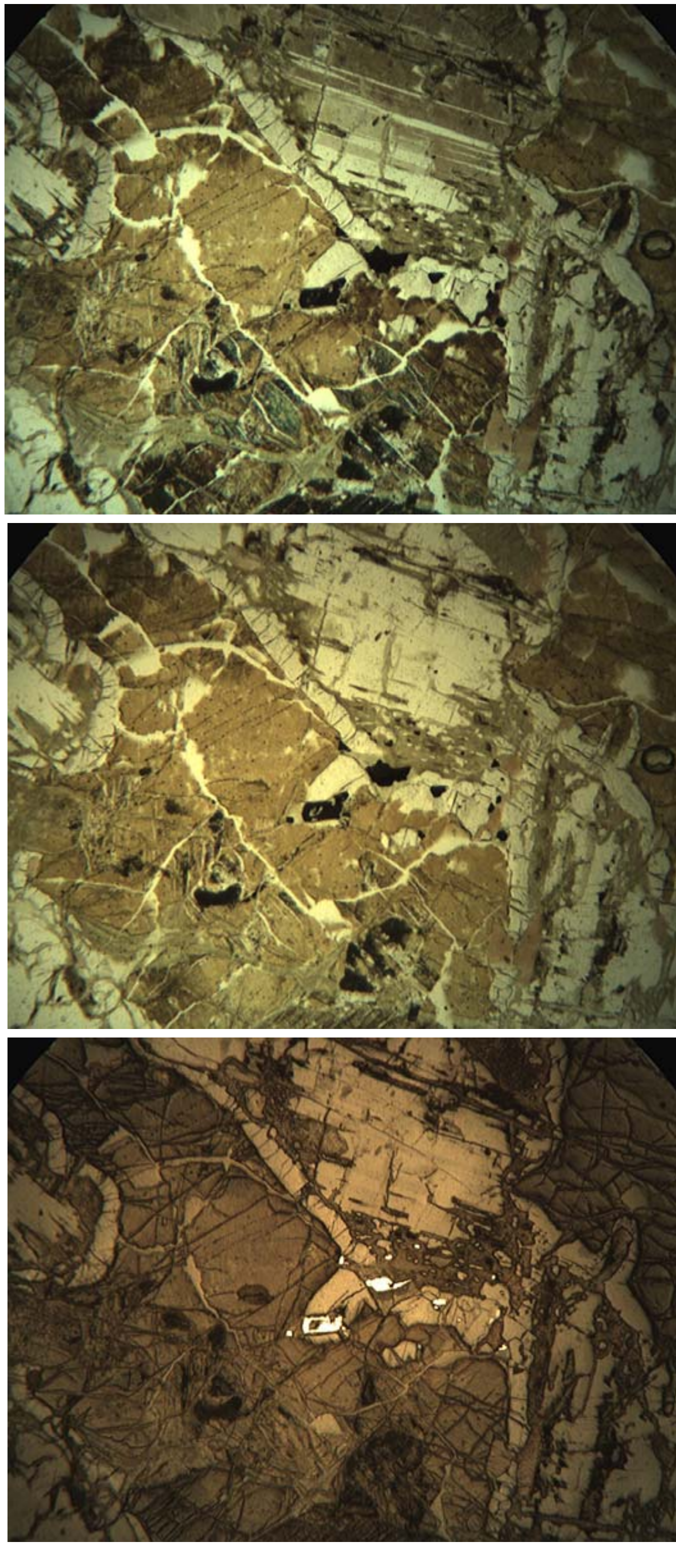
B



C

Humidity Cell Sample 00-367C (260-280)-50

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

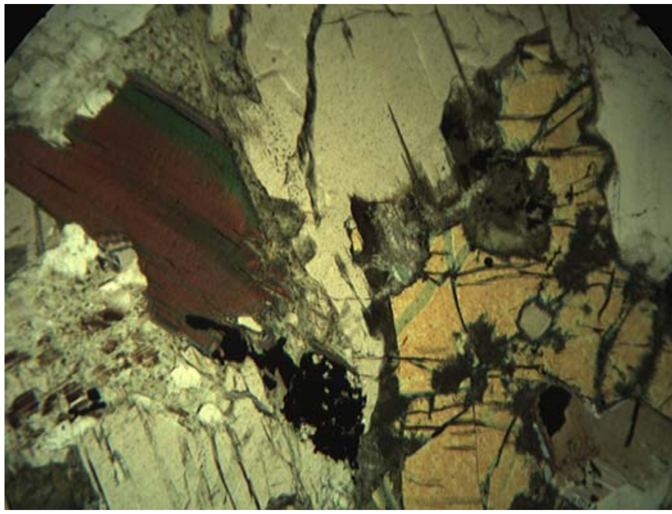


A

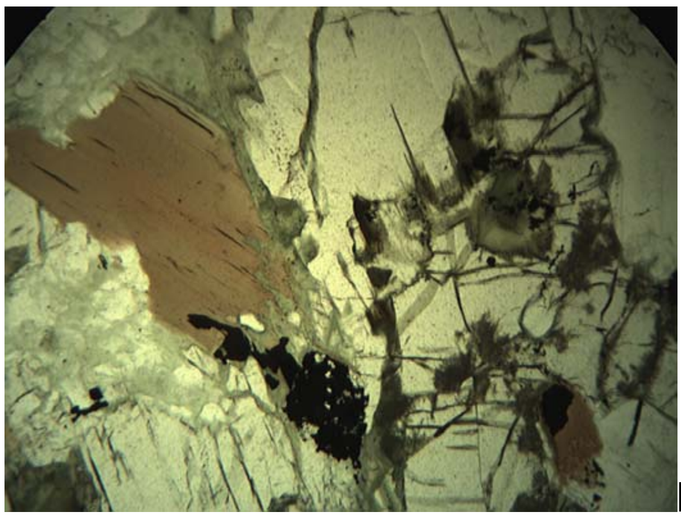
B

C

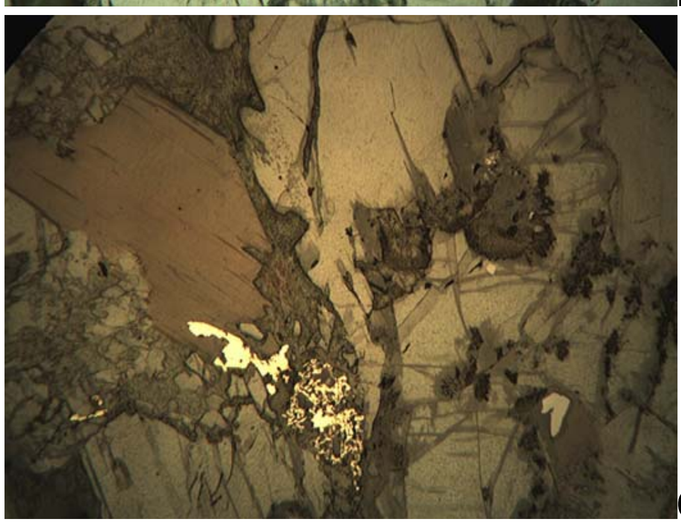
Humidity Cell Sample 00-367C (290-310)-51
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

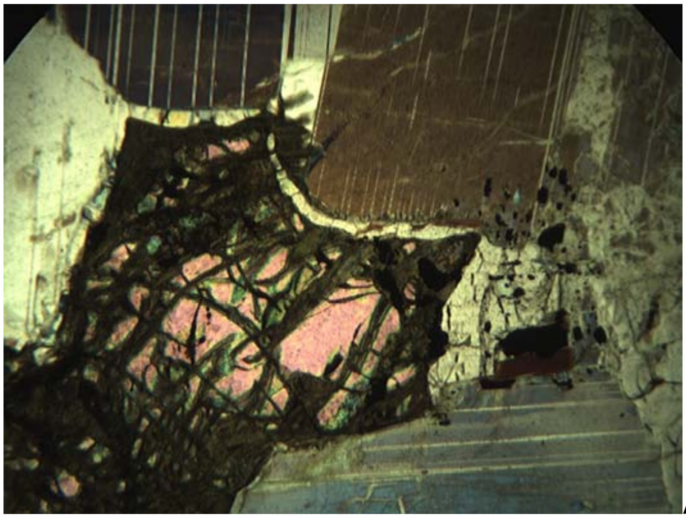


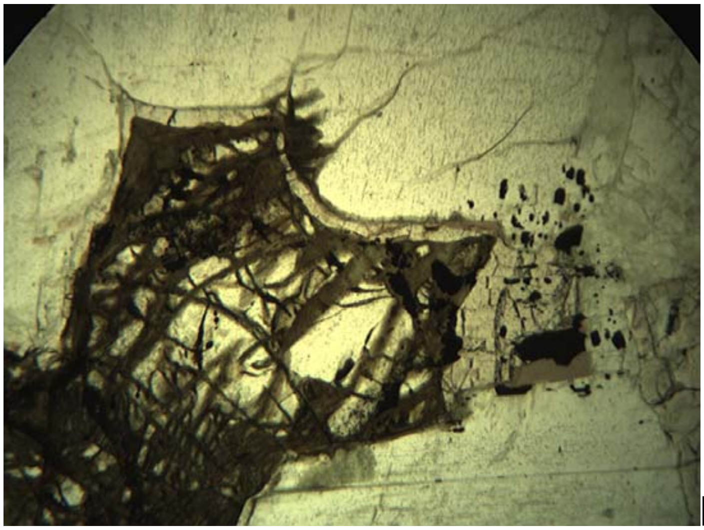
B

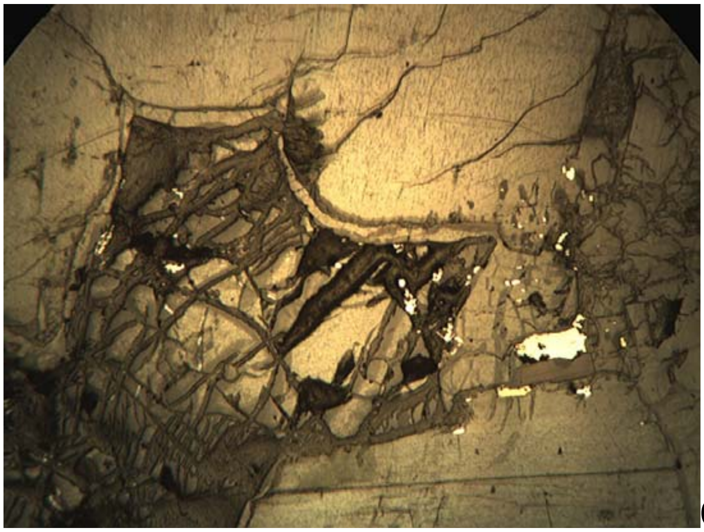


C

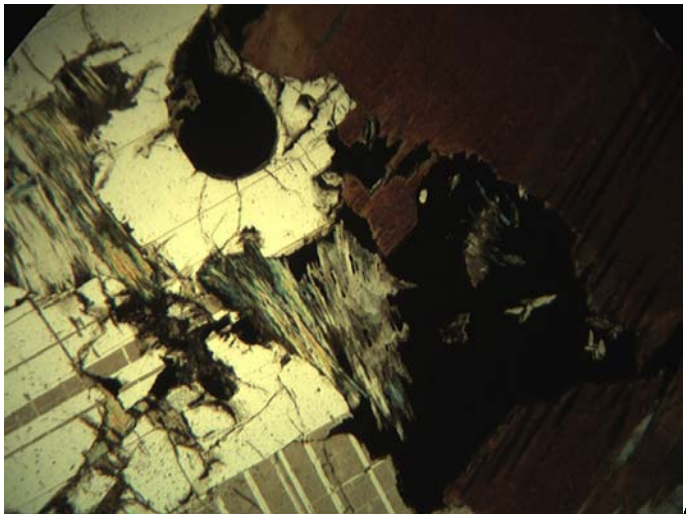
Humidity Cell Sample 00-370 C (20-30)-52
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

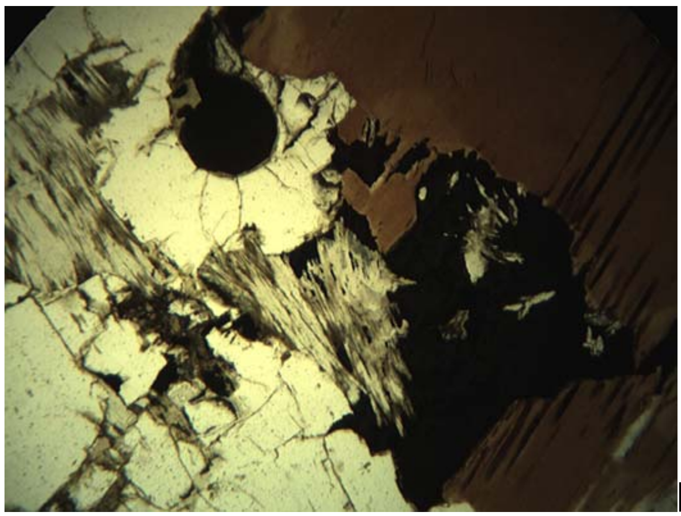

A

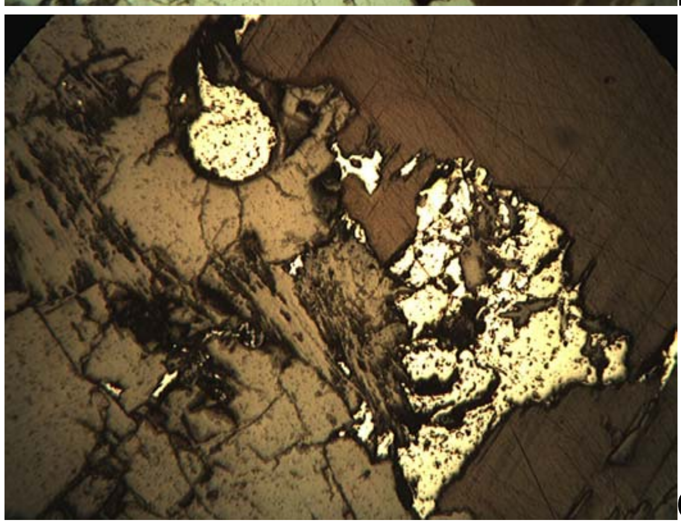

B


C

Humidity Cell Sample 00-369 C (20-30)-53
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B

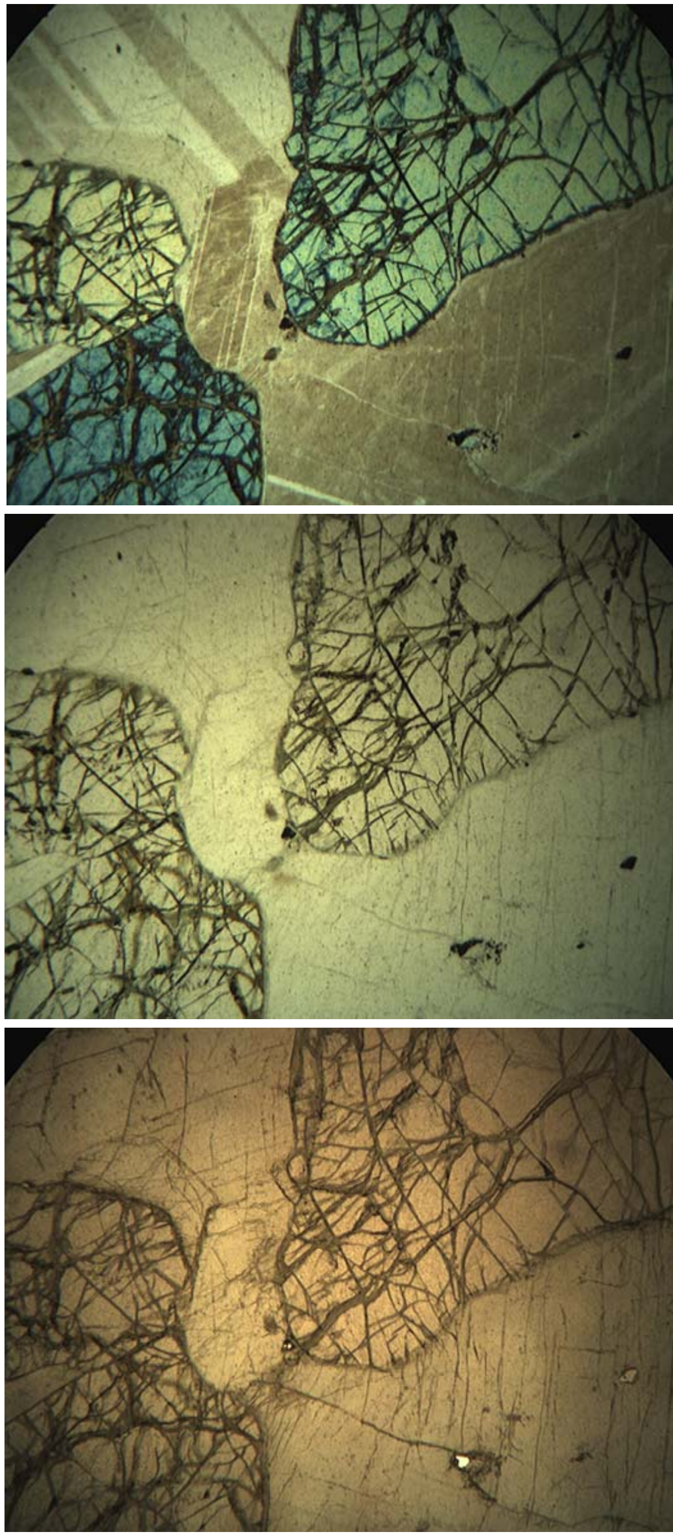

C

Humidity Cell Sample 00-367 C (170-175)-54
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

A B C

Humidity Cell Sample 00-367 C (395-400)-55

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



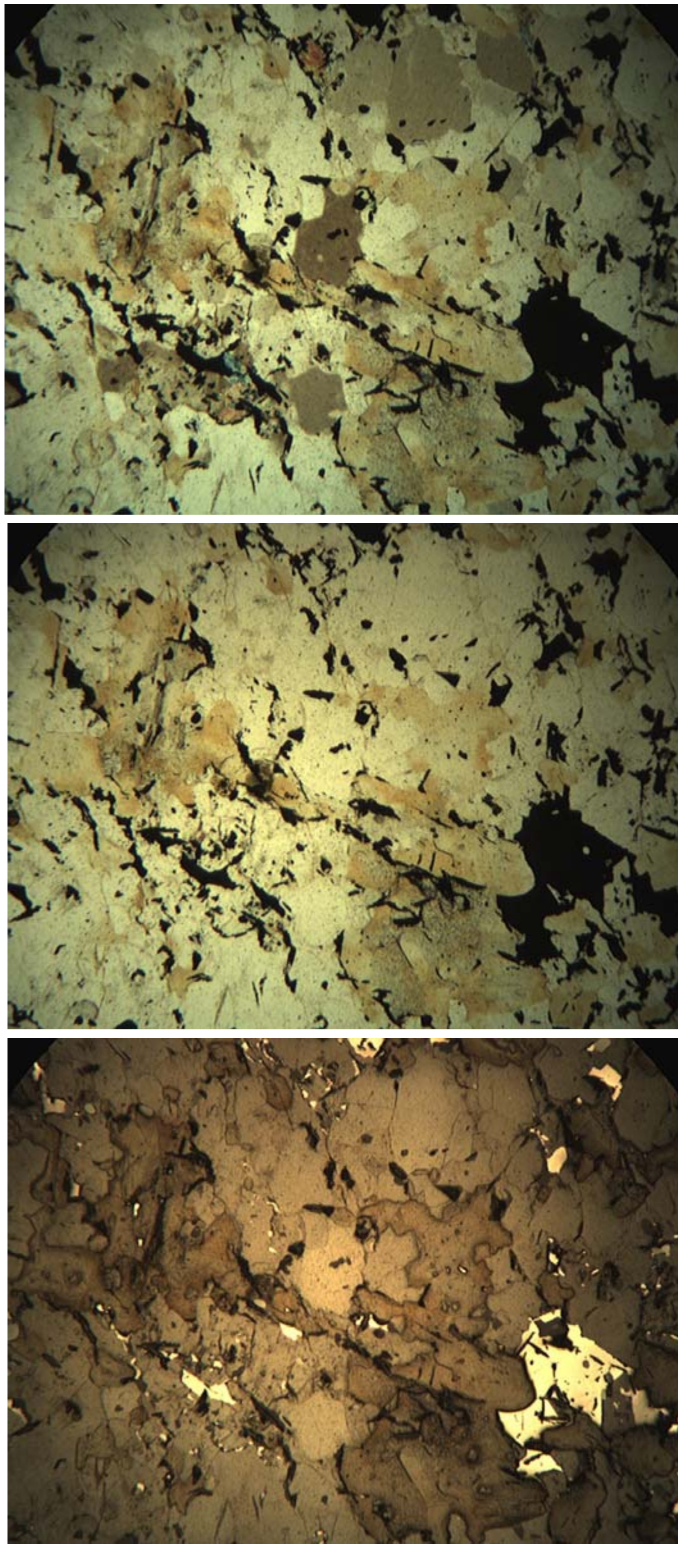
A

B

C

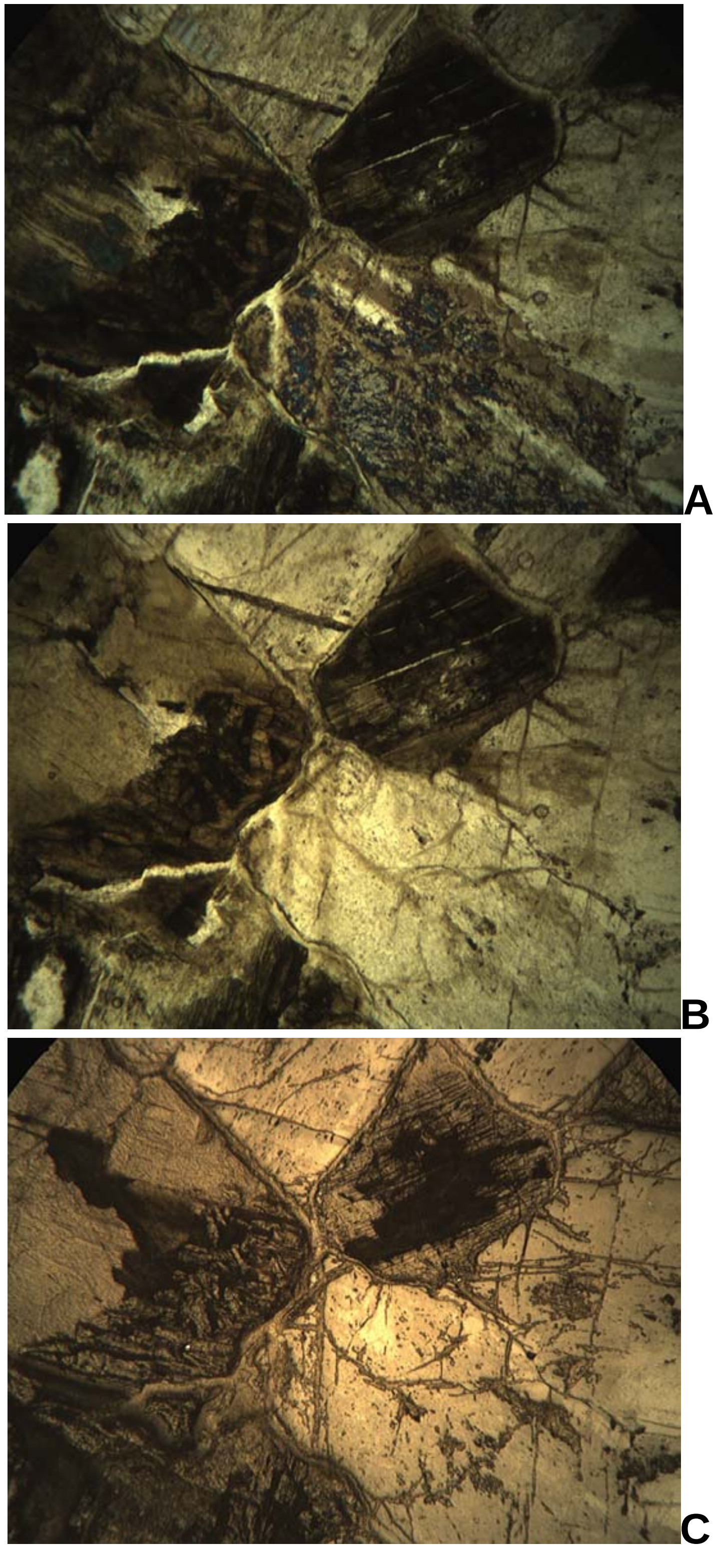
Humidity Cell Sample 26064 (44--54)-56

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

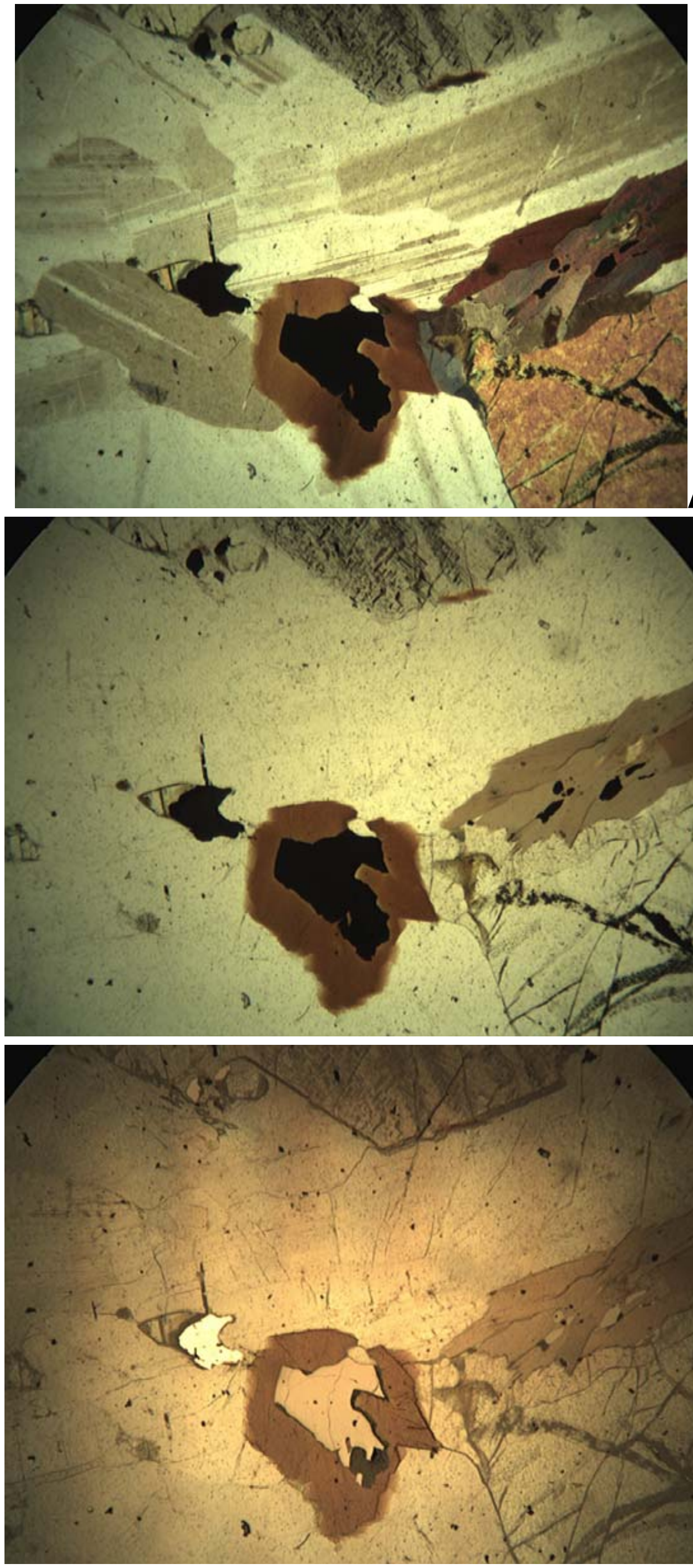


A
B
C

Humidity Cell Sample 00-364 C (210-229)-58D
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



Humidity Cell Sample 26064 (264-269)-59a
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



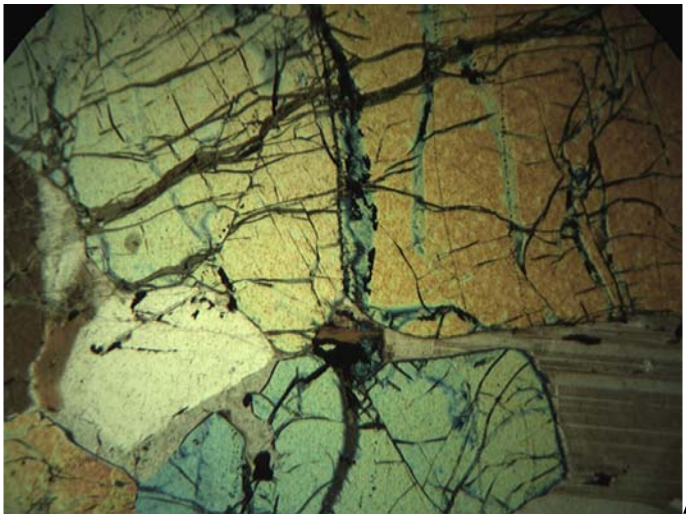
A

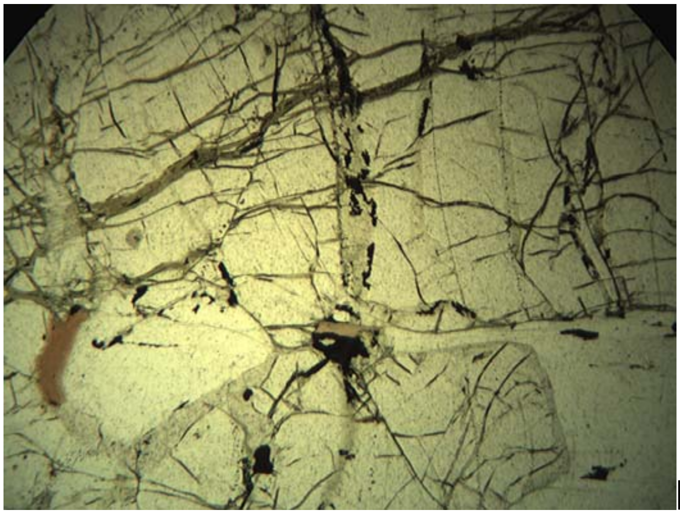
B

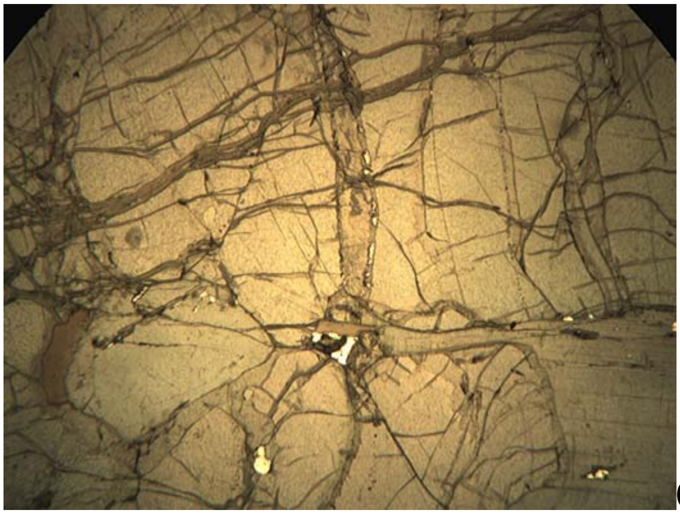
C

Humidity Cell Sample 26064 (146-156)-59b

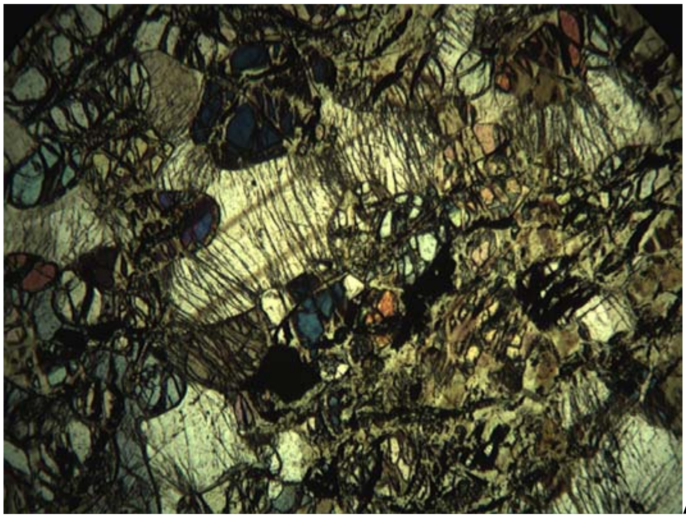
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

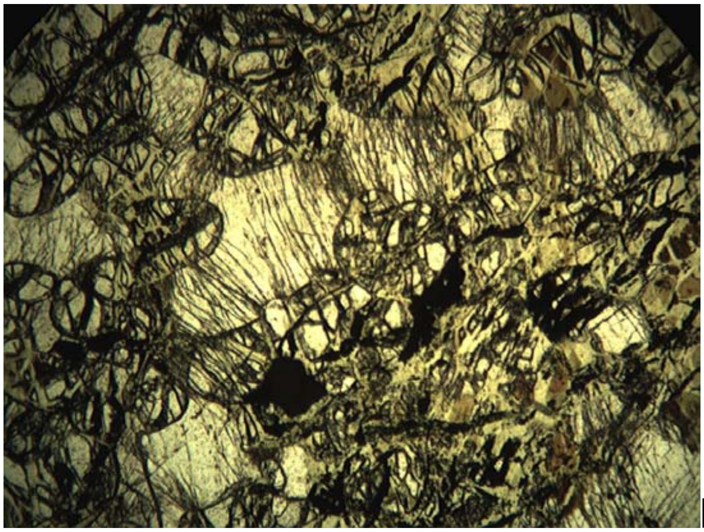

A

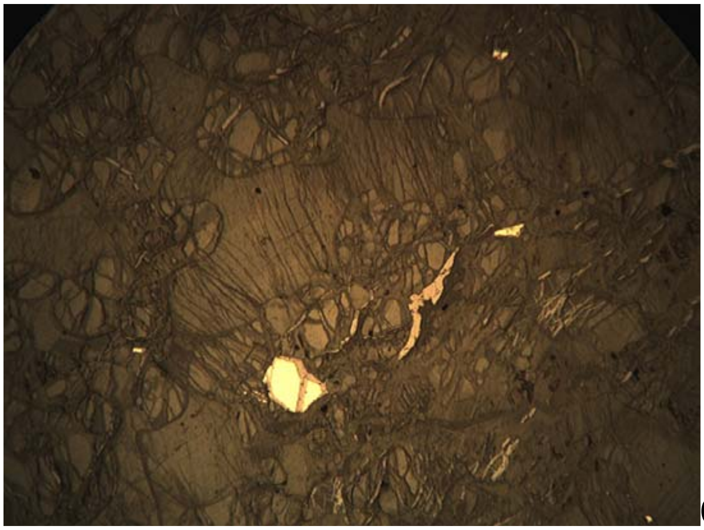

B


C

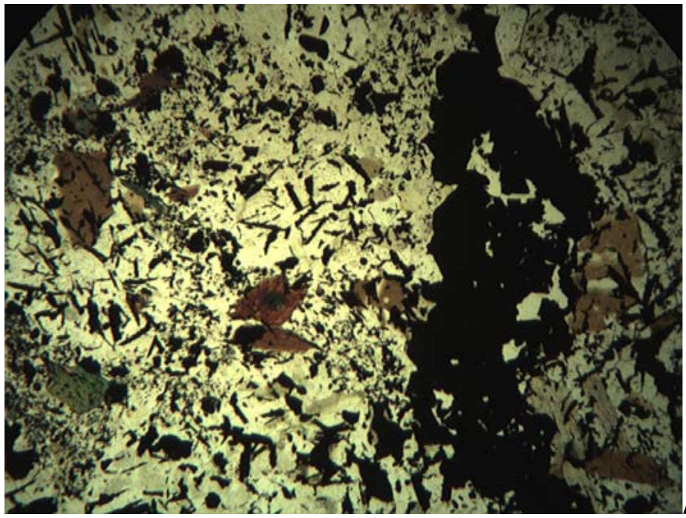
Humidity Cell Sample 26056 (110-125)-60
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

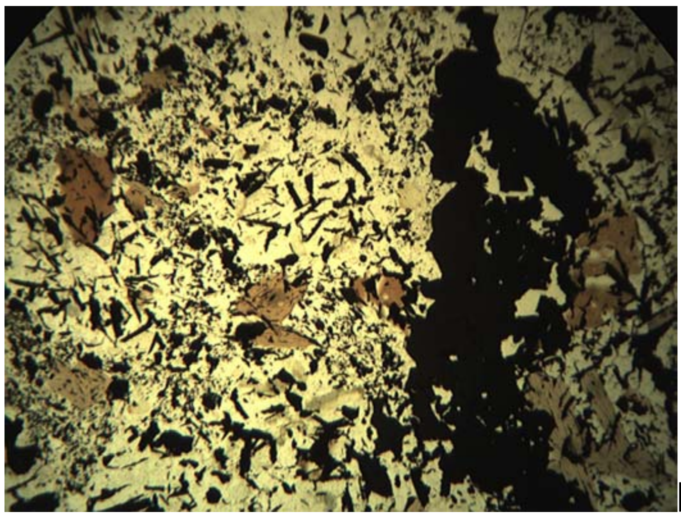

A

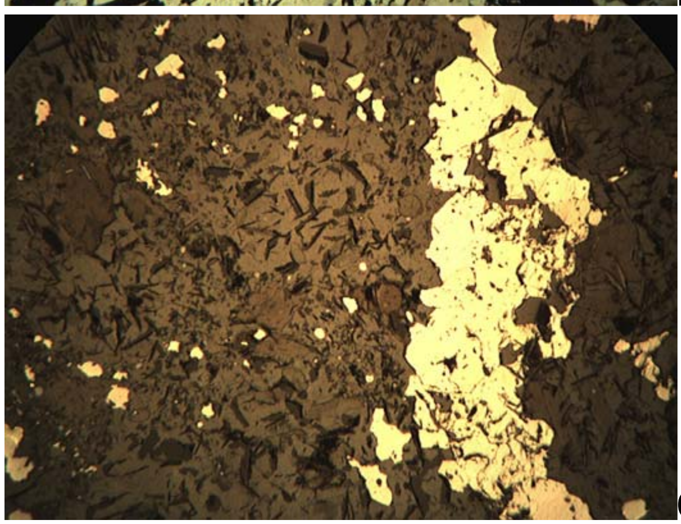

B


C

Humidity Cell Sample 00-361 C (240-245)-61D
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

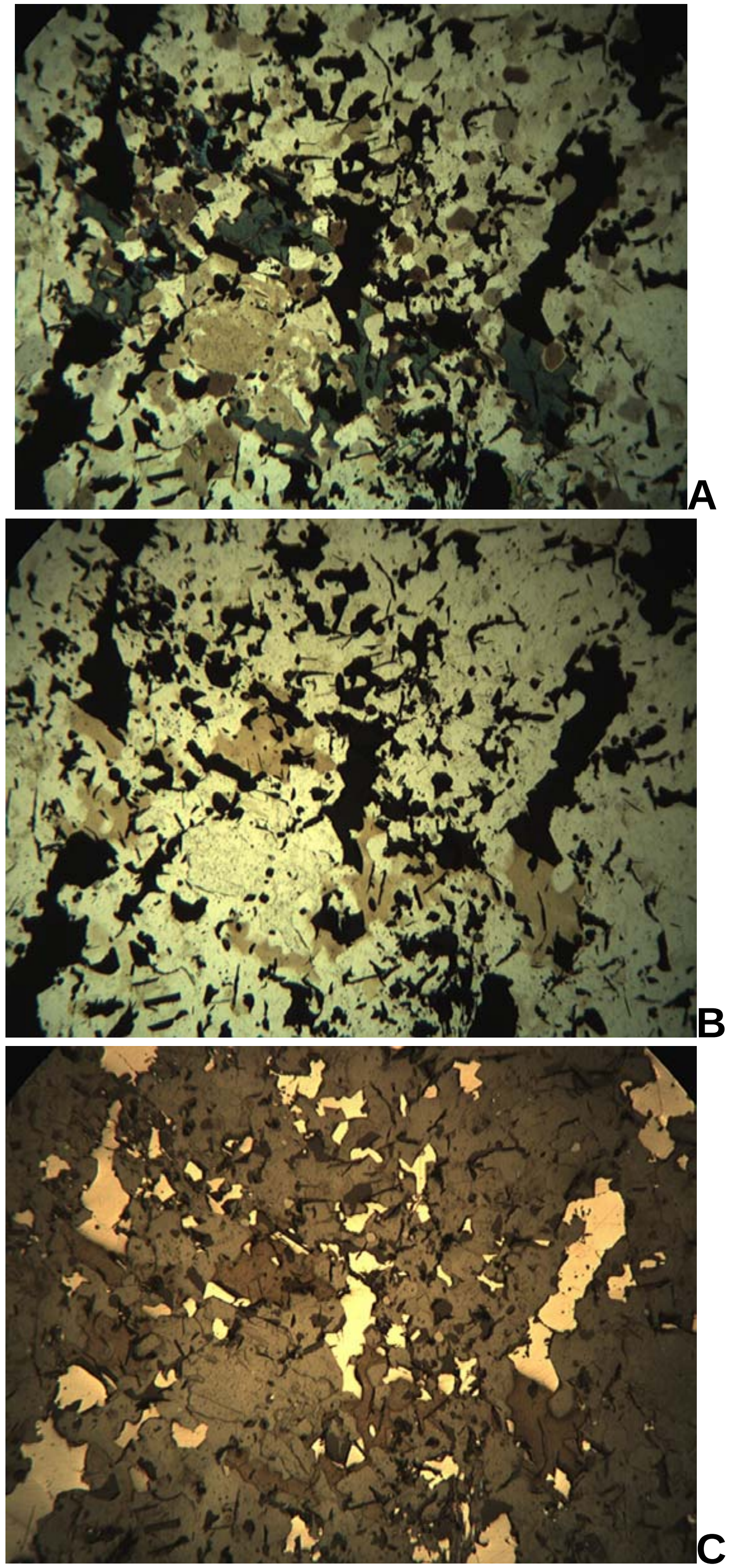

A


B

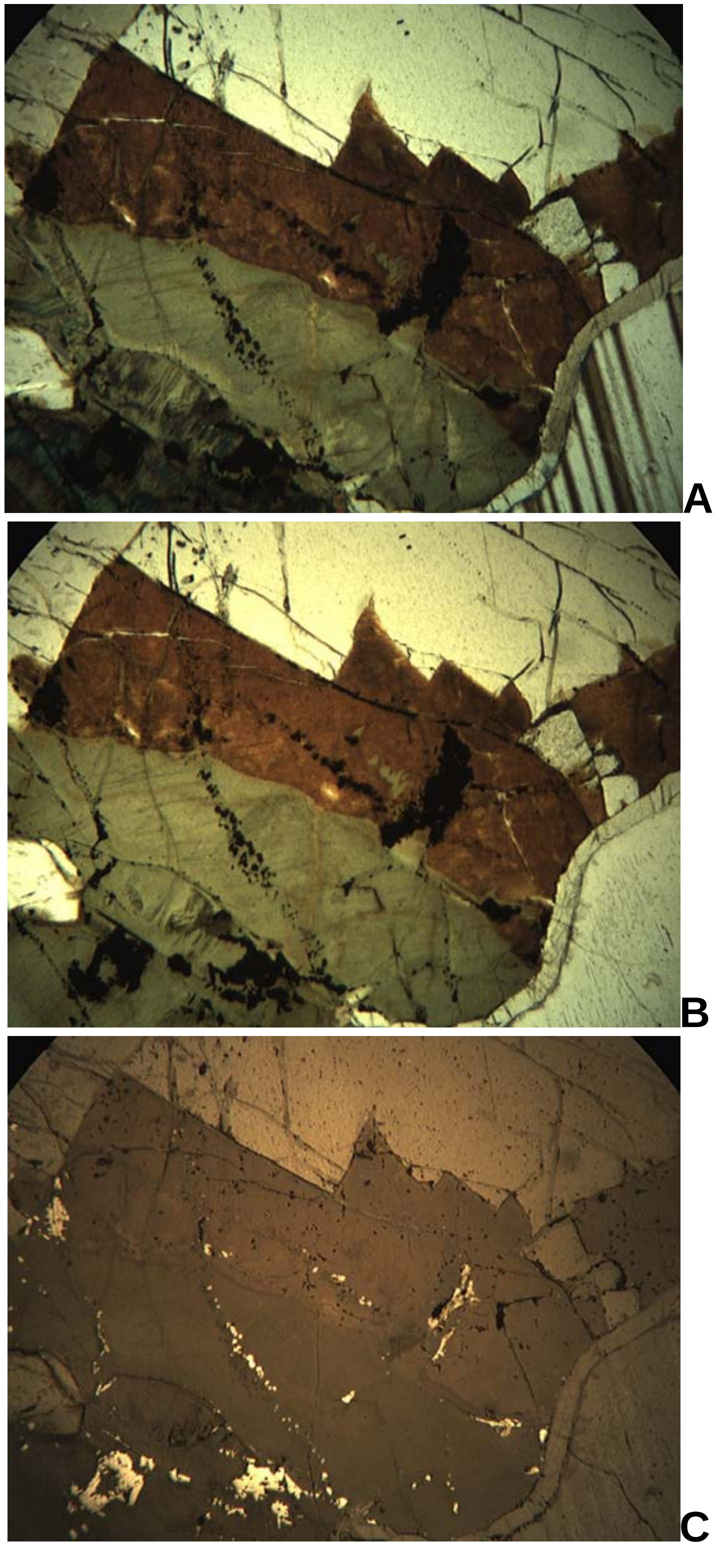

C

Humidity Cell Sample 00-361 C (737-749)-62

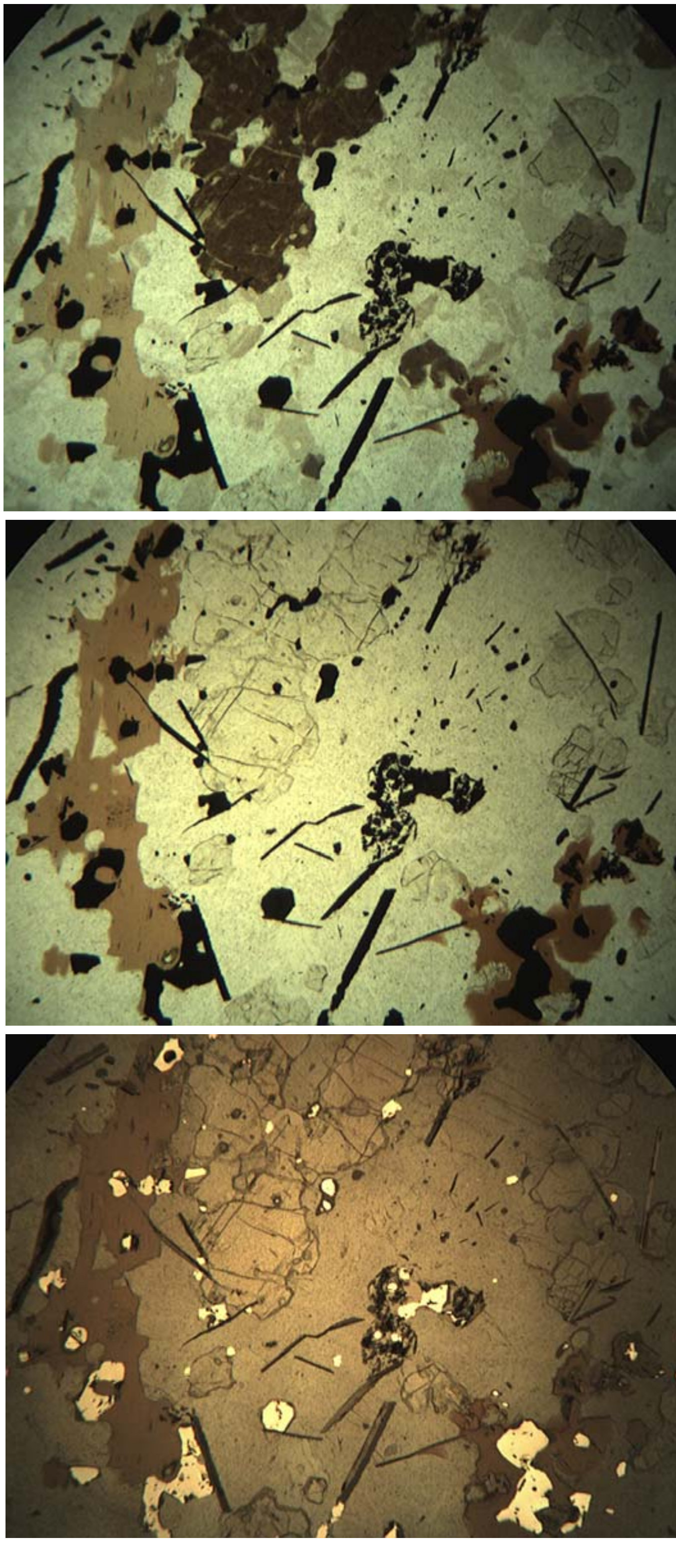
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



Humidity Cell Sample 00-337 C (510-520)-64
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

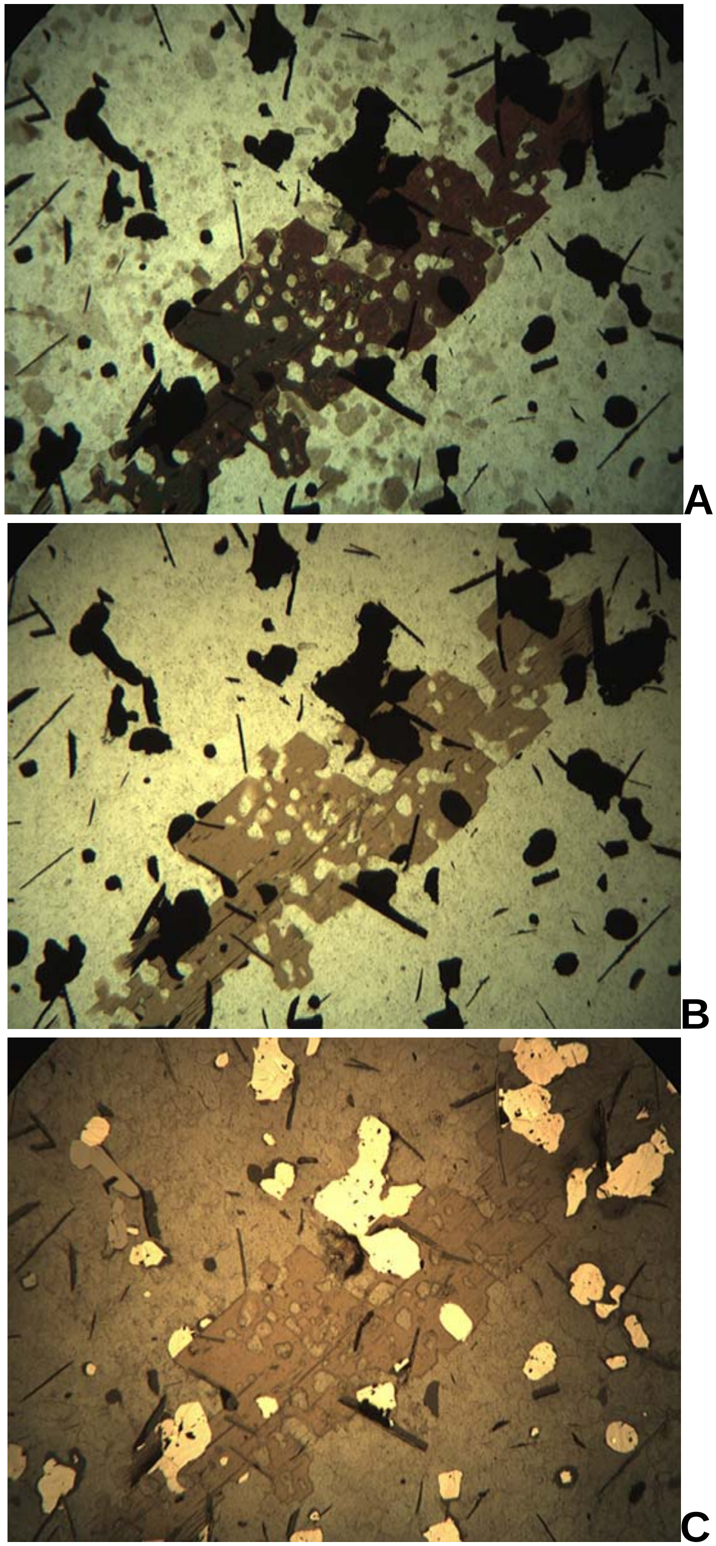


Humidity Cell Sample 26027 (616-626)-65
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



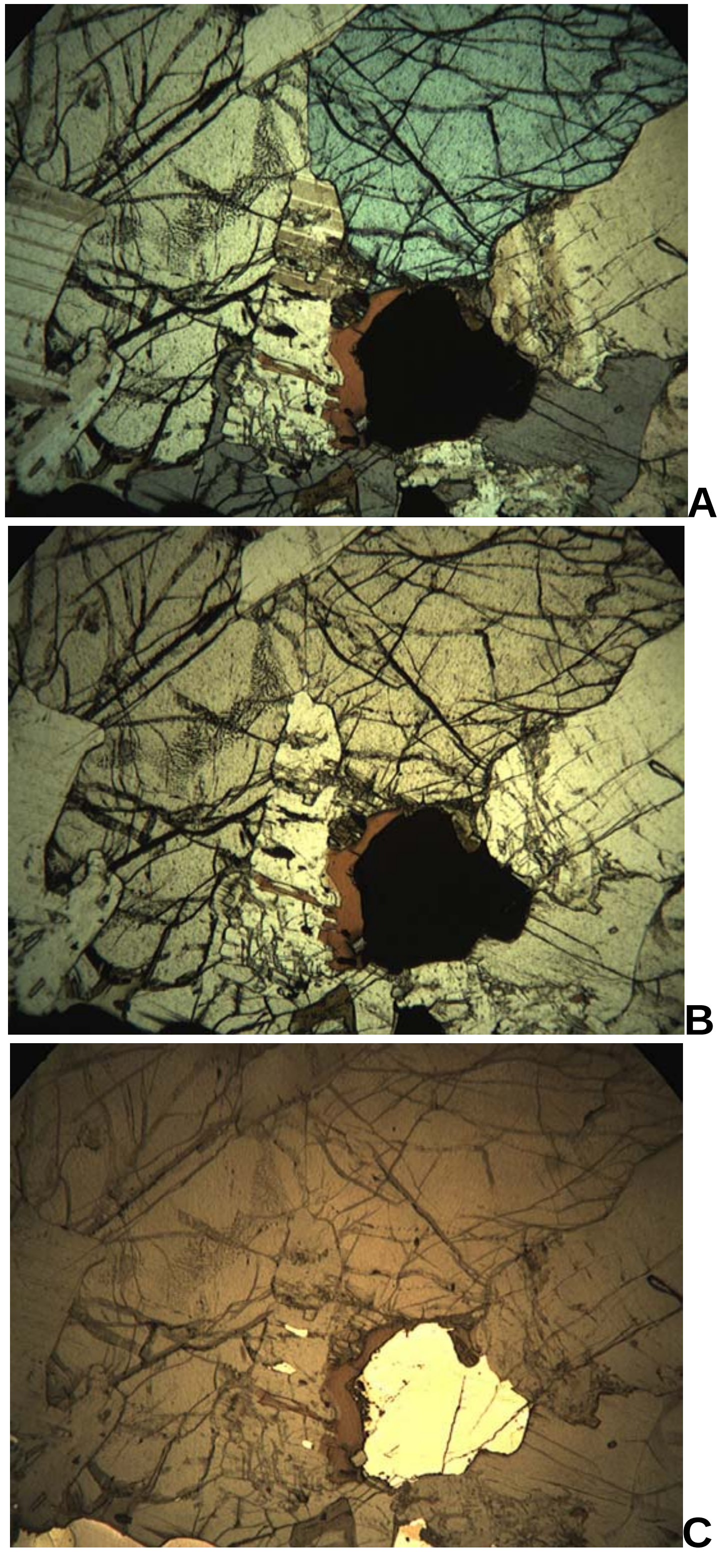
A
B
C

Humidity Cell Sample 26062 (993-998) -68a
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

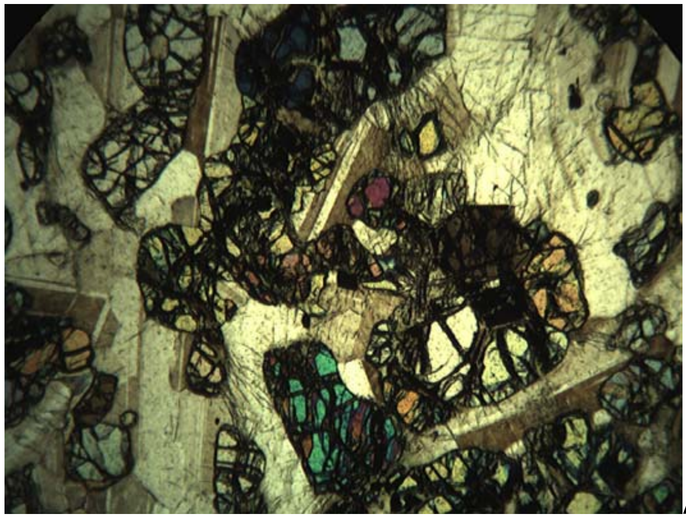


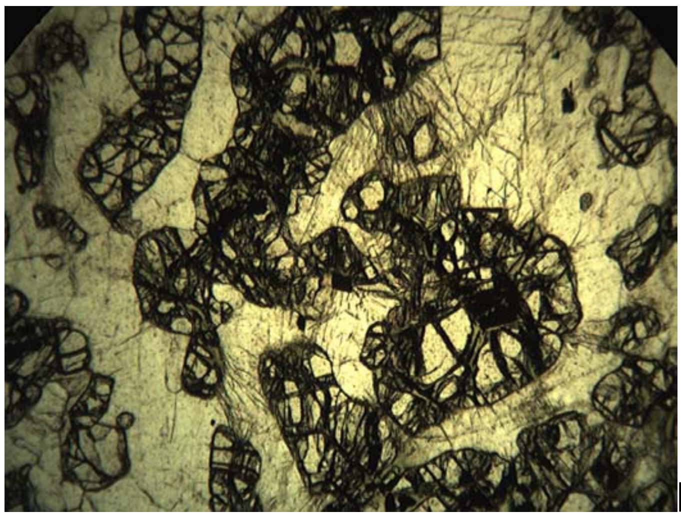
Humidity Cell Sample 26026 (565-568) -68b

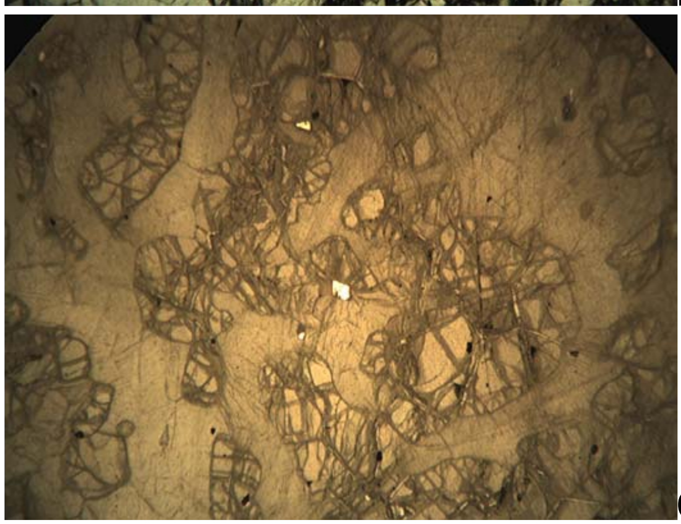
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



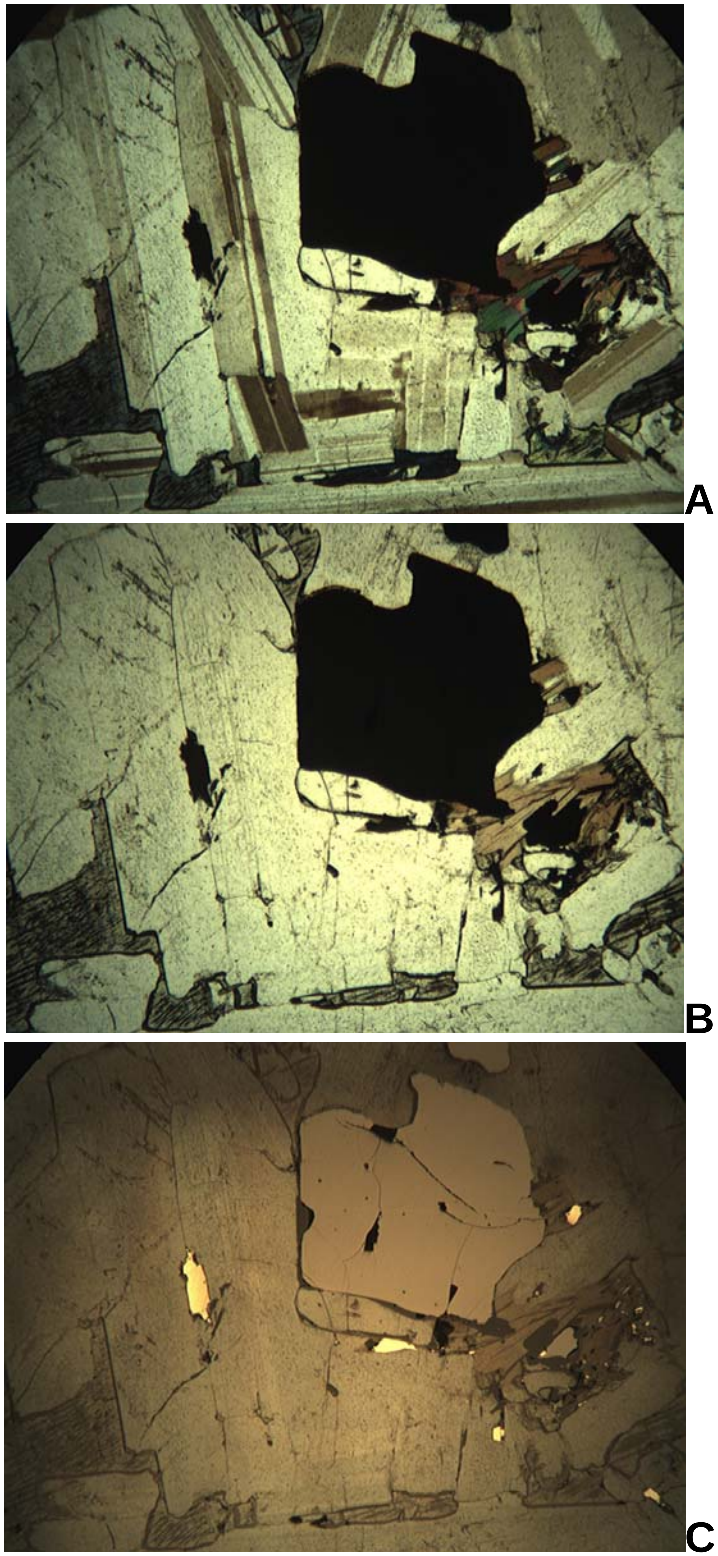
Humidity Cell Sample 00-340C (725-745) -69
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B

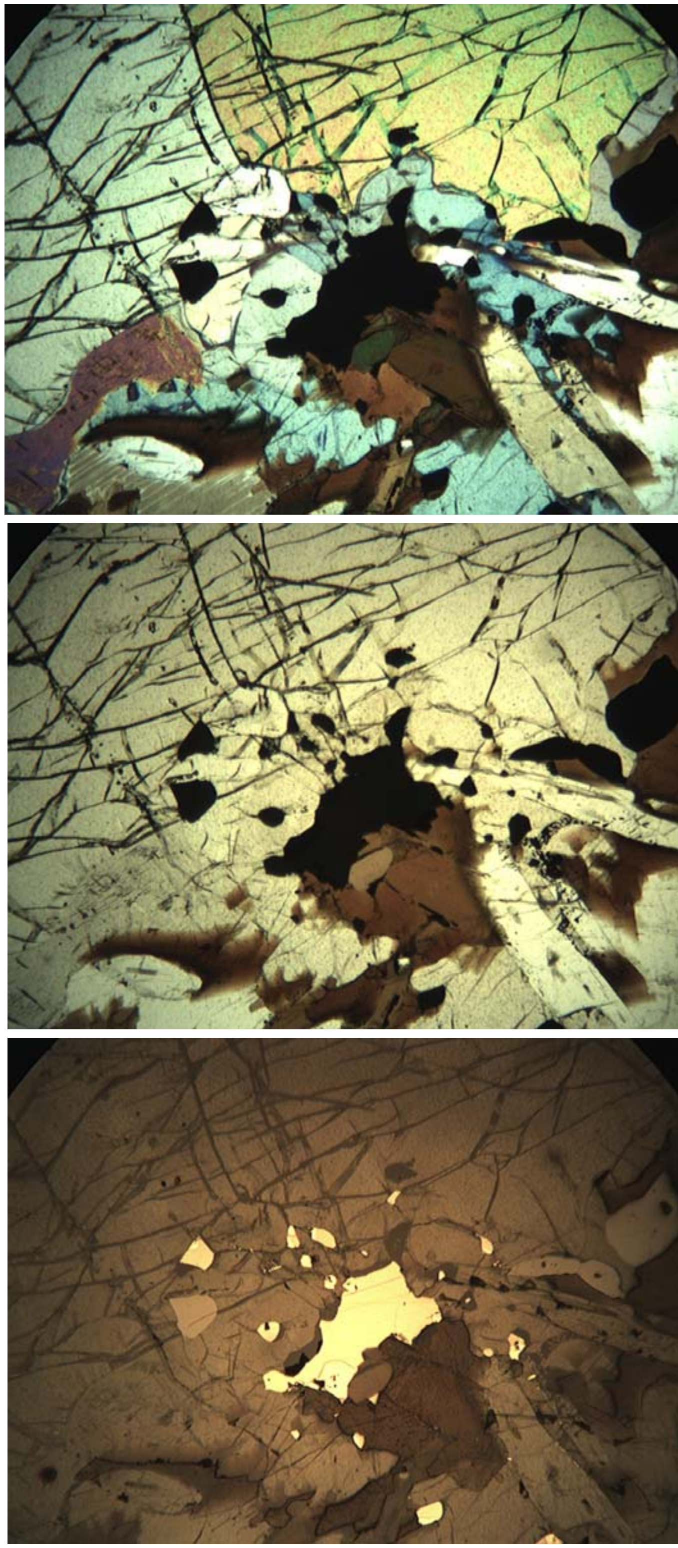

C

Humidity Cell Sample 00-344C (515-520) -70
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



Humidity Cell Sample 00-340C (380-390) -71

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



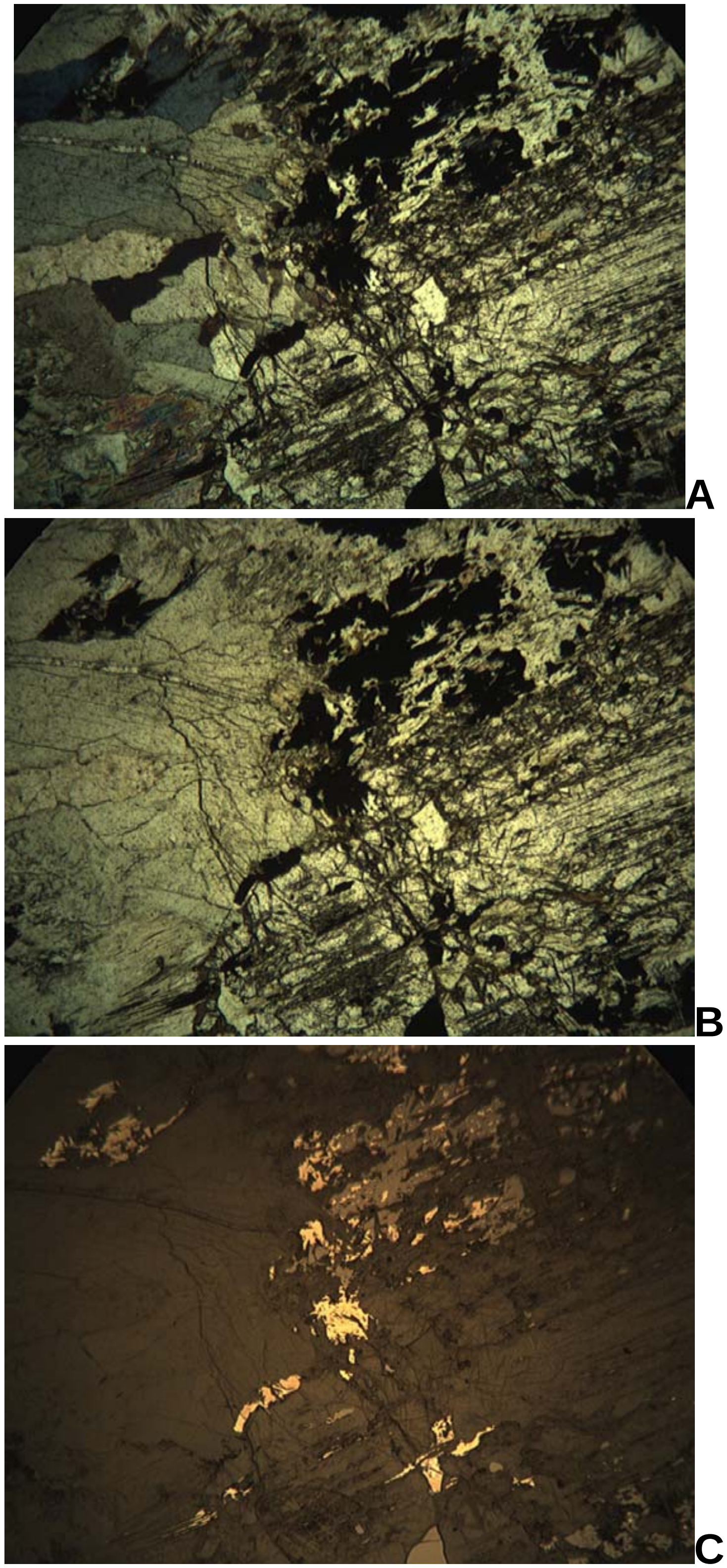
A

B

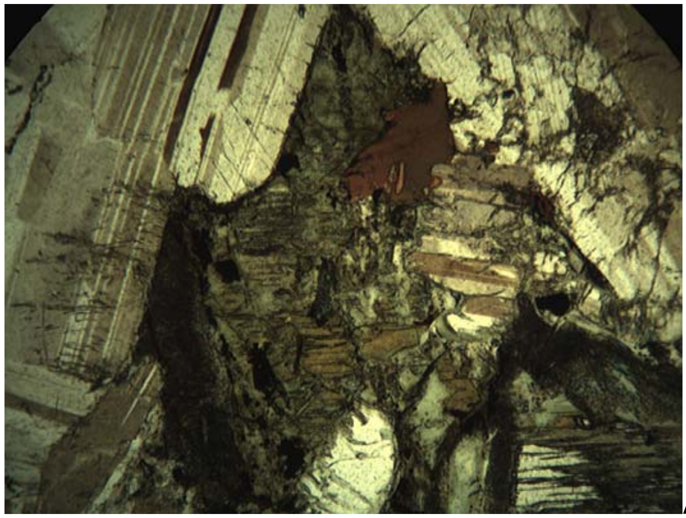
C

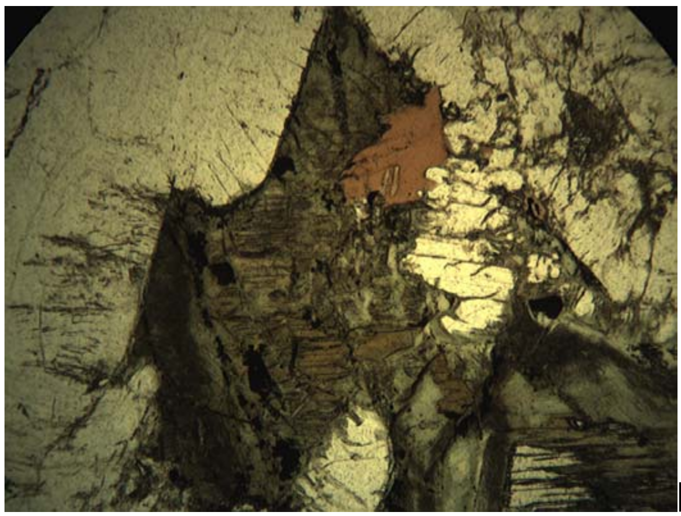
Humidity Cell Sample 26029 (815-825) -74

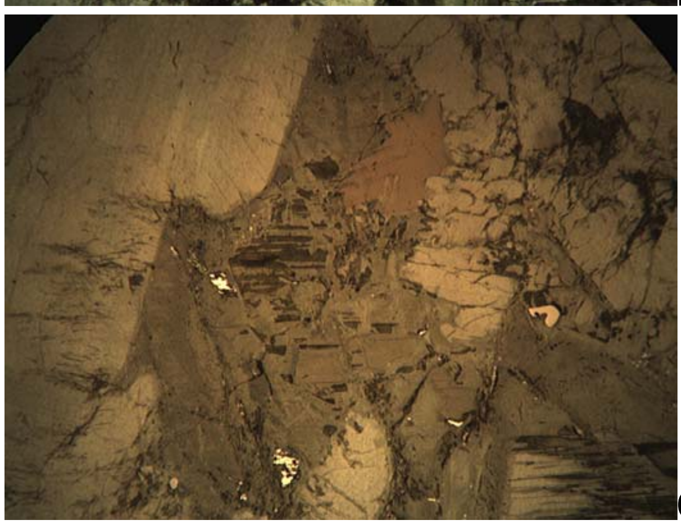
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



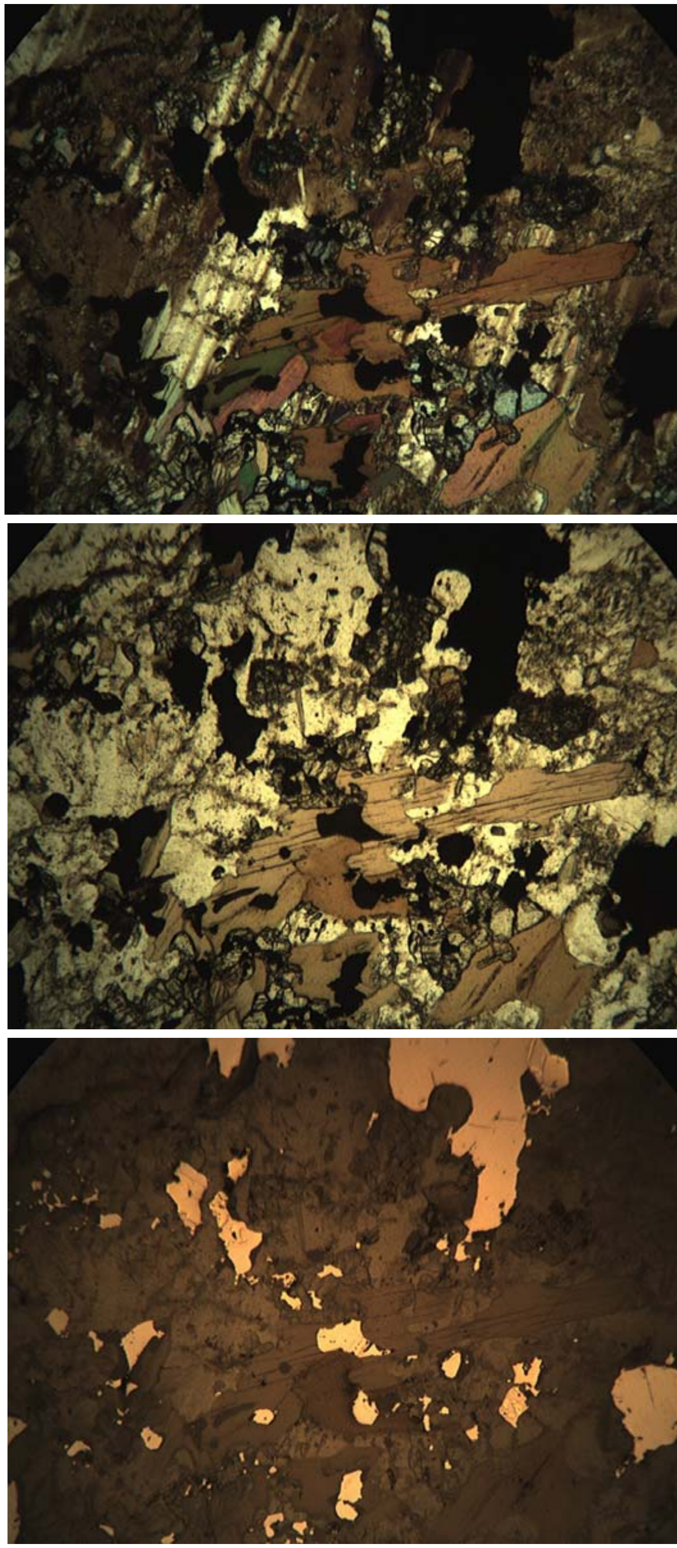
Humidity Cell Sample 26030 (291-296) -75a
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B


C

Humidity Cell Sample 26049 (358-362) -75b
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



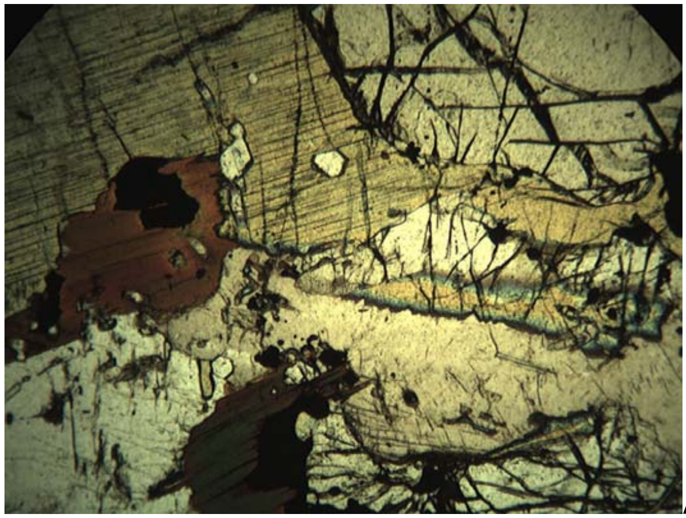
A

B

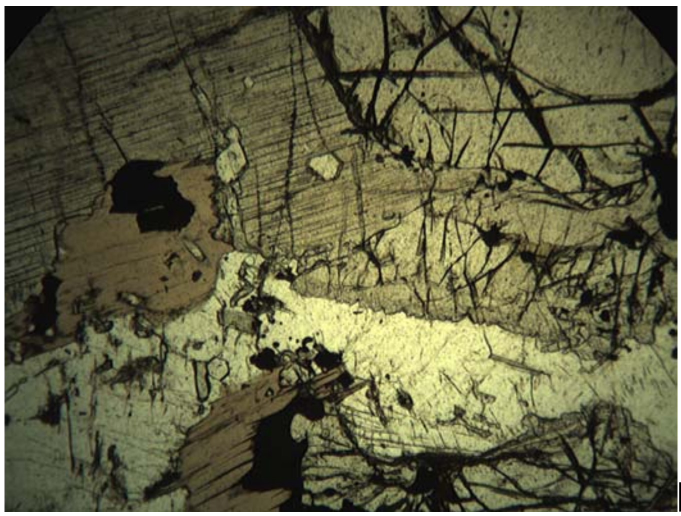
C

Humidity Cell Sample 00-367C (400-405) -76

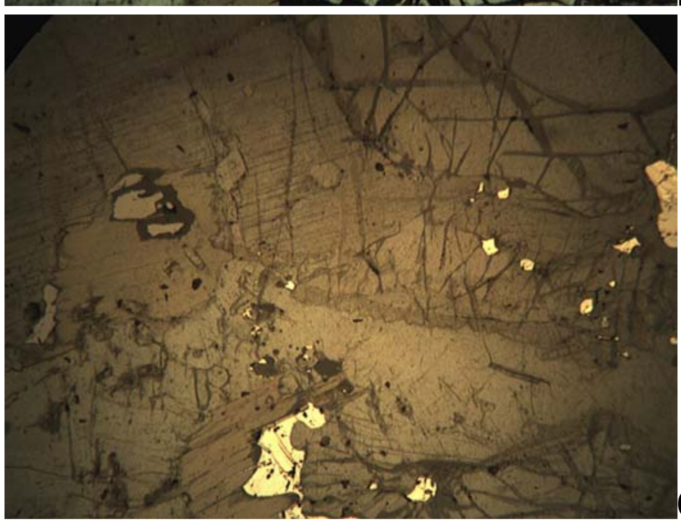
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

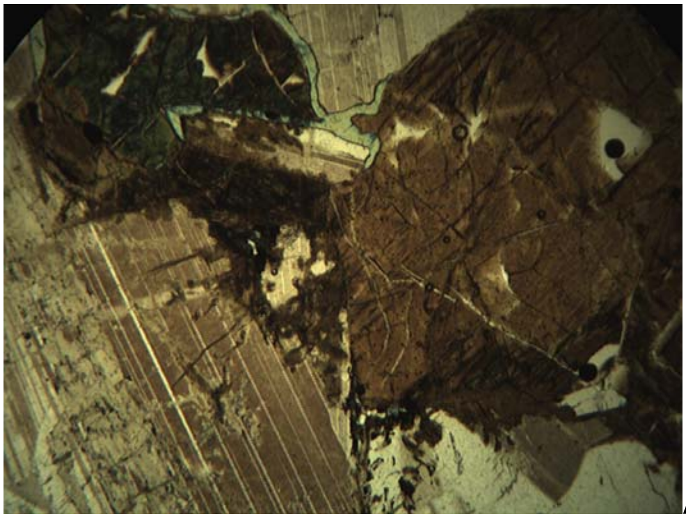


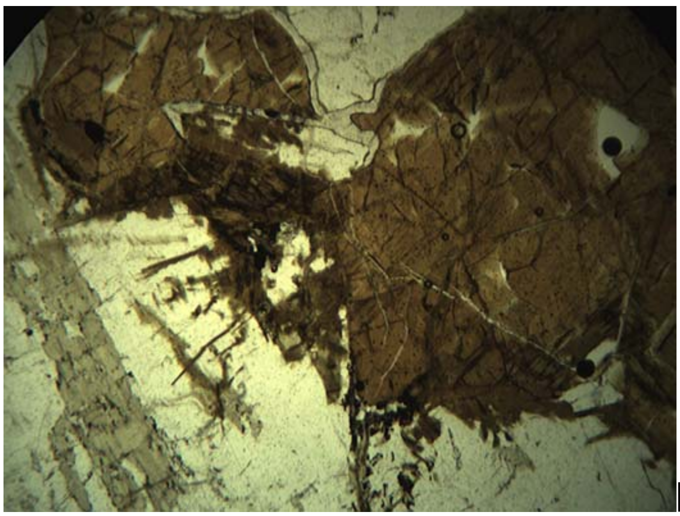
B

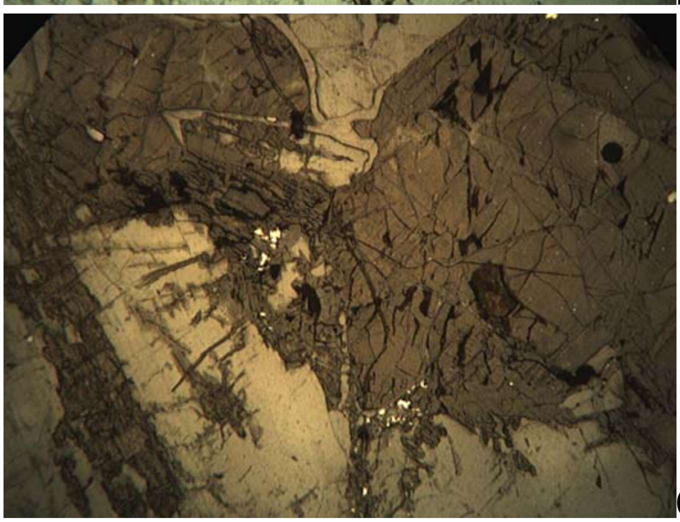


C

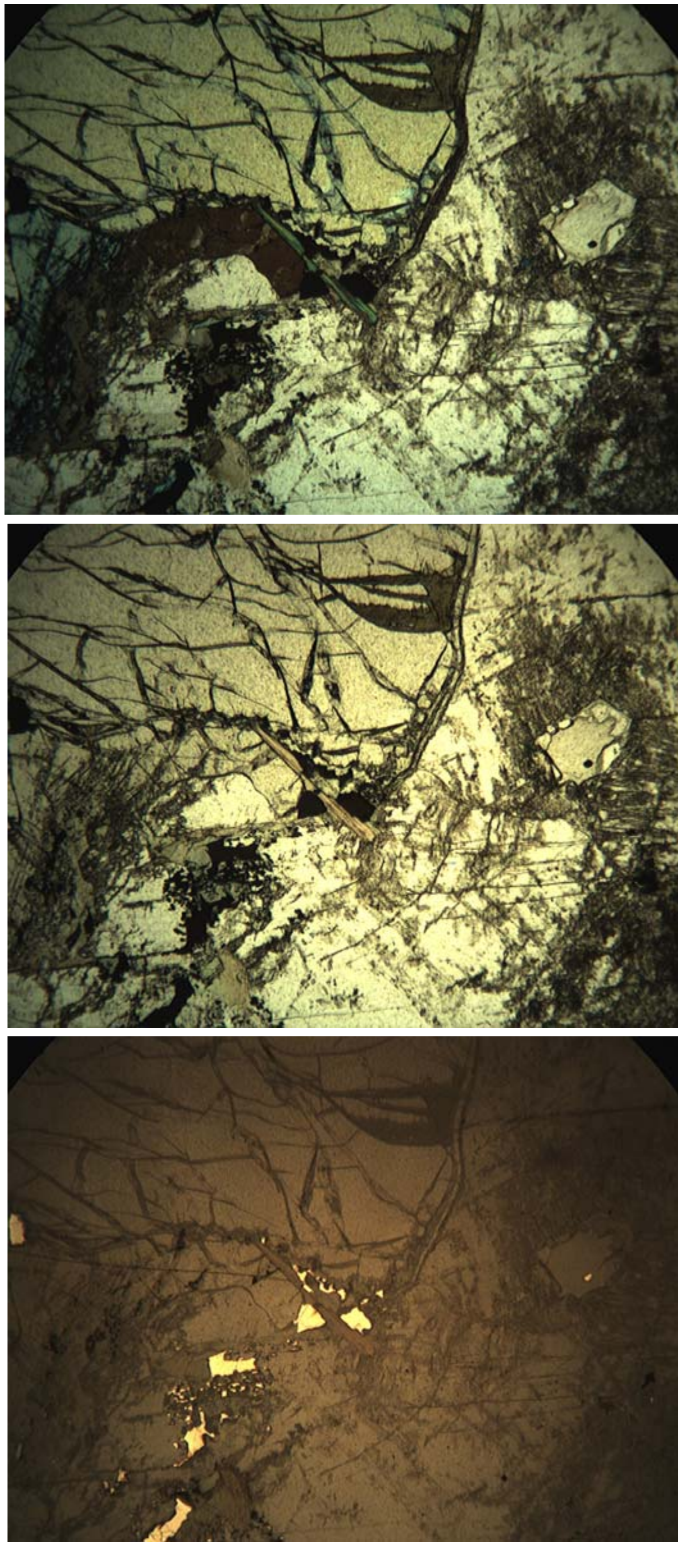
Humidity Cell Sample 26056 (302-312) -77
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A

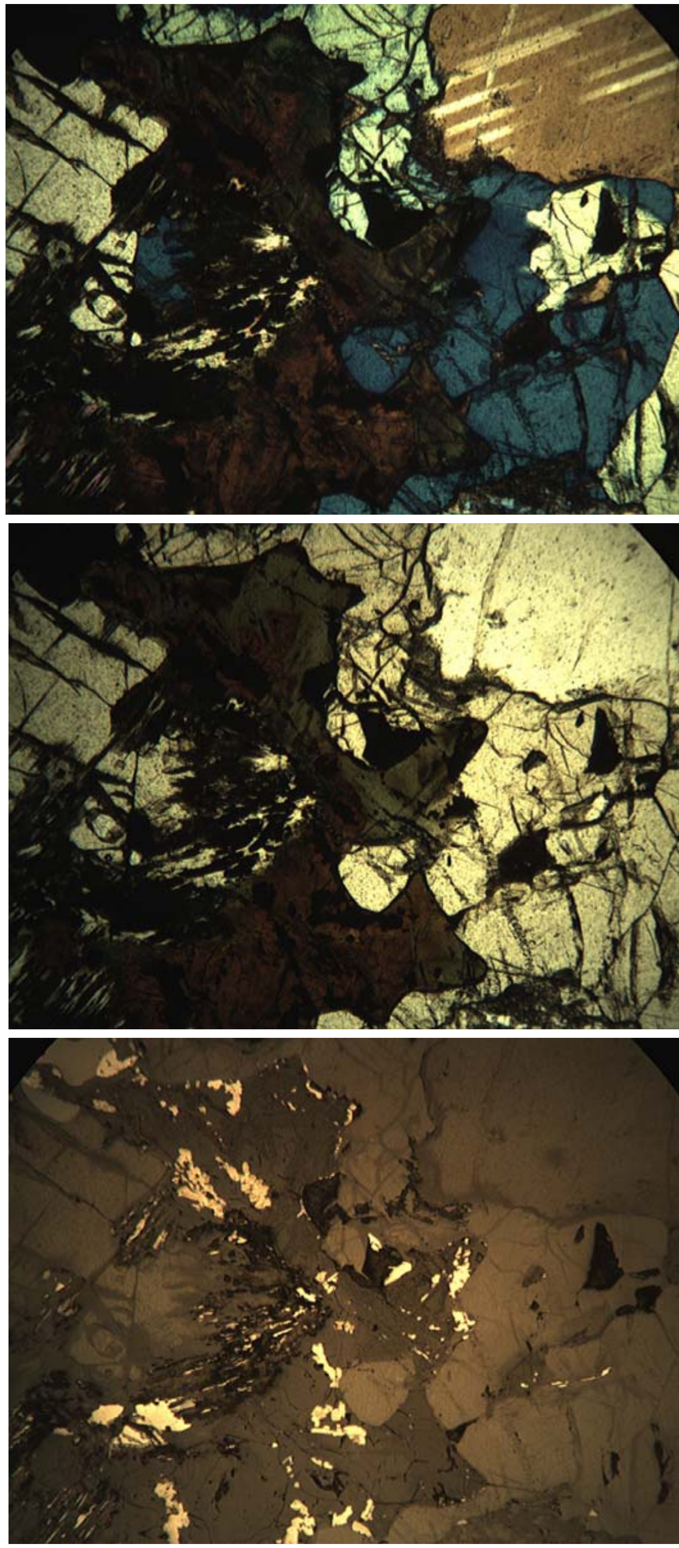

B


C

Humidity Cell Sample 26056 (135-153) -78
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A
B
C

Humidity Cell Sample 26142 (360-365) -80a
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



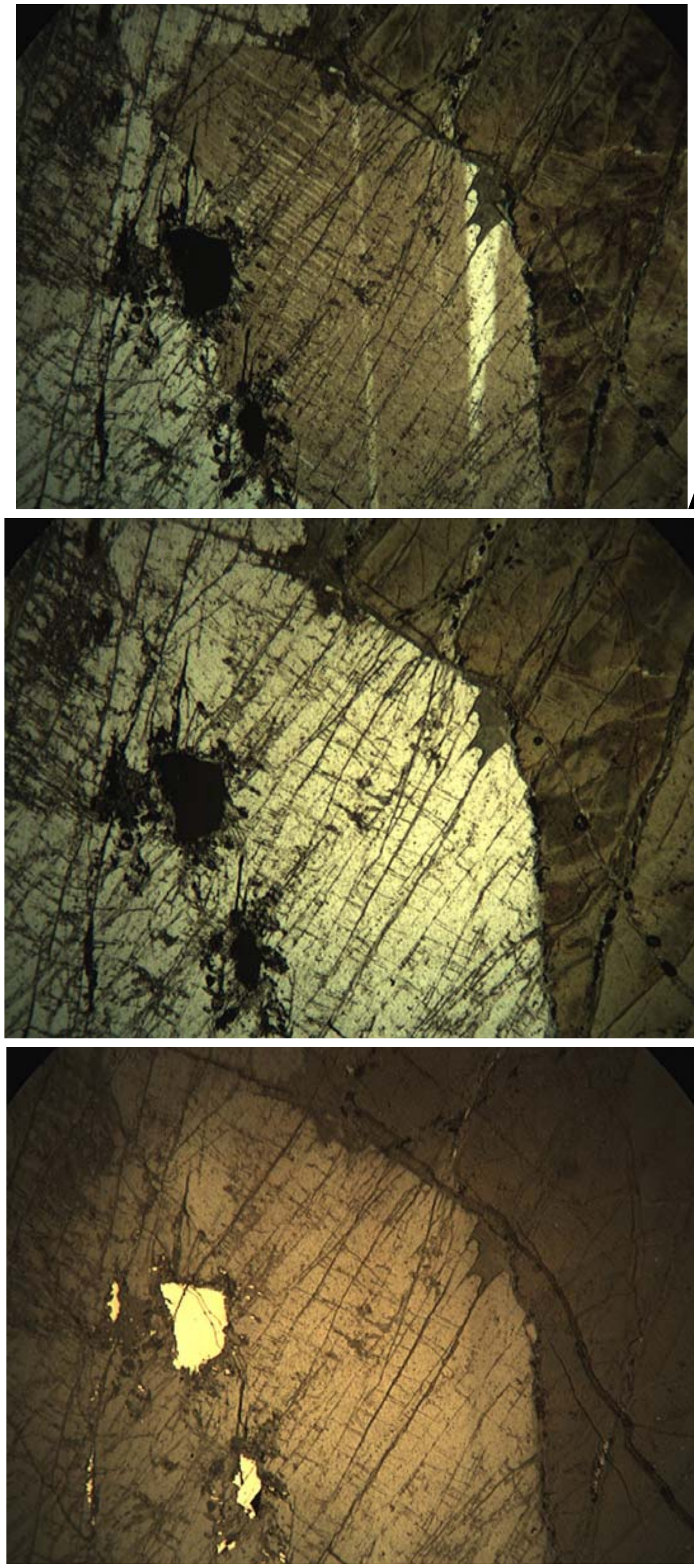
A

B

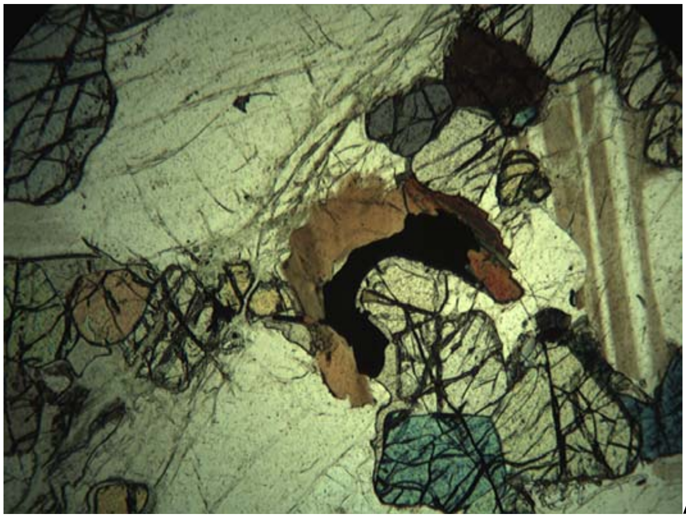
C

Humidity Cell Sample 26142 (345-350) -80b

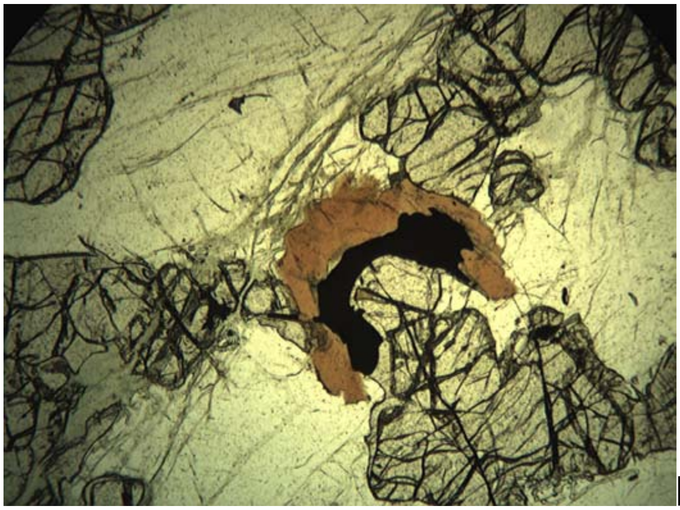
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A
B
C

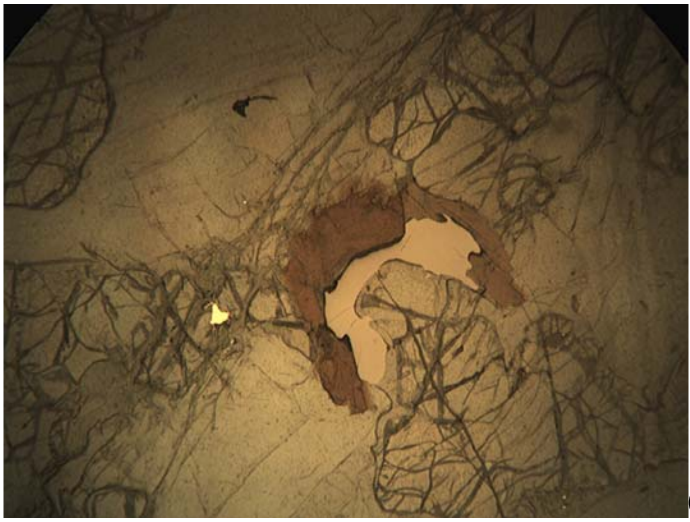
Humidity Cell Sample 00-331C (255-260) -93
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

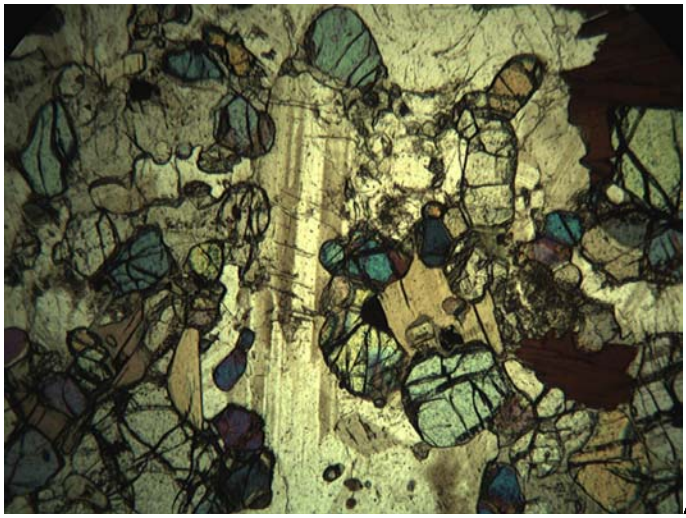


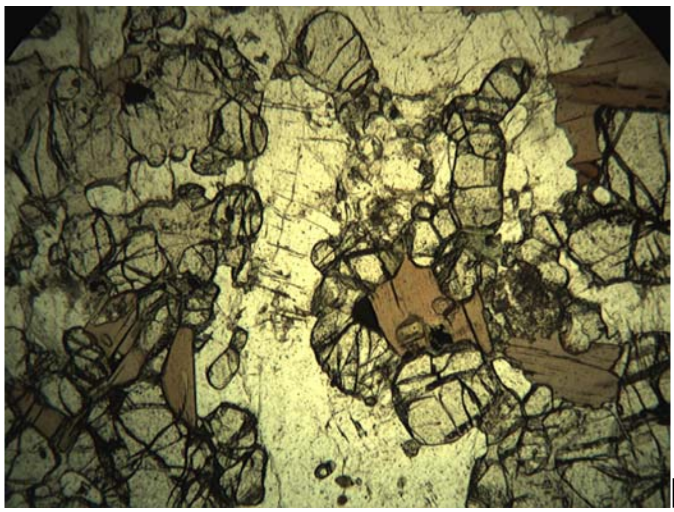
B

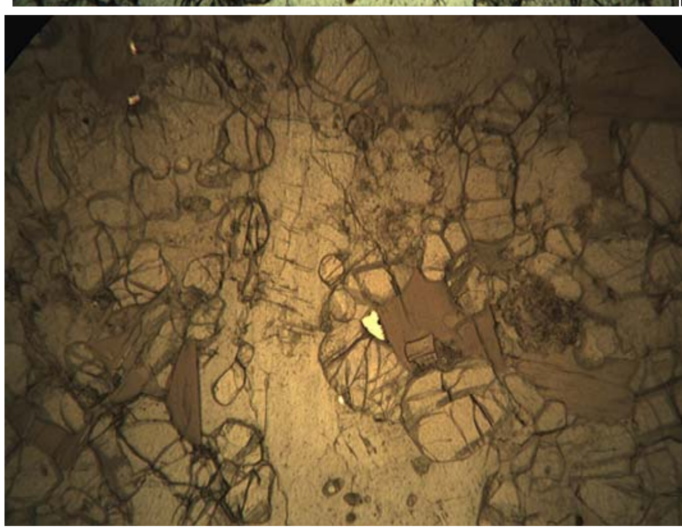


C

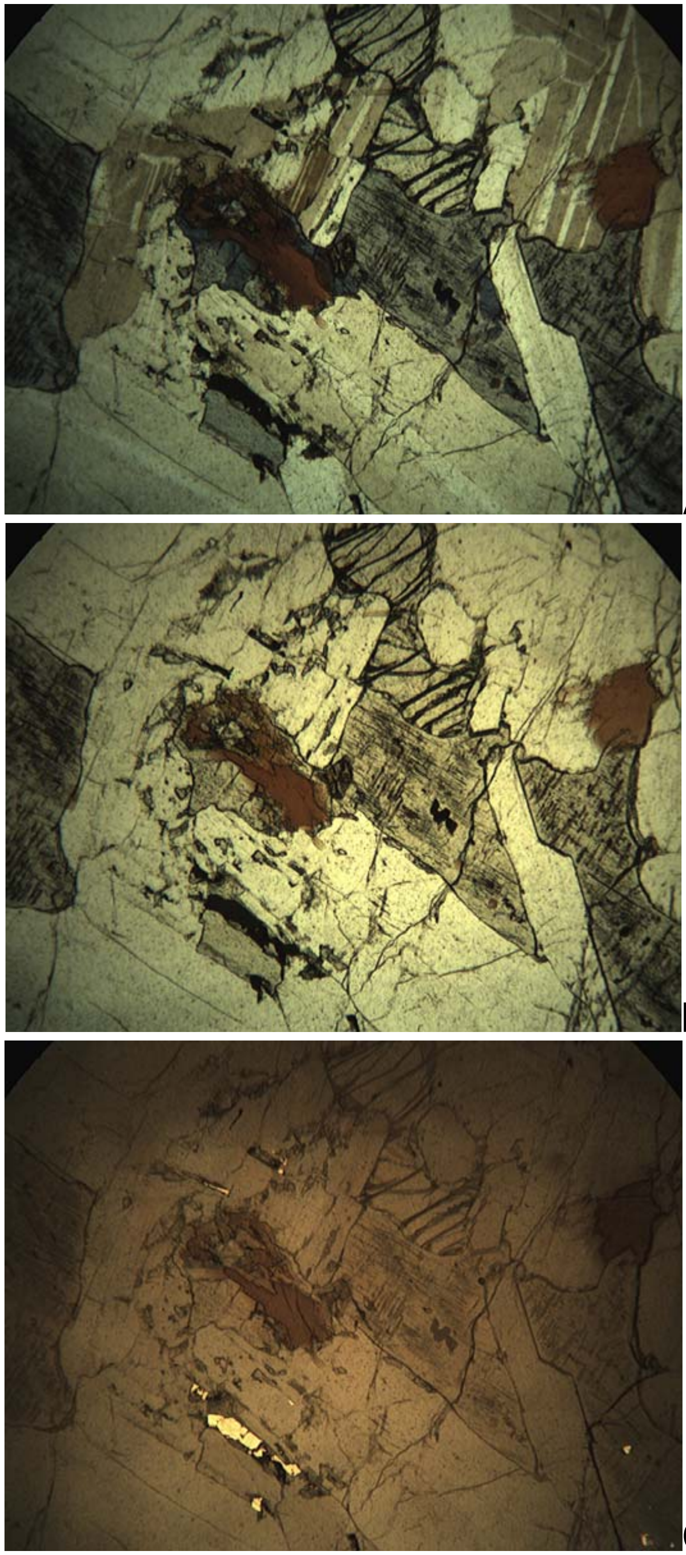
Humidity Cell Sample 00-344C (630-635) -94
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A


B


C

Humidity Cell Sample 00-326C (495-505) -95
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



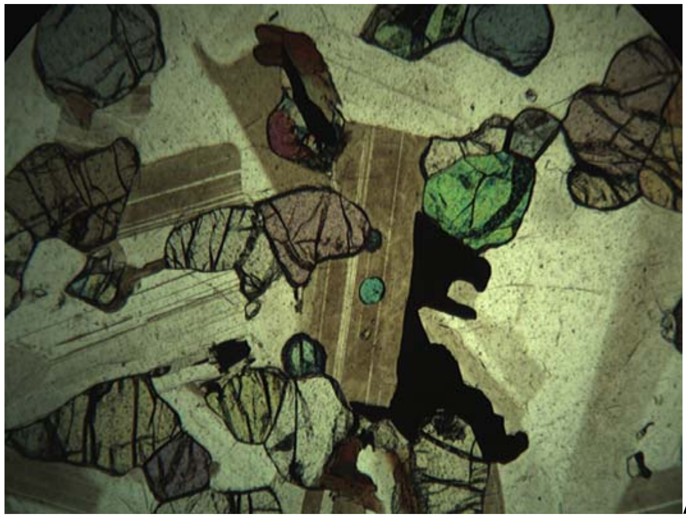
A

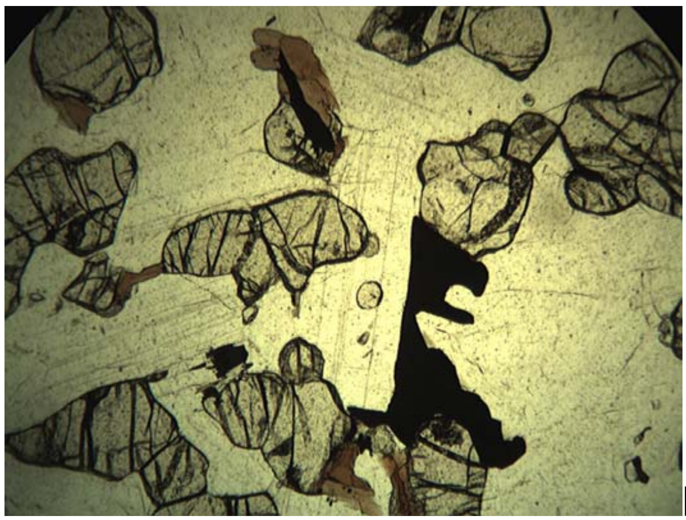
B

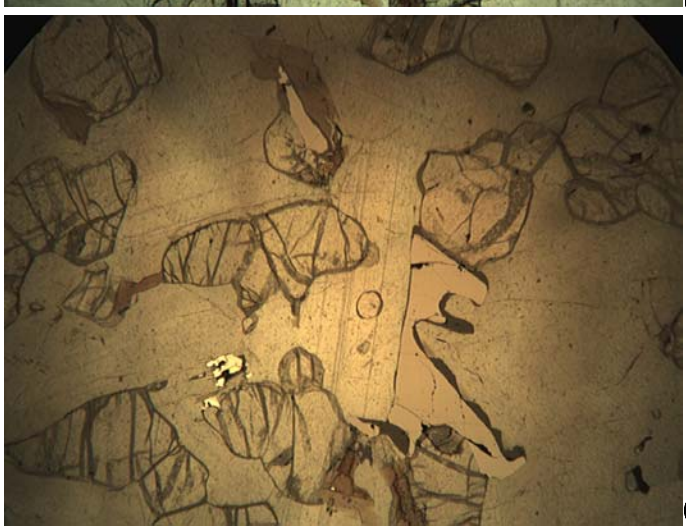
C

Humidity Cell Sample 99-318C (325-330) -96

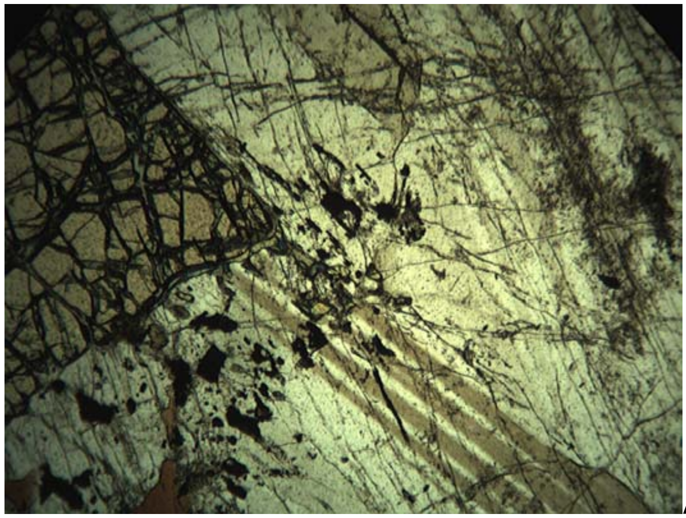
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A

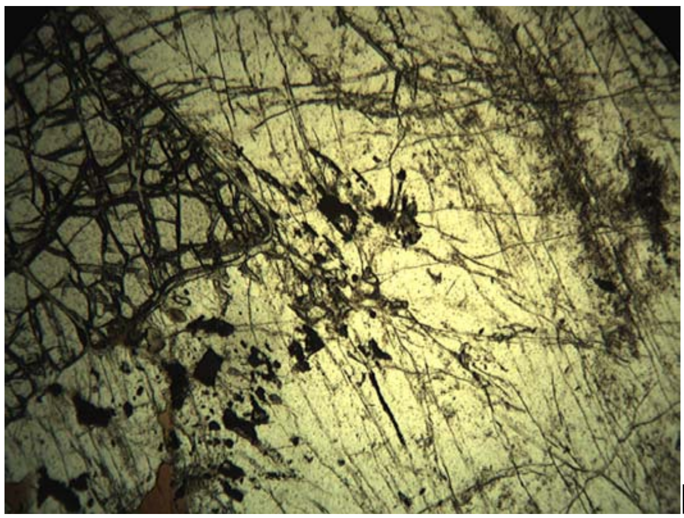

B


C

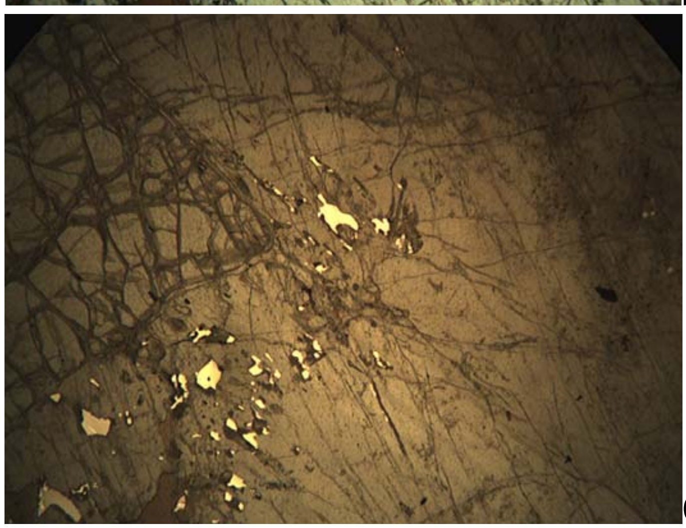
Humidity Cell Sample 00-330C (275-280) -97
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A

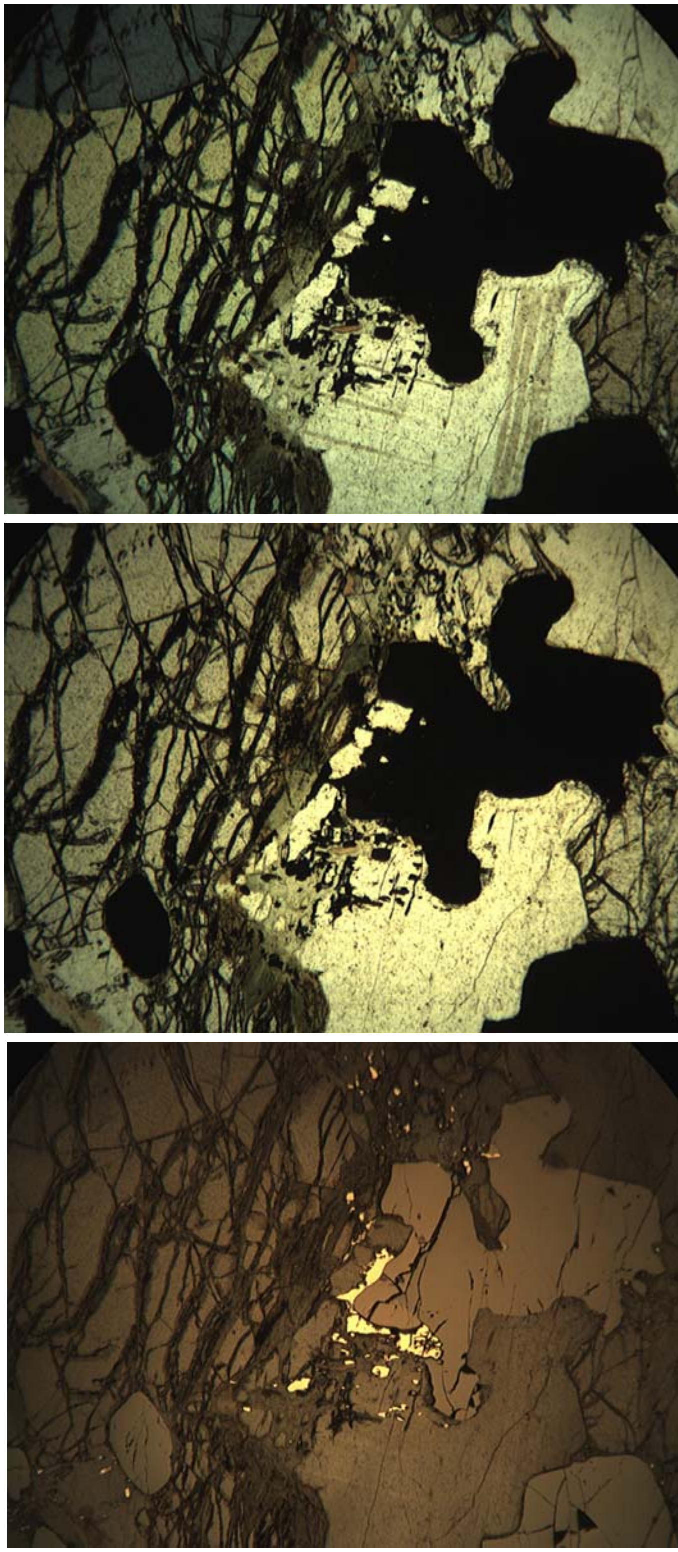


B



C

Humidity Cell Sample 26056 (282-292) -98
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

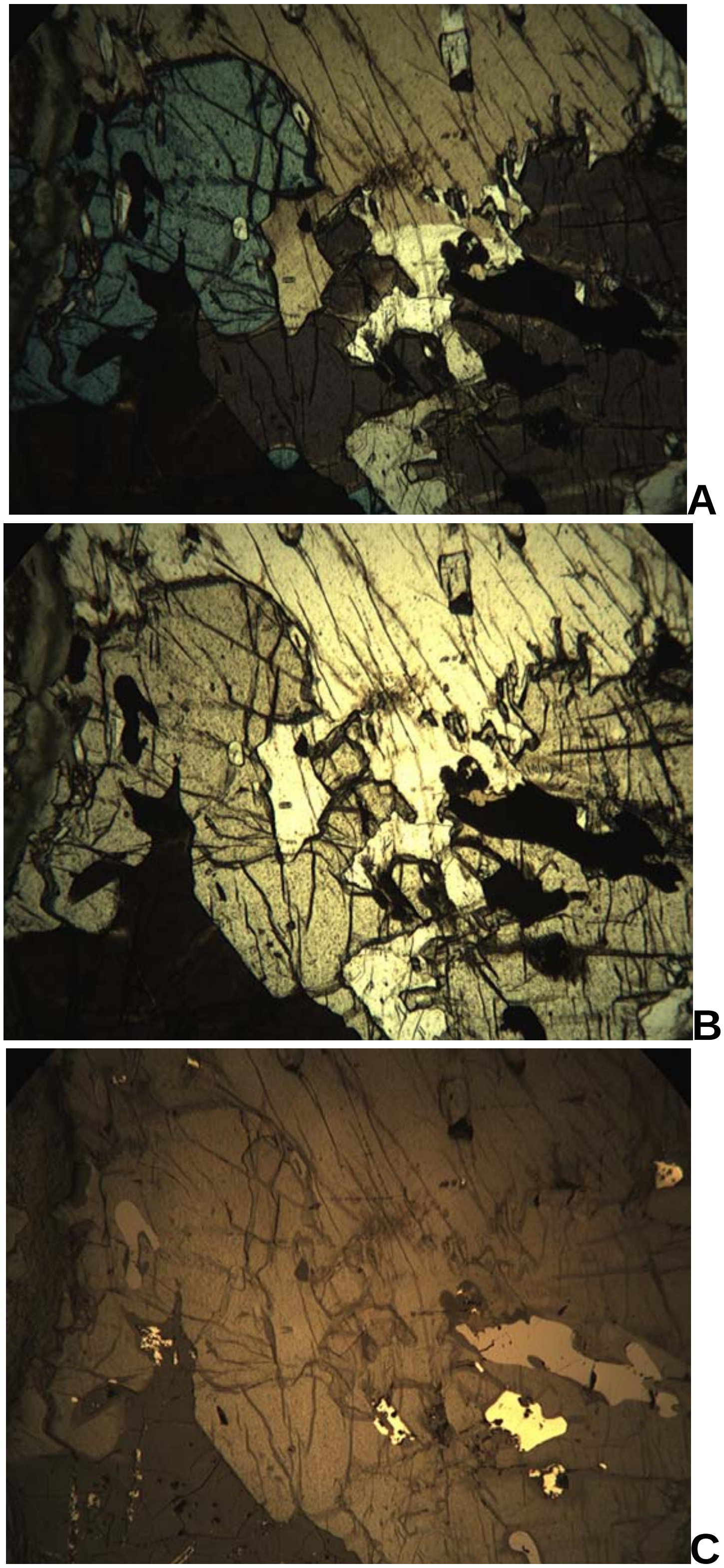


A

B

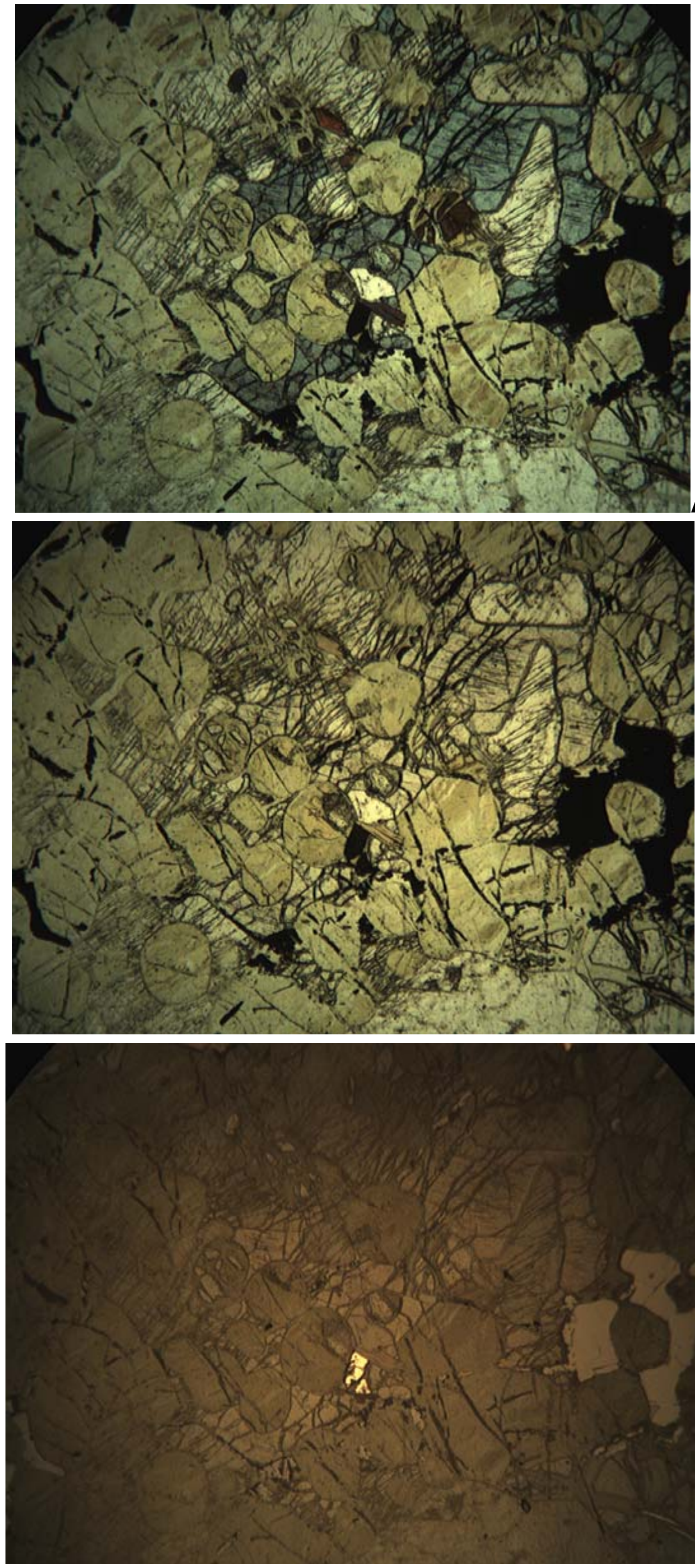
C

Humidity Cell Sample 00-326C (250-265) -99
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

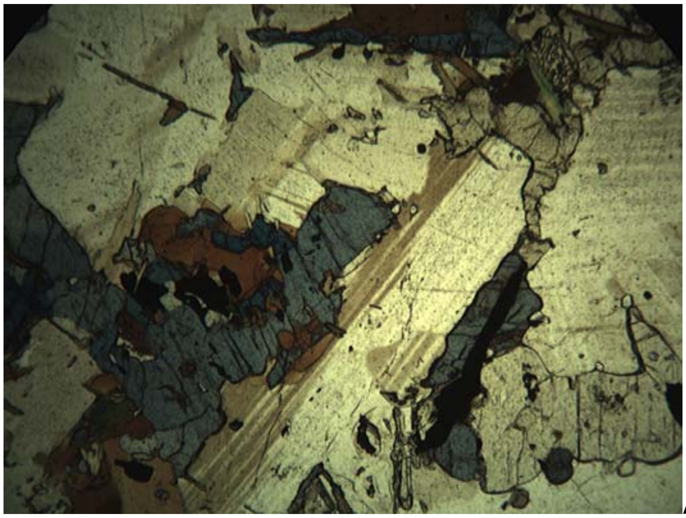


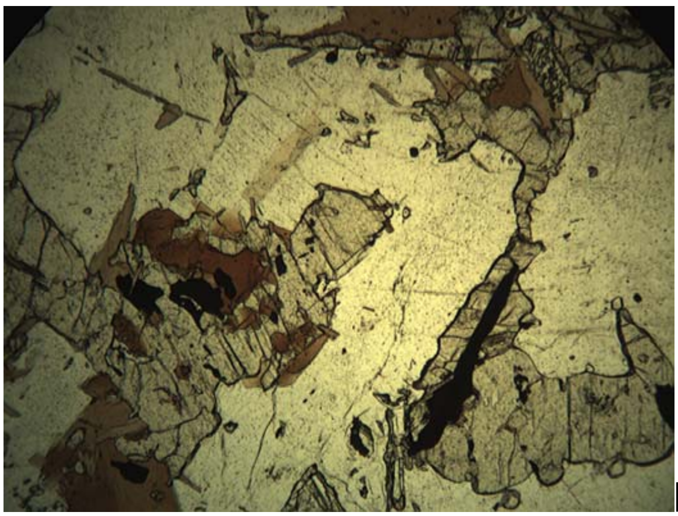
Humidity Cell Sample 00-340 (910-925) -100

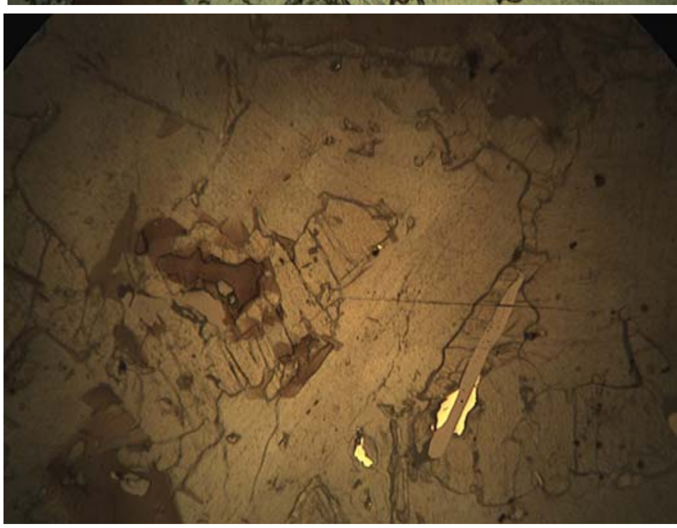
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



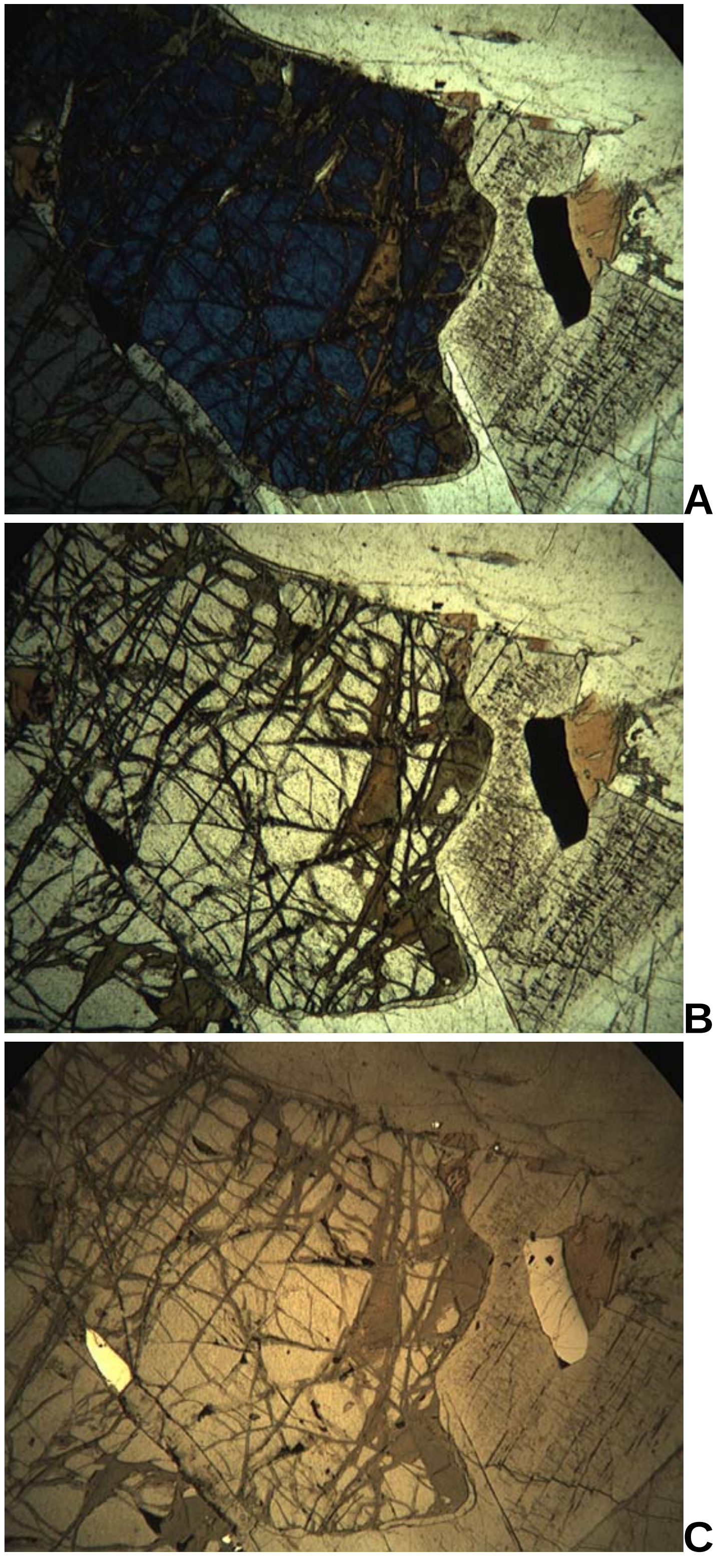
Humidity Cell Sample 26039 (310-315) -101
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm


A

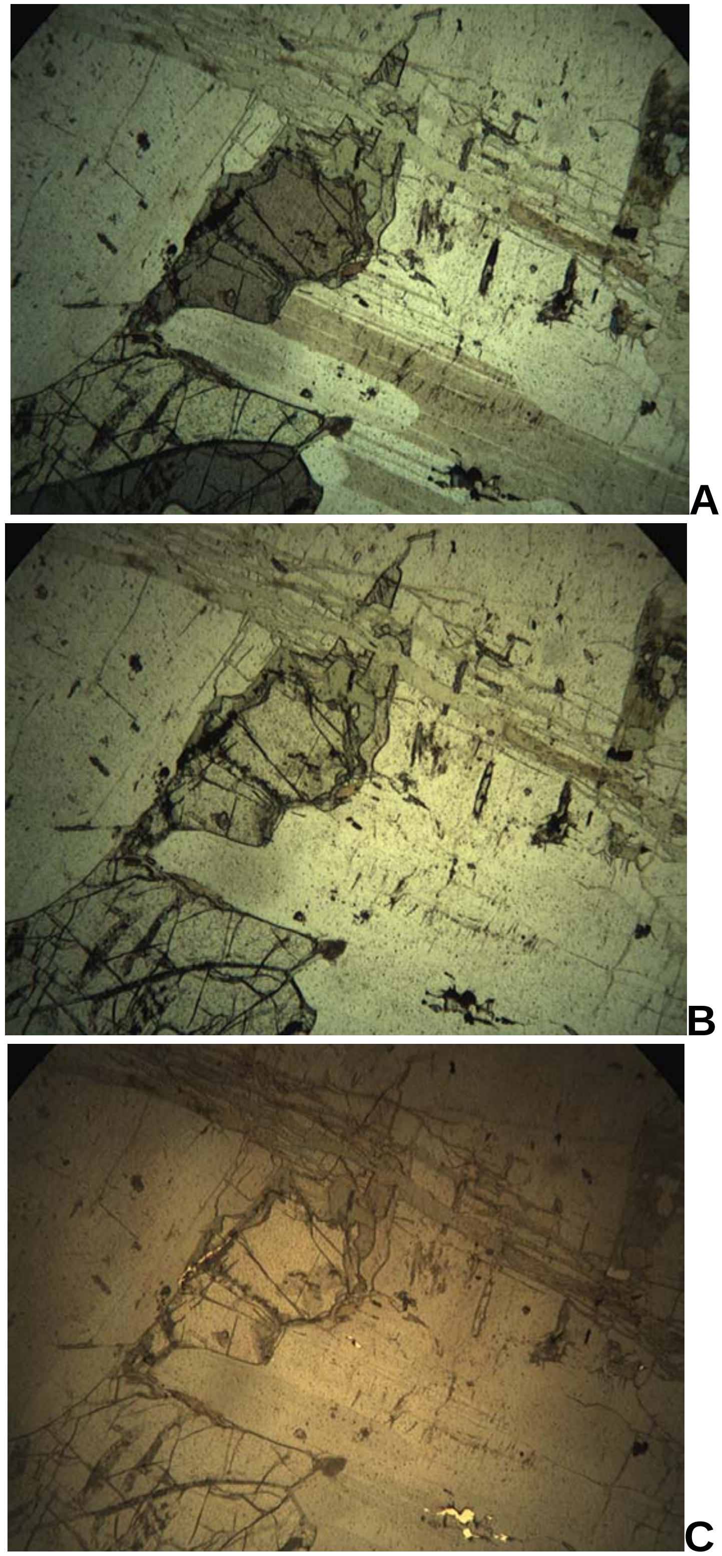

B


C

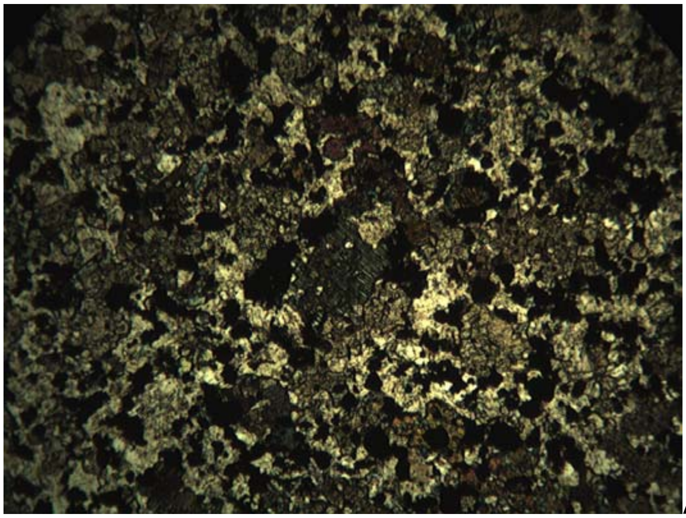
Humidity Cell Sample 00-331C (190-210) -102
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



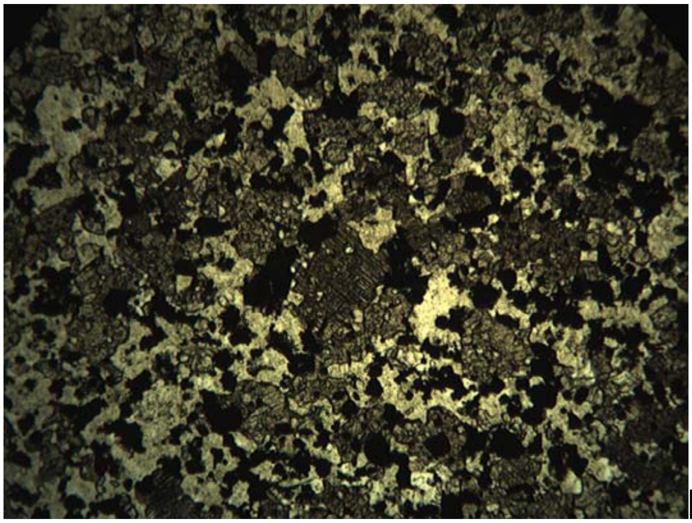
Humidity Cell Sample 99-320C (400-405) -103
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



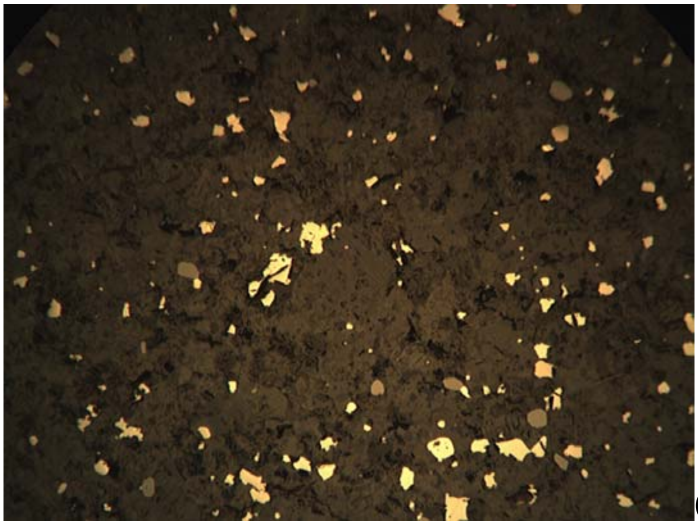
Humidity Cell Sample 00-367C (495-500) -105
A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm



A



B



C

Humidity Cell Sample 26058 (704-715) -106

A) Cross Polarized Light, Field of View = ~2 mm, B) Plain Polarized Light, Field of View = ~2 mm, C) Reflected Light, Field of View = ~2 mm

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Appendix D.3

Results of Microprobe Analyses

(Produced by PolyMet)

Notes:
* determined by difference
All values are in weight %.
If values were below the method detection limit (D.L.) they are expressed as the method detection limit.

Oxides: Ilmenite

Thin Section	SiO2	Al2O3	MgO	FeO (t)	MnO	TiO2	Cr2O3	CuO	CoO	NiO	ex O2 *
00-344C-518	0.012	0.014	2.660	41.943	0.572	52.868	0.124	0.023	0.049	0.026	1.71
00-367C-401	0.012	0.013	0.597	45.447	0.600	52.064	0.022	0.023	0.061	0.026	1.14
00-367C-401	0.012	0.021	0.555	45.618	0.566	52.406	0.022	0.023	0.053	0.026	0.70
00-367C-401	0.012	0.011	0.681	45.407	0.561	51.974	0.022	0.023	0.039	0.026	1.24
26039-311	0.012	0.055	2.704	42.729	0.535	52.155	0.370	0.023	0.061	0.055	1.30
26039-311	0.012	0.047	2.790	42.547	0.506	51.793	0.312	0.023	0.056	0.038	1.88
26039-311	0.012	0.054	2.750	42.547	0.548	52.175	0.290	0.023	0.057	0.045	1.50
00-331C-194	0.012	0.050	0.971	45.175	0.495	51.351	0.107	0.023	0.064	0.031	1.72
00-331C-194	0.012	0.035	0.953	45.487	0.439	51.441	0.099	0.023	0.050	0.026	1.43
00-331C-194	0.012	0.035	0.882	45.387	0.481	51.089	0.108	0.023	0.050	0.027	1.91
00-331C-194	0.012	0.030	0.279	45.779	0.383	52.104	0.022	0.023	0.037	0.026	1.31
26039-311	0.012	0.032	2.387	42.708	0.545	52.808	0.080	0.023	0.042	0.038	1.32
26142-364	0.012	0.028	1.080	44.883	0.628	50.938	0.110	0.023	0.062	0.026	2.21
26142-364	0.012	0.025	0.966	45.376	0.642	51.521	0.081	0.023	0.082	0.028	1.24
00-340C-389	0.012	0.087	2.165	42.960	0.520	51.150	0.085	0.023	0.064	0.026	2.91
00-340C-389	0.012	0.051	2.377	43.202	0.517	51.582	0.050	0.023	0.057	0.026	2.10
00-340C-389	0.012	0.052	2.238	43.605	0.487	51.994	0.113	0.023	0.056	0.044	1.38
26049-361	0.012	0.018	2.127	42.900	0.563	52.155	0.122	0.023	0.062	0.026	1.99
99-318C-267	0.012	0.080	2.666	45.014	0.444	49.089	0.083	0.023	0.065	0.026	2.50
99-318C-267	0.012	0.084	2.304	45.638	0.434	48.767	0.051	0.023	0.089	0.031	2.57
99-318C-267	0.012	0.078	2.261	46.031	0.466	49.290	0.060	0.023	0.062	0.030	1.69
26026-566	0.012	0.024	0.201	45.779	0.456	51.119	0.022	0.023	0.028	0.026	2.31
26026-566	0.012	0.031	0.333	45.779	0.430	51.833	0.022	0.023	0.047	0.026	1.46
26026-566	0.012	0.033	0.280	45.719	0.356	51.139	0.022	0.023	0.035	0.026	2.36
99-320C-172	0.012	0.046	2.389	44.312	0.600	49.980	0.141	0.023	0.051	0.026	2.42
99-317C-462	0.012	0.038	0.940	45.748	0.428	50.840	0.022	0.023	0.039	0.026	1.88
99-317C-462	0.012	0.028	0.525	46.405	0.522	52.400	0.022	0.023	0.047	0.026	-0.01
99-317C-462	0.012	0.026	0.418	46.395	0.478	50.650	0.022	0.023	0.049	0.026	1.90
00-367C-398	0.012	0.018	1.328	44.150	0.522	53.250	0.077	0.023	0.041	0.026	0.55
00-367C-398	0.012	0.014	1.439	43.928	0.525	51.780	0.091	0.023	0.054	0.026	2.11
00-367C-398	0.012	0.027	1.360	44.262	0.581	53.510	0.117	0.023	0.042	0.026	0.04
00-368C-132	0.012	0.084	1.809	46.081	0.455	49.170	0.022	0.023	0.055	0.026	2.26
00-368C-132	0.012	0.065	1.826	46.021	0.445	50.690	0.022	0.023	0.047	0.026	0.82
00-368C-132	0.012	0.080	1.871	45.657	0.462	49.650	0.022	0.023	0.059	0.030	2.13
00-370C-22	0.012	0.033	1.055	44.433	0.659	53.550	0.022	0.023	0.059	0.026	0.13
00-370C-22	0.012	0.021	0.746	44.808	0.754	51.630	0.022	0.023	0.060	0.026	1.90
00-370C-22	0.012	0.018	0.211	45.455	0.933	53.170	0.022	0.023	0.053	0.026	0.08
00-361C-311	0.012	0.039	2.492	42.361	0.525	52.320	0.079	0.023	0.050	0.026	2.07
00-361C-311	0.012	0.038	2.516	42.007	0.524	54.370	0.098	0.023	0.059	0.026	0.33
00-361C-311	0.012	0.028	2.750	42.068	0.439	52.410	0.163	0.023	0.043	0.034	2.03
00-347C-299	0.012	0.031	2.161	43.645	0.551	52.740	0.087	0.023	0.049	0.026	0.68
00-347C-299	0.012	0.044	2.263	43.786	0.560	50.790	0.143	0.023	0.031	0.034	2.31
00-357C-112	0.012	0.082	1.812	45.141	0.443	50.030	0.101	0.023	0.050	0.037	2.27
00-357C-112	0.012	0.060	1.883	45.293	0.450	51.280	0.098	0.023	0.066	0.026	0.81
00-357C-112	0.012	0.056	2.447	44.211	0.448	50.060	0.212	0.023	0.070	0.045	2.42
00-340C-778	0.012	0.012	1.648	43.412	0.424	53.280	0.223	0.023	0.033	0.026	0.91
00-340C-778	0.012	0.024	1.935	42.877	0.383	51.740	0.189	0.023	0.053	0.026	2.74
00-340C-778	0.012	0.026	1.812	43.554	0.367	53.340	0.176	0.023	0.049	0.026	0.62
00-347C-798	0.012	0.062	1.901	44.373	0.494	50.490	0.148	0.023	0.053	0.026	2.42
00-347C-798	0.012	0.085	1.821	45.353	0.476	51.220	0.180	0.023	0.054	0.026	0.75
00-347C-798	0.189	0.210	2.123	44.363	0.474	51.150	0.108	0.023	0.057	0.026	1.28
26064-264	0.012	0.025	2.344	42.775	0.514	52.120	0.229	0.037	0.065	0.026	1.85
26064-264	0.085	0.064	2.205	42.836	0.496	51.770	0.172	0.023	0.054	0.026	2.27
26064-264	0.012	0.044	2.645	42.523	0.498	51.930	0.260	0.023	0.063	0.041	1.96
26098-148	0.012	0.079	2.556	43.716	0.465	50.590	0.252	0.023	0.063	0.045	2.20
26098-148	0.012	0.048	2.553	43.230	0.482	51.300	0.210	0.023	0.056	0.028	2.06
26098-148	0.012	0.052	2.372	43.857	0.444	50.700	0.109	0.023	0.056	0.033	2.34
00-340C-596	0.012	0.045	2.170	44.797	0.420	50.470	0.097	0.023	0.040	0.032	1.89
00-340C-596	0.012	0.047	2.477	43.453	0.484	51.390	0.121	0.023	0.034	0.028	1.93
26056-138	0.012	0.035	0.952	45.030	0.808	50.590	0.353	0.023	0.050	0.057	2.09
26056-138	0.012	0.031	1.877	43.240	0.644	51.810	0.250	0.023	0.056	0.033	2.02
26056-138	0.012	0.044	2.538	42.947	0.548	51.910	0.143	0.023	0.045	0.042	1.75
Min.	0.012	0.011	0.201	41.943	0.356	48.767	0.022	0.023	0.028	0.026	-0.010
P5	0.012	0.014	0.283	42.369	0.385	49.308	0.022	0.023	0.034	0.026	0.138
Median	0.012	0.038	1.892	44.337	0.496	51.606	0.100	0.023	0.053	0.026	1.890
Mean	0.016	0.045	1.732	44.293	0.514	51.530	0.117	0.023	0.053	0.030	1.647
P95	0.012	0.084	2.702	46.030	0.658	53.337	0.289	0.023	0.066	0.045	2.494
Max.	0.189	0.210	2.790	46.405	0.933	54.370	0.370	0.037	0.089	0.057	2.908
D.L.	0.012	0.011	0.009	0.021	0.019	0.020	0.022	0.023	0.020	0.026	

Oxides: Magnetite										
Thin Section	**SiO2**	**Al2O3**	**MgO**	**FeO (t)**	**MnO**	**TiO2**	**Cr2O3**	**CuO**	**CoO**	**NiO**	**ex O2 ***
00-344C-518	0.133	0.024	0.234	93.481	0.456	51.119	0.022	0.023	0.100	0.026	5.962
00-344C-518	0.489	0.024	0.431	92.646	0.561	51.119	0.022	0.023	0.124	0.026	5.741
26039-311	0.012	7.000	1.795	55.525	0.456	51.119	19.760	0.023	0.086	0.108	4.822
26039-311	0.012	11.350	1.542	49.434	0.456	51.119	27.030	0.023	0.074	0.066	4.624
26039-311	0.012	8.000	1.606	53.793	0.456	51.119	22.040	0.023	0.085	0.104	5.523
26142-364	0.012	6.150	1.244	63.600	0.456	51.119	16.700	0.023	0.108	0.143	6.355
26049-361	0.164	11.990	1.789	45.779	0.456	51.119	36.120	0.023	0.085	0.060	5.117
26049-361	0.012	12.770	1.962	45.779	0.456	51.119	35.260	0.023	0.084	0.041	4.630
99-320C-172	0.012	2.673	0.798	80.951	0.456	51.119	2.584	0.023	0.099	0.108	5.338
99-320C-172	0.012	2.752	0.808	79.687	0.456	51.119	2.577	0.023	0.093	0.090	5.076
00-347C-299	0.012	4.450	0.824	74.096	0.456	51.119	9.020	0.023	0.097	0.107	5.691
00-347C-299	0.012	4.760	0.959	72.024	0.456	51.119	10.020	0.023	0.119	0.123	5.234
00-340C-596	0.012	3.800	1.043	73.843	0.456	51.119	5.400	0.023	0.096	0.143	5.857
26056-138	0.012	4.710	1.047	69.941	0.456	51.119	8.350	0.023	0.096	0.171	5.370
Min.	0.012	0.024	0.234	45.779	0.456	51.119	0.022	0.023	0.074	0.026	4.624
P5	0.012	0.024	0.362	45.779	0.456	51.119	0.022	0.023	0.080	0.026	4.627
Median	0.012	4.735	1.045	70.982	0.456	51.119	9.520	0.023	0.096	0.105	5.354
Mean	0.066	5.747	1.149	67.899	0.463	51.119	13.922	0.023	0.096	0.094	5.381
P95	0.278	12.263	1.853	92.938	0.493	51.119	35.561	0.023	0.121	0.153	6.100
Max.	0.489	12.770	1.962	93.481	0.561	51.119	36.120	0.023	0.124	0.171	6.355
D.L.	0.012	0.011	0.009	0.021	0.019	0.020	0.022	0.023	0.020	0.026	

Silicates: Biotite												
Thin Section:	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
00-347C-798	36.973	13.880	7.750	12.870	0.047	14.350	9.410	0.011	0.143	0.067	0.031	0.031
00-347C-798	37.072	13.840	7.630	11.530	0.053	15.280	9.640	0.048	0.225	0.072	0.031	0.027
00-347C-798	36.410	13.810	7.600	12.790	0.072	14.310	9.350	0.011	0.165	0.082	0.031	0.038
00-340C-778	36.904	13.850	6.720	13.050	0.050	14.430	9.300	0.017	0.278	0.031	0.031	0.028
00-340C-778	37.427	14.250	6.050	12.720	0.025	14.980	8.650	0.011	0.703	0.020	0.031	0.029
00-340C-778	36.647	14.320	6.460	13.830	0.047	13.740	9.220	0.023	0.261	0.020	0.031	0.027
00-340C-596	36.327	14.520	5.480	15.162	0.067	14.720	9.190	0.056	0.124	0.105	0.031	0.027
00-340C-596	38.267	15.570	2.914	8.892	0.073	19.690	9.180	0.011	0.417	0.053	0.031	0.027
00-340C-596	36.445	13.540	7.320	17.034	0.036	12.820	9.410	0.012	0.216	0.072	0.031	0.041
26026-566	37.274	14.790	3.930	15.970	0.025	13.580	8.780	0.011	0.164	0.020	0.031	0.030
26026-566	37.749	13.980	4.840	15.150	0.054	13.610	9.250	0.011	0.224	0.036	0.031	0.027
26026-566	37.430	14.510	3.350	16.290	0.036	13.730	8.710	0.070	0.192	0.041	0.031	0.027
00-344C-518	36.480	14.884	5.340	11.360	0.078	17.910	9.040	0.059	0.273	0.066	0.031	0.027
00-344C-518	37.800	14.657	6.150	9.700	0.025	16.800	9.150	0.011	0.379	0.088	0.031	0.027
00-344C-518	38.050	13.630	5.480	10.260	0.025	17.890	9.260	0.015	0.165	0.113	0.046	0.027
99-317C-462	36.985	14.820	4.180	15.200	0.029	14.780	8.980	0.015	0.492	0.069	0.031	0.027
99-317C-462	36.113	14.520	4.570	18.780	0.063	11.750	8.850	0.011	0.301	0.116	0.031	0.027
99-317C-462	36.436	14.950	4.300	17.410	0.061	12.810	8.890	0.017	0.346	0.075	0.031	0.032
00-367C-401	36.420	13.843	6.910	17.730	0.057	11.030	9.410	0.037	0.192	0.020	0.031	0.027
00-367C-401	36.840	14.163	6.240	16.420	0.027	12.100	9.280	0.011	0.133	0.020	0.031	0.027
00-367C-401	36.540	14.173	5.990	17.650	0.025	11.890	9.680	0.011	0.136	0.020	0.031	0.029
00-367C-398	37.170	14.730	6.140	11.910	0.045	15.970	9.120	0.011	0.759	0.020	0.031	0.027
00-367C-398	37.880	14.920	5.100	11.340	0.048	16.870	8.270	0.027	0.787	0.029	0.031	0.027
00-367C-398	37.840	15.120	5.770	11.930	0.089	15.820	8.490	0.011	0.698	0.020	0.031	0.027
00-340C-389	37.084	13.515	6.500	15.000	0.032	12.670	9.750	0.011	0.151	0.077	0.038	0.027
00-340C-389	37.405	13.872	5.160	13.290	0.054	14.500	9.680	0.011	0.221	0.130	0.031	0.035
00-340C-389	37.872	13.576	5.640	12.270	0.059	15.490	9.090	0.011	0.217	0.086	0.031	0.027
26142-364	38.493	14.137	4.730	11.240	0.045	17.360	7.720	0.044	0.804	0.096	0.031	0.040
26142-364	37.975	13.872	4.760	10.860	0.054	17.150	9.060	0.044	0.256	0.079	0.031	0.027
26142-364	37.865	13.719	5.620	12.100	0.070	16.560	7.970	0.069	0.729	0.058	0.031	0.041
26049-361	37.413	12.730	6.720	17.190	0.025	11.100	9.160	0.013	0.089	0.080	0.031	0.037
26049-361	37.675	12.862	7.030	15.810	0.074	11.990	9.200	0.071	0.084	0.086	0.031	0.030
26049-361	37.099	13.250	6.440	17.390	0.094	11.200	9.220	0.028	0.090	0.067	0.031	0.027
26056-311	38.140	14.710	4.960	10.100	0.073	18.020	9.560	0.057	0.090	0.109	0.031	0.029
26056-311	38.588	14.657	3.900	8.650	0.084	18.850	9.390	0.075	0.186	0.067	0.031	0.027
26056-311	37.864	14.500	5.230	9.740	0.051	17.800	9.240	0.025	0.240	0.115	0.031	0.027
26056-311	38.354	14.188	4.710	8.860	0.025	17.570	9.750	0.023	0.077	0.109	0.031	0.027
26056-311	38.243	14.430	5.480	9.060	0.025	17.420	9.410	0.021	0.284	0.133	0.031	0.027
26056-311	39.067	14.840	4.200	8.060	0.025	18.950	9.140	0.055	0.121	0.075	0.031	0.027
26056-311	37.430	14.470	5.680	10.550	0.025	16.260	8.950	0.011	0.179	0.125	0.031	0.028
26056-311	38.223	14.260	4.670	9.560	0.025	17.490	9.120	0.062	0.154	0.043	0.031	0.027
26056-311	38.229	14.880	4.490	9.890	0.050	18.200	9.930	0.022	0.040	0.095	0.031	0.027
00-347C-299	37.565	14.160	5.990	11.290	0.036	16.380	9.580	0.011	0.135	0.066	0.031	0.027
00-347C-299	37.674	13.640	5.140	13.190	0.050	15.660	9.910	0.011	0.027	0.066	0.031	0.039
00-347C-299	37.249	14.300	5.510	10.790	0.025	16.900	9.470	0.011	0.075	0.055	0.031	0.027
99-318C-267	37.957	13.790	4.620	10.730	0.025	18.520	8.740	0.033	0.153	0.075	0.031	0.027
99-318C-267	37.798	14.350	5.050	10.190	0.025	17.610	9.630	0.011	0.102	0.108	0.031	0.027
26064-264	37.323	14.690	4.010	16.401	0.036	14.140	9.120	0.050	0.075	0.086	0.031	0.027
26064-264	38.254	15.520	2.780	7.382	0.053	20.490	8.980	0.060	0.157	0.072	0.031	0.028
26064-264	37.303	15.000	4.110	13.356	0.025	15.790	10.040	0.032	0.013	0.074	0.031	0.027
00-370C-22	37.481	13.780	6.280	12.640	0.048	15.370	9.060	0.062	0.246	0.073	0.031	0.049
00-370C-22	38.471	13.620	5.240	12.000	0.025	16.700	9.000	0.011	0.278	0.076	0.031	0.034
00-370C-22	38.521	13.240	5.750	11.670	0.061	16.660	9.570	0.016	0.201	0.027	0.031	0.033
00-331C-194	36.410	14.320	4.950	14.930	0.025	14.150	9.030	0.017	0.411	0.020	0.031	0.029
00-331C-194	37.712	14.580	4.450	15.120	0.061	13.350	8.660	0.041	0.278	0.023	0.031	0.037
00-331C-194	36.868	13.560	5.180	17.530	0.029	12.160	9.100	0.016	0.278	0.067	0.031	0.027
99-320C-172	36.209	13.870	6.650	17.150	0.072	12.080	9.810	0.032	0.034	0.086	0.031	0.027
99-320C-172	36.563	13.540	6.490	15.640	0.081	13.150	9.270	0.040	0.088	0.077	0.031	0.027
99-320C-172	36.593	13.550	6.240	16.060	0.025	12.850	9.110	0.032	0.121	0.117	0.031	0.027
26098-148	37.481	14.090	7.350	12.023	0.064	15.450	9.340	0.017	0.292	0.096	0.031	0.052
26098-148	37.333	13.260	6.460	12.663	0.092	16.650	8.920	0.055	0.234	0.073	0.031	0.027
26098-148	37.224	14.400	7.010	10.605	0.025	16.530	9.480	0.011	0.164	0.069	0.031	0.027
26056-138	37.519	14.940	4.540	10.347	0.025	17.710	9.180	0.011	0.300	0.082	0.031	0.027
26056-138	38.060	14.720	5.000	10.454	0.025	18.040	9.360	0.012	0.210	0.162	0.031	0.027
26056-138	37.794	14.680	4.470	10.465	0.025	18.380	9.420	0.011	0.242	0.109	0.031	0.027
00-368C-132	37.840	14.340	6.090	13.030	0.036	15.450	9.590	0.011	0.103	0.090	0.031	0.027
00-368C-132	37.600	13.820	5.530	14.450	0.047	14.680	9.450	0.011	0.065	0.065	0.031	0.027
00-368C-132	37.060	13.370	6.740	16.870	0.042	12.540	9.460	0.011	0.039	0.093	0.031	0.027
00-357C-112	36.572	14.220	6.820	11.340	0.025	16.280	9.680	0.028	0.167	0.054	0.031	0.027
00-357C-112	35.976	13.510	6.720	12.516	0.025	15.790	9.630	0.011	0.132	0.085	0.039	0.043
00-357C-112	36.825	14.210	6.030	11.214	0.025	16.710	9.590	0.011	0.057	0.090	0.031	0.044
Min.	35.976	12.730	2.780	7.382	0.025	11.030	7.720	0.011	0.013	0.020	0.031	0.027
P5	36.369	13.255	3.915	8.876	0.025	11.820	8.570	0.011	0.039	0.020	0.031	0.027
Median	37.430	14.210	5.510	12.516	0.045	15.660	9.240	0.016	0.186	0.074	0.031	0.027
Mean	37.405	14.180	5.540	12.910	0.045	15.431	9.226	0.026	0.232	0.072	0.031	0.030
P95	38.482	14.975	7.335	17.470	0.083	18.685	9.780	0.065	0.716	0.121	0.031	0.042
Max.	39.067	15.570	7.750	18.780	0.094	20.490	10.040	0.075	0.804	0.162	0.046	0.052
D.L.	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027

Silicates: Plagioclase												
Thin Section:	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
00347C-798	52.143	30.330	0.065	0.200	0.028	0.010	0.358	12.230	4.150	0.039	0.000	0.000
00347C-798	51.334	30.560	0.064	0.190	0.000	0.016	0.340	13.990	3.990	0.000	0.000	0.023
00347C-798	51.818	30.570	0.115	0.227	0.036	0.039	0.321	12.400	4.150	0.008	0.002	0.023
00-340C-778	56.654	27.150	0.051	0.054	0.017	0.042	0.434	8.660	6.340	0.031	0.000	0.019
00-340C-778	52.824	29.970	0.180	0.102	0.042	0.009	0.230	11.670	4.760	0.000	0.000	0.000
00-340C-778	52.982	29.770	0.054	0.102	0.006	0.021	0.270	12.660	4.710	0.000	0.017	0.000
00-340C-596	55.367	27.850	0.073	0.233	0.028	0.025	0.542	10.430	5.730	0.000	0.000	0.000
00-340C-596	51.693	29.420	0.165	0.267	0.014	0.017	0.400	12.680	4.520	0.024	0.022	0.000
00-340C-596	57.780	25.930	0.019	0.136	0.050	0.013	0.675	8.390	6.810	0.000	0.007	0.001
00-344C-518	50.240	32.270	0.112	0.240	0.006	0.052	0.219	14.560	3.350	0.000	0.000	0.000
00-344C-518	51.660	31.920	0.142	0.123	0.004	0.030	0.230	12.850	3.800	0.000	0.000	0.000
00-344C-518	52.250	30.530	0.211	0.100	0.000	0.030	0.286	13.420	4.090	0.000	0.006	0.000
00-344C-518	51.540	30.890	0.168	0.132	0.000	0.021	0.267	12.570	4.060	0.000	0.007	0.000
99-317C-462	56.722	27.270	0.038	0.201	0.002	0.013	0.364	8.790	5.870	0.000	0.011	0.019
99-317C-462	57.379	26.860	0.090	0.165	0.027	0.004	0.350	8.340	6.420	0.016	0.000	0.010
99-317C-462	55.742	28.050	0.061	0.101	0.016	0.006	0.314	10.160	5.670	0.011	0.007	0.019
00-367C-401	54.550	29.561	0.087	0.136	0.013	0.018	0.389	11.410	5.060	0.019	0.000	0.004
00-367C-401	55.020	29.355	0.093	0.039	0.011	0.005	0.528	10.090	5.020	0.000	0.000	0.004
00-367C-401	53.170	29.685	0.099	0.386	0.000	0.039	0.439	10.650	4.780	0.007	0.000	0.000
00-367C-398	56.910	27.410	0.073	0.254	0.000	0.058	0.257	9.760	6.390	0.004	0.000	0.019
00-367C-398	56.560	27.840	0.040	0.025	0.000	0.002	0.300	9.270	6.170	0.000	0.049	0.008
00-367C-398	55.630	28.380	0.069	0.032	0.023	0.000	0.193	10.890	5.820	0.006	0.000	0.000
00-340C-389	52.560	30.233	0.077	0.140	0.000	0.027	0.385	12.910	4.450	0.000	0.000	0.000
00-340C-389	53.706	29.335	0.132	0.092	0.016	0.028	0.404	10.840	4.830	0.028	0.019	0.000
00-340C-389	52.575	29.600	0.120	0.137	0.030	0.034	0.332	12.390	4.630	0.002	0.000	0.000
26142-364	51.085	30.824	0.187	0.195	0.000	0.028	0.344	13.820	3.880	0.014	0.004	0.031
26142-364	52.458	29.917	0.177	0.224	0.000	0.037	0.377	12.630	4.440	0.000	0.025	0.000
26142-364	50.954	30.692	0.192	0.213	0.005	0.014	0.316	13.510	3.930	0.000	0.034	0.010
26049-361	52.224	30.600	0.134	0.140	0.025	0.026	0.421	13.200	4.160	0.004	0.000	0.000
26049-361	49.560	32.630	0.144	0.082	0.000	0.033	0.243	14.330	2.991	0.000	0.013	0.000
26049-361	51.020	31.273	0.135	0.082	0.000	0.025	0.328	14.280	3.720	0.000	0.015	0.000
00-361C-311	51.056	30.784	0.222	0.218	0.000	0.027	0.361	12.610	3.750	0.000	0.015	0.000
00-361C-311	49.990	32.050	0.023	0.086	0.011	0.024	0.234	15.720	3.210	0.000	0.015	0.010
00-361C-311	50.334	31.691	0.153	0.252	0.016	0.019	0.292	13.780	3.220	0.000	0.002	0.002
00-361C-311	54.633	29.170	0.169	0.140	0.000	0.157	0.326	10.900	4.670	0.015	0.000	0.014
00-361C-311	55.094	29.180	0.160	0.132	0.000	0.032	0.397	11.990	4.770	0.000	0.005	0.000
00-361C-311	50.330	32.040	0.127	0.143	0.000	0.025	0.229	15.330	3.310	0.033	0.026	0.017
00-361C-311	51.356	31.273	0.258	0.325	0.005	0.030	0.337	14.100	3.660	0.000	0.005	0.002
00-361C-311	54.417	29.460	0.157	0.166	0.011	0.024	0.437	11.320	4.510	0.025	0.013	0.000
00-361C-311	49.308	32.120	0.018	0.155	0.000	0.019	0.196	14.880	3.060	0.000	0.000	0.000
00-347C-299	50.159	31.260	0.094	0.254	0.022	0.063	0.313	14.900	3.460	0.000	0.000	0.005
00-347C-299	53.693	28.850	0.046	0.261	0.000	0.039	0.538	10.600	4.920	0.000	0.009	0.008
00-347C-299	53.022	29.520	0.042	0.251	0.000	0.013	0.487	12.630	4.630	0.000	0.000	0.005
99-318C-267	51.856	30.800	0.123	0.288	0.030	0.048	0.393	13.850	3.800	0.022	0.001	0.021
99-318C-267	52.609	29.860	0.060	0.274	0.000	0.036	0.371	12.890	4.350	0.000	0.000	0.000
99-318C-267	49.540	32.630	0.174	0.370	0.005	0.028	0.241	15.090	2.777	0.000	0.004	0.000
26064-264	51.777	30.440	0.246	0.390	0.034	0.018	0.375	13.790	4.020	0.000	0.029	0.016
26064-264	51.728	30.280	0.158	0.269	0.042	0.023	0.370	13.590	4.070	0.000	0.007	0.010
26064-264	52.054	30.320	0.094	0.264	0.031	0.064	0.426	13.490	4.210	0.026	0.000	0.000
00-370C-22	55.409	28.820	0.047	0.116	0.045	0.007	0.516	10.870	5.290	0.011	0.016	0.000
00-370C-22	53.570	28.910	0.050	0.034	0.000	0.014	0.309	12.090	5.260	0.000	0.000	0.000
00-370C-22	55.237	28.750	0.073	0.043	0.003	0.029	0.575	11.640	5.230	0.000	0.017	0.018
00-331C-194	54.506	30.280	0.071	0.163	0.000	0.019	0.118	12.240	4.190	0.000	0.001	0.008
00-331C-194	55.193	27.480	0.107	0.129	0.017	0.000	0.246	9.360	5.640	0.028	0.000	0.000
00-331C-194	52.095	30.150	0.085	0.138	0.007	0.011	0.172	12.500	3.970	0.000	0.000	0.014
99-320C-172	54.855	28.150	0.081	0.245	0.000	0.000	0.534	10.230	5.150	0.002	0.002	0.000
99-320C-172	53.348	29.070	0.092	0.323	0.000	0.031	0.356	12.140	4.710	0.000	0.015	0.000
99-320C-172	53.781	28.980	0.053	0.279	0.007	0.019	0.367	10.380	5.110	0.013	0.013	0.000
99-320C-172	53.244	29.290	0.128	0.319	0.037	0.039	0.463	11.480	4.260	0.000	0.024	0.000
26098-148	56.064	27.760	0.043	0.212	0.022	0.030	0.732	9.480	5.770	0.000	0.001	0.008
26098-148	51.985	30.220	0.081	0.202	0.003	0.025	0.334	13.520	4.240	0.000	0.029	0.013
26098-148	56.222	27.700	0.065	0.216	0.000	0.040	0.800	9.350	5.790	0.000	0.000	0.010
26056-138	53.032	29.370	0.091	0.375	0.000	0.124	0.442	12.360	4.790	0.000	0.000	0.023
26056-138	50.747	31.010	0.121	0.262	0.006	0.021	0.280	14.290	3.670	0.000	0.003	0.000
26056-138	53.259	29.590	0.090	0.276	0.020	0.050	0.450	12.170	4.900	0.000	0.001	0.008
00-368C-132	53.370	29.870	0.047	0.279	0.000	0.011	0.380	13.080	4.480	0.012	0.021	0.005
00-368C-132	54.530	28.930	0.036	0.225	0.003	0.021	0.497	11.370	4.840	0.000	0.009	0.017
00-368C-132	54.580	29.220	0.032	0.222	0.014	0.006	0.478	12.060	5.030	0.018	0.000	0.010
00-357C-112	52.783	30.390	0.112	0.326	0.000	0.030	0.414	13.240	4.130	0.020	0.003	0.000
00-357C-112	54.318	27.430	0.084	0.276	0.000	0.024	0.664	10.070	5.300	0.009	0.000	0.012
00-357C-112	54.217	28.100	0.056	0.273	0.000	0.019	0.446	12.730	4.460	0.006	0.000	0.004
Min.	49.308	25.930	0.018	0.025	0.000	0.000	0.118	8.340	2.777	0.000	0.000	0.000
P5	50.075	27.340	0.034	0.041	0.000	0.003	0.208	9.030	3.215	0.000	0.000	0.000
Median	53.022	29.685	0.091	0.202	0.005	0.025	0.364	12.390	4.510	0.000	0.002	0.002
Mean	53.175	29.688	0.103	0.196	0.011	0.028	0.377	12.139	4.582	0.006	0.007	0.006
P95	56.688	32.085	0.202	0.348	0.039	0.061	0.619	14.890	6.255	0.028	0.027	0.022
Max.	57.780	32.630	0.258	0.390	0.050	0.157	0.800	15.720	6.810	0.039	0.049	0.031
D.L.	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027

Silicates: Olivine												
Thin Section:	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
00-347C-798	36.572	14.220	6.820	35.660	0.444	27.230	9.680	0.037	0.167	0.101	0.031	0.077
00-347C-798	36.572	14.220	6.820	36.550	0.495	27.260	9.680	0.050	0.167	0.054	0.031	0.102
00-347C-798	36.572	14.220	6.820	35.150	0.530	27.610	9.680	0.064	0.167	0.100	0.031	0.053
00-340C-778	36.572	14.220	6.820	39.680	0.374	24.350	9.680	0.060	0.167	0.054	0.031	0.048
00-340C-778	36.572	14.220	6.820	39.260	0.415	23.860	9.680	0.036	0.167	0.054	0.031	0.068
00-340C-778	36.572	14.220	6.820	39.880	0.455	24.430	9.680	0.049	0.167	0.054	0.031	0.070
00-340C-778	36.572	14.220	6.820	39.120	0.495	24.850	9.680	0.057	0.167	0.054	0.031	0.066
00-340C-596	36.572	14.220	6.820	40.050	0.561	25.650	9.680	0.029	0.167	0.116	0.031	0.073
00-340C-596	36.572	14.220	6.820	40.050	0.543	26.200	9.680	0.049	0.167	0.168	0.031	0.067
00-340C-596	36.572	14.220	6.820	40.072	0.516	25.730	9.680	0.056	0.167	0.138	0.031	0.060
00-344C-518	37.030	14.220	6.820	30.080	0.325	32.400	9.680	0.028	0.167	0.118	0.031	0.067
00-344C-518	36.572	14.220	6.820	33.120	0.036	30.060	9.680	0.046	0.167	0.112	0.031	0.027
00-344C-518	36.970	14.220	6.820	30.110	0.317	31.460	9.680	0.032	0.167	0.142	0.031	0.055
00-344C-518	36.830	14.220	6.820	29.290	0.356	31.880	9.680	0.082	0.167	0.102	0.031	0.054
99-317C-462	36.572	14.220	6.820	36.210	0.436	27.180	9.680	0.034	0.167	0.135	0.035	0.056
99-317C-462	36.572	14.220	6.820	40.470	0.414	24.690	9.680	0.036	0.167	0.106	0.031	0.066
99-317C-462	36.572	14.220	6.820	48.820	0.580	16.780	9.680	0.069	0.167	0.091	0.031	0.096
00-367C-401	36.572	14.220	6.820	43.730	0.510	20.980	9.680	0.088	0.167	0.054	0.031	0.068
00-367C-401	36.572	14.220	6.820	43.920	0.503	20.050	9.680	0.130	0.167	0.054	0.031	0.059
00-367C-401	36.572	14.220	6.820	45.520	0.519	19.430	9.680	0.065	0.167	0.054	0.031	0.075
00-340C-389	36.572	14.220	6.820	37.440	0.510	25.170	9.680	0.040	0.167	0.102	0.031	0.067
00-340C-389	36.572	14.220	6.820	38.030	0.390	24.840	9.680	0.036	0.167	0.082	0.031	0.068
00-340C-389	36.572	14.220	6.820	39.310	0.445	24.590	9.680	0.051	0.167	0.110	0.031	0.093
26142-364	36.639	14.220	6.820	30.670	0.373	28.700	9.680	0.069	0.167	0.160	0.031	0.038
26142-364	36.675	14.220	6.820	30.880	0.407	30.000	9.680	0.039	0.167	0.115	0.031	0.065
26142-364	36.741	14.220	6.820	31.510	0.358	29.970	9.680	0.056	0.167	0.143	0.031	0.048
26049-361	36.572	14.220	6.820	33.140	0.341	29.380	9.680	0.058	0.167	0.117	0.031	0.057
26049-361	36.572	14.220	6.820	31.380	0.293	29.710	9.680	0.066	0.167	0.080	0.031	0.080
26049-361	36.572	14.220	6.820	30.710	0.262	30.400	9.680	0.031	0.167	0.054	0.031	0.048
00-361C-311	36.572	14.220	6.820	33.370	0.483	29.030	9.680	0.043	0.167	0.150	0.031	0.070
00-361C-311	36.572	14.220	6.820	34.640	0.415	28.120	9.680	0.085	0.167	0.129	0.031	0.066
00-361C-311	37.259	14.220	6.820	29.900	0.324	31.810	9.680	0.028	0.167	0.117	0.031	0.057
00-361C-311	36.572	14.220	6.820	34.330	0.408	28.100	9.680	0.061	0.167	0.089	0.031	0.060
00-361C-311	37.698	14.220	6.820	29.710	0.329	32.030	9.680	0.053	0.167	0.114	0.031	0.043
00-361C-311	36.572	14.220	6.820	33.820	0.500	29.000	9.680	0.053	0.167	0.126	0.031	0.040
00-361C-311	37.464	14.220	6.820	29.620	0.349	32.140	9.680	0.056	0.167	0.105	0.031	0.027
00-361C-311	36.650	14.220	6.820	33.150	0.502	30.210	9.680	0.088	0.167	0.072	0.031	0.070
00-347C-299	36.572	14.220	6.820	35.170	0.505	27.660	9.680	0.041	0.167	0.091	0.031	0.056
00-347C-299	36.572	14.220	6.820	36.280	0.570	27.300	9.680	0.039	0.167	0.098	0.031	0.044
00-347C-299	36.572	14.220	6.820	35.470	0.459	27.240	9.680	0.058	0.167	0.130	0.031	0.086
99-318C-267	36.699	14.220	6.820	33.960	0.419	29.890	9.680	0.028	0.167	0.167	0.031	0.061
99-318C-267	36.590	14.220	6.820	33.060	0.369	30.100	9.680	0.038	0.167	0.133	0.031	0.055
99-318C-267	36.670	14.220	6.820	33.540	0.377	30.120	9.680	0.053	0.167	0.112	0.031	0.093
00-370C-22	36.572	14.220	6.820	37.280	0.496	26.630	9.680	0.079	0.167	0.054	0.031	0.063
00-370C-22	36.572	14.220	6.820	37.100	0.619	26.900	9.680	0.080	0.167	0.096	0.031	0.086
00-370C-22	36.572	14.220	6.820	37.120	0.558	26.080	9.680	0.030	0.167	0.074	0.031	0.063
00-331C-194	36.572	14.220	6.820	46.480	0.506	18.230	9.680	0.070	0.167	0.054	0.031	0.063
00-331C-194	36.572	14.220	6.820	49.130	0.560	16.700	9.680	0.038	0.167	0.054	0.031	0.067
00-331C-194	36.572	14.220	6.820	47.740	0.536	17.500	9.680	0.075	0.167	0.054	0.031	0.062
26098-148	36.572	14.220	6.820	32.834	0.459	30.680	9.680	0.056	0.167	0.144	0.031	0.065
26098-148	36.572	14.220	6.820	33.558	0.412	30.710	9.680	0.050	0.167	0.141	0.031	0.048
26098-148	36.689	14.220	6.820	33.422	0.459	30.250	9.680	0.028	0.167	0.156	0.031	0.070
26056-138	36.572	14.220	6.820	33.095	0.453	31.890	9.680	0.075	0.167	0.182	0.031	0.066
26056-138	36.573	14.220	6.820	32.448	0.459	31.470	9.680	0.033	0.167	0.147	0.031	0.072
26056-138	36.572	14.220	6.820	32.603	0.405	31.260	9.680	0.034	0.167	0.166	0.031	0.054
00-368C-132	36.572	14.220	6.820	39.600	0.612	24.350	9.680	0.053	0.167	0.121	0.031	0.059
00-368C-132	36.572	14.220	6.820	39.870	0.587	24.630	9.680	0.049	0.167	0.063	0.031	0.082
00-368C-132	36.572	14.220	6.820	39.890	0.577	24.460	9.680	0.082	0.167	0.094	0.031	0.070
00-357C-112	36.572	14.220	6.820	35.721	0.528	28.510	9.680	0.043	0.167	0.097	0.031	0.079
00-357C-112	36.572	14.220	6.820	35.921	0.497	27.810	9.680	0.033	0.167	0.090	0.031	0.050
00-357C-112	36.815	14.220	6.820	35.973	0.532	28.220	9.680	0.044	0.167	0.137	0.031	0.078
Min.	36.572	14.220	6.820	29.290	0.036	16.700	9.680	0.028	0.167	0.054	0.031	0.027
P5	36.572	14.220	6.820	29.900	0.317	18.230	9.680	0.028	0.167	0.054	0.031	0.040
Median	36.572	14.220	6.820	35.660	0.459	27.660	9.680	0.050	0.167	0.105	0.031	0.065
Mean	36.651	14.220	6.820	36.322	0.450	27.113	9.680	0.053	0.167	0.104	0.031	0.064
P95	37.030	14.220	6.820	46.480	0.580	31.890	9.680	0.085	0.167	0.166	0.031	0.093
Max.	37.698	14.220	6.820	49.130	0.619	32.400	9.680	0.130	0.167	0.182	0.035	0.102
D.L.	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027
Silicates: Altered Olivine												
Thin Section:	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
26064-264	41.867	14.510	3.350	23.289	0.543	13.730	8.710	2.372	0.192	0.041	0.031	0.027
26064-264	42.659	14.510	3.350	24.696	0.618	13.730	8.710	2.457	0.192	0.041	0.031	0.030
26064-264	42.521	14.510	3.350	23.762	0.538	13.730	8.710	2.036	0.583	0.041	0.031	0.027
00-347C-299	43.181	14.510	3.350	25.020	0.258	13.730	8.710	2.360	0.192	0.069	0.031	0.043
Min.	41.867	14.510	3.350	23.289	0.258	13.730	8.710	2.036	0.192	0.041	0.031	0.027
P5	41.965	14.510	3.350	23.360	0.300	13.730	8.710	2.085	0.192	0.041	0.031	0.027
Median	42.590	14.510	3.350	24.229	0.541	13.730	8.710	2.366	0.192	0.041	0.031	0.028
Mean	42.557	14.510	3.350	24.192	0.489	13.730	8.710	2.306	0.289	0.048	0.031	0.032
P95	43.103	14.510	3.350	24.971	0.606	13.730	8.710	2.444	0.524	0.064	0.031	0.041
Max.	43.181	14.510	3.350	25.020	0.618	13.730	8.710	2.457	0.583	0.069	0.031	0.043
D.L.	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027

Silicates: Clinopyroxene												
Thin Section:	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
00-331C-194	49.587	14.680	4.470	12.350	0.242	18.380	9.420	21.630	0.242	0.109	0.031	0.027
00-331C-194	51.823	14.680	4.470	12.210	0.208	18.380	9.420	20.250	0.242	0.109	0.031	0.027
00-331C-194	51.615	14.680	4.470	12.950	0.240	18.380	9.420	19.140	0.242	0.109	0.031	0.027
00-340C-389	51.253	14.680	4.470	10.465	0.248	18.380	9.420	21.390	0.252	0.109	0.031	0.027
00-340C-389	51.027	14.680	4.470	10.465	0.212	18.380	9.420	20.440	0.263	0.109	0.031	0.027
00-340C-389	51.662	14.680	4.470	10.465	0.141	18.380	9.420	20.090	0.338	0.109	0.031	0.029
00-340C-596	51.328	14.680	4.470	10.850	0.283	18.380	9.420	21.020	0.246	0.109	0.031	0.027
00-340C-596	51.072	14.680	4.470	11.396	0.190	18.380	9.420	18.460	0.322	0.109	0.031	0.027
00-344C-518	51.730	14.680	4.470	10.465	0.227	18.380	9.420	20.400	0.321	0.109	0.031	0.027
00-347C-299	50.367	14.680	4.470	10.820	0.288	18.380	9.420	19.300	0.300	0.109	0.031	0.035
00-347C-798	52.123	14.680	4.470	10.465	0.330	18.380	9.420	20.360	0.321	0.109	0.031	0.027
00-347C-798	52.153	14.680	4.470	10.760	0.301	18.380	9.420	20.360	0.357	0.109	0.031	0.027
00-347C-798	50.900	14.680	4.470	10.465	0.325	18.380	9.420	19.040	0.365	0.109	0.047	0.027
00-357C-112	50.157	14.680	4.470	10.465	0.291	18.380	9.420	21.950	0.377	0.109	0.031	0.027
00-357C-112	50.995	14.680	4.470	10.868	0.295	18.380	9.420	20.500	0.347	0.109	0.031	0.034
00-357C-112	49.719	14.680	4.470	11.645	0.266	18.380	9.420	18.090	0.347	0.109	0.031	0.027
00-361C-311	51.875	14.680	4.470	10.465	0.181	18.380	9.420	20.410	0.305	0.109	0.031	0.027
00-361C-311	50.998	14.680	4.470	10.465	0.187	18.380	9.420	19.630	0.283	0.109	0.031	0.027
00-361C-311	51.370	14.680	4.470	10.465	0.239	18.380	9.420	19.630	0.247	0.109	0.031	0.027
00-361C-311	50.820	14.680	4.470	11.260	0.344	18.380	9.420	19.130	0.242	0.109	0.031	0.027
00-361C-311	51.130	14.680	4.470	11.470	0.265	18.380	9.420	18.120	0.242	0.109	0.031	0.030
00-367C-401	51.930	14.680	4.470	12.400	0.262	18.380	9.420	21.160	0.242	0.109	0.031	0.027
00-367C-401	52.330	14.680	4.470	11.520	0.217	18.380	9.420	20.100	0.245	0.109	0.031	0.027
00-368C-132	51.070	14.680	4.470	11.710	0.324	18.380	9.420	21.180	0.296	0.109	0.031	0.027
00-368C-132	51.370	14.680	4.470	11.630	0.357	18.380	9.420	19.610	0.313	0.109	0.031	0.027
00-368C-132	52.030	14.680	4.470	11.970	0.276	18.380	9.420	19.140	0.289	0.109	0.031	0.029
00-370C-22	51.460	14.680	4.470	10.465	0.372	18.380	9.420	21.380	0.242	0.109	0.031	0.027
00-370C-22	51.167	14.680	4.470	10.465	0.294	18.380	9.420	19.630	0.305	0.109	0.031	0.027
00-370C-22	51.439	14.680	4.470	10.560	0.297	18.380	9.420	19.580	0.242	0.109	0.031	0.027
26039-311	50.727	14.680	4.470	10.465	0.178	18.380	9.420	21.960	0.296	0.109	0.031	0.027
26039-311	52.121	14.680	4.470	10.465	0.161	18.380	9.420	20.080	0.320	0.109	0.031	0.027
26049-361	51.450	14.680	4.470	10.465	0.164	18.380	9.420	21.910	0.242	0.109	0.033	0.027
26049-361	50.056	14.680	4.470	10.465	0.244	18.380	9.420	21.210	0.251	0.109	0.031	0.032
26049-361	50.932	14.680	4.470	10.465	0.209	18.380	9.420	20.320	0.242	0.109	0.031	0.027
26056-138	51.644	14.680	4.470	10.465	0.288	18.380	9.420	22.100	0.303	0.109	0.031	0.027
26056-138	51.092	14.680	4.470	10.465	0.232	18.380	9.420	22.010	0.275	0.109	0.031	0.027
26056-138	50.993	14.680	4.470	10.465	0.240	18.380	9.420	20.150	0.314	0.109	0.031	0.027
26056-311	49.280	14.680	4.470	10.465	0.216	18.380	9.420	21.860	0.343	0.109	0.031	0.027
26056-311	52.305	14.680	4.470	10.465	0.196	18.380	9.420	20.830	0.242	0.109	0.031	0.027
26056-311	52.257	14.680	4.470	10.870	0.213	18.380	9.420	20.730	0.242	0.109	0.031	0.027
26064-264	51.965	14.680	4.470	10.465	0.243	18.380	9.420	20.910	0.242	0.109	0.031	0.027
26064-264	51.490	14.680	4.470	10.465	0.193	18.380	9.420	20.720	0.296	0.109	0.031	0.027
26098-148	51.371	14.680	4.470	10.465	0.249	18.380	9.420	21.440	0.325	0.109	0.031	0.051
26098-148	51.134	14.680	4.470	10.465	0.285	18.380	9.420	21.330	0.382	0.109	0.044	0.027
26098-148	51.688	14.680	4.470	10.465	0.199	18.380	9.420	19.970	0.361	0.109	0.031	0.027
26142-364	51.173	14.680	4.470	10.465	0.201	18.380	9.420	22.190	0.329	0.109	0.031	0.027
26142-364	51.319	14.680	4.470	10.465	0.173	18.380	9.420	20.580	0.279	0.109	0.031	0.027
26142-364	51.830	14.680	4.470	10.465	0.217	18.380	9.420	20.150	0.310	0.109	0.031	0.027
99-317C-462	50.940	14.680	4.470	13.920	0.279	18.380	9.420	22.130	0.242	0.109	0.031	0.027
99-317C-462	49.941	14.680	4.470	15.240	0.246	18.380	9.420	19.840	0.367	0.109	0.041	0.027
99-317C-462	51.568	14.680	4.470	14.890	0.319	18.380	9.420	19.710	0.242	0.109	0.031	0.027
99-318C-267	51.856	14.680	4.470	10.465	0.218	18.380	9.420	20.670	0.281	0.109	0.031	0.027
99-318C-267	49.955	14.680	4.470	10.465	0.222	18.380	9.420	20.570	0.304	0.109	0.031	0.027
99-318C-267	50.262	14.680	4.470	11.150	0.231	18.380	9.420	19.360	0.242	0.109	0.031	0.027
99-320-172	49.735	14.680	4.470	14.080	0.217	18.380	9.420	18.270	0.270	0.109	0.031	0.027
99-320C-172	52.481	14.680	4.470	11.160	0.248	18.380	9.420	20.650	0.242	0.109	0.031	0.027
99-320C-172	48.462	14.680	4.470	12.880	0.236	18.380	9.420	18.710	0.271	0.109	0.031	0.027
Min.	48.46	14.68	4.47	10.46	0.14	18.38	9.42	18.09	0.24	0.11	0.03	0.03
P5	49.69	14.68	4.47	10.46	0.17	18.38	9.42	18.42	0.24	0.11	0.03	0.03
Median	51.32	14.68	4.47	10.46	0.24	18.38	9.42	20.40	0.28	0.11	0.03	0.03
Mean	51.17	14.68	4.47	11.15	0.25	18.38	9.42	20.38	0.29	0.11	0.03	0.03
P95	52.27	14.68	4.47	13.95	0.33	18.38	9.42	22.03	0.37	0.11	0.03	0.03
Max.	52.48	14.68	4.47	15.24	0.37	18.38	9.42	22.19	0.38	0.11	0.05	0.05
D.L.	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027

Silicates: Orthopyroxene											
Thin Section:	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
00-340C-778	52.242	14.137	4.730	22.200	0.399	20.890	7.720	1.190	0.804	0.096	0.031	0.043
00-340C-778	52.331	14.137	4.730	23.010	0.393	21.200	7.720	0.995	0.804	0.096	0.031	0.040
00-340C-596	52.727	14.137	4.730	23.690	0.546	22.250	7.720	1.553	0.804	0.096	0.031	0.050
26026-566	48.312	14.137	4.730	28.700	0.178	17.360	7.720	0.196	0.804	0.096	0.031	0.040
26026-566	49.807	14.137	4.730	28.430	0.222	17.360	7.720	0.182	0.804	0.096	0.031	0.040
26026-566	50.144	14.137	4.730	28.280	0.180	17.360	7.720	0.160	0.804	0.096	0.031	0.040
00-344C-518	51.750	14.137	4.730	17.620	0.317	25.370	7.720	0.929	0.804	0.096	0.031	0.040
00-367C-401	51.470	14.137	4.730	26.610	0.449	18.030	7.720	1.588	0.804	0.096	0.031	0.040
00-367C-398	52.880	14.137	4.730	22.290	0.544	21.210	7.720	0.543	0.804	0.096	0.031	0.061
00-367C-398	52.400	14.137	4.730	22.140	0.528	21.410	7.720	0.691	0.804	0.096	0.031	0.055
00-367C-398	52.580	14.137	4.730	22.100	0.492	21.860	7.720	0.602	0.804	0.096	0.031	0.040
00-367C-398	52.200	14.137	4.730	22.080	0.416	21.360	7.720	0.612	0.804	0.096	0.031	0.040
00-367C-398	52.240	14.137	4.730	22.320	0.539	21.890	7.720	0.603	0.804	0.096	0.046	0.040
00-367C-398	51.830	14.137	4.730	22.420	0.465	21.860	7.720	0.673	0.804	0.096	0.031	0.040
00-347C-299	53.614	14.137	4.730	19.820	0.487	23.380	7.720	1.056	0.804	0.096	0.031	0.042
99-318C-267	53.866	14.137	4.730	19.670	0.383	24.150	7.720	0.738	0.804	0.096	0.031	0.040
26064-264	53.292	14.137	4.730	20.780	0.349	22.730	7.720	2.329	0.804	0.096	0.031	0.040
99-320C-172	52.412	14.137	4.730	22.700	0.411	21.010	7.720	1.981	0.804	0.096	0.031	0.040
99-320C-172	51.456	14.137	4.730	24.600	0.446	19.950	7.720	1.536	0.804	0.096	0.031	0.040
99-320C-172	52.185	14.137	4.730	24.120	0.480	20.400	7.720	1.474	0.804	0.096	0.031	0.040
Min.	48.312	14.137	4.730	17.620	0.178	17.360	7.720	0.160	0.804	0.096	0.031	0.040
P5	49.732	14.137	4.730	19.568	0.180	17.360	7.720	0.181	0.804	0.096	0.031	0.040
Median	52.241	14.137	4.730	22.370	0.431	21.285	7.720	0.833	0.804	0.096	0.031	0.040
Mean	51.987	14.137	4.730	23.179	0.411	21.052	7.720	0.981	0.804	0.096	0.032	0.043
P95	53.626	14.137	4.730	28.444	0.545	24.211	7.720	1.998	0.804	0.096	0.032	0.056
Max.	53.866	14.137	4.730	28.700	0.546	25.370	7.720	2.329	0.804	0.096	0.046	0.061
	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027
Silicates: Cordierite												
Thin Section	**SiO2**	**Al2O3**	**TiO2**	**FeO**	**MnO**	**MgO**	**K2O**	**CaO**	**Na2O**	**NiO**	**CuO**	**CoO**
26026-566	48.946	33.940	3.350	16.290	0.048	13.730	8.710	0.070	0.192	0.041	0.031	0.027
26026-566	48.866	33.820	3.350	16.290	0.084	13.730	8.710	0.070	0.192	0.041	0.031	0.027
26026-566	48.609	33.820	3.350	16.290	0.041	13.730	8.710	0.070	0.192	0.041	0.031	0.027
26026-566	48.659	33.620	3.350	16.290	0.057	13.730	8.710	0.070	0.192	0.041	0.031	0.027
Min.	48.609	33.620	3.350	16.290	0.041	13.730	8.710	0.070	0.192	0.041	0.031	0.027
P5	48.616	33.650	3.350	16.290	0.042	13.730	8.710	0.070	0.192	0.041	0.031	0.027
Median	48.762	33.820	3.350	16.290	0.052	13.730	8.710	0.070	0.192	0.041	0.031	0.027
Mean	48.770	33.800	3.350	16.290	0.057	13.730	8.710	0.070	0.192	0.041	0.031	0.027
P95	48.934	33.922	3.350	16.290	0.080	13.730	8.710	0.070	0.192	0.041	0.031	0.027
Max.	48.946	33.940	3.350	16.290	0.084	13.730	8.710	0.070	0.192	0.041	0.031	0.027
	0.015	0.013	0.020	0.050	0.025	0.012	0.015	0.011	0.013	0.020	0.031	0.027

Sulfides: Chalcopyrite										
Thin Section	**Mineral Rpt**	**Mineral Actual**	**Fe**	**Cu**	**S**	**Ni**	**Co**	**Zn**	**Ti**	**As**
26064-264	Chalcopyrite	Chalcopyrite	30.730	33.950	34.630	0.106	0.042	0.030	0.010	0.030
26064-264	Chalcopyrite	Chalcopyrite	30.720	34.410	33.710	0.027	0.037	0.024	0.010	0.030
26064-264	Chalcopyrite	Chalcopyrite	30.640	34.390	33.750	0.022	0.039	0.026	0.010	0.030
26064-264	Chalcopyrite	Chalcopyrite	30.660	34.020	34.630	0.045	0.022	0.024	0.010	0.030
26098-148	Chalcopyrite	Chalcopyrite	30.550	33.580	34.970	0.089	0.054	0.024	0.010	0.030
26098-148	Chalcopyrite	Chalcopyrite	30.510	33.670	34.490	0.045	0.040	0.033	0.010	0.030
26056-138	Chalcopyrite	Chalcopyrite	30.610	34.220	34.020	0.025	0.029	0.024	0.010	0.030
26056-138	Chalcopyrite	Chalcopyrite	31.030	34.440	34.980	0.021	0.028	0.024	0.010	0.030
26056-138	Chalcopyrite	Chalcopyrite	30.660	33.720	34.840	0.117	0.031	0.024	0.010	0.030
00-340C-596	Chalcopyrite	Chalcopyrite	30.980	34.230	34.060	0.021	0.042	0.024	0.010	0.030
00-340C-596	Chalcopyrite	Chalcopyrite	30.840	34.060	35.110	0.021	0.033	0.024	0.010	0.030
00-340C-596	Chalcopyrite	Chalcopyrite	30.760	34.440	34.210	0.021	0.044	0.042	0.010	0.030
00-368C-132	Chalcopyrite	Chalcopyrite	30.960	33.710	33.760	0.110	0.045	0.024	0.010	0.030
00-368C-132	Chalcopyrite	Chalcopyrite	30.800	34.090	34.850	0.021	0.023	0.024	0.010	0.030
00-368C-132	Chalcopyrite	Chalcopyrite	30.770	33.970	34.860	0.021	0.036	0.024	0.010	0.030
00-367C-398	Chalcopyrite	Chalcopyrite	29.940	33.480	34.670	0.094	0.050	0.024	0.010	0.030
00-367C-398	Chalcopyrite	Chalcopyrite	30.790	33.370	34.540	0.021	0.049	0.024	0.010	0.030
00-367C-398	Chalcopyrite	Chalcopyrite	31.140	33.300	35.250	0.073	0.075	0.024	0.010	0.030
00-370C-22	Chalcopyrite	Chalcopyrite	30.750	34.140	34.950	0.021	0.023	0.024	0.010	0.030
00-370C-22	Chalcopyrite	Chalcopyrite	30.780	33.640	33.810	0.021	0.023	0.024	0.010	0.030
00-370C-22	Chalcopyrite	Chalcopyrite	31.140	33.420	35.000	0.021	0.037	0.024	0.010	0.030
00-361C-311	Chalcopyrite	Chalcopyrite	30.680	33.620	34.900	0.141	0.048	0.024	0.010	0.030
00-361C-311	Chalcopyrite	Chalcopyrite	30.380	33.510	34.680	0.021	0.034	0.024	0.010	0.030
00-361C-311	Chalcopyrite	Chalcopyrite	30.810	33.940	34.660	0.024	0.025	0.033	0.010	0.030
00-347C-299	Chalcopyrite	Chalcopyrite	30.350	34.000	34.760	0.041	0.038	0.024	0.010	0.030
00-347C-299	Chalcopyrite	Chalcopyrite	30.740	34.270	33.600	0.034	0.030	0.024	0.010	0.030
00-347C-299	Chalcopyrite	Chalcopyrite	30.630	33.880	34.970	0.097	0.038	0.026	0.010	0.030
00-357C-112	Chalcopyrite	Chalcopyrite	30.440	33.900	33.710	0.031	0.034	0.027	0.010	0.030
00-357C-112	Chalcopyrite	Chalcopyrite	31.100	33.720	34.460	0.136	0.038	0.024	0.010	0.030
00-357C-112	Chalcopyrite	Chalcopyrite	30.790	33.560	34.650	0.639	0.116	0.024	0.010	0.030
00-347C-798	Chalcopyrite	Chalcopyrite	30.800	33.890	34.590	0.021	0.028	0.024	0.016	0.030
00-347C-798	Chalcopyrite	Chalcopyrite	30.550	33.420	34.990	0.120	0.059	0.024	0.010	0.030
00-347C-798	Chalcopyrite	Chalcopyrite	30.140	33.470	34.350	0.076	0.049	0.035	0.014	0.030
00-340C-778	Chalcopyrite	Chalcopyrite	30.840	34.350	33.800	0.021	0.022	0.024	0.010	0.030
00-340C-778	Chalcopyrite	Chalcopyrite	31.010	34.100	33.720	0.021	0.026	0.036	0.010	0.030
00-340C-778	Chalcopyrite	Chalcopyrite	30.660	34.030	34.510	0.096	0.116	0.024	0.010	0.030
00-340C-778	Chalcopyrite	Chalcopyrite	30.640	34.060	34.520	0.099	0.107	0.024	0.010	0.030
99-318C-267	Chalcopyrite	Chalcopyrite	31.290	33.630	34.780	0.021	0.047	0.024	0.010	0.030
99-318C-267	Chalcopyrite	Chalcopyrite	30.500	33.770	33.580	0.021	0.028	0.024	0.010	0.030
99-318C-267	Chalcopyrite	Chalcopyrite	30.390	34.180	35.330	0.021	0.046	0.024	0.010	0.030
99-318C-267	Chalcopyrite	Chalcopyrite	31.570	32.880	35.110	0.246	0.048	0.024	0.013	0.030
26026-566	Chalcopyrite	Chalcopyrite	30.690	34.300	34.720	0.021	0.032	0.024	0.010	0.030
26026-566	Chalcopyrite	Chalcopyrite	30.610	34.580	34.020	0.021	0.041	0.024	0.010	0.030
26026-566	Chalcopyrite	Chalcopyrite	30.810	34.100	34.880	0.021	0.048	0.024	0.010	0.030
99-320C-172	Chalcopyrite	Chalcopyrite	30.600	34.050	34.800	0.094	0.036	0.024	0.013	0.030
99-320C-172	Chalcopyrite	Chalcopyrite	30.660	34.680	33.840	0.021	0.028	0.025	0.010	0.030
99-320C-172	Chalcopyrite	Chalcopyrite	30.790	34.340	33.950	0.021	0.032	0.024	0.010	0.030
99-317C-462	Chalcopyrite	Chalcopyrite	30.450	34.060	35.150	0.021	0.030	0.024	0.011	0.030
99-317C-462	Chalcopyrite	Chalcopyrite	30.310	33.930	34.050	0.071	0.036	0.024	0.010	0.030
99-317C-462	Chalcopyrite	Chalcopyrite	30.720	34.220	33.920	0.047	0.025	0.027	0.010	0.030
26056-311	Chalcopyrite	Chalcopyrite	30.680	34.030	34.570	0.021	0.028	0.024	0.010	0.030
26056-311	Chalcopyrite	Chalcopyrite	30.640	34.280	33.940	0.021	0.030	0.024	0.010	0.030
26056-311	Chalcopyrite	Chalcopyrite	30.900	33.370	34.820	0.021	0.038	0.028	0.026	0.030
26142-364	Chalcopyrite	Chalcopyrite	30.410	33.390	34.990	0.021	0.031	0.024	0.010	0.030
26142-364	Chalcopyrite	Chalcopyrite	30.250	34.040	34.820	0.037	0.028	0.024	0.010	0.030
26142-364	Chalcopyrite	Chalcopyrite	30.570	34.200	33.720	0.021	0.025	0.024	0.010	0.030
26142-364	Chalcopyrite	Chalcopyrite	30.390	33.800	35.220	0.083	0.028	0.024	0.013	0.030
26049-361	Chalcopyrite	Chalcopyrite	29.760	34.290	35.250	0.021	0.020	0.024	0.010	0.030
26049-361	Chalcopyrite	Chalcopyrite	30.330	34.420	33.900	0.021	0.029	0.024	0.010	0.030
26049-361	Chalcopyrite	Chalcopyrite	30.350	34.490	34.810	0.021	0.025	0.024	0.010	0.030
26049-361	Chalcopyrite	Chalcopyrite	29.970	33.530	34.720	0.066	0.030	0.035	0.043	0.030
00-340C-389	Chalcopyrite	Chalcopyrite	30.770	34.200	34.210	0.033	0.023	0.024	0.010	0.030
00-340C-389	Chalcopyrite	Chalcopyrite	30.460	34.610	34.490	0.021	0.031	0.024	0.010	0.030
00-344C-518	Chalcopyrite	Chalcopyrite	30.800	34.190	35.250	0.125	0.042	0.059	0.010	0.030
00-344C-518	Chalcopyrite	Chalcopyrite	30.060	34.210	34.640	0.024	0.048	0.024	0.012	0.030
00-344C-518	Chalcopyrite	Chalcopyrite	30.600	34.120	34.690	0.043	0.028	0.024	0.010	0.030
00-367C-401	Chalcopyrite	Chalcopyrite	30.570	34.380	34.590	0.021	0.030	0.030	0.010	0.030
00-367C-401	Chalcopyrite	Chalcopyrite	30.430	34.130	34.840	0.021	0.020	0.024	0.010	0.030
00-367C-401	Chalcopyrite	Chalcopyrite	30.680	34.390	34.040	0.021	0.019	0.024	0.010	0.030
00-331C-194	Chalcopyrite	Chalcopyrite	30.580	34.360	34.240	0.061	0.048	0.024	0.010	0.030
00-331C-194	Chalcopyrite	Chalcopyrite	30.560	34.300	33.870	0.021	0.037	0.024	0.010	0.030
00-331C-194	Chalcopyrite	Chalcopyrite	30.610	34.610	34.070	0.021	0.047	0.024	0.010	0.030
26039-311	Chalcopyrite	Chalcopyrite	30.420	33.930	33.870	0.106	0.035	0.031	0.010	0.030
26039-311	Chalcopyrite	Chalcopyrite	30.670	34.350	33.840	0.129	0.029	0.024	0.010	0.030
26039-311	Chalcopyrite	Chalcopyrite	30.450	33.950	33.750	0.050	0.019	0.024	0.017	0.030
n			75	75	75	75	75	75	75	75
Min.			29.760	32.880	33.580	0.021	0.019	0.024	0.010	0.030
P5			30.116	33.384	33.717	0.021	0.021	0.024	0.010	0.030
Median			30.660	34.060	34.590	0.022	0.034	0.024	0.010	0.030
Mean			30.635	34.003	34.470	0.057	0.038	0.026	0.011	0.030
P95			31.112	34.517	35.229	0.131	0.064	0.035	0.015	0.030
Max.			31.570	34.680	35.330	0.639	0.116	0.059	0.043	0.030
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Pentlandite										
Thin Section	**Mineral Rpt**	**Mineral Actual**	**Fe**	**Cu**	**S**	**Ni**	**Co**	**Zn**	**Ti**	**As**
26064-264	Pyrrhotite	Pentlandite	30.860	0.193	33.630	32.540	3.630	0.024	0.010	0.030
26064-264	Pyrrhotite	Pentlandite	32.430	0.034	33.160	32.740	2.051	0.024	0.010	0.030
26064-264	Pyrrhotite	Pentlandite	32.030	0.040	33.640	32.070	2.952	0.024	0.010	0.030
26064-264	Pyrrhotite	Pentlandite	33.460	0.077	32.590	31.490	1.885	0.024	0.010	0.030
26064-264	Pentlandite	Pentlandite	33.520	0.165	32.460	31.460	1.897	0.024	0.010	0.030
26098-148	Pentlandite	Pentlandite	34.510	0.126	32.380	31.050	1.358	0.024	0.010	0.030
26098-148	Pentlandite	Pentlandite	27.300	0.369	33.380	35.730	2.365	0.024	0.010	0.030
26098-148	Pentlandite	Pentlandite	29.960	0.114	33.370	35.910	1.389	0.024	0.010	0.030
26098-148	Pentlandite	Pentlandite	29.570	0.222	32.310	35.690	1.465	0.024	0.010	0.030
26056-138	Pentlandite	Pentlandite	34.920	4.380	34.320	26.110	1.530	0.024	0.010	0.030
00-340C-596	Pentlandite	Pentlandite	30.690	0.064	32.260	35.050	1.493	0.024	0.010	0.030
00-340C-596	Pentlandite	Pentlandite	29.820	0.077	33.720	35.910	1.650	0.024	0.010	0.030
00-340C-596	Pentlandite	Pentlandite	28.780	0.154	33.380	36.600	1.796	0.024	0.010	0.030
00-368C-132	Pentlandite	Pentlandite	32.130	0.152	33.530	32.680	2.076	0.043	0.010	0.030
00-368C-132	Pentlandite	Pentlandite	31.840	0.035	32.770	32.660	2.419	0.024	0.010	0.030
00-368C-132	Pentlandite	Pentlandite	32.210	0.055	33.470	32.740	1.999	0.026	0.010	0.030
00-370C-22	Pentlandite	Pentlandite	35.130	0.061	32.570	29.070	2.864	0.024	0.010	0.030
00-370C-22	Pentlandite	Pentlandite	32.960	0.106	32.230	31.130	2.724	0.024	0.010	0.030
00-361C-311	Cubanite	Pentlandite	33.220	0.068	32.240	32.150	1.661	0.024	0.010	0.043
00-361C-311	Pentlandite	Pentlandite	33.570	0.035	33.250	32.100	1.105	0.024	0.010	0.030
00-361C-311	Pentlandite	Pentlandite	32.080	0.101	32.280	33.600	1.287	0.024	0.010	0.030
00-361C-311	Pentlandite	Pentlandite	31.930	0.208	32.850	32.860	1.448	0.024	0.010	0.030
00-361C-311	Cubanite	Pentlandite	32.850	0.051	32.930	31.930	1.476	0.024	0.011	0.030
00-361C-311	Pentlandite	Pentlandite	35.600	0.303	32.520	30.170	0.903	0.024	0.010	0.030
00-347C-299	Pentlandite	Pentlandite	28.110	0.118	32.300	36.260	1.876	0.024	0.010	0.030
00-347C-299	Pentlandite	Pentlandite	28.020	1.241	33.420	35.260	2.323	0.024	0.010	0.030
00-347C-299	Pentlandite	Pentlandite	28.460	0.303	32.300	35.720	2.035	0.024	0.010	0.030
00-347C-299	Pyrrhotite	Pentlandite	25.790	0.347	37.750	30.970	2.218	0.024	0.010	0.030
00-357C-112	Pentlandite	Pentlandite	35.450	0.260	32.940	29.220	1.636	0.024	0.010	0.030
00-357C-112	Pentlandite	Pentlandite	37.660	0.097	32.310	27.400	1.576	0.024	0.010	0.030
00-357C-112	Chalcopyrite	Pentlandite	38.080	0.206	32.420	27.250	1.479	0.024	0.010	0.030
00-357C-112	Pentlandite	Pentlandite	35.050	0.071	32.360	30.120	1.699	0.024	0.010	0.030
00-347C-798	Pentlandite	Pentlandite	32.100	0.108	33.160	32.620	1.653	0.024	0.010	0.030
00-347C-798	Pentlandite	Pentlandite	32.410	0.049	32.980	32.490	1.814	0.024	0.010	0.030
00-347C-798	Pentlandite	Pentlandite	34.290	0.133	32.330	31.020	2.038	0.024	0.015	0.030
00-340C-778	Pentlandite	Pentlandite	30.850	0.038	33.160	28.810	7.090	0.024	0.010	0.030
00-340C-778	Pentlandite	Pentlandite	30.140	0.019	33.020	28.940	7.910	0.024	0.010	0.030
00-340C-778	Pentlandite	Pentlandite	30.550	0.082	31.710	29.560	6.700	0.024	0.010	0.030
99-318C-267	Pentlandite	Pentlandite	33.740	0.181	32.730	30.880	1.825	0.024	0.010	0.030
99-318C-267	Pentlandite	Pentlandite	34.290	0.058	31.970	30.840	1.540	0.024	0.010	0.030
99-318C-267	Pentlandite	Pentlandite	35.570	0.060	32.630	29.380	1.847	0.024	0.010	0.030
26026-566	Pentlandite	Pentlandite	31.350	0.022	32.350	30.090	5.040	0.024	0.010	0.030
26026-566	Pentlandite	Pentlandite	31.980	0.021	32.810	29.810	5.060	0.024	0.010	0.030
26026-566	Pentlandite	Pentlandite	31.910	0.033	32.470	29.950	5.130	0.024	0.010	0.030
99-320C-172	Pentlandite	Pentlandite	33.130	0.189	32.520	31.970	1.710	0.024	0.010	0.030
99-320C-172	Pentlandite	Pentlandite	30.710	0.294	33.640	33.740	1.585	0.024	0.010	0.030
99-320C-172	Pentlandite	Pentlandite	33.480	0.045	33.410	31.140	1.863	0.024	0.010	0.030
99-317C-462	Pentlandite	Pentlandite	31.850	0.207	32.670	32.580	2.590	0.024	0.010	0.030
99-317C-462	Pentlandite	Pentlandite	31.130	0.132	33.460	32.810	2.388	0.024	0.010	0.030
99-317C-462	Pentlandite	Pentlandite	30.010	0.797	33.530	33.750	2.294	0.024	0.010	0.030
26056-311	Pentlandite	Pentlandite	25.070	0.345	32.050	39.730	1.330	0.025	0.010	0.030
26056-311	Pentlandite	Pentlandite	28.080	0.239	32.510	37.140	1.402	0.024	0.010	0.030
26142-364	Pentlandite	Pentlandite	31.730	0.234	34.480	31.060	2.486	0.024	0.010	0.030
26142-364	Cubanite	Pentlandite	35.130	0.082	33.050	29.010	1.711	0.024	0.010	0.030
26142-364	Pentlandite	Pentlandite	35.130	0.311	33.360	29.080	1.205	0.024	0.012	0.030
26049-361	Pentlandite	Pentlandite	28.130	0.132	33.380	28.550	9.370	0.024	0.010	0.098
26049-361	Pentlandite	Pentlandite	32.670	0.162	33.800	30.000	3.670	0.028	0.010	0.052
26049-361	Pentlandite	Pentlandite	33.250	0.268	33.530	30.780	1.974	0.024	0.017	0.030
00-340C-389	Pentlandite	Pentlandite	34.010	0.144	34.030	30.010	2.517	0.024	0.010	0.030
00-340C-389	Pentlandite	Pentlandite	34.140	0.195	34.150	31.690	0.740	0.024	0.010	0.030
00-340C-389	Pentlandite	Pentlandite	33.480	0.056	33.420	31.770	1.654	0.024	0.010	0.030
00-344C-518	Pentlandite	Pentlandite	28.740	1.008	33.410	35.540	1.508	0.024	0.010	0.030
00-344C-518	Pentlandite	Pentlandite	20.090	0.313	33.220	43.130	2.992	0.024	0.010	0.030
00-344C-518	Pentlandite	Pentlandite	30.940	1.856	34.460	29.200	1.454	0.024	0.010	0.030
00-331C-194	Pentlandite	Pentlandite	32.790	0.046	32.650	32.270	1.900	0.024	0.010	0.030
00-331C-194	Pentlandite	Pentlandite	33.350	0.072	32.500	32.010	1.699	0.024	0.010	0.030
00-331C-194	Pentlandite	Pentlandite	32.520	0.060	32.570	31.750	2.059	0.024	0.010	0.030
26039-311	Pentlandite	Pentlandite	28.360	0.760	32.550	36.870	0.734	0.024	0.010	0.030
26039-311	Pentlandite	Pentlandite	28.480	2.954	32.790	32.700	0.552	0.043	0.036	0.030
26039-311	Pentlandite	Pentlandite	28.960	2.611	32.860	33.030	0.724	0.024	0.010	0.030
n			70	70	70	70	70	70	70	70
Min.			20.090	0.019	31.710	26.110	0.552	0.024	0.010	0.030
P5			27.624	0.034	32.235	28.667	0.813	0.024	0.010	0.030
Median			32.090	0.132	32.895	31.950	1.836	0.024	0.010	0.030
Mean			31.750	0.345	33.034	32.162	2.315	0.025	0.011	0.031
P95			35.516	1.579	34.244	36.749	5.994	0.025	0.012	0.030
Max.			38.080	4.380	37.750	43.130	9.370	0.043	0.036	0.098
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Pyrrhotite										
Thin Section	**Mineral Rpt**	**Mineral Actual**	**Fe**	**Cu**	**S**	**Ni**	**Co**	**Zn**	**Ti**	**As**
26098-148	Pyrrhotite	Pyrrhotite	63.610	0.018	36.890	0.021	0.059	0.024	0.010	0.030
26098-148	Pyrrhotite	Pyrrhotite	60.430	0.061	38.600	0.240	0.056	0.024	0.010	0.030
26098-148	Pyrrhotite	Pyrrhotite	60.020	0.102	38.730	0.411	0.061	0.024	0.010	0.030
26056-138	Pyrrhotite	Pyrrhotite	63.830	0.039	36.990	0.021	0.042	0.024	0.010	0.030
26056-138	Pyrrhotite	Pyrrhotite	64.110	0.148	36.060	0.021	0.050	0.024	0.010	0.030
26056-138	Pyrrhotite	Pyrrhotite	63.730	0.045	35.760	0.021	0.063	0.024	0.010	0.030
00-340C-596	Pyrrhotite	Pyrrhotite	63.960	0.018	36.350	0.021	0.070	0.024	0.010	0.030
00-340C-596	Pyrrhotite	Pyrrhotite	63.630	0.023	35.980	0.021	0.075	0.024	0.010	0.030
00-340C-596	Pyrrhotite	Pyrrhotite	61.280	0.030	37.930	0.028	0.054	0.024	0.010	0.030
00-368C-132	Pyrrhotite	Pyrrhotite	61.190	0.046	38.700	0.255	0.052	0.024	0.010	0.030
00-368C-132	Pyrrhotite	Pyrrhotite	61.450	0.033	38.020	0.283	0.049	0.024	0.010	0.030
00-368C-132	Pyrrhotite	Pyrrhotite	61.950	0.046	37.910	0.269	0.063	0.024	0.010	0.030
00-370C-22	Pyrrhotite	Pyrrhotite	63.880	0.037	35.820	0.021	0.063	0.024	0.010	0.030
00-370C-22	Pyrrhotite	Pyrrhotite	63.430	0.023	36.950	0.021	0.056	0.024	0.010	0.030
00-370C-22	Pyrrhotite	Pyrrhotite	64.130	0.036	35.780	0.021	0.072	0.024	0.010	0.030
00-370C-22	Pentlandite	Pyrrhotite	60.910	0.062	35.290	1.251	0.203	0.024	0.017	0.030
00-361C-311	Pyrrhotite	Pyrrhotite	61.010	0.041	37.840	0.116	0.057	0.024	0.010	0.030
00-361C-311	Cubanite	Pyrrhotite	60.020	0.365	39.870	0.148	0.061	0.024	0.011	0.030
00-361C-311	Pyrrhotite	Pyrrhotite	60.110	0.103	39.860	0.183	0.053	0.024	0.012	0.030
00-361C-311	Pyrrhotite	Pyrrhotite	60.720	0.032	38.130	0.165	0.052	0.024	0.010	0.030
00-361C-311	Pyrrhotite	Pyrrhotite	63.740	0.018	35.630	0.039	0.030	0.024	0.010	0.030
00-347C-299	Pyrrhotite	Pyrrhotite	59.640	0.055	39.640	0.446	0.074	0.024	0.010	0.030
00-347C-299	Pyrrhotite	Pyrrhotite	59.610	0.404	38.670	0.577	0.057	0.024	0.010	0.030
00-357C-112	Pyrrhotite	Pyrrhotite	63.560	0.061	35.570	0.035	0.066	0.024	0.010	0.030
00-357C-112	Pyrrhotite	Pyrrhotite	63.770	0.024	35.780	0.026	0.056	0.024	0.010	0.030
00-357C-112	Pyrrhotite	Pyrrhotite	63.510	0.030	36.840	0.021	0.072	0.024	0.010	0.030
00-347C-798	Pyrrhotite	Pyrrhotite	60.410	0.109	38.500	0.056	0.060	0.024	0.028	0.030
00-347C-798	Pyrrhotite	Pyrrhotite	61.310	0.038	37.790	0.120	0.061	0.024	0.010	0.030
00-347C-798	Pyrrhotite	Pyrrhotite	63.300	0.027	36.480	0.021	0.061	0.024	0.010	0.030
00-340C-778	Pyrrhotite	Pyrrhotite	61.800	0.026	37.450	0.105	0.075	0.024	0.010	0.030
00-340C-778	Pyrrhotite	Pyrrhotite	61.630	0.020	38.670	0.085	0.071	0.024	0.010	0.030
00-340C-778	Pyrrhotite	Pyrrhotite	61.420	0.036	37.300	0.185	0.076	0.024	0.010	0.030
99-318C-267	Pyrrhotite	Pyrrhotite	61.060	0.098	38.000	0.027	0.041	0.033	0.010	0.030
99-318C-267	Pyrrhotite	Pyrrhotite	60.920	0.090	38.630	0.084	0.064	0.024	0.010	0.030
99-318C-267	Pyrrhotite	Pyrrhotite	63.690	0.046	35.750	0.046	0.058	0.024	0.010	0.030
26026-566	Pyrrhotite	Pyrrhotite	60.820	0.021	39.100	0.128	0.057	0.024	0.013	0.030
26026-566	Pyrrhotite	Pyrrhotite	60.440	0.029	39.270	0.111	0.063	0.024	0.018	0.030
26026-566	Pyrrhotite	Pyrrhotite	60.900	0.028	38.300	0.109	0.052	0.024	0.010	0.030
99-320C-172	Pyrrhotite	Pyrrhotite	60.950	0.043	38.960	0.061	0.073	0.024	0.010	0.030
99-320C-172	Pyrrhotite	Pyrrhotite	60.570	0.027	39.140	0.081	0.057	0.024	0.022	0.030
99-320C-172	Pyrrhotite	Pyrrhotite	61.210	0.018	37.740	0.087	0.053	0.024	0.010	0.030
99-317C-462	Pyrrhotite	Pyrrhotite	60.190	0.069	39.610	0.203	0.048	0.024	0.010	0.030
99-317C-462	Pyrrhotite	Pyrrhotite	60.620	0.038	38.260	0.255	0.056	0.024	0.010	0.030
99-317C-462	Pyrrhotite	Pyrrhotite	59.700	0.090	39.620	0.230	0.057	0.024	0.014	0.030
26056-311	Pyrrhotite	Pyrrhotite	59.530	0.151	39.730	0.622	0.054	0.024	0.010	0.030
26056-311	Pyrrhotite	Pyrrhotite	59.380	0.094	38.720	1.015	0.061	0.024	0.010	0.030
26142-364	Pyrrhotite	Pyrrhotite	62.710	0.040	36.470	0.021	0.063	0.024	0.012	0.030
26142-364	Pyrrhotite	Pyrrhotite	63.530	0.027	35.580	0.021	0.052	0.024	0.010	0.030
26049-361	Pyrrhotite	Pyrrhotite	60.070	0.127	38.700	0.044	0.062	0.024	0.010	0.030
26049-361	Pyrrhotite	Pyrrhotite	59.730	0.225	38.680	0.167	0.091	0.024	0.010	0.087
26049-361	Pyrrhotite	Pyrrhotite	61.240	0.064	37.810	0.055	0.057	0.024	0.010	0.030
00-340C-389	Pyrrhotite	Pyrrhotite	63.430	0.019	35.660	0.021	0.051	0.024	0.010	0.030
00-340C-389	Pyrrhotite	Pyrrhotite	63.600	0.088	36.170	0.021	0.058	0.024	0.010	0.030
00-340C-389	Pyrrhotite	Pyrrhotite	63.320	0.022	36.440	0.021	0.062	0.024	0.010	0.030
00-344C-518	Pyrrhotite	Pyrrhotite	58.370	0.398	39.170	1.480	0.065	0.024	0.010	0.030
00-367C-401	Pyrrhotite-Mono	Pyrrhotite-Mono	58.070	0.018	41.120	0.482	0.099	0.024	0.010	0.030
00-367C-401	Pyrrhotite-Hex	Pyrrhotite-Hex	59.640	0.034	39.570	0.201	0.124	0.024	0.010	0.030
00-367C-401	Pyrrhotite	Pyrrhotite	58.090	0.190	41.610	0.485	0.095	0.024	0.023	0.030
00-331C-194	Pyrrhotite	Pyrrhotite	60.880	0.026	38.130	0.108	0.066	0.024	0.010	0.030
00-331C-194	Pyrrhotite	Pyrrhotite	60.890	0.021	37.860	0.103	0.053	0.024	0.010	0.030
00-331C-194	Pyrrhotite	Pyrrhotite	60.840	0.037	37.960	0.103	0.064	0.024	0.010	0.030
26039-311	Pyrrhotite	Pyrrhotite	59.630	0.229	38.950	0.675	0.052	0.024	0.010	0.030
26039-311	Pyrrhotite	Pyrrhotite	59.060	0.419	39.070	0.779	0.077	0.024	0.010	0.030
26039-311	Pyrrhotite	Pyrrhotite	59.670	0.280	38.660	0.798	0.066	0.024	0.011	0.030
n			64	64	64	64	64	64	64	64
Min.			58.070	0.018	35.290	0.021	0.030	0.024	0.010	0.030
P5			59.108	0.018	35.635	0.021	0.048	0.024	0.010	0.030
Median			60.980	0.040	38.010	0.104	0.061	0.024	0.010	0.030
Mean			61.404	0.082	37.878	0.217	0.064	0.024	0.011	0.031
P95			63.873	0.352	39.841	0.795	0.095	0.024	0.017	0.030
Max.			64.130	0.419	41.610	1.480	0.203	0.033	0.028	0.087
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Cubanite										
Thin Section	**Mineral Rpt**	**Mineral Actual**	**Fe**	**Cu**	**S**	**Ni**	**Co**	**Zn**	**Ti**	**As**
26098-148	Cubanite	Cubanite	41.490	22.550	35.470	0.021	0.028	0.024	0.010	0.030
26098-148	Chalcopyrite	Cubanite	40.760	22.950	34.430	1.874	0.085	0.024	0.010	0.030
26098-148	Cubanite	Cubanite	41.270	22.500	34.600	0.028	0.039	0.024	0.010	0.030
26098-148	Cubanite	Cubanite	41.620	22.590	35.410	0.021	0.024	0.024	0.010	0.030
00-340C-596	Cubanite	Cubanite	41.590	23.010	34.840	0.021	0.027	0.024	0.010	0.030
00-340C-596	Cubanite	Cubanite	41.470	23.110	34.430	0.021	0.028	0.024	0.010	0.030
00-340C-596	Cubanite	Cubanite	41.460	22.850	35.590	0.021	0.043	0.024	0.010	0.030
00-370C-22	Cubanite	Cubanite	41.250	23.040	35.200	0.031	0.046	0.024	0.010	0.030
00-347C-299	Cubanite	Cubanite	41.510	22.710	34.250	0.119	0.041	0.024	0.010	0.030
00-347C-299	Cubanite	Cubanite	40.900	23.090	35.200	0.021	0.039	0.024	0.010	0.030
00-347C-299	Cubanite	Cubanite	41.430	22.770	34.890	0.036	0.057	0.028	0.010	0.030
00-357C-112	Cubanite	Cubanite	41.140	23.150	35.160	0.021	0.043	0.024	0.010	0.030
00-357C-112	Cubanite	Cubanite	41.080	23.160	35.340	0.194	0.069	0.024	0.010	0.030
00-357C-112	Cubanite	Cubanite	41.570	22.740	34.300	0.193	0.054	0.024	0.010	0.030
00-347C-798	Cubanite	Cubanite	41.630	22.620	35.090	0.021	0.034	0.024	0.028	0.030
00-347C-798	Cubanite	Cubanite	41.390	22.710	34.120	0.021	0.048	0.024	0.010	0.030
00-347C-798	Cubanite	Cubanite	41.700	22.430	34.040	0.021	0.045	0.024	0.010	0.030
00-340C-778	Cubanite	Cubanite	41.550	23.160	35.410	0.021	0.028	0.024	0.010	0.030
00-340C-778	Cubanite	Cubanite	41.600	23.000	34.970	0.040	0.081	0.024	0.010	0.030
99-318C-267	Cubanite	Cubanite	41.140	22.910	35.000	0.021	0.037	0.024	0.010	0.030
99-318C-267	Cubanite	Cubanite	40.930	23.260	35.690	0.021	0.029	0.024	0.010	0.030
99-318C-267	Cubanite	Cubanite	41.170	22.760	35.540	0.152	0.064	0.025	0.010	0.030
26026-566	Cubanite	Cubanite	41.140	23.370	34.330	0.021	0.026	0.024	0.010	0.030
26026-566	Cubanite	Cubanite	40.900	23.170	35.530	0.021	0.033	0.027	0.010	0.030
26026-566	Cubanite	Cubanite	41.100	23.040	35.590	0.046	0.043	0.024	0.010	0.030
99-320C-172	Cubanite	Cubanite	34.290	0.053	32.420	30.750	1.770	0.024	0.010	0.030
99-320C-172	Cubanite	Cubanite	40.920	23.060	34.480	0.021	0.031	0.024	0.010	0.030
26142-364	Cubanite	Cubanite	55.410	2.152	36.100	4.270	0.950	0.024	0.011	0.030
26142-364	Pyrrhotite	Cubanite	40.950	22.630	35.370	0.139	0.044	0.024	0.011	0.030
26049-361	Cubanite	Cubanite	41.040	22.930	35.640	0.021	0.052	0.025	0.010	0.030
26049-361	Cubanite	Cubanite	40.650	23.120	35.240	0.066	0.082	0.024	0.010	0.030
26049-361	Cubanite	Cubanite	41.010	23.000	35.140	0.025	0.040	0.024	0.010	0.030
00-340C-389	Cubanite	Cubanite	41.160	23.190	35.740	0.038	0.034	0.024	0.015	0.030
00-340C-389	Cubanite	Cubanite	30.490	34.470	34.880	0.021	0.036	0.024	0.010	0.030
00-340C-389	Cubanite	Cubanite	40.790	23.400	35.470	0.021	0.043	0.024	0.010	0.030
00-340C-389	Cubanite	Cubanite	41.100	23.250	35.180	0.021	0.033	0.024	0.010	0.030
00-367C-401	Cubanite	Cubanite	41.350	23.200	35.250	0.021	0.032	0.024	0.010	0.030
00-367C-401	Cubanite	Cubanite	40.840	23.170	34.560	0.021	0.042	0.024	0.010	0.030
00-331C-194	Cubanite	Cubanite	40.940	23.270	34.830	0.021	0.034	0.024	0.010	0.030
00-331C-194	Cubanite	Cubanite	41.160	23.140	34.490	0.021	0.030	0.024	0.010	0.030
00-331C-194	Cubanite	Cubanite	40.970	23.160	34.340	0.021	0.043	0.039	0.035	0.030
			41	41	41	41	41	41	41	41
Min.			30.490	0.053	32.420	0.021	0.024	0.024	0.010	0.030
P5			40.650	22.430	34.120	0.021	0.027	0.024	0.010	0.030
Median			41.140	23.040	35.140	0.021	0.041	0.024	0.010	0.030
Mean			41.119	22.191	34.965	0.940	0.107	0.025	0.011	0.030
P95			41.630	23.370	35.690	1.874	0.085	0.027	0.015	0.030
Max.			55.410	34.470	36.100	30.750	1.770	0.039	0.035	0.030
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Bornite										
Thin Section	**Mineral Rpt**	**Mineral Actual**	**Fe**	**Cu**	**S**	**Ni**	**Co**	**Zn**	**Ti**	**As**
26056-138	Pentlandite	Bornite	8.500	67.720	24.540	0.128	0.032	0.024	0.010	0.030
26056-138	Pentlandite	Bornite	13.740	60.000	25.790	0.106	0.023	0.024	0.010	0.030
26142-364	Pentlandite	Bornite	14.280	59.340	25.930	0.021	0.015	0.024	0.010	0.030
n			3	3	3	3	3	3	3	3
Min.			8.500	59.340	24.540	0.021	0.015	0.024	0.010	0.030
P5			9.024	59.406	24.665	0.029	0.016	0.024	0.010	0.030
Median			13.740	60.000	25.790	0.106	0.023	0.024	0.010	0.030
Mean			12.173	62.353	25.420	0.085	0.023	0.024	0.010	0.030
P95			14.226	66.948	25.916	0.126	0.031	0.024	0.010	0.030
Max.			14.280	67.720	25.930	0.128	0.032	0.024	0.010	0.030
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Cobalite

Thin Section	Mineral Rpt	Mineral Actual	Fe	Cu	S	Ni	Co	Zn	Ti	As
00-367C-398	Pyrrhotite	Cobaltite	9.750	7.660	39.730	18.350	22.940	0.024	0.010	0.030
00-367C-398	Pyrrhotite	Cobaltite	10.520	5.460	41.160	19.880	22.010	0.024	0.010	0.030
00-340C-778	Unknown	Cobaltite	3.880	0.299	18.770	11.260	20.770	0.024	0.010	45.020
			3	3	3	3	3	3	3	3
Min.			3.880	0.299	18.770	11.260	20.770	0.024	0.010	0.030
P5			4.467	0.815	20.866	11.969	20.894	0.024	0.010	0.030
Median			9.750	5.460	39.730	18.350	22.010	0.024	0.010	0.030
Mean			8.050	4.473	33.220	16.497	21.907	0.024	0.010	15.027
P95			10.443	7.440	41.017	19.727	22.847	0.024	0.010	40.521
Max.			10.520	7.660	41.160	19.880	22.940	0.024	0.010	45.020
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Maucherite

Thin Section	Mineral Rpt	Mineral Actual	Fe	Cu	S	Ni	Co	Zn	Ti	As
00-340C-778	Unknown	Maucherite	0.562	0.077	0.026	45.880	0.396	0.024	0.010	49.550
26026-566	Unknown	Maucherite-like	0.164	0.039	0.030	52.880	1.392	0.024	0.010	38.360
26026-566	Unknown	Maucherite-like	0.349	0.051	0.046	52.080	1.676	0.024	0.010	38.280
n			3	3	3	3	3	3	3	3
Min.			0.164	0.039	0.026	45.880	0.396	0.024	0.010	38.280
P5			0.182	0.040	0.026	46.500	0.496	0.024	0.010	38.288
Median			0.349	0.051	0.030	52.080	1.392	0.024	0.010	38.360
Mean			0.358	0.055	0.034	50.280	1.155	0.024	0.010	42.063
P95			0.540	0.074	0.044	52.800	1.648	0.024	0.010	48.431
Max.			0.562	0.077	0.046	52.880	1.676	0.024	0.010	49.550
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Pyrite

Thin Section	Mineral Rpt	Mineral Actual	Fe	Cu	S	Ni	Co	Zn	Ti	As
00-367C-398	Violarite	Pyrite	46.200	0.091	53.560	1.011	0.089	0.024	0.010	0.030
00-367C-398	Pentlandite	Pyrite	46.700	0.312	52.070	0.177	0.054	0.024	0.010	0.030
00-367C-398	Chalcopyrite	Pyrite	47.320	0.217	53.350	0.062	0.060	0.024	0.010	0.030
00-367C-398	Pentlandite	Pyrite	47.390	0.044	52.570	0.021	0.051	0.024	0.010	0.030
00-367C-398	Pentlandite	Pyrite	47.010	0.043	52.960	0.260	0.108	0.024	0.010	0.030
26056-311	Pentlandite	Pyrite	45.690	0.043	50.460	1.219	0.052	0.024	0.010	0.042
26056-311	Pentlandite	Pyrite	46.330	0.034	53.910	0.675	0.043	0.024	0.010	0.030
00-367C-401	Pentlandite	Pyrite	46.590	0.532	53.590	0.623	0.041	0.024	0.010	0.030
n			8	8	8	8	8	8	8	8
Min.			45.690	0.034	50.460	0.021	0.041	0.024	0.010	0.030
P5			45.869	0.037	51.024	0.035	0.042	0.024	0.010	0.030
Median			46.645	0.068	53.155	0.442	0.053	0.024	0.010	0.030
Mean			46.654	0.164	52.809	0.506	0.062	0.024	0.010	0.031
P95			47.366	0.455	53.798	1.147	0.101	0.024	0.010	0.038
Max.			47.390	0.532	53.910	1.219	0.108	0.024	0.010	0.042
D.L.			0.016	0.018	0.009	0.021	0.015	0.024	0.010	0.030

Sulfides: Sphalerite

Thin Section	Mineral Rpt	Mineral Actual	Fe	Cu	S	Ni	Co	Zn	Ti	As
00-367C-398	Sphalerite	Sphalerite	9.630	0.103	32.130	0.065	0.111	57.170	0.010	0.030

Appendix D.4

Chemical Analytical Results for Humidity Cell Samples

HCT ID	Comment	HCT Full ID (Drill Hole, Footage, HCT)	Waste Type	Geological Unit	Rock Type From Logging	Rock Type From Mineralogy	Total S	Cu	Ni	S ICP	Pt	Pd	Au	Pt+Pd+Au	Co
								Metals by 4-acid Digestion							
							%	%	%	%	ppb	ppb	ppb	ppb	ppm
1		DDH-99-320C(830-850)-1	Reactive	1	Anorthositic	Anorthositic Troctolite	0.09	0.0365	0.0174	0.09	160	210	40	410	48
2		DDH-00-361C(310-320)-2	Reactive	1	Anorthositic	Anorthositic Troctolite	0.18	0.0152	0.0208	0.16	<5	40	20	60	42
3		DDH-00-361C(345-350)-3	Reactive	1	Anorthositic	Troctolitic Anorthosite	0.05	0.0236	0.0276	0.05	110	160	50	320	63
4		DDH-00-343C(240-250)-4	Reactive	1	Anorthositic	Norite	0.68	0.0759	0.0199	0.68	<5	190	50	240	48
5		DDH-26030(1047-1052)-5	Reactive	1	Sedimentary Hornfels	Recrystallized/Granoblastic Calc-Silicate	0.24	0.0098	0.0104	0.26	<5	1	3	4	25
6		DDH-26061(1218-1233)-6	Reactive	1	Sedimentary Hornfels	Granoblastic cordierite biotite Graywacke	0.44	0.0146	0.0122	0.44	<5	30	20	50	24
7		DDH-00-340C(990-995)-7	Reactive	1	Sedimentary Hornfels	Granoblastic Graywacke	0.55	0.0142	0.0144	0.5	80	30	60	170	34
8		DDH-00-340C(965-974.5)-8	Reactive	1	Sedimentary Hornfels	Granoblastic cordierite biotite pyrrhotite Graywacke	1.74	0.0198	0.012	1.49	60	30	30	120	21
9	1 Dup	DDH-99-320C(830-850)-9D	Reactive	1	Anorthositic	Anorthositic Troctolite	0.09	0.0365	0.0174	0.09	160	210	40	410	48
10		DDH-00-340C(765-780)-10D	Reactive	1	Troctolitic	Augite Troctolite	1.68	0.0707	0.0304	1.41	100	210	260	570	96
11		DDH-26043&26027(1501&740-1506&745)-11	Reactive	1	Sedimentary Hornfels		2.47	0.04	0.02	2.46	<5	7.00	8.00	15	48.00
12	Blank	Method Blank - 12													
13		DDH-00-340C(595-615)-13	Non-reactive	1	Troctolitic	Olivine Gabbro	0.04	0.0141	0.0365	0.04	70	140	10	220	65
14		DDH-00-334C(580-600)-14	Non-reactive	1	Troctolitic	Augite Troctolite	0.06	0.0278	0.0319	0.05	150	170	30	350	63
15		DDH-00-334C(640-660)-15	Reactive	1	Troctolitic	Augite Troctolite	0.07	0.0311	0.0497	0.08	170	240	30	440	77
16		DDH-00-347C(795-815)-16	Reactive	1	Troctolitic	Augite Troctolite	0.07	0.0446	0.0389	0.07	150	240	150	540	79
17		DDH-00-350C(580-600)-17	Reactive	1	Troctolitic	Augite Troctolite	0.19	0.0423	0.0298	0.18	110	90	30	230	59
18		DDH-00-327C(225-245)-18	Reactive	1	Troctolitic	MelaTroctolite (Picrite)/Troctolite	0.44	0.0324	0.0156	0.39	110	80	40	230	51
19		DDH-00-371C(435-440)-19	Reactive	1	Troctolitic	Norite	0.88	0.0563	0.0267	0.8	160	280	50	490	61
20	10 Dup	DDH-00-340C(765-780)-20	Reactive	1	Troctolitic	Augite Troctolite	1.68	0.0707	0.0304	1.41	100	210	260	570	96
21		DDH-00357C(335-340)-21	Reactive	1	Ultramafic	MelaTroctolite (Picrite)	0.08	0.0269	0.0255	0.08	<5	7	1	8	57
22		DDH-00326C(680-685)-22	Reactive	1	Ultramafic	MelaTroctolite (Picrite)	0.30	0.105	0.023	0.29	18	99	11	128	47
23		DDH-00-357C(535-540)-23	Reactive	1	Ultramafic	MelaGabbro	0.2	0.1015	0.0257	0.21	16	47	5	68	56
24		DDH-99-318C(725-735)-24	Reactive	1	Ultramafic	Basalt Inclusion	0.72	0.0534	0.0196	0.63	150	280	50	480	52
25		DDH-99-317C(460-470)-25	Reactive	1	Ultramafic	MelaGabbro	1.24	0.0668	0.0224	1.02	90	220	40	350	49
26		DDH-00-366C(185-205)-26	Non-reactive	2	Anorthositic	Gabbroic Anorthosite	0.02	0.0082	0.0208	0.02	50	150	<1	200	41
27		DDH-00-366C(230-240)-27	Non-reactive	2	Anorthositic	Troctolitic Anorthosite	0.02	0.0125	0.0171	0.03	<5	100	10	110	39
28		DDH-99-320C(165-175)-28	Non-reactive	2	Anorthositic	Gabbroic Anorthosite	0.03	0.014	0.025	0.03	60	130	10	200	51
29		DDH-99-318C(250-370)-29	Non-reactive	2	Troctolitic	Troctolite	0.04	0.0139	0.0311	0.03	<5	50	<1	50	56
30		DDH-00-373C(95-115)-30	Non-reactive	2	Troctolitic	Troctolite	0.04	0.0226	0.0477	0.04	110	260	50	420	83
31		DDH-00-373C(75-95)-31	Non-reactive	2	Troctolitic	Troctolite	0.06	0.0286	0.0432	0.06	290	1010	120	1420	75
32		DDH-00-357C(110-130)-32	Reactive	2	Troctolitic	Troctolite	0.08	0.0427	0.0356	0.08	290	920	90	1300	67
33		DDH-99-320C(315-330)-33	Reactive	2	Troctolitic	Troctolite	0.07	0.0355	0.0213	0.06	210	190	50	450	48
34		DDH-00-369C(335-345)-34	Reactive	2	Troctolitic	Troctolite	0.18	0.0433	0.0207	0.17	140	120	40	300	49
35		DDH-00-368C(460-465)-35	Non-reactive	2	Ultramafic	Serpentinized MelaTroctolite (Picrite)	0.06	0.0413	0.0535	0.05	70	70	30	170	81
36		DDH-26055(940-945)-36	Non-reactive	2	Ultramafic	MelaTroctolite (Picrite)	0.06	0.0321	0.0495	0.05	180	90	40	310	88
37		DDH-00-368C(125-145)-37D	Non-reactive	3	Anorthositic	Anorthositic Troctolite	0.04	0.0182	0.0201	0.04	90	70	20	180	49
38		DDH-00-369C(305-325)-38D	Reactive	3	Troctolitic	Troctolite	0.25	0.0349	0.0299	0.23	150	120	40	310	62
39		DDH-26098&00-337C(145&105-148.5&110)-39	Non-reactive	2	Ultramafic		0.1	0.023	0.055	0.09	<5	7	4	11	89
40		DDH-00-334C(30-50)-40	Non-reactive	3	Anorthositic	Troctolitic Anorthosite	0.02	0.0085	0.0262	0.02	<5	<1	<1		50
41	37 Dup	DDH-00-368C(125-145)-41	Non-reactive	3	Anorthositic	Anorthositic Troctolite	0.04	0.0182	0.0201	0.04	90	70	20	180	49
42		DDH-00-368C(20-40)-42	Non-reactive	3	Anorthositic	Troctolite	0.04	0.022	0.0108	0.04	50	20	20	90	32
43		DDH-00-366C(35-55)-43	Non-reactive	3	Troctolitic	Troctolite	0.02	0.0054	0.0238	0.01	100	<1	<1	100	54
44		DDH-00-334C(110-130)-44	Non-reactive	3	Troctolitic	Troctolite	0.04	0.0135	0.0363	0.03	100	80	10	190	63
45		DDH-00-347C(155-175)-45	Non-reactive	3	Troctolitic	Troctolite/Anorthositic Troctolite	0.06	0.0162	0.018	0.03	110	60	70	240	53
46		DDH-00-347C(280-300)-46	Reactive	3	Troctolitic	Troctolite	0.06	0.0355	0.0211	0.05	180	180	40	400	47
47		DDH-00-326C(60-70)-47	Reactive	3	Troctolitic	Troctolite	0.14	0.043	0.0413	0.13	220	150	40	410	74
48	38 Dup	DDH-00-369C(305-325)-48	Reactive	3	Troctolitic	Troctolite	0.25	0.0349	0.0299	0.23	150	120	40	310	62
49		DDH-00-367C(50-65)-49	Non-reactive	4	Troctolitic	Serpentinized Troctolite	0.03	0.0108	0.0192	0.02	430	520	10	960	48
50		DDH-00-367C(260-280)-50	Non-reactive	4	Troctolitic	Augite Troctolite	0.04	0.018	0.0254	0.03	80	40	20	140	58
51		DDH-00-367C(290-310)-51	Non-reactive	4	Troctolitic	Troctolite	0.04	0.0198	0.0249	0.04	70	20	30	120	51
52		DDH-00-370C(20-30)-52	Reactive	4	Troctolitic	Augite Troctolite	0.08	0.0177	0.0137	0.08	130	50	<1	180	52
53		DDH-00-369C(20-30)-53	Reactive	4	Troctolitic	Troctolite	0.21	0.0577	0.0303	0.17	130	120	60	310	55
54		DDH-00-367C(170-175)-54	Reactive	4	Troctolitic	Augite Troctolite	0.51	0.0331	0.0267	0.4	80	120	70	270	62
55		DDH-00-367C(395-400)-55	Reactive	4	Troctolitic	Chloritic Troctolite	0.77	0.112	0.0363	0.63	160	360	70	590	110
56		DDH-26064(44-54)-56	Non-reactive	5	Troctolitic	Anorthositic Troctolite	0.02	0.0104	0.0426	0.01	<5	10	10	20	72
57	51 Dup	DDH-00-367C(290-310)-57D	Non-reactive	4	Troctolitic	Troctolite	0.04	0.0198	0.0249	0.04	70	20	30	120	51
58		DDH-00-364C(210-229)-58D	Reactive	20	Virginia	Granoblastic pyrrhotite Graywacke	3.79	0.0155	0.0186	3.6	<5	30	30	60	26
59		DDH-26064(264&146-269&156)-59	Non-reactive	5	Troctolitic		0.06	0.027	0.029	0.06	<5	10	12	22	58
60		DDH-26056(110-125)-60	Non-reactive	6	Troctolitic	Troctolite	0.04	0.0293	0.0401	0.02	110	240	70	420	79
61		DDH-00-361C(240-245)-61D	Lean Ore	2	Ultramafic	Serpentinized MelaTroctolite (Picrite)	0.06	0.0196	0.1075	0.06	50	50	<1	100	124
62		DDH-00-361C(737-749)-62	Reactive	20	Virginia	Granoblastic graphitic cordierite Argillite	2	0.0152	0.0121	1.77	<5	20	30	50	25
63	58 Dup	DDH-00-364C(210-229)-63	Reactive	20	Virginia	Granoblastic pyrrhotite Graywacke	3.79	0.0155	0.0186	3.6	<5	30	30	60	26
64		DDH-00-337C(510-520)-64	Reactive	20	Virginia	Bedded Granoblastic pyrrhotite cordierite Graywacke	5.68	0.0198	0.0168	3.78	<5	30	30	60	32
65		DDH-26027(616-626)-65	Lean Ore	1	Anorthositic	Anorthositic Troctolite	1.83	0.126	0.0528	1.92	50	210	70	330	93
66		P1-0-66	Ore				0.86	0.345	0.0971	0.88	63	199	28	290	86
67		P2-0-67	Ore				0.9	0.349	0.1485	0.88	77	278	55	410	98
68		DDH-26062&26026(993&565-998&568)-68	Lean Ore	1	Sedimentary Hornfels		4.46	0.129	0.047	4.62	<5	28	12	40	74
69		DDH-00-340C(725-745)-69	Lean Ore	1	Troctolitic	Troctolite	0.91	0.1005	0.0407	0.89	240	570	120	930	104
70		DDH-00-344C(515-520)-70	Lean Ore	1	Ultramafic	Serpentinized MelaTroctolite (Picrite)	1.2	0.0899	0.0529	1.2	110	280	60	450	82
71		DDH-00-340C(380-390)-71	Lean Ore	2	Troctolitic	MelaTroctolite (Picrite)	0.15	0.0502	0.0342	0.15	120	150	20	290	72
72	61 Dup	DDH-00-361C(240-245)-72	Lean Ore	2	Ultramafic	Serpentinized MelaTroctolite (Picrite)	0.06	0.0196	0.1075	0.06	50	50	<1	100	124
73		P30-73	Ore				0.86	0.444	0.0972	0.87	69	320	34	423	82
74		26029(interval 815-825)-74	Non-reactive	1	Troctolitic	Augite Troctolite	0.02	0.0055	0.0114	0.01	<5	1	18	19	27
75		DDH-26030&26049(291&358-296&362)-75	Lean Ore	3	Troctolitic		0.59	0.174	0.071	0.61	28	52	18	98	87
76		DDH-00-367C(400-405)-76	Lean Ore	4	Troctolitic	MelaGabbro	1.37	0.1	0.0299	1.39	290	520	60	870	88
77		DDH-26056(302-312)-77	Lean Ore	5	Troctolitic	Anorthositic Troctolite	0.23	0.0866	0.0365	0.23	90	210	60	360	56
78		26056(135-153)-78	Non-reactive	6	Troctolitic	Troctolite	0.05	0.0389	0.0439	0.04	320	820	250	1390	73
80		DDH-26142(360&345-365&350)-80	Lean Ore	6	Troctolitic		0.18	0.115	0.048	0.18	37	112	20	169	61
93		00-331C(255-260)-93	Lean Ore	1	Anorthositic	Anorthosite	0.86	0.153	0.043	0.81	17	53	26	96	54
94		00-344C (630-635)-94	Lean Ore	1	Ultramafic	MelaTroctolite (Picrite)	0.34	0.155	0.055	0.32	15	72	9	96	65
95		00-326C(495-505)-95	Lean Ore	1	Ultramafic	MelaTroctolite (Picrite)	0.16	0.077	0.065	0.15	11	45	4	60	96
96		99-318C(325-330)-96	Lean Ore	2	Troctolitic	Troctolite	0.17	0.117	0.054	0.15	44	162	17	223	73
97		00-330C(275-280)-97	Lean Ore	1	Ultramafic	MelaTroctolite (Picrite)/Troctolite	0.75	0.148	0.069	0.65	18	39	8	65	115
98		26056(282-292)-98	Lean Ore	5	Troctolitic	Troctolite	0.32	0.141	0.047	0.3	40	67	12	119	61
99		00-326C (250-265)-99	Lean Ore	1	Troctolitic	Anorthositic Troctolite	0.08	0.052	0.034	0.08	62	293	18	373	50
100		00-340C(910-925)-100	Lean Ore	1	Troctolitic	Olivine Gabbro	0.36	0.174	0.041	0.3	39	94	13	146	60
101		26039(310-315)-101	Lean Ore	2	Ultramafic	MelaTroctolite (Picrite)	0.06	0.039	0.095	0.08	7	8	2	17	110
102		00-331C(190-210)-102	Lean Ore	1	Troctolitic	Augite Troctolite	0.42	0.175	0.046	0.44	54	62	29	145	67
103		99-320C(400-405)-103	Lean Ore	1	Anorthositic	Anorthositic Troctolite	0.18	0.1	0.068	0.18	46	140	4	190	61
104		00-326C(225-235)-104	Lean Ore	2	Ultramafic	MelaTroctolite (Picrite)	0.12	0.094	0.071	0.12	20	107	8	135	91
105		00-367C(495-500)-105	Lean Ore	3	Troctolitic	Anorthositic Troctolite	0.28	0.193	0.051	0.29	39	162	14	215	50
106		26058(704-715)-106	Lean Ore	1	Sedimentary Hornfels	Granoblastic pyrrhotite pyroxene argillite	1.46	0.083	0.03	1.3	7	39	11	57	37

HCT ID	Ag	Zn	Cd	Mo	Pb	As	Cr	V	Ti	Al	Ca	Fe	K	Na	Mg	Mn	P	Ba	Be	Bi	Sb	Sr	W
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1	<0.5	118	<0.5	<1	2	<5	140	190	1.33	8.90	6.28	8.58	0.90	2.15	3.26	1150	1280	260	1.0	<2	<5	374	<10
2	<0.5	72	<0.5	<1	<2	<5	260	102	0.46	8.85	6.76	5.53	0.20	2.06	2.96	703	430	110	0.5	<2	<5	322	<10
3	<0.5	91	<0.5	<1	<2	<5	152	83	0.45	8.24	5.68	7.77	0.30	1.91	4.55	945	420	110	<0.5	<2	<5	267	<10
4	<0.5	192	<0.5	8	10	10	185	377	2.43	8.03	4.26	11.05	1.11	2.18	2.90	1255	2230	270	1.5	<2	<5	218	<10
5	<0.5	168	0.8	2	6	14	151	153	0.47	8.10	13.60	5.47	0.53	0.89	2.20	2730	670	240	1.4	<2	<5	326	10
6	<0.5	225	0.8	10	37	27	196	216	0.52	8.19	2.78	4.51	3.09	1.84	2.20	1355	730	770	2.1	<2	<5	222	<10
7	<0.5	399	1.1	8	12	11	260	285	0.71	8.64	3.53	7.01	2.14	1.54	3.03	1070	610	880	2.4	<2	<5	269	<10
8	0.5	348	1.7	12	30	17	164	204	0.45	7.56	0.69	5.27	2.90	1.48	1.71	327	670	600	2.0	<2	<5	173	<10
9	<0.5	118	<0.5	<1	2	<5	140	190	1.33	8.90	6.28	8.58	0.90	2.15	3.26	1150	1280	260	1.0	<2	<5	374	<10
10	<0.5	116	<0.5	6	13	11	489	358	1.11	8.76	5.10	12.05	0.58	2.02	4.46	1075	820	170	0.7	<2	<5	220	<10
11	<0.5	413.00	1.80	15.00	10.00	42.00	288.00	343	0.85	8.67	2.13	9.69	1.07	1.16	3.30	747	380	360	2.1	<2	<5	252	<10
12																							
13	<0.5	92	<0.5	<1	<2	<5	174	97	0.53	8.40	6.10	7.78	0.36	2.05	4.96	994	500	120	0.5	<2	<5	279	<10
14	<0.5	111	<0.5	<1	2	<5	164	137	0.88	8.84	6.36	9.41	0.45	2.19	4.99	1205	800	150	0.7	<2	<5	270	<10
15	<0.5	139	<0.5	<1	7	<5	98	173	1.30	7.46	5.03	11.35	0.59	1.78	6.95	1415	1160	170	0.9	<2	<5	207	<10
16	0.5	125	<0.5	<1	4	<5	444	170	0.91	7.43	4.90	10.50	0.48	1.92	5.83	1280	840	140	0.7	<2	<5	237	<10
17	<0.5	146	<0.5	<1	8	<5	140	237	1.57	7.70	3.92	10.70	1.32	1.92	4.95	1465	1300	420	1.3	<2	<5	212	<10
18	<0.5	132	<0.5	2	4	<5	124	148	0.65	9.49	4.39	7.76	0.94	1.81	4.37	813	660	220	1.3	<2	<5	241	<10
19	<0.5	182	<0.5	3	10	19	118	515	3.27	7.44	4.94	11.85	0.88	1.98	3.14	1425	2990	260	1.1	<2	<5	221	<10
20	<0.5	116	<0.5	6	13	11	489	358	1.11	8.76	5.10	12.05	0.58	2.02	4.46	1075	820	170	0.7	<2	<5	220	<10
21	<0.5	126	<0.5	<1	7	<5	116	176	1.31	9.26	6.10	9.05	0.63	1.94	4.36	1210	1360	200	0.9	<2	<5	246	<10
22	<0.5	157	0.9	3	8	<5	93	293	2.15	7.49	6.03	11.55	0.69	1.88	3.13	1540	2020	250	1.2	<2	<5	217	<10
23	<0.5	148	<0.5	1	7	<5	108	240	1.80	8.81	6.11	11.00	0.85	2.00	3.61	1445	1760	260	1.4	<2	<5	236	<10
24	<0.5	174	<0.5	3	7	<5	115	279	1.96	7.90	4.69	11.10	0.85	1.95	3.02	1360	2110	280	1.5	<2	<5	209	<10
25	0.5	257	<0.5	6	8	10	221	301	1.38	9.52	2.93	10.20	0.87	1.41	3.22	842	930	380	2.5	<2	<5	181	<10
26	<0.5	61	<0.5	<1	<2	<5	85	64	0.40	8.75	7.19	4.94	0.15	2.24	2.70	665	290	100	<0.5	<2	<5	309	<10
27	<0.5	66	<0.5	<1	<2	<5	167	109	0.61	9.13	7.25	5.41	0.21	2.34	2.65	740	360	110	<0.5	<2	<5	307	<10
28	<0.5	83	<0.5	<1	<2	<5	207	123	0.68	9.35	6.36	7.01	0.29	2.11	3.83	892	300	110	0.5	<2	<5	271	<10
29	<0.5	90	<0.5	<1	<2	<5	124	110	0.71	8.57	6.68	7.52	0.29	1.96	4.49	982	700	120	0.5	<2	<5	276	<10
30	<0.5	114	<0.5	<1	<2	<5	164	104	0.60	7.67	5.07	10.30	0.34	1.80	6.91	1295	570	110	0.5	<2	<5	219	<10
31	<0.5	113	<0.5	<1	<2	<5	162	120	0.79	8.46	5.16	10.15	0.43	1.91	6.57	1265	770	130	0.6	<2	<5	225	<10
32	<0.5	112	<0.5	<1	2	<5	152	145	0.95	8.38	5.53	9.45	0.48	2.05	5.29	1195	940	150	0.7	<2	<5	245	<10
33	<0.5	99	<0.5	<1	4	<5	171	148	1.03	9.05	6.16	7.77	0.47	2.27	3.82	1020	1110	160	0.7	<2	<5	276	<10
34	0.8	95	<0.5	<1	5	<5	62	104	0.53	9.77	6.15	7.61	0.48	2.36	3.72	924	770	170	0.6	<2	<5	283	<10
35	<0.5	114	<0.5	<1	4	5	170	106	0.57	6.75	4.03	10.55	0.28	1.12	8.24	1385	540	90	0.5	<2	<5	147	<10
36	<0.5	116	<0.5	<1	5	<5	224	136	0.68	6.87	4.76	11.30	0.32	1.60	7.30	1405	550	120	0.5	<2	<5	197	<10
37	<0.5	86	<0.5	<1	<2	<5	110	116	0.71	9.38	6.82	6.99	0.31	2.34	3.34	917	620	130	0.6	<2	<5	298	<10
38	<0.5	73	<0.5	<1	5	<5	118	89	0.36	9.15	6.41	6.81	0.29	2.17	3.61	838	320	120	<0.5	<2	<5	281	<10
39	<0.5	137	<0.5	<1	4	8	151	154	1.08	6.13	4.19	12.50	0.46	1.28	8.29	1570	1070	150	0.7	<2	<5	152	<10
40	<0.5	69	<0.5	<1	2	<5	255	64	0.27	8.31	6.38	5.50	0.16	2.10	3.73	754	160	110	<0.5	<2	<5	293	<10
41	<0.5	86	<0.5	<1	<2	<5	110	116	0.71	9.38	6.82	6.99	0.31	2.34	3.34	917	620	130	0.6	<2	<5	298	<10
42	<0.5	72	<0.5	<1	<2	7	128	147	0.95	9.86	7.23	5.59	0.35	2.52	2.18	754	930	150	0.6	<2	<5	307	<10
43	<0.5	67	<0.5	<1	<2	<5	133	56	0.30	8.79	6.40	6.16	0.17	2.09	4.34	810	290	90	<0.5	<2	<5	286	<10
44	<0.5	81	<0.5	<1	<2	5	195	79	0.29	8.77	5.88	7.53	0.23	1.98	5.00	950	180	80	<0.5	<2	<5	264	<10
45	<0.5	89	<0.5	<1	<2	<5	179	142	0.72	8.99	6.93	7.32	0.28	2.28	3.77	998	480	120	0.5	<2	<5	291	<10
46	<0.5	72	<0.5	<1	<2	<5	115	91	0.53	8.67	6.54	6.15	0.24	2.14	3.18	830	500	110	<0.5	<2	<5	271	<10
47	<0.5	100	<0.5	<1	4	<5	180	118	0.70	7.52	5.45	8.97	0.33	1.85	5.26	1140	620	110	0.5	<2	<5	230	<10
48	<0.5	73	<0.5	<1	5	<5	118	89	0.36	9.15	6.41	6.81	0.29	2.17	3.61	838	320	120	<0.5	<2	<5	281	<10
49	<0.5	71	<0.5	<1	<2	<5	178	91	0.43	8.30	6.91	5.69	0.24	2.07	3.19	799	310	90	<0.5	<2	<5	302	<10
50	<0.5	90	<0.5	<1	<2	<5	233	114	0.55	7.95	5.97	7.75	0.31	1.97	4.30	1040	460	110	<0.5	<2	<5	255	<10
51	<0.5	85	<0.5	<1	5	5	192	110	0.62	8.17	6.47	6.56	0.31	2.04	3.65	914	490	120	<0.5	<2	<5	275	<10
52	<0.5	95	<0.5	<1	3	<5	178	230	0.91	8.70	6.95	8.32	0.52	1.96	4.48	1120	2220	150	0.7	<2	<5	246	<10
53	<0.5	86	<0.5	<1	<2	<5	176	122	0.70	8.58	6.34	7.07	0.30	2.01	3.56	908	310	120	0.5	<2	<5	269	<10
54	<0.5	105	<0.5	1	6	<5	238	203	0.91	7.83	5.32	7.85	0.55	1.72	3.55	1015	570	150	0.6	<2	<5	246	<10
55	<0.5	211	<0.5	3	14	<5	1670	730	1.95	4.18	2.47	14.05	0.53	1.08	6.16	1695	510	110	0.9	<2	<5	130	<10
56	<0.5	74	<0.5	<1	<2	<5	165	35	0.13	7.28	5.70	6.87	0.19	1.79	5.40	918	80	60	<0.5	<2	<5	264	<10
57	<0.5	85	<0.5	<1	5	5	192	110	0.62	8.17	6.47	6.56	0.31	2.04	3.65	914	490	120	<0.5	<2	<5	275	<10
58	1.1	899	6.5	29	46	31	128	222	0.08	7.80	0.37	6.90	3.70	1.20	1.40	197	530	410	1.7	<2	<5	153	<10
59	<0.5	82	<0.5	<1	<2	8	162	69	0.30	9.28	5.04	7.55	0.28	1.66	5.11	978	180	90	<0.5	<2	<5	258	<10
60	<0.5	100	<0.5	<1	<2	<5	102	60	0.31	7.48	5.23	9.69	0.24	1.89	5.74	1260	260	80	<0.5	<2	<5	251	<10
61	<0.5	144	<0.5	<1	6	<5	123	110	0.76	4.4	2.67	13.7	0.15	0.54	12.3	1775	530	60	<0.5	<2	<5	75	<10
62	<0.5	291	0.9	12	24	39	170	188	0.40	8.20	1.98	6.62	1.99	1.30	2.56	809	600	500	2.2	<2	<5	191	<10
63	1.1	899	6.5	29	46	31	128	222	0.08	7.80	0.37	6.90	3.70	1.20	1.40	197	530	410	1.7	<2	<5	153	<10
64	1	522	2.9	26	41	27	122	178	0.13	7.66	0.45	8.45	3.01	1.49	1.34	180	450	490	1.8	<2	<5	148	<10
65	<0.5	200	<0.5	13	6	19	334	423	1.1	8.02	3.38	13.3	0.45	1.32	5.22	1295	310	130	1.1	<2	<5	201	<10
66	0.9	109	<0.5	3	12	17	185	126	0.72	9.51	5.96	9.43	0.43	1.83	4.76	1040	690	150	0.6	<2	<5	277	<10
67	1.2	102	<0.5	3	4	<5	161	118	0.73	9.29	5.76	8.86	0.41	1.79	4.51	1020	620	150	0.6	<2	<5	277	<10
68	0.5	351	2.4	28	9	75	365	368	0.33	8.55	1.51	11.7	0.58	0.71	3.33	516	350	180	2.6	<2	<5	123	<10
69	<0.5	98	<0.5	<1	11	50	182	140	0.69	8.42	5.23	10.05	0.39	1.7	5.05	1035	700	140	0.6	<2	<5	226	<10
70	0.8	149	<0.5	4	8	8	201	150	0.51	8.68	3.48	10.7	0.26	1.23	6.68	1070	430	100	1	<2	<5	208	<10
71	<0.5	142	<0.5	<1	14	<5	201	198	1.22	7.62	5.5	11.25	0.35	1.57	5.91	1425	1450	120	0.5	<2	<5	212	<10
72	<0.5	144	<0.5	<1	6	<5	123	110	0.76	4.4	2.67	13.7	0.15	0.54	12.3	1775	530	60	<0.5	<2	<5	75	<10
73	1.2	105	<0.5	3	9	13	175	129	0.77	9.54	5.78	9.37	0.5	1.75	4.87	1055	760	160	0.6	<2	<5	263	<10
74	<0.5	44	<0.5	<1	<2	<5	55	51	0.34	9.31	7.94	3.63	0.15	2.37	1.58	469	280	100	<0.5	<2	<5	358	<10
75	0.8	104	<0.5	2	5	<5	114	121	0.48	9.13	5.03	9.38	0.35	1.41	6.34	1070	210	90	<0.5	<2	<5	280	<10
76	<0.5	173	<0.5	4	17	<5	227	353	1.6	7.97	4.07	11.25	0.91	1.6	4.53	1315	1900	230	1	<2	<5	286	<10
77	<0.5	65	<0.5	<1	5	8	215	57	0.23	8.99	5.98	6.46	0.15	1.9	3.94	799	220	80	<0.5	<2	<5	266	<10
78	<0.5	104	<0.5	<1	<2	<5	133	66	0.35	7.94	5.44	8.39	0.30	1.86	5.49	1130	290	90	<0.5	<2	<5	265	<10
80	<0.5	85	<0.5	<1	5	<5	129	43	0.23	9.81	5.55	7.4	0.27	1.71	5	925	180	90	<0.5	<2	5	266	<10
93	0.9		1	7	12	6	266	321	1.33	9.27	3.06	10.35	0.8	1.77	3.33	806	120	290	1.6	5	<5	294	<10
94	0.8		0.5	<1	7	<5	206	150	0.96	9.34	6.37	9.41	0.36	1.97	4.51	1160	340	140	0.5	<2	<5	273	<10
95	0.5		<0.5	<1	<2	<5	109	149	0.93	6.13	4.38	12.3	0.44	1.34	8.46	1555	930	140	0.7	3	<5	164	<10
96	0.5		0.6	<1	5	<5	132	112	0.71	8.61	5.53	9.59	0.37	1.79	6.15	1225	490	130	0.6	5	<5	245	<10
97	0.9		<0.5	<1	6	<5	73	80	0.36	8.23	5.22	10.95	0.26	1.6	6.83	1170	320	100	<0.5	<2	<5	226	<10
98	0.7		0.5	<1	5	<5	162	51	0.25	9.54	6.34	6.18	0.22	1.98	3.91	762	170	90	<0.5	3	<5	287	<10
99	<0.5		<0.5	<1	3	<5	159	89	0.57	9.75	6.74	6.08	0.33	1.89	4.06	778	530	130	0.5	<2	<5	313	<10
100	0.8		<0.5	<1	6	<5	179	184	1.27	8.89	5.93	8.85	0.69	1.98	3.79	1110	1260	200	1	<2	<5	253	<10
101	<0.5		<0.5	<1	11	10	120	85	0.52	5.06	3.19	13.35	0.15	0.8	11.3	1660	360	60	<0.5	<2	<5	118	<10
102	0.5		0.6	<1	17	<5	148	217	1.61	9.13	5.87	10.7	0.41	1.93	3.97	1335	1620	230	1	<2	<5	251	<10
103	<0.5		<0.5	<1	5	<5	83	70	0.46	9.72	5.25	6.52	1.11	1.39	5.41	912	440	220	<0.5	<2	<5	329	<10
104	<0.5		<0.5	<1	10	5	131	128	0.81	6.98	4.27	12.6	0.3	1.25	8.89	1620	730	110	0.5	<2	<5	169	<10
105	0.5		<0.5	<1	8	12	140	75	0.38	9.84	6.5	5.92	0.26	1.99	3.85	775	420	110	<0.5	<2	<5	310	<10
106	<0.5		3.8	7	10	35	263	277	0.53	9.17	5.67	8.32	0.55	0.62	4.56	1750	280	110	2.3	<2	<5	226	<10

Notes:
1. Result not available if no value shown.

HCT ID	Comment	HCT Full ID (Drill Hole, Footage, HCT)	Cu	Ni	S ICP	Co	Ag	Zn	Cd	Mo	Pb	As	Cr	V	Ti	Al	Ca	Fe	K	Na	Mg	Mn	P	B	Ba	Be	Bi	Ga	Hg	La	Sb	Sc	Sr	W	Tl	U
			Metals by Aqua Regia Digestion																																	
			%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
1		DDH-99-320C(830-850)-1	0.032	0.014	0.100	34	<0.2	72	<0.5	<1	<2	3	122	84	0.22	4.20	2.61	5.58	0.32	0.50	1.98	607	1230	10	80	<0.5	<2	10	<1	10	2	3	93	<10	<10	<10
2		DDH-00-361C(310-320)-2	0.014	0.019	0.170	36	<0.2	46	<0.5	<1	<2	2	36	16	0.07	5.94	3.59	4.56	0.12	0.81	2.68	492	420	<10	40	<0.5	<2	10	1	<10	<2	2	143	<10	<10	<10
3		DDH-00-361C(345-350)-3	0.022	0.025	0.050	55	<0.2	71	<0.5	<1	<2	<2	36	18	0.09	4.22	2.53	6.91	0.14	0.60	4.54	778	430	<10	40	<0.5	<2	<10	<1	<10	<2	3	99	<10	<10	<10
4		DDH-00-343C(240-250)-4	0.069	0.018	0.720	34	<0.2	67	<0.5	5	2	8	76	107	0.22	1.73	1.43	3.80	0.24	0.30	0.84	255	2150	<10	40	<0.5	<2	<10	<1	20	<2	6	40	<10	<10	<10
5		DDH-26030(1047-1052)-5	0.010	0.007	0.260	11	<0.2	33	0.7	2	4	17	39	26	0.13	2.95	8.15	1.24	0.12	0.16	0.37	799	630	10	50	0.6	<2	10	<1	10	<2	2	94	10	<10	<10
6		DDH-26061(1218-1233)-6	0.013	0.011	0.460	19	0.2	181	0.5	9	16	27	154	160	0.26	2.81	1.27	3.51	0.78	0.07	1.58	381	580	20	160	0.9	<2	10	<1	20	2	12	29	<10	<10	<10
7		DDH-00-340C(990-995)-7	0.013	0.014	0.580	26	<0.2	200	<0.5	8	3	12	235	232	0.46	3.47	1.74	4.23	1.22	0.08	1.78	331	490	50	370	0.9	2	10	1	20	2	15	38	<10	<10	<10
8		DDH-00-340C(965-974.5)-8	0.020	0.013	1.900	21	0.4	324	1.7	14	2	26	177	205	0.28	2.85	0.25	5.37	0.97	0.07	1.37	206	540	<10	90	1	<2	10	<1	10	2	20	14	<10	<10	<10
9	1 Dup	DDH-99-320C(830-850)-9D	0.032	0.014	0.100	34	<0.2	72	<0.5	<1	<2	3	122	84	0.22	4.20	2.61	5.58	0.32	0.50	1.98	607	1230	10	80	<0.5	<2	10	<1	10	2	3	93	<10	<10	<10
10		DDH-00-340C(765-780)-10D	0.064	0.029	1.660	92	<0.2	83	<0.5	6	4	17	143	92	0.17	2.65	1.66	9.56	0.24	0.36	3.30	760	780	<10	50	<0.5	<2	<10	<1	10	2	3	52	<10	<10	<10
11		DDH-26043&26027(1501&740-1506&745)-11	0.039	0.025	2.590	45	0.3	223	1.4	16	8	30	126	152	0.22	3.31	0.64	6.09	0.51	0.14	1.42	191	330	<10	110	0.9	2	10	<1	10	<2	11	39	<10	<10	<10
12	Blank	Method Blank - 12																																		
13		DDH-00-340C(595-615)-13	0.012	0.034	0.040	58	<0.2	75	<0.5	<1	<2	<2	80	28	0.12	4.28	2.59	6.91	0.21	0.63	5.01	815	500	<10	60	<0.5	2	<10	<1	<10	<2	3	104	<10	<10	<10
14		DDH-00-334C(580-600)-14	0.024	0.028	0.050	53	<0.2	83	<0.5	<1	2	<2	128	56	0.16	2.67	1.68	7.31	0.20	0.39	4.20	885	770	<10	60	<0.5	<2	<10	1	10	<2	2	60	<10	<10	<10
15		DDH-00-334C(640-660)-15	0.028	0.047	0.090	71	<0.2	106	<0.5	<1	<2	2	65	67	0.23	2.18	1.37	8.90	0.28	0.30	5.63	1065	1110	<10	70	<0.5	<2	<10	<1	10	<2	3	46	<10	<10	<10
16		DDH-00-347C(795-815)-16	0.040	0.037	0.070	70	<0.2	98	<0.5	<1	2	<2	289	73	0.2	2.49	1.53	8.95	0.24	0.40	5.53	1060	810	<10	70	<0.5	<2	<10	<1	10	2	3	60	<10	<10	<10
17		DDH-00-350C(580-600)-17	0.039	0.028	0.200	54	<0.2	116	<0.5	<1	3	7	110	115	0.31	2.95	1.08	8.10	0.48	0.26	3.92	1100	1280	<10	120	0.5	<2	10	<1	10	<2	10	41	<10	<10	<10
18		DDH-00-327C(225-245)-18	0.031	0.015	0.460	49	<0.2	74	<0.5	3	<2	6	49	38	0.11	4.41	2.41	5.71	0.18	0.50	3.19	552	600	<10	50	0.5	<2	10	<1	10	<2	4	94	<10	<10	<10
19		DDH-00-371C(435-440)-19	0.051	0.026	0.920	40	<0.2	53	<0.5	3	2	12	32	81	0.25	1.62	1.57	3.53	0.18	0.29	0.56	207	2970	<10	40	<0.5	<2	<10	<1	20	<2	4	38	<10	<10	<10
20	10 Dup	DDH-00-340C(765-780)-20	0.064	0.029	1.660	92	<0.2	83	<0.5	6	4	17	143	92	0.17	2.65	1.66	9.56	0.24	0.36	3.30	760	780	<10	50	<0.5	<2	<10	<1	10	2	3	52	<10	<10	<10
21		DDH-00357C(335-340)-21	0.027	0.000	0.080	40	<0.2	72	<0.5	<1	<2	2	94	76	0.24	3.55	2.22	5.75	0.27	0.54	2.61	635	1370	<10	70	<0.5	<2	10	1	10	<2	2	85	<10	<10	<10
22		DDH-00326C(680-685)-22	0.104	0.022	0.290	31	0.5	78	<0.5	2	4	<2	71	109	0.36	1.87	1.36	5.06	0.42	0.30	0.97	485	2020	<10	150	<0.5	4	10	<1	10	<2	3	41	<10	<10	<10
23		DDH-00-357C(535-540)-23	0.098	0.000	0.200	32	0.4	70	<0.5	1	5	<2	88	98	0.32	2.39	1.36	5.06	0.61	0.35	1.38	473	1630	<10	160	<0.5	<2	<10	1	10	<2	3	52	<10	<10	<10
24		DDH-99-318C(725-735)-24	0.049	0.017	0.750	29	<0.2	47	<0.5	2	5	9	42	67	0.22	2.16	1.73	3.02	0.22	0.34	0.50	203	2130	<10	50	0.5	<2	10	<1	20	<2	3	43	<10	<10	<10
25		DDH-99-317C(460-470)-25	0.061	0.021	1.280	37	0.3	79	<0.5	6	2	13	91	101	0.21	2.71	0.65	4.89	0.36	0.15	1.03	207	900	<10	110	0.7	<2	<10	<1	10	<2	4	22	<10	<10	<10
26		DDH-00-366C(185-205)-26	0.008	0.019	0.020	35	<0.2	49	<0.5	<1	<2	<2	72	23	0.09	6.14	3.77	4.68	0.15	0.92	3.03	548	290	<10	50	<0.5	<2	10	<1	<10	<2	2	149	<10	<10	<10
27		DDH-00-366C(230-240)-27	0.012	0.015	0.030	32	<0.2	48	<0.5	<1	<2	<2	140	44	0.11	4.48	2.78	4.57	0.13	0.69	2.50	525	360	<10	40	<0.5	<2	10	<1	<10	<2	1	108	<10	<10	10
28		DDH-99-320C(165-175)-28	0.013	0.023	0.030	45	<0.2	67	<0.5	<1	2	<2	185	56	0.15	3.90	2.34	6.14	0.13	0.58	3.70	718	290	<10	40	<0.5	<2	10	<1	<10	<2	2	89	<10	<10	<10
29		DDH-99-318C(250-370)-29	0.013	0.028	0.040	50	<0.2	71	<0.5	<1	<2	<2	91	39	0.12	4.86	3.03	6.37	0.16	0.69	4.22	763	700	<10	50	<0.5	<2	10	1	10	<2	2	116	<10	<10	<10
30		DDH-00-373C(95-115)-30	0.022	0.046	0.040	78	<0.2	102	<0.5	<1	<2	<2	130	39	0.13	2.82	1.67	9.40	0.17	0.43	6.96	1175	560	<10	50	<0.5	<2	<10	<1	<10	<2	3	63	<10	<10	<10
31		DDH-00-373C(75-95)-31	0.027	0.041	0.060	71	<0.2	97	<0.5	<1	<2	<2	118	50	0.15	2.44	1.51	8.72	0.21	0.37	5.98	1065	770	<10	60	<0.5	<2	<10	<1	10	<2	3	54	<10	<10	<10
32		DDH-00-357C(110-130)-32	0.040	0.033	0.090	59	<0.2	89	<0.5	<1	3	<2	120	61	0.19	2.57	1.61	7.81	0.23	0.37	4.59	935	950	<10	70	<0.5	<2	<10	<1	10	2	3	55	<10	<10	<10
33		DDH-99-320C(315-330)-33	0.033	0.019	0.070	39	<0.2	67	<0.5	<1	2	2	143	67	0.19	2.87	1.83	5.93	0.19	0.44	2.80	661	1140	<10	60	<0.5	<2	10	<1	10	<2	2	66	<10	<10	<10
34		DDH-00-369C(335-345)-34	0.039	0.019	0.180	46	0.3	74	<0.5	<1	<2	4	22	18	0.09	2.89	1.85	6.50	0.12	0.44	3.12	705	740	<10	40	<0.5	<2	<10	<1	10	<2	2	65	<10	<10	<10
35		DDH-00-368C(460-465)-35	0.039	0.049	0.060	74	<0.2	99	<0.5	<1	2	<2	145	52	0.12	3.95	1.92	9.66	0.15	0.29	8.20	1265	540	20	40	<0.5	<2	<10	<1	10	2	3	53	<10	<10	<10
36		DDH-26055(940-945)-36	0.030	0.046	0.060	82	<0.2	101	<0.5	<1	<2	<2	126	44	0.14	2.19	1.37	9.99	0.17	0.30	6.96	1225	530	<10	50	<0.5	<2	<10	<1	<10	3	3	46	<10	<10	<10
37		DDH-00-368C(125-145)-37D	0.016	0.018	0.040	40	<0.2	64	<0.5	<1	<2	2	95	49	0.15	4.14	2.53	5.85	0.16	0.62	3.00	682	600	<10	50	<0.5	<2	10	<1	<10	<2	2	94	<10	<10	<10
38		DDH-00-369C(305-325)-38D	0.033	0.030	0.260	58	<0.2	61	<0.5	<1	<2	2	29	16	0.07	3.93	2.39	6.54	0.12	0.58	3.68	699	310	<10	30	<0.5	<2	<10	1	<10	<2	2	85	<10	<10	<10
39		DDH-26098&00-337C(145&105-148.5&110)-39	0.024	0.055	0.090	85	0.2	118	<0.5	<1	7	<2	95	69	0.25	1.66	0.96	10.95	0.27	0.23	7.49	1290	1040	<10	70	<0.5	<2	<10	<1	10	<2	4	33	<10	<10	<10
40		DDH-00-334C(30-50)-40	0.008	0.024	0.030	47	<0.2	58	<0.5	<1	<2	<2	51	12	0.05	5.31	3.22	5.55	0.10	0.79	4.31	681	140	<10	40	<0.5	<2	10	<1	<10	3	2	123	<10	<10	<10
41	37 Dup	DDH-00-368C(125-145)-41	0.016	0.018	0.040	40	<0.2	64	<0.5	<1	<2	2	95	49	0.15	4.14	2.53	5.85	0.16	0.62	3.00	682	600	<10	50	<0.5	<2	10	<1	<10	<2	2	94	<10	<10	<10
42		DDH-00-368C(20-40)-42	0.020	0.009	0.050	23	<0.2	44	<0.5	<1	2	<2	112	68	0.16	3.48	2.29	3.86	0.14	0.52	1.44	417	930	<10	50	<0.5	<2	<10	<1	<10	<2	1	80	<10	<10	<10
43		DDH-00-366C(35-55)-43	0.005	0.022	0.020	51	<0.2	57	<0.5	<1	<2	<2	87	18	0.07	4.55	2.78	5.90	0.11	0.67	4.57	703	280	<10	40	<0.5	<2	10	<1	<10	2	2	110	<10	<10	<10
44		DDH-00-334C(110-130)-44	0.013	0.035	0.040	62	<0.2	74	<0.5	<1	<2	<2	32	12	0.05	3.70	2.16	7.37	0.08	0.52	5.44	903	160	<10	30	<0.5	<2	<10	<1	<10	<2	3	79	<10	<10	<10
45		DDH-00-347C(155-175)-45	0.015	0.016	0.040	44	<0.2	65	<0.5	<1	<2	<2	102	41	0.14	3.47	2.10	6.09	0.14	0.54	3.38	718	460	<10	40	<0.5	<2	<10	1	<10	<2	2	81	<10	<10	<10
46		DDH-00-347C(280-300)-46	0.034	0.020	0.060	41	<0.2	59	<0.5	<1	<2	<2	88	28	0.12	3.99	2.42	5.61	0.13	0.63	3.24	662	500	<10	50	<0.5	<2	<10	<1	<10	<2	2	95	<10	<10	<10
47		DDH-00-326C(60-70)-47	0.041	0.041	0.150	68	<0.2	88	<0.5	<1	<2	<2	128	40	0.13	2.62	1.58	7.98	0.15	0.40	5.38	970	620	<10	40	<0.5	<2	<10	<1	<10	<2	3	56	<10	<10	<10
48	38 Dup	DDH-00-369C(305-325)-48	0.033	0.030	0.260	58	<0.2	61	<0.5	<1	<2	2	29	16	0.07	3.93	2.39	6.54	0.12	0.58	3.68	699	310	<10	30	<0.5	<2	<10	1	<10	<2	2	85	<10	<10	<10
49		DDH-00-367C(50-65)-49	0.010	0.018	0.040	41	<0.2	58	<0.5	<1	<2	<2	147	40	0.1	5.26	3.33	5.42	0.13	0.72	3.42	652	330	<10	40	<0.5	<2	10	<1	<10	<2	2	117	<10	<10	<10
50		DDH-00-367C(260-280)-50	0.018	0.025	0.050	53	<0.2	76	<0.5	<1	<2	<2	168	50	0.14	3.59	2.15	7.01	0.19	0.51	4.41	859	510	<10	50	<0.5	<2	<10	<1	<10	<2	2	80	<10	<10	<10
51		DDH-00-367C(290-310)-51	0.019	0.023	0.050	42	<0.2	64	<0.5	<1	3	2	72	25	0.12	4.68	3.11	5.58	0.16	0.64	3.35	674	520	<10	50	<0.5	<2	10	<1	<10	<2	2	100	<10	<10	<10
52		DDH-00-370C(20-30)-52	0.016	0.011	0.090	40	<0.2	67	<0.5	<1	2	2	49	45	0.12	3.26	2.47	5.97	0.23	0.39	2.85	652	2140	<10	50	<0.5	<2	<10	<1	10	<2	2	58	<10	<10	<10
53		DDH-00-369C(20-30)-53	0.057	0.030	0.210	47	<0.2	64	<0.5	<1	<2	<2	86	33	0.15	3.90	2.31	5.99	0.19	0.59	3.04	650	320	<10	50	<0.5	<2	<10	<1	<10	<2	2	92	<10	<10	<10
54		DDH-00-367C(170-175)-54	0.033	0.025	0.510	50	<0.2	52	<0.5	<1	4	<2	119	89	0.21	4.73	2.82	4.69	0.45	0.63	2.04	400	610	<10	100	<0.5	<2	10	<1	10	<2	3	106	<10	<10	<10
55		DDH-00-367C(395-400)-55	0.106	0.036	0.730	95	<0.2	113	<0.5	2	4	6	229	175	0.31	3.71	1.37	10.75	0.36	0.28	5.72	1130	540	10	70	<0.5	<2	10	<1	<10	2	11	41	<10	<10	<10
56		DDH-26064(44-54)-56	0.009	0.040	0.020	67	<0.2	66	<0.5	<1	<2	<2	36	7	0.03	5.27	3.14	7.32	0.07	0.76	6.74	888	80	<10	20	<0.5	<2	10	<1	<10	<2	3	121	<10	<10	<10
57	51 Dup	DDH-00-367C(290-310)-57D	0.019	0.023	0.050	42	<0.2	64	<0.5	<1	3	2	72	25	0.12	4.68	3.11	5.58	0.16	0.64	3.35	674	520	<10	50	<0.5	<2	10	<1	<10	<2	2	100	<10	<10	<10
58		DDH-00-364C(210-229)-58D	0.016	0.020	4.100	27	0.9	918	6.5	27	17	42	76	107	0.01	2.67	0.09	7.09	0.40	0.04	1.30	179	230	20	30	1.4	<2	10	<1	10	2	10	9	<10	<10	10
59		DDH-26064(264&146-269&156)-59	0.026	0.026	0.060	55	<0.2	70	<0.5	<1	6	3	58	20	0.07	5.56	2.70	6.89	0.11	0.72	4.72	821	170	10	30	<0.5	3	10	1	<10	2	3	119	<10	<10	<10
60		DDH-26056(110-125)-60	0.027	0.039	0.030	72	<0.2	90	<0.5	<1	<2	<2	94	28	0.06	2.66	1.60	9.45	0.07	0.43	6.49	1185	270	<10	20	<0.5	<2	<10	<1	<10	<2	3	63	<10	<10	<10
61		DDH-00-361C(240-245)-61D	0.0196	0.0952	0.06	103	<0.2	123	<0.5	1	5	<2	57	35	0.1	3.09	1.21	11.85	0.13	0.28	10.15	1470	510	20	40	<0.5	<2	10	<1	<10	<2	7	47	<10	<10	<10
62		DDH-00-361C(737-749)-62	0.015	0.013	2.080	24	0.3	252	1.1	12	5	41	149	157	0.19	3.12	0.79	5.80	0.66	0.09	1.94	377	470	10	100	1.2	<2	10	<1	10	<2	16	26	<10	<10	<10
63	58 Dup	DDH-00-364C(210-229)-63	0.016	0.020	4.100	27	0.9	918	6.5	27	17	42	76	107	0.01	2.67	0.09	7.09	0.40	0.04	1.30	179	230	20	30	1.4	<2	10	<1	10	2	10	9	<10	<10	10
64		DDH-00-337C(510-520)-64	0.021	0.019	5.330	36	1.0	554	3.3	28	8	45	78	99	0.02	2.14	0.06	9.00	0.32	0.06	0.94	125	120	<10	30	1.2	<2	10	<1	10	4	12	11	<10	<10	10
65		DDH-26027(616-626)-65	0.125	0.049	1.97	69	0.3	54	<0.5	14	4	20	78	93	0.18	3.07	1.57	6.11	0.24	0.36	1.4	349	280	<10	50	<0.5	<2	10	1	<10	<2	6	71	<10	<10	<10
66		P1-0-66	0.323	0.0881	0.89	79	1.1	75	<0.5	<1	5	7	76	41	0.16	4.16	2.28	7.33	0.22	0.63	3.83	707	660	<10	60	<0.5	<2	10	<1	10	<2	3	102	<10	<10	<10
67		P2-0-67	0.335	0.1385	0.93	94	1.3	71	<0.5	<1	6	4	69	40	0.17	4.56	2.51	7.12	0.22	0.71	3.7	705	600	10	60	<0.5	2	10	<1	10	<2	3	114	<10	<10	<10
68		DDH-26062&26026(993&565-998&568)-68	0.125	0.047	4.65	72	0.5	142	2.4	27	7	67	133	144	0.1	4.56	1.13	8.96	0.25	0.21	1.29	154	300	<10	40	1.1	4	10	1	<10	<2	6	57	<10	<10	<10
69		DDH-00-340C(725-745)-69	0.1115	0.0428	0.95	101	0.5	86	<0.5	3	12	54	54	35	0.15	4.31	2.37	9.5	0.21	0.66	4.43	866	780	<10	50	<0.5	<2	10	<1	10	<2	3	106	<10	<10	<10
70		DDH-00-344C(515-520)-70	0.0902	0.048	1.18	67	0.7	109	<0.5	6	7	11	108	77	0.08	6.16	2.24	8.9	0.12	0.55	5.51	723	450	10	40	0.7	<2	10	<1	<10	<2	8	121	<10	<10	<10
71		DDH-00-340C(380-390)-71	0.0502	0.0307	0.16	56	0.2	92	<0.5	1	3	3	48	33	0.16	2.53	1.69	8.62	0.15	0.38	4.33	962	1500	<10	40	<0.5	<2	10	<1	10	<2	4	61	<10	<10	<10
72	61 Dup	DDH-00-361C(240-245)-72	0.0196	0.0952	0.06	103	<0.2	123	<0.5	1	5	<2	57	35	0.1	3.09	1.21	11.85	0.13	0.28	10.15	1470	510	20	40	<0.5	<2	10	<1	<10	<2	7	47	<10	<10	<10
73		P30-73	0.422	0.0914	0.88	76	1.5	76	<0.5	<1	6	7	95	50	0.2	4.66	2.58	7.43	0.27	0.71	3.93	739	710	<10	70	<0.5	2	10	1	10	<2	3	112	<10	<10	<10
74		26029(interval 815-825)-74	0.005	0.011	<0.01	21	<0.2	33	<0.5	<1	<2	<2	43	25	0.09	6.12	3.56	3.22	0.14	0.94	1.71	351	270	<10	40	<0.5	<2	10	<1	<10	<2	1	167	<10	<10	10
75		DDH-26030&26049(291&358-296&362)-75	0.166	0.07	0.6	80	0.7	87	<0.5	3	12	<2	31	28	0.07	5.42	2.88	7.11	0.11	0.61	4.53	673	180	<10	40	<0.5	<2	10	1	<10	<2	3	114	<10	<10	<10
76		DDH-00-367C(400-405)-76	0.102	0.0295	1.5	70	0.3	68	<0.5	5	9	8	108	126	0.22	2.91	1.73	5.33	0.54	0.37	1.46	320	1980	<10	110	0.5	<2	10	1	10	<2	6	65	<10	<10	<10
77		DDH-26056(302-312)-77	0.0903	0.0347	0.23	50	0.3	53	<0.5	1	7	<2	51	12	0.04	5.69	2.91	6.38	0.1	0.84	4.11	719	220	10	30	<0.5	<2	10	<1	<10	<2	2	125	<10	<10	<10
78		26056(135-153)-78	0.038	0.043	0.050	72	<0.2	94	<0.5	<1	<2	3	95	27	0.08	3.64	2.08	8.15	0.12	0.51	5.97	1035	290	<10	30	<0.5	<2	<10	<1	<10	2	3	81	<10	<10	<10
80		DDH-26142(360&345-365&350)-80	0.117	0.046	0.19	60	0.5	74	<0.5	<1	10	2	66	16	0.05	5.11	3.01	7.02	0.1	0.7	5.03	822	150	<10	30	<0.5	<2	10	1	<10	3	2	107	<10	<10	<10
93		00-331C(255-260)-93	0.147	0.042	0.87	36	0.6	50	0.6	6	3	25	85	84	0.32	2.78	0.85	3.36	0.24	0.31	0.7	151	70	<10	40	0.6	3	10	<1	10	<2	6	60	<10	<10	<10
94		00-344C (630-635)-94	0.151	0.054	0.35	62	0.6	100	<0.5	<1	2	3	120	54	0.2	2.72	1.56	7.87	0.17	0.42	3.42	901	340	<10	40	<0.5	<2	<10	<1	<10	<2	3	69	<10	<10	<10
95		00-326C(495-505)-95	0.08	0.066	0.16	94	0.3	130	<0.5	<1	<2	<2	54	52	0.22	1.62	0.94	11.05	0.28	0.21	7.03	1325	1000	<10	70	<0.5	<2	<10	<1	10	<2	4	34	<10	<10	<10
96		99-318C(325-330)-96	0.121	0.053	0.18	66	0.4	93	<0.5	<1	2	2	91	45	0.12	2.37	1.41	7.82	0.14	0.34	4.62	919	520	<10	30	<0.5	<2	<10	<1	<10	<2	3	58	<10	<10	<10
97		00-330C(275-280)-97	0.152	0.071	0.78	119	0.5	104	<0.5	<1	4	12	32	25	0.08	2.86	1.6	10.45	0.13	0.4	6.06	1080	330	<10	30	<0.5	2	<10	<1	<10	<2	4	70	<10	<10	<10
98		26056(282-292)-98	0.143	0.048	0.36	61	0.6	61	<0.5	<1	4	4	31	10	0.04	4.59	2.66	6.28	0.08	0.59	3.91	714	180	<10	20	<0.5	2	10	<1	<10	2	2	94	<10	<10	<10
99		00-326C (250-265)-99	0.052	0.031	0.08	42	0.3	55	<0.5	<1	2	3	29	19	0.1	5.92	3.52	4.86	0.14	0.75	3.39	562	540	<10	40	<0.5	3	10	<1	<10	2	2	146	<10	<10	<10
100		00-340C(910-925)-100	0.179	0.042	0.4	50	0.7	80	<0.5	<1	2	<2	150	95	0.25	3.01	1.82	6.48	0.39	0.39	2.36	664	1470	<10	90	<0.5	<2	<10	1	10	2	3	70	<10	<10	<10
101		26039(310-315)-101	0.041	0.095	0.07	117	0.2	136	<0.5	<1	<2	<2	53	28	0.09	2.74	1.37	12.55	0.11	0.32	10.3	1545	400	20	20	<0.5	2	<10	<1	<10	<2	6	54	<10	<10	<10
102		00-331C(190-210)-102	0.173	0.043	0.48	42	0.8	50	<0.5	1	4	4	63	56	0.23	3.36	2.18	4.23	0.24	0.44	1.38	367	1640	<10	100	<0.5	3	10	1	10	<2	3	81	<10	<10	<10
103		99-320C(400-405)-103	0.111	0.072	0.21	67	0.3	73	<0.5	<1	<2	4	47	33	0.1	6.21	3.25	6.23	0.21	0.69	5.26	818	490	10	40	<0.5	2	10	1	<10	<2	5	139	<10	<10	10
104		00-326C(225-235)-104	0.095	0.066	0.12	89	0.3	109	<0.5	<1	<2	<2	92	52	0.14	2.51	1.12	10.8	0.15	0.28	7.47	1350	760	20	40	<0.5	<2	<10	<1	<10	<2	5	45	<10	<10	<10
105		00-367C(495-500)-105	0.205	0.054	0.31	51	1	62	<0.5	<1	4	<2	45	23	0.08	5.21	2.86	5.52	0.18	0.73	3.62	636	440	<10	40	<0.5	2	10	<1	<10	<2	2	120	<10	<10	<10
106		26058(704-715)-106	0.091	0.032	1.67	35	0.4	317	4	9	4	46	48	49	0.09	4.21	3.03	3.9	0.19	0.25	1.8	406	290	400	20	1	2	10	1	10	<2	3	121	<10	<10	<10

Notes:
1. Result not available if no value shown.

			Humidity Cell Oxides																ABA	
HCT ID	**Comment**	**HCT Full ID (Drill Hole, Footage, HCT)**	**SiO_2**	**Al_2O_3**	**TiO_2**	**Fe_2O_3**	**FeO**	**CaO**	**MgO**	**MnO**	**Na_2O**	**K_2O**	**P_2O_5**	**Cr_2O_3**	**BaO**	**SrO**	**LOI**	**Total**	**C (%)**	**CO_2**
			%	%	%	%	%	%	%	%	%	%	%	%	%	%		%		
1		DDH-99-320C(830-850)-1	46.5	18.5	2.25	13.1	10.8	9.60	5.94	0.16	2.62	1.10	0.21	0.03	0.03	0.04	0.49	101	<0.05	0.2
2		DDH-00-361C(310-320)-2	46.5	23.1	0.88	9.0	7.8	10.60	6.31	0.10	2.66	0.38	0.01	0.06	0.01	0.04	0.41	100	<0.05	<0.2
3		DDH-00-361C(345-350)-3	46.0	19.3	0.84	12.7	10.8	9.09	9.52	0.14	2.44	0.37	0.23	0.04	0.01	0.03	0.06	101	<0.05	<0.2
4		DDH-00-343C(240-250)-4	49.0	14.1	4.16	16.5	14.1	6.38	4.89	0.18	2.61	1.22	0.43	0.03	0.03	0.03	1.13	101	0.09	0.3
5		DDH-26030(1047-1052)-5	48.0	14.3	0.74	8.3	6.9	20.10	3.82	0.35	1.20	0.63	0.13	0.03	0.09	0.04	2.19	100	0.26	1
6		DDH-26061(1218-1233)-6	59.1	16.0	0.92	6.8	5.8	4.23	3.77	0.19	2.23	3.44	0.15	0.03	0.09	0.03	3.74	101	0.09	0.3
7		DDH-00-340C(990-995)-7	51.8	18.3	1.19	10.6	9.7	5.34	5.64	0.15	1.98	2.70	0.02	0.04	0.11	0.03	2.08	100	0.05	0.2
8		DDH-00-340C(965-974.5)-8	59.9	16.6	0.83	8.2	7.6	1.18	3.23	0.05	2.09	3.71	0.18	0.03	0.07	0.02	2.94	99	<0.05	<0.2
9	1 Dup	DDH-99-320C(830-850)-9D	46.5	18.5	2.25	13.1	10.8	9.60	5.94	0.16	2.62	1.10	0.21	0.03	0.03	0.04	0.49	101	<0.05	0.2
10		DDH-00-340C(765-780)-10D	43.0	15.8	1.79	18.1	16.0	7.29	7.72	0.13	2.33	0.59	0.12	0.09	0.02	0.03	0.55	98	<0.05	<0.2
11		DDH-26043&26027(1501&740-1506&745)-11	48.9	18.9	1.55	16.0	13.8	3.24	6.41	0.11	1.58	1.49	0.09	0.05	0.05	0.03	2.44	101	<0.05	<0.2
12	Blank	Method Blank - 12																		
13		DDH-00-340C(595-615)-13	46.4	18.8	0.97	11.9	10.4	9.14	9.79	0.14	2.48	0.39	<0.01	0.03	0.01	0.03	-0.25	100	<0.05	<0.2
14		DDH-00-334C(580-600)-14	45.2	18.0	1.49	13.7	11.5	9.37	9.05	0.16	2.46	0.53	0.15	0.03	0.02	0.03	-0.59	100	<0.05	<0.2
15		DDH-00-334C(640-660)-15	44.4	13.5	2.18	16.8	14.2	7.56	11.95	0.20	2.16	0.61	0.08	0.03	0.02	0.02	0.23	100	<0.05	<0.2
16		DDH-00-347C(795-815)-16	45.3	16.1	1.56	16.0	13.7	7.85	11.20	0.18	2.47	0.53	0.08	0.09	0.02	0.03	-0.78	101	<0.05	<0.2
17		DDH-00-350C(580-600)-17	45.0	15.0	2.77	16.4	13.9	6.14	8.99	0.21	2.35	1.51	0.20	0.03	0.05	0.03	1.53	100	<0.05	<0.2
18		DDH-00-327C(225-245)-18	49.2	18.9	1.18	11.9	10.5	6.66	7.87	0.11	2.33	1.16	0.08	0.02	0.03	0.03	0.93	101	<0.05	<0.2
19		DDH-00-371C(435-440)-19	45.7	13.5	5.62	18.1	15.8	7.72	5.48	0.21	2.43	0.99	0.68	0.02	0.03	0.03	0.23	101	<0.05	<0.2
20	10 Dup	DDH-00-340C(765-780)-20	43.0	15.8	1.79	18.1	16.0	7.29	7.72	0.13	2.33	0.59	0.12	0.09	0.02	0.03	0.55	98	<0.05	<0.2
21		DDH-00357C(335-340)-21	46.1	17.3	2.13	14.0	11.5	9.31	7.85	0.16	2.65	0.77	0.28	0.02	0.02	0.03	0.19	101	<0.05	<0.2
22		DDH-00326C(680-685)-22	46.0	13.9	3.75	18.3	15.4	8.73	5.49	0.22	2.44	0.85	0.44	0.02	0.03	0.02	-0.63	100	<0.05	<0.2
23		DDH-00-357C(535-540)-23	47.0	15.5	2.91	16.3	13.9	8.99	6.32	0.19	2.70	1.02	0.38	0.02	0.04	0.03	-0.31	101	<0.05	<0.2
24		DDH-99-318C(725-735)-24	49.5	14.5	3.41	16.9	15.1	7.30	5.28	0.20	2.44	0.94	0.28	0.02	0.03	0.03	0.11	101	<0.05	<0.2
25		DDH-99-317C(460-470)-25	47.7	19.9	2.40	16.2	14.3	4.58	6.07	0.13	1.78	1.09	0.06	0.04	0.05	0.02	0.80	101	<0.05	<0.2
26		DDH-00-366C(185-205)-26	47.6	22.9	0.73	8.0	6.6	11.05	6.01	0.09	2.83	0.32	<0.01	0.02	0.01	0.04	0.02	100	<0.05	<0.2
27		DDH-00-366C(230-240)-27	48.1	22.3	1.10	8.5	7.1	11.15	5.62	0.10	2.93	0.37	0.02	0.04	0.01	0.04	-0.13	100	<0.05	<0.2
28		DDH-99-320C(165-175)-28	46.4	20.0	1.22	11.1	9.1	10.15	7.61	0.13	2.63	0.38	<0.01	0.05	0.01	0.03	0.02	100	<0.05	<0.2
29		DDH-99-318C(250-370)-29	45.8	19.4	1.28	11.6	9.7	9.99	8.68	0.14	2.38	0.38	0.08	0.03	0.01	0.03	-0.08	100	<0.05	<0.2
30		DDH-00-373C(95-115)-30	45.4	15.9	1.05	15.7	13.3	7.83	12.65	0.18	2.27	0.36	0.05	0.04	0.01	0.03	-0.53	101	<0.05	<0.2
31		DDH-00-373C(75-95)-31	45.3	16.1	1.36	15.3	13.2	7.98	11.55	0.18	2.39	0.48	0.22	0.04	0.01	0.03	-0.46	101	<0.05	<0.2
32		DDH-00-357C(110-130)-32	45.4	16.9	1.66	14.7	12.4	8.69	9.83	0.17	2.54	0.56	0.23	0.04	0.02	0.03	-0.32	101	<0.05	<0.2
33		DDH-99-320C(315-330)-33	46.4	18.5	1.81	12.0	9.9	9.43	7.00	0.14	2.81	0.59	0.08	0.04	0.02	0.03	-0.05	99	<0.05	<0.2
34		DDH-00-369C(335-345)-34	47.4	20.0	0.93	11.9	10.1	9.05	7.07	0.13	3.01	0.60	0.11	0.01	0.02	0.04	0.04	101	<0.05	<0.2
35		DDH-00-368C(460-465)-35	42.7	13.2	0.96	15.8	13.3	6.34	14.60	0.19	1.39	0.30	<0.01	0.04	0.01	0.02	4.01	100	<0.05	<0.2
36		DDH-26055(940-945)-36	44.1	14.4	1.22	17.2	14.4	7.52	13.60	0.20	2.10	0.36	0.06	0.05	0.01	0.02	0.27	101	<0.05	<0.2
37		DDH-00-368C(125-145)-37D	47.8	20.9	1.22	10.8	9.0	10.40	6.58	0.13	2.87	0.44	0.15	0.03	0.01	0.04	-0.23	101	<0.05	<0.2
38		DDH-00-369C(305-325)-38D	47.2	20.5	0.67	11.1	9.4	9.72	7.50	0.12	2.86	0.40	0.01	0.03	0.01	0.03	0.33	101	<0.05	0.2
39		DDH-26098&00-337C(145&105-148.5&110)-39	43.3	11.3	1.87	19.7	15.9	6.34	15.10	0.22	1.78	0.58	0.23	0.03	0.02	0.02	-0.11	101	<0.05	0.2
40		DDH-00-334C(30-50)-40	47.2	21.7	0.50	9.1	7.4	10.10	8.14	0.11	2.74	0.29	<0.01	0.06	0.01	0.04	1.14	101	0.05	0.2
41	37 Dup	DDH-00-368C(125-145)-41	47.8	20.9	1.22	10.8	9.0	10.40	6.58	0.13	2.87	0.44	0.15	0.03	0.01	0.04	-0.23	101	<0.05	<0.2
42		DDH-00-368C(20-40)-42	47.6	22.3	1.67	8.9	7.1	11.40	4.30	0.11	3.23	0.55	0.23	0.03	0.02	0.04	-0.09	100	<0.05	<0.2
43		DDH-00-366C(35-55)-43	46.8	20.8	0.54	9.7	8.0	9.95	8.57	0.11	2.66	0.27	0.02	0.03	0.01	0.04	0.01	100	<0.05	<0.2
44		DDH-00-334C(110-130)-44	45.7	19.1	0.52	11.9	10.0	8.73	9.81	0.13	2.43	0.27	<0.01	0.05	0.01	0.03	0.42	99	<0.05	<0.2
45		DDH-00-347C(155-175)-45	47.9	19.9	1.25	11.2	9.4	10.30	7.32	0.14	2.79	0.38	<0.01	0.04	0.01	0.03	-0.43	101	<0.05	<0.2
46		DDH-00-347C(280-300)-46	47.5	20.9	1.01	10.1	8.5	10.40	6.74	0.12	2.86	0.36	0.01	0.03	0.01	0.04	-0.22	100	<0.05	<0.2
47		DDH-00-326C(60-70)-47	45.3	16.9	1.29	14.5	12.2	8.58	10.85	0.16	2.45	0.40	0.11	0.04	0.01	0.03	-0.10	101	<0.05	<0.2
48	38 Dup	DDH-00-369C(305-325)-48	47.2	20.5	0.67	11.1	9.4	9.72	7.50	0.12	2.86	0.40	0.01	0.03	0.01	0.03	0.33	101	<0.05	0.2
49		DDH-00-367C(50-65)-49	46.4	21.0	0.76	9.2	7.6	10.25	6.92	0.11	2.61	0.38	0.06	0.04	0.01	0.04	0.59	98	<0.05	<0.2
50		DDH-00-367C(260-280)-50	45.9	18.8	1.03	12.8	10.4	9.11	9.01	0.15	2.57	0.45	0.09	0.06	0.01	0.03	0.19	100	<0.05	<0.2
51		DDH-00-367C(290-310)-51	46.9	19.3	1.14	10.9	8.6	9.93	7.65	0.13	2.65	0.49	0.06	0.05	0.01	0.03	1.21	101	<0.05	0.2
52		DDH-00-370C(20-30)-52	45.1	16.9	1.55	12.7	10.3	10.25	8.25	0.15	2.41	0.61	0.43	0.04	0.02	0.03	1.78	100	0.1	0.4
53		DDH-00-369C(20-30)-53	47.2	19.5	1.32	11.7	9.6	9.68	7.24	0.13	2.70	0.40	0.04	0.04	0.01	0.03	0.13	100	<0.05	<0.2
54		DDH-00-367C(170-175)-54	47.8	17.7	1.64	12.5	11.0	7.90	7.22	0.14	2.32	0.68	0.14	0.05	0.02	0.03	0.67	99	0.05	0.2
55		DDH-00-367C(395-400)-55	38.1	11.8	3.59	22.6	17.6	3.67	12.65	0.24	1.40	0.57	0.08	0.33	0.01	0.02	5.21	101	0.07	0.2
56		DDH-26064(44-54)-56	45.6	19.0	0.26	11.6	9.4	8.54	11.70	0.12	2.25	0.26	0.01	0.04	0.01	0.03	0.93	101	0.06	0.2
57	51 Dup	DDH-00-367C(290-310)-57D	46.9	19.3	1.14	10.9	8.6	9.93	7.65	0.13	2.65	0.49	0.06	0.05	0.01	0.03	1.21	101	<0.05	0.2
58		DDH-00-364C(210-229)-58D	56.1	16.5	0.74	10.3	7.9	0.51	2.69	0.03	1.66	4.70	0.09	0.03	0.07	0.02	7.10	101	<0.05	<0.2
59		DDH-26064(264&146-269&156)-59	45.1	18.8	0.53	11.9	8.5	7.87	9.61	0.14	2.37	0.38	0.04	0.03	0.01	0.03	3.43	100	0.07	0.2
60		DDH-26056(110-125)-60	44.8	16.9	0.56	15.1	13.0	7.66	11.65	0.16	2.35	0.26	<0.01	0.02	0.01	0.03	-0.51	99	<0.05	<0.2
61		DDH-00-361C(240-245)-61D	37	7.47	1.31	20.1	12.8	3.81	20.6	0.22	0.75	0.23	0.19	0.03	0.01	0.01	8.37	100	0.1	0.4
62		DDH-00-361C(737-749)-62	57.1	16.4	0.86	10.1	8.6	2.81	4.62	0.11	1.73	2.39	0.12	0.03	0.06	0.02	4.41	101	0.09	0.3
63	58 Dup	DDH-00-364C(210-229)-63	56.1	16.5	0.74	10.3	7.9	0.51	2.69	0.03	1.66	4.70	0.09	0.03	0.07	0.02	7.10	101	<0.05	<0.2
64		DDH-00-337C(510-520)-64	54.8	16.4	0.75	13.3	11.4	0.66	2.64	0.03	2.19	3.90	0.13	0.03	0.07	0.02	5.66	101	<0.05	<0.2
65		DDH-26027(616-626)-65	44.3	14.85	1.88	19.7	16.4	5.09	9.08	0.18	2.06	0.55	0.07	0.06	0.02	0.02	2.71	100.5	0.05	0.2
66		P1-0-66	45.6	17.7	1.17	14.15	11.25	8.49	8.41	0.14	2.45	0.59	0.21	0.03	0.02	0.03	0.8	99.8	<0.05	<0.2
67		P2-0-67	45.6	17.65	1.25	14	11.05	8.59	8.22	0.14	2.5	0.58	0.1	0.03	0.02	0.03	0.93	99.6	<0.05	<0.2
68		DDH-26062&26026(993&565-998&568)-68	43.5	20.6	0.57	18.45	16.1	2.25	6.6	0.07	0.92	1.04	0.09	0.06	0.02	0.01	5.02	99.2	<0.05	<0.2
69		DDH-00-340C(725-745)-69	44	16.4	1.23	15.55	13.9	8.07	8.99	0.15	2.38	0.52	0.18	0.03	0.02	0.03	0.56	98.1	<0.05	<0.2
70		DDH-00-344C(515-520)-70	42.4	15.6	0.85	15.35	12.8	4.99	11.2	0.14	1.62	0.31	0.13	0.04	0.01	0.02	4.89	97.6	<0.05	<0.2
71		DDH-00-340C(380-390)-71	44.5	14.4	2.09	16.85	15.2	8.19	10.3	0.19	2.1	0.42	0.36	0.04	0.01	0.02	-0.63	98.8	0.06	0.2
72	61 Dup	DDH-00-361C(240-245)-72	37	7.47	1.31	20.1	12.8	3.81	20.6	0.22	0.75	0.23	0.19	0.03	0.01	0.01	8.37	100	0.1	0.4
73		P30-73	44.8	17.4	1.31	14.95	11.35	8.59	8.88	0.15	2.4	0.65	0.16	0.03	0.02	0.03	1.09	100.5	<0.05	0.2
74		26029(interval 815-825)-74	48.9	24.4	0.54	5.9	4.9	11.40	3.56	0.05	3.20	0.36	0.10	0.01	0.01	0.04	-0.10	98		
75		DDH-26030&26049(291&358-296&362)-75	44.1	16.75	0.79	14.55	10.95	7.35	10.85	0.14	1.76	0.41	0.06	0.02	0.01	0.03	3.09	99.9	0.1	0.4
76		DDH-00-367C(400-405)-76	44.7	14.75	2.9	17.35	13.75	6.26	8.01	0.18	2.27	1.15	0.46	0.04	0.03	0.03	1.83	100	0.05	0.2
77		DDH-26056(302-312)-77	46	21	0.43	10.45	7.85	9.33	7.78	0.12	2.72	0.32	0.11	0.05	0.01	0.03	1.88	100	0.06	0.2
78		26056(135-153)-78	46.1	17.8	0.61	13.3	10.8	8.08	10.90	0.15	2.36	0.35	0.01	0.03	0.01	0.03	1.07	101	0.05	0.2
80		DDH-26142(360&345-365&350)-80	45.3	19.4	0.39	11.6	9.5	8.62	9.52	0.12	2.38	0.35	0.03	0.03	0.01	0.03	1.44	99.2	0.07	0.3
93		00-331C(255-260)-93	48.9	17.6	2.24	15.6	13.55	4.25	5.4	0.11	2.33	0.91	0.1		0.03	0.03	0.19		<0.05	<0.2
94		00-344C (630-635)-94	45.2	18.4	1.73	14.9	11.8	9.49	7.78	0.16	2.65	0.47	0.11		0.02	0.03	-0.43		<0.05	<0.2
95		00-326C(495-505)-95	43	11.25	1.67	19.55	15.95	6.42	14.55	0.22	1.82	0.51	0.27		0.01	0.02	0.19		<0.05	<0.2
96		99-318C(325-330)-96	46.1	15.85	1.17	14.4	12.45	7.56	9.88	0.17	2.28	0.4	0.1		0.01	0.03	-0.28		<0.05	<0.2
97		00-330C(275-280)-97	44.4	16.35	0.64	17.15	14.6	7.56	11.65	0.16	2.23	0.31	0.11		0.01	0.03	-0.25		<0.05	<0.2
98		26056(282-292)-98	46.1	20.6	0.46	9.83	7.72	8.98	6.99	0.11	2.62	0.33	0.07		0.01	0.03	1.58		<0.05	<0.2
99		00-326C (250-265)-99	46.5	21.1	1.03	9.84	7.87	9.94	7.21	0.11	2.57	0.47	0.19		0.01	0.03	0.98		<0.05	<0.2
100		00-340C(910-925)-100	45.7	16.8	2.25	14.1	11.7	8.79	6.41	0.16	2.63	0.78	0.3		0.02	0.03	-0.39		<0.05	<0.2
101		26039(310-315)-101	39.1	8.99	0.91	20.1	12.7	4.6	19.15	0.23	1.08	0.18	0.15		<0.01	0.01	5.68		0.05	0.2
102		00-331C(190-210)-102	46.5	15.2	2.54	15.45	13	7.99	6.43	0.17	2.43	0.45	0.38		0.02	0.02	-0.04		<0.05	<0.2
103		99-320C(400-405)-103	44.2	18.75	0.81	10.05	7.33	7.65	9.35	0.12	1.89	1.37	0.17		0.02	0.04	3.9		0.13	0.5
104		00-326C(225-235)-104	42.2	12.4	1.34	18.6	14.3	6.13	14.75	0.22	1.66	0.36	0.16		0.01	0.02	2.33		<0.05	0.2
105		00-367C(495-500)-105	46.4	20.5	0.67	9.09	7.25	9.08	6.93	0.11	2.61	0.4	0.11		0.01	0.03	1.76		<0.05	<0.2
106		26058(704-715)-106	46.5	17.6	0.95	13.2	9.7	8.48	8.08	0.25	0.9	0.69	0.07		0.01	0.03	3.44		0.07	0.3

Notes:
1. Result not available if no value shown.

Appendix D.5

Chemical Analytical Results for Size Fractions

HCT ID	HCT Full ID (Drill Hole, Footage, HCT)	Waste Type	Geological Unit	Rock Type	Target S Percentile or Level	Test Date	Size Fraction Distribution																				
							Weight Retained [gr]							Weight Retained [%]							Cumulative Weight [%]					
							+ 1/4	-1/4 + 10	-10 + 35	-35 + 100	-100 + 270	-270	TOTAL	+ 1/4	-1/4 + 10	-10 + 35	-35 + 100	-100 + 270	-270	TOTAL	+ 1/4	-1/4 + 10	-10 + 35	-35 + 100	-100 + 270	-270
1-9	DDH-99-320C(830-850)-1/9D	Reactive	1	Anorthositic	P25	2005, May31-Jun03	0.0	73.1	16.8	4.7	2.8	2.5	99.9	0.0%	73.2%	16.8%	4.7%	2.8%	2.5%	100.0%	0.0%	73.2%	90.0%	94.7%	97.5%	100.0%
2	DDH-00-361C(310-320)	Reactive	1	Anorthositic	P50	2005, May31-Jun03	1.0	58.5	19.6	8.2	6.2	6.2	99.6	1.0%	58.7%	19.6%	8.3%	6.2%	6.3%	100.0%	1.0%	59.7%	79.3%	87.6%	93.7%	100.0%
3	DDH-00-361C(345-350)-3	Reactive	1	Anorthositic	P75	2005, May31-Jun03	0.0	59.9	23.2	7.9	5.3	4.3	100.6	0.0%	59.5%	23.1%	7.9%	5.3%	4.3%	100.0%	0.0%	59.5%	82.6%	90.5%	95.7%	100.0%
4	DDH-00-343C(240-250)-4	Reactive	1	Anorthositic	P95	2005, May31-Jun03	0.4	28.6	25.4	19.9	15.1	12.2	101.5	0.4%	28.2%	25.0%	19.6%	14.8%	12.0%	100.0%	0.4%	28.6%	53.6%	73.2%	88.0%	100.0%
5	DDH-26030(1047-1052)-5	Reactive	1	Sedimentary Hornfels	P10	2005, Jul19	0.0	56.0	23.7	7.2	5.4	7.4	99.7	0.0%	56.2%	23.8%	7.2%	5.4%	7.4%	100.0%	0.0%	56.2%	79.9%	87.2%	92.6%	100.0%
6	DDH-26061(1218-1233)-6	Reactive	1	Sedimentary Hornfels	P25	2005, May31-Jun03	0.7	64.6	16.8	5.7	5.6	6.4	99.8	0.7%	64.7%	16.8%	5.7%	5.6%	6.4%	100.0%	0.7%	65.4%	82.3%	88.0%	93.6%	100.0%
7	DDH-00-340C(990-995)-7	Reactive	1	Sedimentary Hornfels	P50	2005, May31-Jun03	0.9	45.4	23.7	9.5	9.8	11.1	100.4	0.9%	45.2%	23.6%	9.5%	9.8%	11.1%	100.0%	0.9%	46.1%	69.7%	79.2%	88.9%	100.0%
8	DDH-00-340C(965-974.5)-8	Reactive	1	Sedimentary Hornfels	P75	2005, May31-Jun03	0.0	48.8	22.9	9.5	9.3	9.8	100.3	0.0%	48.7%	22.8%	9.5%	9.3%	9.8%	100.0%	0.0%	48.7%	71.5%	81.0%	90.2%	100.0%
11	DDH-26043&26027(1501&740-1506&745)-1	Reactive	1	Sedimentary Hornfels	P85	2005, Nov14	Insufficient Sample																			
13	DDH-00-340C(595-615)-13	Non-reactive	1	Troctolitic	NR-0.03	2005, May31-Jun03	0.0	44.5	23.9	13.4	10.0	8.3	100.1	0.0%	44.5%	23.9%	13.4%	10.0%	8.3%	100.0%	0.0%	44.5%	68.3%	81.7%	91.7%	100.0%
14	DDH-00-334C(580-600)-14	Non-reactive	1	Troctolitic	NR-0.05	2005, May31-Jun03	0.0	39.3	25.9	15.3	11.4	9.1	101.0	0.0%	38.9%	25.6%	15.1%	11.3%	9.0%	100.0%	0.0%	38.9%	64.6%	79.7%	91.0%	100.0%
15	DDH-00-334C(640-660)	Reactive	1	Troctolitic	P25	2005, May31-Jun03	0.8	54.7	23.3	9.4	7.0	6.2	101.4	0.8%	54.0%	23.0%	9.3%	6.9%	6.1%	100.0%	0.8%	54.8%	77.8%	87.0%	93.9%	100.0%
16	DDH-00-347C(795-815)-16	Reactive	1	Troctolitic	P50	2005, May31-Jun03	0.0	63.7	17.7	7.2	6.1	5.8	100.5	0.0%	63.4%	17.6%	7.2%	6.1%	5.8%	100.0%	0.0%	63.4%	81.0%	88.2%	94.2%	100.0%
17	DDH-00-350C(580-600)-17	Reactive	1	Troctolitic	P80	2005, May31-Jun03	0.6	58.0	18.9	8.5	7.1	6.8	99.8	0.6%	58.1%	18.9%	8.5%	7.1%	6.8%	100.0%	0.6%	58.7%	77.6%	86.1%	93.2%	100.0%
18	DDH-00-327C(225-245)-18	Reactive	1	Troctolitic	P90	2005, May31-Jun03	0.3	48.5	23.5	10.6	8.3	8.1	99.2	0.3%	48.8%	23.7%	10.7%	8.3%	8.2%	100.0%	0.3%	49.1%	72.9%	83.5%	91.8%	100.0%
19	DDH-00-371C(435-440)-19	Reactive	1	Troctolitic	P95	2005, May31-Jun03	0.0	40.2	25.8	15.9	10.7	8.2	100.8	0.0%	39.9%	25.6%	15.8%	10.6%	8.1%	100.0%	0.0%	39.9%	65.5%	81.3%	91.9%	100.0%
10-20	DDH-00-340C(765-780)-20/10D	Reactive	1	Troctolitic	P100	2005, May31-Jun03	0.0	39.7	23.9	14.6	11.7	10.3	100.2	0.0%	39.6%	23.9%	14.6%	11.7%	10.3%	100.0%	0.0%	39.6%	63.5%	78.0%	89.7%	100.0%
21	DDH-00357C(335-340)-21	Reactive	1	Ultramafic	P25	2005, Jul19	0.0	52.0	23.9	10.8	7.2	5.7	99.6	0.0%	52.2%	24.0%	10.8%	7.2%	5.7%	100.0%	0.0%	52.2%	76.2%	87.0%	94.3%	100.0%
22	DDH-00326C(680-685)-22	Reactive	1	Ultramafic	P80		Insufficient Sample																			
23	DDH-00-357C(535-540)-23	Reactive	1	Ultramafic	P85	2005, Jul19	0.0	53.3	22.6	10.0	7.3	6.5	99.7	0.0%	53.5%	22.7%	10.0%	7.3%	6.5%	100.0%	0.0%	53.5%	76.1%	86.2%	93.5%	100.0%
24	DDH-99-318C(725-735)-24	Reactive	1	Ultramafic	P90	2005, May31-Jun03	0.0	46.0	22.6	12.5	11.4	8.1	100.6	0.0%	45.7%	22.5%	12.4%	11.3%	8.1%	100.0%	0.0%	45.7%	68.2%	80.6%	91.9%	100.0%
25	DDH-99-317C(460-470)-25	Reactive	1	Ultramafic	P95	2005, May31-Jun03	0.0	61.2	22.8	7.1	5.0	4.5	100.6	0.0%	60.8%	22.7%	7.1%	5.0%	4.5%	100.0%	0.0%	60.8%	83.5%	90.6%	95.5%	100.0%
26	DDH-00-366C(185-205)-26	Non-reactive	2	Anorthositic	NR-0.01	2005, May31-Jun03	0.0	64.4	17.7	6.8	5.5	5.1	99.5	0.0%	64.7%	17.8%	6.8%	5.5%	5.1%	100.0%	0.0%	64.7%	82.5%	89.3%	94.9%	100.0%
27	DDH-00-366C(230-240)-27	Non-reactive	2	Anorthositic	NR-0.03	2005, May31-Jun03	0.4	51.6	22.7	11.4	8.0	6.1	100.0	0.4%	51.6%	22.7%	11.4%	8.0%	6.1%	100.0%	0.4%	51.9%	74.6%	86.0%	93.9%	100.0%
28	DDH-99-320C(165-175)-28	Non-reactive	2	Anorthositic	NR-0.05	2005, May31-Jun03	0.0	57.8	20.0	9.4	7.2	6.2	100.6	0.0%	57.5%	19.9%	9.3%	7.2%	6.2%	100.0%	0.0%	57.5%	77.3%	86.7%	93.8%	100.0%
29	DDH-99-318C(250-370)-29	Non-reactive	2	Troctolitic	NR-0.01	2005, May31-Jun03	0.0	44.0	24.0	13.6	10.3	8.6	100.5	0.0%	43.8%	23.9%	13.5%	10.2%	8.6%	100.0%	0.0%	43.8%	67.7%	81.2%	91.4%	100.0%
30	DDH-00-373C(95-115)-30	Non-reactive	2	Troctolitic	NR-0.03	2005, May31-Jun03	0.0	34.1	27.4	15.9	12.9	10.7	101.0	0.0%	33.8%	27.1%	15.7%	12.8%	10.6%	100.0%	0.0%	33.8%	60.9%	76.6%	89.4%	100.0%
31	DDH-00-373C(75-95)-31	Non-reactive	2	Troctolitic	NR-0.05	2005, May31-Jun03	0.9	51.5	22.1	11.3	9.1	8.0	102.9	0.9%	50.0%	21.5%	11.0%	8.8%	7.7%	100.0%	0.9%	50.9%	72.4%	83.4%	92.3%	100.0%
32	DDH-00-357C(110-130)-32	Reactive	2	Troctolitic	P50	2005, May31-Jun03	0.0	39.1	23.8	15.6	11.8	10.2	100.5	0.0%	38.9%	23.7%	15.5%	11.7%	10.1%	100.0%	0.0%	38.9%	62.6%	78.1%	89.9%	100.0%
33	DDH-99-320C(315-330)-33	Reactive	2	Troctolitic	P80	2005, May31-Jun03	0.0	49.5	22.4	11.5	9.4	8.8	101.6	0.0%	48.7%	22.0%	11.3%	9.3%	8.7%	100.0%	0.0%	48.7%	70.8%	82.1%	91.3%	100.0%
34	DDH-00-369C(335-345)-34	Reactive	2	Troctolitic	P95	2005, May31-Jun03	0.4	50.6	25.8	10.4	6.9	6.2	100.2	0.4%	50.5%	25.7%	10.3%	6.8%	6.2%	100.0%	0.4%	50.9%	76.6%	86.9%	93.8%	100.0%
35	DDH-00-368C(460-465)-35	Non-reactive	2	Ultramafic	NR-0.01	2005, May31-Jun03	0.0	57.7	22.6	9.3	6.7	6.2	102.5	0.0%	56.3%	22.0%	9.1%	6.5%	6.0%	100.0%	0.0%	56.3%	78.3%	87.4%	94.0%	100.0%
36	DDH-26055(940-945)-36	Non-reactive	2	Ultramafic	NR-0.03	2005, May31-Jun03	0.3	53.5	24.3	9.7	6.6	5.1	99.5	0.3%	53.8%	24.4%	9.7%	6.6%	5.1%	100.0%	0.3%	54.1%	78.5%	88.2%	94.9%	100.0%
39	DDH-26098&00-337C(145&105-148.5&110)-	Non-reactive	2	Ultramafic	NR-0.05	2005, Nov14	0.0	43.1	26.6	12.1	10.6	7.4	99.7	0.0%	43.2%	26.7%	12.1%	10.6%	7.4%	100.0%	0.0%	43.2%	69.9%	82.0%	92.6%	100.0%
40	DDH-00-334C(30-50)-40	Non-reactive	3	Anorthositic	NR-0.01	2005, May31-Jun03	0.9	48.9	23.7	10.2	8.2	8.0	100.0	0.9%	48.9%	23.7%	10.2%	8.2%	8.0%	100.0%	0.9%	49.8%	73.6%	83.8%	92.0%	100.0%
37-41	DDH-00-368C(125-145)-41/37D	Non-reactive	3	Anorthositic	NR-0.03	2005, May31-Jun03	0.0	35.3	29.2	14.9	11.4	10.6	101.4	0.0%	34.8%	28.8%	14.7%	11.2%	10.5%	100.0%	0.0%	34.8%	63.6%	78.3%	89.5%	100.0%
42	DDH-00-368C(20-40)-42	Non-reactive	3	Anorthositic	NR-0.05	2005, May31-Jun03	0.0	34.9	25.7	15.6	12.6	11.6	100.4	0.0%	34.8%	25.6%	15.5%	12.6%	11.6%	100.0%	0.0%	34.8%	60.3%	75.9%	88.4%	100.0%
43	DDH-00-366C(35-55)-43	Non-reactive	3	Troctolitic	NR-0.01	2005, May31-Jun03	0.5	46.6	19.0	11.1	11.0	11.5	99.7	0.5%	46.7%	19.0%	11.2%	11.0%	11.5%	100.0%	0.5%	47.2%	66.3%	77.4%	88.5%	100.0%
44	DDH-00-334C(110-130)-44	Non-reactive	3	Troctolitic	NR-0.03	2005, May31-Jun03	0.0	48.1	25.5	10.5	8.1	8.1	100.3	0.0%	48.0%	25.5%	10.5%	8.1%	8.0%	100.0%	0.0%	48.0%	73.4%	83.9%	92.0%	100.0%
45	DDH-00-347C(155-175)-45	Non-reactive	3	Troctolitic	NR-0.05	2005, May31-Jun03	0.0	40.0	24.1	13.8	11.4	10.6	100.0	0.0%	40.0%	24.2%	13.8%	11.4%	10.6%	100.0%	0.0%	40.0%	64.1%	78.0%	89.4%	100.0%
46	DDH-00-347C(280-300)-46	Reactive	3	Troctolitic	P50	2005, May31-Jun03	0.0	36.6	23.4	14.3	13.1	13.2	100.6	0.0%	36.4%	23.3%	14.2%	13.0%	13.1%	100.0%	0.0%	36.4%	59.6%	73.9%	86.9%	100.0%
47	DDH-00-326C(60-70)-47	Reactive	3	Troctolitic	P85	2005, May31-Jun03	0.0	51.8	22.4	10.1	8.3	7.9	100.5	0.0%	51.6%	22.3%	10.0%	8.3%	7.8%	100.0%	0.0%	51.6%	73.8%	83.9%	92.2%	100.0%
38-48	DDH-00-369C(305-325)	Reactive	3	Troctolitic	P95	2005, May31-Jun03	0.5	38.9	23.8	13.9	11.8	12.0	100.9	0.5%	38.5%	23.6%	13.8%	11.7%	11.9%	100.0%	0.5%	39.0%	62.6%	76.4%	88.1%	100.0%
49	DDH-00-367C(50-65)-49	Non-reactive	4	Troctolitic	NR-0.01	2005, May31-Jun03	0.0	36.3	26.9	15.5	11.8	10.8	101.3	0.0%	35.8%	26.6%	15.3%	11.6%	10.7%	100.0%	0.0%	35.8%	62.4%	77.7%	89.3%	100.0%
50	DDH-00-367C(260-280)-50	Non-reactive	4	Troctolitic	NR-0.03	2005, May31-Jun03	0.0	47.3	25.5	11.9	8.2	7.3	100.0	0.0%	47.2%	25.4%	11.9%	8.2%	7.2%	100.0%	0.0%	47.2%	72.7%	84.6%	92.8%	100.0%
51-57	DDH-00-367C(290-310)	Non-reactive	4	Troctolitic	NR-0.05	2005, May31-Jun03	0.0	39.7	26.1	14.7	10.3	9.4	100.1	0.0%	39.6%	26.1%	14.6%	10.3%	9.4%	100.0%	0.0%	39.6%	65.7%	80.3%	90.6%	100.0%
52	DDH-00-370C(20-30)-52	Reactive	4	Troctolitic	P25	2005, May31-Jun03	0.0	52.3	22.8	10.6	7.9	7.7	101.3	0.0%	51.6%	22.5%	10.5%	7.8%	7.6%	100.0%	0.0%	51.6%	74.1%	84.6%	92.4%	100.0%
53	DDH-00-369C(20-30)-53	Reactive	4	Troctolitic	P75	2005, May31-Jun03	0.0	35.5	25.3	16.3	12.2	11.4	100.7	0.0%	35.3%	25.1%	16.2%	12.1%	11.3%	100.0%	0.0%	35.3%	60.4%	76.6%	88.7%	100.0%
54	DDH-00-367C(170-175)-54	Reactive	4	Troctolitic	P90	2005, May31-Jun03	0.5	33.2	27.1	16.6	11.5	10.4	99.3	0.5%	33.4%	27.3%	16.7%	11.6%	10.5%	100.0%	0.5%	33.9%	61.2%	77.9%	89.5%	100.0%
55	DDH-00-367C(395-400)-55	Reactive	4	Troctolitic	P95	2005, May31-Jun03	0.0	45.7	26.6	11.4	7.9	7.4	99.0	0.0%	46.2%	26.9%	11.5%	8.0%	7.5%	100.0%	0.0%	46.2%	73.0%	84.5%	92.5%	100.0%
56	DDH-26064(44-54)-56	Non-reactive	5	Troctolitic	NR-0.01	2005, May31-Jun03	0.0	38.4	27.7	13.8	10.5	8.9	99.3	0.0%	38.7%	27.9%	13.9%	10.6%	9.0%	100.0%	0.0%	38.7%	66.6%	80.5%	91.0%	100.0%
59	DDH-26064(264&146-269&156)-59	Non-reactive	5	Troctolitic	NR-0.05	2005, Nov14	0.0	49.0	27.6	10.5	7.4	5.2	99.7	0.0%	49.1%	27.7%	10.6%	7.4%	5.2%	100.0%	0.0%	49.1%	76.8%	87.3%	94.8%	100.0%
60	DDH-26056(110-125)-60	Non-reactive	6	Troctolitic	NR-0.01	2005, May31-Jun03	0.5	41.9	23.8	13.7	10.8	9.1	99.8	0.5%	42.0%	23.8%	13.7%	10.8%	9.1%	100.0%	0.5%	42.5%	66.3%	80.1%	90.9%	100.0%
62	DDH-00-361C(737-749)-62	Reactive	20	Virginia	P25	2005, May31-Jun03	0.0	43.1	25.9	10.6	9.5	11.1	100.2	0.0%	43.0%	25.8%	10.6%	9.5%	11.1%	100.0%	0.0%	43.0%	68.9%	79.4%	88.9%	100.0%
58-63	DDH-00-364C(210-229)	Reactive	20	Virginia	P75	2005, May31-Jun03	0.0	38.0	21.5	11.5	14.1	15.0	100.1	0.0%	38.0%	21.5%	11.5%	14.1%	15.0%	100.0%	0.0%	38.0%	59.4%	70.9%	85.0%	100.0%
64	DDH-00-337C(510-520)-64	Reactive	20	Virginia	P90	2005, May31-Jun03	0.0	30.5	24.8	9.9	16.2	18.3	99.7	0.0%	30.6%	24.9%	9.9%	16.2%	18.4%	100.0%	0.0%	30.6%	55.5%	65.4%	81.6%	100.0%
65	DDH-26027(616-626)-65	Lean Ore	1	Anorthositic	P95	2006, Jan10	0.0	43.2	28.1	12.0	9.1	7.1	99.5	0.0%	43.4%	28.2%	12.1%	9.1%	7.1%	100.0%	0.0%	43.4%	71.7%	83.7%	92.9%	100.0%
66	P1-0-66	Ore				2006, Jan10	0.0	53.3	24.3	9.4	7.4	5.3	99.7	0.0%	53.5%	24.4%	9.4%	7.4%	5.3%	100.0%	0.0%	53.5%	77.8%	87.3%	94.7%	100.0%
67	P2-0-67	Ore				2006, Jan10	0.0	70.6	20.9	3.8	2.3	1.7	99.3	0.0%	71.1%	21.0%	3.8%	2.3%	1.7%	100.0%	0.0%	71.1%	92.1%	96.0%	98.3%	100.0%
68	DDH-26062&26026(993&565-998&568)-68	Lean Ore	1	Sedimentary Hornfels	P95	2005, Nov14	0.3	46.1	23.0	9.8	7.9	6.8	93.8	0.3%	49.1%	24.5%	10.4%	8.5%	7.2%	100.0%	0.3%	49.4%	73.9%	84.3%	92.8%	100.0%
69	DDH-00-340C(725-745)-69	Lean Ore	1	Troctolitic	P95	2006, Jan10	0.0	44.7	30.0	10.5	8.1	6.5	99.8	0.0%	44.8%	30.1%	10.5%	8.1%	6.5%	100.0%	0.0%	44.8%	74.8%	85.4%	93.5%	100.0%
70	DDH-00-344C(515-520)-70	Lean Ore	1	Ultramafic	P95	2006, Jan10	0.6	57.2	25.8	6.2	4.6	4.7	99.1	0.6%	57.7%	26.0%	6.3%	4.6%	4.7%	100.0%	0.6%	58.3%	84.4%	90.6%	95.3%	100.0%
71	DDH-00-340C(380-390)-71	Lean Ore	2	Troctolitic	P95	2006, Jan10	0.0	49.1	27.5	10.1	7.2	5.7	99.6	0.0%	49.3%	27.6%	10.1%	7.2%	5.7%	100.0%	0.0%	49.3%	76.9%	87.0%	94.3%	100.0%
61-72	DDH-00-361C(240-245)-72/61D	Lean Ore	2	Ultramafic	P95		Insufficient Sample																			
73	P30-73	Ore				2006, Jan10	0.6	54.5	24.7	8.1	6.3	5.4	99.6	0.6%	54.7%	24.8%	8.1%	6.3%	5.4%	100.0%	0.6%	55.3%	80.1%	88.3%	94.6%	100.0%
74	26029(interval 815-825)-74	Non-reactive	1	Troctolitic	NR-0.01	2005, Sep07	0.0	56.1	22.9	10.1	6.5	4.3	99.9	0.0%	56.2%	22.9%	10.1%	6.5%	4.3%	100.0%	0.0%	56.2%	79.1%	89.2%	95.7%	100.0%
75	DDH-26030&26049(291&358-296&362)-75	Lean Ore	3	Troctolitic	P95	2005, Nov14	0.0	41.7	27.5	12.9	10.0	7.4	99.5	0.0%	41.9%	27.6%	12.9%	10.1%	7.4%	100.0%	0.0%	41.9%	69.5%	82.5%	92.6%	100.0%
76	DDH-00-367C(400-405)-76	Lean Ore	4	Troctolitic	P95	2006, Jan10	0.4	44.7	29.5	10.0	7.2	7.4	99.2	0.4%	45.1%	29.7%	10.1%	7.3%	7.5%	100.0%	0.4%	45.5%	75.2%	85.3%	92.5%	100.0%
77	DDH-26056(302-312)-77	Lean Ore	5	Troctolitic	P50	2006, Jan10	0.0	44.0	29.6	11.8	8.2	5.9	99.5	0.0%	44.2%	29.7%	11.9%	8.2%	5.9%	100.0%	0.0%	44.2%	74.0%	85.8%	94.1%	100.0%
78	26056(135-153)-78	Non-reactive	6	Troctolitic	NR-0.03	2005, May31-Jun03	0.0	42.3	26.6	13.7	9.9	8.0	100.5	0.0%	42.1%	26.5%	13.6%	9.9%	8.0%	100.0%	0.0%	42.1%	68.6%	82.2%	92.0%	100.0%
80	DDH-26142(360&345-365&350)-80	Lean Ore	6	Troctolitic	P95	2005, Nov14	0.0	50.5	25.7	10.7	7.5	5.2	99.7	0.0%	50.7%	25.8%	10.8%	7.6%	5.2%	100.0%	0.0%	50.7%	76.5%	87.2%	94.8%	100.0%
93	00-331C(255-260)-93	Lean Ore	1	Anorthositic	P75	2005, Oct20	0.0	27.1	28.6	11.4	15.7	17.1	99.8	0.0%	27.1%	28.6%	11.4%	15.7%	17.1%	100.0%	0.0%	27.1%	55.8%	67.2%	82.9%	100.0%
94	00-344C (630-635)-94	Lean Ore	1	Ultramafic	P75	2005, Oct20	0.0	18.8	30.0	19.1	15.5	16.4	99.8	0.0%	18.9%	30.1%	19.1%	15.6%	16.4%	100.0%	0.0%	18.9%	48.9%	68.1%	83.6%	100.0%
95	00-326C(495-505)-95	Lean Ore	1	Ultramafic	P50	2005, Oct20	0.0	45.9	31.6	7.0	6.4	8.8	99.8	0.0%	46.0%	31.7%	7.0%	6.4%	8.8%	100.0%	0.0%	46.0%	77.7%	84.7%	91.2%	100.0%
96	99-318C(325-330)-96	Lean Ore	2	Troctolitic	P85	2005, Oct20	0.0	38.9	26.8	12.0	11.1	10.7	99.6	0.0%	39.1%	27.0%	12.1%	11.1%	10.8%	100.0%	0.0%	39.1%	66.1%	78.1%	89.2%	100.0%
97	00-330C(275-280)-97	Lean Ore	1	Ultramafic	P85	2005, Oct20	0.0	25.9	27.9	16.0	15.5	14.1	99.4	0.0%	26.0%	28.1%	16.1%	15.6%	14.2%	100.0%	0.0%	26.0%	54.1%	70.3%	85.8%	100.0%
98	26056(282-292)-98	Lean Ore	5	Troctolitic	P95	2005, Oct20	0.0	21.9	33.5	16.6	13.1	14.3	99.4	0.0%	22.0%	33.7%	16.7%	13.2%	14.4%	100.0%	0.0%	22.0%	55.7%	72.4%	85.6%	100.0%
99	00-326C (250-265)-99	Lean Ore	1	Troctolitic	P25	2005, Oct20	0.0	34.4	28.5	13.3	11.0	13.0	100.2	0.0%	34.3%	28.5%	13.3%	11.0%	12.9%	100.0%	0.0%	34.3%	62.8%	76.1%	87.1%	100.0%
100	00-340C(910-925)-100	Lean Ore	1	Troctolitic	P50	2005, Oct20	0.0	28.8	28.7	13.1	13.3	15.6	99.4	0.0%	28.9%	28.8%	13.2%	13.4%	15.7%	100.0%	0.0%	28.9%	57.7%	70.9%	84.3%	100.0%
101	26039(310-315)-101	Lean Ore	2	Ultramafic	P95	2005, Oct20	0.0	26.0	33.5	14.8	11.9	12.9	99.2	0.0%	26.2%	33.8%	15.0%	12.0%	13.0%	100.0%	0.0%	26.2%	60.0%	75.0%	87.0%	100.0%
102	00-331C(190-210)-102	Lean Ore	1	Troctolitic	P85	2005, Oct20	0.0	33.2	26.3	11.9	12.0	16.3	99.7	0.0%	33.3%	26.3%	12.0%	12.0%	16.4%	100.0%	0.0%	33.3%	59.7%	71.6%	83.6%	100.0%
103	99-320C(400-405)-103	Lean Ore	1	Anorthositic	P50	2005, Oct20	0.0	29.1	33.3	13.7	11.1	12.1	99.3	0.0%	29.3%	33.5%	13.8%	11.1%	12.2%	100.0%	0.0%	29.3%	62.8%	76.7%	87.8%	100.0%
104	00-326C(225-235)-104	Lean Ore	2	Ultramafic	P80	2005, Oct20	0.0	41.0	29.6	10.3	8.6	10.4	99.9	0.0%	41.1%	29.7%	10.3%	8.6%	10.4%	100.0%	0.0%	41.1%	70.8%	81.1%	89.6%	100.0%
105	00-367C(495-500)-105	Lean Ore	3	Troctolitic	P75	2005, Oct20	0.0	27.6	30.4	14.9	12.9	14.0	99.7	0.0%	27.7%	30.4%	15.0%	12.9%	14.0%	100.0%	0.0%	27.7%	58.1%	73.1%	86.0%	100.0%
106	26058(704-715)-106	Lean Ore	1	Sedimentary Hornfels	P50	2005, Oct20	0.0	22.9	32.4	13.6	12.9	18.0	99.8	0.0%	23.0%	32.5%	13.7%	12.9%	18.0%	100.0%	0.0%	23.0%	55.5%	69.1%	82.0%	100.0%

HCT ID	HCT Full ID (Drill Hole, Footage, HCT)	Metals by 4-acid Digestion																															
		Cu [%]					Ni [%]					S [%]					S [%]				Co (ppm)					Ag (ppm)				Zn (ppm)			
		All	+ 10	-10 + 35	-35 + 100	-100 + 270	All	+ 10	-10 + 35	-35 + 100	-100 + 270	All	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	All	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270
1-9	DDH-99-320C(830-850)-1/9D	0.0365	0.034	0.036	0.033	0.039	0.0174	0.017	0.016	0.019	0.020	0.09	0.11	0.13	0.10	0.14	0.11	0.12	0.10	0.13	48	49	42	48	54	<0.5	<0.5	<0.5	<0.5	115	109	112	136
2	DDH-00-361C(310-320)	0.0152	0.016	0.014	0.016	0.016	0.0208	0.021	0.020	0.021	0.024	0.18	0.19	0.16	0.18	0.24	0.15	0.15	0.16	0.22	42	44	44	46	54	<0.5	<0.5	<0.5	<0.5	72	73	79	96
3	DDH-00-361C(345-350)-3	0.0236	0.020	0.024	0.024	0.028	0.0276	0.028	0.027	0.027	0.032	0.05	0.06	0.06	0.08	0.09	0.05	0.06	0.05	0.08	63	65	62	63	75	<0.5	<0.5	<0.5	<0.5	90	89	89	111
4	DDH-00-343C(240-250)-4	0.0759	0.070	0.053	0.064	0.084	0.0199	0.018	0.016	0.018	0.022	0.68	0.74	0.71	0.65	0.81	0.70	0.64	0.62	0.71	48	53	49	50	58	<0.5	<0.5	<0.5	<0.5	196	179	176	194
5	DDH-26030(1047-1052)-5	0.0098	0.008	0.008	0.011	0.010	0.0104	0.010	0.010	0.010	0.009	0.24	0.21	0.21	0.21	0.21	0.22	0.20	0.21	0.21	25	26	24	25	26	<0.5	<0.5	0.5	<0.5	178	161	165	174
6	DDH-26061(1218-1233)-6	0.0146	0.014	0.014	0.014	0.013	0.0122	0.012	0.011	0.011	0.010	0.44	0.44	0.42	0.43	0.35	0.41	0.39	0.38	0.35	24	24	23	23	22	<0.5	0.5	<0.5	<0.5	208	202	221	222
7	DDH-00-340C(990-995)-7	0.0142	0.013	0.012	0.012	0.009	0.0144	0.015	0.012	0.012	0.011	0.55	0.55	0.50	0.44	0.32	0.53	0.46	0.40	0.33	34	37	30	30	31	<0.5	<0.5	0.6	<0.5	413	366	390	418
8	DDH-00-340C(965-974.5)-8	0.0198	0.020	0.019	0.015	0.015	0.012	0.013	0.012	0.009	0.010	1.74	1.90	1.83	1.26	1.48	1.66	1.52	1.12	1.38	21	23	21	18	17	<0.5	0.5	<0.5	<0.5	388	352	320	341
11	DDH-26043&26027(1501&740-1506&745)-1	0.04					0.02					2.47									48.00												
13	DDH-00-340C(595-615)-13	0.0141	0.012	0.012	0.010	0.012	0.0365	0.035	0.032	0.039	0.040	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04	65	62	59	74	75	<0.5	<0.5	<0.5	<0.5	84	83	100	106
14	DDH-00-334C(580-600)-14	0.0278	0.026	0.024	0.019	0.021	0.0319	0.030	0.028	0.029	0.031	0.06	0.05	0.04	0.04	0.03	0.05	0.04	0.04	0.04	63	62	59	62	66	<0.5	<0.5	<0.5	<0.5	106	99	102	112
15	DDH-00-334C(640-660)	0.0311	0.032	0.028	0.026	0.025	0.0497	0.051	0.051	0.046	0.054	0.07	0.10	0.07	0.06	0.07	0.09	0.07	0.07	0.08	77	84	82	77	92	<0.5	<0.5	<0.5	<0.5	138	136	132	146
16	DDH-00-347C(795-815)-16	0.0446	0.027	0.037	0.055	0.061	0.0389	0.038	0.038	0.037	0.039	0.07	0.05	0.06	0.08	0.09	0.05	0.06	0.08	0.09	79	84	81	78	82	<0.5	<0.5	<0.5	<0.5	126	122	118	130
17	DDH-00-350C(580-600)-17	0.0423	0.040	0.040	0.036	0.035	0.0298	0.030	0.030	0.028	0.031	0.19	0.15	0.16	0.17	0.20	0.14	0.16	0.16	0.20	59	65	64	63	67	<0.5	<0.5	<0.5	<0.5	153	148	149	155
18	DDH-00-327C(225-245)-18	0.0324	0.031	0.032	0.036	0.035	0.0156	0.015	0.015	0.017	0.019	0.44	0.43	0.40	0.38	0.50	0.40	0.37	0.37	0.50	51	57	55	58	69	<0.5	<0.5	<0.5	<0.5	136	135	140	158
19	DDH-00-371C(435-440)-19	0.0563	0.041	0.057	0.071	0.090	0.0267	0.020	0.027	0.032	0.039	0.88	0.56	0.85	1.13	1.50	0.54	0.78	1.00	1.31	61	65	65	71	83	<0.5	<0.5	<0.5	<0.5	208	186	172	180
10-20	DDH-00-340C(765-780)-20/10D	0.0707	0.052	0.066	0.086	0.096	0.0304	0.024	0.030	0.036	0.039	1.68	1.24	1.62	2.33	2.33	1.22	1.60	2.12	2.14	96	89	95	108	122	<0.5	<0.5	<0.5	<0.5	113	117	116	130
21	DDH-00357C(335-340)-21	0.0269	0.027	0.023	0.022	0.026	0.0255	0.026	0.023	0.022	0.025	0.08	0.08	0.07	0.07	0.08	0.08	0.06	0.07	0.09	57	58	51	50	55	<0.5	<0.5	<0.5	<0.5	130	118	109	114
22	DDH-00326C(680-685)-22	0.105					0.023					0.30									47												
23	DDH-00-357C(535-540)-23	0.1015	0.078	0.091	0.096	0.118	0.0257	0.028	0.022	0.032	0.037	0.2	0.17	0.17	0.23	0.28	0.17	0.17	0.22	0.28	56	54	51	53	57	<0.5	<0.5	<0.5	<0.5	144	144	132	145
24	DDH-99-318C(725-735)-24	0.0534	0.052	0.041	0.046	0.054	0.0196	0.018	0.017	0.018	0.021	0.72	0.72	0.50	0.76	0.86	0.68	0.53	0.72	0.81	52	56	53	52	56	<0.5	<0.5	<0.5	<0.5	189	188	172	174
25	DDH-99-317C(460-470)-25	0.0668	0.072	0.062	0.063	0.072	0.0224	0.026	0.022	0.024	0.027	1.24	1.40	1.21	0.92	0.89	1.26	1.12	0.78	0.78	49	58	50	45	52	<0.5	<0.5	<0.5	<0.5	287	278	233	224
26	DDH-00-366C(185-205)-26	0.0082	0.008	0.008	0.008	0.007	0.0208	0.017	0.017	0.020	0.023	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.02	0.02	41	35	32	42	42	<0.5	<0.5	<0.5	<0.5	51	49	64	67
27	DDH-00-366C(230-240)-27	0.0125	0.012	0.011	0.010	0.010	0.0171	0.016	0.014	0.016	0.019	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.02	39	36	33	39	44	<0.5	<0.5	<0.5	<0.5	61	56	62	79
28	DDH-99-320C(165-175)-28	0.014	0.014	0.013	0.011	0.013	0.025	0.024	0.023	0.021	0.025	0.03	0.04	0.03	0.03	0.04	0.03	0.03	0.02	0.02	51	51	47	45	53	<0.5	<0.5	<0.5	<0.5	83	80	74	87
29	DDH-99-318C(250-370)-29	0.0139	0.012	0.011	0.011	0.012	0.0311	0.027	0.027	0.029	0.031	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.03	56	52	49	54	60	<0.5	<0.5	<0.5	<0.5	82	81	88	91
30	DDH-00-373C(95-115)-30	0.0226	0.023	0.021	0.018	0.018	0.0477	0.042	0.040	0.047	0.051	0.04	0.04	0.03	0.03	0.04	0.03	0.03	0.03	0.03	83	73	72	87	93	<0.5	<0.5	<0.5	<0.5	103	102	118	129
31	DDH-00-373C(75-95)-31	0.0286	0.029	0.024	0.022	0.023	0.0432	0.041	0.038	0.043	0.047	0.06	0.07	0.04	0.04	0.04	0.05	0.04	0.04	0.04	75	71	70	81	85	<0.5	<0.5	<0.5	<0.5	109	103	118	125
32	DDH-00-357C(110-130)-32	0.0427	0.038	0.038	0.033	0.037	0.0356	0.033	0.031	0.032	0.037	0.08	0.07	0.06	0.06	0.07	0.07	0.06	0.06	0.07	67	66	56	64	71	<0.5	<0.5	<0.5	<0.5	108	99	109	125
33	DDH-99-320C(315-330)-33	0.0355	0.032	0.032	0.025	0.027	0.0213	0.021	0.019	0.019	0.020	0.07	0.05	0.04	0.05	0.05	0.05	0.05	0.04	0.05	48	51	45	46	47	<0.5	<0.5	<0.5	<0.5	107	95	93	98
34	DDH-00-369C(335-345)-34	0.0433	0.035	0.036	0.041	0.048	0.0207	0.016	0.018	0.021	0.025	0.18	0.11	0.16	0.17	0.23	0.10	0.14	0.18	0.22	49	46	45	50	56	<0.5	<0.5	<0.5	<0.5	89	87	102	109
35	DDH-00-368C(460-465)-35	0.0413	0.044	0.041	0.037	0.034	0.0535	0.054	0.052	0.051	0.055	0.06	0.05	0.05	0.04	0.04	0.06	0.05	0.05	0.05	81	78	77	75	81	<0.5	<0.5	<0.5	<0.5	115	114	114	121
36	DDH-26055(940-945)-36	0.0321	0.032	0.032	0.026	0.025	0.0495	0.048	0.047	0.049	0.053	0.06	0.05	0.05	0.03	0.04	0.05	0.05	0.04	0.04	88	84	79	86	91	<0.5	<0.5	<0.5	<0.5	116	117	120	132
39	DDH-26098&00-337C(145&105-148.5&110)-	0.023	0.024	0.023	0.023	0.024	0.055	0.057	0.055	0.058	0.061	0.1	0.050	0.050	0.060	0.060	0.050	0.050	0.050	0.060	89	93	90	96	100	<0.5	<0.5	<0.5	<0.5	142	137	146	160
40	DDH-00-334C(30-50)-40	0.0085	0.009	0.007	0.008	0.007	0.0262	0.027	0.027	0.027	0.030	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02	50	49	50	52	56	<0.5	<0.5	<0.5	<0.5	70	70	73	82
37-41	DDH-00-368C(125-145)-41/37D	0.0182	0.018	0.017	0.015	0.014	0.0201	0.022	0.020	0.017	0.019	0.04	0.04	0.04	0.02	0.03	0.04	0.04	0.03	0.04	49	51	45	41	46	<0.5	<0.5	<0.5	<0.5	98	88	78	94
42	DDH-00-368C(20-40)-42	0.022	0.022	0.022	0.018	0.018	0.0108	0.011	0.011	0.009	0.010	0.04	0.04	0.04	0.02	0.03	0.04	0.05	0.03	0.04	32	32	31	28	29	<0.5	<0.5	<0.5	<0.5	77	75	65	71
43	DDH-00-366C(35-55)-43	0.0054	0.006	0.006	0.005	0.004	0.0238	0.023	0.023	0.026	0.027	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	54	51	53	62	60	<0.5	<0.5	<0.5	<0.5	67	70	78	78
44	DDH-00-334C(110-130)-44	0.0135	0.010	0.013	0.014	0.014	0.0363	0.034	0.034	0.035	0.040	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	63	61	58	60	68	<0.5	<0.5	<0.5	<0.5	84	81	85	98
45	DDH-00-347C(155-175)-45	0.0162	0.015	0.016	0.014	0.012	0.018	0.018	0.017	0.018	0.017	0.06	0.03	0.03	0.02	0.02	0.03	0.03	0.03	0.03	53	49	47	48	48	<0.5	<0.5	<0.5	<0.5	90	86	87	93
46	DDH-00-347C(280-300)-46	0.0355	0.032	0.032	0.028	0.026	0.0211	0.022	0.020	0.019	0.021	0.06	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.04	47	50	44	43	45	<0.5	<0.5	<0.5	<0.5	83	74	74	81
47	DDH-00-326C(60-70)-47	0.043	0.040	0.040	0.038	0.041	0.0413	0.041	0.046	0.043	0.047	0.14	0.17	0.12	0.15	0.15	0.11	0.12	0.14	0.14	74	69	71	70	73	<0.5	<0.5	<0.5	<0.5	104	104	104	113
38-48	DDH-00-369C(305-325)	0.0349	0.038	0.031	0.032	0.033	0.0299	0.031	0.027	0.027	0.034	0.25	0.25	0.23	0.25	0.30	0.23	0.21	0.23	0.27	62	57	54	57	64	<0.5	<0.5	<0.5	<0.5	71	69	75	81
49	DDH-00-367C(50-65)-49	0.0108	0.012	0.011	0.010	0.010	0.0192	0.019	0.018	0.021	0.022	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	48	41	41	46	52	<0.5	<0.5	<0.5	<0.5	73	69	76	84
50	DDH-00-367C(260-280)-50	0.018	0.019	0.016	0.013	0.018	0.0254	0.026	0.025	0.027	0.031	0.04	0.04	0.03	0.03	0.04	0.04	0.03	0.03	0.04	58	56	52	61	65	<0.5	<0.5	<0.5	<0.5	94	86	97	106
51-57	DDH-00-367C(290-310)	0.0198	0.019	0.019	0.017	0.019	0.0249	0.024	0.023	0.028	0.031	0.04	0.04	0.04	0.04	0.08	0.04	0.04	0.03	0.04	51	46	43	55	56	<0.5	<0.5	<0.5	<0.5	84	78	96	104
52	DDH-00-370C(20-30)-52	0.0177	0.016	0.017	0.016	0.018	0.0137	0.013	0.013	0.014	0.016	0.08	0.11	0.08	0.14	0.16	0.09	0.07	0.08	0.10	52	45	49	50	55	<0.5	<0.5	<0.5	<0.5	92	94	99	109
53	DDH-00-369C(20-30)-53	0.0577	0.044	0.050	0.067	0.086	0.0303	0.023	0.025	0.033	0.042	0.21	0.12	0.17	0.24	0.28	0.11	0.16	0.22	0.25	55	47	48	58	60	<0.5	<0.5	<0.5	<0.5	89	84	97	98
54	DDH-00-367C(170-175)-54	0.0331	0.040	0.032	0.030	0.042	0.0267	0.027	0.025	0.027	0.030	0.51	0.41	0.46	0.54	0.60	0.37	0.44	0.50	0.55	62	58	57	62	64	<0.5	<0.5	<0.5	<0.5	111	110	113	113
55	DDH-00-367C(395-400)-55	0.112	0.109	0.109	0.112	0.130	0.0363	0.036	0.035	0.037	0.039	0.77	0.75	0.80	0.91	1.02	0.65	0.70	0.73	0.83	110	100	99	99	103	0.5	<0.5	0.6	<0.5	216	211	216	237
56	DDH-26064(44-54)-56	0.0104	0.012	0.013	0.010	0.010	0.0426	0.036	0.038	0.043	0.051	0.02	0.07	0.03	0.08	0.06	0.02	0.02	0.01	0.02	72	57	61	68	81	<0.5	<0.5	<0.5	<0.5	63	62	71	84
59	DDH-26064(264&146-269&156)-59	0.027	0.022	0.021	0.022	0.032	0.029	0.026	0.030	0.037	0.041	0.06	0.040	0.050	0.070	0.080	0.040	0.050	0.060	0.090	58	55	63	77	85	<0.5	<0.5	<0.5	<0.5	71	84	103	142
60	DDH-26056(110-125)-60	0.0293	0.028	0.028	0.024	0.025	0.0401	0.037	0.038	0.043	0.047	0.04	0.03	0.03	0.11	0.02	0.02	0.03	0.02	0.02	79	65	66	76	85	<0.5	<0.5	<0.5	<0.5	88	91	100	114
62	DDH-00-361C(737-749)-62	0.0152	0.015	0.015	0.013	0.012	0.0121	0.012	0.012	0.010	0.011	2.00	1.76	1.92	1.47	1.91	1.66	1.79	1.35	1.71	25	23	21	18	21	<0.5	0.5	<0.5	<0.5	275	306	287	290
58-63	DDH-00-364C(210-229)	0.0155	0.016	0.016	0.014	0.011	0.0186	0.018	0.019	0.017	0.017	3.79	3.64	3.87	3.39	3.55	3.54	3.91	3.49	3.29	26	23	24	22	23	0.8	2.0	0.8	1.0	772	816	781	769
64	DDH-00-337C(510-520)-64	0.0198	0.021	0.020	0.016	0.012	0.0168	0.018	0.017	0.014	0.014	5.68	5.14	5.16	3.86	5.19	4.38	4.35	3.66	4.12	32	30	32	25	28	1.1	0.9	1.4	1.0	514	489	414	397
65	DDH-26027(616-626)-65	0.126	0.101	0.101	0.116	0.151	0.0528	0.051	0.050	0.057	0.070	1.83	1.91	1.80	2.44	3.18	1.57	1.42	2.18	2.62	93	97	94	103	124	<0.5	0.5	<0.5	<0.5	208	194	218	238
66	P1-0-66	0.345	0.244	0.345	0.319	0.354	0.0971	0.104	0.088	0.110	0.120	0.86	0.56	0.79	0.90	0.96	0.52	0.73	0.91	0.95	86	81	85	95	109	1	1.6	1	2	106	106	110	128
67	P2-0-67	0.349	0.213	0.322	0.390	0.456	0.1485	0.079	0.089	0.132	0.147	0.9	0.47	0.80	1.03	1.13	0.41	0.72	1.09	1.15	98	81	83	102	113	1	1.1	2	1	105	107	108	131
68	DDH-26062&26026(993&565-998&568)-68	0.129	0.118	0.128	0.102	0.138	0.047	0.044	0.047	0.043	0.055	4.46	4.130	4.450	3.970	5.560	3.400	3.800	2.880	4.160	74	73	76	67	87	<0.5	0.7	0.6	0.6	354	357	360	378
69	DDH-00-340C(725-745)-69	0.1005	0.088	0.118	0.114	0.130	0.0407	0.035	0.047	0.046	0.057	0.91	0.77	1.09	1.19	1.25	0.67	0.88	1.07	1.10	104	104	120	123	142	1	0.6	1	1	104	110	119	133
70	DDH-00-344C(515-520)-70	0.0899	0.079	0.094	0.095	0.095	0.0529	0.053	0.052	0.050	0.057	1.2	0.97	1.04	1.14	1.21	0.90	0.94	1.18	1.14	82	86	90	89	97	1	0.8	1	1	142	160	212	204
71	DDH-00-340C(380-390)-71	0.0502	0.071	0.072	0.089	0.092	0.0342	0.038	0.036	0.041	0.042	0.15	0.21	0.21	0.24	0.25	0.20	0.18	0.23	0.26	72	83	76	81	83	1	<0.5	1	1	158	143	155	161
61-72	DDH-00-361C(240-245)-72/61D	0.0196					0.1075					0.06									124												
73	P30-73	0.444	0.335	0.349	0.390	0.439	0.0972	0.089	0.091	0.138	0.139	0.86	0.67	0.88	1.00	1.13	0.61	0.78	1.03	1.13	82	81	75	101	106	1	1.6	2	2	106	108	114	125
74	26029(interval 815-825)-74	0.0055	0.006	0.005	0.005	0.007	0.0114	0.014	0.013	0.013	0.015	0.02	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	27	32	28	29	33	<0.5	<0.5	<0.5	<0.5	56	50	53	65
75	DDH-26030&26049(291&358-296&362)-75	0.174	0.146	0.177	0.195	0.224	0.071	0.062	0.063	0.079	0.102	0.59	0.450	0.530	0.640	0.790	0.420	0.490	0.470	0.640	87	80	87	104	126	0.6	0.7	0.8	0.8	89	106	118	158
76	DDH-00-367C(400-405)-76	0.1	0.081	0.096	0.105	0.161	0.0299	0.027	0.025	0.033	0.048	1.37	1.25	1.17	1.69	2.67	1.04	0.92	1.61	2.40	88	89	87	100	131	<0.5	<0.5	<0.5	<0.5	184	196	192	238
77	DDH-26056(302-312)-77	0.0866	0.120	0.103	0.112	0.115	0.0365	0.034	0.037	0.055	0.061	0.23	0.29	0.36	0.46	0.41	0.29	0.42	0.37	0.46	56	56	57	80	87	1	<0.5	<0.5	<0.5	67	66	87	106
78	26056(135-153)-78	0.0389	0.038	0.042	0.039	0.035	0.0439	0.038	0.039	0.049	0.054	0.05	0.04	0.07	0.07	0.10	0.03	0.04	0.04	0.04	73	61	60	79	87	<0.5	<0.5	<0.5	<0.5	90	90	112	120
80	DDH-26142(360&345-365&350)-80	0.115	0.110	0.104	0.098	0.130	0.048	0.043	0.042	0.052	0.066	0.18	0.130	0.140	0.150	0.200	0.130	0.150	0.140	0.200	61	58	60	77	89	<0.5	<0.5	<0.5	0.6	83	118	102	124
93	00-331C(255-260)-93	0.153	0.102	0.125	0.118	0.099	0.043	0.034	0.035	0.033	0.033	0.86	0.67	0.74	0.65	0.61	0.54	0.58	0.63	0.49	54	51	50	43	47	0.6	0.8	0.5	0.5	234	225	197	237
94	00-344C (630-635)-94	0.155	0.143	0.108	0.126	0.157	0.055	0.037	0.045	0.050	0.060	0.34	0.25	0.23	0.29	0.38	0.21	0.21	0.26	0.35	65	61	58	60	66	0.8	0.6	0.7	0.7	127	115	112	115
95	00-326C(495-505)-95	0.077	0.068	0.071	0.065	0.060	0.065	0.062	0.067	0.066	0.069	0.16	0.13	0.14	0.14	0.14	0.12	0.12	0.13	0.13	96	96	94	98	99	<0.5	<0.5	0.6	0.7	140	140	156	147
96	99-318C(325-330)-96	0.117	0.142	0.115	0.111	0.139	0.054	0.060	0.051	0.059	0.067	0.17	0.18	0.15	0.16	0.19	0.17	0.14	0.14	0.19	73	69	68	69	80	0.6	0.5	0.6	0.5	120	119	114	130
97	00-330C(275-280)-97	0.148	0.136	0.153	0.137	0.140	0.069	0.062	0.059	0.061	0.074	0.75	0.70	0.78	0.77	0.83	0.59	0.63	0.70	0.70	115	112	108	116	127	0.8	0.7	0.7	0.8	107	103	116	123
98	26056(282-292)-98	0.141	0.139	0.144	0.127	0.159	0.047	0.040	0.042	0.047	0.064	0.32	0.25	0.30	0.36	0.44	0.23	0.28	0.31	0.43	61	56	56	60	81	0.7	0.9	0.6	0.6	64	63	64	89
99	00-326C (250-265)-99	0.052	0.064	0.080	0.077	0.086	0.034	0.037	0.047	0.042	0.047	0.08	0.07	0.11	0.11	0.11	0.08	0.11	0.11	0.12	50	49	51	48	56	0.5	0.5	0.5	0.7	72	68	71	77
100	00-340C(910-925)-100	0.174	0.141	0.138	0.143	0.159	0.041	0.030	0.037	0.043	0.045	0.36	0.26	0.26	0.30	0.39	0.24	0.24	0.29	0.33	60	57	57	55	57	<0.5	<0.5	0.5	<0.5	124	122	113	116
101	26039(310-315)-101	0.039	0.053	0.041	0.040	0.040	0.095	0.099	0.090	0.096	0.103	0.06	0.07	0.07	0.08	0.08	0.08	0.06	0.07	0.08	110	110	105	111	120	<0.5	<0.5	<0.5	<0.5	131	128	139	148
102	00-331C(190-210)-102	0.175	0.095	0.122	0.138	0.170	0.046	0.031	0.036	0.039	0.051	0.42	0.21	0.31	0.36	0.51	0.20	0.28	0.36	0.43	67	56	59	53	61	<0.5	<0.5	<0.5	<0.5	138	138	129	135
103	99-320C(400-405)-103	0.1	0.091	0.127	0.228	0.266	0.068	0.048	0.074	0.098	0.143	0.18	0.13	0.20	0.28	0.38	0.12	0.21	0.27	0.37	61	49	62	72	91	<0.5	<0.5	0.5	0.5	60	77	209	201
104	00-326C(225-235)-104	0.094	0.082	0.091	0.084	0.087	0.071	0.065	0.069	0.076	0.077	0.12	0.12	0.12	0.11	0.12	0.11	0.12	0.12	0.12	91	84	88	88	90	<0.5	<0.5	<0.5	<0.5	118	122	106	112
105	00-367C(495-500)-105	0.193	0.143	0.163	0.140	0.137	0.051	0.041	0.048	0.050	0.051	0.28	0.16	0.24	0.23	0.25	0.18	0.25	0.22	0.22	50	51	46	47	52	<0.5	<0.5	0.7	0.9	71	64	61	69
106	26058(704-715)-106	0.083	0.091	0.096	0.079	0.081	0.03	0.030	0.037	0.031	0.038	1.46	1.52	1.53	1.33	1.50	1.13	1.19	1.11	1.18	37	39	43	37	39	<0.5	<0.5	<0.5	<0.5	489	442	471	510

Metals by 4-acid Digestion

HCT ID	HCT Full ID (Drill Hole, Footage, HCT)	Cd (ppm)				Mo (ppm)				Pb (ppm)				As (ppm)			
		+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270
1-9	DDH-99-320C(830-850)-1/9D	<0.5	<0.5	<0.5	<0.5	<1	1	1	1	10	12	135	82	<5	<5	<5	6
2	DDH-00-361C(310-320)	<0.5	<0.5	<0.5	<0.5	1	1	<1	<1	<2	20	58	22	<5	<5	<5	<5
3	DDH-00-361C(345-350)-3	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	1	4	7	42	15	<5	<5	<5	<5
4	DDH-00-343C(240-250)-4	<0.5	<0.5	<0.5	<0.5	5	3	4	8	30	19	30	17	7	<5	7	<5
5	DDH-26030(1047-1052)-5	1.1	0.6	0.7	1.0	2	2	1	1	12	9	14	13	19	13	22	14
6	DDH-26061(1218-1233)-6	<0.5	<0.5	<0.5	<0.5	10	9	8	10	42	37	52	54	26	31	27	22
7	DDH-00-340C(990-995)-7	0.7	0.9	0.6	0.5	9	8	7	6	15	19	35	24	9	10	8	<5
8	DDH-00-340C(965-974.5)-8	1.7	1.4	1.2	1.4	14	12	9	11	28	35	50	36	22	24	30	24
11	DDH-26043&26027(1501&740-1506&745)-1																
13	DDH-00-340C(595-615)-13	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	3	2	13	5	<5	<5	<5	<5
14	DDH-00-334C(580-600)-14	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	1	<2	5	13	8	<5	<5	<5	<5
15	DDH-00-334C(640-660)	<0.5	<0.5	<0.5	<0.5	1	<1	<1	<1	<2	8	13	10	<5	<5	<5	<5
16	DDH-00-347C(795-815)-16	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	1	4	4	10	8	<5	5	<5	<5
17	DDH-00-350C(580-600)-17	<0.5	<0.5	<0.5	<0.5	1	<1	<1	<1	8	12	14	11	7	<5	<5	5
18	DDH-00-327C(225-245)-18	<0.5	<0.5	<0.5	<0.5	3	2	2	2	7	6	14	9	12	8	8	9
19	DDH-00-371C(435-440)-19	<0.5	<0.5	<0.5	<0.5	4	4	5	8	5	14	13	15	11	8	21	17
10-20	DDH-00-340C(765-780)-20/10D	<0.5	<0.5	<0.5	<0.5	4	6	6	10	13	15	18	11	15	15	23	22
21	DDH-00357C(335-340)-21	<0.5	<0.5	<0.5	<0.5	1	1	<1	1	7	8	6	11	<5	<5	<5	<5
22	DDH-00326C(680-685)-22																
23	DDH-00-357C(535-540)-23	<0.5	<0.5	<0.5	<0.5	<1	1	1	1	8	10	11	15	6	<5	<5	<5
24	DDH-99-318C(725-735)-24	<0.5	<0.5	<0.5	<0.5	3	3	2	3	15	12	21	12	9	<5	<5	10
25	DDH-99-317C(460-470)-25	<0.5	<0.5	<0.5	<0.5	7	7	3	3	9	11	19	10	18	12	13	24
26	DDH-00-366C(185-205)-26	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	2	2	9	13	<5	14	<5	<5
27	DDH-00-366C(230-240)-27	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	8	2	10	<5	<5	<5	<5
28	DDH-99-320C(165-175)-28	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	4	8	3	8	<5	<5	8	<5
29	DDH-99-318C(250-370)-29	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	4	7	5	12	<5	<5	<5	8
30	DDH-00-373C(95-115)-30	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	1	6	3	3	3	<5	<5	<5	<5
31	DDH-00-373C(75-95)-31	<0.5	<0.5	<0.5	<0.5	<1	1	<1	<1	2	7	4	7	<5	13	<5	<5
32	DDH-00-357C(110-130)-32	<0.5	<0.5	<0.5	<0.5	<1	1	1	<1	3	10	2	8	11	8	<5	<5
33	DDH-99-320C(315-330)-33	<0.5	<0.5	<0.5	<0.5	<1	<1	1	<1	6	8	6	5	<5	<5	<5	<5
34	DDH-00-369C(335-345)-34	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	11	6	7	8	15	8	<5
35	DDH-00-368C(460-465)-35	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	3	<2	<2	10	<5	<5	<5
36	DDH-26055(940-945)-36	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	3	<2	3	5	<5	5	<5
39	DDH-26098&00-337C(145&105-148.5&110)-	<0.5	<0.5	<0.5	<0.5	<1	<1	1	1	5	7	8	14	8	6	11	5
40	DDH-00-334C(30-50)-40	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	4	3	<5	<5	<5	<5
37-41	DDH-00-368C(125-145)-41/37D	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	<2	7	<5	<5	<5	<5
42	DDH-00-368C(20-40)-42	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	2	2	<2	2	5	<5	<5	<5
43	DDH-00-366C(35-55)-43	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	<2	<2	<5	<5	<5	<5
44	DDH-00-334C(110-130)-44	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	5	<2	10	<5	<5	<5
45	DDH-00-347C(155-175)-45	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	<2	3	10	<5	<5	<5
46	DDH-00-347C(280-300)-46	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	<2	<2	5	<5	6	<5
47	DDH-00-326C(60-70)-47	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	3	2	3	<5	<5	<5	<5
38-48	DDH-00-369C(305-325)	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	4	5	4	8	<5	8	7
49	DDH-00-367C(50-65)-49	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	4	<2	<2	<2	<5	<5	<5	8
50	DDH-00-367C(260-280)-50	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	2	<2	2	<5	<5	<5	<5
51-57	DDH-00-367C(290-310)	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	3	2	<2	6	<5	9	6
52	DDH-00-370C(20-30)-52	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	<2	2	<5	10	<5	12
53	DDH-00-369C(20-30)-53	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	4	<2	11	<5	<5	<5
54	DDH-00-367C(170-175)-54	<0.5	<0.5	<0.5	<0.5	1	<1	<1	2	<2	6	<2	7	<5	<5	<5	6
55	DDH-00-367C(395-400)-55	<0.5	<0.5	<0.5	<0.5	1	1	<1	2	6	3	6	<2	<5	10	8	<5
56	DDH-26064(44-54)-56	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	<2	<2	8	2	<5	<5	<5	<5
59	DDH-26064(264&146-269&156)-59	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	4	4	7	19	<5	<5	<5	<5
60	DDH-26056(110-125)-60	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	4	3	6	6	<5	<5	<5	17
62	DDH-00-361C(737-749)-62	<0.5	1	<0.5	0.6	12	11	7	11	21	22	21	22	45	35	34	40
58-63	DDH-00-364C(210-229)	5.4	5.0	5.0	4.7	25	24	21	23	51	45	41	48	38	30	60	46
64	DDH-00-337C(510-520)-64	2.0	2.0	1.5	1.2	29	24	19	21	43	50	40	54	56	49	63	37
65	DDH-26027(616-626)-65	<0.5	<0.5	<0.5	<0.5	13	14	14	22	7	11	10	7	9	10	19	12
66	P1-0-66	<0.5	<0.5	<0.5	<0.5	3	2	4	7	9	9	17	21	15	6	9	34
67	P2-0-67	<0.5	<0.5	<0.5	<0.5	2	3	2	13	9	8	17	19	11	<5	<5	13
68	DDH-26062&26026(993&565-998&568)-68	2	2	2	2	28	29	25	32	10	11	12	21	31	10	60	41
69	DDH-00-340C(725-745)-69	<0.5	<0.5	<0.5	<0.5	4	2	1	10	21	16	12	13	36	36	46	50
70	DDH-00-344C(515-520)-70	<0.5	<0.5	<0.5	<0.5	5	5	6	8	5	5	<2	16	17	5	15	17
71	DDH-00-340C(380-390)-71	<0.5	<0.5	<0.5	<0.5	2	2	2	3	9	12	11	39	9	9	<5	10
61-72	DDH-00-361C(240-245)-72/61D																
73	P30-73	<0.5	<0.5	<0.5	<0.5	1	3	3	8	13	18	12	14	<5	<5	15	15
74	26029(interval 815-825)-74	<0.5	<0.5	<0.5	<0.5	<1	1	1	2	8	4	7	20	<5	<5	<5	<5
75	DDH-26030&26049(293&358-296&362)-75	<0.5	<0.5	<0.5	<0.5	<1	1	12	1	7	10	14	20	12	6	5	32
76	DDH-00-367C(400-405)-76	<0.5	<0.5	<0.5	<0.5	6	7	7	9	9	29	15	16	6	<5	<5	6
77	DDH-26056(302-312)-77	<0.5	<0.5	<0.5	<0.5	2	1	1	3	16	6	5	5	10	<5	6	8
78	26056(135-153)-78	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	7	2	3	5	8	<5	<5	<5
80	DDH-26142(360&345-365&350)-80	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	5	6	12	31	9	7	<5	<5
93	00-331C(255-260)-93	1.1	1.1	<0.5	0.8	5	5	5	2	20	14	20	13	5	<5	26	12
94	00-344C (630-635)-94	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	11	8	8	6	<5	<5	<5	<5
95	00-326C(495-505)-95	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	3	3	12	13	<5	<5	<5	<5
96	99-318C(325-330)-96	<0.5	0.8	<0.5	<0.5	<1	<1	<1	<1	13	13	11	11	<5	<5	<5	<5
97	00-330C(275-280)-97	<0.5	<0.5	<0.5	0.6	<1	<1	<1	1	8	11	11	12	<5	11	<5	<5
98	26056(282-292)-98	<0.5	<0.5	0.5	<0.5	<1	<1	<1	<1	8	7	5	7	<5	<5	<5	<5
99	00-326C (250-265)-99	0.6	0.5	0.6	<0.5	<1	<1	<1	<1	6	6	12	10	<5	<5	<5	<5
100	00-340C(910-925)-100	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	13	20	14	18	<5	8	<5	12
101	26039(310-315)-101	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	9	9	8	10	<5	11	<5	<5
102	00-331C(190-210)-102	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	1	18	21	17	21	<5	10	13	<5
103	99-320C(400-405)-103	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	7	11	10	15	<5	<5	<5	<5
104	00-326C(225-235)-104	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	13	14	18	12	8	14	<5	18
105	00-367C(495-500)-105	<0.5	<0.5	<0.5	<0.5	<1	<1	<1	<1	8	13	9	9	18	5	9	<5
106	26058(704-715)-106	2.8	2.1	2.8	2.9	7	7	6	5	12	16	26	16	32	31	23	39

HCT ID	HCT Full ID (Drill Hole, Footage, HCT)	Cr (ppm)				V (ppm)				Ti (%)				Al (%)			
		+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270
1-9	DDH-99-320C(830-850)-1/9D	196	194	380	397	195	168	182	220	1.30	1.05	1.33	1.81	9.37	9.63	10.25	9.20
2	DDH-00-361C(310-320)	194	235	366	501	82	88	112	147	0.43	0.39	0.54	0.63	10.00	9.11	10.00	10.05
3	DDH-00-361C(345-350)-3	138	156	223	296	75	81	84	101	0.42	0.39	0.51	0.59	8.07	8.07	9.46	9.45
4	DDH-00-343C(240-250)-4	209	199	234	220	354	376	459	428	2.15	2.19	3.26	2.96	7.48	7.90	7.62	7.63
5	DDH-26030(1047-1052)-5	147	148	136	150	150	149	153	162	0.46	0.46	0.42	0.41	8.15	8.08	7.99	7.81
6	DDH-26061(1218-1233)-6	228	210	294	314	213	200	260	251	0.51	0.50	0.56	0.52	8.08	8.03	8.16	8.55
7	DDH-00-340C(990-995)-7	302	259	318	368	305	256	286	368	0.71	0.61	0.68	0.87	9.89	8.80	9.46	9.44
8	DDH-00-340C(965-974.5)-8	225	231	265	310	219	212	211	275	0.48	0.46	0.44	0.51	8.82	8.73	8.26	8.34
11	DDH-26043&26027(1501&740-1506&745)-1																
13	DDH-00-340C(595-615)-13	150	149	260	252	77	84	108	106	0.42	0.42	0.68	0.71	8.14	8.12	8.91	8.99
14	DDH-00-334C(580-600)-14	208	158	214	200	152	126	142	140	0.92	0.71	1.14	1.09	9.00	8.64	10.25	9.12
15	DDH-00-334C(640-660)	120	116	136	140	175	176	190	196	1.24	1.20	1.54	1.77	7.68	8.06	7.64	7.62
16	DDH-00-347C(795-815)-16	456	446	426	508	180	168	154	185	0.96	0.85	0.87	1.13	8.67	8.88	8.77	8.46
17	DDH-00-350C(580-600)-17	140	140	164	187	248	239	253	296	1.58	1.44	1.67	2.05	8.11	8.32	8.14	8.56
18	DDH-00-327C(225-245)-18	150	144	161	176	152	158	160	174	0.63	0.63	0.69	0.87	9.22	9.64	9.40	9.01
19	DDH-00-371C(435-440)-19	157	126	278	150	592	513	607	607	3.27	2.94	4.12	4.30	7.29	8.24	7.97	7.09
10-20	DDH-00-340C(765-780)-20/10D	539	537	560	657	370	392	419	448	1.04	1.09	1.51	1.50	8.59	7.91	8.42	8.32
21	DDH-00357C(335-340)-21	165	142	146	140	184	176	176	164	1.16	1.15	1.60	1.64	9.25	8.90	8.44	9.44
22	DDH-00326C(680-685)-22																
23	DDH-00-357C(535-540)-23	122	128	144	176	243	226	239	270	1.73	1.58	1.73	2.41	8.74	8.38	9.00	9.21
24	DDH-99-318C(725-735)-24	155	140	166	170	304	298	283	323	2.00	1.81	1.67	2.58	8.38	8.02	8.27	8.13
25	DDH-99-317C(460-470)-25	288	272	277	257	339	320	280	286	1.44	1.34	1.20	1.62	10.55	10.35	9.75	9.69
26	DDH-00-366C(185-205)-26	105	108	182	167	58	59	66	66	0.31	0.32	0.39	0.41	9.19	9.20	9.20	8.32
27	DDH-00-366C(230-240)-27	208	176	177	207	108	96	101	105	0.60	0.49	0.63	0.70	10.15	9.10	8.39	10.80
28	DDH-99-320C(165-175)-28	226	224	207	247	113	114	106	111	0.54	0.58	0.65	0.67	8.97	9.03	9.71	8.74
29	DDH-99-318C(250-370)-29	146	151	151	147	94	118	116	102	0.53	0.75	0.90	0.82	8.98	10.05	8.63	9.32
30	DDH-00-373C(95-115)-30	203	183	185	220	97	98	103	112	0.50	0.48	0.61	0.70	8.35	7.38	7.25	7.49
31	DDH-00-373C(75-95)-31	181	171	194	206	121	109	128	126	0.75	0.62	0.87	0.90	7.98	8.62	7.59	7.66
32	DDH-00-357C(110-130)-32	176	166	182	198	134	136	156	155	0.80	0.73	1.18	1.20	9.23	8.28	8.72	8.96
33	DDH-99-320C(315-330)-33	194	194	199	206	150	150	155	148	0.90	0.89	1.18	1.18	8.18	8.70	8.15	8.87
34	DDH-00-369C(335-345)-34	87	78	92	94	108	97	107	104	0.40	0.43	0.63	0.67	9.32	9.11	9.63	10.65
35	DDH-00-368C(460-465)-35	144	150	140	209	104	105	101	118	0.58	0.54	0.58	0.76	7.88	7.81	7.87	7.04
36	DDH-26055(940-945)-36	217	217	241	228	127	134	142	138	0.55	0.64	0.85	0.87	7.32	7.50	7.59	7.27
39	DDH-26098&00-337C(145&105-148.5&110)-	171	156	194	190	167	161	187	194	1.00	0.95	1.32	1.50	6.38	6.33	6.77	6.33
40	DDH-00-334C(30-50)-40	251	241	277	372	70	63	70	82	0.28	0.25	0.33	0.33	11.70	12.05	10.10	10.60
37-41	DDH-00-368C(125-145)-41/37D	124	106	114	132	112	106	99	118	0.71	0.65	0.66	0.83	12.50	10.90	10.55	11.60
42	DDH-00-368C(20-40)-42	142	140	146	154	146	155	142	163	0.86	0.94	0.91	1.10	10.45	10.80	11.90	11.20
43	DDH-00-366C(35-55)-43	132	156	180	168	56	59	57	55	0.31	0.29	0.34	0.31	11.35	10.90	11.10	9.22
44	DDH-00-334C(110-130)-44	281	176	251	309	95	75	90	102	0.32	0.25	0.36	0.38	10.45	9.61	10.70	10.55
45	DDH-00-347C(155-175)-45	171	164	186	190	134	144	150	152	0.59	0.68	0.87	0.86	10.05	9.82	11.55	10.15
46	DDH-00-347C(280-300)-46	135	118	138	146	104	88	97	108	0.61	0.50	0.60	0.70	10.75	9.94	9.17	8.97
47	DDH-00-326C(60-70)-47	207	196	221	230	127	122	140	134	0.73	0.62	0.99	0.88	9.84	8.44	9.45	7.60
38-48	DDH-00-369C(305-325)	124	124	125	159	86	88	90	92	0.33	0.31	0.40	0.45	9.28	9.45	8.85	9.48
49	DDH-00-367C(50-65)-49	211	206	192	220	104	99	95	98	0.45	0.40	0.51	0.58	9.68	9.46	9.40	10.35
50	DDH-00-367C(260-280)-50	260	247	269	313	128	116	124	132	0.65	0.50	0.72	0.72	9.70	8.33	9.61	8.39
51-57	DDH-00-367C(290-310)	230	203	203	249	126	108	120	126	0.71	0.53	0.78	0.77	10.25	8.63	10.05	9.06
52	DDH-00-370C(20-30)-52	169	160	165	183	241	232	237	247	0.85	0.82	1.12	1.34	9.36	9.32	8.99	9.48
53	DDH-00-369C(20-30)-53	196	164	188	212	128	120	146	136	0.63	0.66	1.00	0.90	9.33	10.40	9.46	9.00
54	DDH-00-367C(170-175)-54	268	262	281	288	198	236	268	237	0.74	0.94	1.39	1.16	9.87	10.55	9.52	9.20
55	DDH-00-367C(395-400)-55	1510	1460	2000	2140	718	726	833	834	1.88	2.05	2.40	2.13	6.09	6.66	6.17	6.02
56	DDH-26064(44-54)-56	224	182	202	273	46	39	32	45	0.16	0.13	0.12	0.15	9.78	8.90	8.80	8.20
59	DDH-26064(264&146-269&156)-59	147	191	217	247	69	72	76	85	0.31	0.32	0.36	0.40	9.89	10.65	9.27	9.61
60	DDH-26056(110-125)-60	109	128	118	126	55	59	48	60	0.30	0.27	0.26	0.36	9.41	9.26	7.69	8.59
62	DDH-00-361C(737-749)-62	235	204	272	262	184	178	225	205	0.39	0.37	0.41	0.37	8.09	8.00	8.19	7.79
58-63	DDH-00-364C(210-229)	179	181	190	171	218	241	239	216	0.14	0.14	0.13	0.13	8.08	8.13	7.79	7.69
64	DDH-00-337C(510-520)-64	218	188	242	171	198	190	250	170	0.15	0.14	0.15	0.11	8.80	9.03	8.61	8.16
65	DDH-26027(616-626)-65	331	343	387	422	419	420	488	486	1.17	1.27	1.89	1.77	7.57	8.13	7.57	7.27
66	P1-0-66	207	209	246	275	134	124	135	145	0.81	0.72	0.96	1.07	10.05	9.59	9.88	9.65
67	P2-0-67	188	203	273	294	135	123	127	139	0.80	0.69	0.91	1.03	9.00	9.47	10.10	9.70
68	DDH-26062&26026(993&565-998&568)-68	451	474	438	498	385	385	389	429	0.32	0.31	0.29	0.42	10.20	10.55	9.56	10.05
69	DDH-00-340C(725-745)-69	182	219	245	240	131	156	144	141	0.65	0.76	0.92	0.97	9.14	9.14	8.57	8.35
70	DDH-00-344C(515-520)-70	198	197	218	229	136	146	141	148	0.52	0.57	0.67	0.76	8.66	8.83	8.61	7.99
71	DDH-00-340C(380-390)-71	240	204	276	240	199	189	240	204	1.24	1.28	2.08	1.70	8.21	8.73	8.15	8.00
61-72	DDH-00-361C(240-245)-72/61D																
73	P30-73	165	165	223	244	130	112	138	149	0.78	0.66	0.96	1.06	10.05	10.25	9.81	9.45
74	26029(interval 815-825)-74	71	66	86	111	44	41	37	43	0.33	0.29	0.31	0.36	10.30	10.70	10.60	10.25
75	DDH-26030&26049(293&358-296&362)-75	128	127	145	171	112	118	143	144	0.30	0.41	0.66	0.64	9.48	9.33	8.55	8.60
76	DDH-00-367C(400-405)-76	273	263	388	375	389	383	444	450	1.87	1.63	2.67	2.71	8.48	8.60	8.49	7.90
77	DDH-26056(302-312)-77	194	191	298	340	53	57	72	87	0.23	0.29	0.39	0.38	10.45	11.15	5.95	10.50
78	26056(135-153)-78	135	147	150	173	59	59	60	70	0.31	0.32	0.35	0.40	9.43	10.05	9.63	8.30
80	DDH-26142(360&345-365&350)-80	157	123	159	186	45	40	45	51	0.21	0.20	0.27	0.27	9.53	10.35	9.88	7.77
93	00-331C(255-260)-93	349	341	389	298	322	319	272	302	1.31	1.26	0.85	0.92	8.66	9.25	9.94	8.40
94	00-344C (630-635)-94	225	249	216	265	144	141	158	152	0.97	0.84	1.29	1.22	8.45	9.19	9.81	9.51
95	00-326C(495-505)-95	143	131	216	162	148	146	160	164	0.89	0.87	0.96	1.14	6.05	6.25	6.34	5.95
96	99-318C(325-330)-96	144	158	159	177	102	112	113	111	0.58	0.63	0.91	0.93	9.12	9.10	8.55	9.24
97	00-330C(275-280)-97	106	89	117	110	80	78	80	83	0.35	0.34	0.37	0.45	8.71	8.67	8.54	8.57
98	26056(282-292)-98	181	181	190	300	54	55	59	80	0.23	0.27	0.34	0.39	9.78	9.30	8.94	10.10
99	00-326C (250-265)-99	197	145	161	264	68	67	71	82	0.40	0.43	0.53	0.55	9.53	10.15	9.92	9.49
100	00-340C(910-925)-100	218	203	199	238	190	190	175	203	1.27	1.20	1.19	1.67	9.06	9.42	9.96	9.51
101	26039(310-315)-101	114	111	132	172	87	78	83	105	0.54	0.48	0.51	0.68	5.33	5.19	5.23	4.49
102	00-331C(190-210)-102	159	159	173	186	213	208	208	225	1.47	1.37	1.50	1.84	8.57	8.80	9.55	9.09
103	99-320C(400-405)-103	83	93	114	142	68	69	79	83	0.46	0.43	0.52	0.53	9.72	9.44	9.43	8.69
104	00-326C(225-235)-104	146	146	148	145	121	122	124	125	0.78	0.76	0.90	1.00	6.72	7.30	6.76	6.25
105	00-367C(495-500)-105	170	156	160	208	86	77	64	82	0.41	0.36	0.34	0.40	10.70	9.97	9.48	8.98
106	26058(704-715)-106	331	368	350	347	304	329	304	307	0.59	0.60	0.52	0.56	9.91	10.15	9.83	9.28

Metals by 4-acid Digestion

HCT ID	HCT Full ID (Drill Hole, Footage, HCT)	Ca (%)					Fe (%)				K (%)				Na (%)				Mg (%)					Mn (ppm)				P (ppm)			
		All	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	All	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270
1-9	DDH-99-320C(830-850)-1/9D	6.28	6.30	6.46	6.25	5.88	8.66	7.89	8.55	9.10	0.97	0.95	1.00	1.04	1.96	2.06	2.10	2.10	3.26	3.33	3.09	3.21	3.24	1160	1070	1105	1185	1240	1160	800	740
2	DDH-00-361C(310-320)	6.76	6.96	7.05	6.61	6.58	5.80	5.43	6.17	6.96	0.24	0.21	0.25	0.25	1.96	1.99	1.96	1.86	2.96	3.43	2.99	3.45	3.85	723	692	741	812	460	380	280	510
3	DDH-00-361C(345-350)-3	5.68	5.87	6.11	5.86	5.94	7.78	7.52	8.04	9.27	0.30	0.27	0.27	0.33	1.80	1.92	1.89	1.92	4.55	4.57	4.39	5.00	5.61	973	949	960	1085	400	360	250	570
4	DDH-00-343C(240-250)-4	4.26	4.40	4.11	3.82	4.43	11.25	10.35	11.40	11.80	0.83	1.10	1.18	1.16	2.02	2.03	1.96	2.05	2.90	3.00	2.82	2.79	2.94	1365	1195	1265	1325	2240	1380	1620	4020
5	DDH-26030(1047-1052)-5	13.6	13.7	12.8	13.6	13.8	5.66	5.47	5.62	6.07	0.50	0.53	0.54	0.44	0.83	0.86	0.88	0.98	2.20	2.16	2.18	2.28	2.42	2760	2640	2760	2840	660	640	590	460
6	DDH-26061(1218-1233)-6	2.78	2.89	3.00	2.58	2.23	4.48	4.41	4.75	4.80	2.86	2.88	3.02	3.07	1.70	1.74	1.60	1.62	2.20	2.09	2.09	2.21	2.25	1330	1425	1220	1115	710	720	570	520
7	DDH-00-340C(990-995)-7	3.53	3.88	3.86	3.54	3.49	7.47	7.15	6.91	7.34	2.28	1.86	2.19	2.52	1.56	1.44	1.48	1.62	3.03	3.31	3.18	3.25	3.44	1100	1185	1075	979	640	620	530	420
8	DDH-00-340C(965-974.5)-8	0.69	0.81	0.80	0.74	0.73	5.82	5.55	4.76	5.70	3.05	3.12	2.98	3.00	1.53	1.54	1.51	1.50	1.71	1.85	1.82	1.80	2.15	360	355	348	370	710	660	520	470
11	DDH-26043&26027(1501&740-1506&745)-1	2.13																	3.3												
13	DDH-00-340C(595-615)-13	6.10	6.14	6.27	5.68	5.55	7.05	6.76	8.97	9.18	0.33	0.35	0.37	0.38	1.92	1.97	1.84	1.84	4.96	4.57	4.28	6.08	6.25	934	910	1100	1115	450	400	300	500
14	DDH-00-334C(580-600)-14	6.36	5.83	6.09	6.06	6.02	9.18	8.40	9.01	9.58	0.41	0.37	0.52	0.43	1.96	2.16	2.16	2.15	4.99	5.22	4.64	5.01	5.16	1160	1100	1115	1190	780	590	550	1120
15	DDH-00-334C(640-660)	5.03	5.26	5.25	5.02	4.78	11.55	11.45	11.30	12.25	0.56	0.59	0.67	0.65	1.74	1.78	1.70	1.69	6.95	7.19	7.15	6.71	7.19	1475	1465	1400	1510	1180	1060	760	1300
16	DDH-00-347C(795-815)-16	4.90	5.39	5.42	5.48	5.10	10.90	10.55	10.30	11.10	0.48	0.46	0.46	0.54	1.92	1.94	1.96	1.92	5.83	6.68	6.47	6.29	6.59	1345	1305	1270	1330	800	790	610	560
17	DDH-00-350C(580-600)-17	3.92	4.04	4.03	4.12	3.94	10.95	10.70	10.60	11.45	1.32	1.28	1.30	1.40	1.84	1.80	1.92	1.82	4.95	5.32	5.17	4.94	5.24	1535	1495	1460	1525	1250	1220	840	780
18	DDH-00-327C(225-245)-18	4.39	4.77	4.55	4.51	4.49	7.99	7.89	8.42	9.72	0.80	0.98	0.95	0.89	1.78	1.78	1.81	1.79	4.37	4.49	4.47	4.78	5.25	850	846	899	1005	650	610	470	640
19	DDH-00-371C(435-440)-19	4.94	5.28	5.20	4.99	5.07	12.95	11.95	12.85	13.30	0.82	0.99	1.01	0.93	1.82	2.14	2.08	1.80	3.14	3.76	3.28	2.81	2.86	1700	1465	1430	1445	2360	1620	3710	6150
10-20	DDH-00-340C(765-780)-20/10D	5.10	5.44	5.41	4.64	4.56	11.25	12.15	13.15	14.20	0.53	0.51	0.64	0.62	2.11	2.13	1.88	1.83	4.46	4.41	4.28	4.31	4.76	1100	1110	1060	1170	800	700	520	1170
21	DDH-00357C(335-340)-21	6.10	6.4	6.3	5.5	5.9	9.62	8.71	8.15	8.71	0.58	0.63	0.67	0.72	1.96	1.95	1.90	2.01	4.36	4.68	4.27	3.58	3.94	1290	1175	1045	1110	1500	1060	1060	2270
22	DDH-00326C(680-685)-22	6.03																	3.13												
23	DDH-00-357C(535-540)-23	6.11	6.0	5.9	5.8	5.6	10.70	10.45	9.71	10.95	0.86	0.83	0.97	1.02	1.97	1.98	2.15	2.19	3.61	3.61	3.60	3.19	3.32	1415	1405	1230	1345	1660	1680	1240	840
24	DDH-99-318C(725-735)-24	4.69	4.97	4.76	4.77	4.91	11.85	11.40	10.90	11.80	0.76	0.86	0.96	0.88	1.98	1.86	1.99	1.90	3.02	3.26	3.27	3.00	2.92	1490	1465	1335	1410	1980	1600	1320	2760
25	DDH-99-317C(460-470)-25	2.93	2.98	2.97	3.58	3.69	10.90	10.75	9.73	10.35	0.95	0.95	0.96	0.96	1.38	1.32	1.48	1.53	3.22	3.46	3.45	3.14	3.20	889	912	869	962	870	820	670	930
26	DDH-00-366C(185-205)-26	7.19	7.30	7.45	6.94	6.79	4.37	4.26	5.56	5.83	0.14	0.12	0.16	0.17	2.01	2.06	1.96	1.96	2.70	2.49	2.34	3.26	3.34	578	560	710	734	300	300	210	250
27	DDH-00-366C(230-240)-27	7.25	7.56	7.31	6.28	7.25	5.43	4.86	5.01	6.50	0.24	0.19	0.20	0.29	2.18	2.11	1.87	2.20	2.65	2.89	2.54	2.52	3.36	708	659	649	809	390	270	220	420
28	DDH-99-320C(165-175)-28	6.36	6.95	6.85	6.75	6.58	7.34	6.99	6.54	7.48	0.22	0.25	0.25	0.26	2.05	2.04	2.08	2.08	3.83	4.20	3.93	3.70	4.12	956	911	831	945	320	270	220	410
29	DDH-99-318C(250-370)-29	6.68	6.79	7.12	6.32	6.19	7.20	7.34	7.87	8.36	0.27	0.32	0.30	0.34	1.83	1.84	1.73	1.71	4.49	4.39	4.63	4.62	5.13	933	948	1000	1035	660	590	620	930
30	DDH-00-373C(95-115)-30	5.07	5.35	5.45	4.98	4.85	9.87	9.39	11.25	12.55	0.32	0.32	0.34	0.33	1.69	1.73	1.57	1.51	6.91	6.66	5.91	7.35	8.25	1235	1215	1400	1530	560	500	360	510
31	DDH-00-373C(75-95)-31	5.16	5.34	5.54	5.01	4.88	10.20	9.69	11.05	11.90	0.40	0.41	0.46	0.42	1.74	1.80	1.72	1.57	6.57	6.38	6.28	6.69	7.40	1275	1230	1380	1450	680	650	460	790
32	DDH-00-357C(110-130)-32	5.53	5.94	5.71	5.64	5.60	9.58	8.63	9.82	11.00	0.47	0.47	0.51	0.54	1.92	1.87	1.92	1.91	5.29	5.57	4.82	5.29	5.88	1220	1115	1215	1345	850	680	640	1540
33	DDH-99-320C(315-330)-33	6.16	6.22	6.66	6.35	6.06	8.18	7.81	8.02	7.77	0.41	0.43	0.42	0.52	1.99	2.10	2.13	2.02	3.82	3.92	3.77	3.64	3.57	1085	1060	1040	989	990	740	1180	1860
34	DDH-00-369C(335-345)-34	6.15	6.51	6.16	6.02	6.04	7.53	7.02	8.15	8.78	0.39	0.43	0.44	0.53	2.13	2.13	2.19	2.19	3.72	3.85	3.21	3.81	4.22	939	864	972	1025	560	520	840	1240
35	DDH-00-368C(460-465)-35	4.03	4.61	4.52	4.36	4.03	11.45	11.20	11.25	11.45	0.27	0.28	0.29	0.32	1.12	1.08	1.07	1.04	8.24	8.85	8.80	8.77	8.57	1475	1460	1450	1470	570	530	380	470
36	DDH-26055(940-945)-36	4.76	4.92	5.10	4.87	4.54	11.45	11.30	12.25	12.95	0.31	0.34	0.36	0.32	1.47	1.62	1.52	1.44	7.30	7.52	7.25	7.79	8.26	1425	1425	1480	1545	470	430	420	830
39	DDH-26098&00-337C(145&105-148.5&110)-	4.19	4.48	4.29	4.36	4.09	12.45	12.15	12.90	13.55	0.42	0.45	0.57	0.58	1.42	1.41	1.48	1.40	8.29	9.16	8.88	9.18	9.60	1595	1555	1610	1670	950	880	630	1280
40	DDH-00-334C(30-50)-40	6.38	7.19	7.17	6.83	6.46	6.25	6.27	5.97	7.03	0.22	0.23	0.15	0.18	2.18	2.17	2.12	2.00	3.73	4.62	4.72	4.24	5.14	802	796	773	875	200	150	130	200
37-41	DDH-00-368C(125-145)-41/37D	6.82	7.48	6.93	6.84	7.09	8.57	7.30	6.68	7.59	0.41	0.34	0.34	0.41	2.30	2.16	2.15	2.22	3.34	4.50	3.79	3.33	3.86	1100	949	858	959	700	580	380	820
42	DDH-00-368C(20-40)-42	7.23	7.03	7.37	7.90	7.60	5.81	5.81	5.20	5.59	0.39	0.40	0.44	0.45	2.23	2.41	2.61	2.45	2.18	2.39	2.30	2.07	2.16	776	766	690	725	750	710	810	1580
43	DDH-00-366C(35-55)-43	6.40	7.01	7.24	6.59	5.98	6.41	6.60	7.48	7.16	0.20	0.17	0.22	0.24	2.10	2.14	1.92	1.87	4.34	4.73	4.82	5.61	5.04	807	848	923	891	300	290	200	260
44	DDH-00-334C(110-130)-44	5.88	6.15	6.03	6.48	6.26	8.05	7.58	7.99	8.93	0.26	0.23	0.24	0.27	1.86	1.86	1.94	1.98	5.00	5.50	5.05	5.40	5.95	994	942	986	1090	170	170	170	280
45	DDH-00-347C(155-175)-45	6.93	7.10	7.54	7.34	6.69	7.77	7.70	7.80	7.64	0.29	0.27	0.35	0.31	2.16	2.13	2.32	2.10	3.77	4.18	3.95	4.18	3.99	1025	1020	1005	970	430	410	480	770
46	DDH-00-347C(280-300)-46	6.54	7.08	6.56	6.86	6.71	7.36	6.45	6.28	6.72	0.28	0.25	0.22	0.25	2.22	2.07	2.26	2.18	3.18	4.11	3.63	3.25	3.44	945	836	817	878	530	410	320	620
47	DDH-00-326C(60-70)-47	5.45	6.12	5.93	5.88	5.24	9.51	9.17	9.95	9.90	0.35	0.36	0.37	0.35	1.87	1.89	1.83	1.70	5.26	6.05	5.47	6.08	5.76	1170	1160	1200	1210	590	460	580	1040
38-48	DDH-00-369C(305-325)	6.41	6.34	6.19	6.10	6.14	6.80	6.56	6.77	7.69	0.28	0.29	0.26	0.25	2.01	1.97	1.97	2.00	3.61	3.68	3.64	3.50	4.14	812	788	802	889	300	270	230	380
49	DDH-00-367C(50-65)-49	6.91	7.64	7.30	7.09	6.74	5.95	5.71	6.62	7.14	0.25	0.24	0.22	0.29	2.06	1.98	2.02	1.89	3.19	3.50	3.33	3.84	4.37	799	767	874	906	340	240	240	510
50	DDH-00-367C(260-280)-50	5.97	6.50	6.21	6.15	5.70	8.62	7.59	8.75	9.17	0.32	0.27	0.32	0.37	1.92	1.93	1.91	1.85	4.30	5.17	4.30	5.15	5.07	1115	1000	1110	1165	540	380	290	580
51-57	DDH-00-367C(290-310)	6.47	7.25	6.71	6.60	6.05	7.13	6.28	7.98	8.18	0.36	0.32	0.36	0.32	2.09	2.01	1.98	1.84	3.65	4.18	3.45	4.65	4.72	974	862	1045	1060	500	360	480	790
52	DDH-00-370C(20-30)-52	6.95	7.06	6.81	6.46	6.85	8.23	8.24	8.69	9.53	0.54	0.57	0.53	0.51	1.86	1.84	1.77	1.83	4.48	4.55	4.59	4.57	4.90	1110	1095	1120	1210	2050	1420	2240	4090
53	DDH-00-369C(20-30)-53	6.34	6.35	6.83	6.56	6.10	7.47	7.38	8.43	8.35	0.29	0.33	0.33	0.32	1.88	2.07	2.07	1.98	3.56	4.07	3.95	4.00	3.97	959	939	1025	1000	280	270	320	550
54	DDH-00-367C(170-175)-54	5.32	6.05	6.01	5.46	5.36	8.42	8.38	9.14	8.73	0.52	0.71	0.72	0.62	1.78	1.87	1.77	1.80	3.55	4.40	4.20	4.20	4.03	1105	1150	1095	1050	500	520	680	930
55	DDH-00-367C(395-400)-55	2.47	2.59	2.54	2.34	2.36	14.85	15.50	15.40	15.85	0.55	0.54	0.49	0.44	1.07	1.04	0.88	0.86	6.16	6.84	7.20	7.00	7.11	1700	1735	1680	1685	540	510	580	880
56	DDH-26064(44-54)-56	5.70	6.60	6.26	5.80	5.39	6.74	6.70	7.60	8.69	0.15	0.18	0.17	0.16	1.71	1.68	1.57	1.44	5.40	5.76	5.59	6.66	7.64	824	837	926	1040	120	80	50	90
59	DDH-26064(264&146-269&156)-59	5.04	5.76	5.46	4.82	4.99	7.16	7.97	8.26	9.11	0.30	0.34	0.29	0.28	1.98	2.00	1.80	1.75	5.11	5.30	5.91	5.97	6.57	933	1015	1065	1185	230	150	190	270
60	DDH-26056(110-125)-60	5.23	5.89	5.97	5.14	5.38	9.18	9.55	10.50	11.85	0.24	0.24	0.22	0.23	1.77	1.82	1.62	1.65	5.74	6.07	6.22	6.80	7.85	1150	1185	1310	1450	280	280	160	360
62	DDH-00-361C(737-749)-62	1.98	1.90	2.03	2.18	2.20	6.20	6.29	5.99	6.14	1.91	1.90	2.06	1.88	1.14	1.16	1.07	1.07	2.56	2.57	2.59	2.76	2.47	684	754	841	809	590	590	500	420
58-63	DDH-00-364C(210-229)	0.37	0.38	0.37	0.35	0.34	6.55	6.67	5.96	5.96	3.55	3.54	3.46	3.82	1.08	1.07	0.99	0.97	1.40	1.36	1.40	1.41	1.30	178	180	177	164	540	520	460	540
64	DDH-00-337C(510-520)-64	0.45	0.50	0.54	0.48	0.46	8.50	8.64	7.37	8.15	3.17	3.06	2.85	3.19	1.49	1.54	1.35	1.29	1.34	1.47	1.50	1.63	1.36	181	190	193	168	520	540	460	490
65	DDH-26027(616-626)-65	3.38	3.34	3.59	3.34	3.15	13.55	13.00	14.95	15.70	0.41	0.46	0.44	0.42	1.25	1.34	1.26	1.17	5.22	5.33	5.12	5.19	5.14	1420	1360	1450	1415	300	280	290	490
66	P1-0-66	5.96	6.15	5.94	5.80	5.61	8.88	9.09	9.72	10.50	0.52	0.47	0.51	0.53	1.86	1.79	1.81	1.76	4.76	4.96	4.86	5.05	5.45	1065	1045	1090	1170	710	650	560	860
67	P2-0-67	5.76	5.76	5.91	5.97	5.63	8.82	9.03	9.93	10.40	0.46	0.46	0.49	0.53	1.74	1.79	1.88	1.77	4.51	4.82	4.86	4.98	5.21	1090	1055	1085	1115	700	610	540	950
68	DDH-26062&26026(993&565-998&568)-68	1.51	1.68	1.63	1.48	1.39	11.75	12.20	11.25	14.05	0.75	0.79	0.71	0.74	0.74	0.80	0.76	0.67	3.33	3.85	3.85	3.90	4.05	507	510	527	554	350	280	210	300
69	DDH-00-340C(725-745)-69	5.23	5.57	5.65	5.10	5.00	10.60	10.30	11.85	12.60	0.38	0.45	0.41	0.42	1.68	1.74	1.58	1.55	5.05	5.56	5.08	5.70	6.05	1165	1080	1215	1270	660	590	540	1100
70	DDH-00-344C(515-520)-70	3.48	4.03	3.59	3.33	3.19	10.15	10.95	11.35	11.95	0.26	0.25	0.23	0.21	1.33	1.16	1.04	0.97	6.68	6.13	7.00	7.34	7.52	1105	1145	1130	1235	430	370	360	660
71	DDH-00-340C(380-390)-71	5.50	5.68	5.73	5.55	5.39	12.30	11.65	12.55	12.35	0.34	0.37	0.37	0.36	1.50	1.59	1.53	1.45	5.91	6.60	6.12	6.11	6.15	1580	1495	1545	1505	1280	1380	2940	3800
61-72	DDH-00-361C(240-245)-72/61D	2.67																	12.30												
73	P30-73	5.78	6.16	6.09	5.74	5.50	9.14	9.39	9.81	10.35	0.42	0.43	0.50	0.53	1.83	1.84	1.78	1.72	4.87	4.93	5.06	5.00	5.21	1085	1080	1095	1130	670	620	540	850
74	26029(interval 815-825)-74	7.94	7.78	7.69	7.49	7.38	4.31	3.93	4.19	4.81	0.19	0.19	0.21	0.19	2.32	2.27	2.26	2.22	1.58	2.16	1.97	2.07	2.35	548	502	518	589	310	280	200	280
75	DDH-26030&26049(291&358-296&362)-75	5.03	5.46	5.16	4.93	4.86	9.02	9.40	9.87	11.15	0.37	0.36	0.32	0.30	1.52	1.45	1.39	1.35	6.34	6.51	6.65	6.63	7.48	1035	1055	1110	1210	170	180	200	290
76	DDH-00-367C(400-405)-76	4.07	4.66	4.48	4.48	4.47	12.55	11.75	13.15	14.65	0.87	1.04	1.03	0.92	1.66	1.68	1.67	1.52	4.53	5.17	5.07	4.77	4.81	1605	1495	1515	1525	2270	1660	2700	4320
77	DDH-26056(302-312)-77	5.98	6.47	6.65	4.53	6.04	6.70	7.35	5.57	8.56	0.20	0.19	0.23	0.24	1.95	2.05	1.01	1.82	3.94	4.30	4.55	3.31	4.83	845	916	676	989	260	220	190	460
78	26056(135-153)-78	5.44	6.15	6.08	5.64	5.08	7.81	8.12	9.72	10.30	0.29	0.29	0.29	0.25	1.82	1.77	1.68	1.50	5.49	5.59	5.94	7.03	7.29	1010	1040	1225	1305	320	300	220	410
80	DDH-26142(360&345-365&350)-80	5.55	6.20	6.03	5.51	5.07	7.00	7.41	8.71	9.42	0.25	0.25	0.26	0.23	1.96	1.95	1.84	1.70	5.00	5.00	5.55	6.54	6.71	904	920	1050	1145	180	130	110	200
93	00-331C(255-260)-93	3.06	3.19	2.98	2.99	3.08	10.60	9.97	8.81	10.95	0.67	0.75	0.80	0.69	1.76	1.72	1.74	1.74	3.33	3.51	3.30	2.95	3.80	874	761	655	925	120	110	70	100
94	00-344C (630-635)-94	6.37	5.73	6.28	6.34	6.25	9.43	8.56	8.89	8.95	0.34	0.37	0.38	0.39	1.73	1.89	2.08	2.03	4.51	4.61	4.27	4.14	4.07	1175	1090	1085	1070	310	260	240	420
95	00-326C(495-505)-95	4.38	4.52	4.61	4.55	4.08	12.25	12.15	12.70	13.15	0.41	0.43	0.51	0.56	1.34	1.37	1.34	1.26	8.46	8.63	8.54	8.74	8.94	1580	1575	1605	1630	890	820	580	810
96	99-318C(325-330)-96	5.53	5.84	5.90	5.29	5.68	9.34	9.40	9.19	10.40	0.35	0.35	0.35	0.40	1.81	1.80	1.68	1.84	6.15	6.28	6.35	5.89	6.70	1225	1235	1170	1300	610	460	380	730
97	00-330C(275-280)-97	5.22	5.31	5.48	5.12	5.02	11.05	11.00	12.10	12.25	0.26	0.26	0.26	0.27	1.62	1.68	1.58	1.58	6.83	7.17	6.94	7.61	7.58	1195	1185	1290	1295	340	300	200	260
98	26056(282-292)-98	6.34	6.46	6.34	5.96	6.13	5.97	6.01	6.02	8.18	0.22	0.21	0.22	0.26	1.98	1.96	1.89	1.88	3.91	3.93	3.91	3.72	5.35	760	749	729	930	180	130	120	230
99	00-326C (250-265)-99	6.74	7.00	7.05	6.67	6.68	5.88	5.83	5.53	6.34	0.25	0.26	0.25	0.27	1.88	1.89	1.84	1.82	4.06	4.21	4.23	3.94	4.46	752	729	682	776	430	380	360	490
100	00-340C(910-925)-100	5.93	6.10	6.38	6.52	5.81	9.84	9.49	9.07	9.58	0.60	0.62	0.68	0.81	1.96	2.05	2.20	2.05	3.79	4.24	4.09	3.79	3.78	1285	1255	1180	1170	1320	1290	1030	750
101	26039(310-315)-101	3.19	3.38	3.20	3.18	2.89	13.15	12.55	13.55	14.35	0.15	0.14	0.15	0.17	0.87	0.83	0.82	0.70	11.30	11.20	10.60	11.35	12.10	1680	1615	1730	1715	390	340	330	340
102	00-331C(190-210)-102	5.87	5.72	5.75	5.80	5.54	10.35	10.30	9.66	10.30	0.35	0.41	0.45	0.48	1.76	1.83	2.10	2.01	3.97	4.15	4.06	3.55	3.62	1345	1325	1215	1240	1360	1260	730	1600
103	99-320C(400-405)-103	5.25	5.45	5.37	5.17	4.84	5.69	6.35	7.04	7.87	1.13	1.25	1.27	1.02	1.50	1.47	1.35	1.25	5.41	4.72	5.29	5.83	6.24	803	895	982	1105	470	440	310	330
104	00-326C(225-235)-104	4.27	4.23	4.24	3.74	3.52	11.95	12.80	12.55	12.75	0.30	0.30	0.30	0.31	1.22	1.24	1.12	1.07	8.89	8.45	9.26	9.13	9.19	1550	1675	1625	1595	770	680	460	1000
105	00-367C(495-500)-105	6.5	7.31	7.00	6.33	5.82	6.11	5.69	5.24	5.61	0.30	0.25	0.22	0.25	2.24	2.15	2.01	1.84	3.85	4.00	3.73	3.33	3.55	834	765	679	729	400	350	200	410
106	26058(704-715)-106	5.67	4.54	4.28	4.64	4.67	8.73	9.26	8.63	8.76	0.52	0.55	0.53	0.50	0.67	0.68	0.63	0.61	4.56	4.44	4.81	4.87	4.90	1510	1500	1545	1725	330	280	220	160

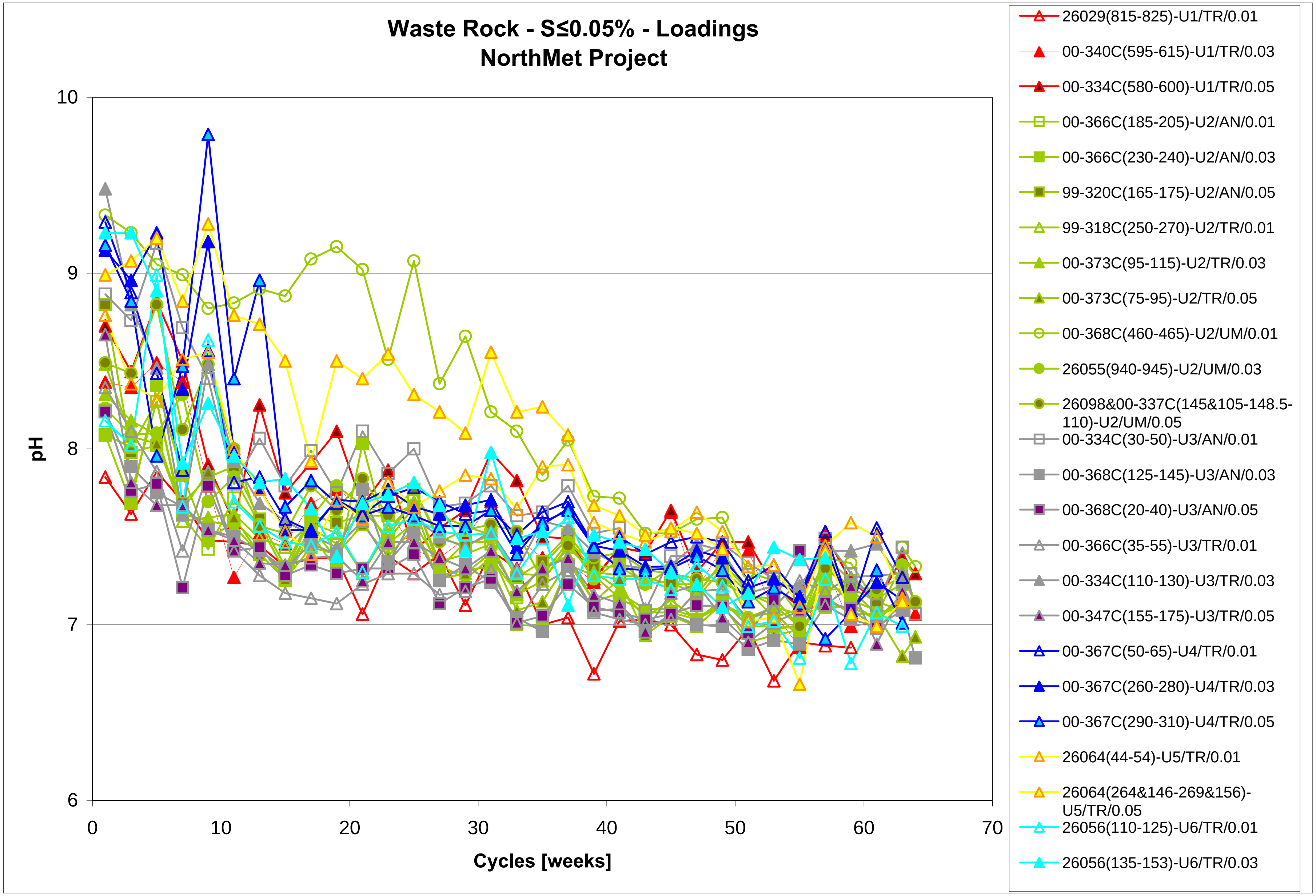
HCT ID	HCT Full ID (Drill Hole, Footage, HCT)	Metals by 4-acid Digestion																							
		Ba (ppm)				Be (ppm)				Bi (ppm)				Sb (ppm)				Sr (ppm)				W (ppm)			
		+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270	+ 10	-10 + 35	-35 + 100	-100 + 270
1-9	DDH-99-320C(830-850)-1/9D	250	260	250	270	1.0	1.0	1.1	1.0	<2	<2	<2	<2	<5	<5	<5	<5	382	389	371	341	<10	<10	<10	10
2	DDH-00-361C(310-320)	110	110	110	110	0.6	0.5	0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	311	318	310	291	<10	<10	<10	<10
3	DDH-00-361C(345-350)-3	100	110	110	110	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	253	267	264	268	<10	<10	<10	<10
4	DDH-00-343C(240-250)-4	210	280	290	290	1.5	1.5	1.5	1.5	<2	<2	<2	<2	<5	<5	<5	<5	203	205	199	209	<10	<10	<10	<10
5	DDH-26030(1047-1052)-5	230	240	250	240	1.4	1.4	1.4	1.3	<2	<2	<2	<2	<5	<5	<5	<5	314	319	329	328	<10	<10	<10	<10
6	DDH-26061(1218-1233)-6	750	770	750	790	2.0	2.0	1.9	2.0	<2	<2	<2	<2	<5	<5	<5	<5	209	224	205	196	<10	<10	<10	<10
7	DDH-00-340C(990-995)-7	970	920	920	1000	2.5	2.2	2.6	2.6	<2	<2	<2	<2	<5	<5	<5	<5	288	275	268	267	<10	<10	<10	<10
8	DDH-00-340C(965-974.5)-8	650	660	640	590	2.1	2.1	2.1	2.1	<2	<2	<2	<2	<5	<5	<5	<5	186	188	180	170	<10	<10	<10	<10
11	DDH-26043&26027(1501&740-1506&745)-1																								
13	DDH-00-340C(595-615)-13	110	110	120	110	0.5	0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	265	270	250	252	<10	<10	<10	<10
14	DDH-00-334C(580-600)-14	140	140	160	150	0.6	0.6	0.7	0.6	<2	<2	<2	<2	<5	<5	<5	<5	243	268	267	267	<10	<10	<10	<10
15	DDH-00-334C(640-660)	170	180	190	180	0.9	0.9	0.9	0.9	<2	<2	<2	<2	<5	<5	<5	<5	202	210	201	199	<10	<10	<10	<10
16	DDH-00-347C(795-815)-16	150	150	140	160	0.7	0.7	0.7	0.7	<2	<2	<2	<2	<5	<5	<5	<5	237	239	242	240	<10	<10	<10	<10
17	DDH-00-350C(580-600)-17	430	430	420	440	1.3	1.3	1.3	1.3	<2	<2	<2	<2	<5	<5	<5	<5	205	203	220	206	<10	<10	<10	<10
18	DDH-00-327C(225-245)-18	210	230	230	230	1.3	1.3	1.3	1.3	<2	<2	<2	<2	<5	<5	<5	<5	244	242	243	239	<10	<10	<10	<10
19	DDH-00-371C(435-440)-19	240	280	290	260	1.1	1.2	1.1	1.0	<2	<2	<2	<2	<5	<5	<5	<5	205	242	240	207	<10	<10	<10	<10
10-20	DDH-00-340C(765-780)-20/10D	170	180	180	170	0.8	0.7	0.7	0.7	<2	<2	<2	<2	<5	<5	<5	<5	233	234	205	197	<10	<10	<10	<10
21	DDH-00357C(335-340)-21	200	210	210	220	0.8	0.8	0.8	0.9	<2	<2	<2	<2	<5	<5	<5	<5	250	246	239	251	<10	<10	<10	<10
22	DDH-00326C(680-685)-22																								
23	DDH-00-357C(535-540)-23	250	250	290	300	1.3	1.3	1.4	1.4	<2	<2	<2	<2	<5	<5	<5	<5	234	232	248	253	<10	<10	<10	<10
24	DDH-99-318C(725-735)-24	250	290	310	300	1.5	1.5	1.5	1.5	<2	<2	<2	<2	<5	<5	<5	<5	215	204	215	211	<10	<10	<10	<10
25	DDH-99-317C(460-470)-25	350	430	440	390	2.7	2.6	2.2	2.1	<2	<2	<2	<2	<5	<5	<5	<5	182	180	200	199	<10	<10	<10	10
26	DDH-00-366C(185-205)-26	100	100	100	100	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	304	310	300	302	10	<10	<10	<10
27	DDH-00-366C(230-240)-27	120	110	90	120	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	321	305	270	318	<10	<10	<10	<10
28	DDH-99-320C(165-175)-28	120	120	120	120	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	292	289	291	292	<10	<10	<10	<10
29	DDH-99-318C(250-370)-29	120	120	110	120	0.5	0.5	<0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	282	283	264	261	<10	<10	<10	10
30	DDH-00-373C(95-115)-30	110	110	110	110	0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	226	230	208	201	<10	<10	<10	<10
31	DDH-00-373C(75-95)-31	130	130	140	130	0.6	0.6	0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	226	234	222	203	<10	<10	<10	<10
32	DDH-00-357C(110-130)-32	150	150	160	160	0.7	0.7	0.7	0.7	<2	<2	3.0	<2	<5	<5	<5	<5	251	246	249	250	<10	<10	<10	<10
33	DDH-99-320C(315-330)-33	160	160	170	170	0.7	0.7	0.7	0.7	<2	<2	<2	<2	<5	<5	<5	<5	268	282	282	267	<10	<10	<10	<10
34	DDH-00-369C(335-345)-34	160	160	170	190	0.5	0.6	0.5	0.6	<2	<2	<2	<2	<5	<5	<5	<5	284	280	288	285	<10	<10	<10	<10
35	DDH-00-368C(460-465)-35	100	100	100	100	0.5	0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	158	155	152	147	<10	<10	<10	<10
36	DDH-26055(940-945)-36	120	130	120	110	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	198	220	205	193	<10	<10	<10	<10
39	DDH-26098&00-337C(145&105-148.5&110)-	140	140	170	170	0.8	0.8	0.8	0.8	3.0	<2	<2	5.0	<5	<5	<5	<5	160	158	167	158	<10	<10	<10	<10
40	DDH-00-334C(30-50)-40	100	100	90	80	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	335	332	324	307	<10	<10	<10	<10
37-41	DDH-00-368C(125-145)-41/37D	150	130	130	140	0.6	0.5	0.5	0.6	<2	<2	<2	<2	<5	<5	<5	<5	323	300	293	307	<10	<10	<10	<10
42	DDH-00-368C(20-40)-42	150	150	170	170	0.6	0.7	0.7	0.7	<2	<2	<2	<2	<5	<5	<5	<5	306	318	344	325	<10	<10	<10	<10
43	DDH-00-366C(35-55)-43	100	100	100	80	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	315	323	287	279	<10	<10	<10	<10
44	DDH-00-334C(110-130)-44	90	90	90	90	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	274	272	283	286	<10	<10	10	<10
45	DDH-00-347C(155-175)-45	120	130	140	130	0.5	<0.5	0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	300	298	317	292	<10	<10	<10	<10
46	DDH-00-347C(280-300)-46	130	110	120	120	0.5	<0.5	0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	308	285	308	301	<10	<10	<10	<10
47	DDH-00-326C(60-70)-47	130	120	120	110	0.5	0.5	0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	252	255	247	229	<10	<10	<10	<10
38-48	DDH-00-369C(305-325)	120	120	110	110	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	283	277	277	280	<10	<10	<10	<10
49	DDH-00-367C(50-65)-49	100	100	100	100	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	329	318	319	294	<10	<10	<10	10
50	DDH-00-367C(260-280)-50	110	110	110	110	0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	271	271	265	256	10	<10	<10	<10
51-57	DDH-00-367C(290-310)	150	120	120	110	0.5	<0.5	0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	313	297	288	267	10	<10	<10	<10
52	DDH-00-370C(20-30)-52	160	160	150	150	0.6	0.6	0.6	0.6	<2	<2	<2	<2	<5	<5	<5	<5	253	248	238	242	<10	<10	<10	<10
53	DDH-00-369C(20-30)-53	110	130	130	130	0.5	0.5	0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	273	303	299	284	<10	<10	<10	10
54	DDH-00-367C(170-175)-54	150	190	170	160	0.5	0.6	0.6	0.6	<2	<2	<2	<2	<5	<5	<5	<5	281	292	266	268	<10	<10	<10	10
55	DDH-00-367C(395-400)-55	120	120	120	110	0.8	0.8	0.7	0.6	<2	<2	4.0	4.0	<5	<5	<5	<5	140	136	117	112	<10	<10	10	<10
56	DDH-26064(44-54)-56	70	60	60	50	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	277	270	252	230	<10	10	10	<10
59	DDH-26064(264&146-269&156)-59	100	100	80	80	<0.5	<0.5	<0.5	<0.5	<2	2.0	<2	3.0	<5	<5	<5	<5	294	294	258	251	<10	<10	<10	<10
60	DDH-26056(110-125)-60	90	90	80	80	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	257	263	233	238	<10	10	<10	<10
62	DDH-00-361C(737-749)-62	500	500	530	470	2.0	1.9	1.8	1.8	<2	<2	<2	<2	<5	<5	<5	<5	196	183	174	167	<10	<10	10	<10
58-63	DDH-00-364C(210-229)	590	560	540	580	1.5	1.5	1.4	1.5	2.0	<2	<2	<2	<5	5.0	<5	<5	157	152	144	151	<10	<10	10	<10
64	DDH-00-337C(510-520)-64	570	580	540	580	1.7	1.8	1.7	1.6	<2	<2	<2	<2	7.0	<5	<5	<5	166	167	147	159	<10	<10	<10	10
65	DDH-26027(616-626)-65	130	150	150	140	1.1	1.1	1.0	1.0	<2	<2	<2	<2	<5	<5	<5	<5	196	213	198	184	<10	<10	<10	<10
66	P1-0-66	160	160	170	170	0.6	0.6	0.7	0.9	<2	<2	<2	<2	<5	<5	<5	<5	282	275	273	262	<10	<10	<10	<10
67	P2-0-67	160	160	180	180	0.6	0.6	0.6	0.6	<2	<2	<2	<2	<5	<5	<5	<5	261	269	280	262	<10	<10	<10	<10
68	DDH-26062&26026(993&565-998&568)-68	210	190	190	160	2.9	2.8	3.0	2.8	<2	2.0	2.0	4.0	<5	<5	<5	<5	125	134	123	113	<10	<10	<10	<10
69	DDH-00-340C(725-745)-69	150	150	140	140	0.6	0.7	0.6	0.6	<2	<2	<2	<2	<5	<5	<5	<5	241	245	222	220	<10	<10	<10	<10
70	DDH-00-344C(515-520)-70	110	110	100	90	1.0	1.0	0.9	0.9	<2	<2	<2	<2	<5	<5	<5	<5	238	210	188	175	<10	<10	<10	<10
71	DDH-00-340C(380-390)-71	130	140	130	140	0.5	0.5	0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	219	228	221	211	<10	<10	<10	<10
61-72	DDH-00-361C(240-245)-72/61D																								
73	P30-73	160	170	170	170	0.6	0.6	0.6	0.6	<2	<2	<2	<2	<5	<5	<5	<5	283	280	268	256	<10	<10	<10	<10
74	26029(interval 815-825)-74	120	110	110	110	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	369	349	359	351	<10	<10	<10	<10
75	DDH-26030&26049(291&358-296&362)-75	90	90	90	80	<0.5	<0.5	<0.5	<0.5	3.0	3.0	2.0	2.0	<5	<5	<5	<5	299	280	267	251	<10	<10	<10	<10
76	DDH-00-367C(400-405)-76	240	260	260	250	0.9	1.1	1.0	1.0	<2	<2	<2	<2	<5	<5	<5	<5	319	325	308	264	<10	<10	<10	<10
77	DDH-26056(302-312)-77	90	100	70	90	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	291	303	213	275	<10	<10	<10	<10
78	26056(135-153)-78	100	100	90	80	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	280	276	258	228	<10	<10	<10	10
80	DDH-26142(360&345-365&350)-80	100	90	80	70	<0.5	<0.5	<0.5	<0.5	2.0	<2	2.0	2.0	<5	<5	<5	<5	294	288	265	240	<10	<10	<10	<10
93	00-331C(255-260)-93	260	280	280	260	1.4	1.8	2.0	1.4	8.0	3.0	<2	<2	<5	<5	<5	<5	286	275	287	286	<10	<10	<10	<10
94	00-344C (630-635)-94	120	130	140	140	<0.5	0.5	<0.5	0.5	2.0	2.0	2.0	3.0	<5	<5	<5	<5	241	262	287	279	<10	<10	<10	<10
95	00-326C(495-505)-95	130	140	160	170	0.7	0.7	0.7	0.6	<2	2.0	<2	<2	<5	<5	<5	<5	160	165	164	156	<10	<10	<10	<10
96	99-318C(325-330)-96	140	140	130	150	0.5	0.6	0.5	0.5	3.0	<2	<2	3.0	<5	<5	<5	5.0	249	246	230	250	<10	<10	<10	<10
97	00-330C(275-280)-97	90	100	90	100	<0.5	<0.5	<0.5	<0.5	2.0	3.0	2.0	<2	<5	<5	<5	<5	230	240	225	223	<10	<10	<10	<10
98	26056(282-292)-98	90	90	80	90	<0.5	<0.5	<0.5	<0.5	<2	2.0	<2	<2	<5	<5	<5	<5	291	287	275	274	<10	<10	<10	<10
99	00-326C (250-265)-99	110	110	110	110	<0.5	<0.5	<0.5	<0.5	<2	2.0	3.0	2.0	<5	<5	<5	<5	327	330	315	315	<10	<10	<10	<10
100	00-340C(910-925)-100	190	200	220	240	1.0	1.0	1.1	1.0	<2	<2	<2	<2	<5	<5	<5	<5	256	265	280	261	<10	<10	<10	<10
101	26039(310-315)-101	70	70	70	60	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	126	122	121	104	<10	<10	<10	<10
102	00-331C(190-210)-102	190	220	240	250	0.9	1.0	1.0	1.0	<2	<2	<2	<2	<5	<5	<5	<5	236	242	263	252	<10	<10	<10	<10
103	99-320C(400-405)-103	240	250	240	180	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	360	364	332	281	<10	<10	<10	<10
104	00-326C(225-235)-104	110	110	110	110	0.5	0.6	0.5	0.5	<2	<2	<2	<2	<5	<5	<5	<5	164	167	149	140	<10	<10	<10	<10
105	00-367C(495-500)-105	120	110	110	100	<0.5	<0.5	<0.5	<0.5	<2	<2	<2	<2	<5	<5	<5	<5	343	330	303	276	<10	<10	<10	<10
106	26058(704-715)-106	100	110	100	90	2.7	2.9	2.9	2.7	<2	<2	<2	<2	<5	<5	<5	<5	254	251	215	198	<10	<10	<10	<10

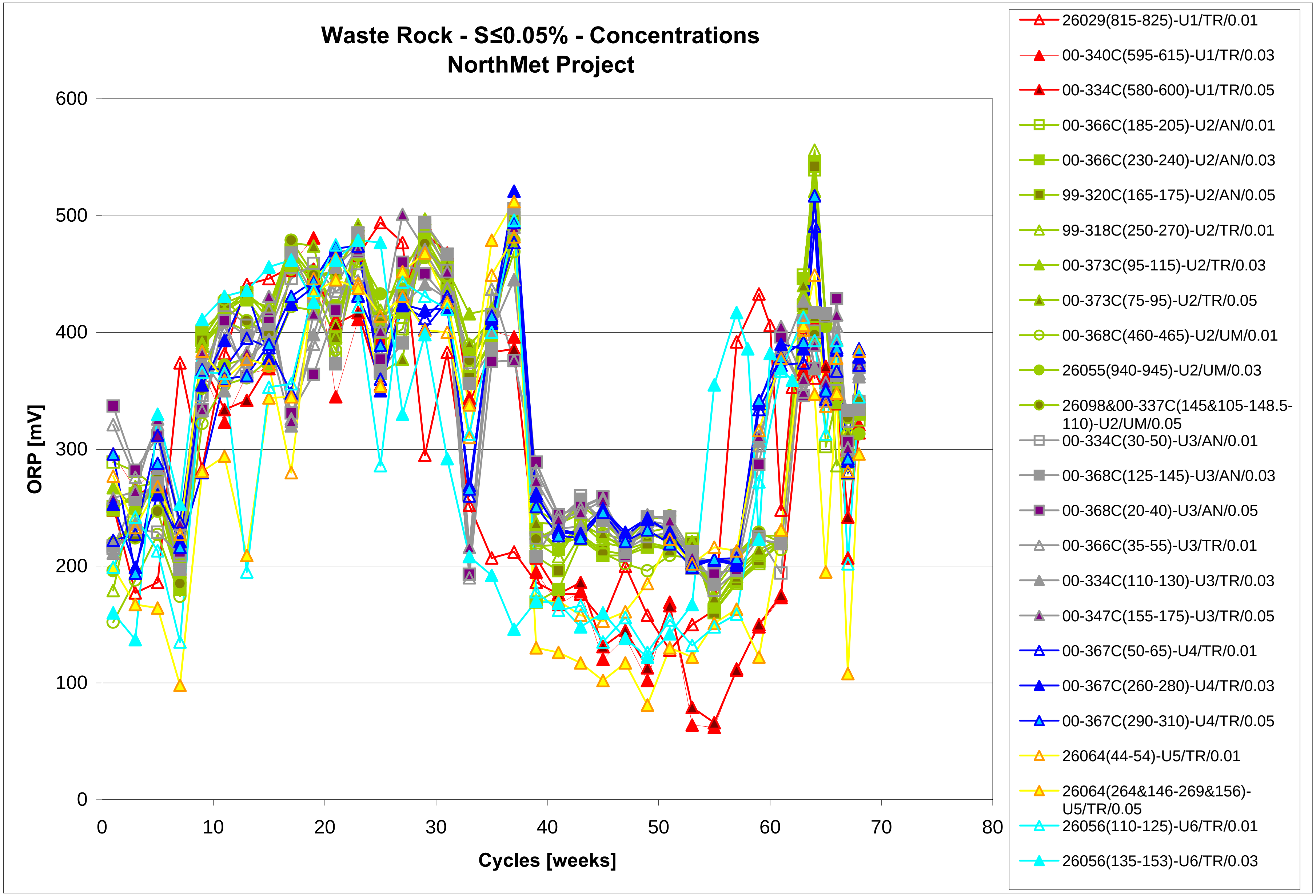
Appendix E

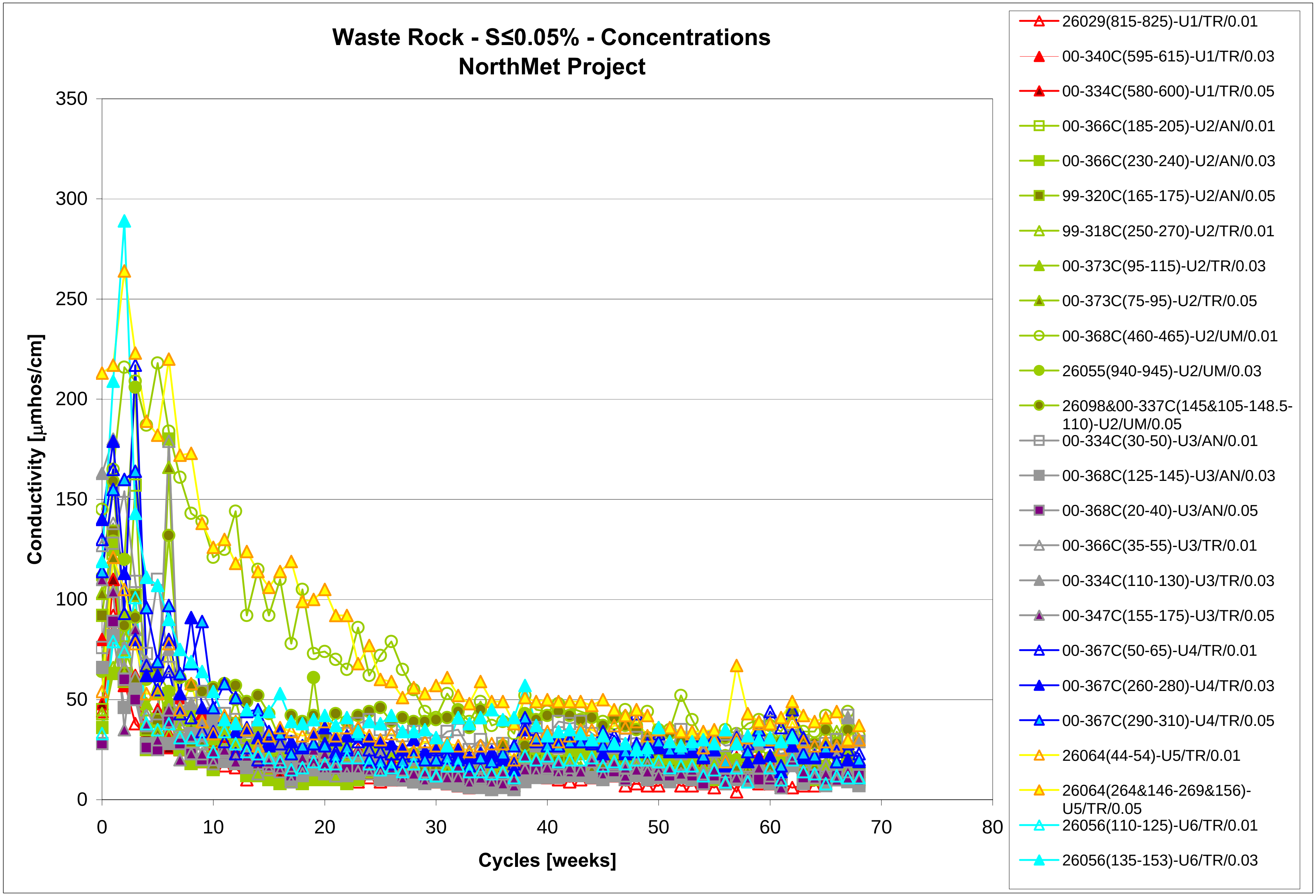
Charts of Dissolution Testwork Results (Humidity Cells)

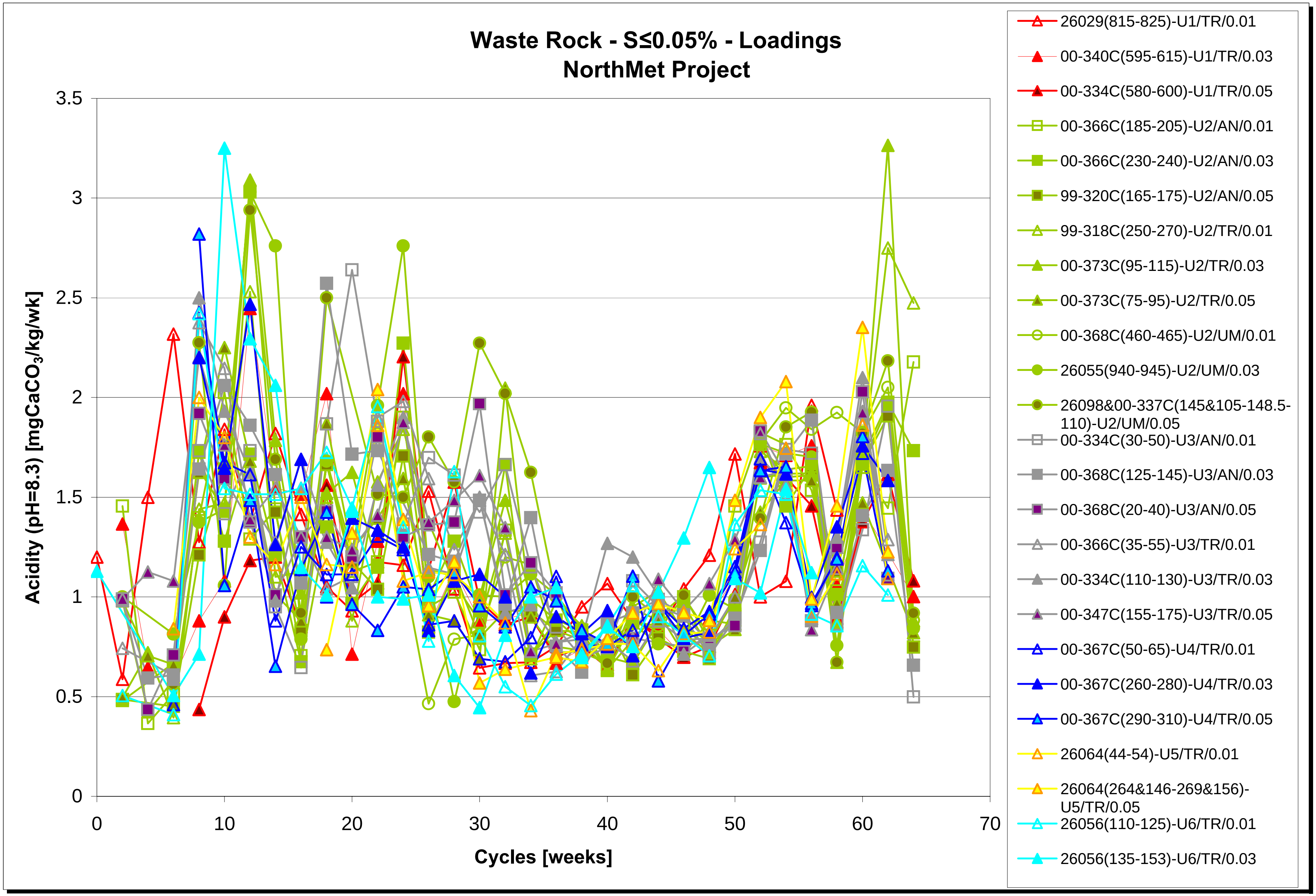
Appendix E.1

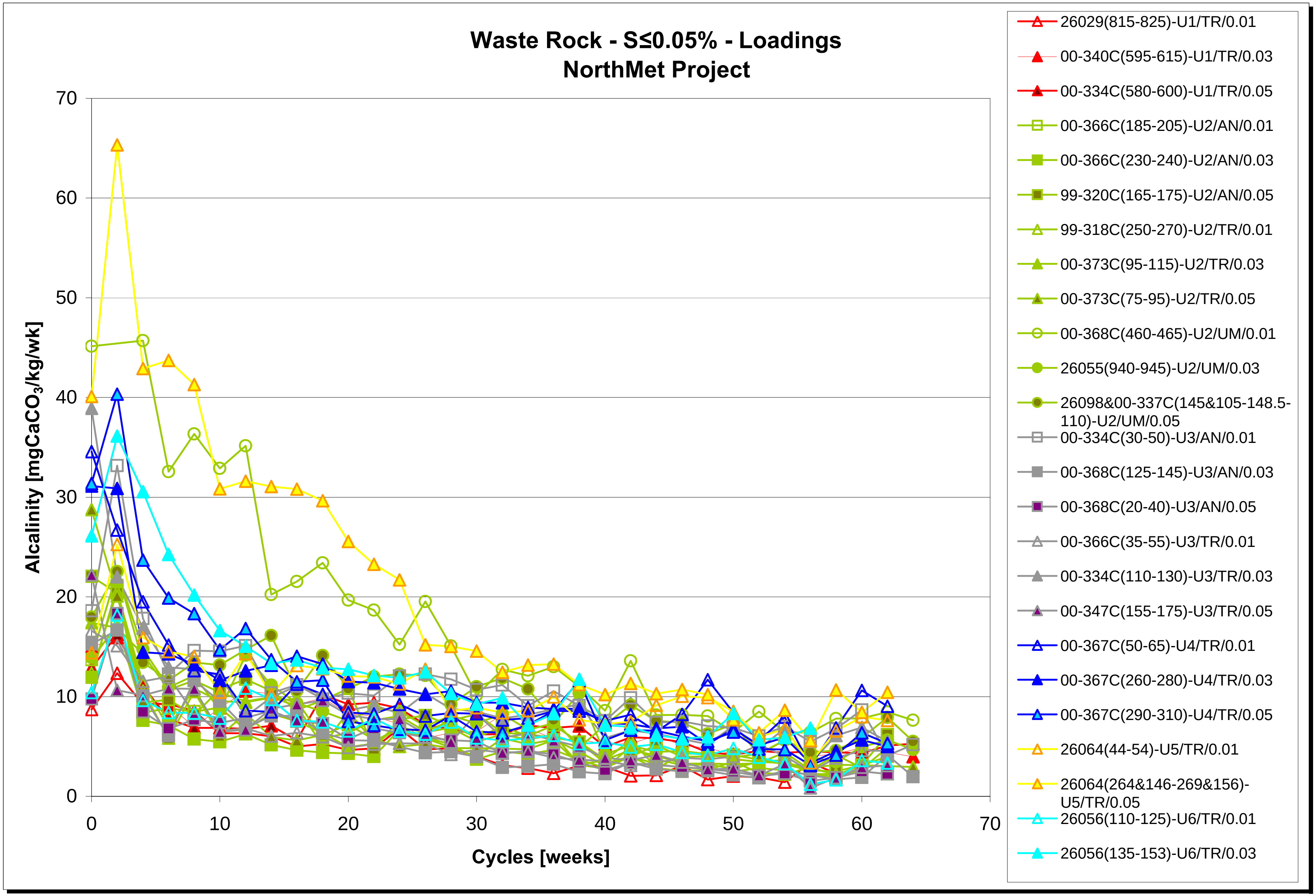
Lower Sulfur Waste Rock

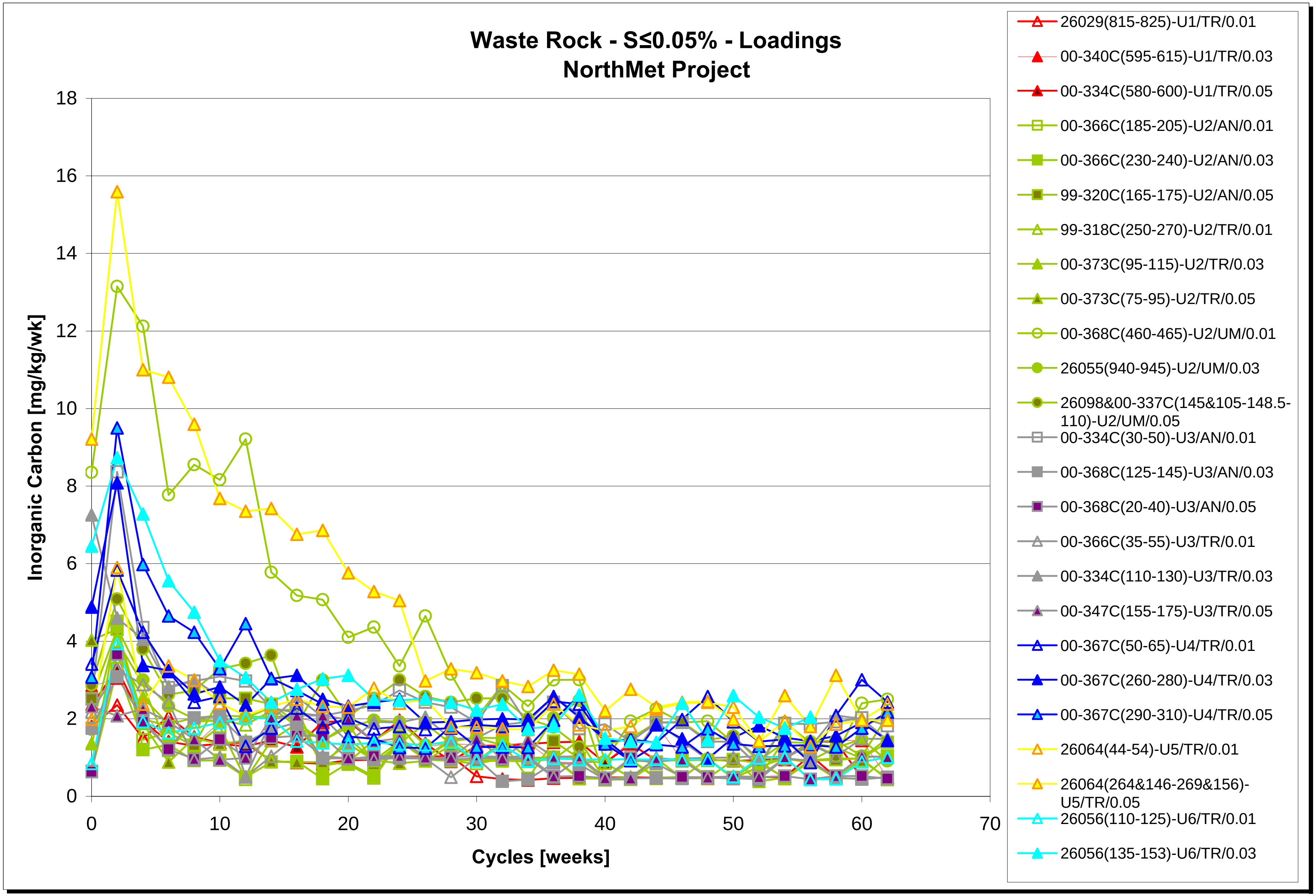

Waste Rock - S≤0.05% - Loadings
NorthMet Project
pH
Cycles [weeks]
10
9
8
7
6
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

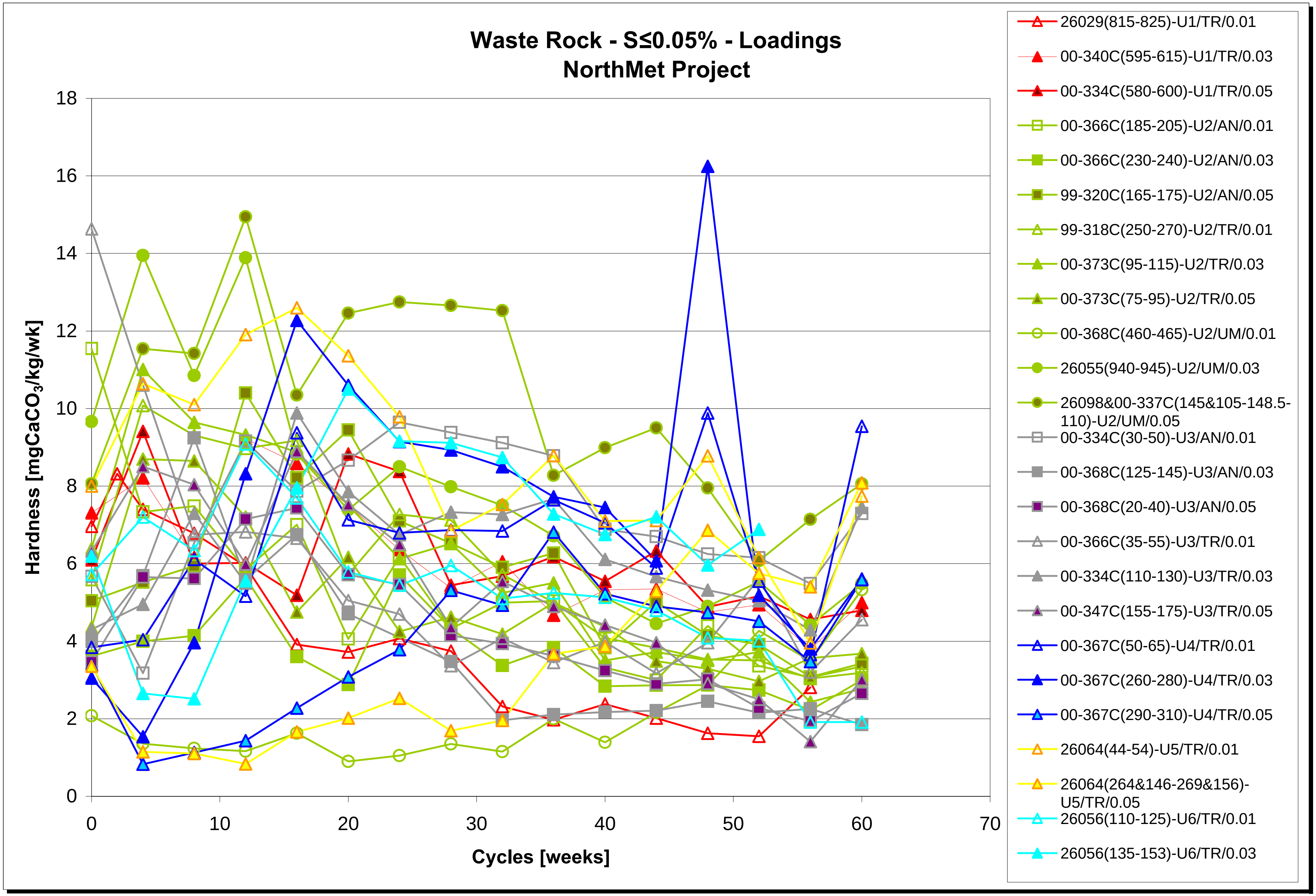

Waste Rock - S≤0.05% - Concentrations
NorthMet Project
ORP [mV]
Cycles [weeks]
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

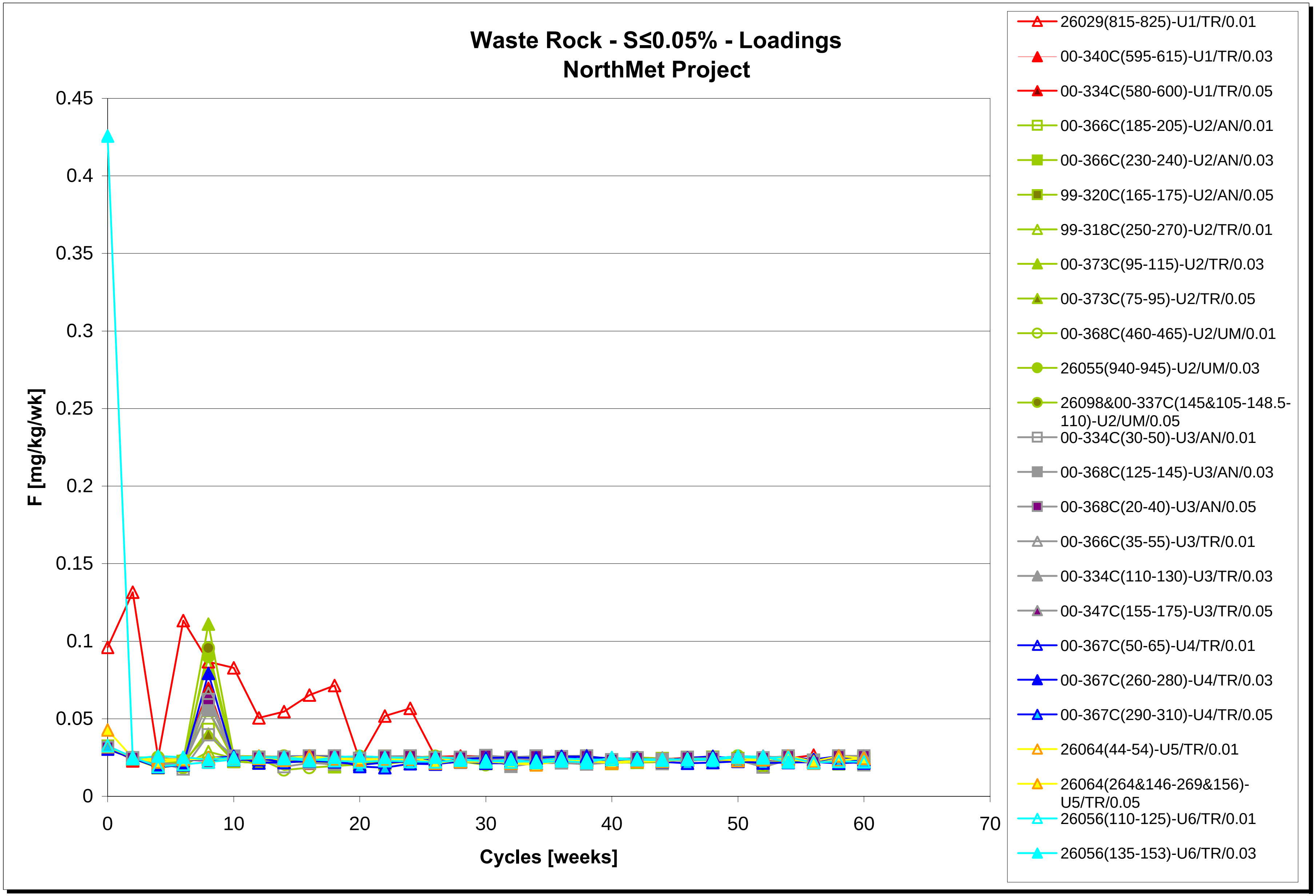

Waste Rock - S≤0.05% - Concentrations
NorthMet Project
Conductivity [µmhos/cm]
Cycles [weeks]
0
50
100
150
200
250
300
350
0
10
20
30
40
50
60
70
80
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

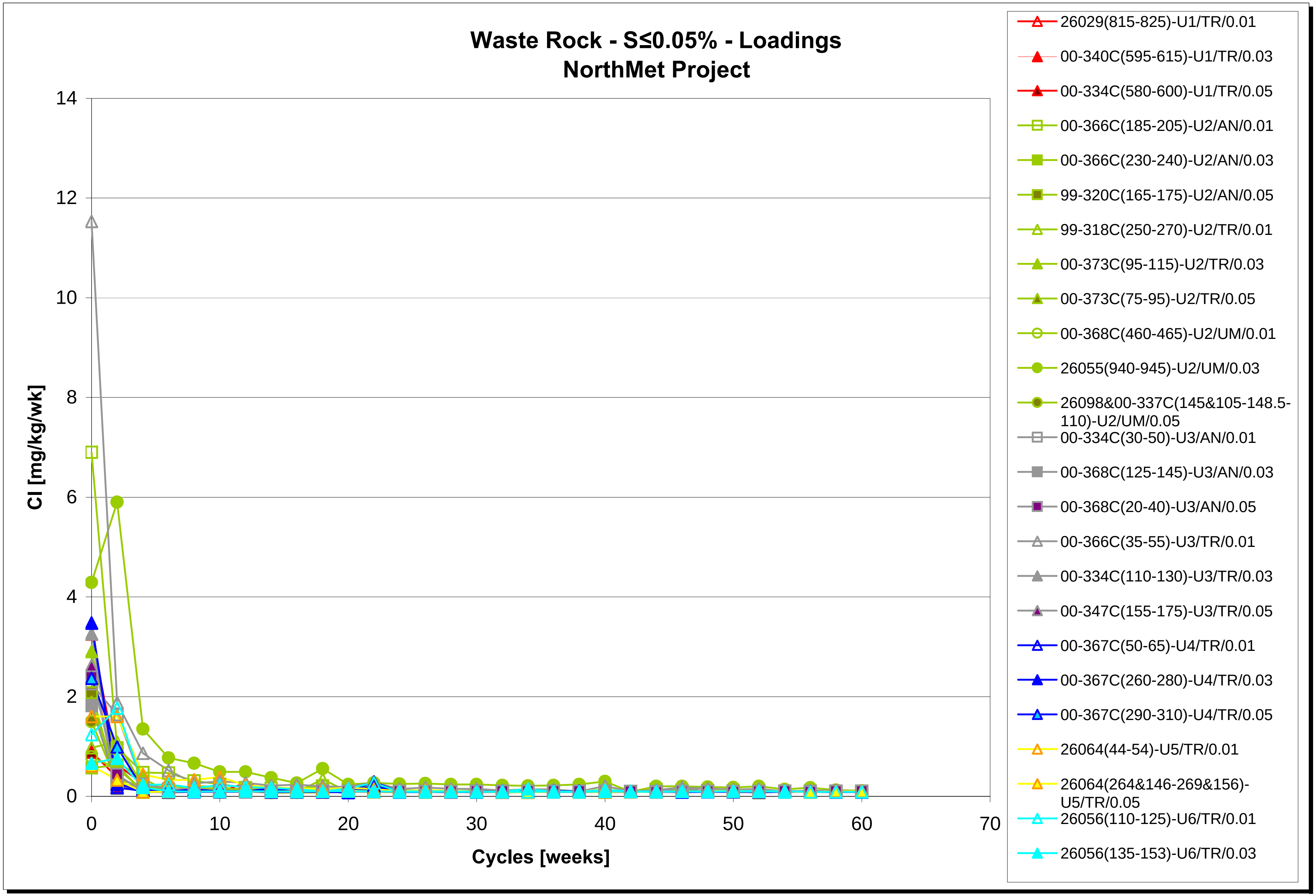

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

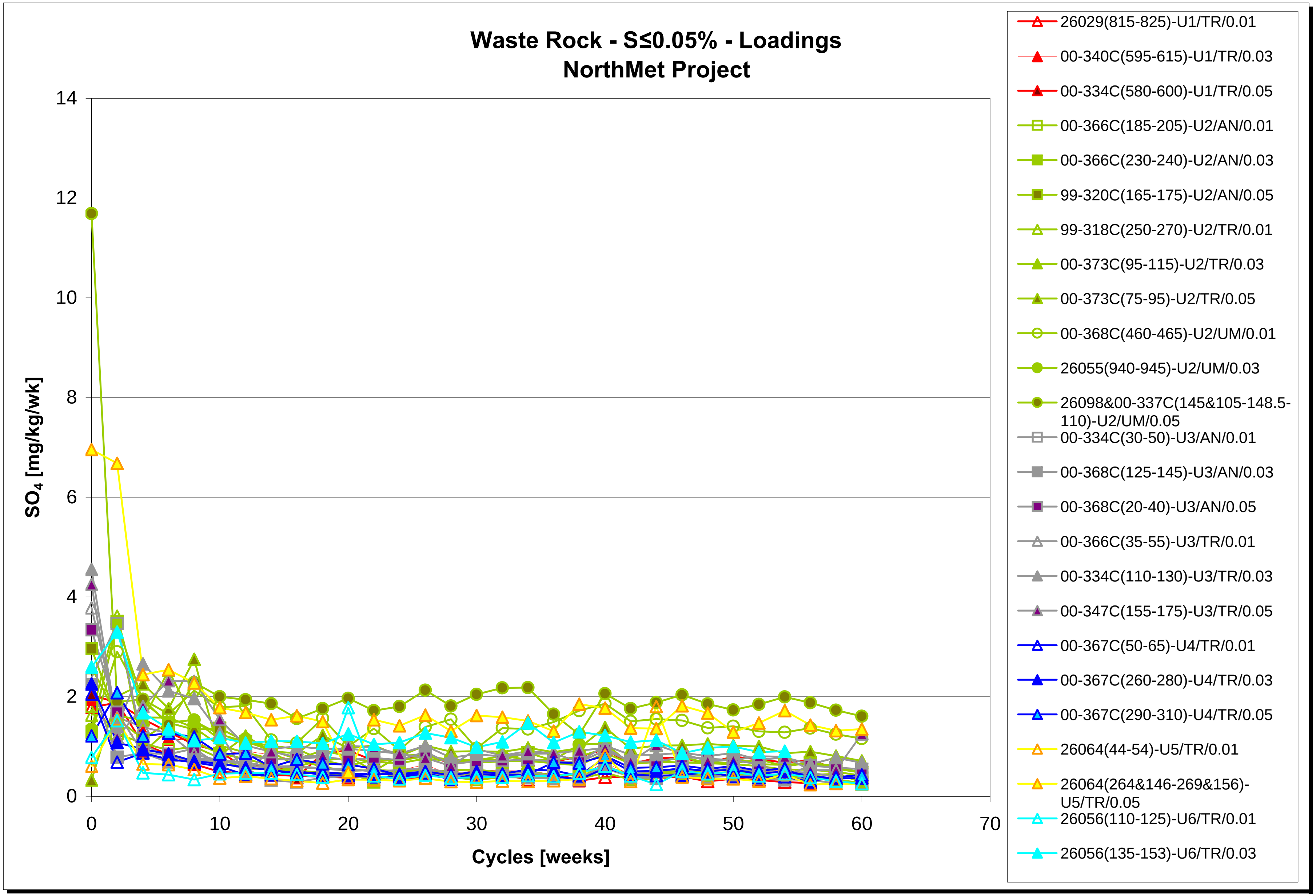

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Alcalinity [mgCaCO3/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

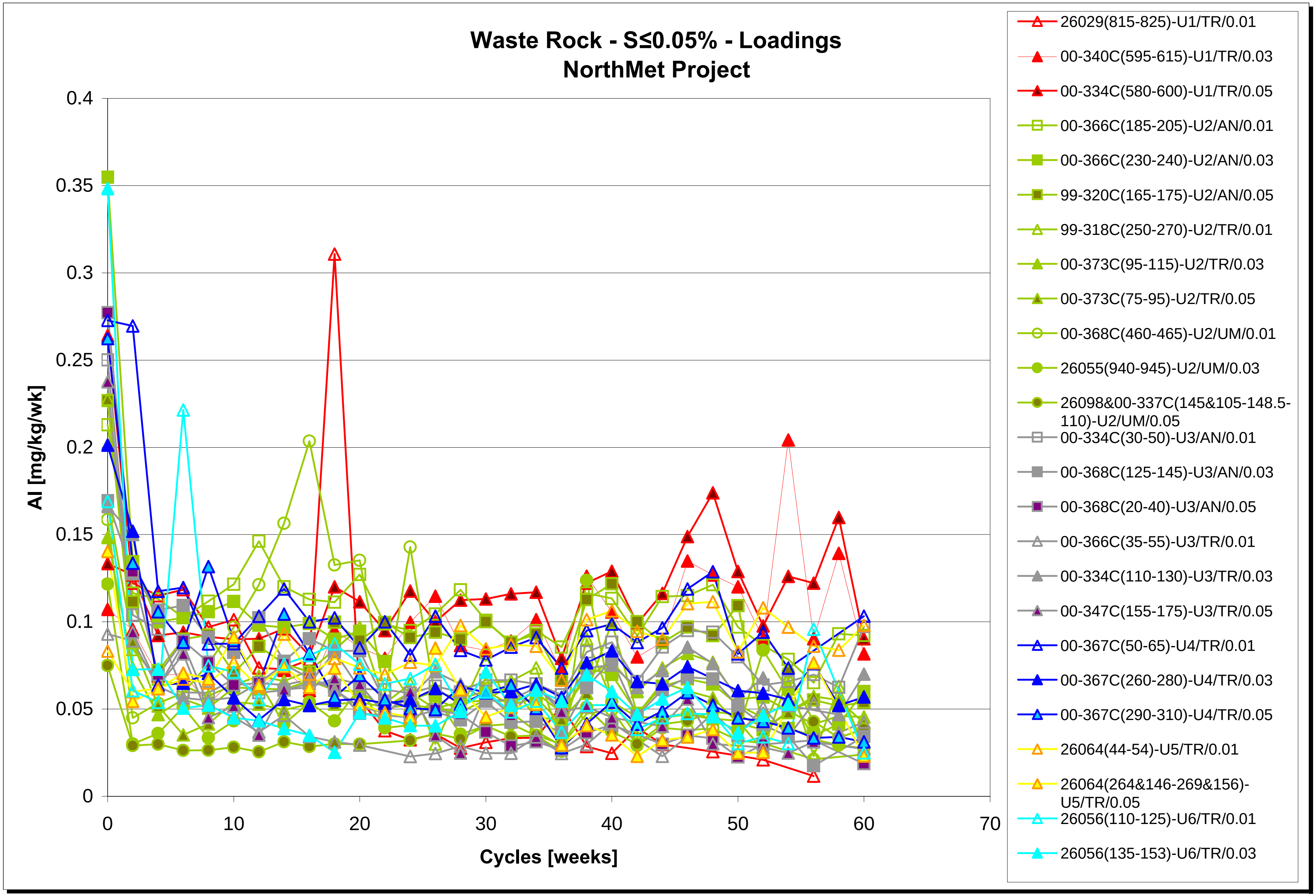

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Inorganic Carbon [mg/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
F [mg/kg/wk]
Cycles [weeks]
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
Cl [mg/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

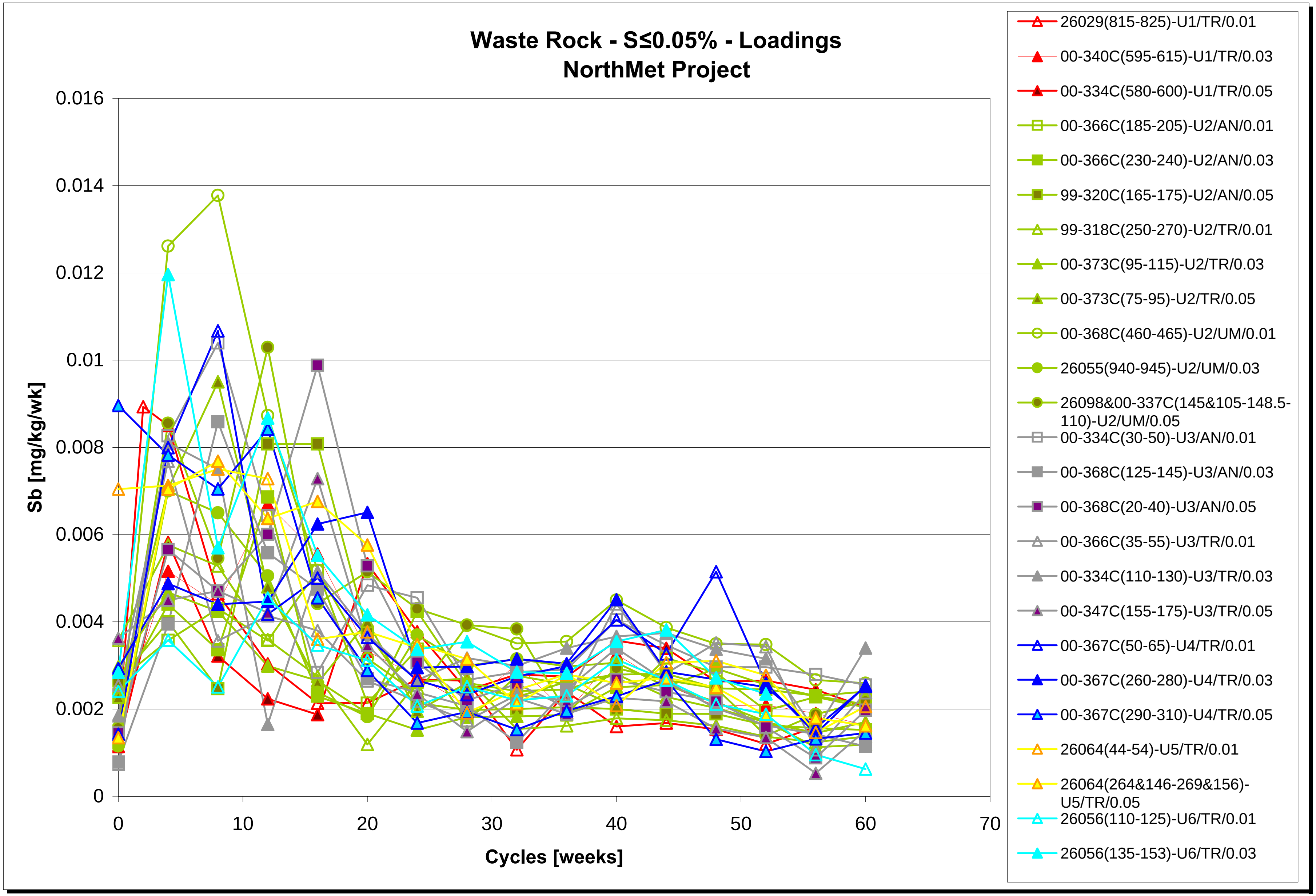

Waste Rock - S≤0.05% - Loadings
NorthMet Project
SO4 [mg/kg/wk]
Cycles [weeks]
14
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03



Waste Rock - S≤0.05% - Loadings
NorthMet Project
Al [mg/kg/wk]
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

Appendix E.1
Lower Sulfur Waste Rock

Chart E.1.12



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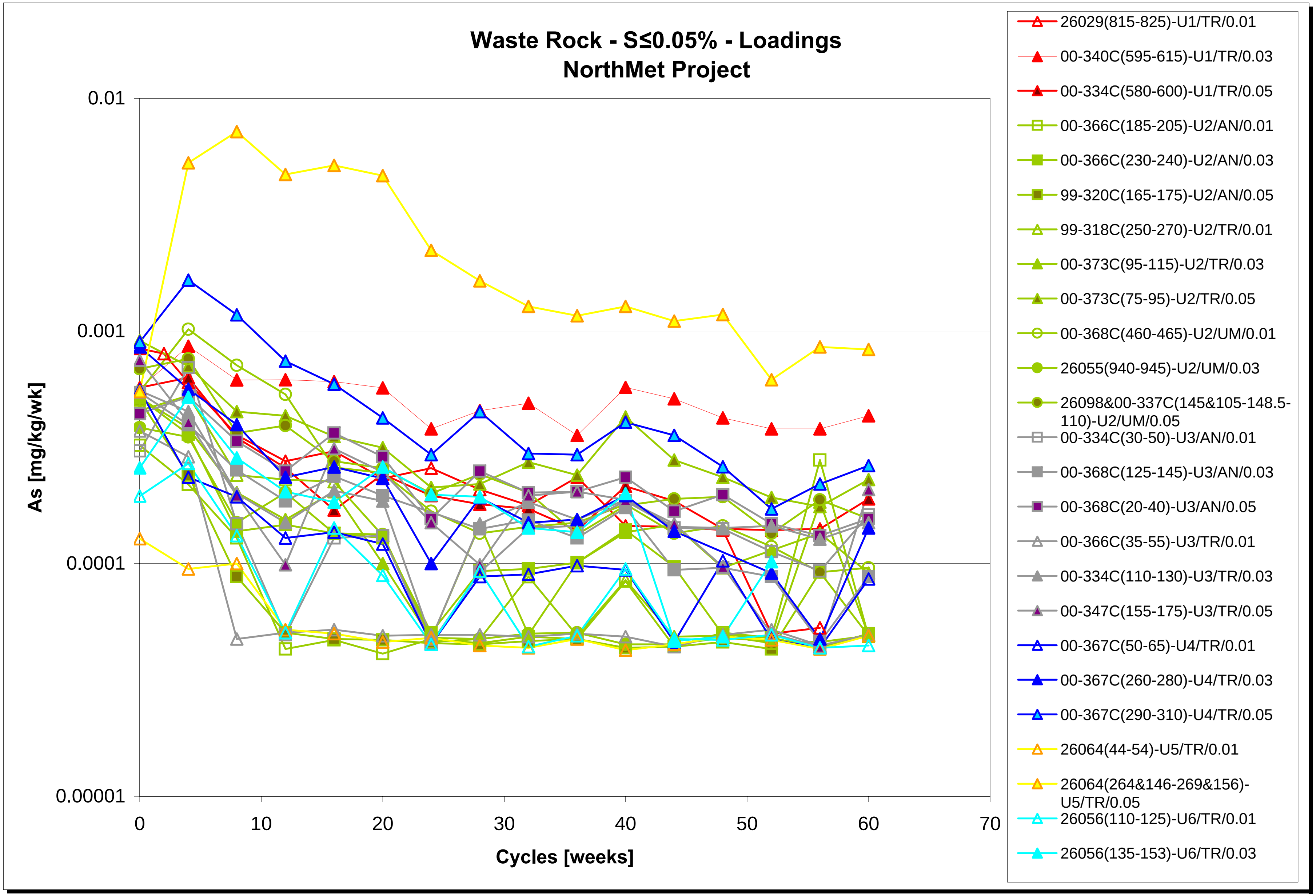
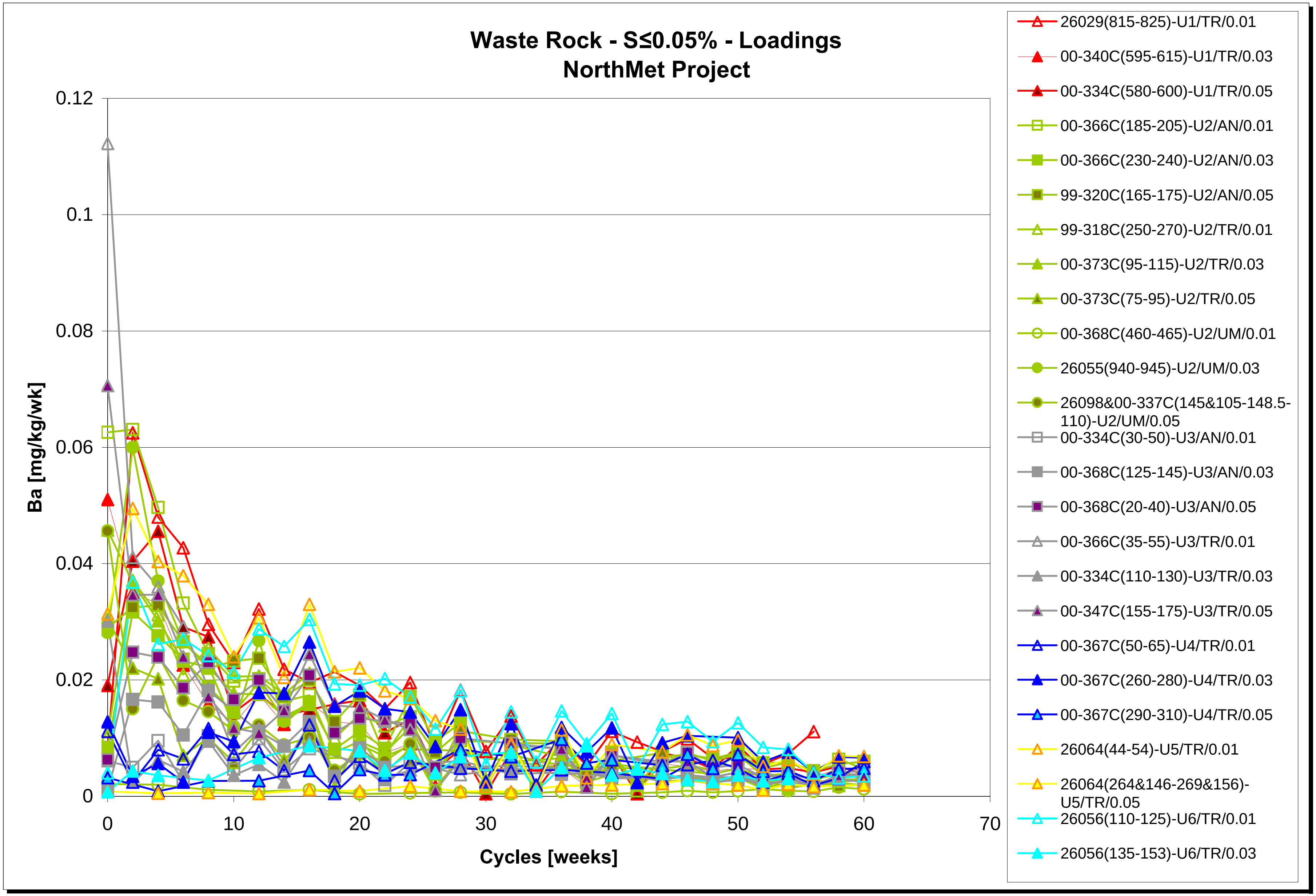
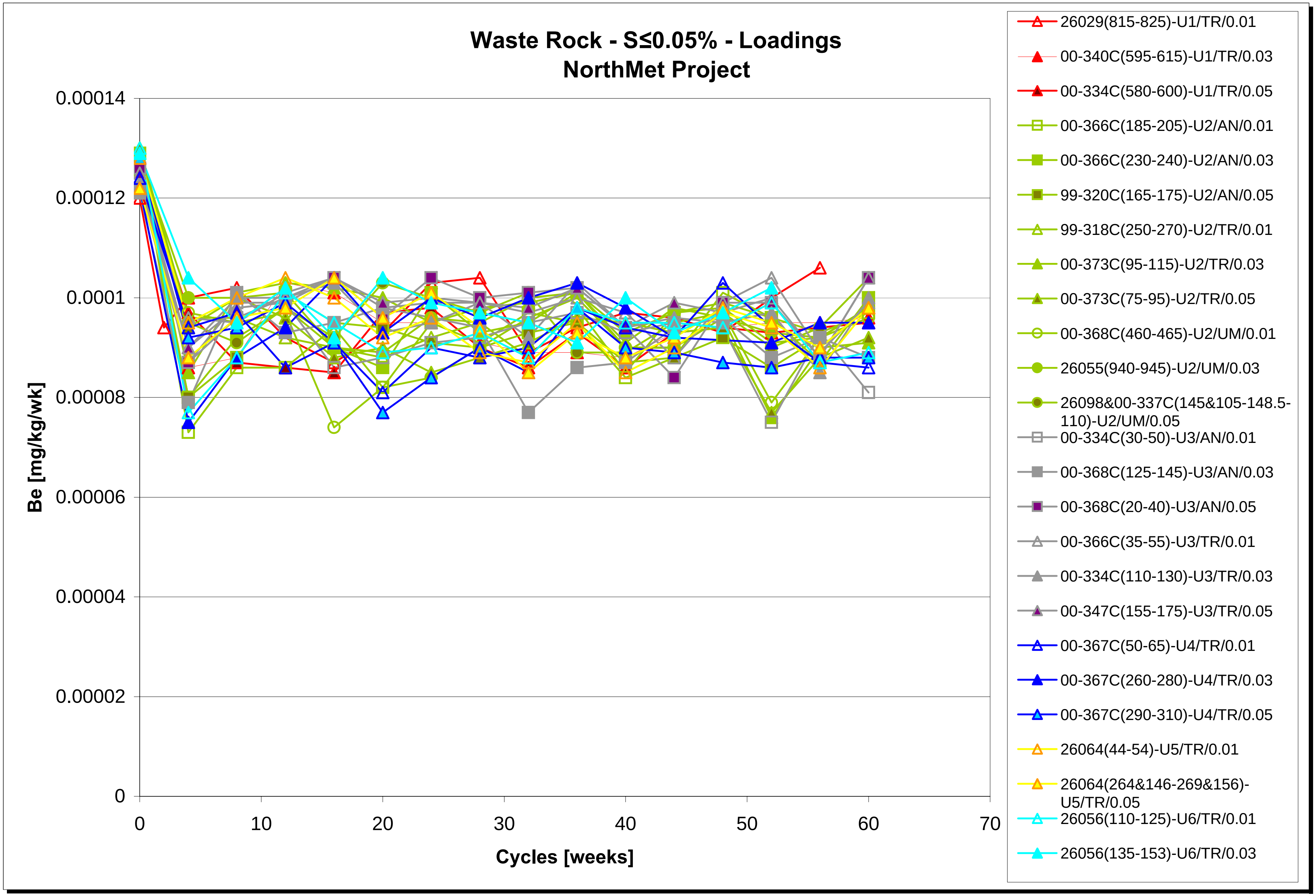
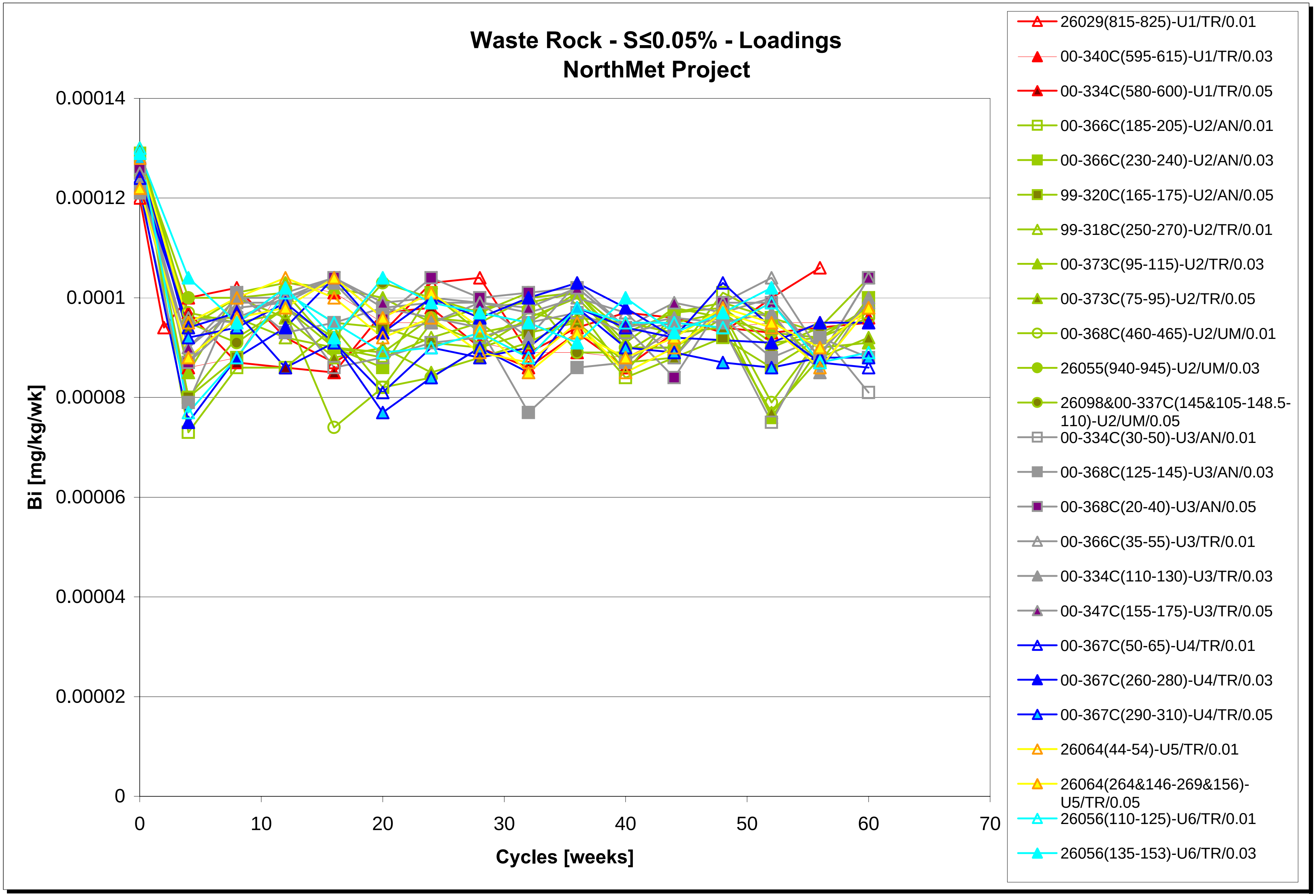
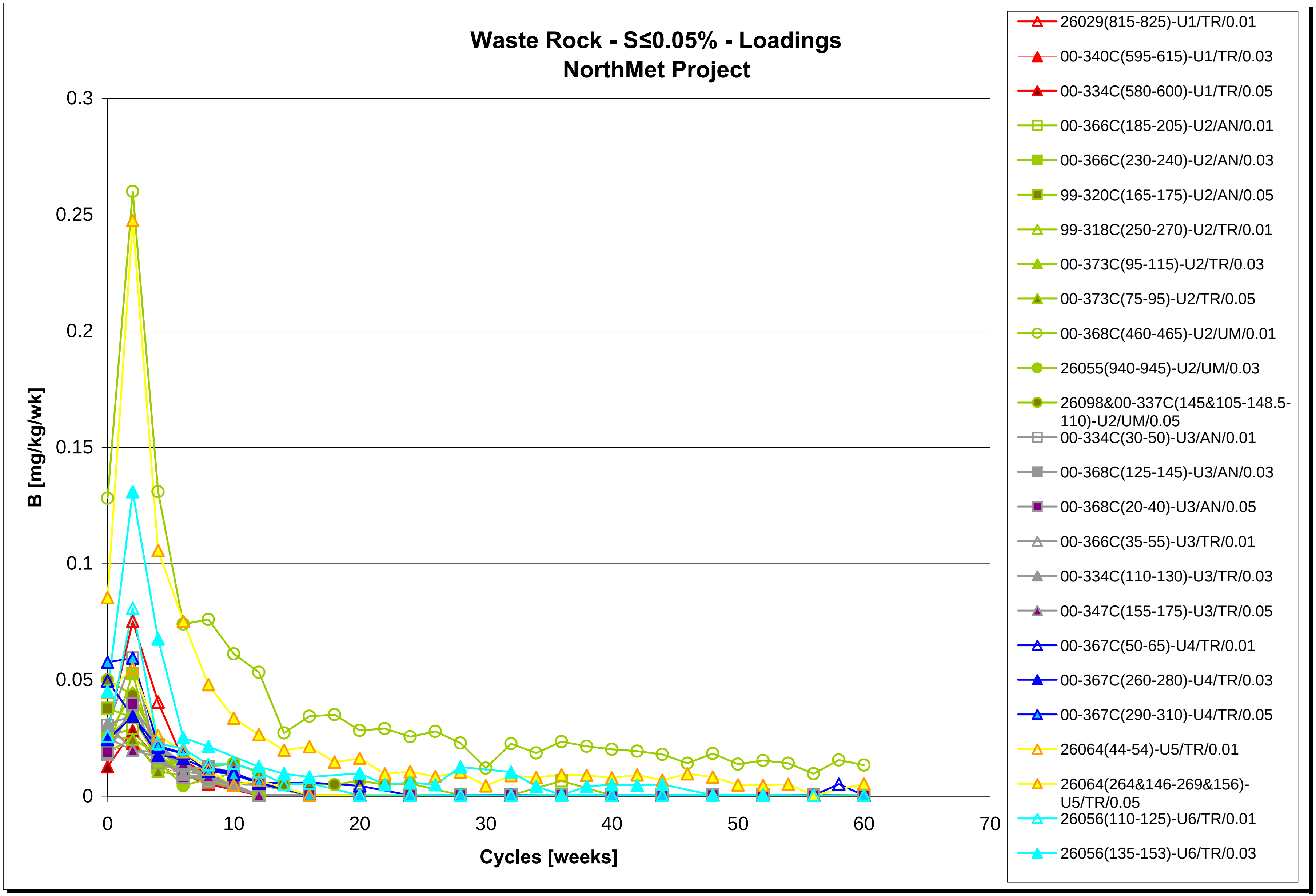
February 2007

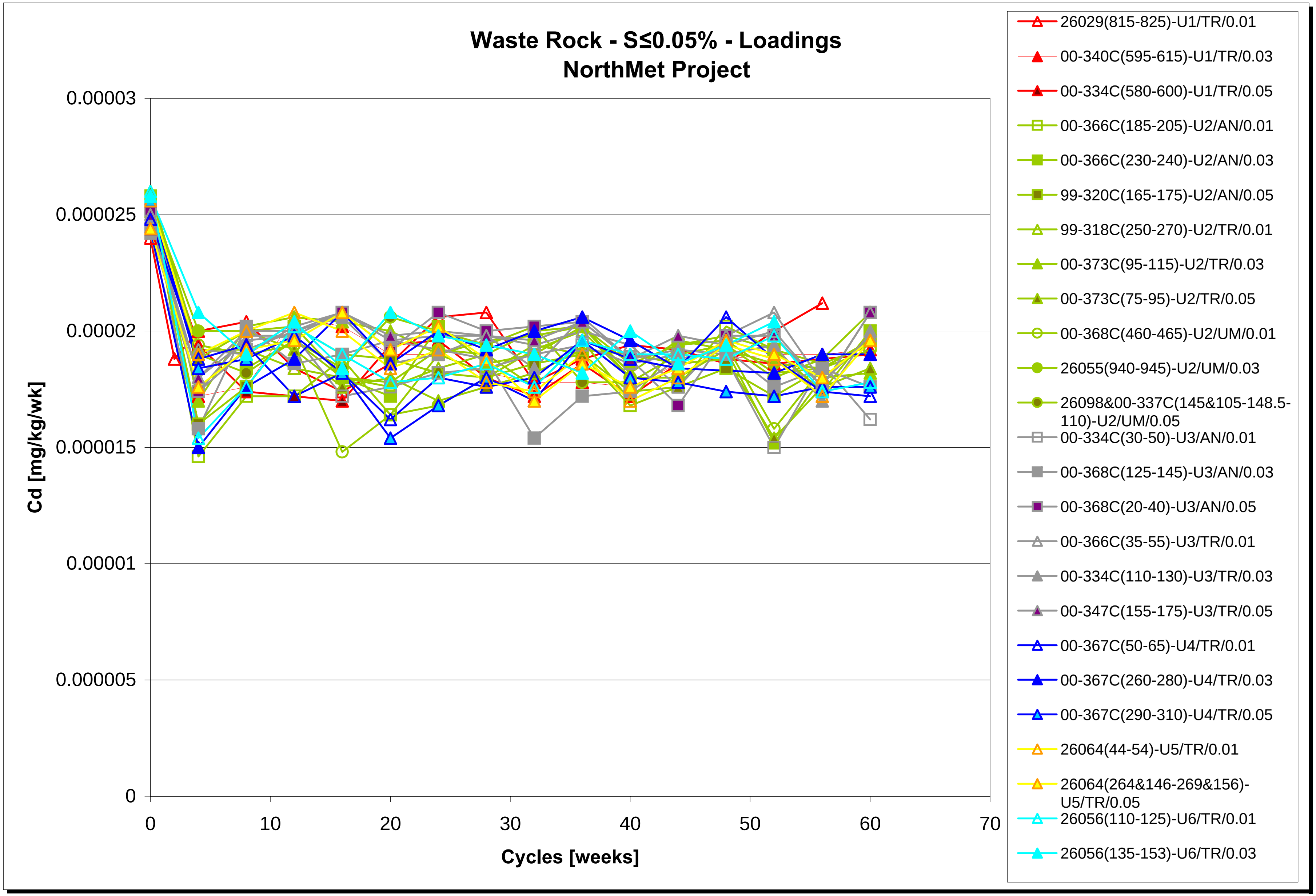

Waste Rock - S≤0.05% - Loadings
NorthMet Project
0.01
0.001
0.0001
0.00001
As [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

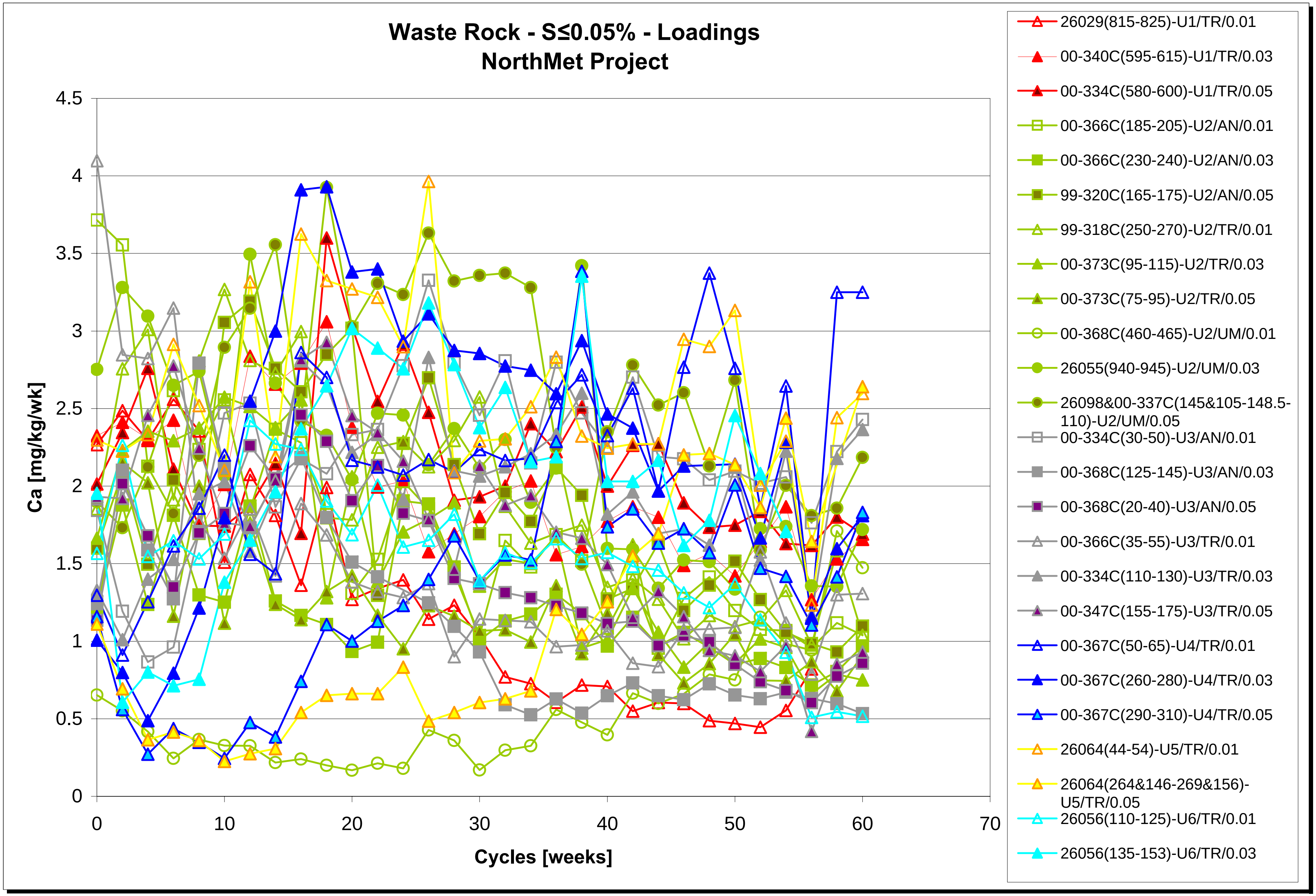

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Ba [mg/kg/wk]
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

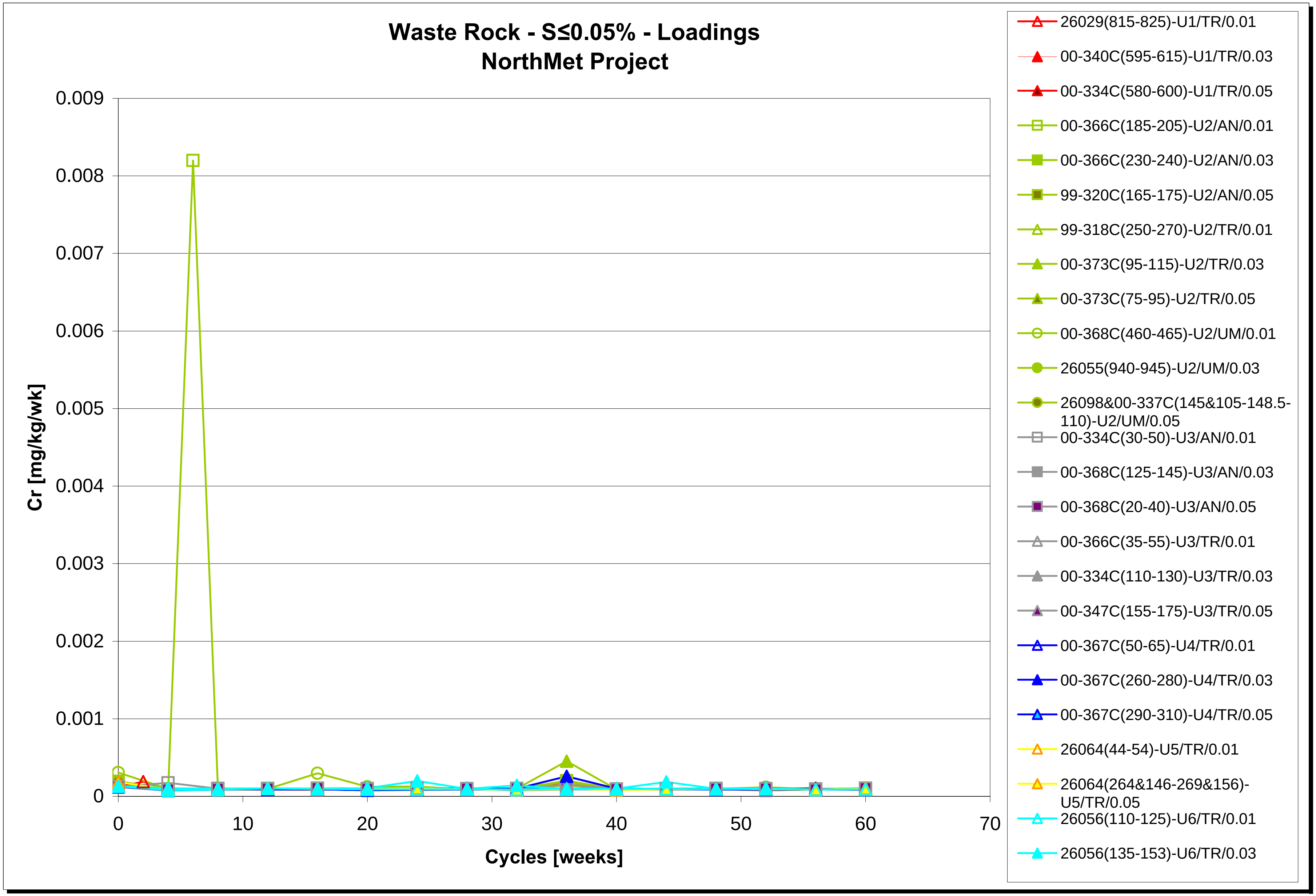

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Be [mg/kg/wk]
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

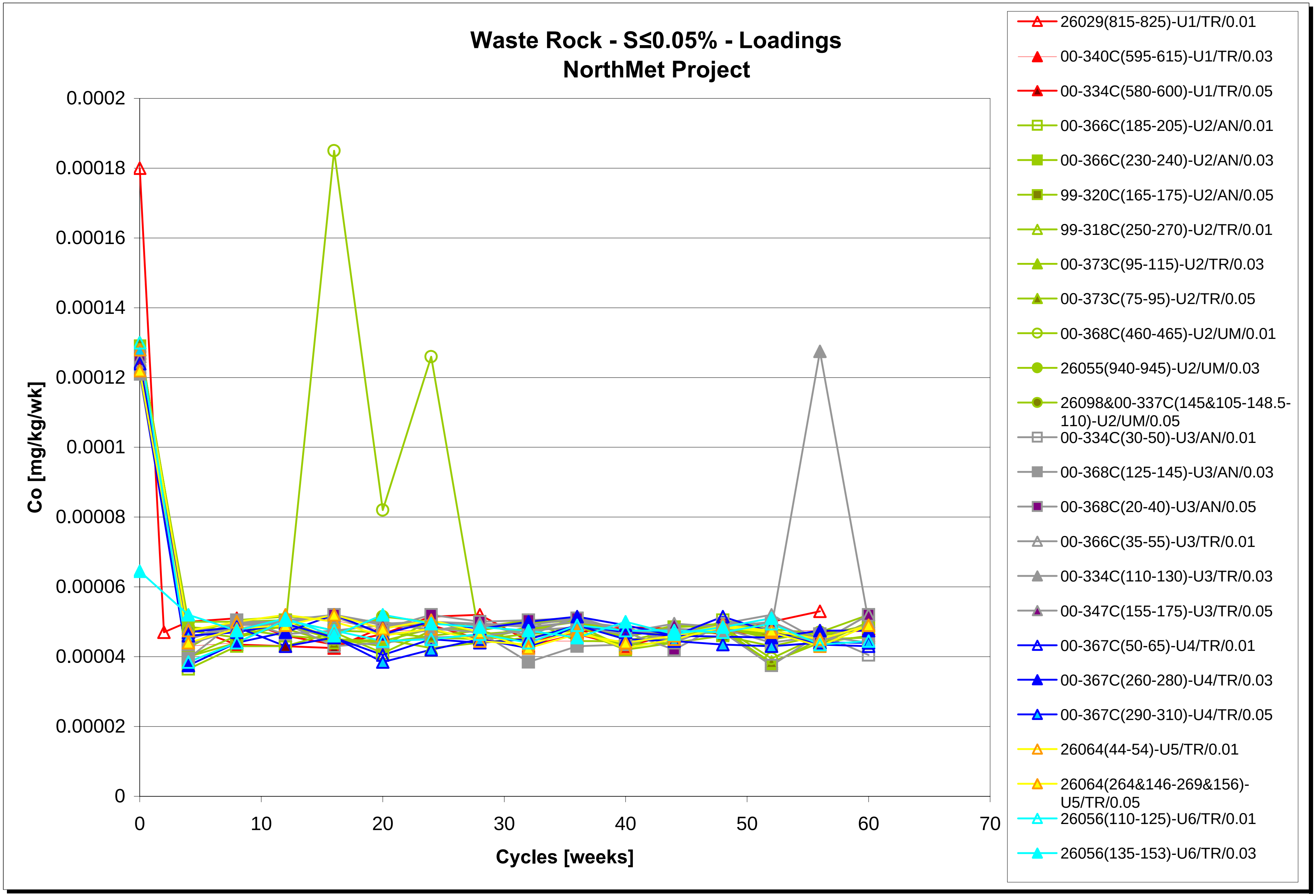

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Bi [mg/kg/wk]
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

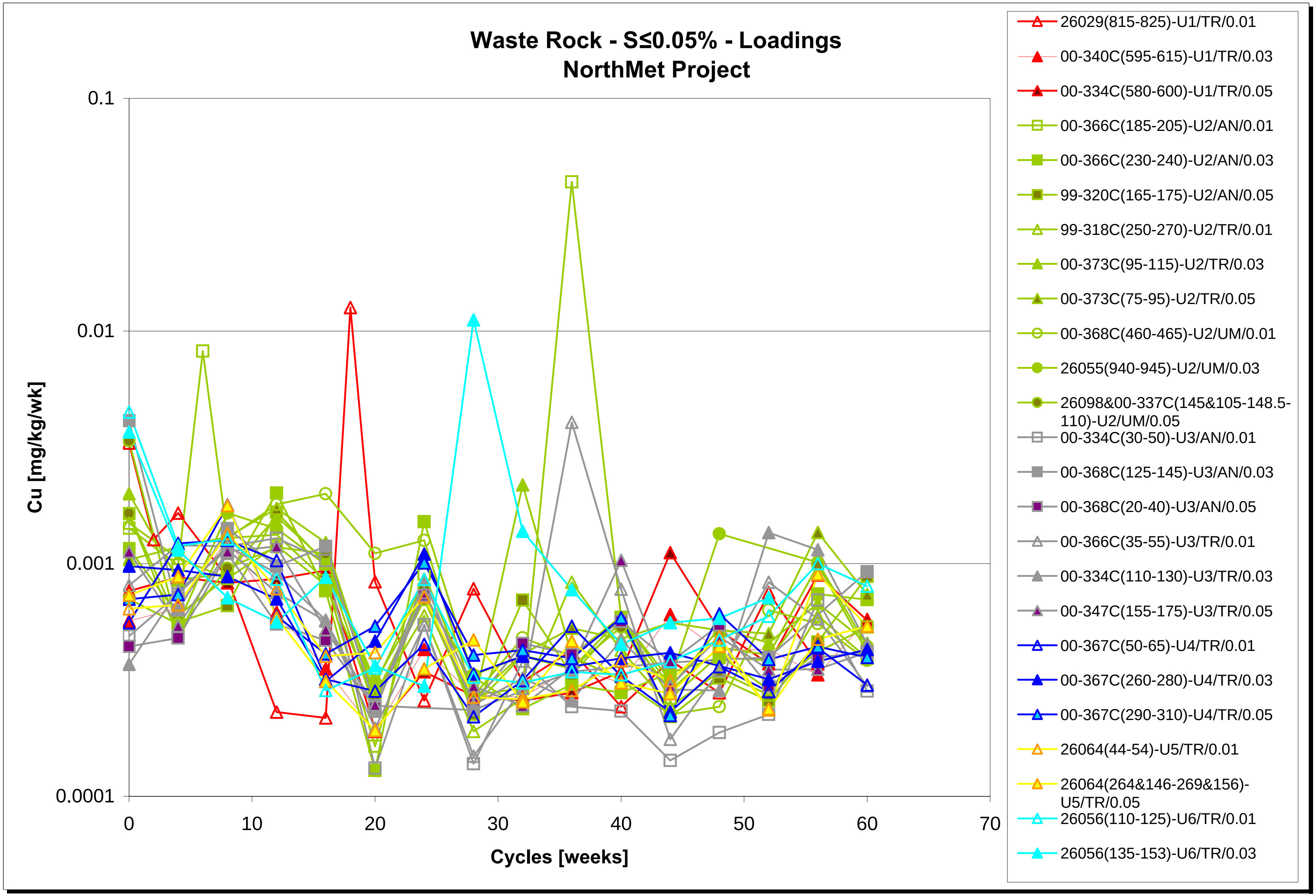

Waste Rock - S≤0.05% - Loadings
NorthMet Project
B [mg/kg/wk]
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

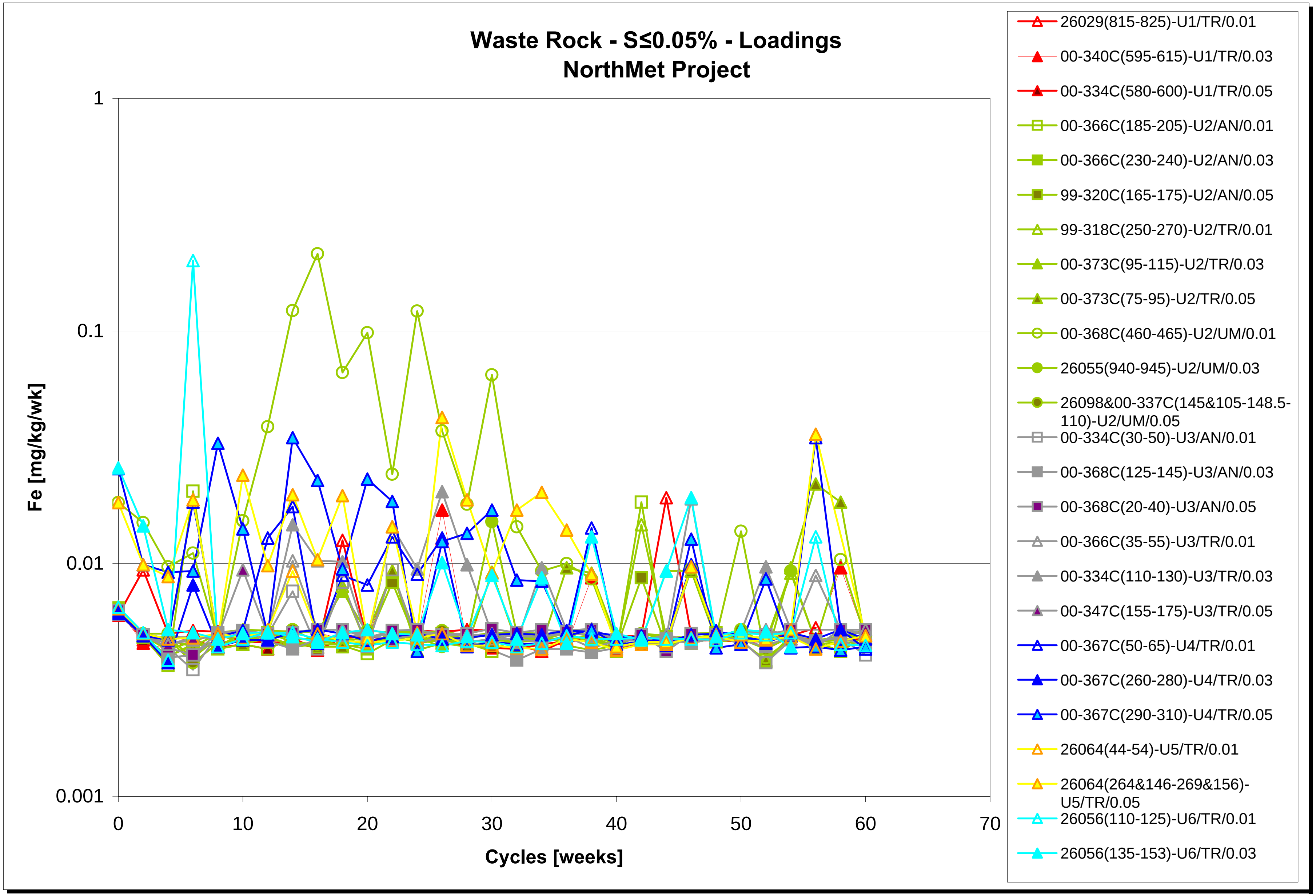

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Cd [mg/kg/wk]
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

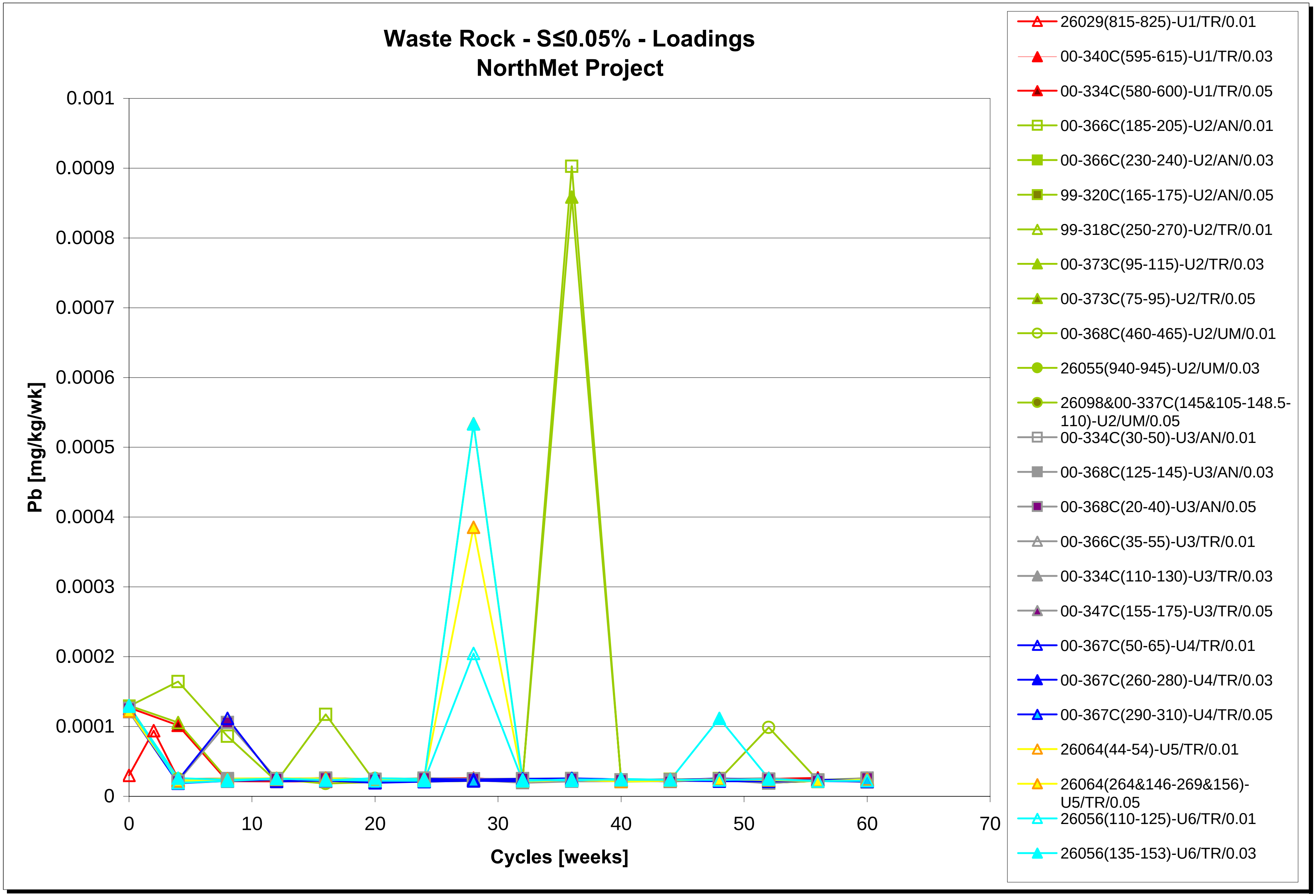

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Ca [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

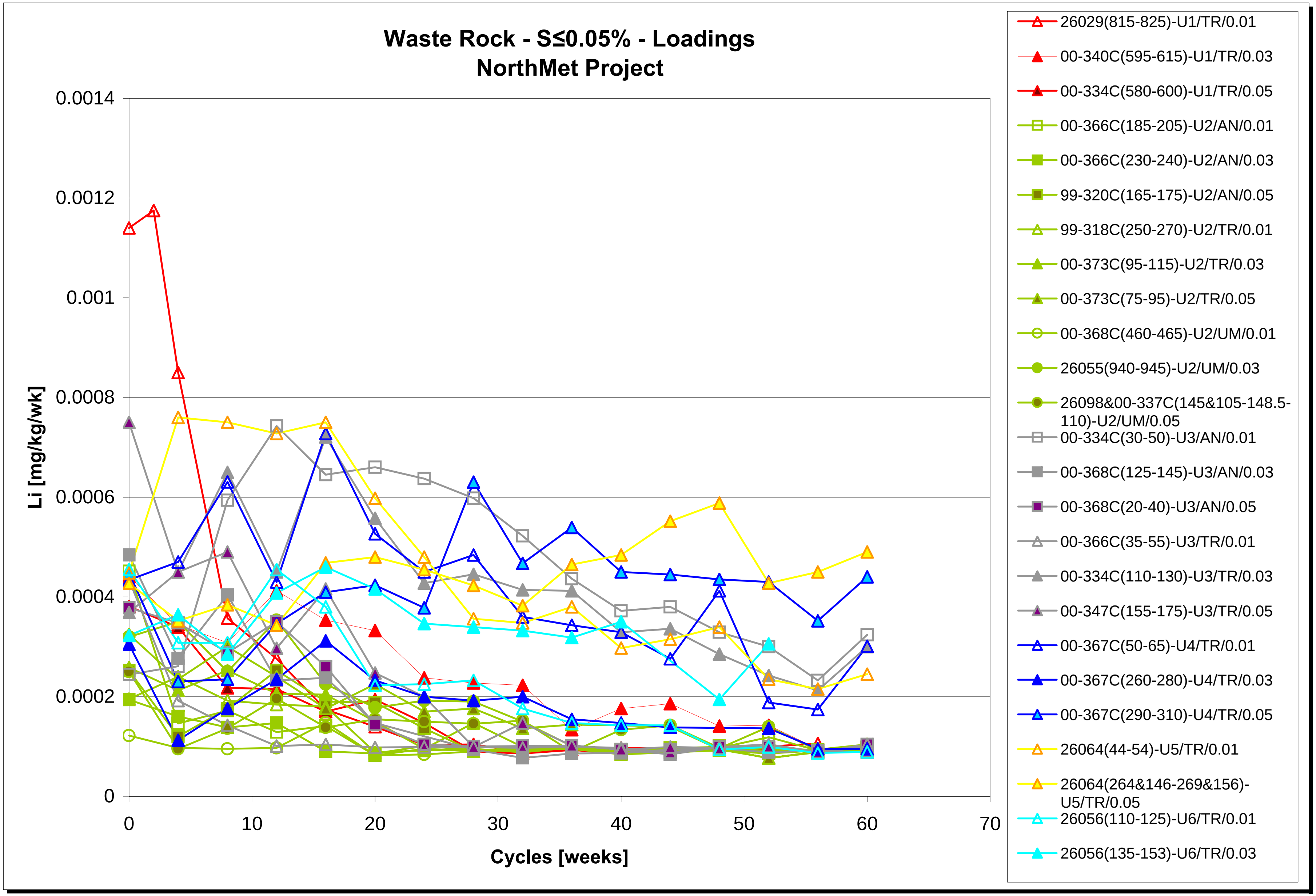

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Cr [mg/kg/wk]
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

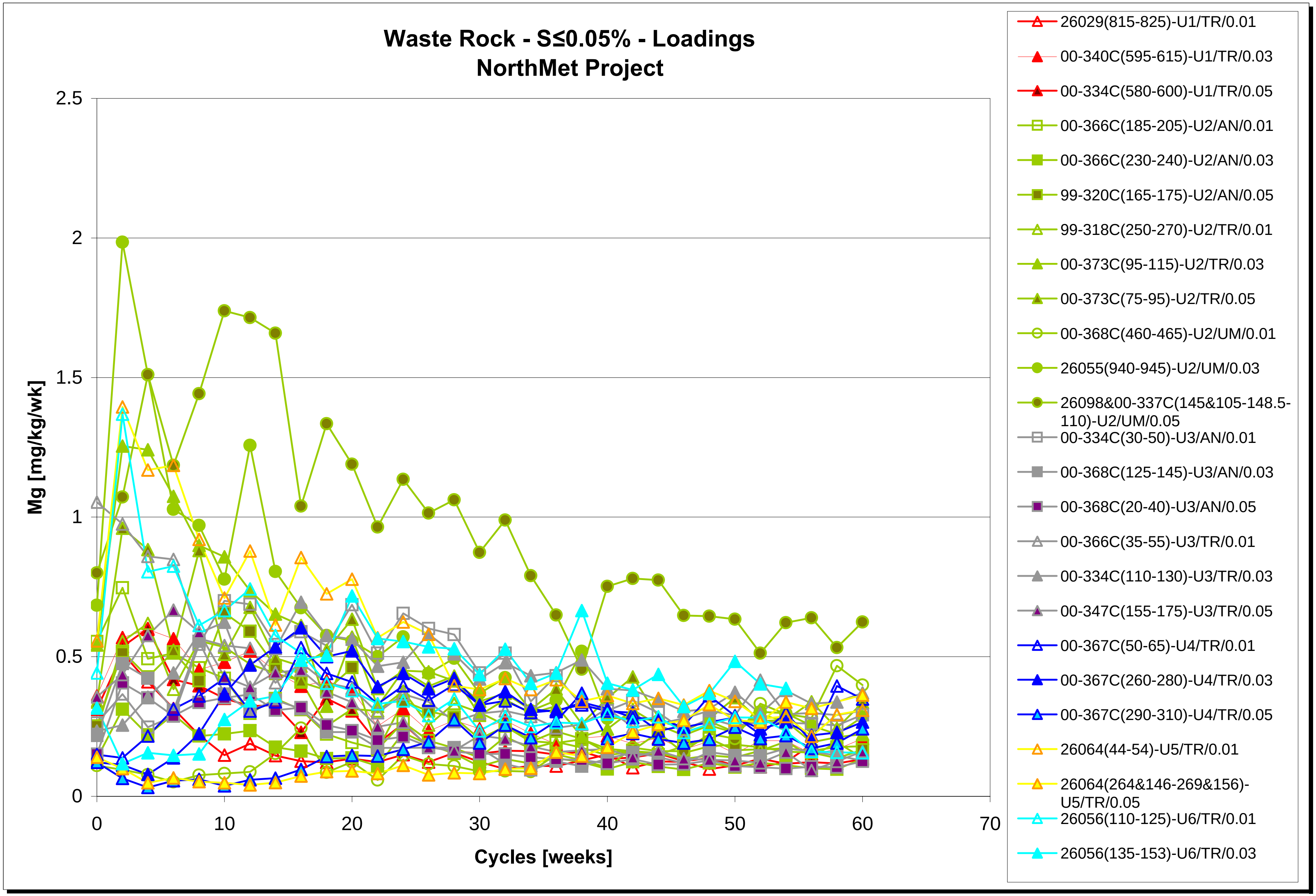

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Co [mg/kg/wk]
0.0002
0.00018
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

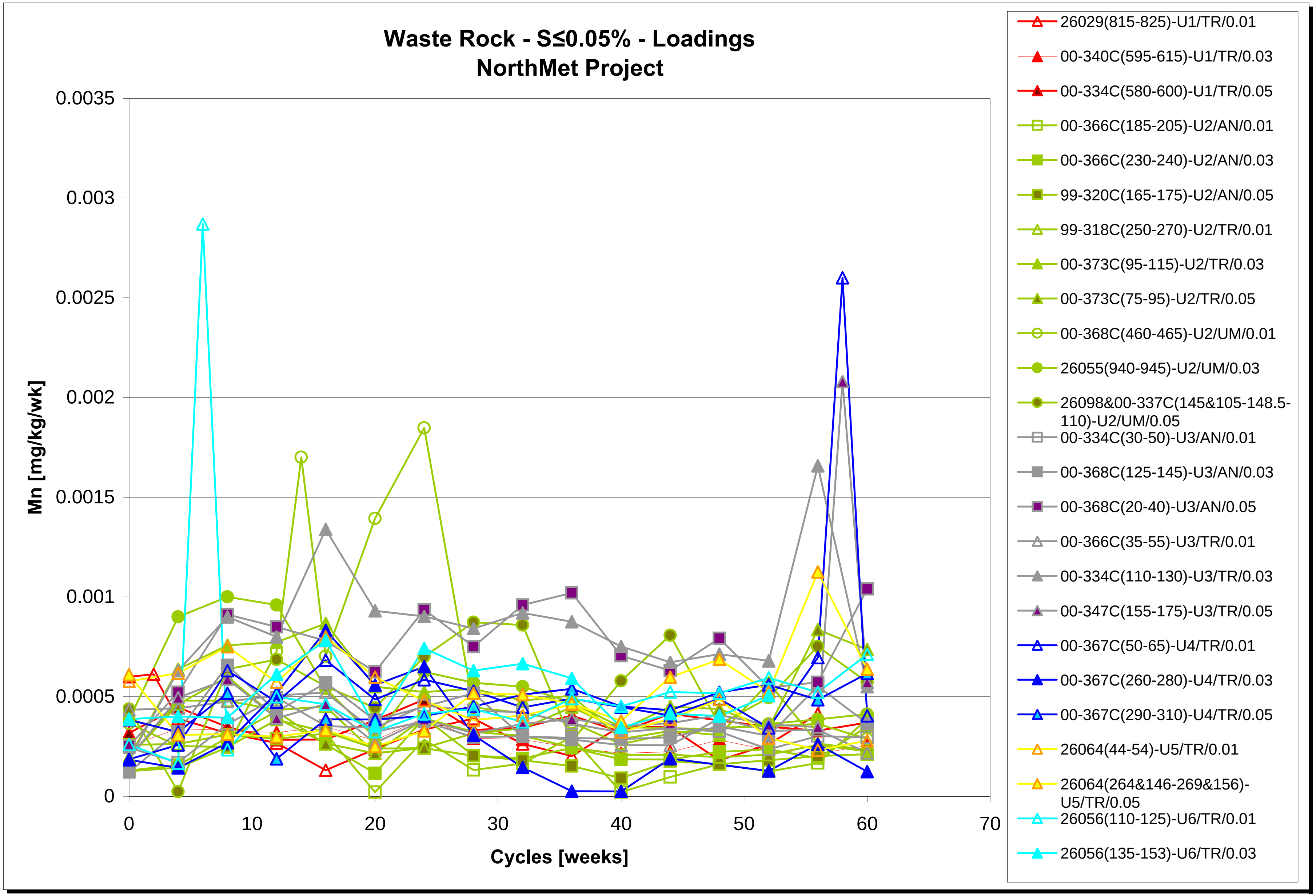

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Cu [mg/kg/wk]
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

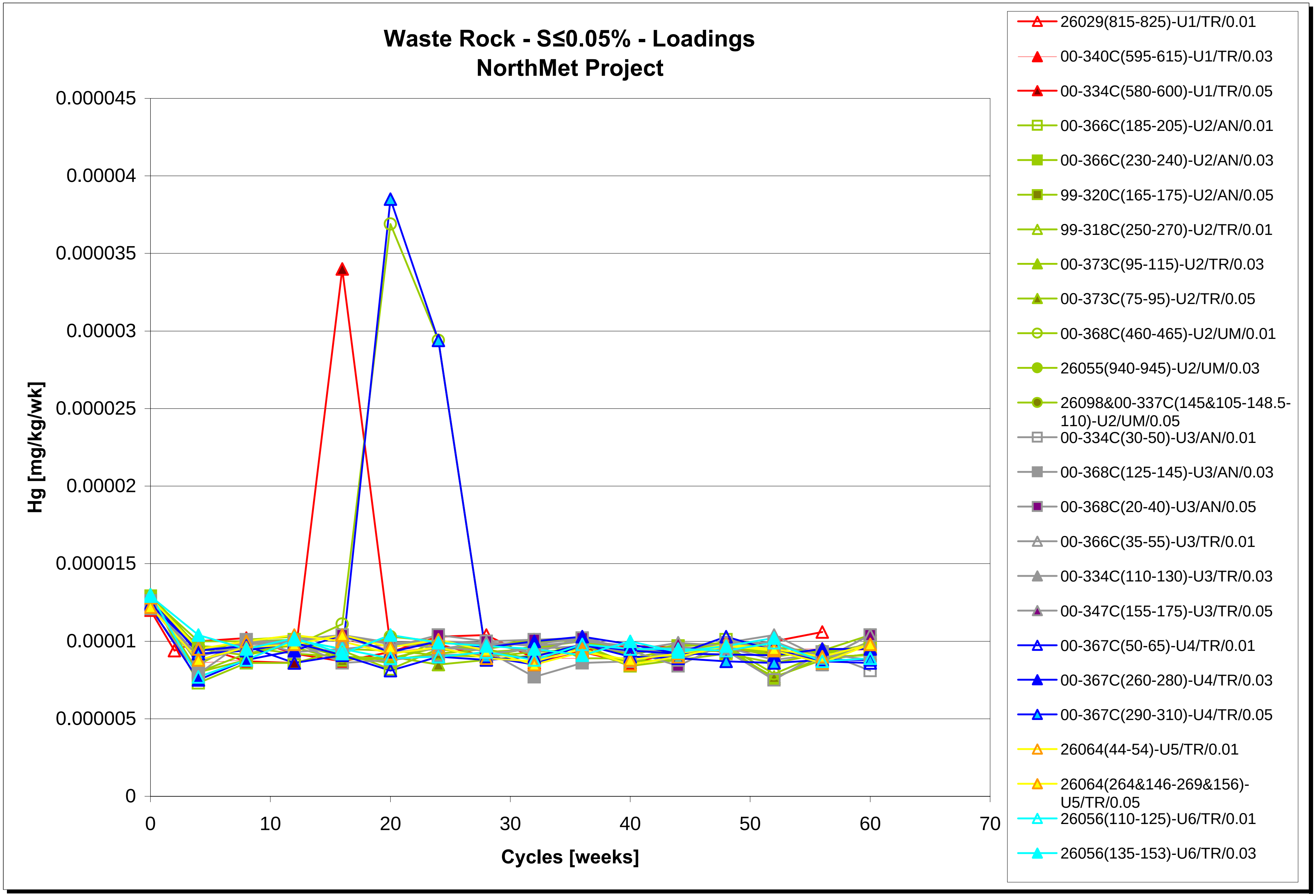

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Fe [mg/kg/wk]
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
Pb [mg/kg/wk]
0.001
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

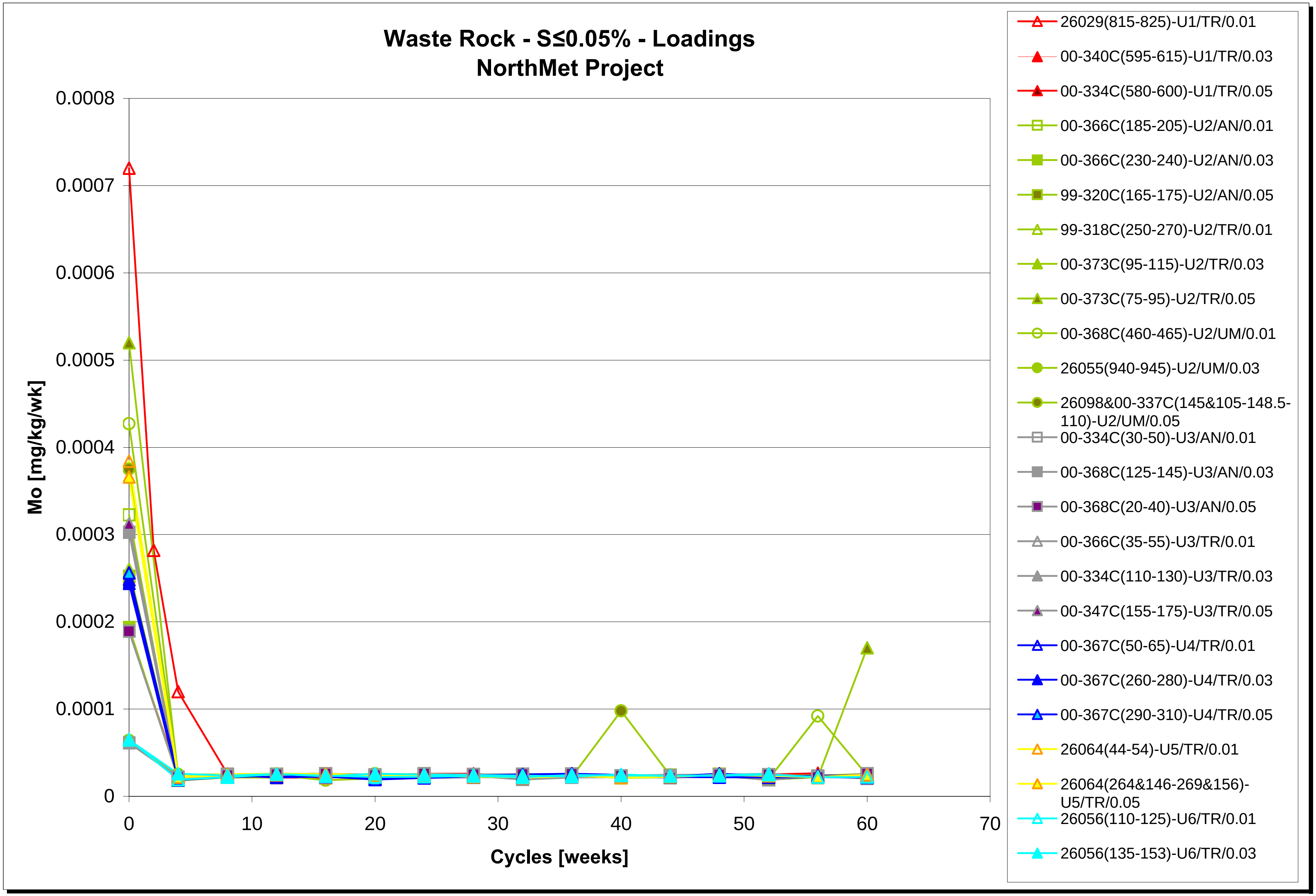

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Li [mg/kg/wk]
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

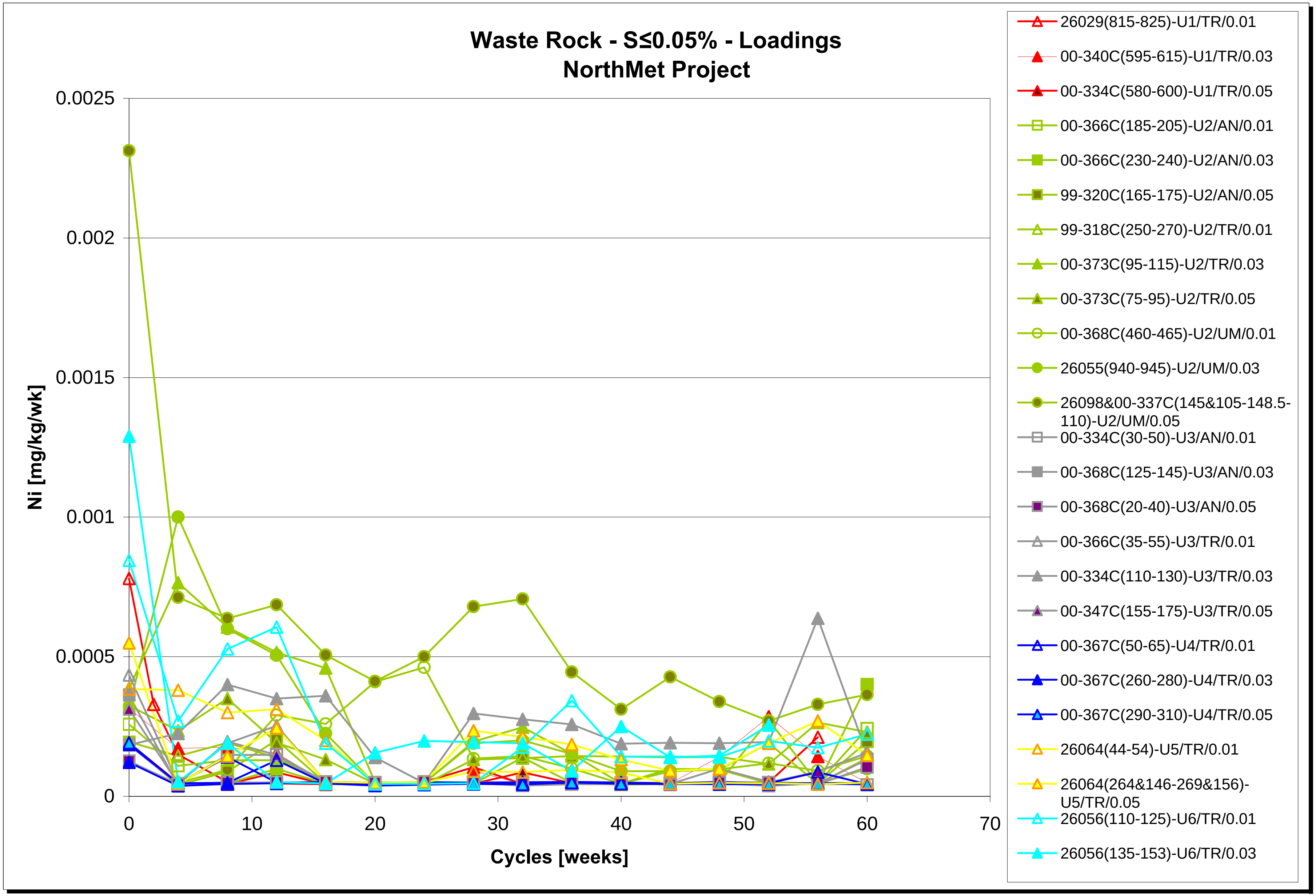

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Mg [mg/kg/wk]
Cycles [weeks]
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

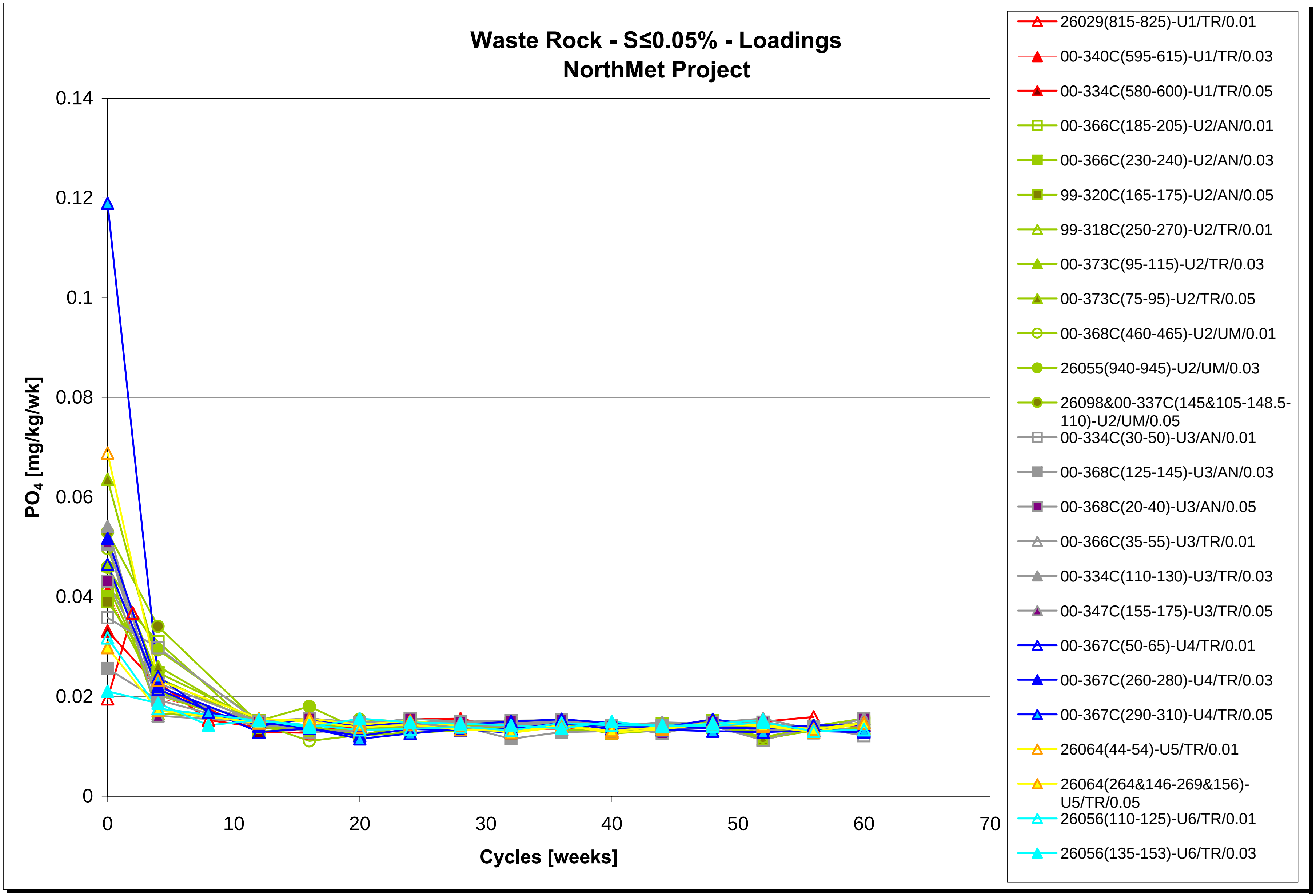

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Mn [mg/kg/wk]
Cycles [weeks]
0
0.0005
0.001
0.0015
0.002
0.0025
0.003
0.0035
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

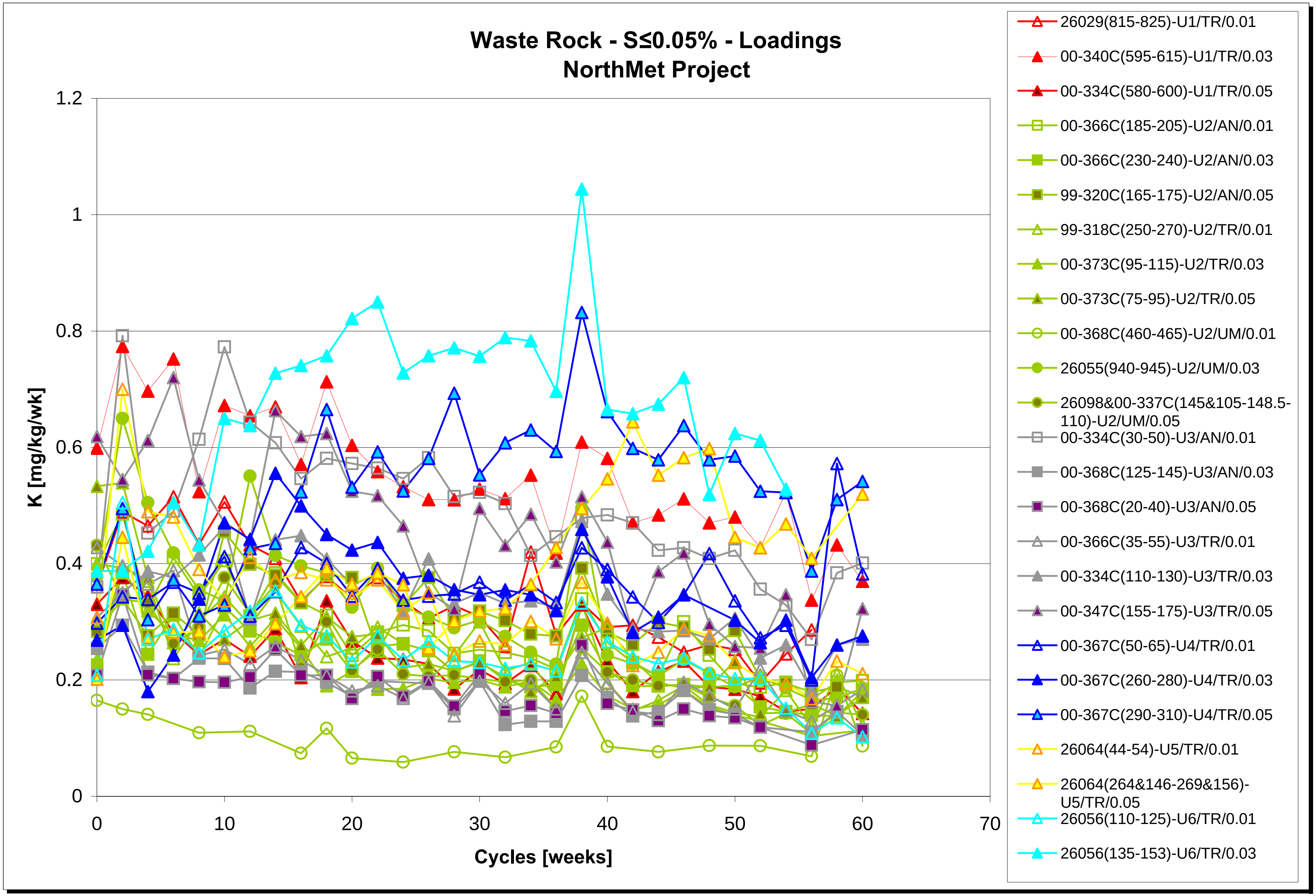


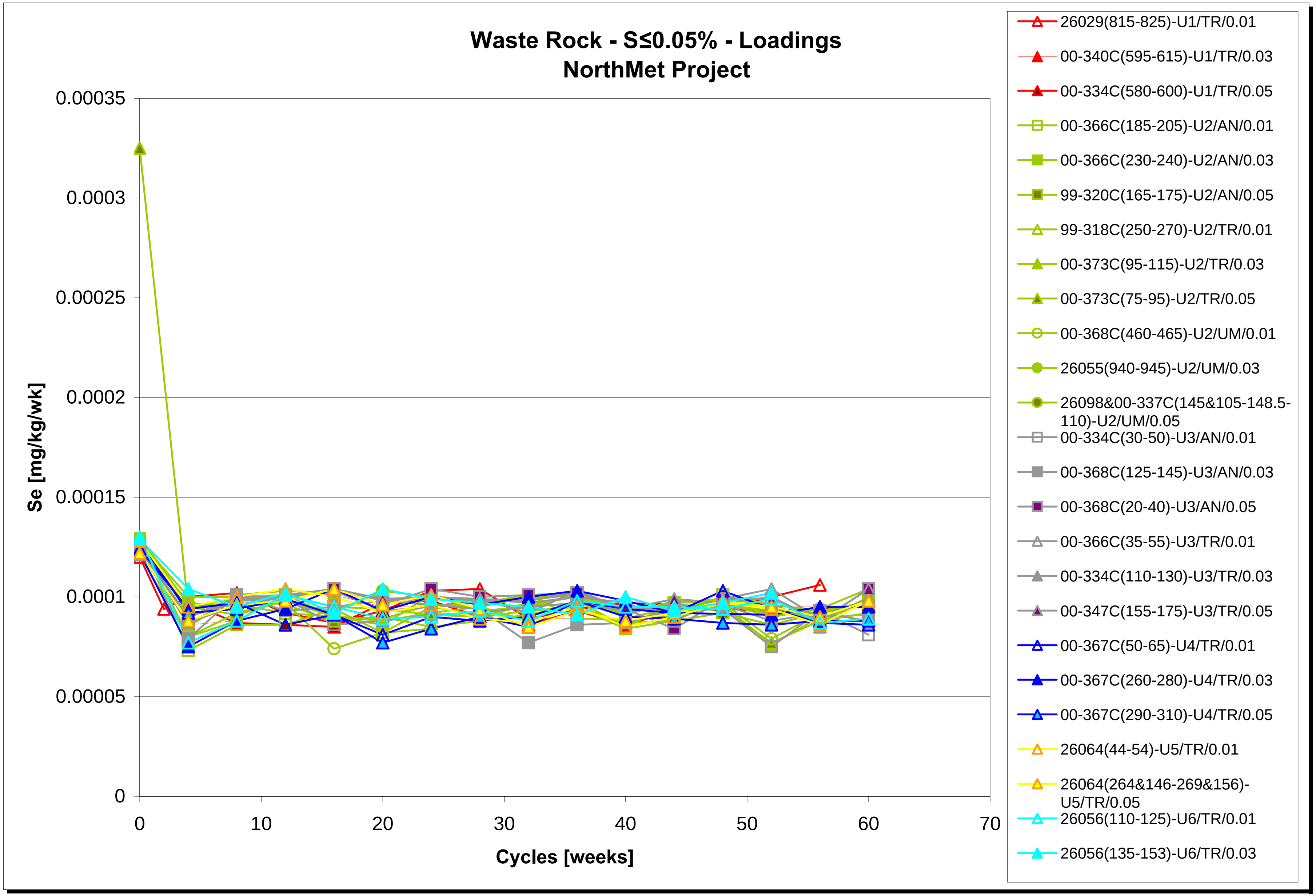
Waste Rock - S≤0.05% - Loadings
NorthMet Project
Hg [mg/kg/wk]
0.000045
0.00004
0.000035
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
Cycles [weeks]
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

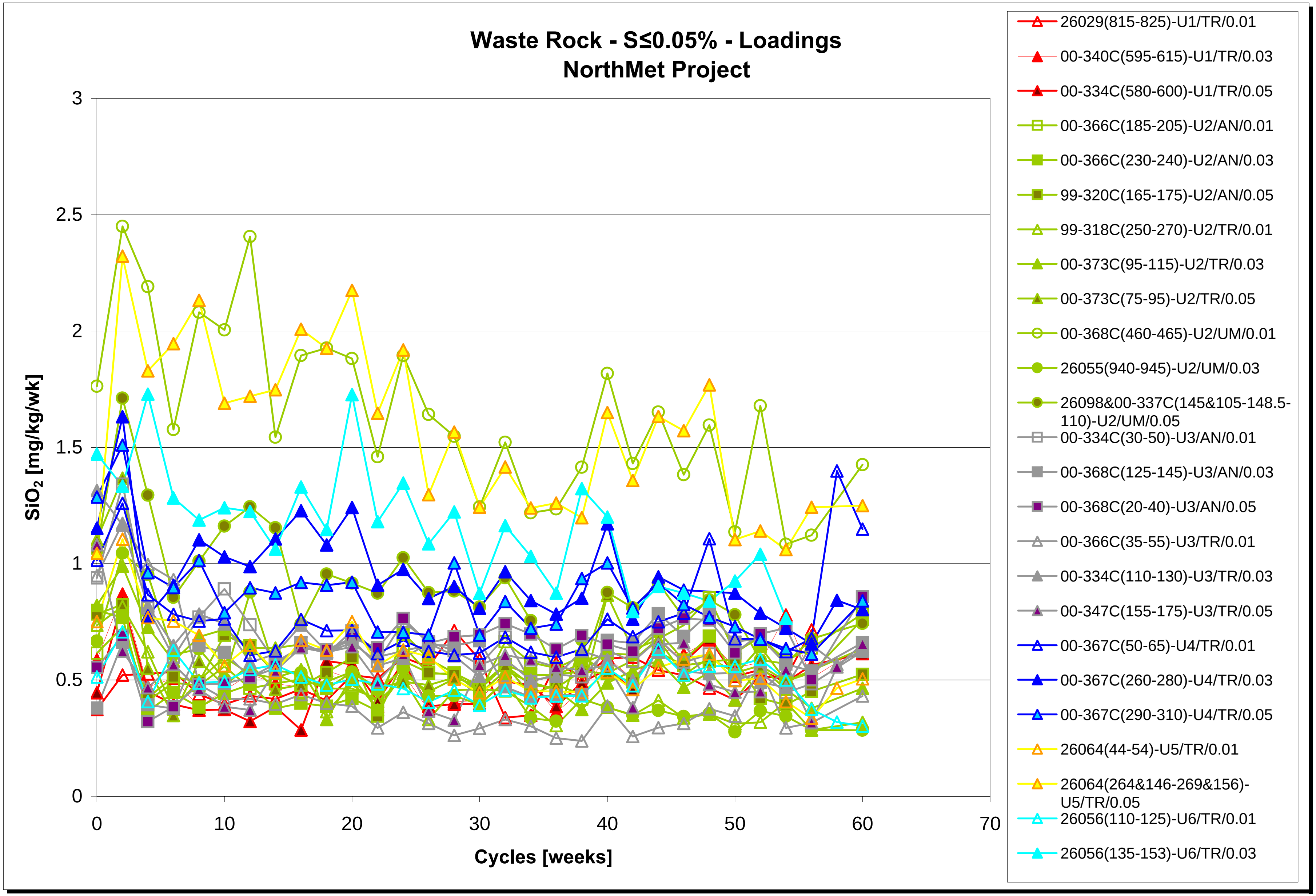

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Mo [mg/kg/wk]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

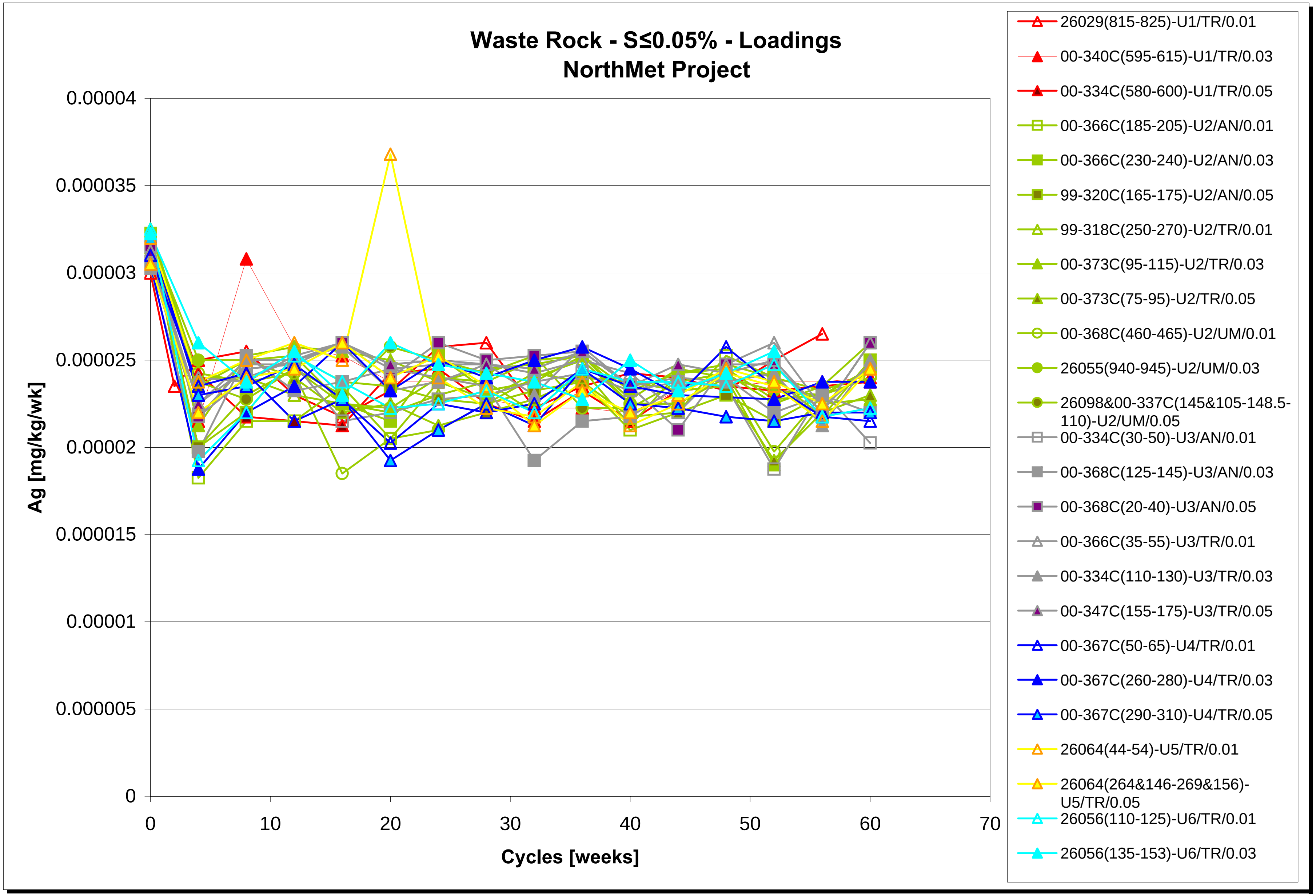

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Ni [mg/kg/wk]
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

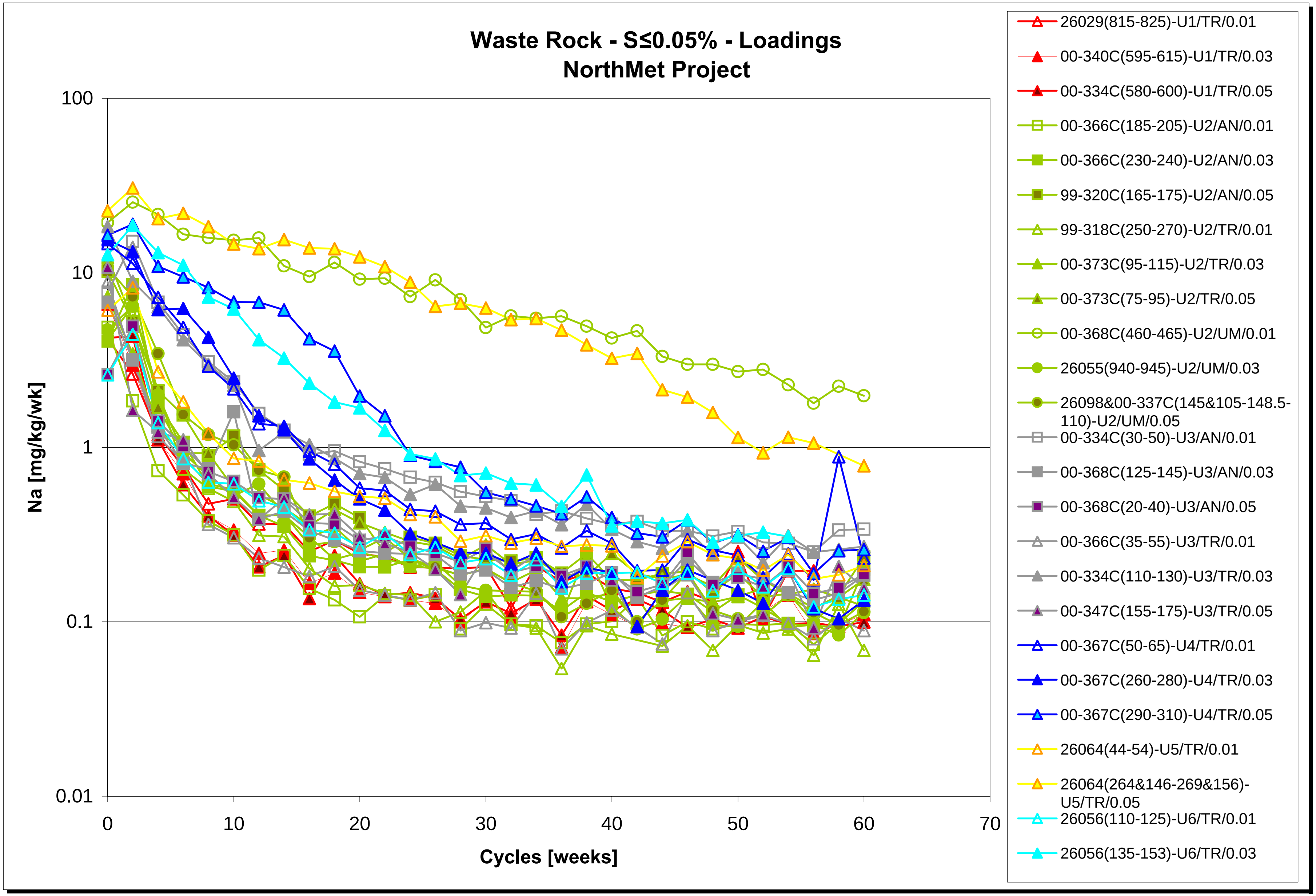

Waste Rock - S≤0.05% - Loadings
NorthMet Project
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
PO4 [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
K [mg/kg/wk]
Cycles [weeks]
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

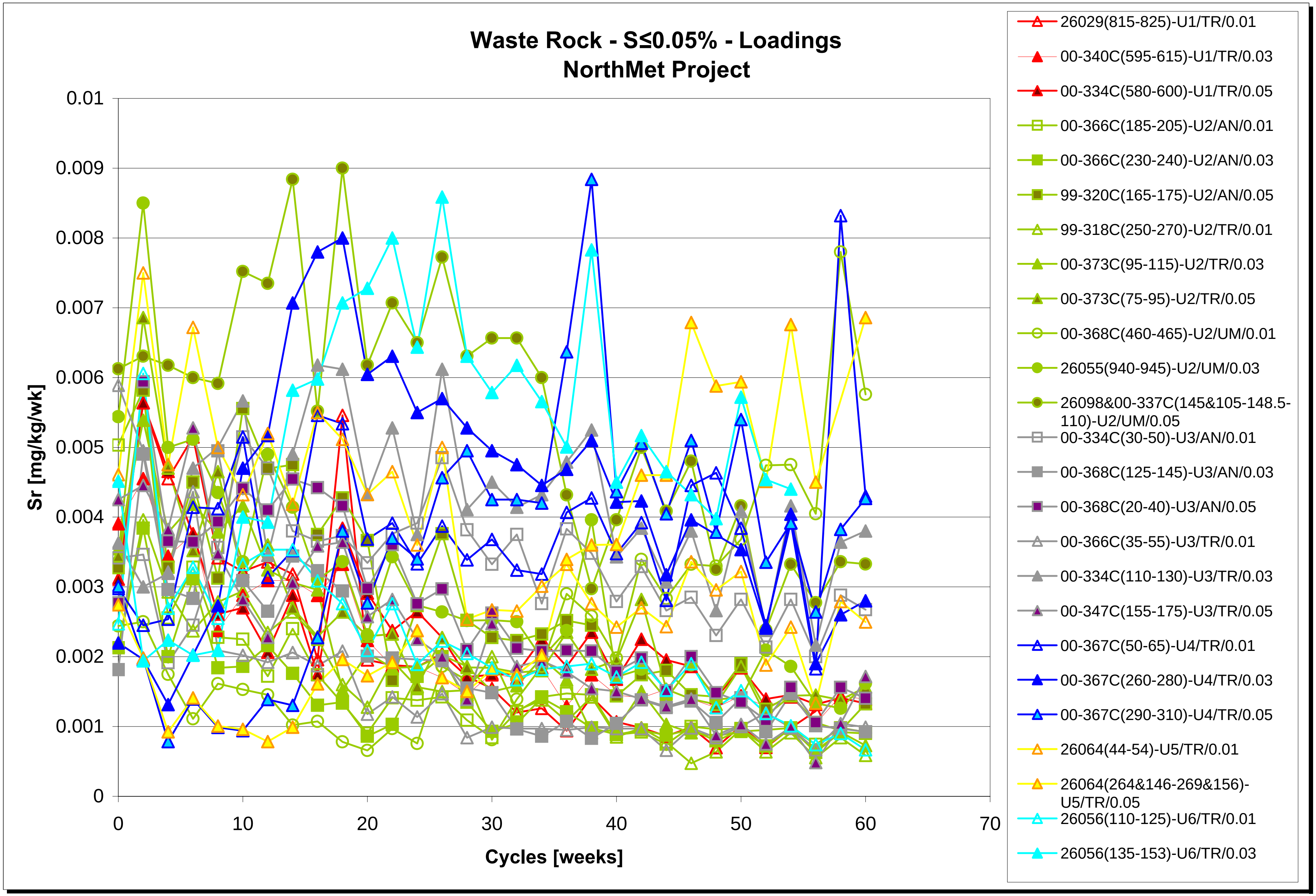

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Se [mg/kg/wk]
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

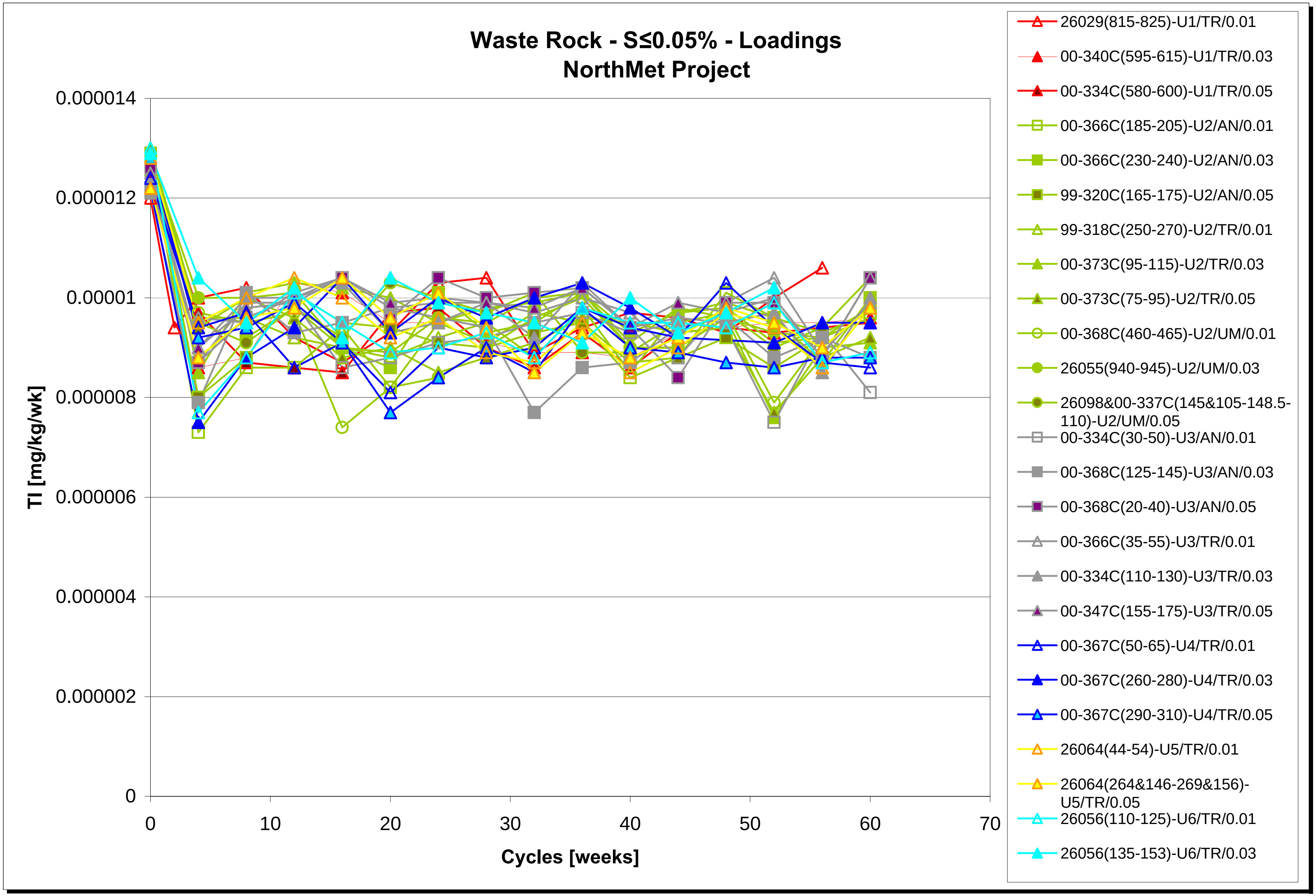

Waste Rock - S≤0.05% - Loadings
NorthMet Project
SiO2 [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

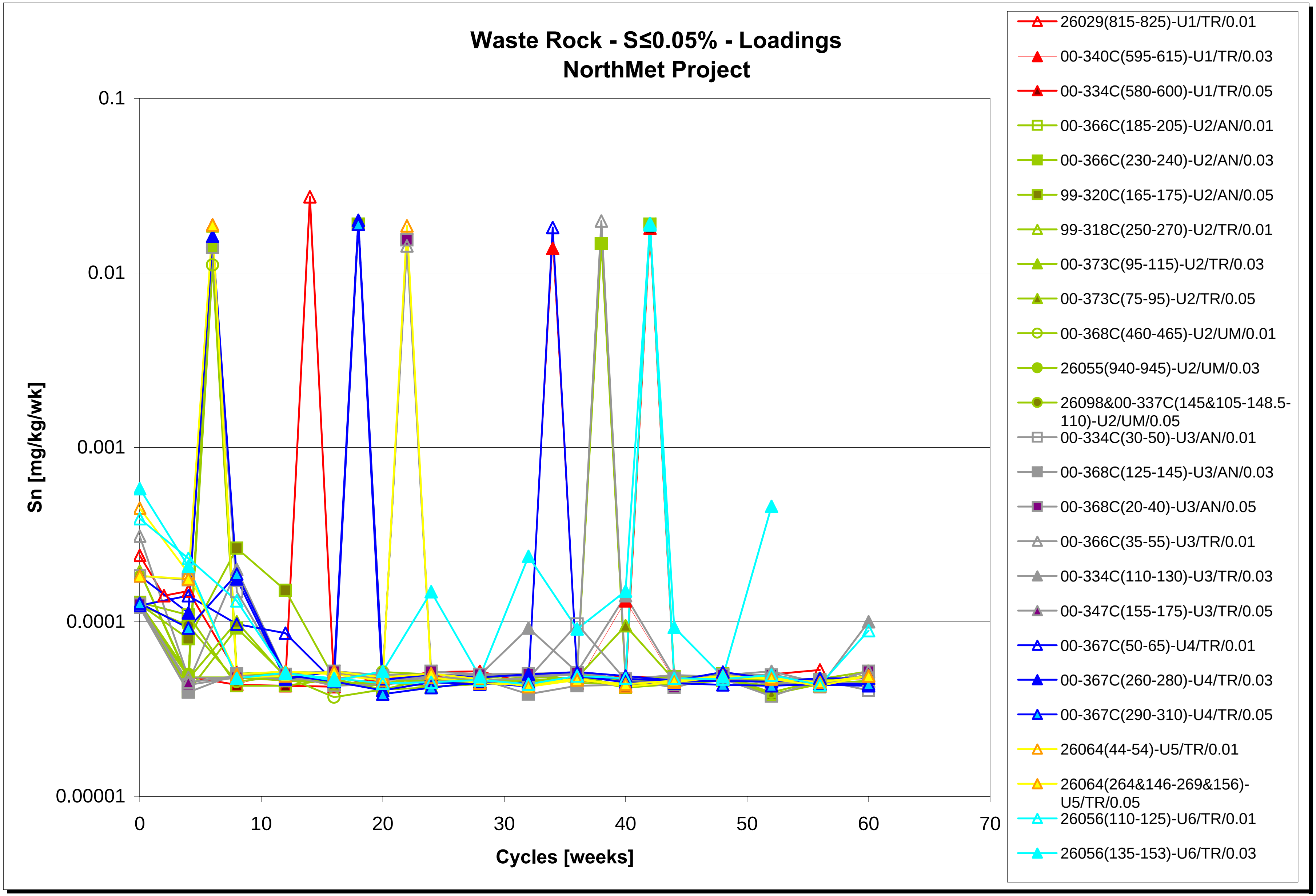

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Ag [mg/kg/wk]
0.00004
0.000035
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03



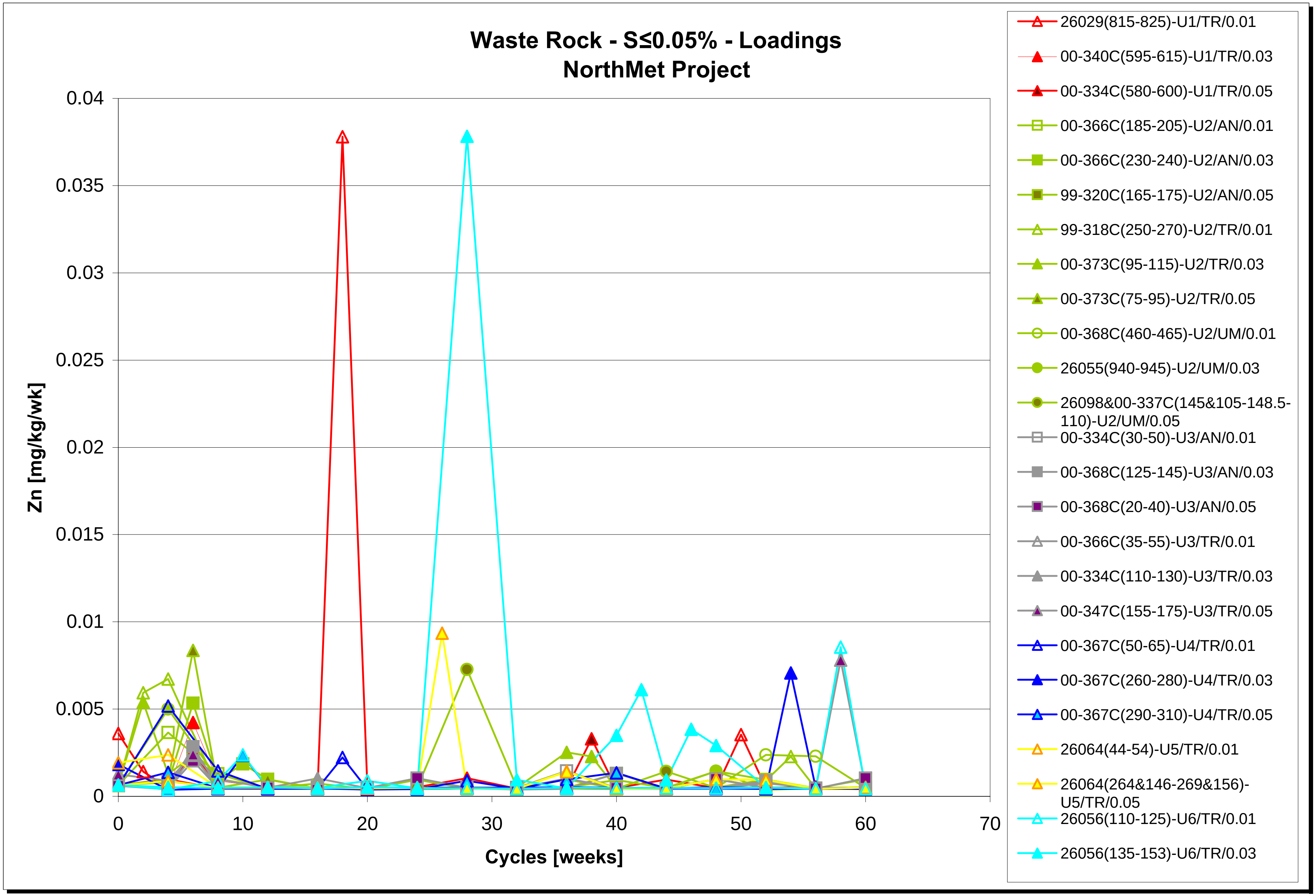
Waste Rock - S≤0.05% - Loadings
NorthMet Project
Na [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
Sr [mg/kg/wk]
Cycles [weeks]
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03


Waste Rock - S≤0.05% - Loadings
NorthMet Project
0.000014
0.000012
0.00001
0.000008
0.000006
0.000004
0.000002
0
Tl [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

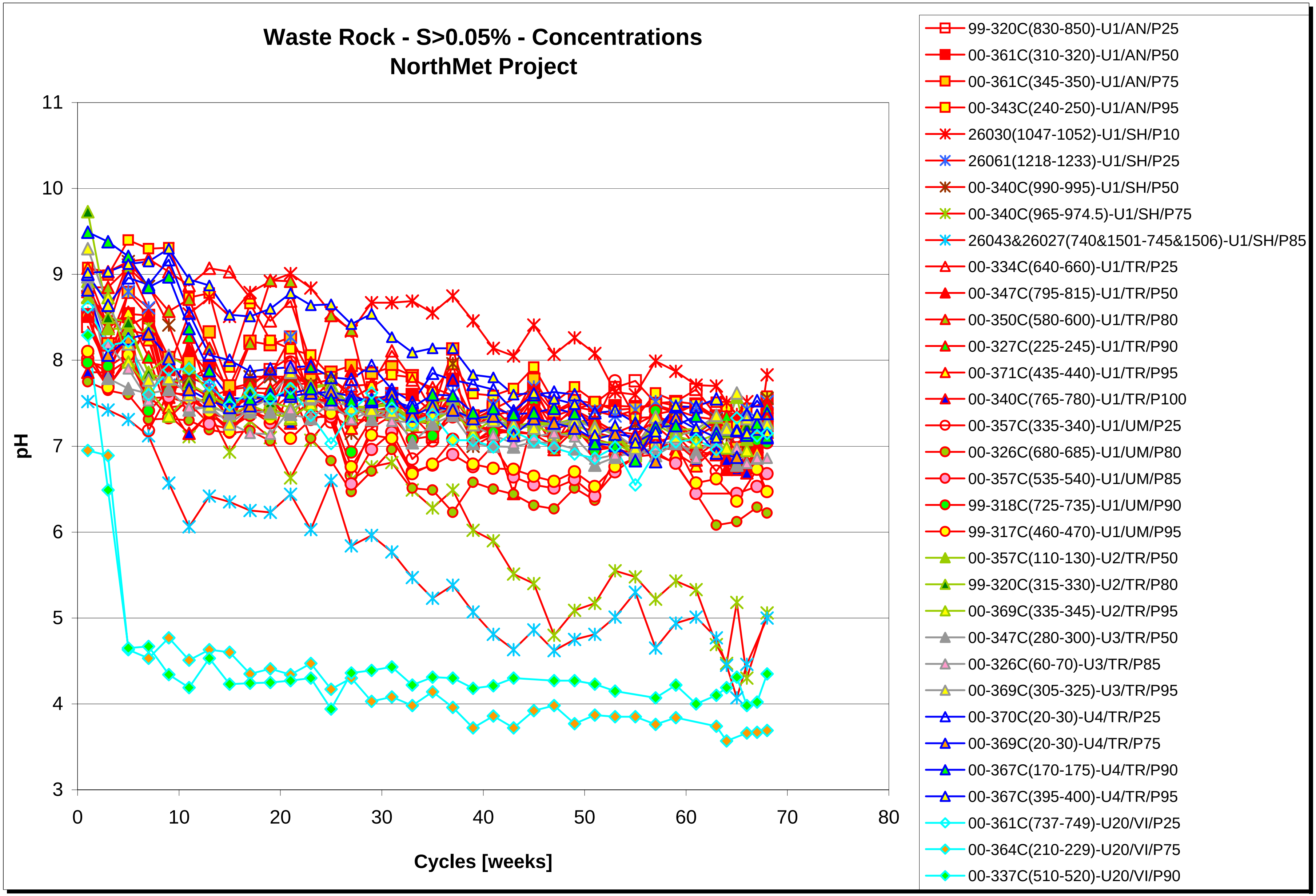


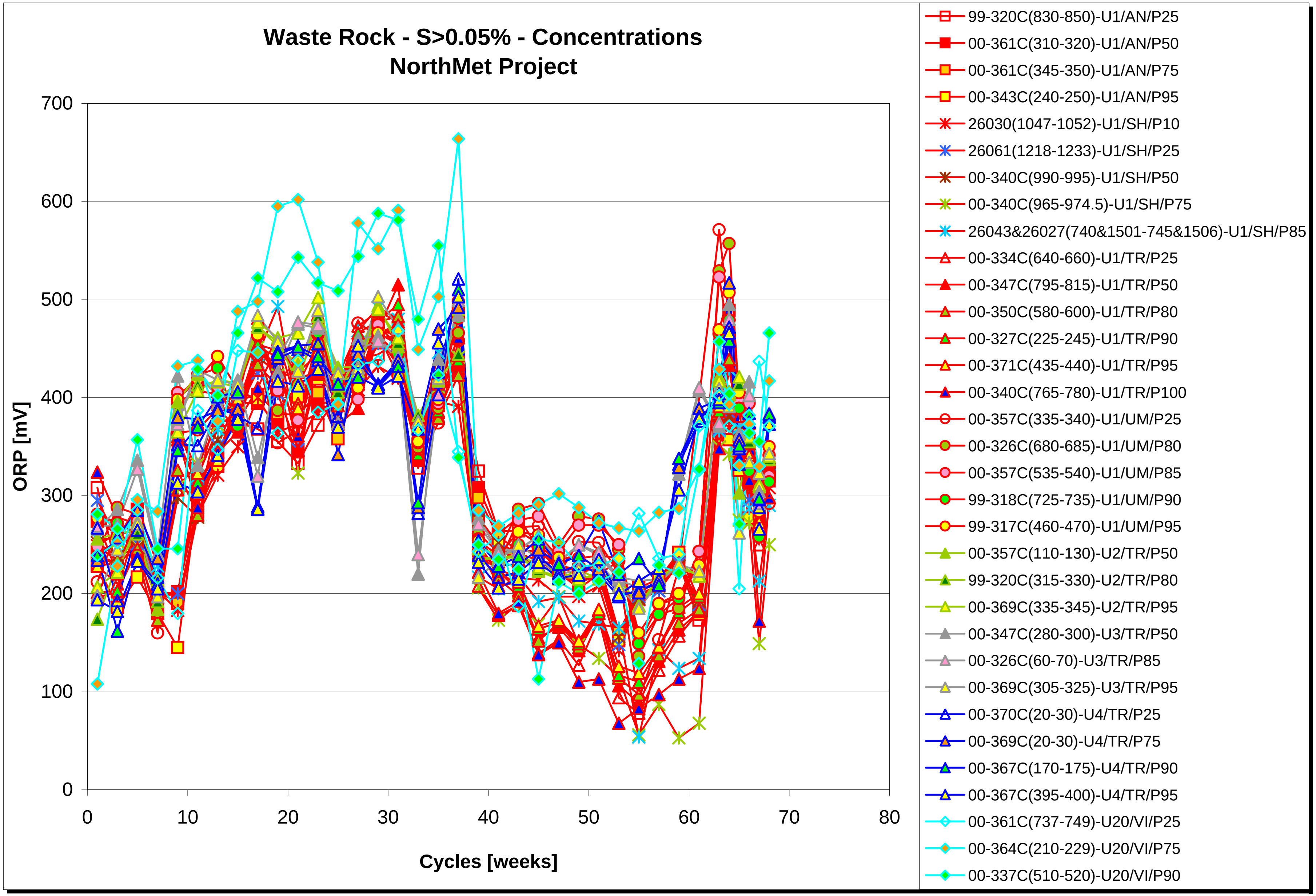
Waste Rock - S≤0.05% - Loadings
NorthMet Project
Sn [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

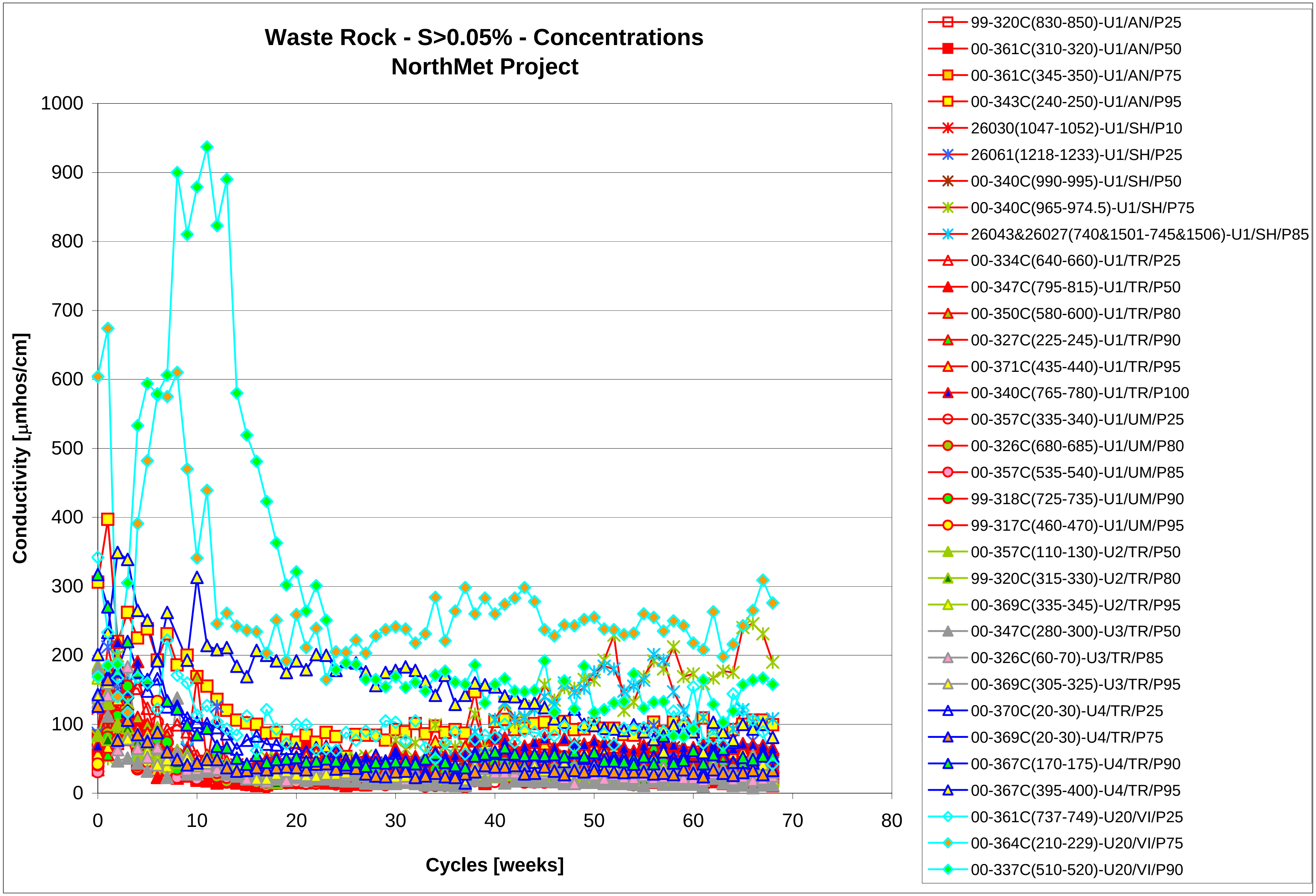

Waste Rock - S≤0.05% - Loadings
NorthMet Project
Zn [mg/kg/wk]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
26029(815-825)-U1/TR/0.01
00-340C(595-615)-U1/TR/0.03
00-334C(580-600)-U1/TR/0.05
00-366C(185-205)-U2/AN/0.01
00-366C(230-240)-U2/AN/0.03
99-320C(165-175)-U2/AN/0.05
99-318C(250-270)-U2/TR/0.01
00-373C(95-115)-U2/TR/0.03
00-373C(75-95)-U2/TR/0.05
00-368C(460-465)-U2/UM/0.01
26055(940-945)-U2/UM/0.03
26098&00-337C(145&105-148.5-110)-U2/UM/0.05
00-334C(30-50)-U3/AN/0.01
00-368C(125-145)-U3/AN/0.03
00-368C(20-40)-U3/AN/0.05
00-366C(35-55)-U3/TR/0.01
00-334C(110-130)-U3/TR/0.03
00-347C(155-175)-U3/TR/0.05
00-367C(50-65)-U4/TR/0.01
00-367C(260-280)-U4/TR/0.03
00-367C(290-310)-U4/TR/0.05
26064(44-54)-U5/TR/0.01
26064(264&146-269&156)-U5/TR/0.05
26056(110-125)-U6/TR/0.01
26056(135-153)-U6/TR/0.03

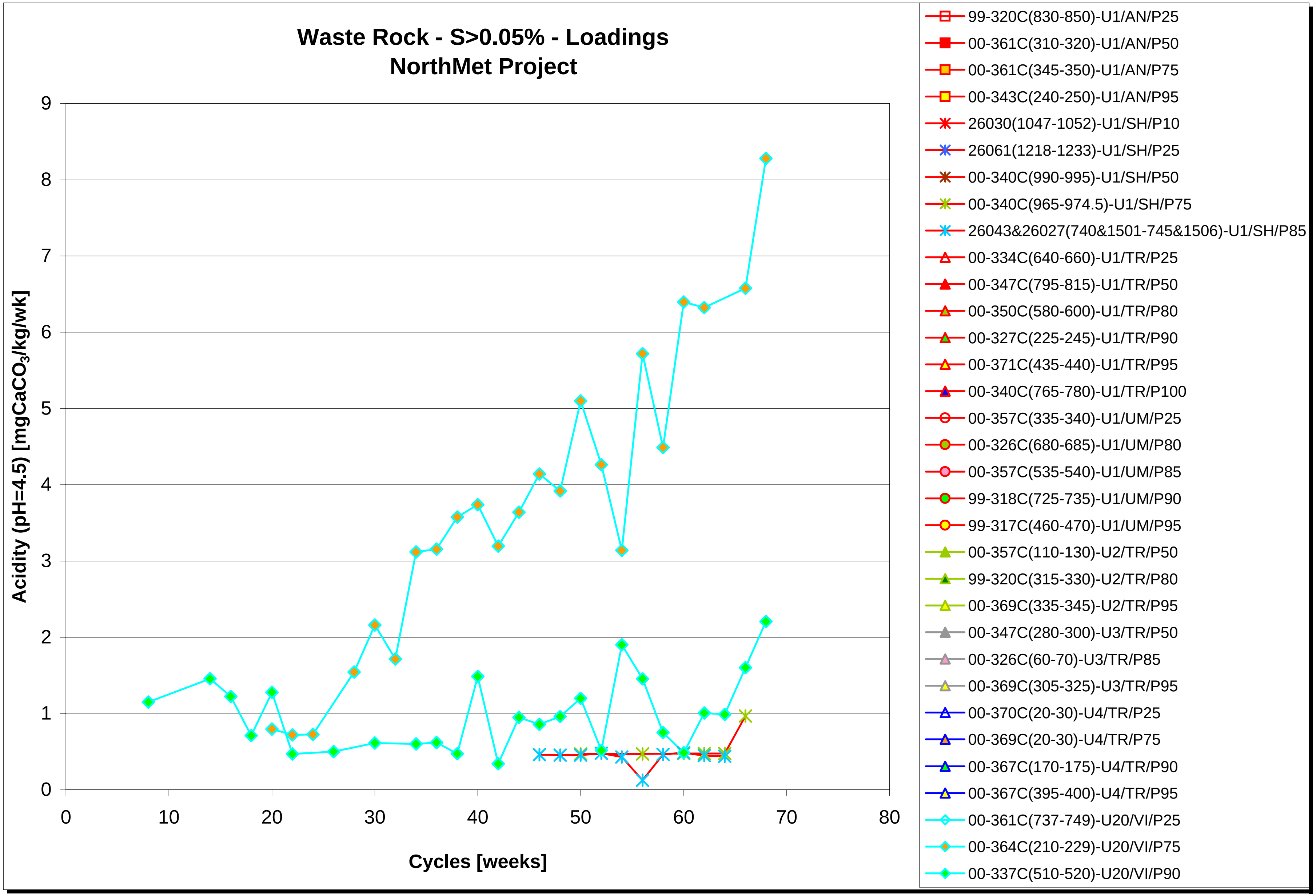
Appendix E.2

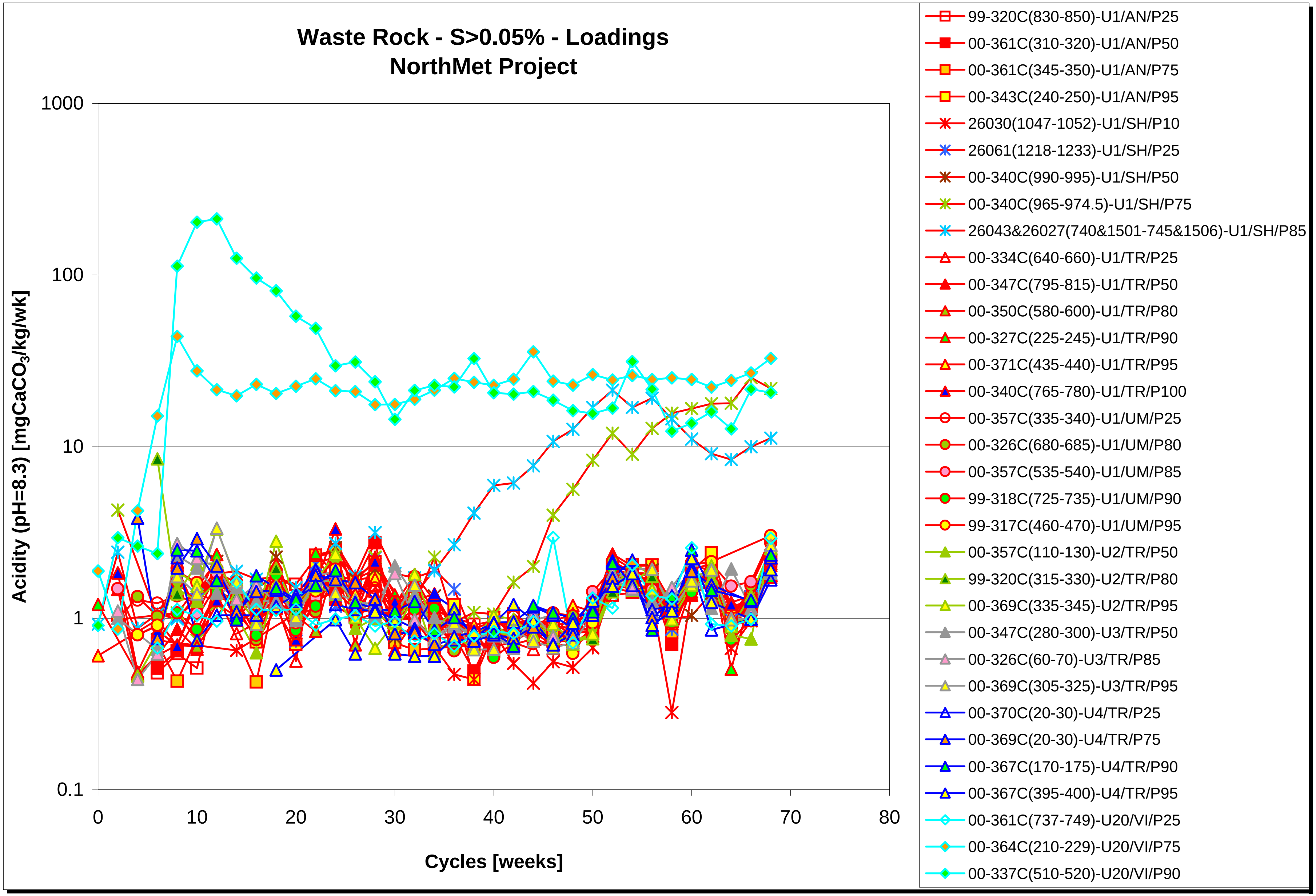
Higher Sulfur Waste Rock

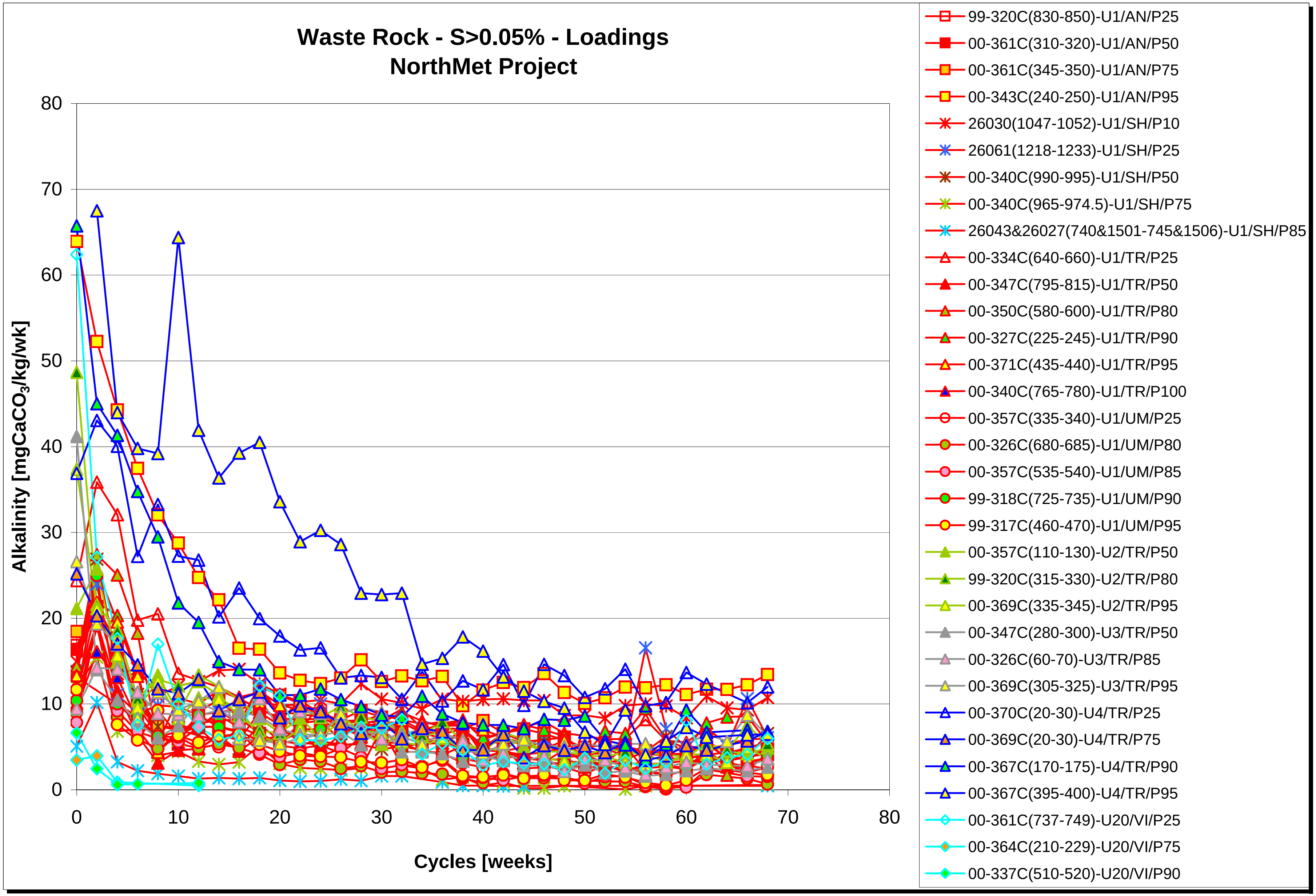

Waste Rock - S>0.05% - Concentrations
NorthMet Project
pH
Cycles [weeks]
11
10
9
8
7
6
5
4
3
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

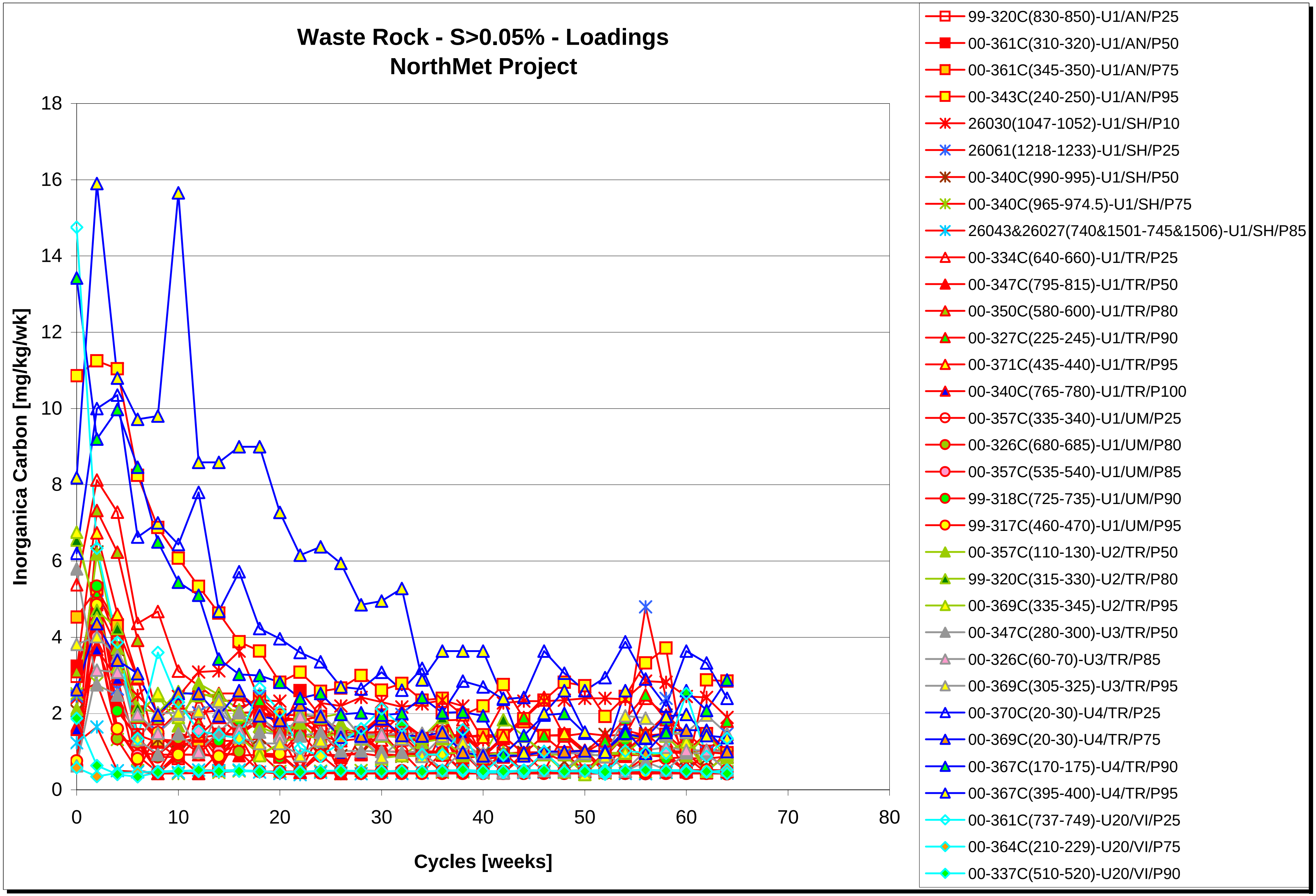

Waste Rock - S>0.05% - Concentrations
NorthMet Project
ORP [mV]
Cycles [weeks]
0
100
200
300
400
500
600
700
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

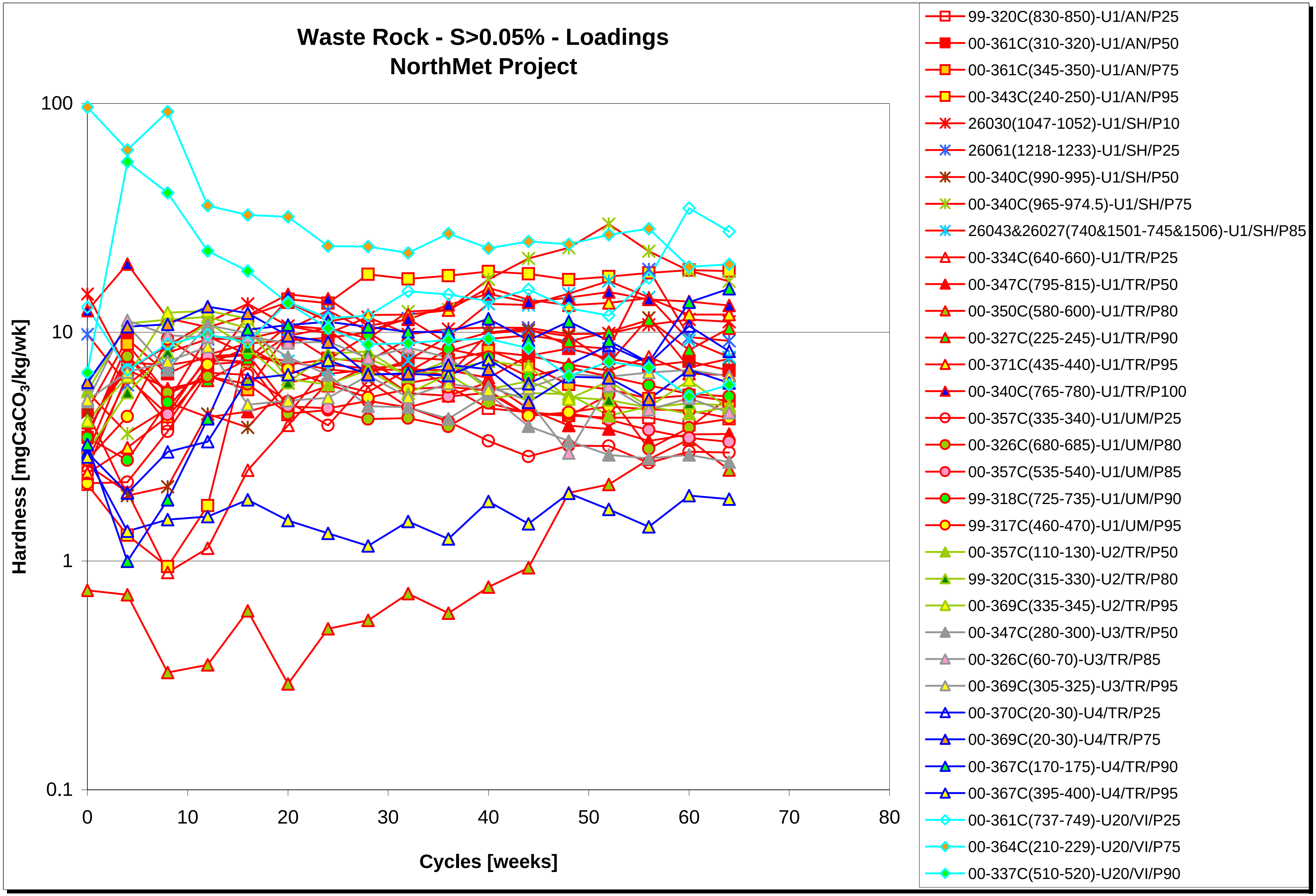

Waste Rock - S>0.05% - Concentrations
NorthMet Project
Conductivity [µmhos/cm]
Cycles [weeks]
1000
900
800
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

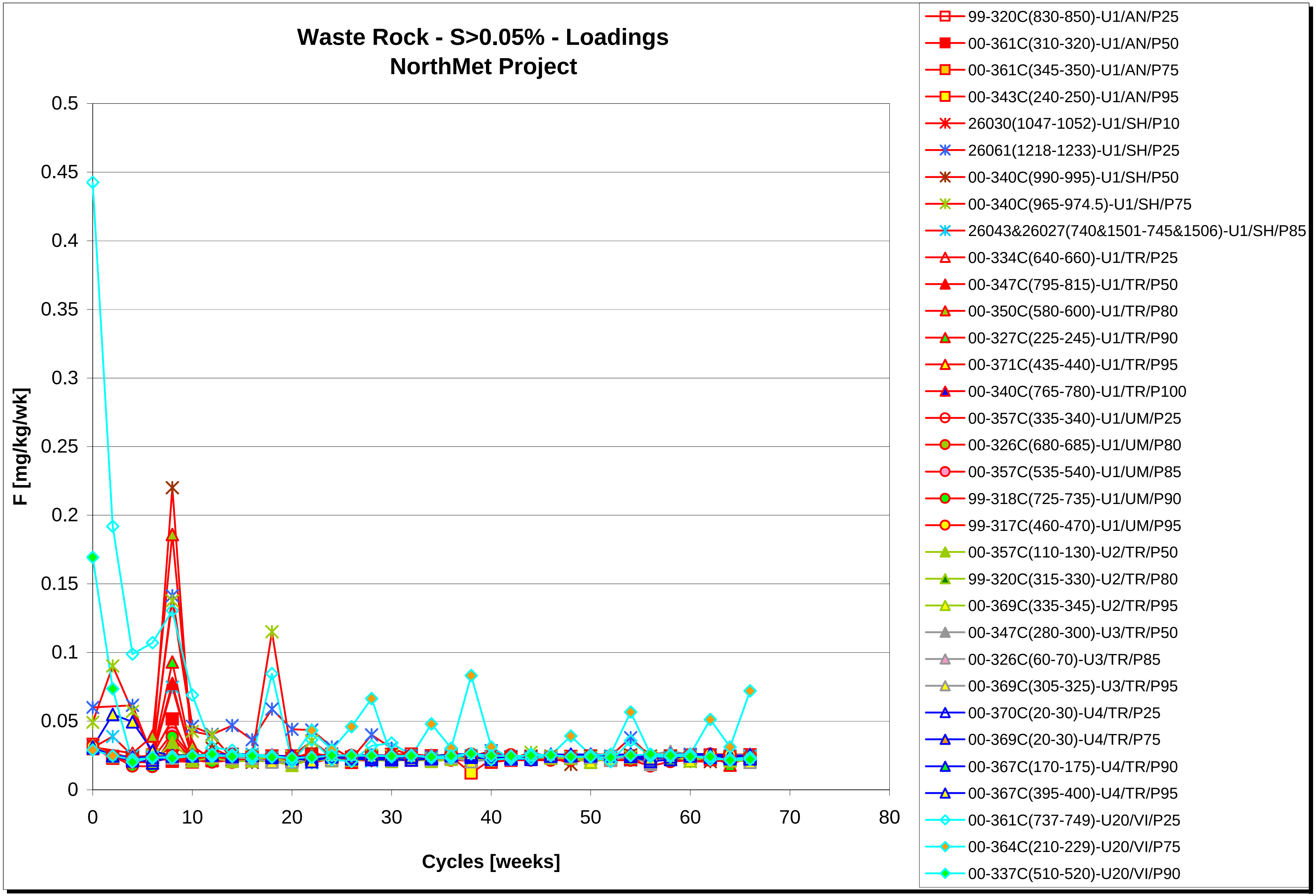

Waste Rock - S>0.05% - Loadings
NorthMet Project
Acidity (pH=4.5) [mgCaCO3/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

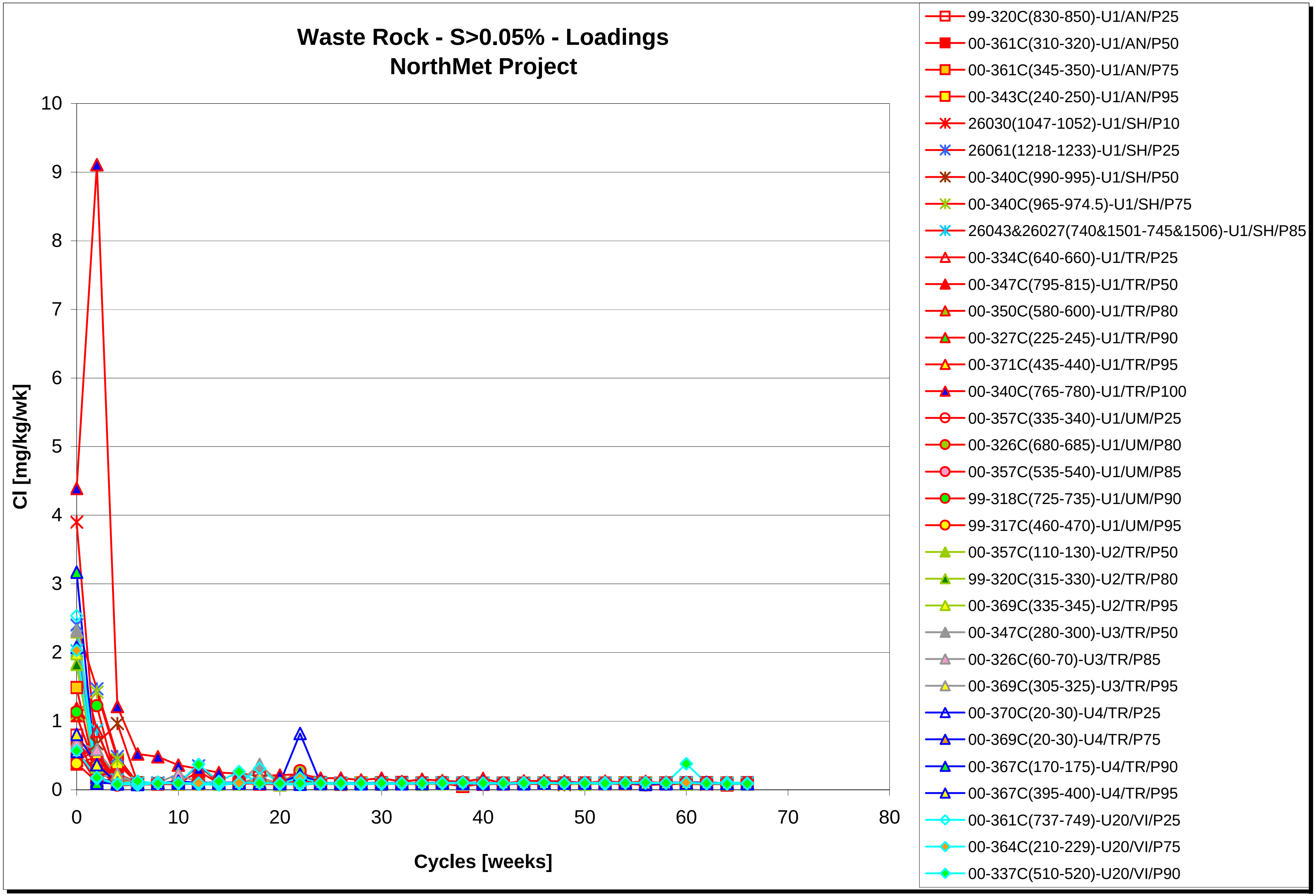

Waste Rock - S>0.05% - Loadings
NorthMet Project
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

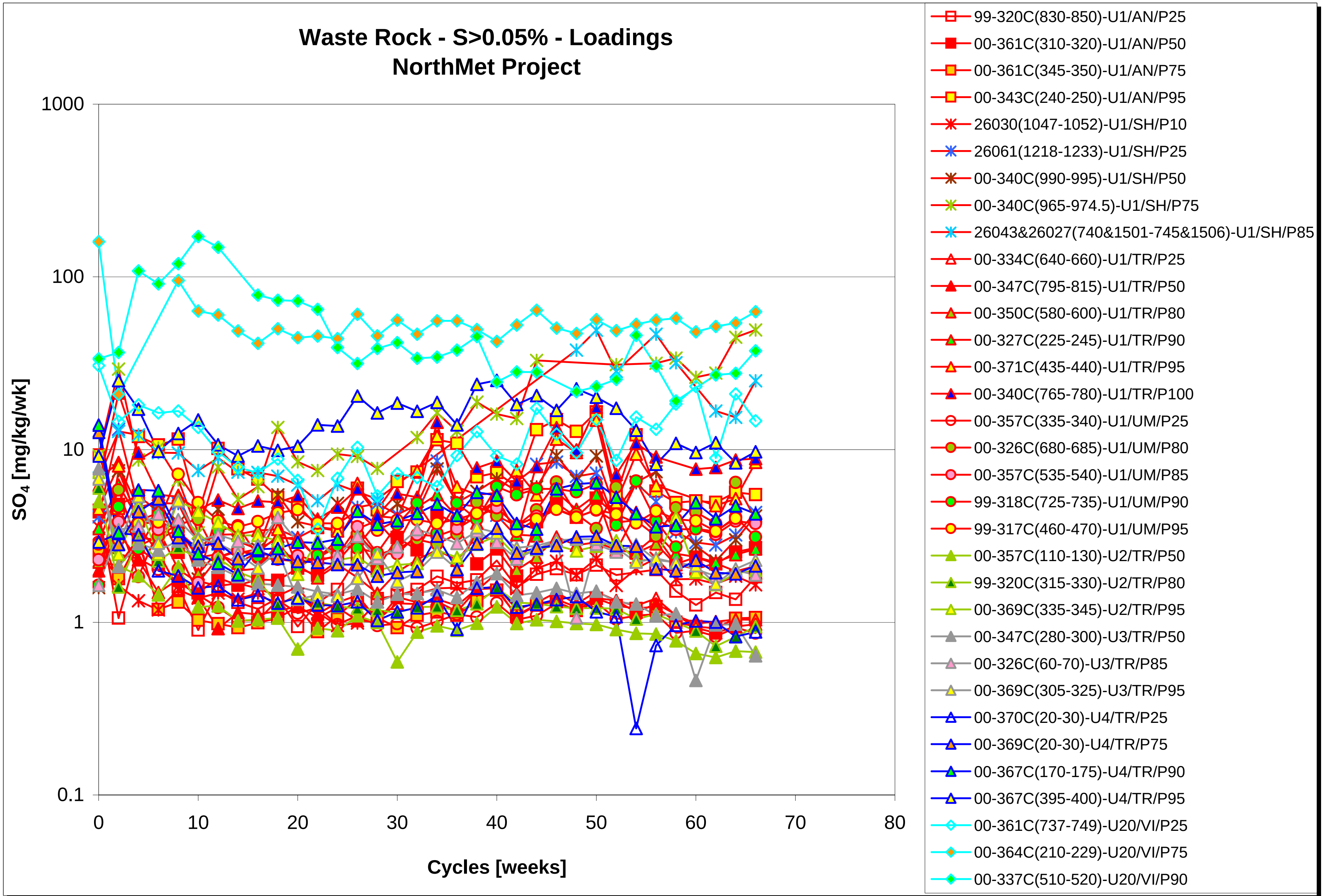

Waste Rock - S>0.05% - Loadings
NorthMet Project
Alkalinity [mgCaCO3/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

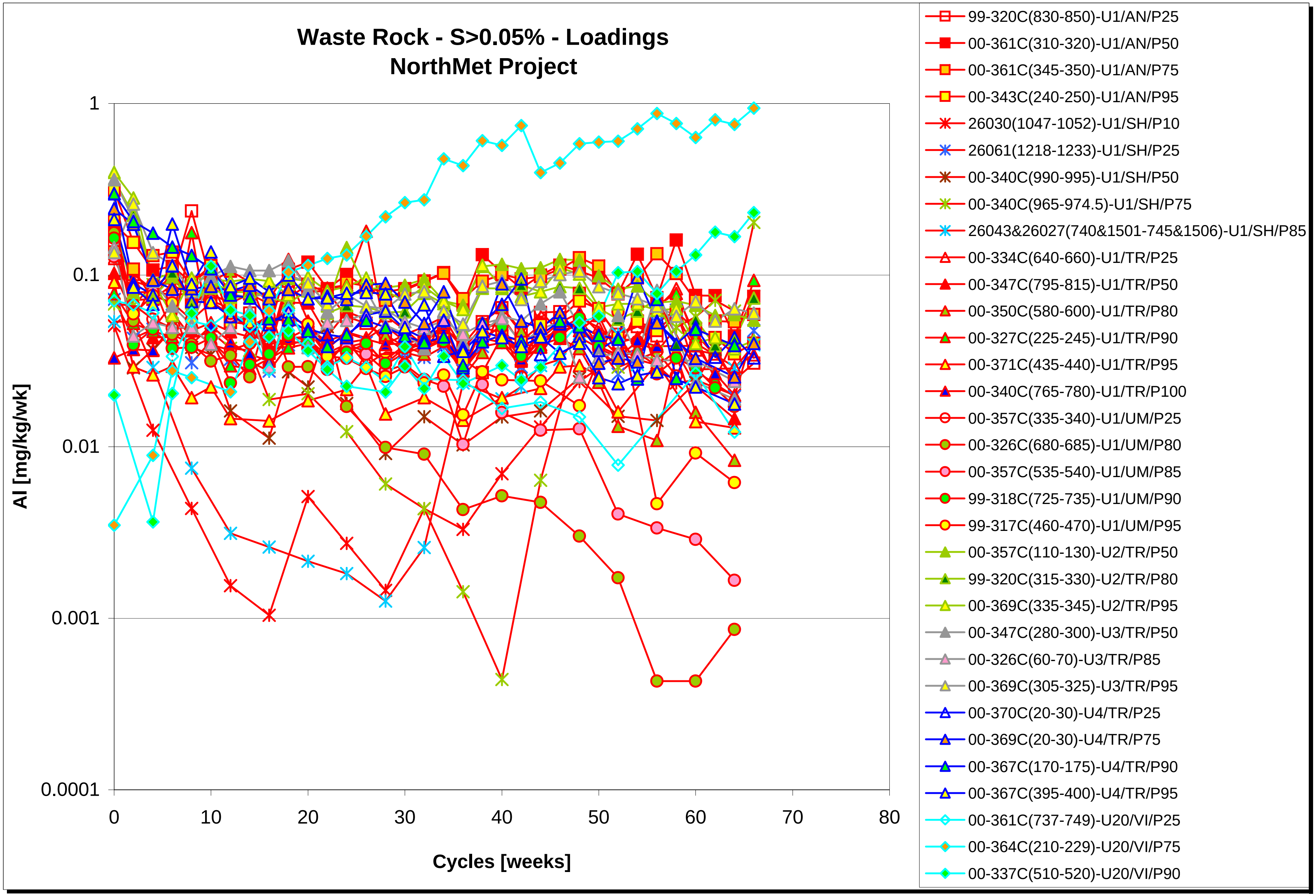

Waste Rock - S>0.05% - Loadings
NorthMet Project
Inorganica Carbon [mg/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

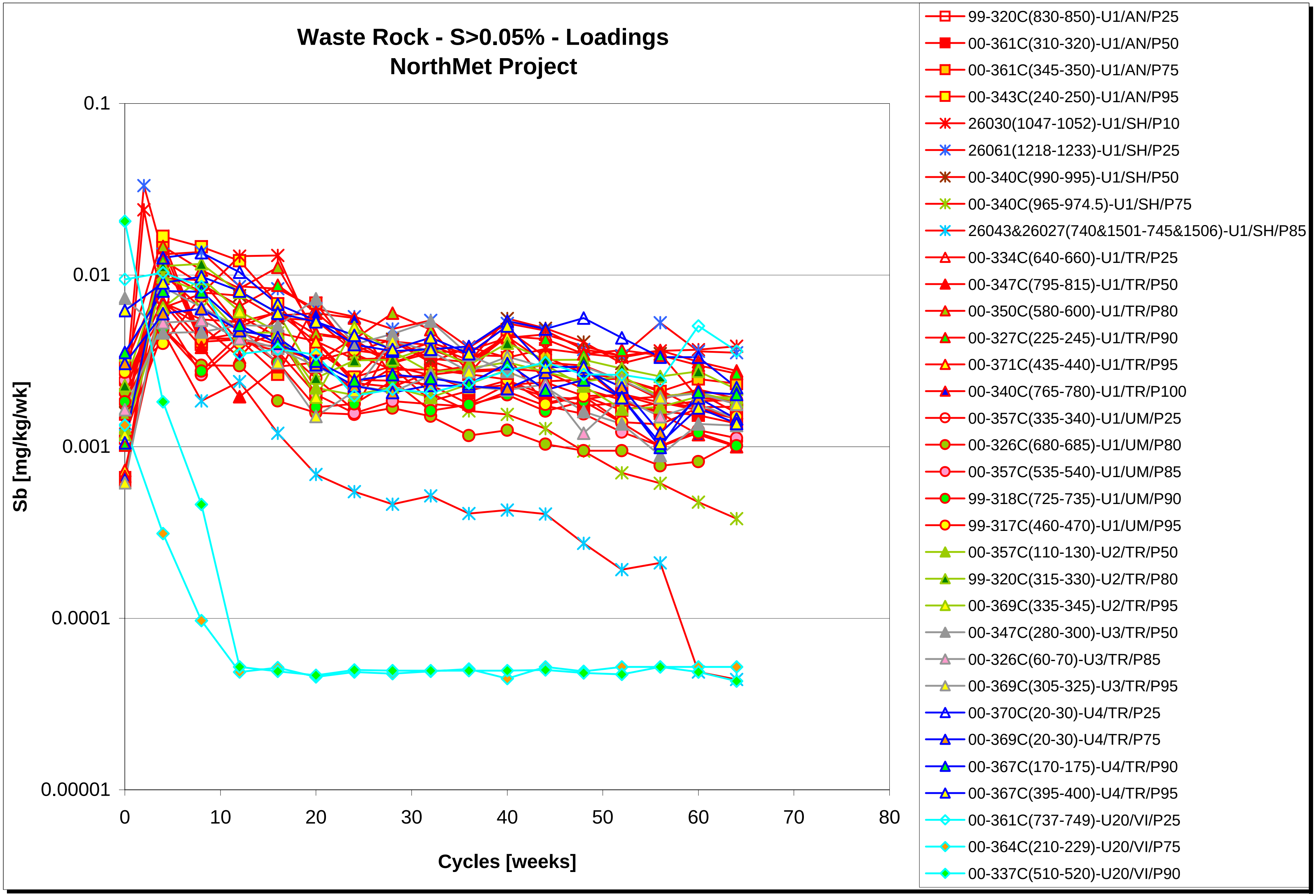

Waste Rock - S>0.05% - Loadings
NorthMet Project
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
100
10
1
0.1
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

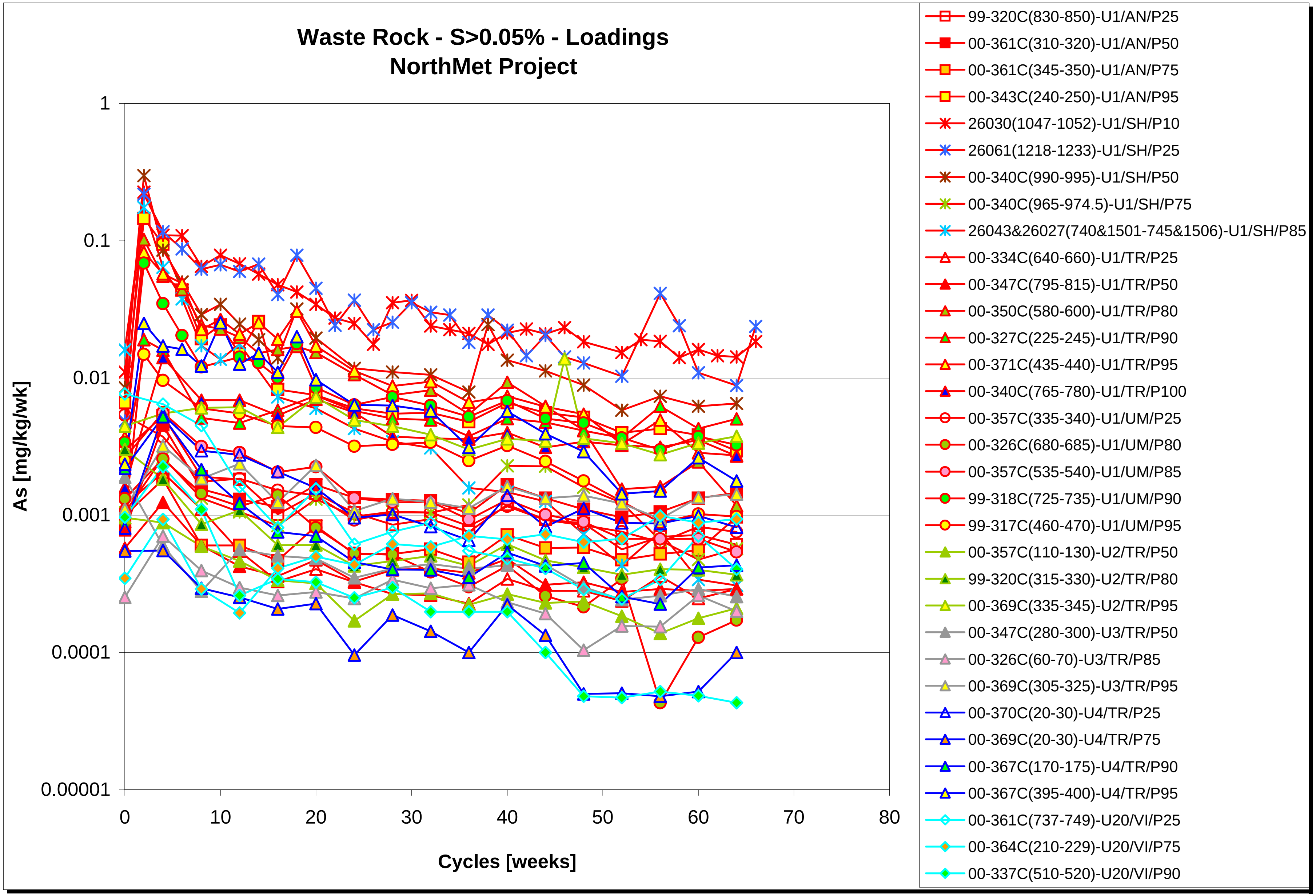

Waste Rock - S>0.05% - Loadings
NorthMet Project
F [mg/kg/wk]
Cycles [weeks]
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

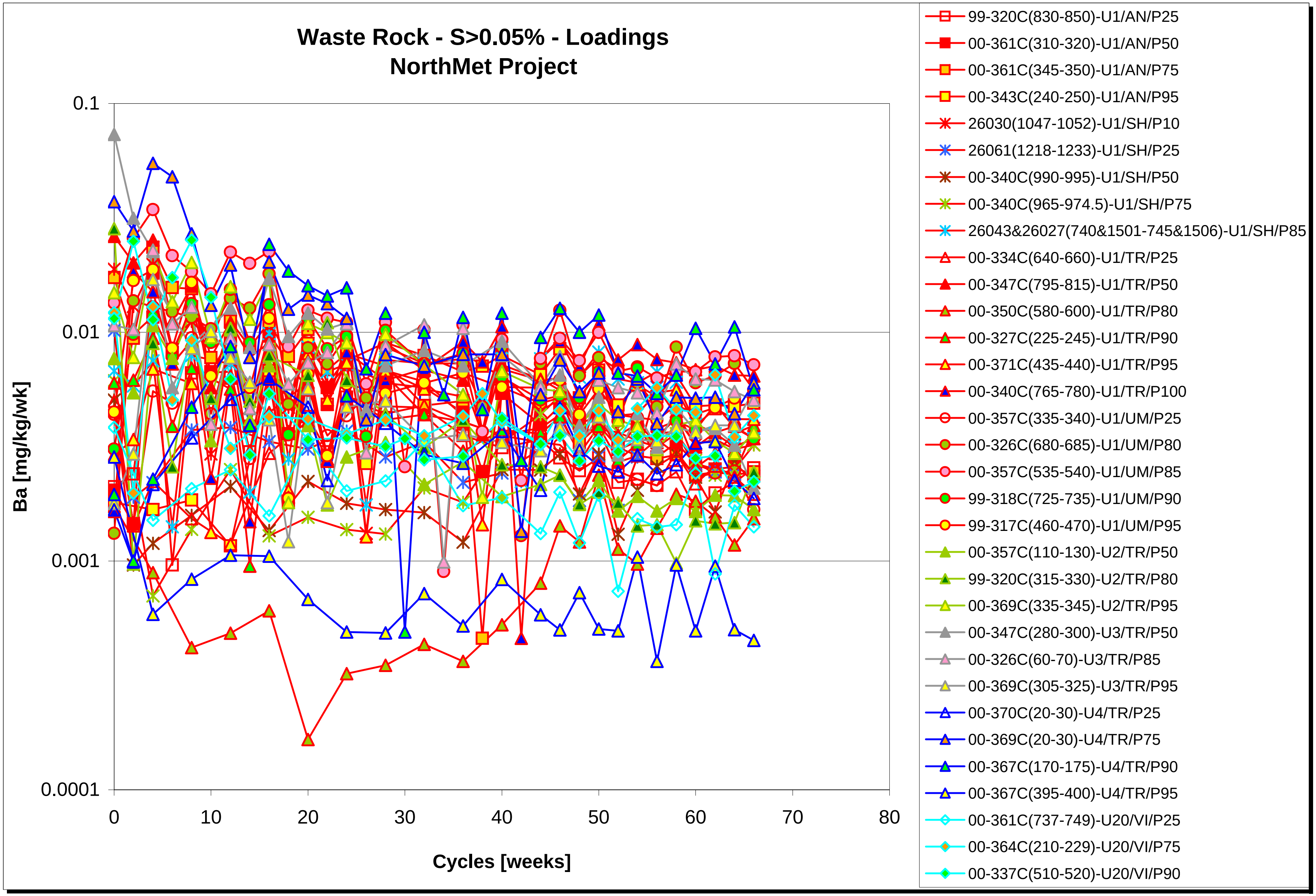

Waste Rock - S>0.05% - Loadings
NorthMet Project
Cl [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

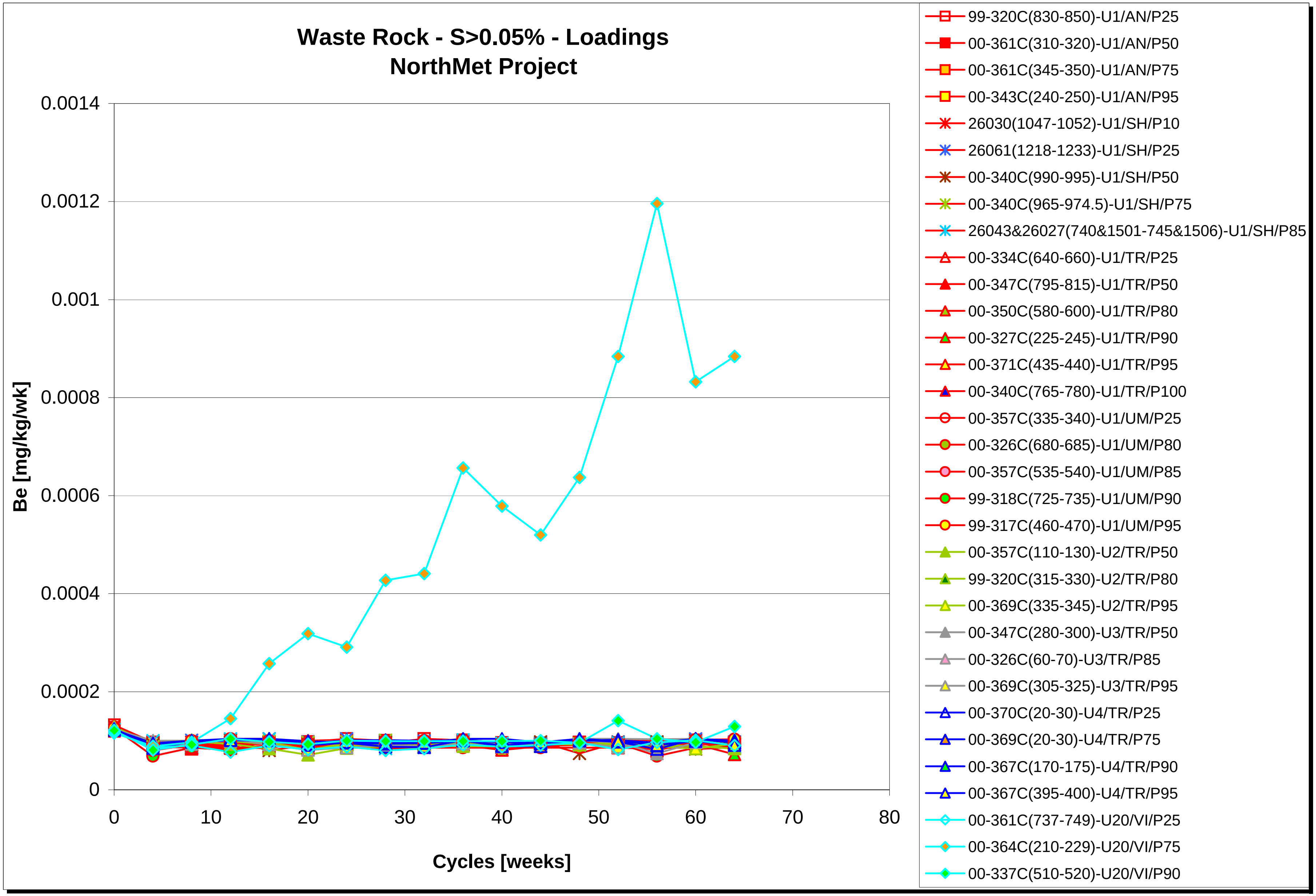

Waste Rock - S>0.05% - Loadings
NorthMet Project
1000
100
10
1
0.1
SO4 [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

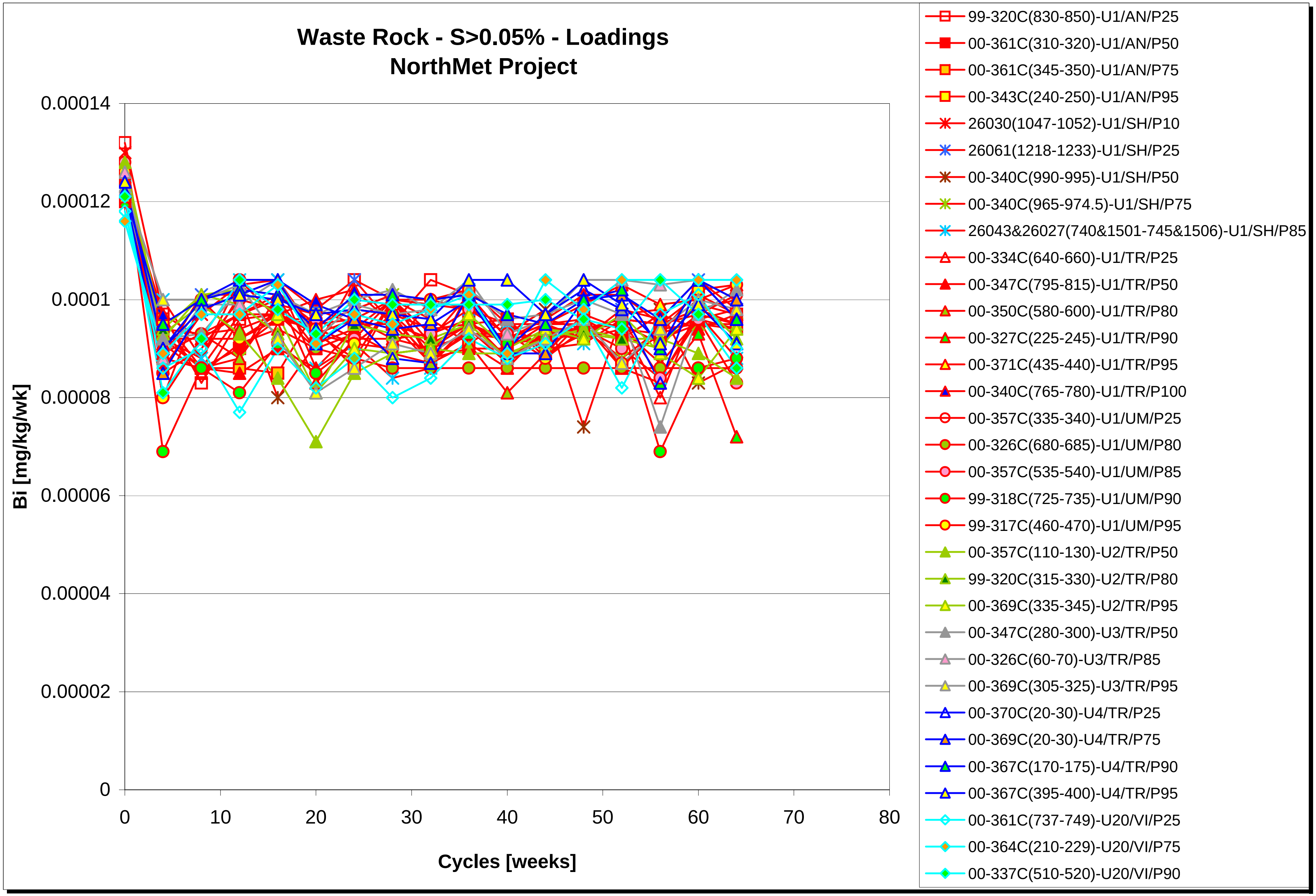

Waste Rock - S>0.05% - Loadings
NorthMet Project
Al [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

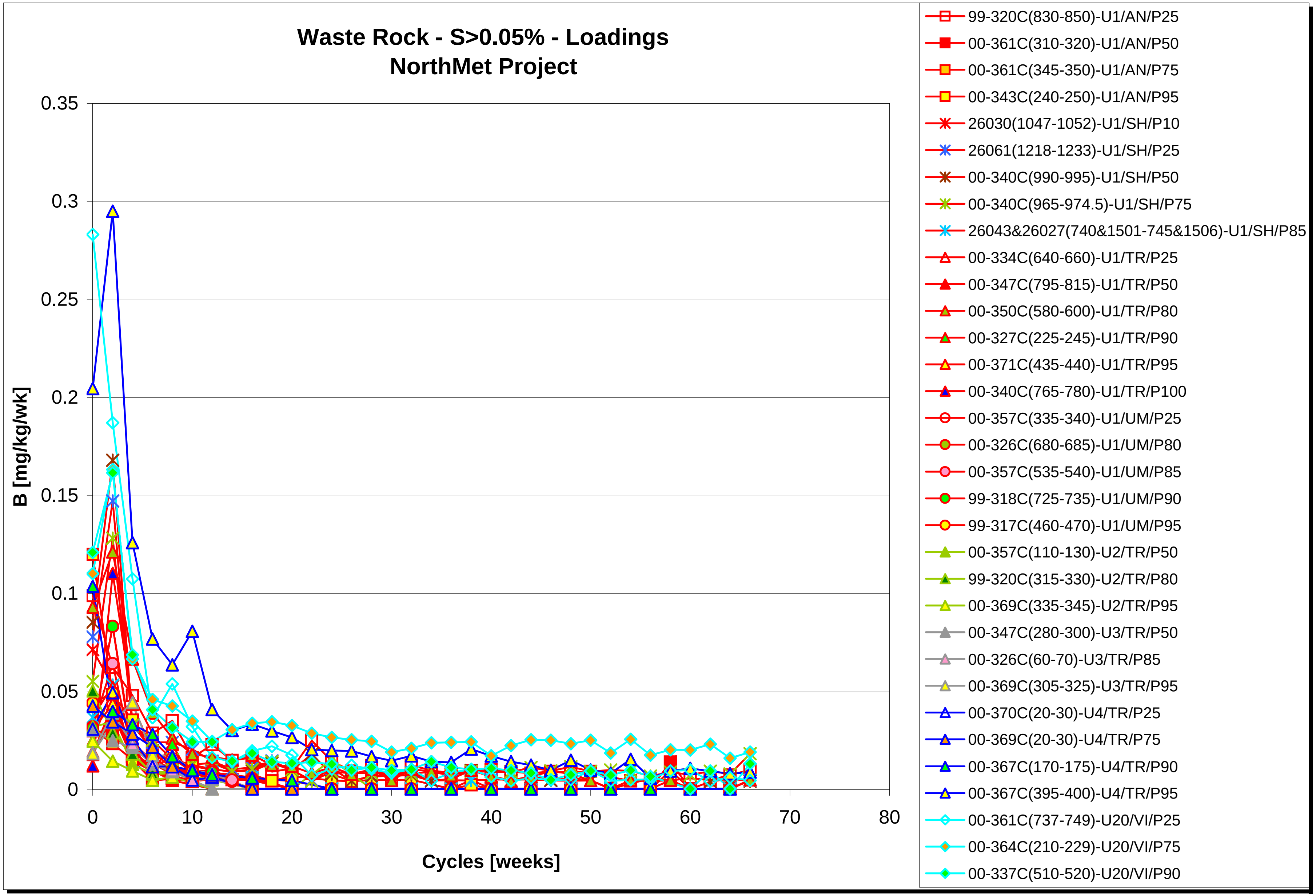

Waste Rock - S>0.05% - Loadings
NorthMet Project
0.1
0.01
0.001
0.0001
0.00001
Sb [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

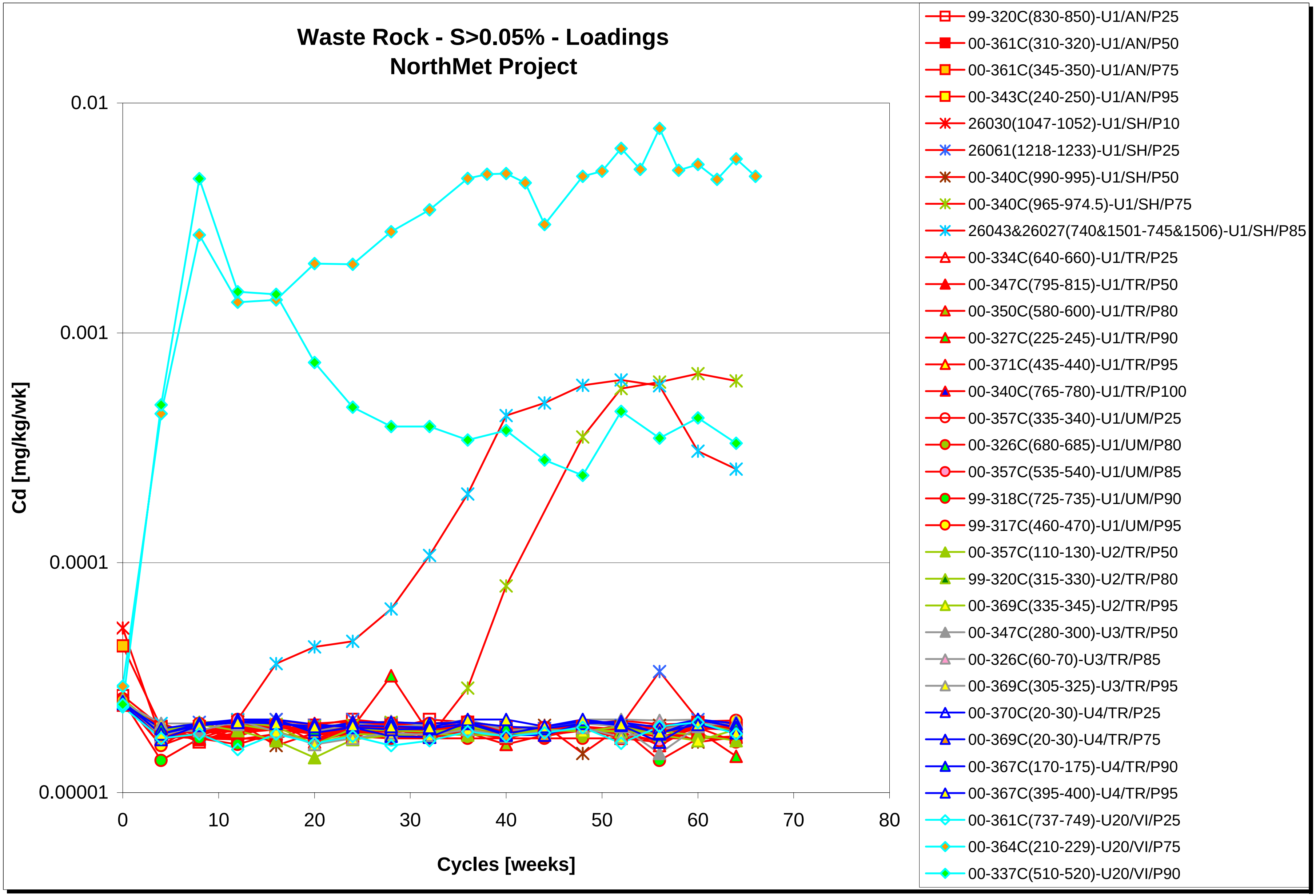

Waste Rock - S>0.05% - Loadings
NorthMet Project
As [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

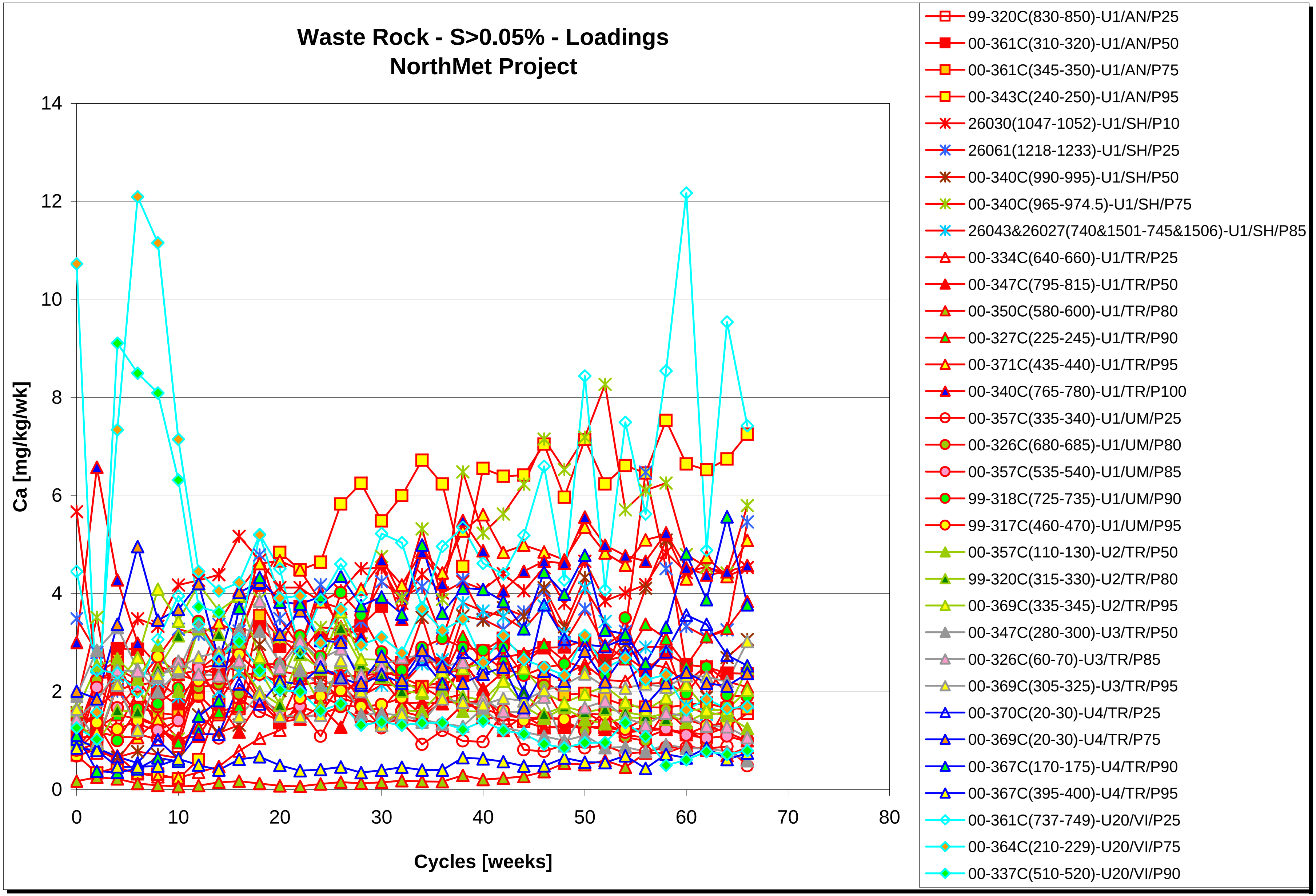

Waste Rock - S>0.05% - Loadings
NorthMet Project
Ba [mg/kg/wk]
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

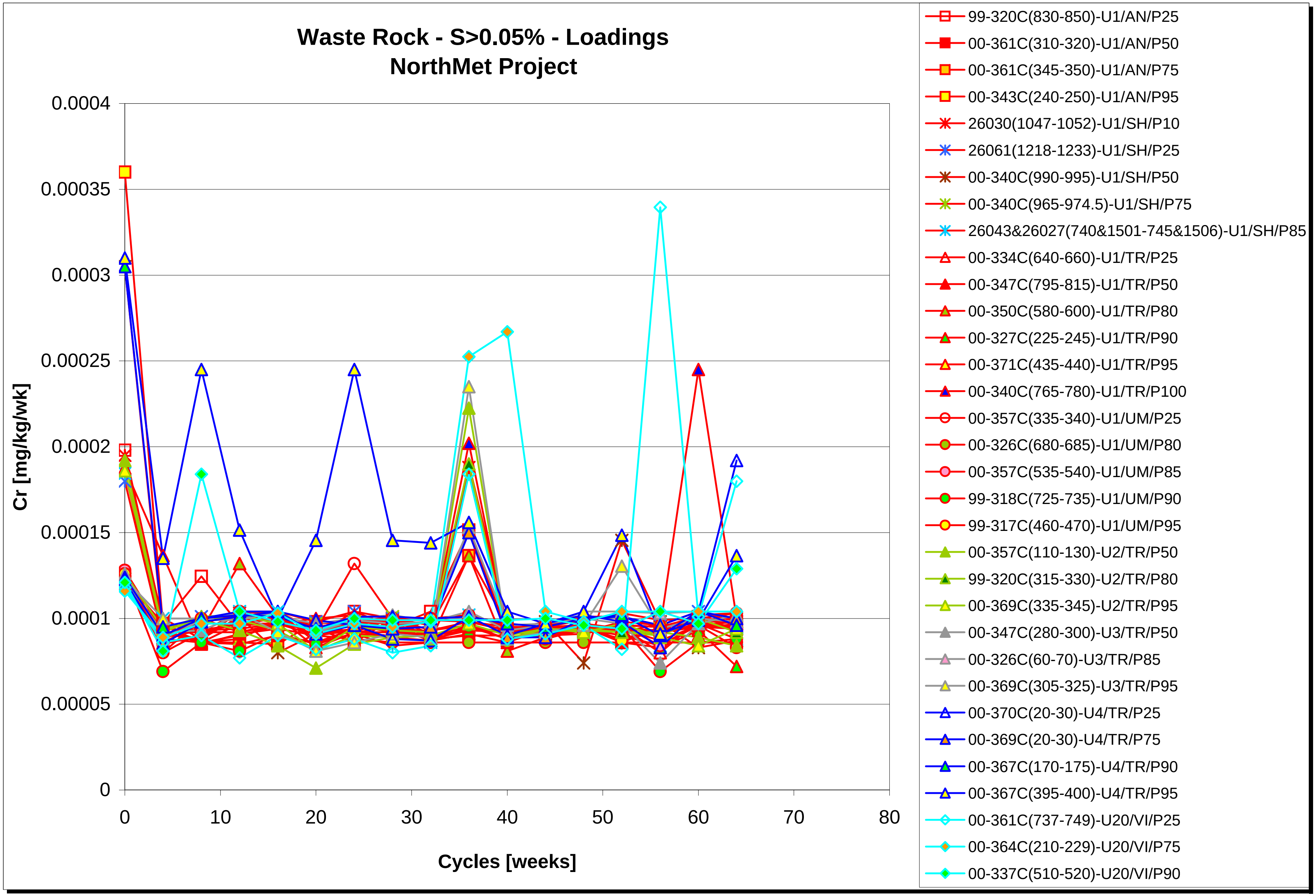

Waste Rock - S>0.05% - Loadings
NorthMet Project
Be [mg/kg/wk]
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

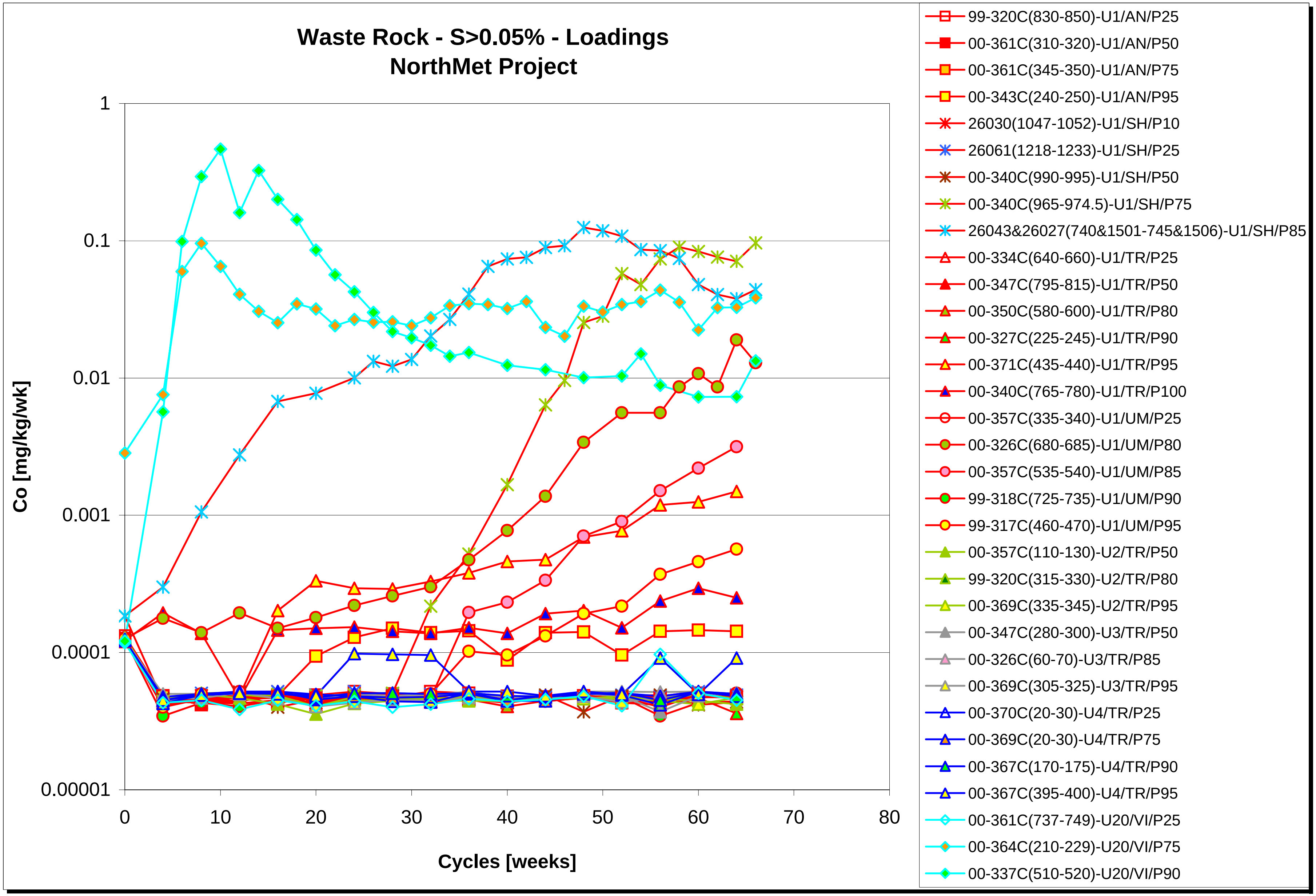

Waste Rock - S>0.05% - Loadings
NorthMet Project
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Bi [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

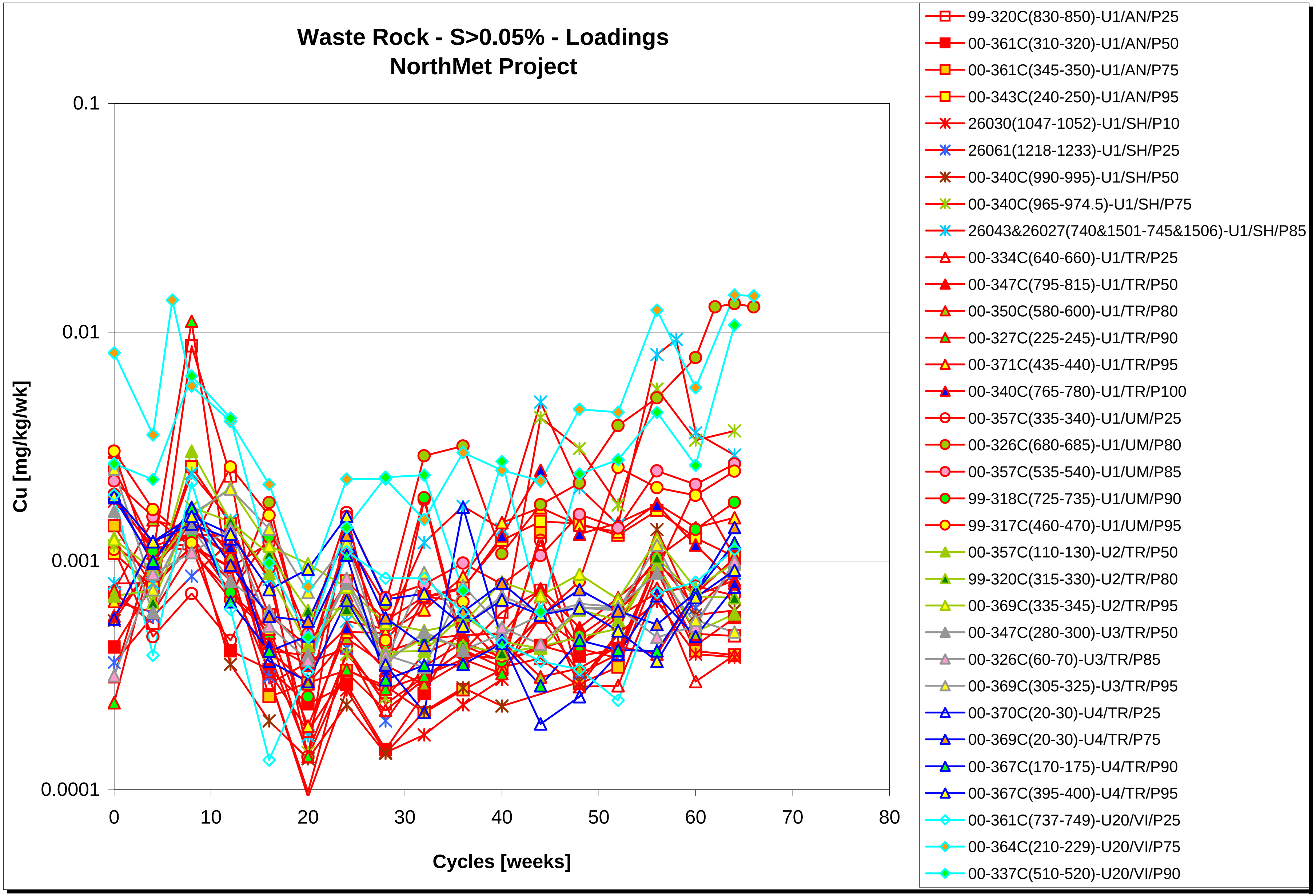

Waste Rock - S>0.05% - Loadings
NorthMet Project
B [mg/kg/wk]
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

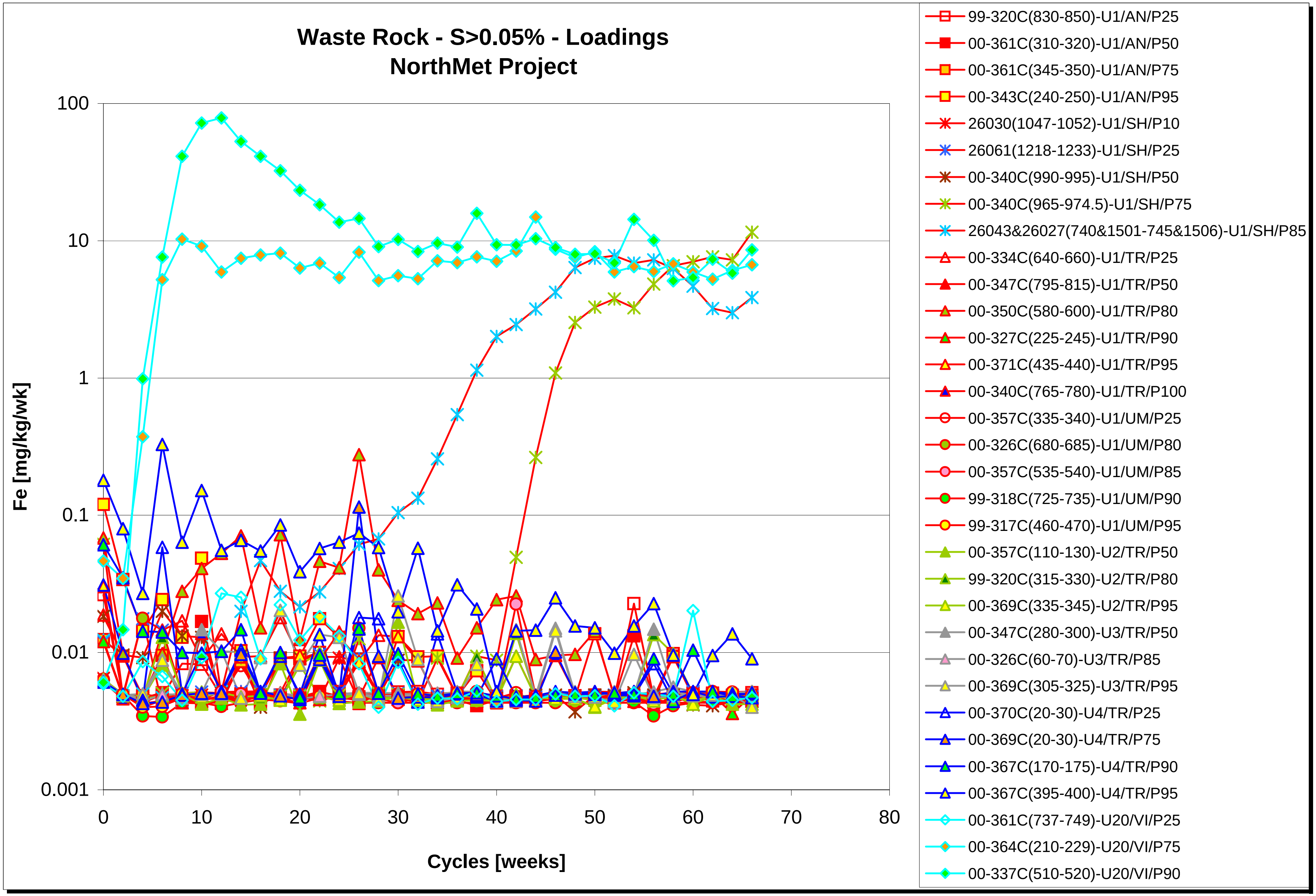

Waste Rock - S>0.05% - Loadings
NorthMet Project
Cd [mg/kg/wk]
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

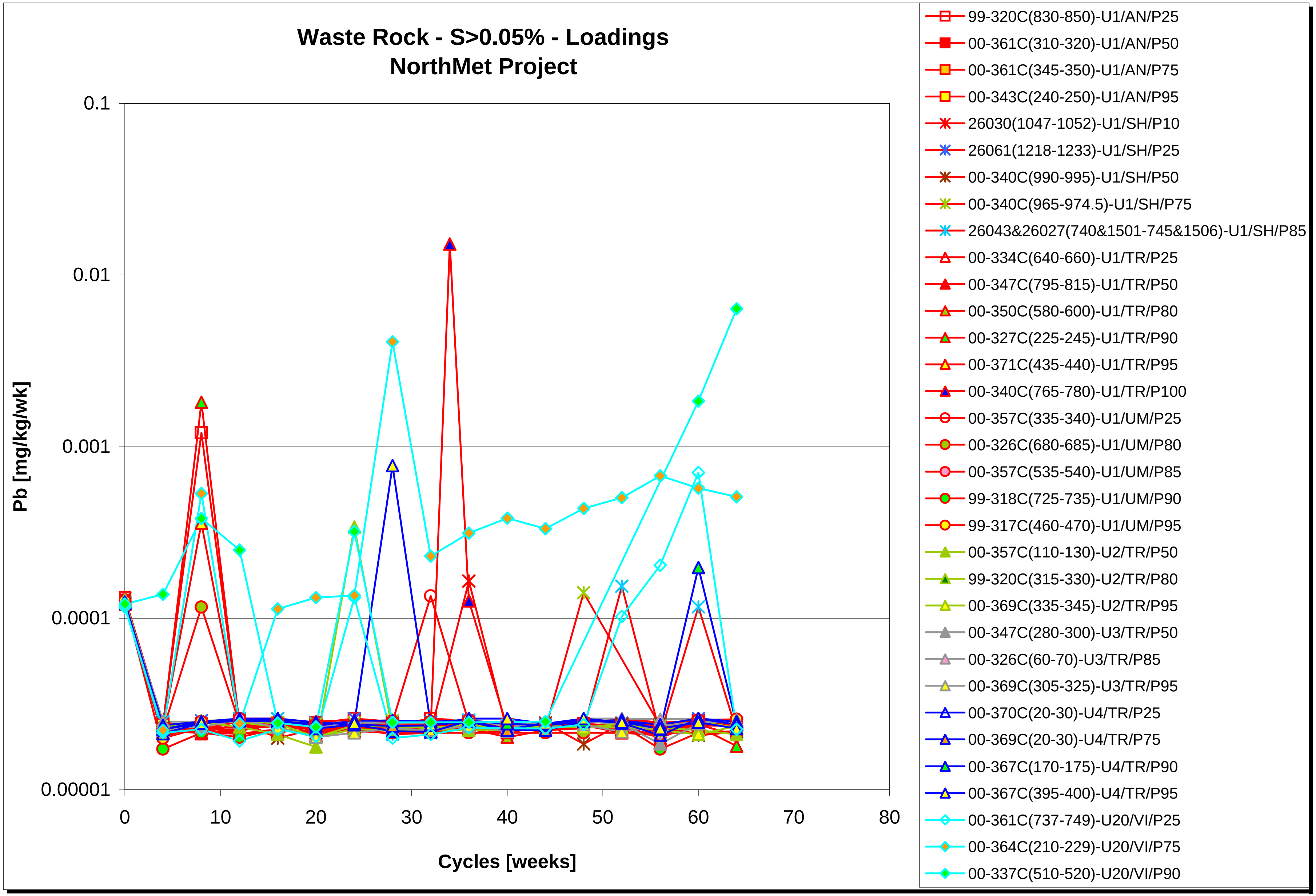

Waste Rock - S>0.05% - Loadings
NorthMet Project
Ca [mg/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

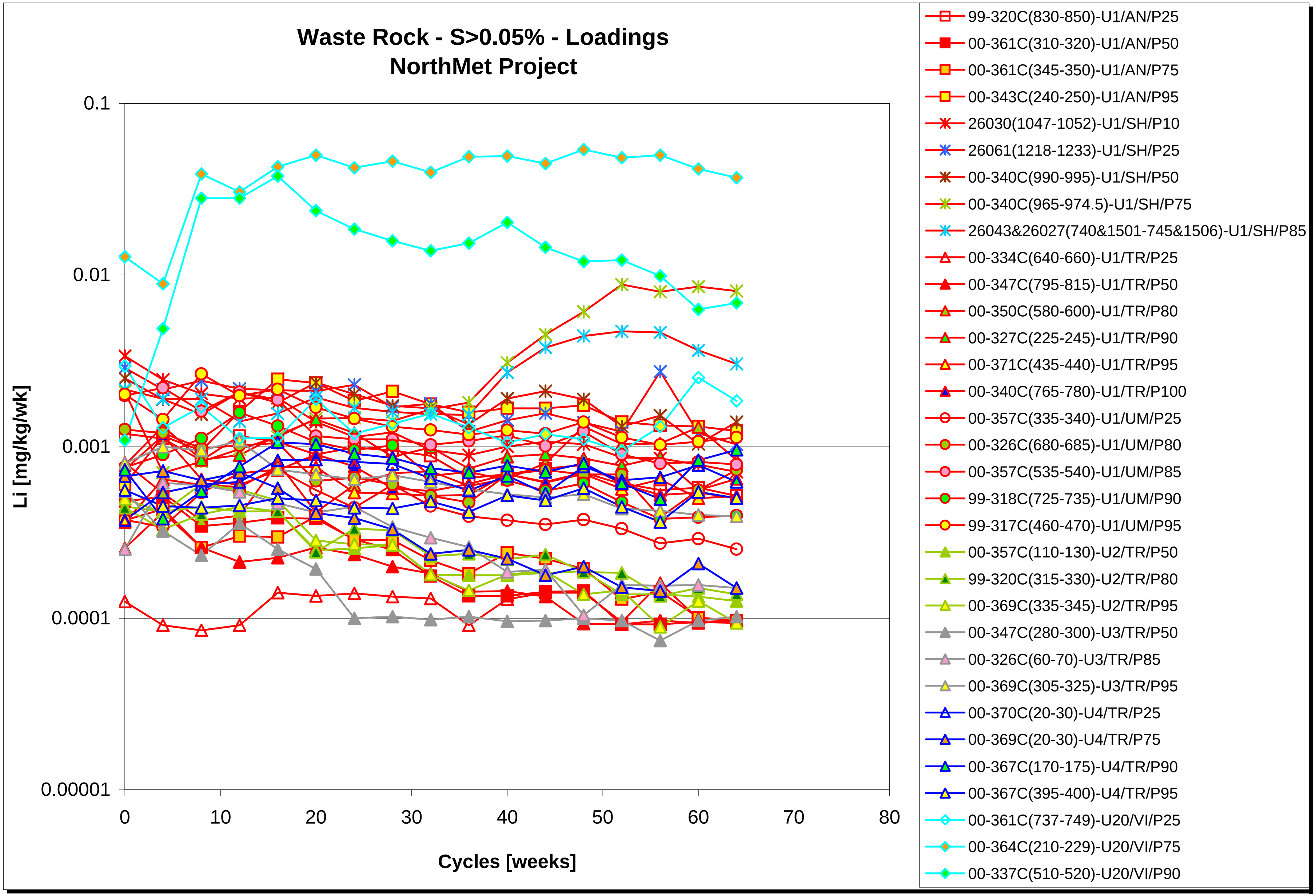

Waste Rock - S>0.05% - Loadings
NorthMet Project
Cr [mg/kg/wk]
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

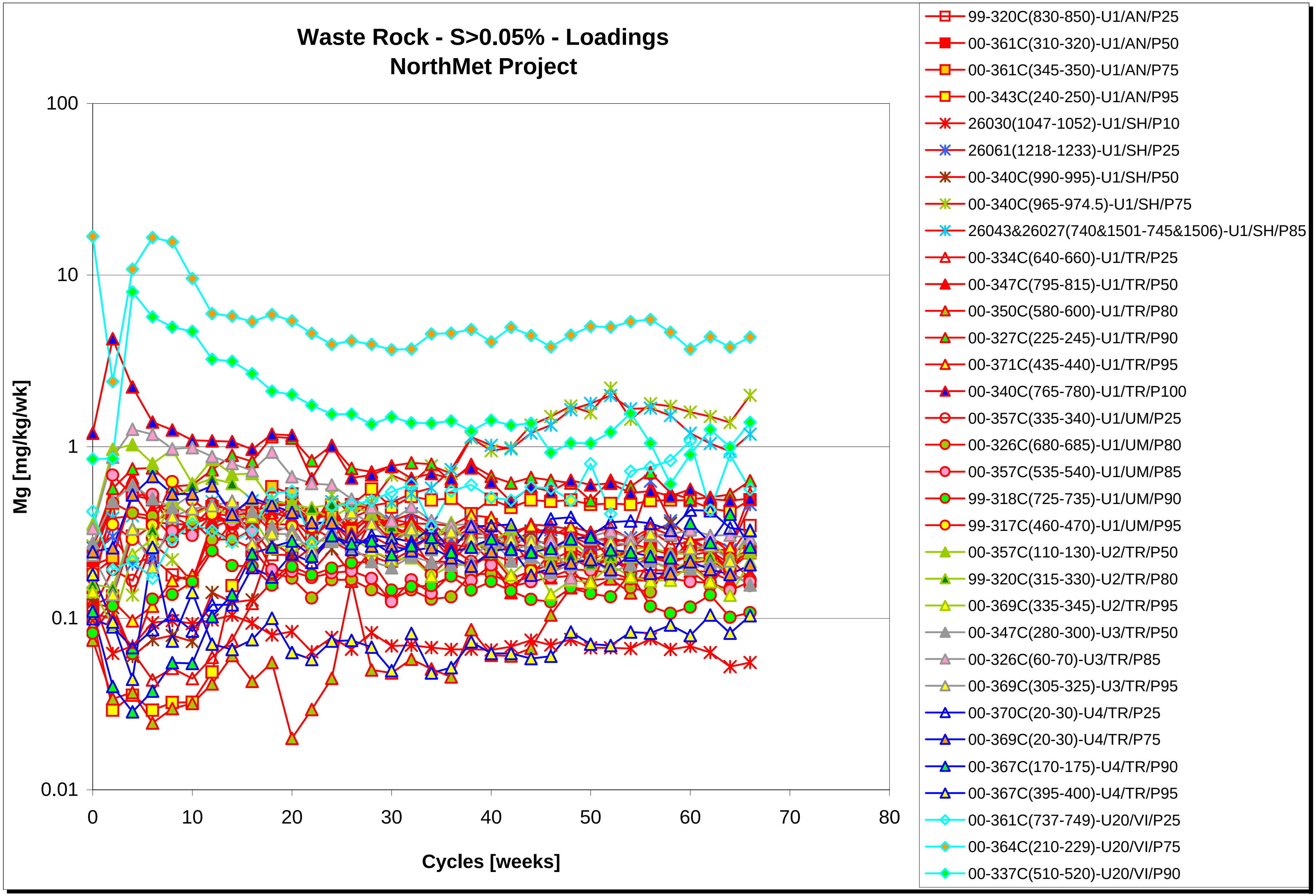

Waste Rock - S>0.05% - Loadings
NorthMet Project
Co [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90


Waste Rock - S>0.05% - Loadings
NorthMet Project
0.1
0.01
0.001
0.0001
Cu [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

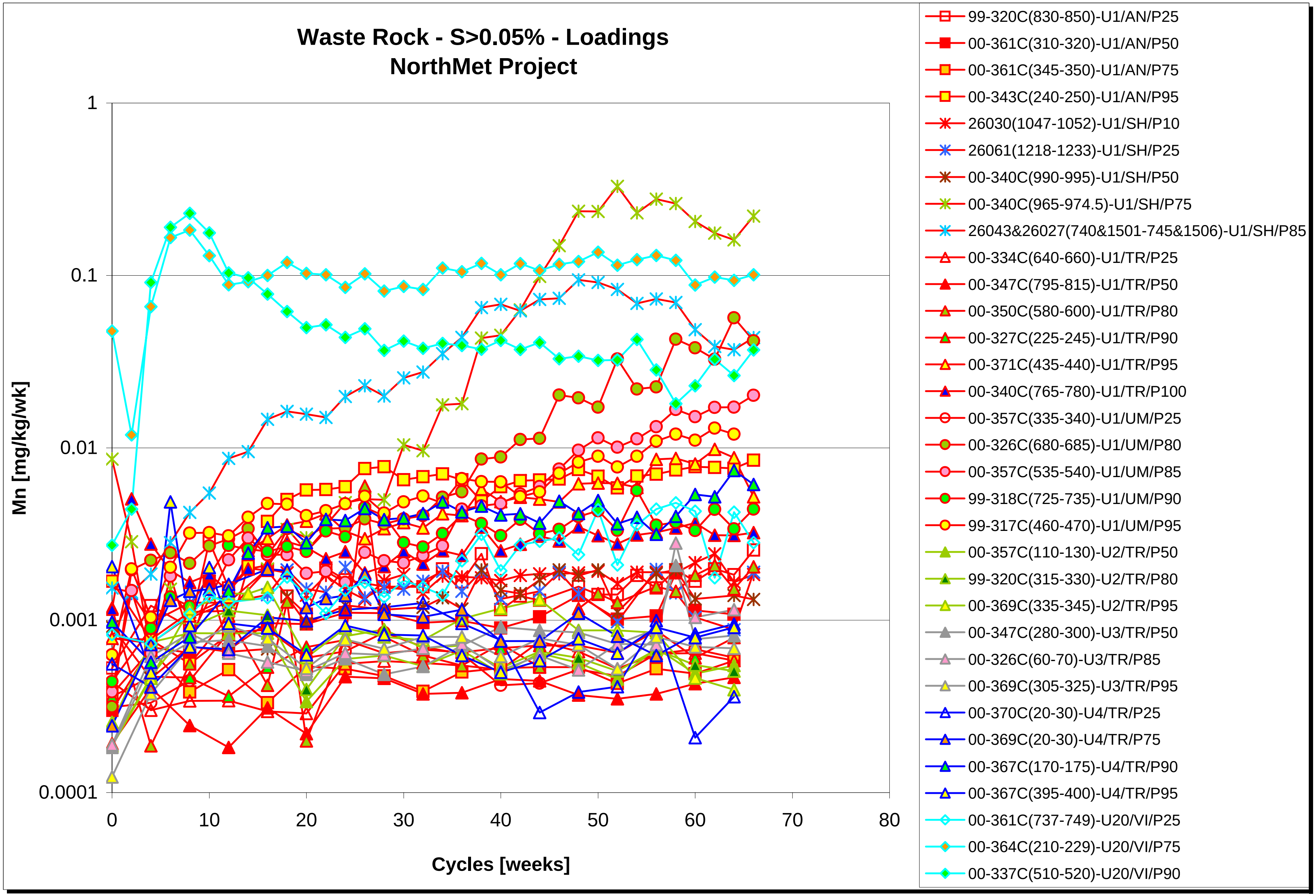

Waste Rock - S>0.05% - Loadings
NorthMet Project
Fe [mg/kg/wk]
100
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

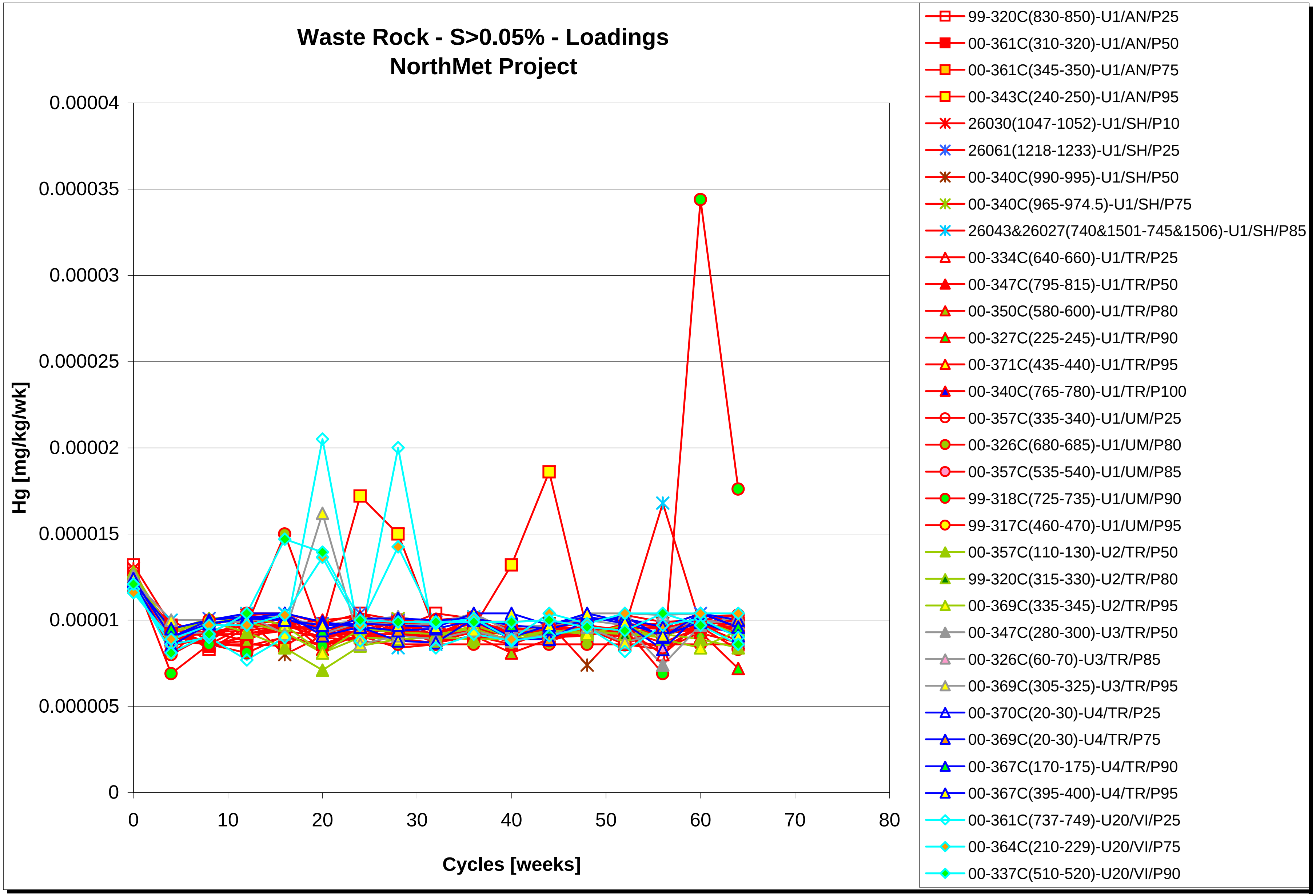

Waste Rock - S>0.05% - Loadings
NorthMet Project
0.1
0.01
0.001
0.0001
0.00001
Pb [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

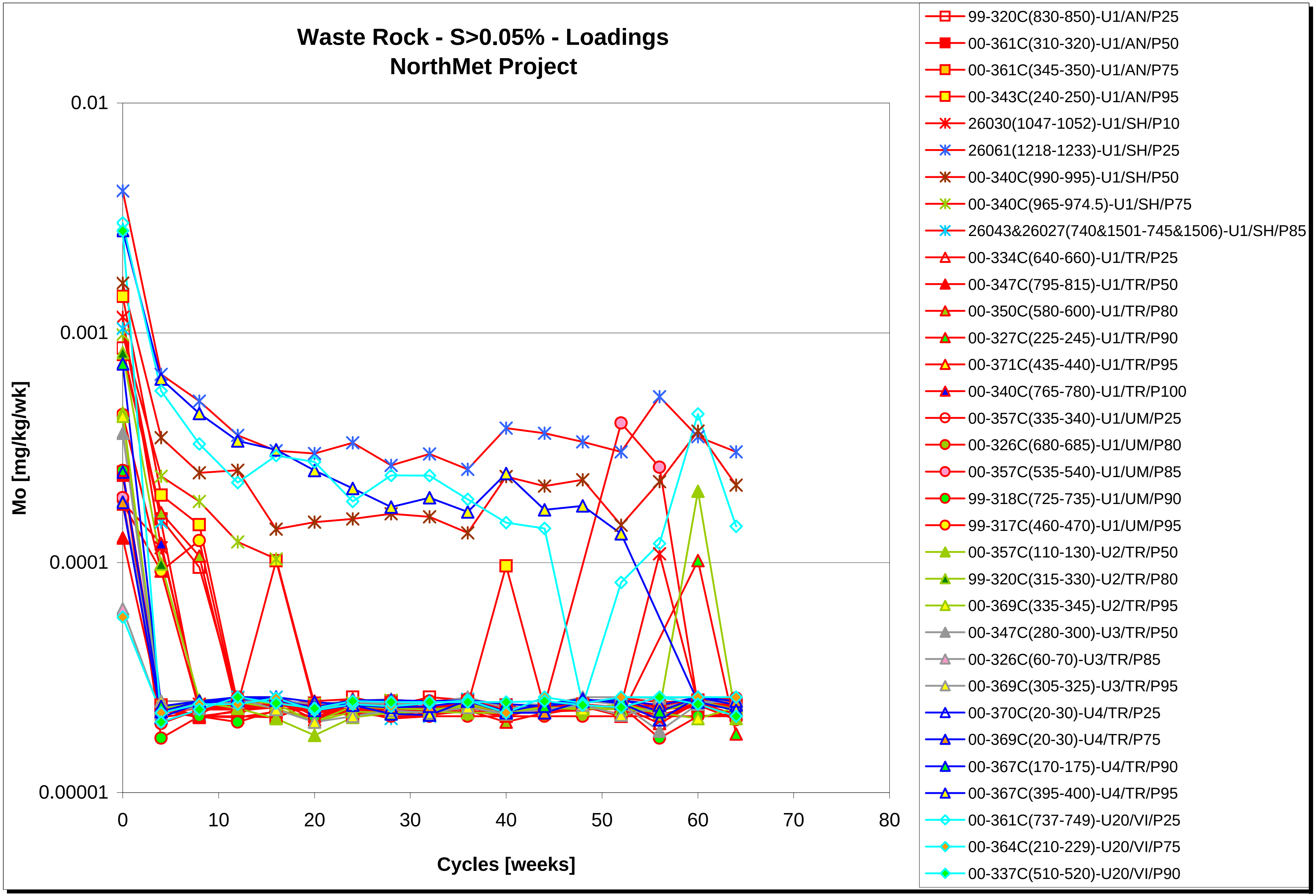

Waste Rock - S>0.05% - Loadings
NorthMet Project
Li [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

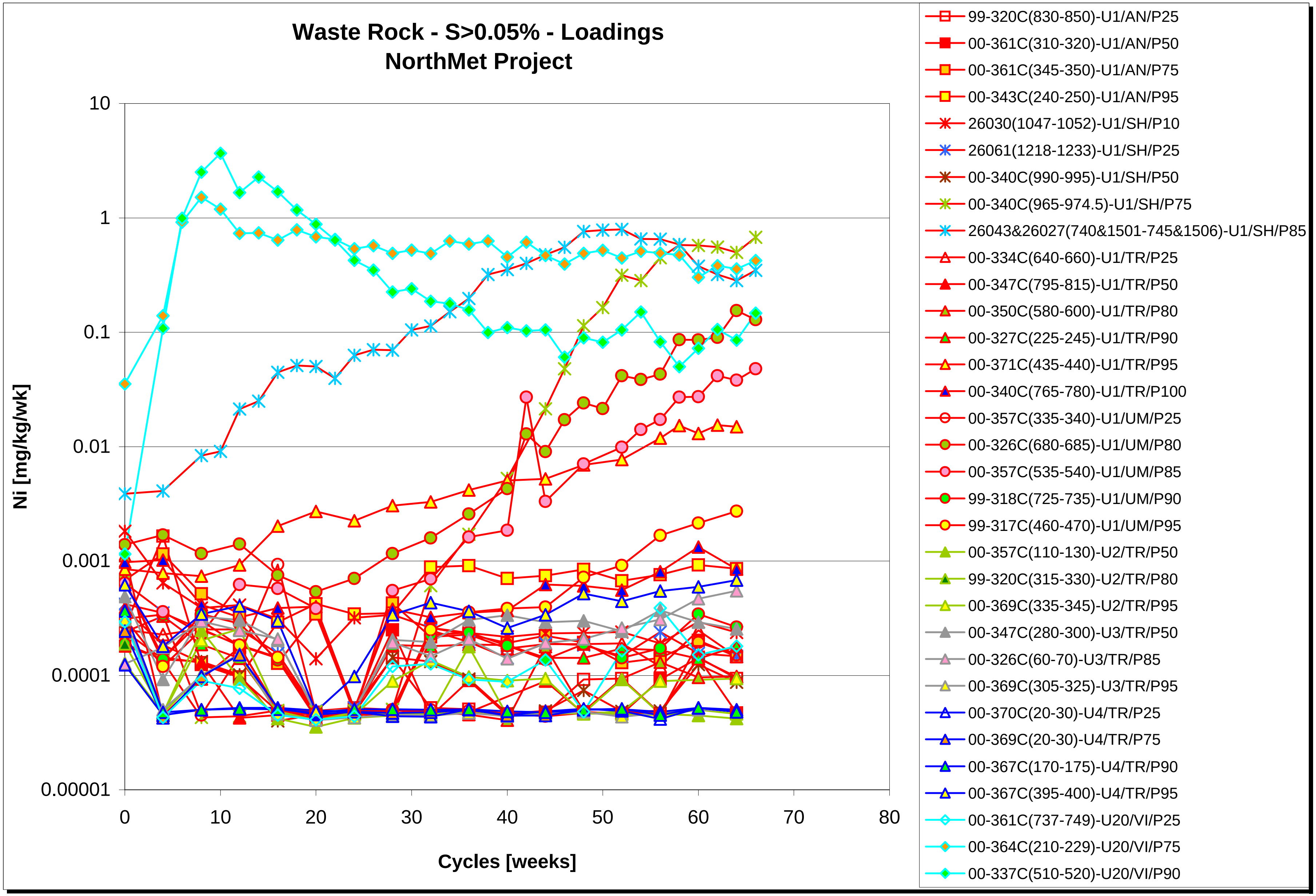


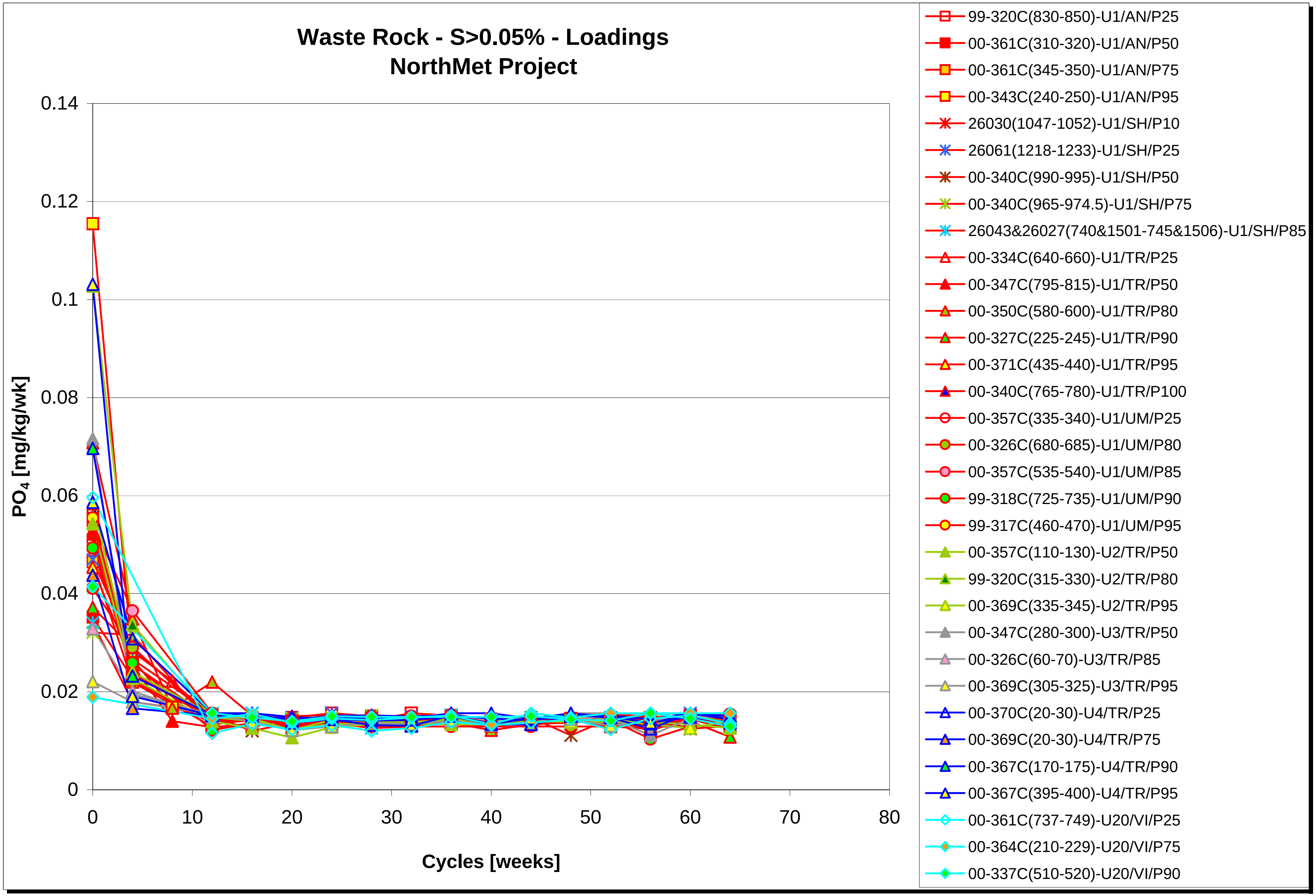
Waste Rock - S>0.05% - Loadings
NorthMet Project
Mg [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

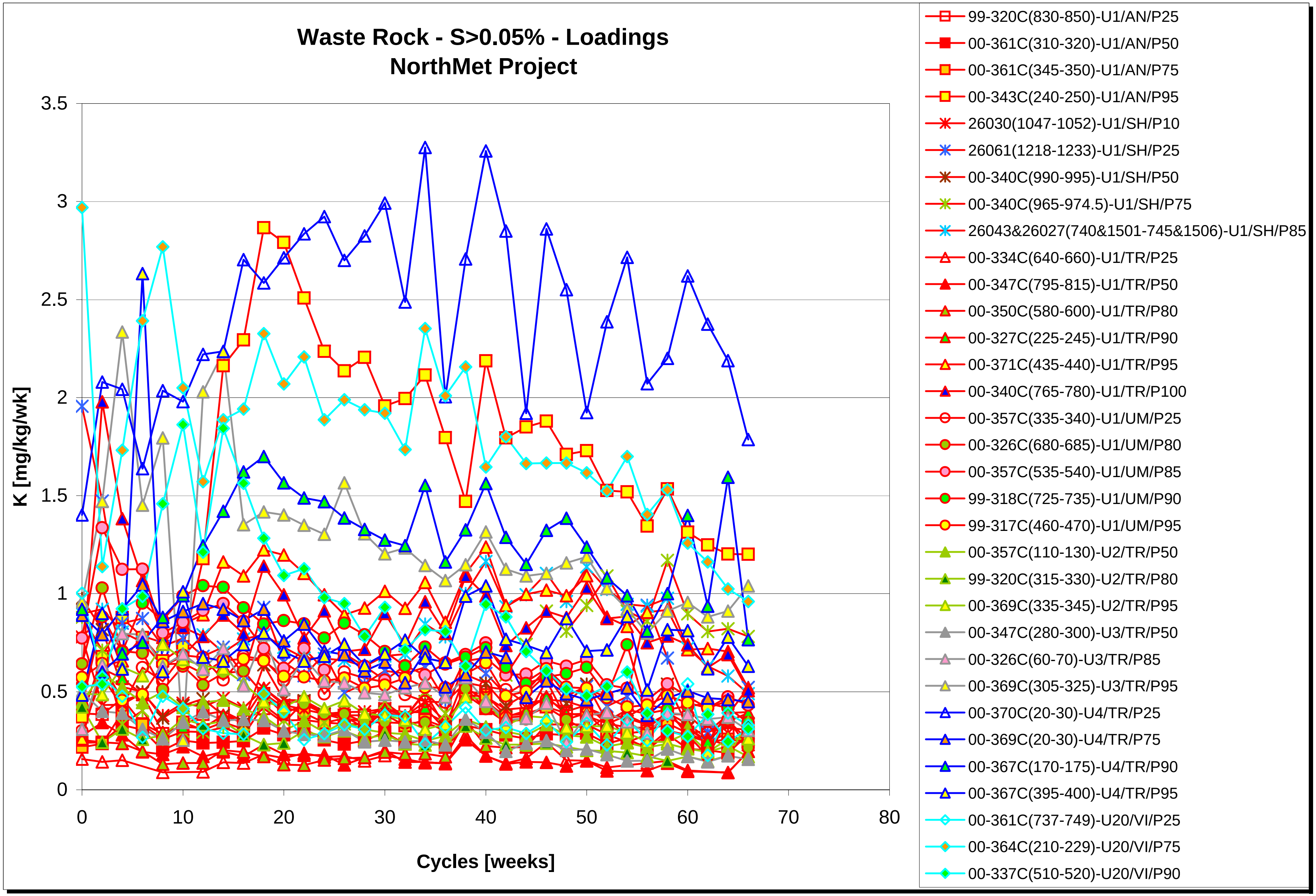

Waste Rock - S>0.05% - Loadings
NorthMet Project
Mn [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

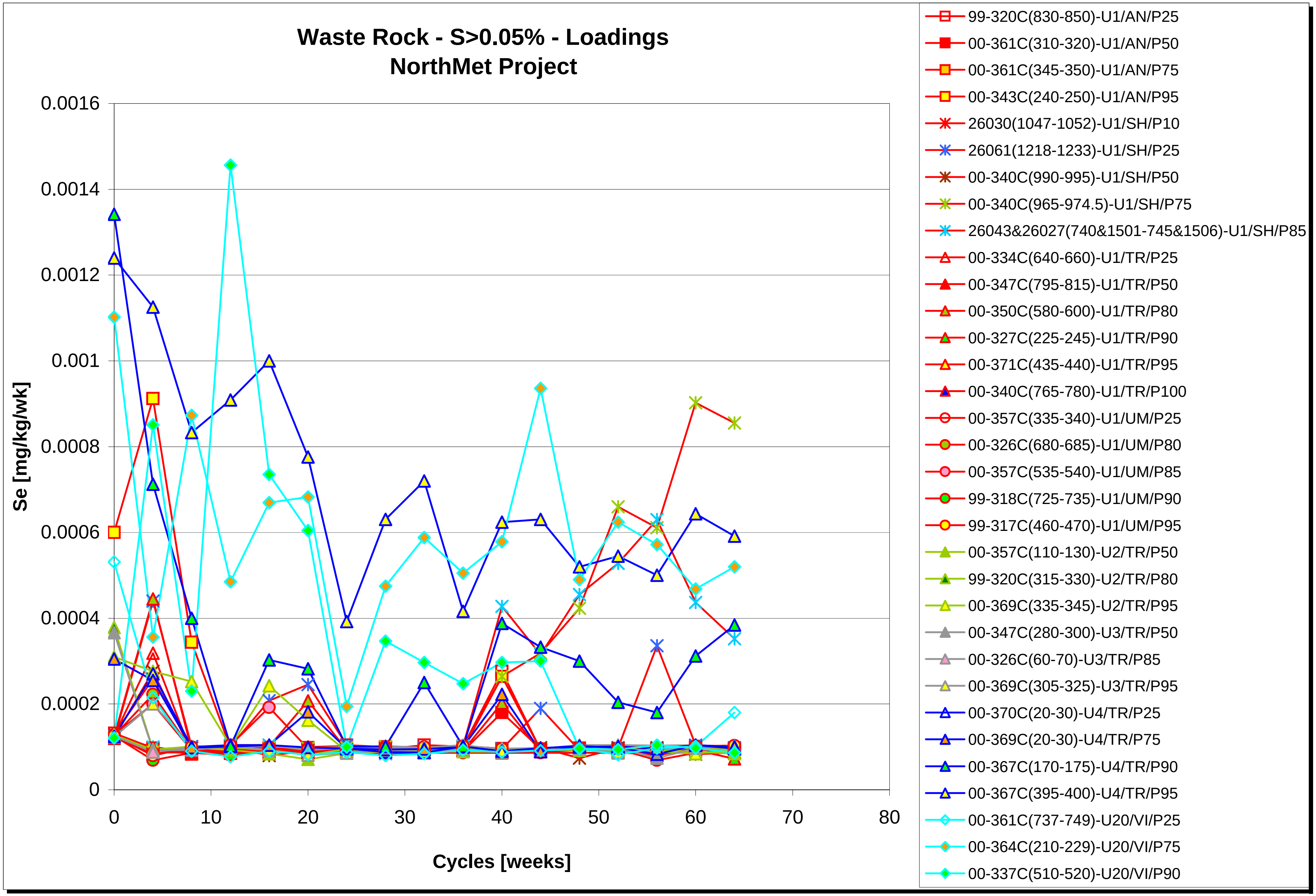

Waste Rock - S>0.05% - Loadings
NorthMet Project
Hg [mg/kg/wk]
0.00004
0.000035
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

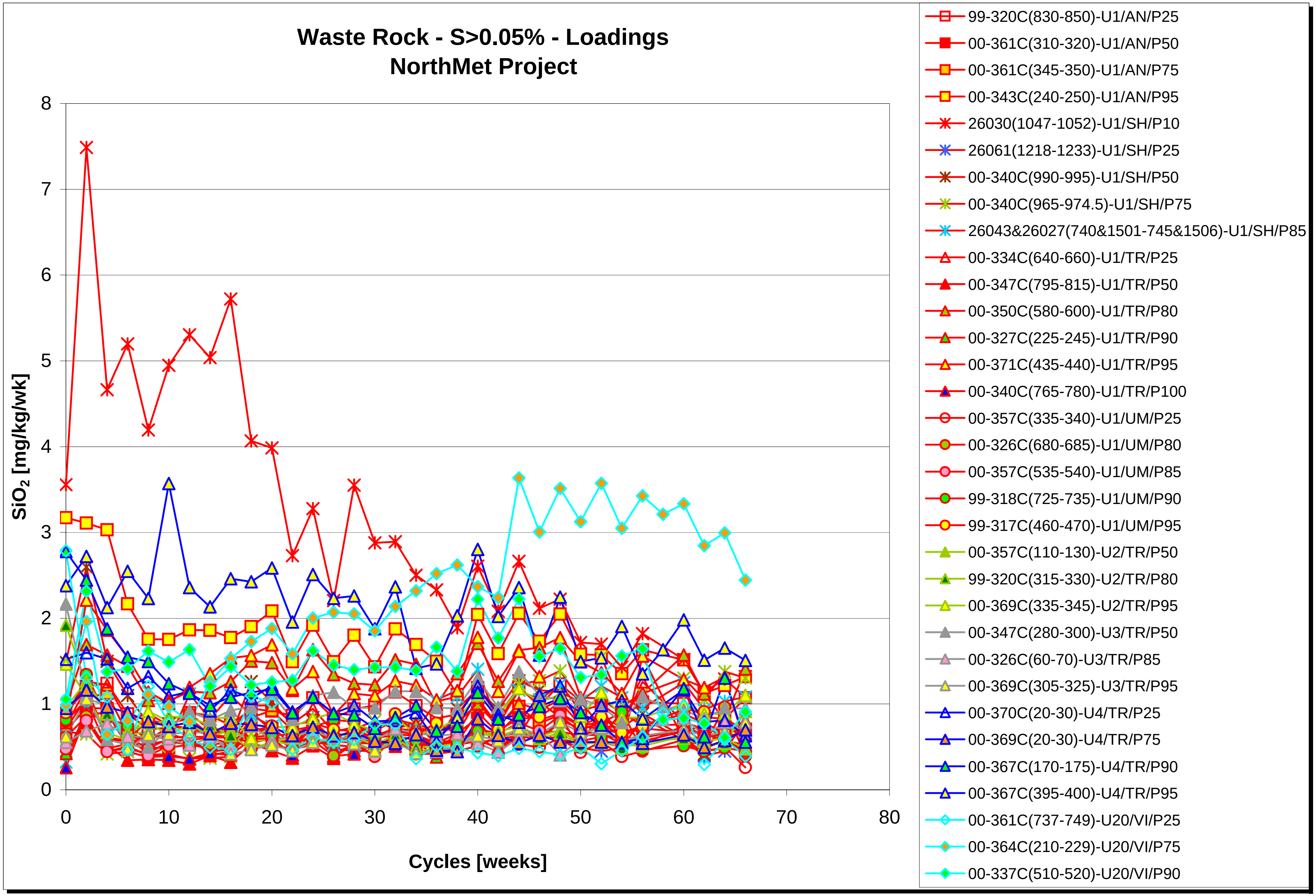

Waste Rock - S>0.05% - Loadings
NorthMet Project
Mo [mg/kg/wk]
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

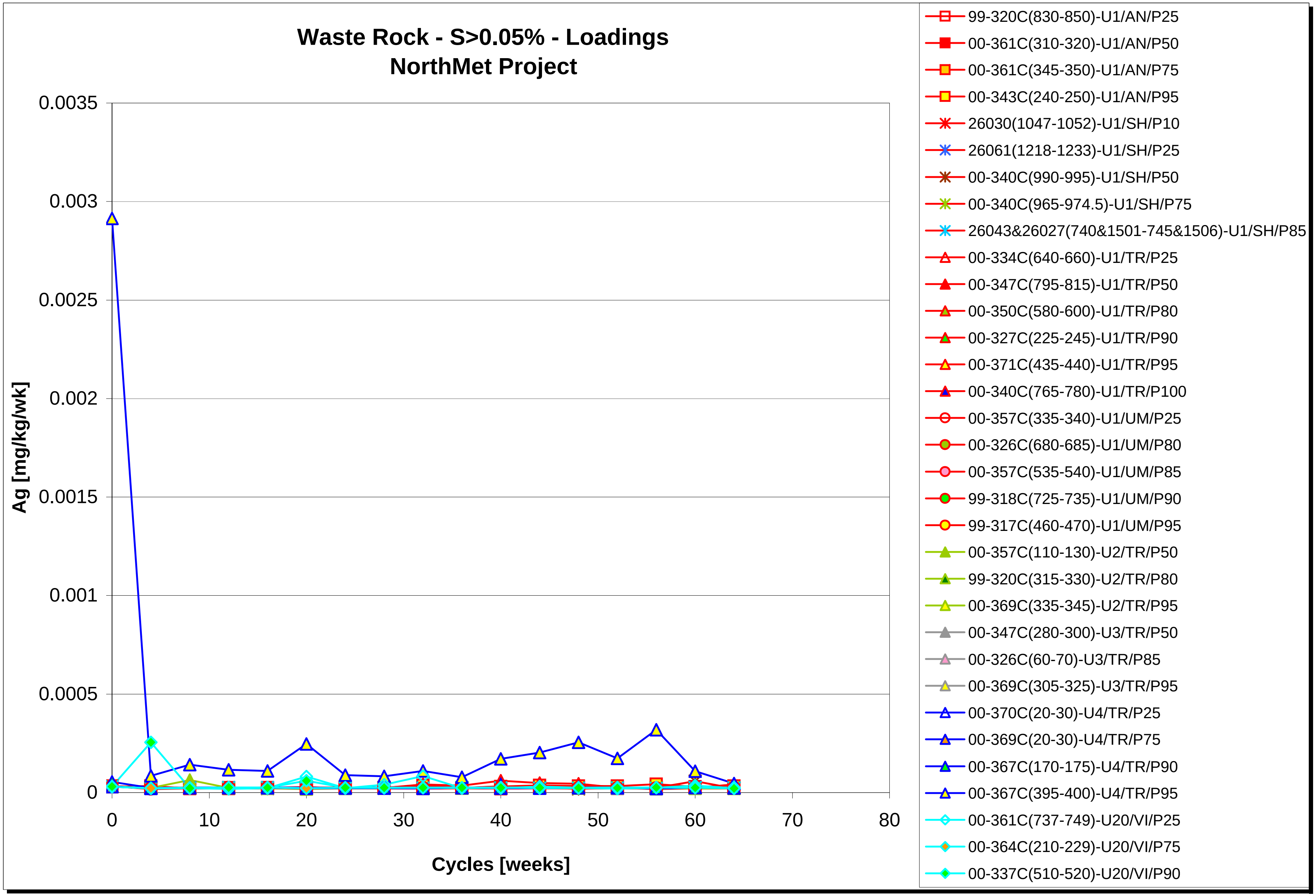

Waste Rock - S>0.05% - Loadings
NorthMet Project
Ni [mg/kg/wk]
10
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90


Waste Rock - S>0.05% - Loadings
NorthMet Project
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
PO4 [mg/kg/wk]
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90


Waste Rock - S>0.05% - Loadings
NorthMet Project
K [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
3.5
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

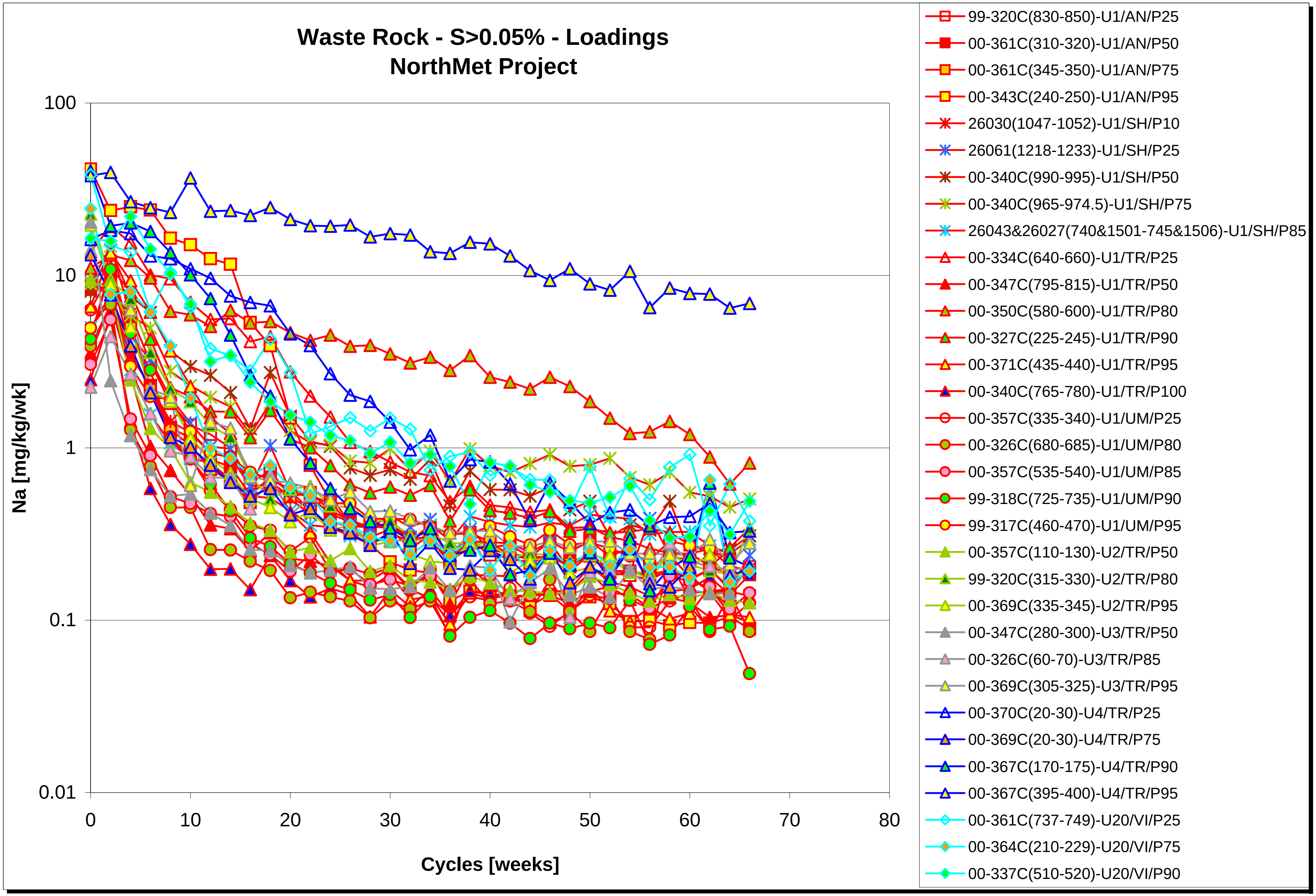

Waste Rock - S>0.05% - Loadings
NorthMet Project
Se [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

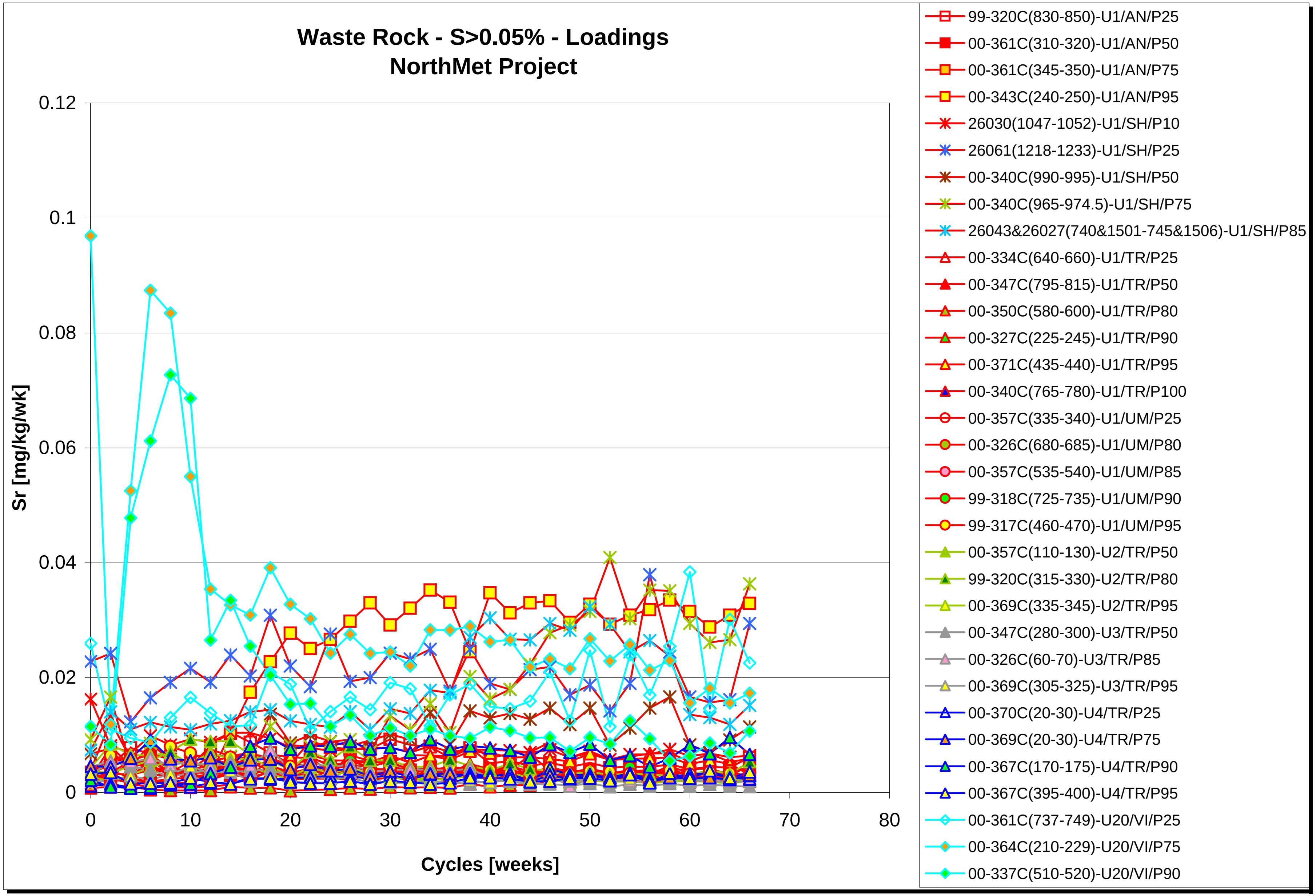

Waste Rock - S>0.05% - Loadings
NorthMet Project
SiO2 [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

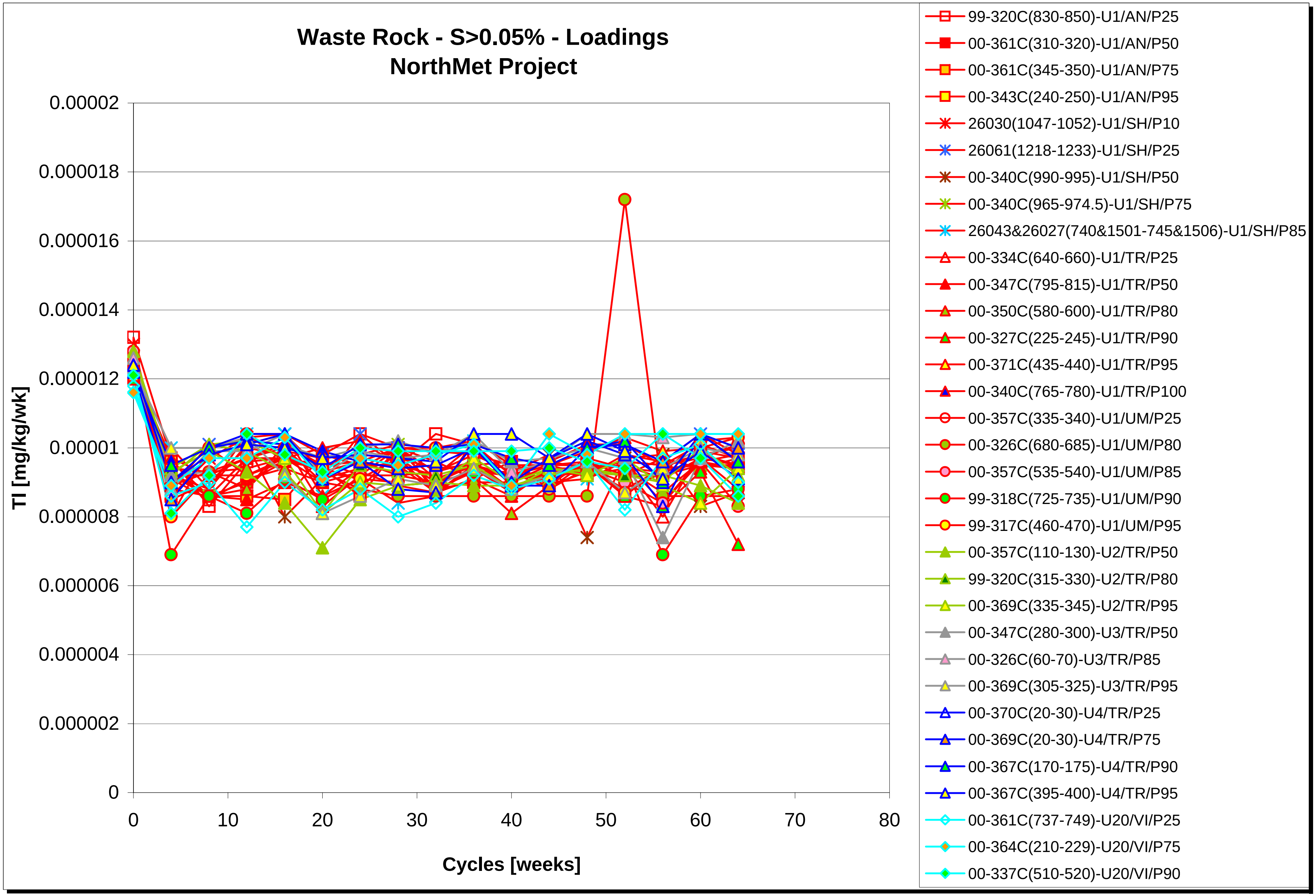

Waste Rock - S>0.05% - Loadings
NorthMet Project
Ag [mg/kg/wk]
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

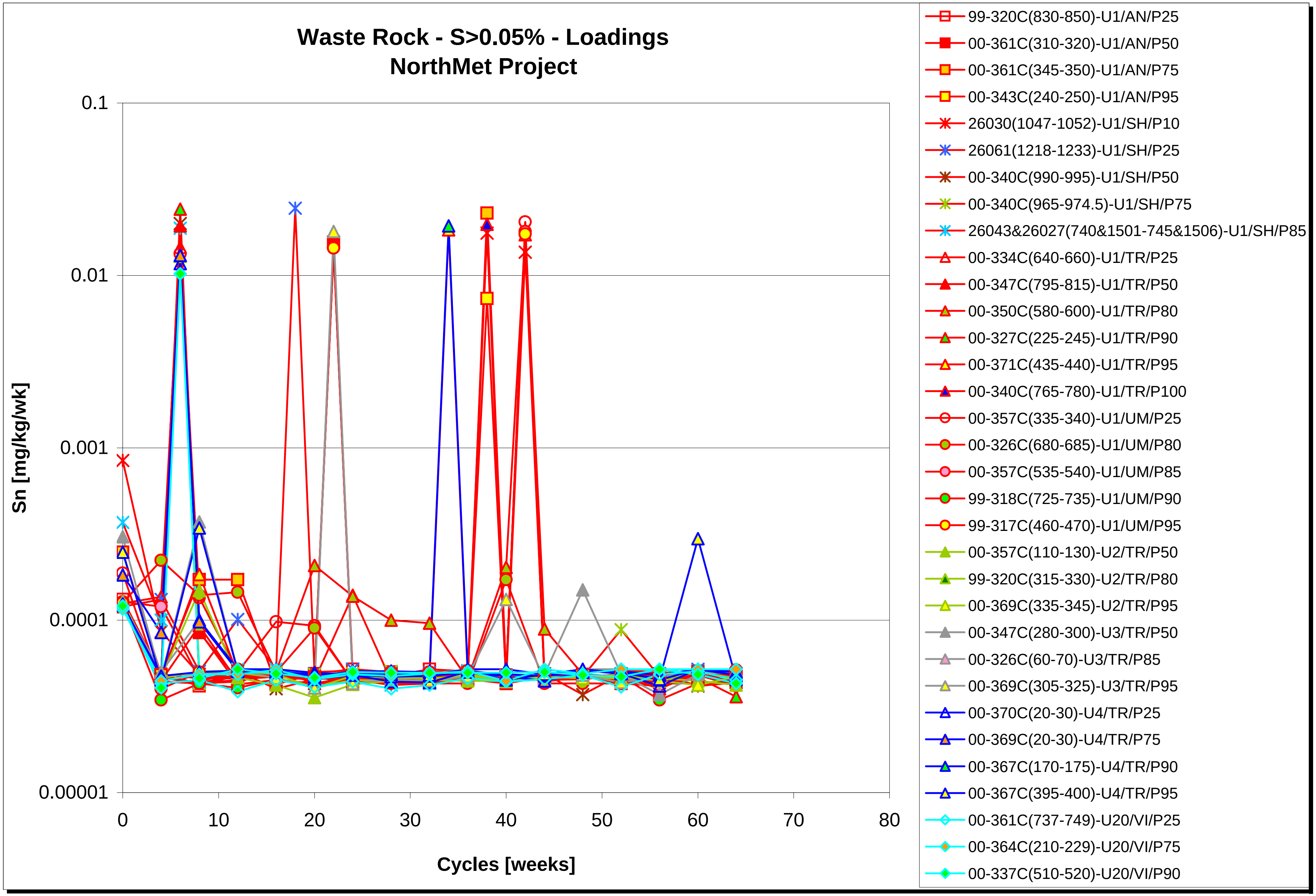
Appendix E.2
Higher Sulfur Waste Rock

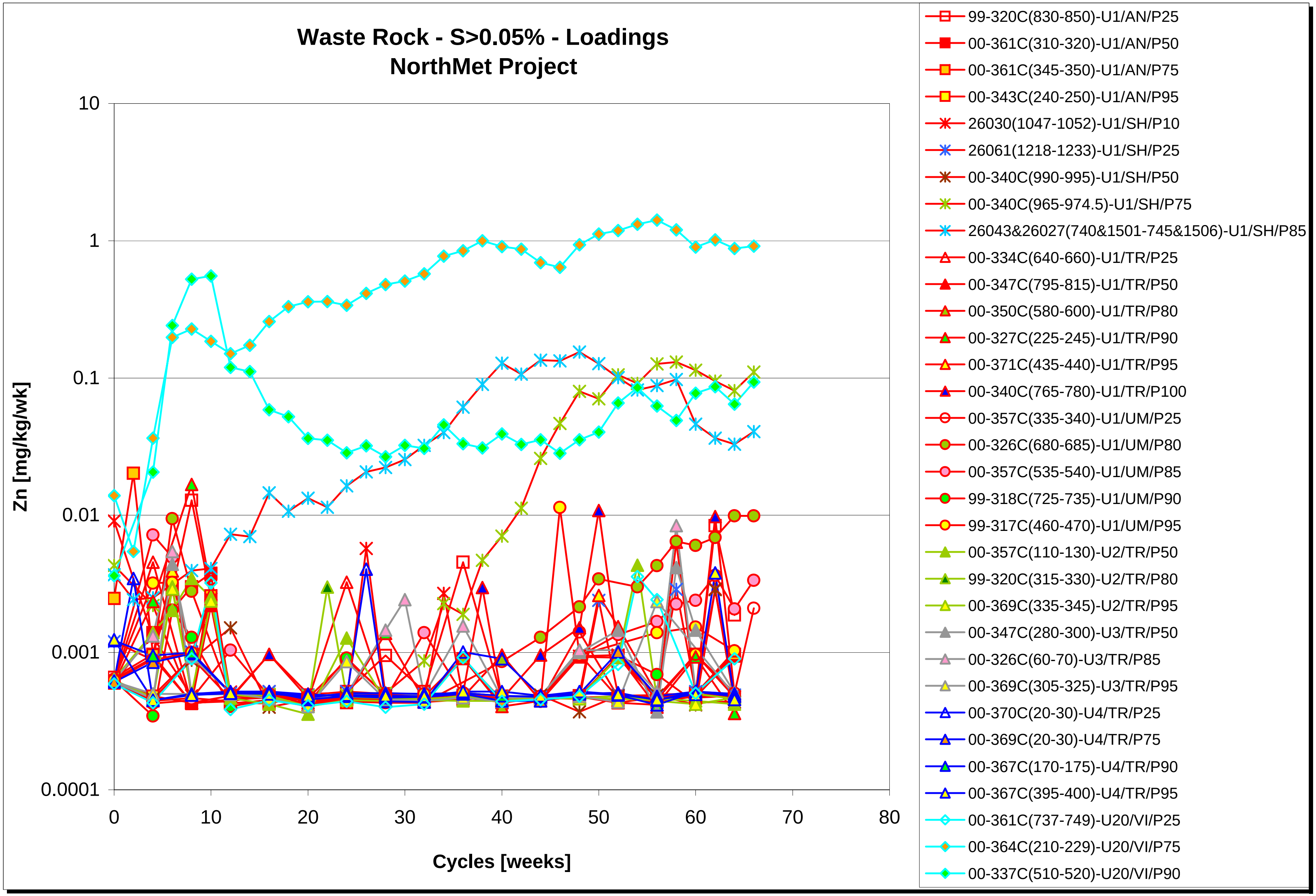
Graph E.2.37




Waste Rock - S>0.05% - Loadings
NorthMet Project
Sr [mg/kg/wk]
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

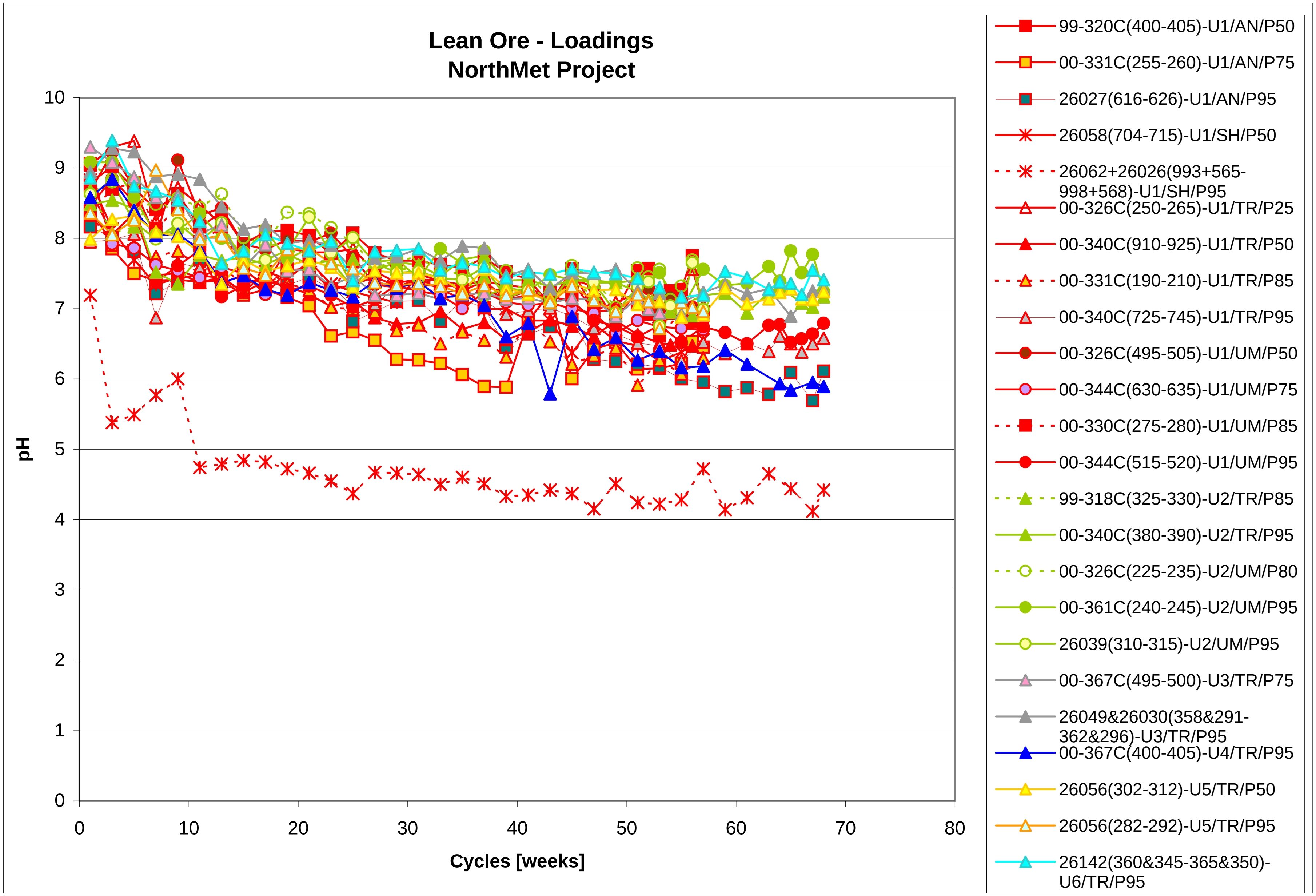

Waste Rock - S>0.05% - Loadings
NorthMet Project
Tl [mg/kg/wk]
0.00002
0.000018
0.000016
0.000014
0.000012
0.00001
0.000008
0.000006
0.000004
0.000002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

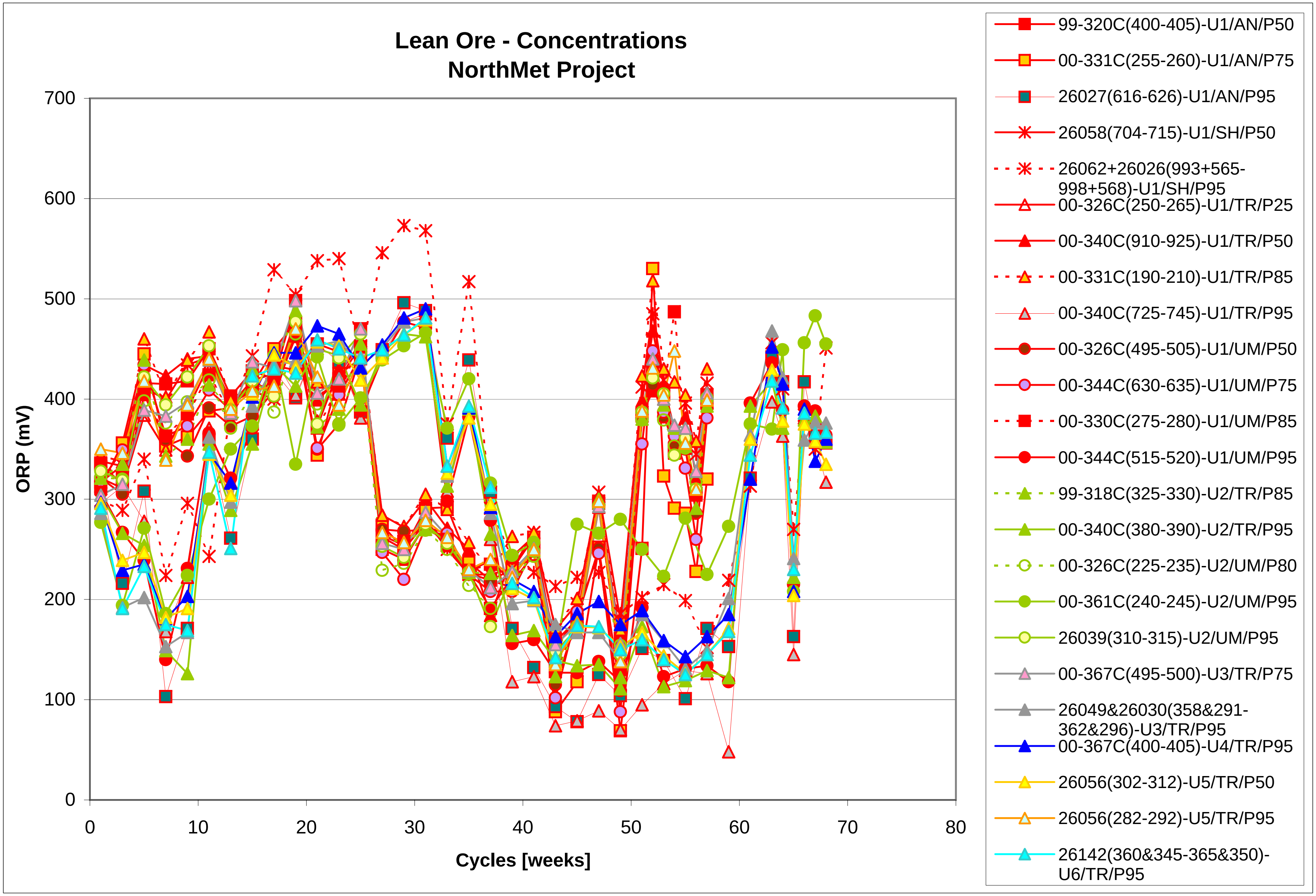

Waste Rock - S>0.05% - Loadings
NorthMet Project
Sn [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

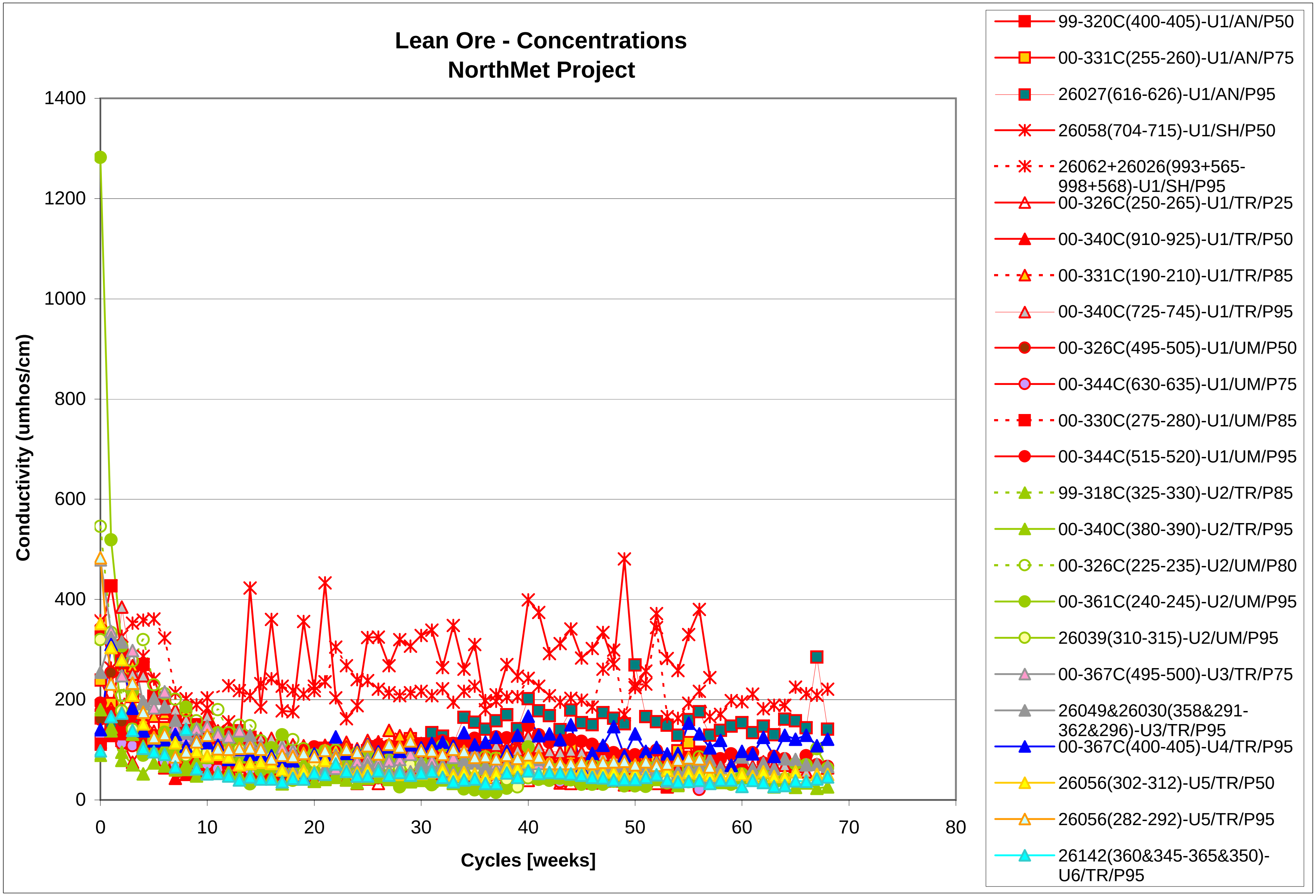

Waste Rock - S>0.05% - Loadings
NorthMet Project
Zn [mg/kg/wk]
10
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(830-850)-U1/AN/P25
00-361C(310-320)-U1/AN/P50
00-361C(345-350)-U1/AN/P75
00-343C(240-250)-U1/AN/P95
26030(1047-1052)-U1/SH/P10
26061(1218-1233)-U1/SH/P25
00-340C(990-995)-U1/SH/P50
00-340C(965-974.5)-U1/SH/P75
26043&26027(740&1501-745&1506)-U1/SH/P85
00-334C(640-660)-U1/TR/P25
00-347C(795-815)-U1/TR/P50
00-350C(580-600)-U1/TR/P80
00-327C(225-245)-U1/TR/P90
00-371C(435-440)-U1/TR/P95
00-340C(765-780)-U1/TR/P100
00-357C(335-340)-U1/UM/P25
00-326C(680-685)-U1/UM/P80
00-357C(535-540)-U1/UM/P85
99-318C(725-735)-U1/UM/P90
99-317C(460-470)-U1/UM/P95
00-357C(110-130)-U2/TR/P50
99-320C(315-330)-U2/TR/P80
00-369C(335-345)-U2/TR/P95
00-347C(280-300)-U3/TR/P50
00-326C(60-70)-U3/TR/P85
00-369C(305-325)-U3/TR/P95
00-370C(20-30)-U4/TR/P25
00-369C(20-30)-U4/TR/P75
00-367C(170-175)-U4/TR/P90
00-367C(395-400)-U4/TR/P95
00-361C(737-749)-U20/VI/P25
00-364C(210-229)-U20/VI/P75
00-337C(510-520)-U20/VI/P90

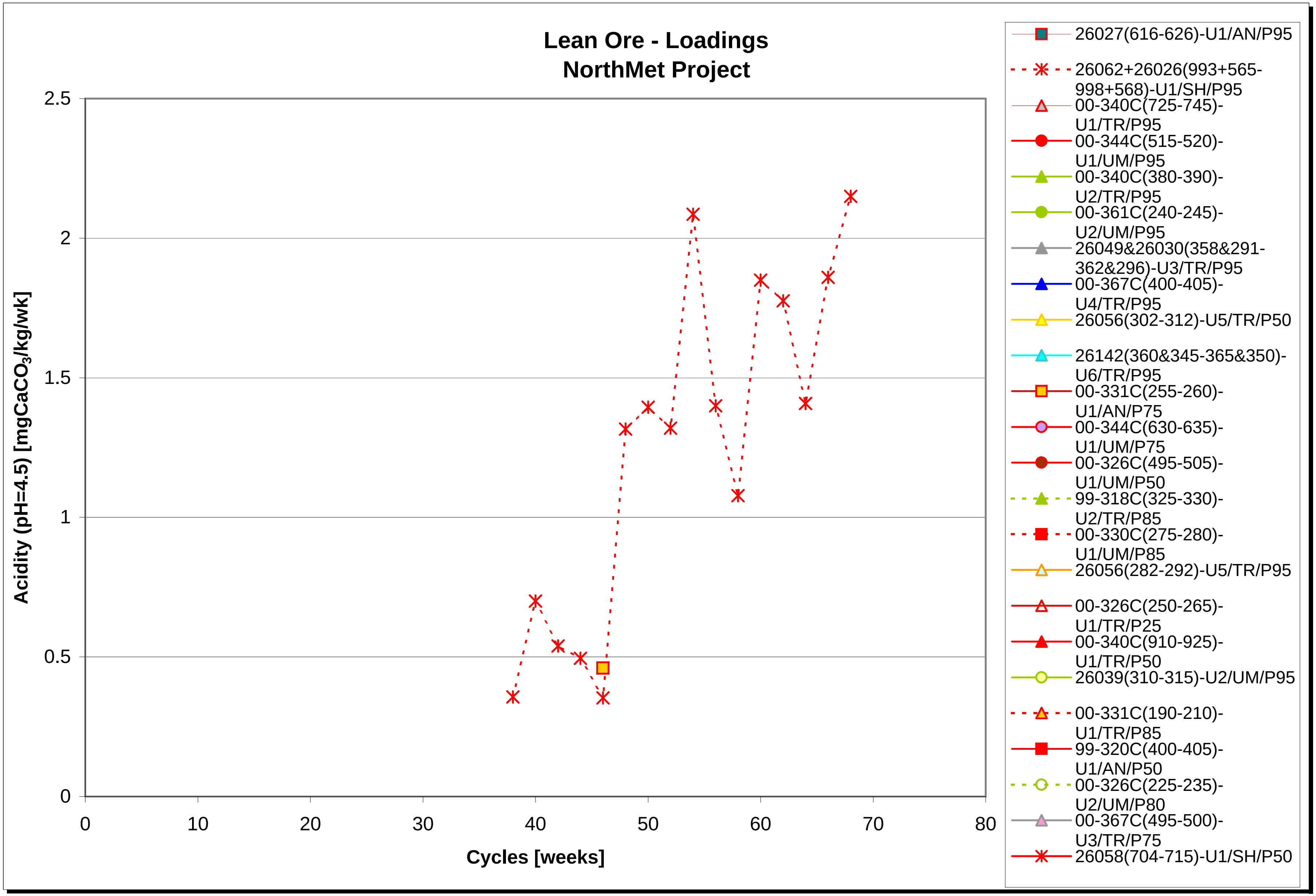
Appendix E.3

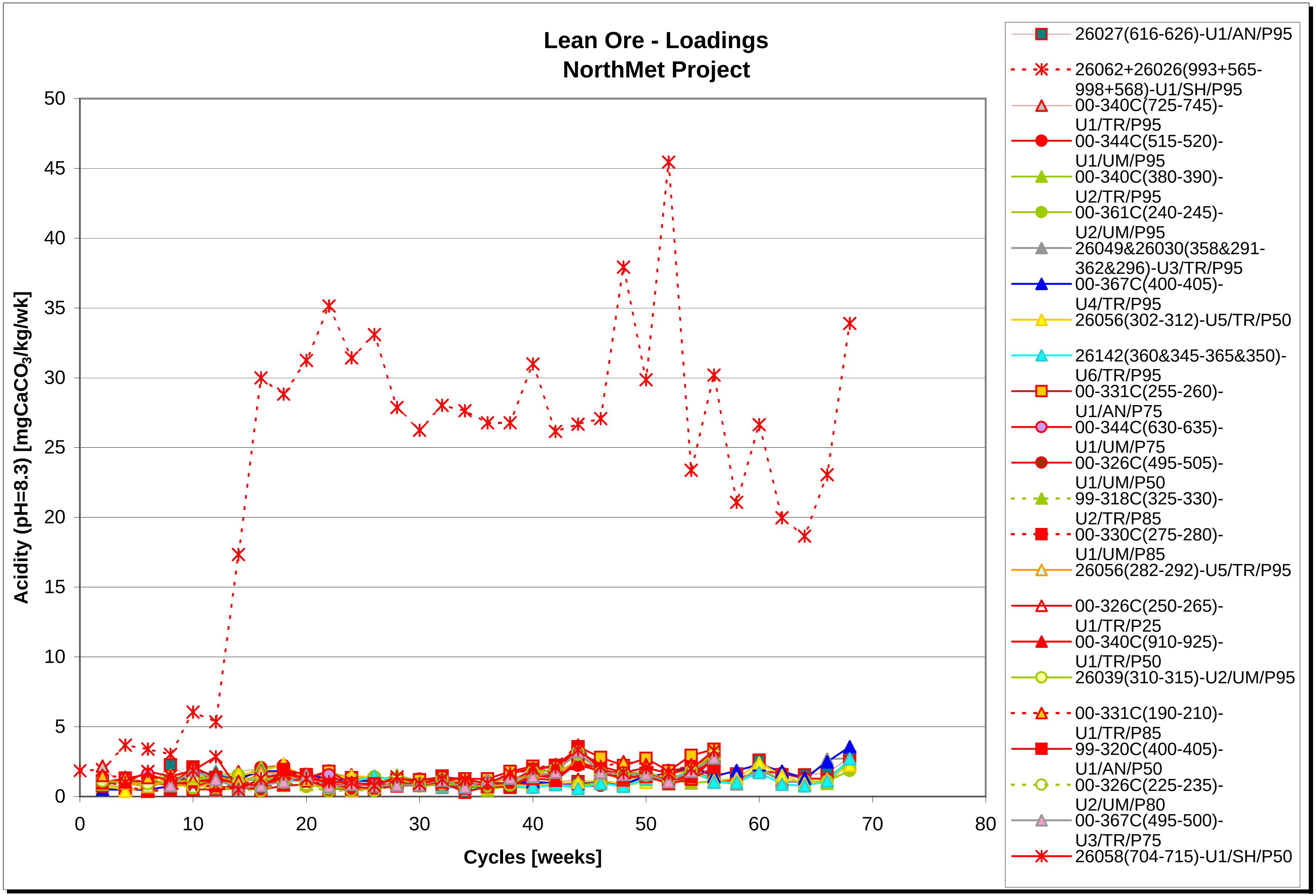
Lean Ore

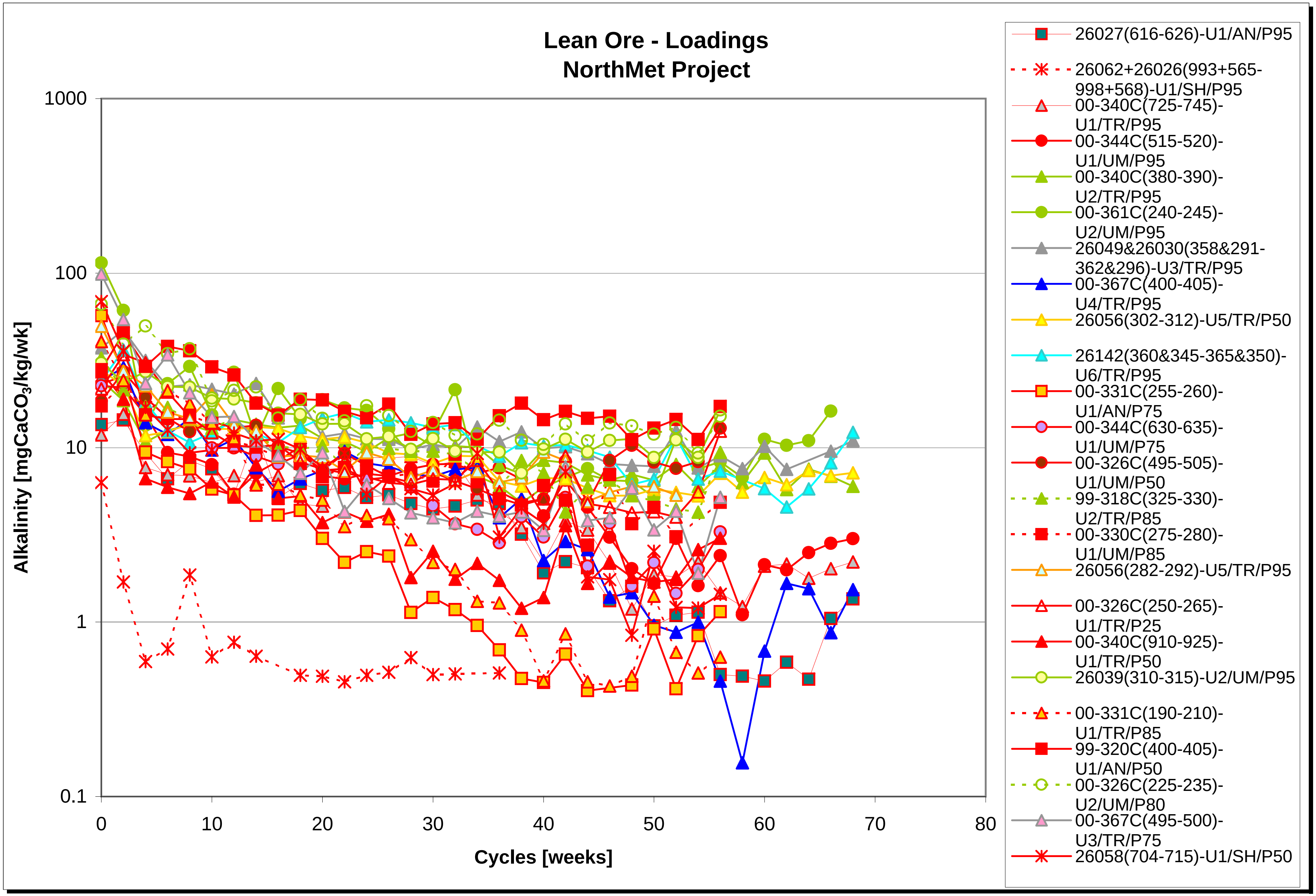

Lean Ore - Loadings
NorthMet Project
pH
Cycles [weeks]
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
99-320C(400-405)-U1/AN/P50
00-331C(255-260)-U1/AN/P75
26027(616-626)-U1/AN/P95
26058(704-715)-U1/SH/P50
26062+26026(993+565-998+568)-U1/SH/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
00-331C(190-210)-U1/TR/P85
00-340C(725-745)-U1/TR/P95
00-326C(495-505)-U1/UM/P50
00-344C(630-635)-U1/UM/P75
00-330C(275-280)-U1/UM/P85
00-344C(515-520)-U1/UM/P95
99-318C(325-330)-U2/TR/P85
00-340C(380-390)-U2/TR/P95
00-326C(225-235)-U2/UM/P80
00-361C(240-245)-U2/UM/P95
26039(310-315)-U2/UM/P95
00-367C(495-500)-U3/TR/P75
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26056(282-292)-U5/TR/P95
26142(360&345-365&350)-U6/TR/P95

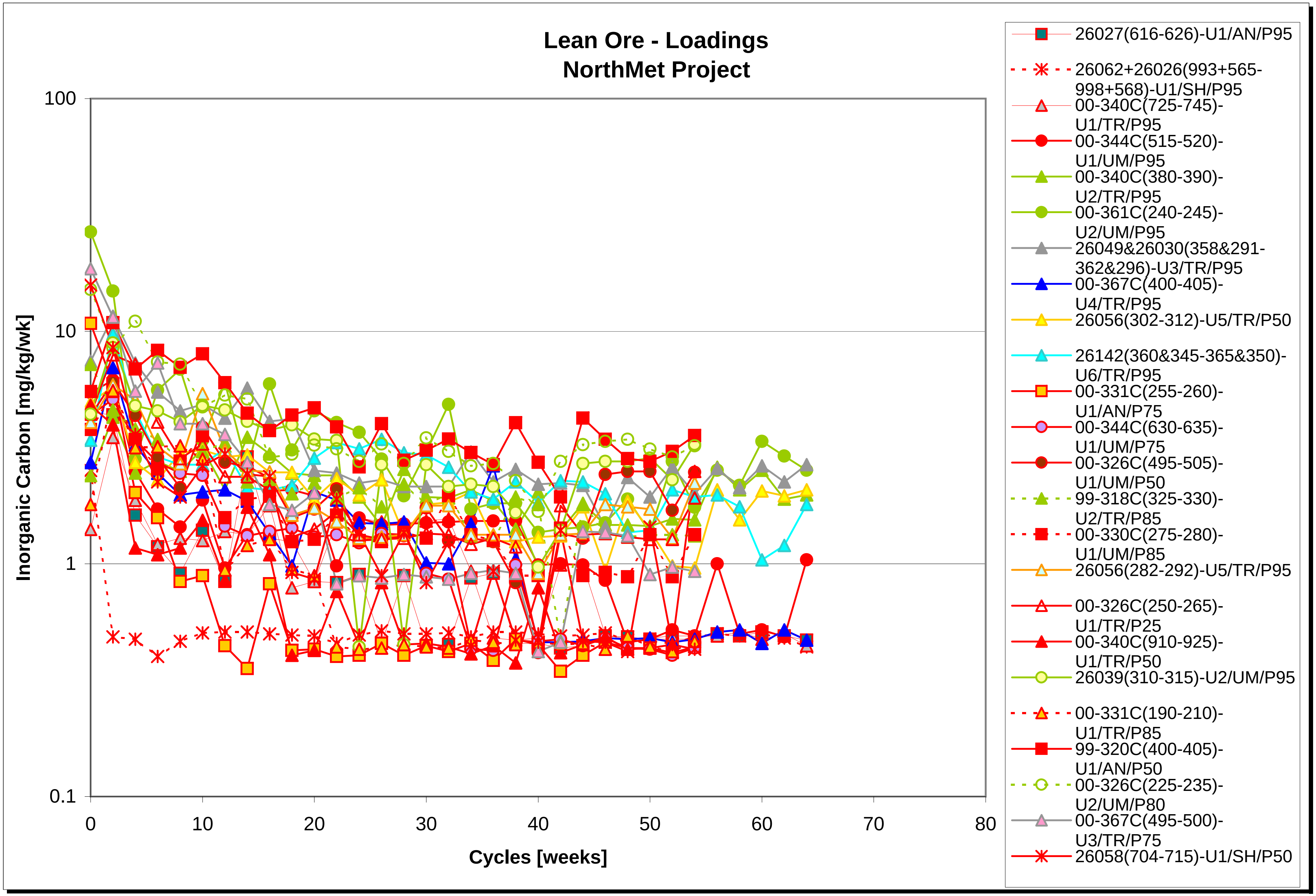

Lean Ore - Concentrations
NorthMet Project
ORP (mV)
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(400-405)-U1/AN/P50
00-331C(255-260)-U1/AN/P75
26027(616-626)-U1/AN/P95
26058(704-715)-U1/SH/P50
26062+26026(993+565-998+568)-U1/SH/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
00-331C(190-210)-U1/TR/P85
00-340C(725-745)-U1/TR/P95
00-326C(495-505)-U1/UM/P50
00-344C(630-635)-U1/UM/P75
00-330C(275-280)-U1/UM/P85
00-344C(515-520)-U1/UM/P95
99-318C(325-330)-U2/TR/P85
00-340C(380-390)-U2/TR/P95
00-326C(225-235)-U2/UM/P80
00-361C(240-245)-U2/UM/P95
26039(310-315)-U2/UM/P95
00-367C(495-500)-U3/TR/P75
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26056(282-292)-U5/TR/P95
26142(360&345-365&350)-U6/TR/P95

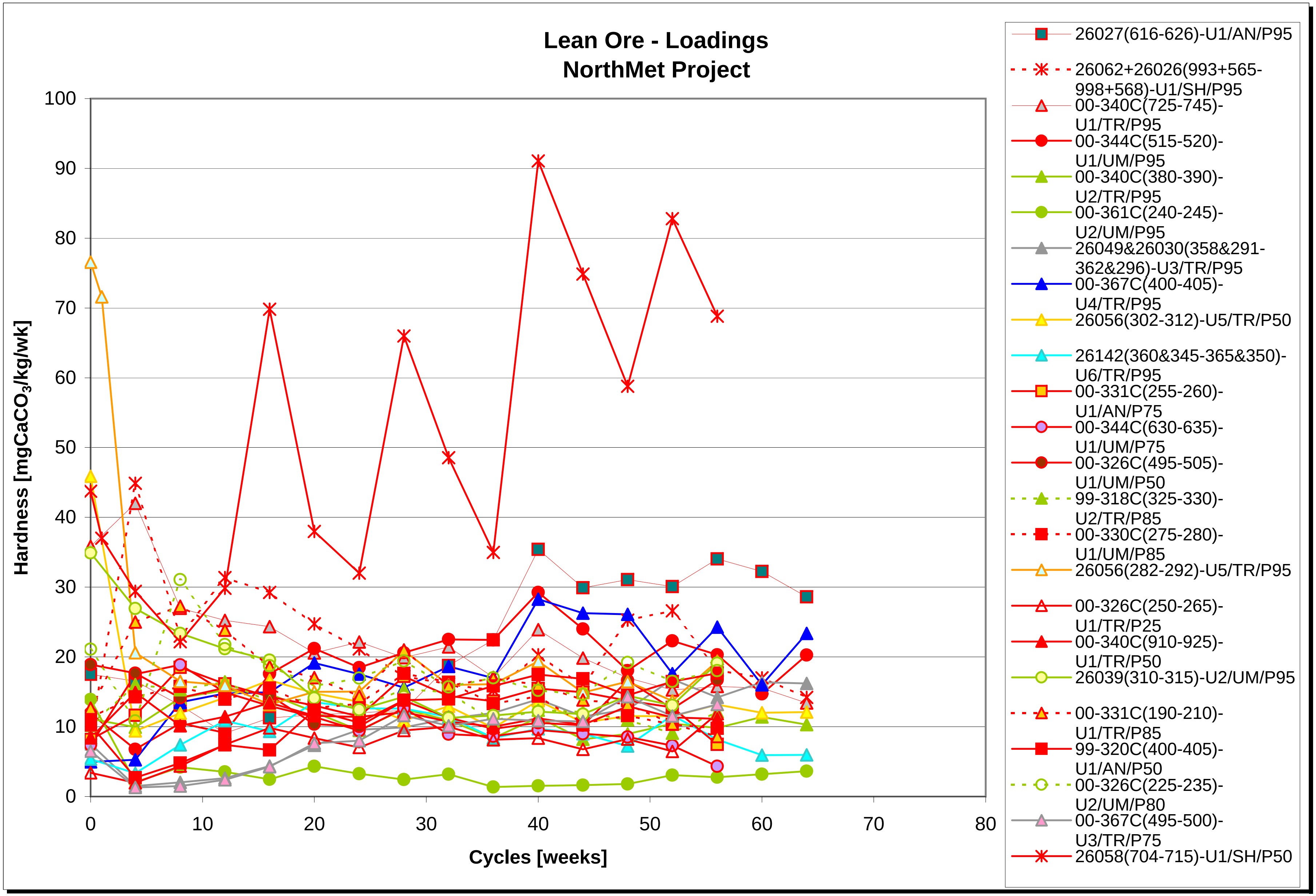

Lean Ore - Concentrations
NorthMet Project
Conductivity (umhos/cm)
1400
1200
1000
800
600
400
200
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
99-320C(400-405)-U1/AN/P50
00-331C(255-260)-U1/AN/P75
26027(616-626)-U1/AN/P95
26058(704-715)-U1/SH/P50
26062+26026(993+565-998+568)-U1/SH/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
00-331C(190-210)-U1/TR/P85
00-340C(725-745)-U1/TR/P95
00-326C(495-505)-U1/UM/P50
00-344C(630-635)-U1/UM/P75
00-330C(275-280)-U1/UM/P85
00-344C(515-520)-U1/UM/P95
99-318C(325-330)-U2/TR/P85
00-340C(380-390)-U2/TR/P95
00-326C(225-235)-U2/UM/P80
00-361C(240-245)-U2/UM/P95
26039(310-315)-U2/UM/P95
00-367C(495-500)-U3/TR/P75
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26056(282-292)-U5/TR/P95
26142(360&345-365&350)-U6/TR/P95

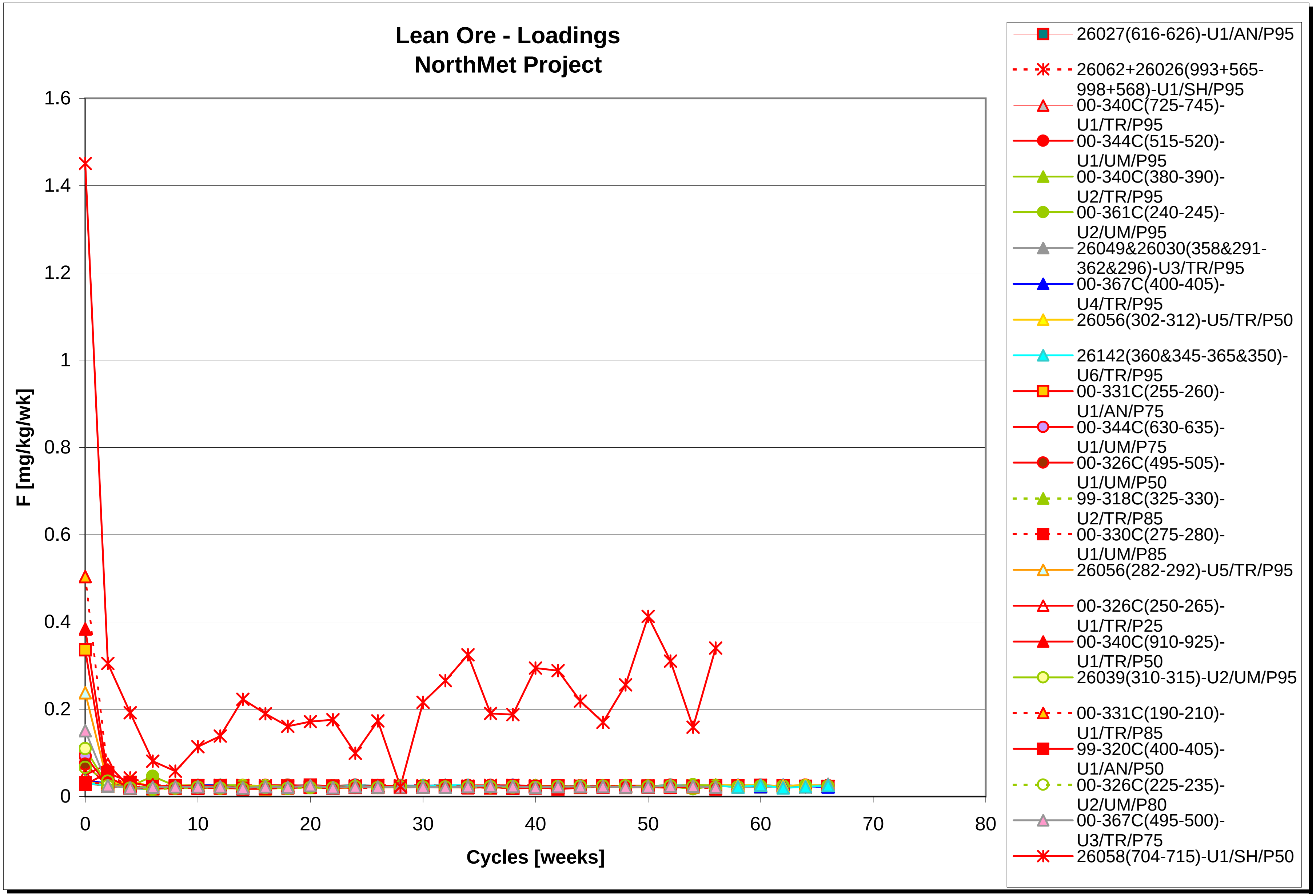

Lean Ore - Loadings
NorthMet Project
Acidity (pH=4.5) [mgCaCO3/kg/wk]
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

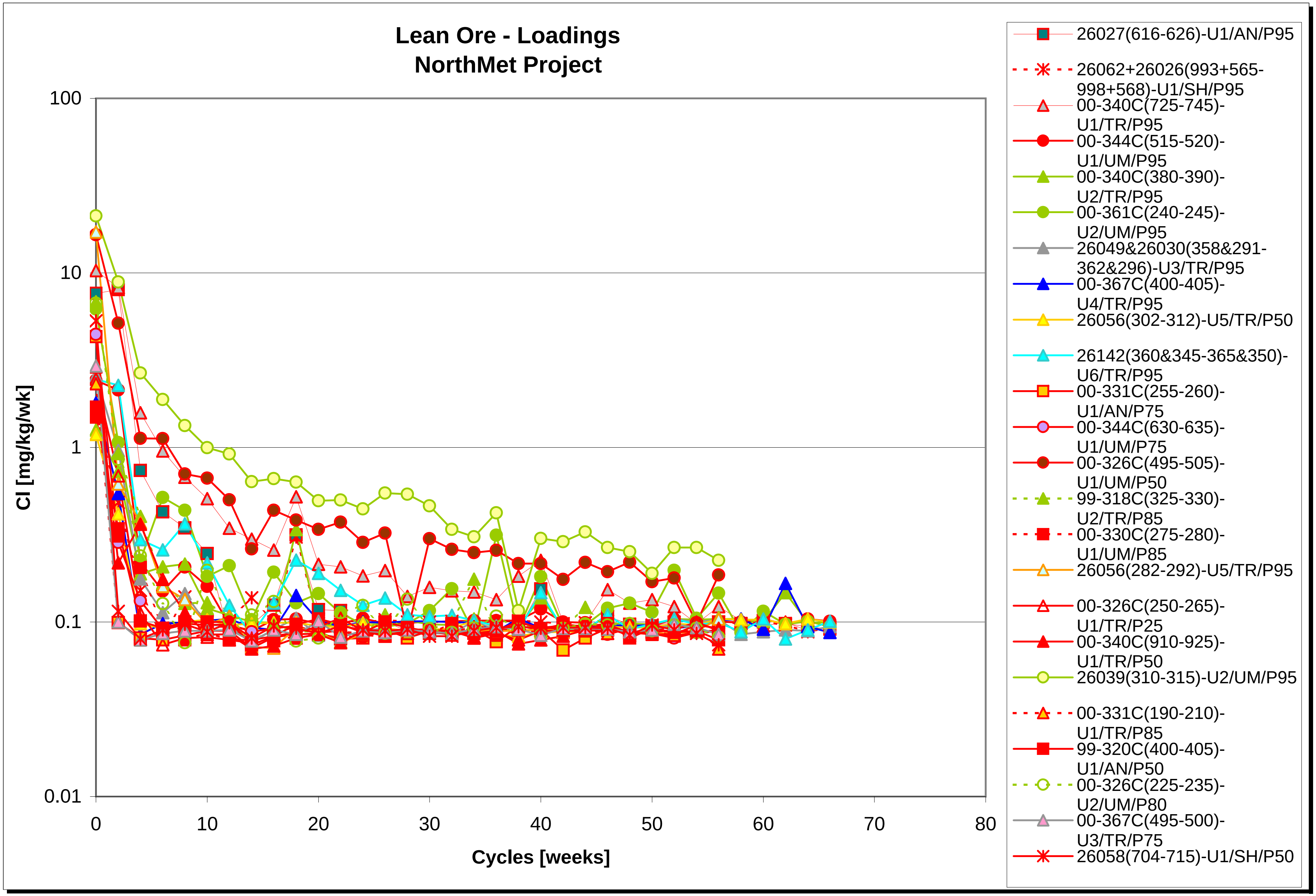

Lean Ore - Loadings
NorthMet Project
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

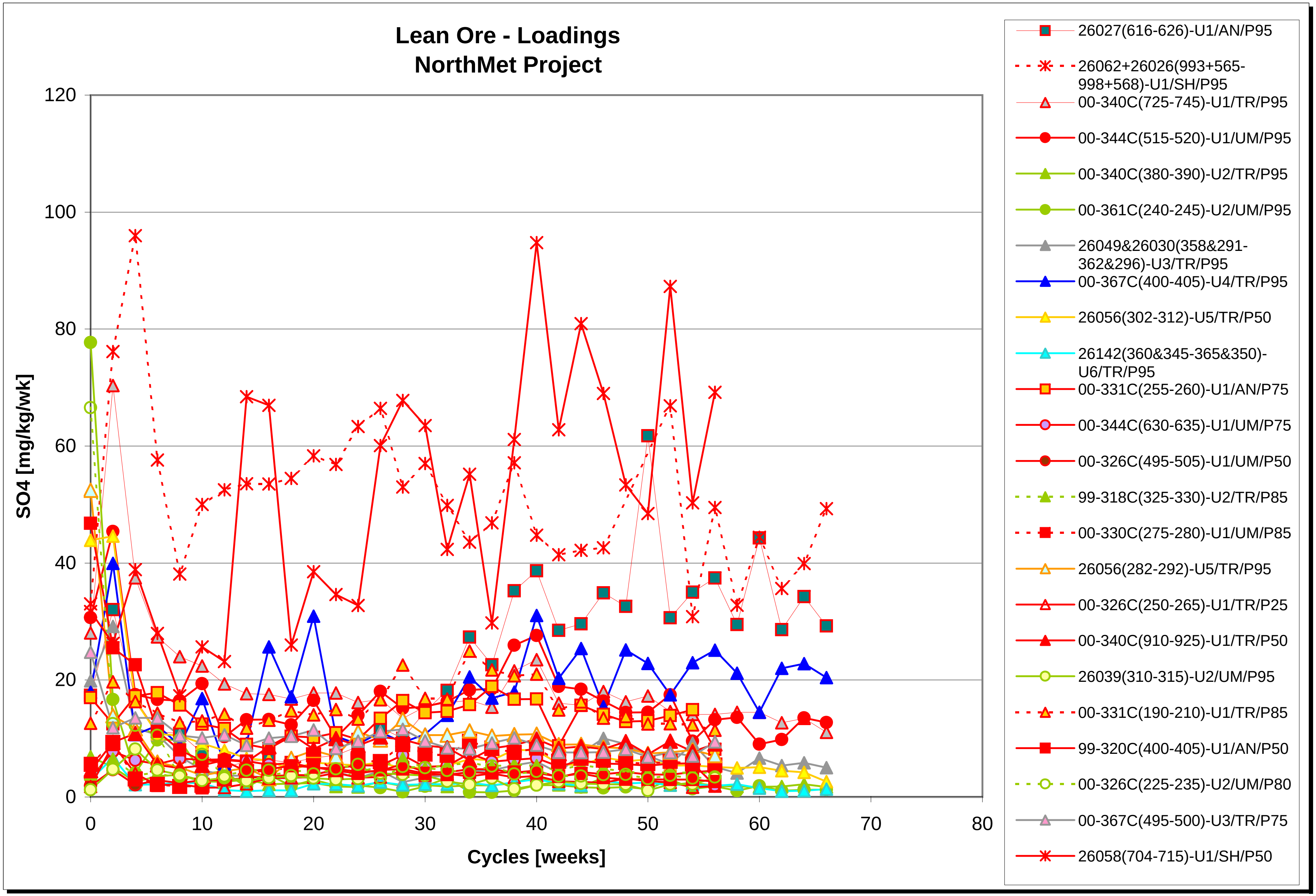

Lean Ore - Loadings
NorthMet Project
Alkalinity [mgCaCO3/kg/wk]
Cycles [weeks]
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

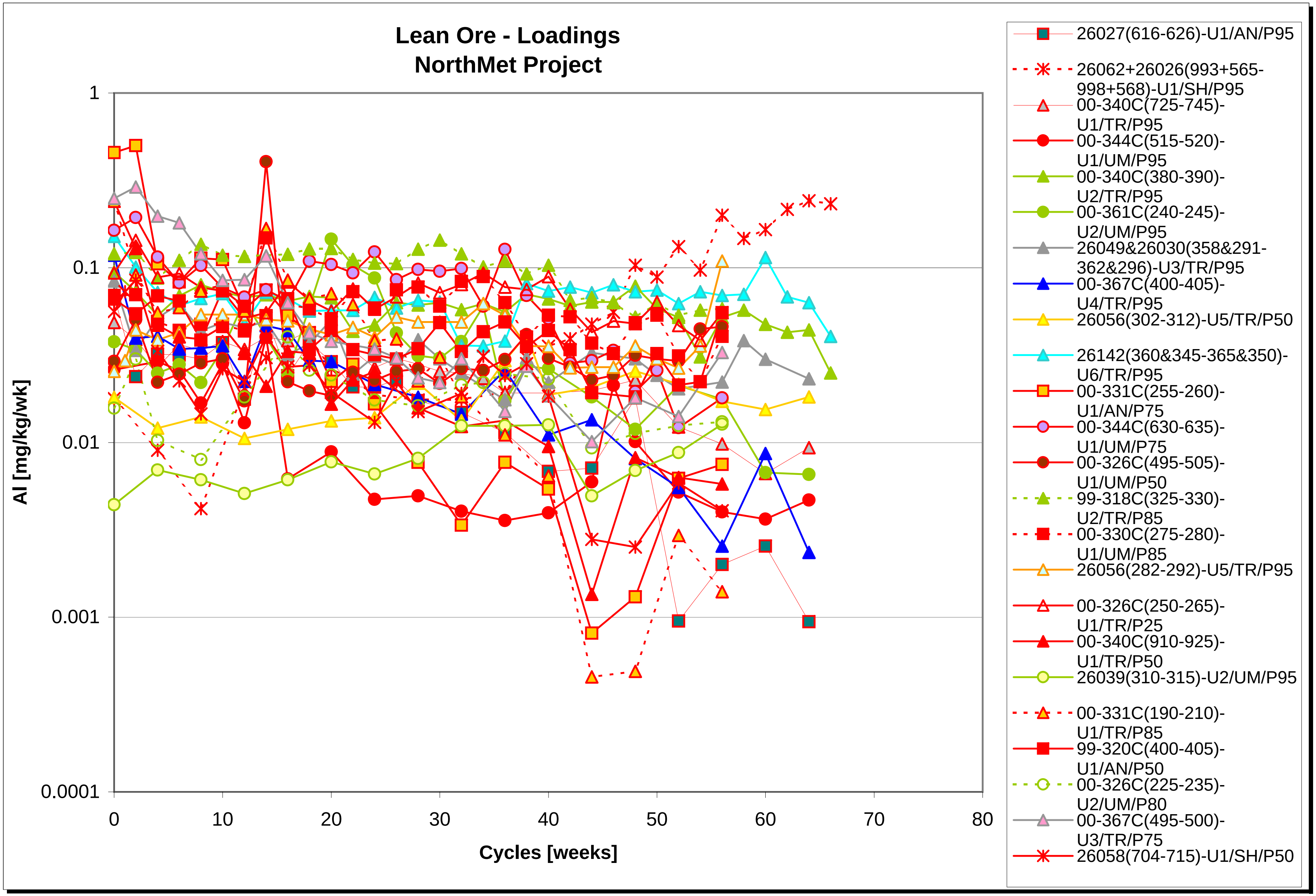

Lean Ore - Loadings
NorthMet Project
Inorganic Carbon [mg/kg/wk]
Cycles [weeks]
100
10
1
0.1
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

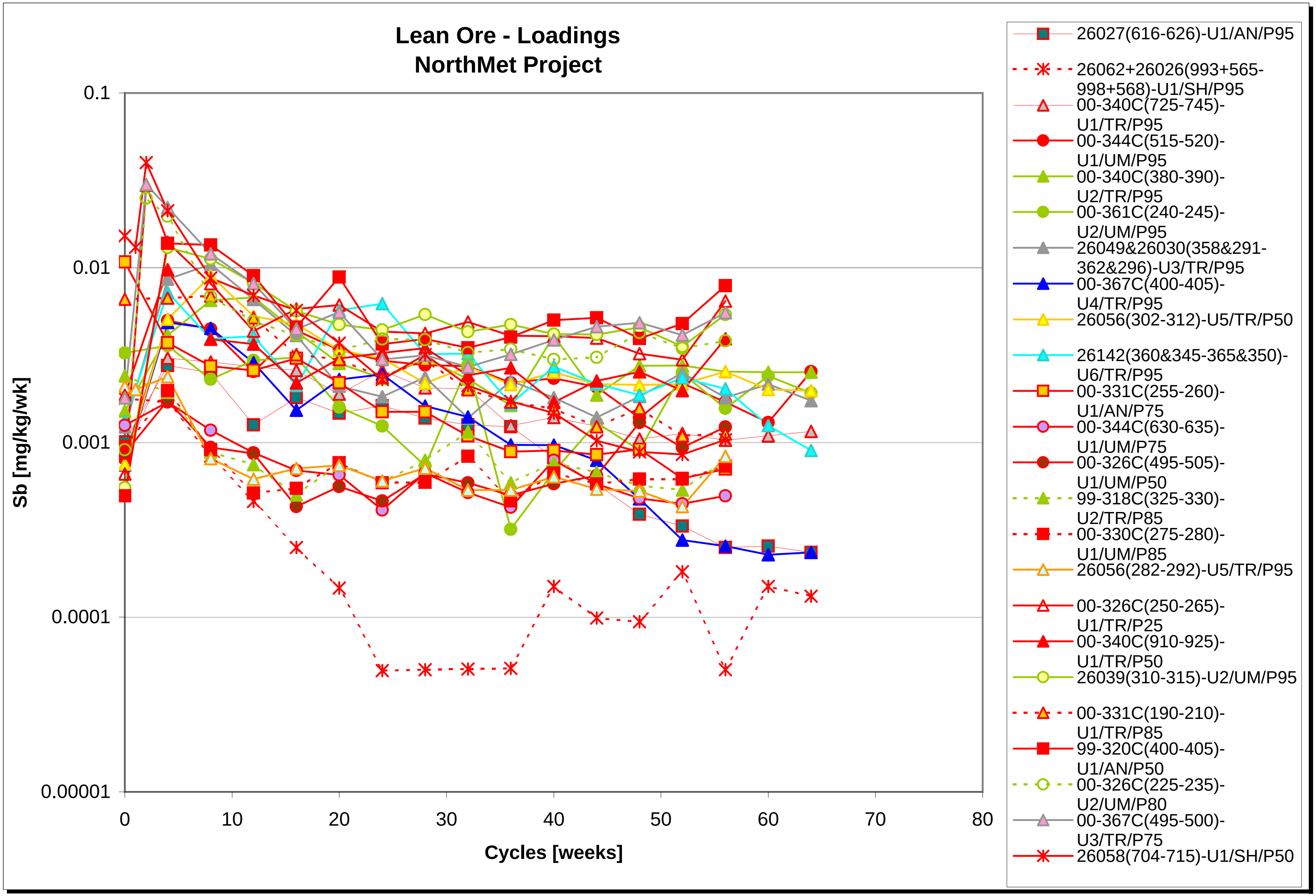

Lean Ore - Loadings
NorthMet Project
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
80
90
100
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

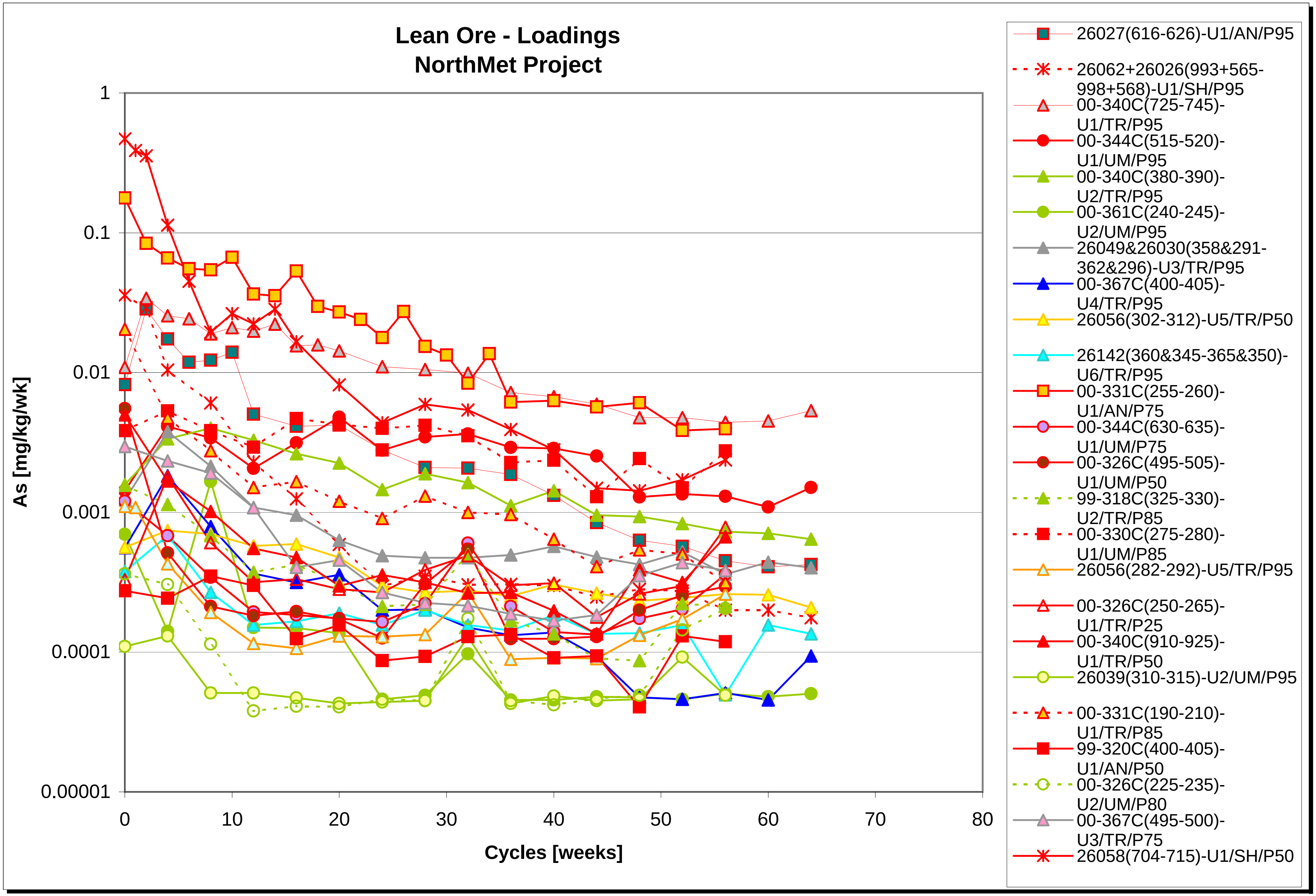

Lean Ore - Loadings
NorthMet Project
F [mg/kg/wk]
Cycles [weeks]
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

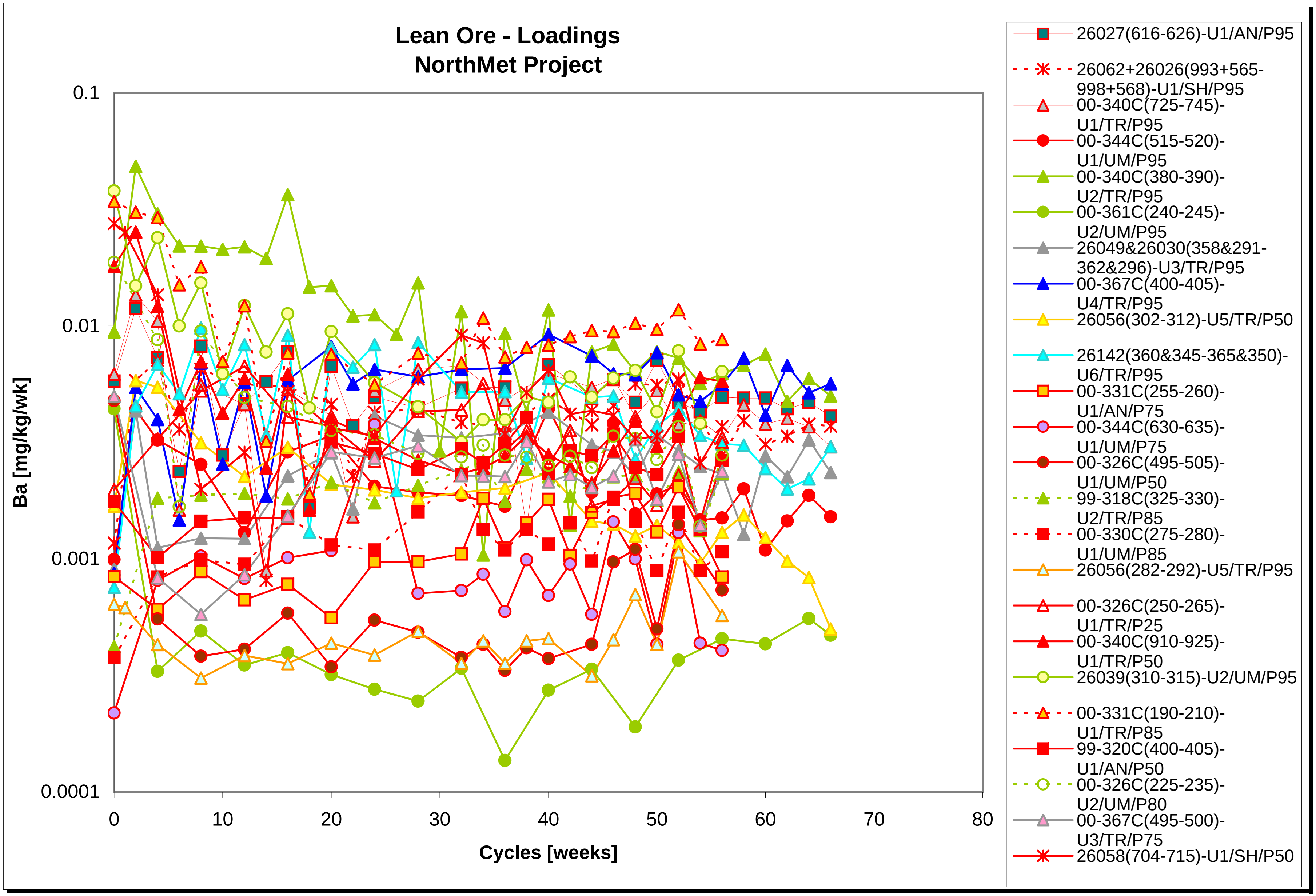

Lean Ore - Loadings
NorthMet Project
Cl [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

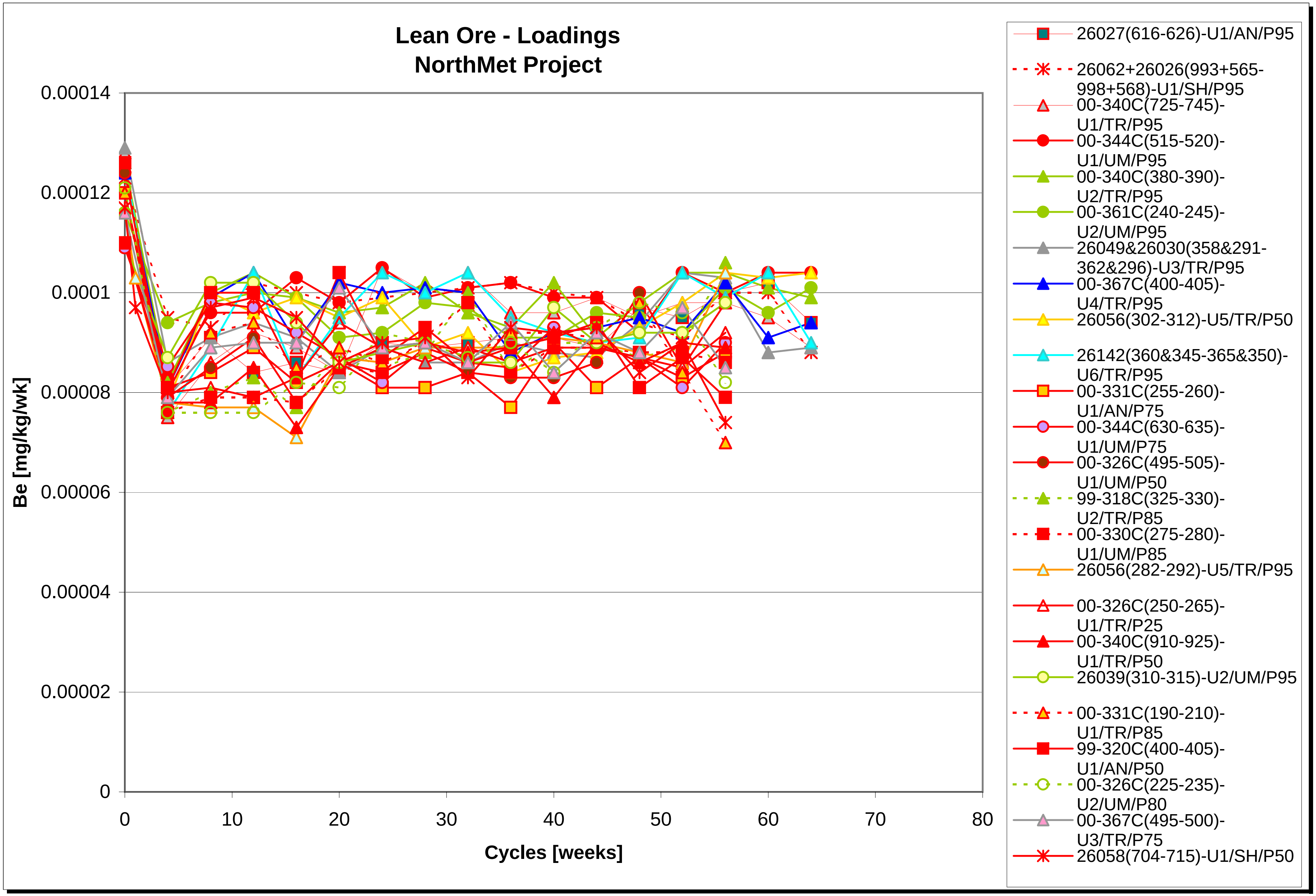

Lean Ore - Loadings
NorthMet Project
SO4 [mg/kg/wk]
Cycles [weeks]
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

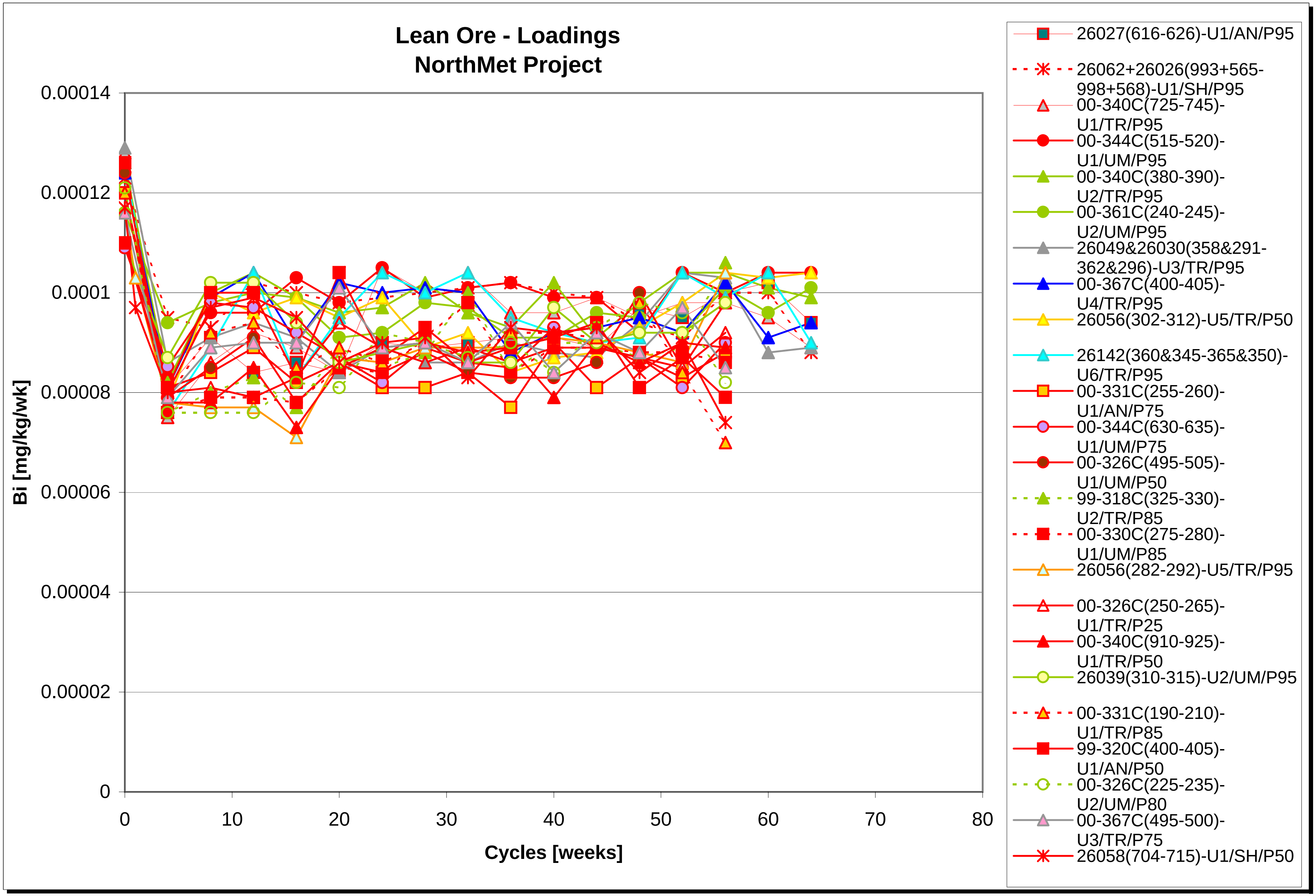

Lean Ore - Loadings
NorthMet Project
Al [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

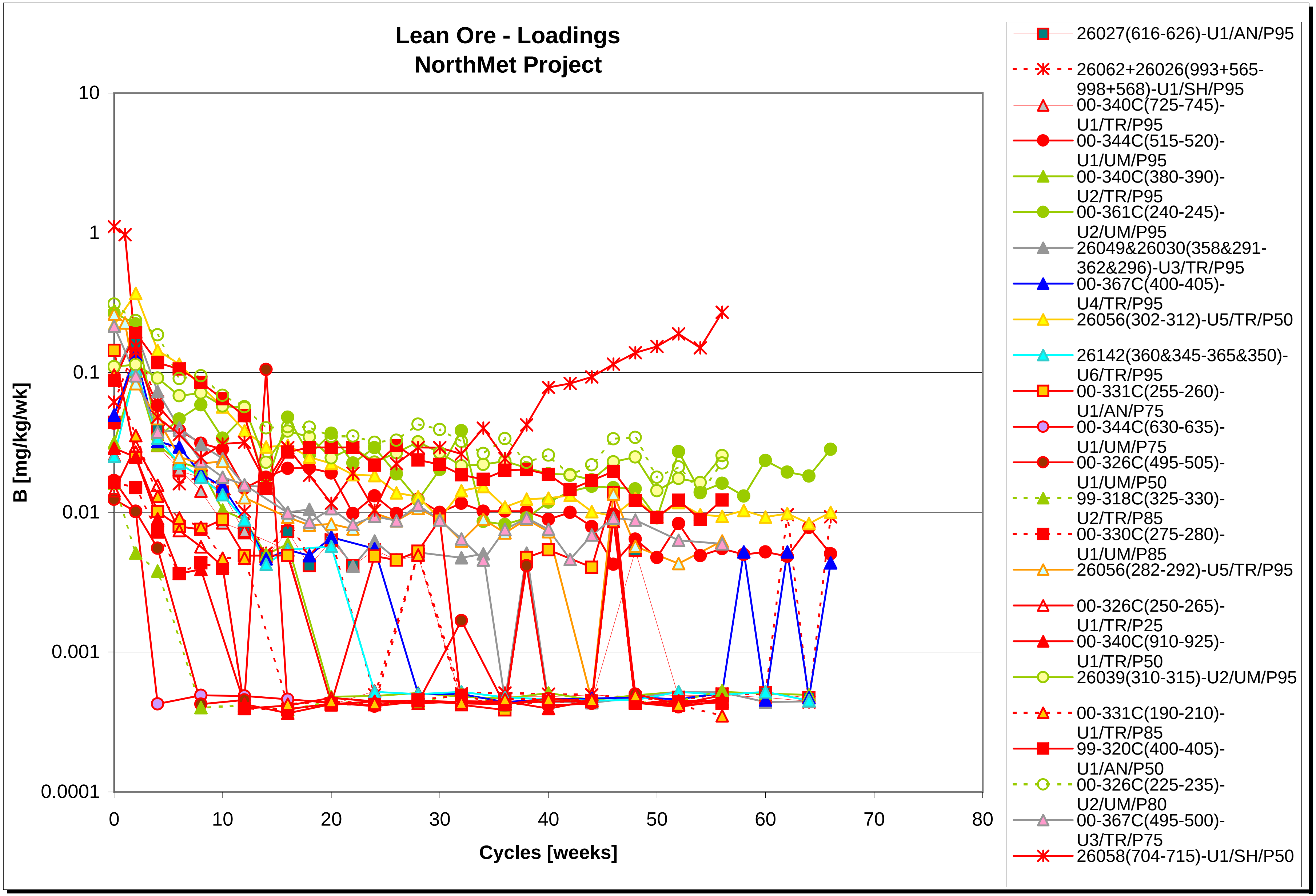

Lean Ore - Loadings
NorthMet Project
0.1
0.01
0.001
0.0001
0.00001
Sb [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

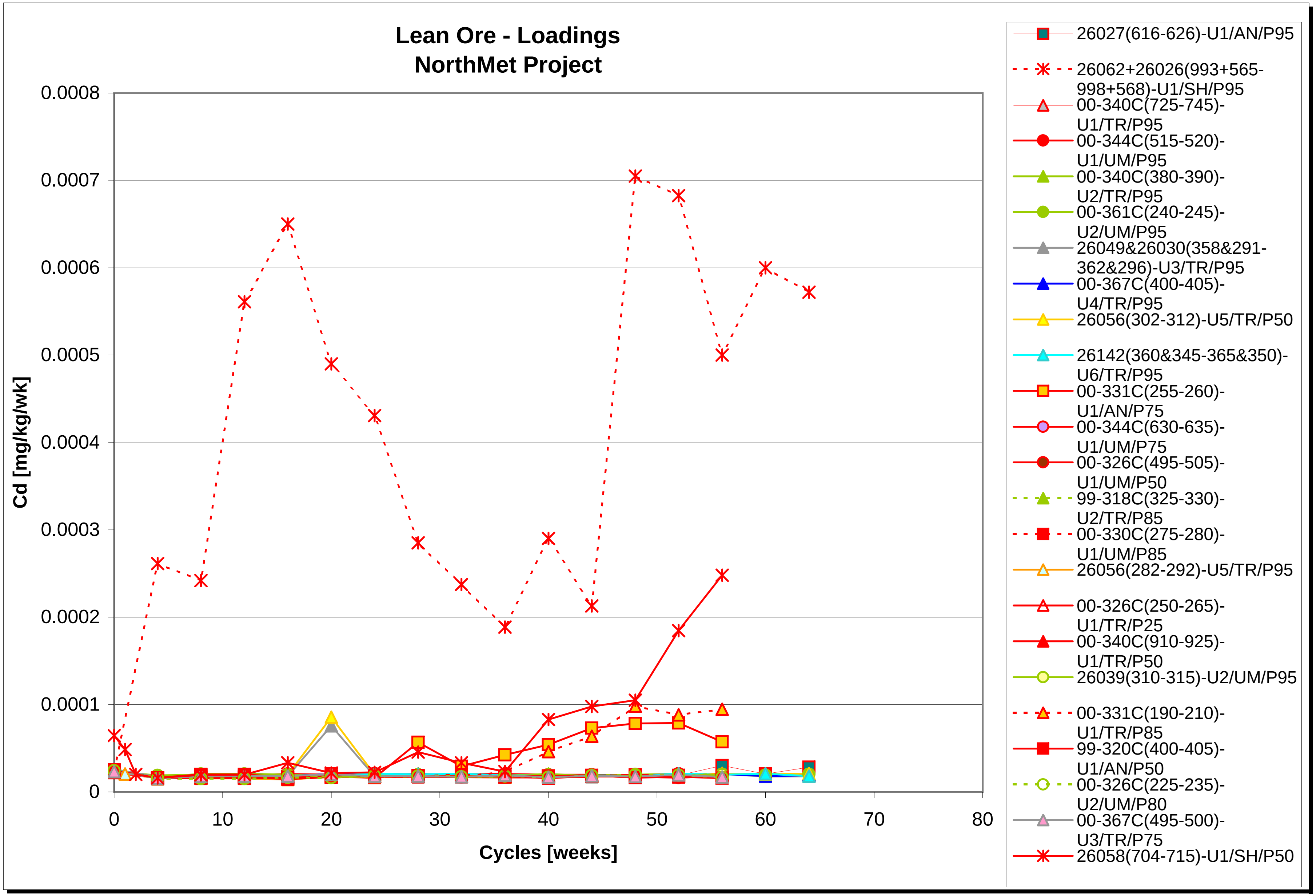

Lean Ore - Loadings
NorthMet Project
As [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

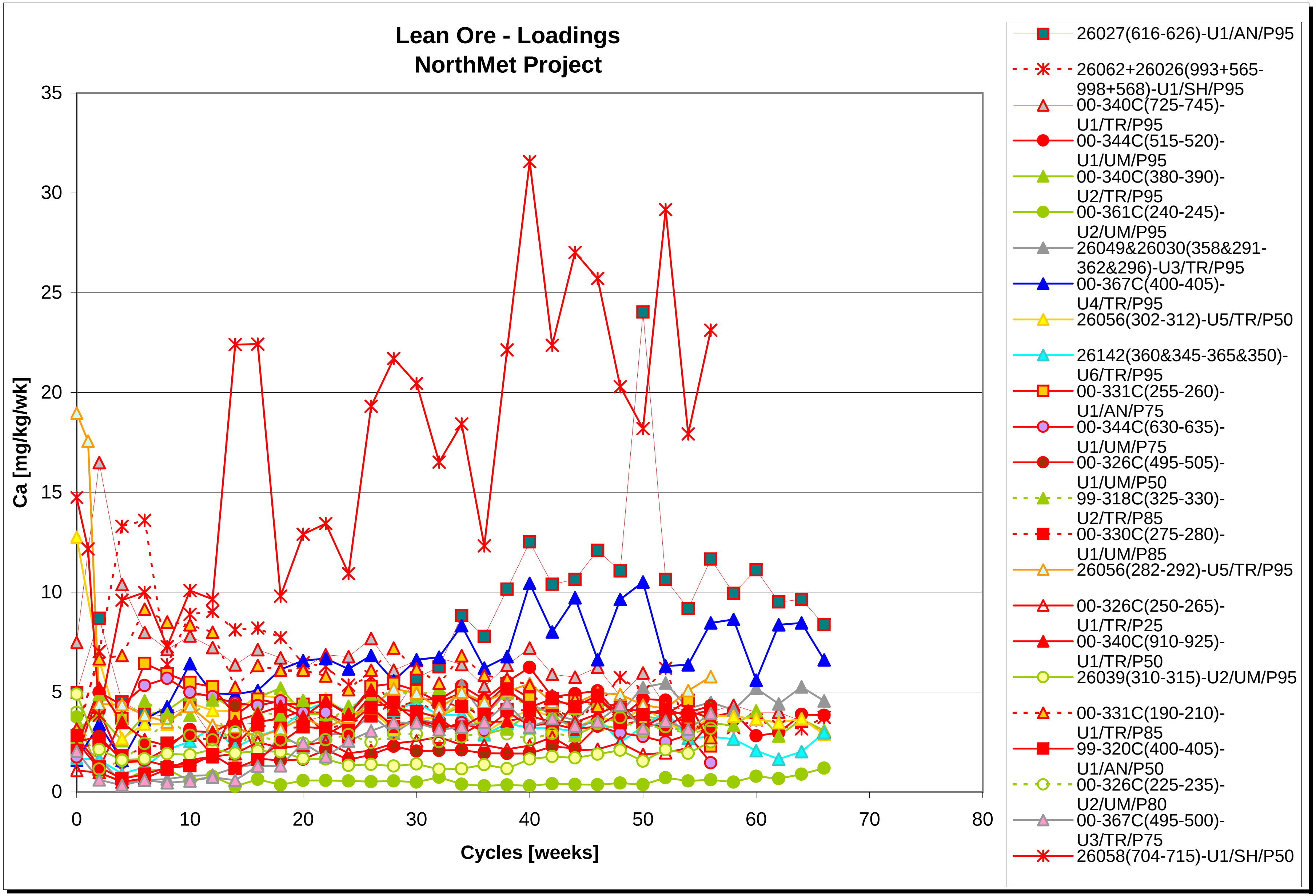

Lean Ore - Loadings
NorthMet Project
Ba [mg/kg/wk]
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

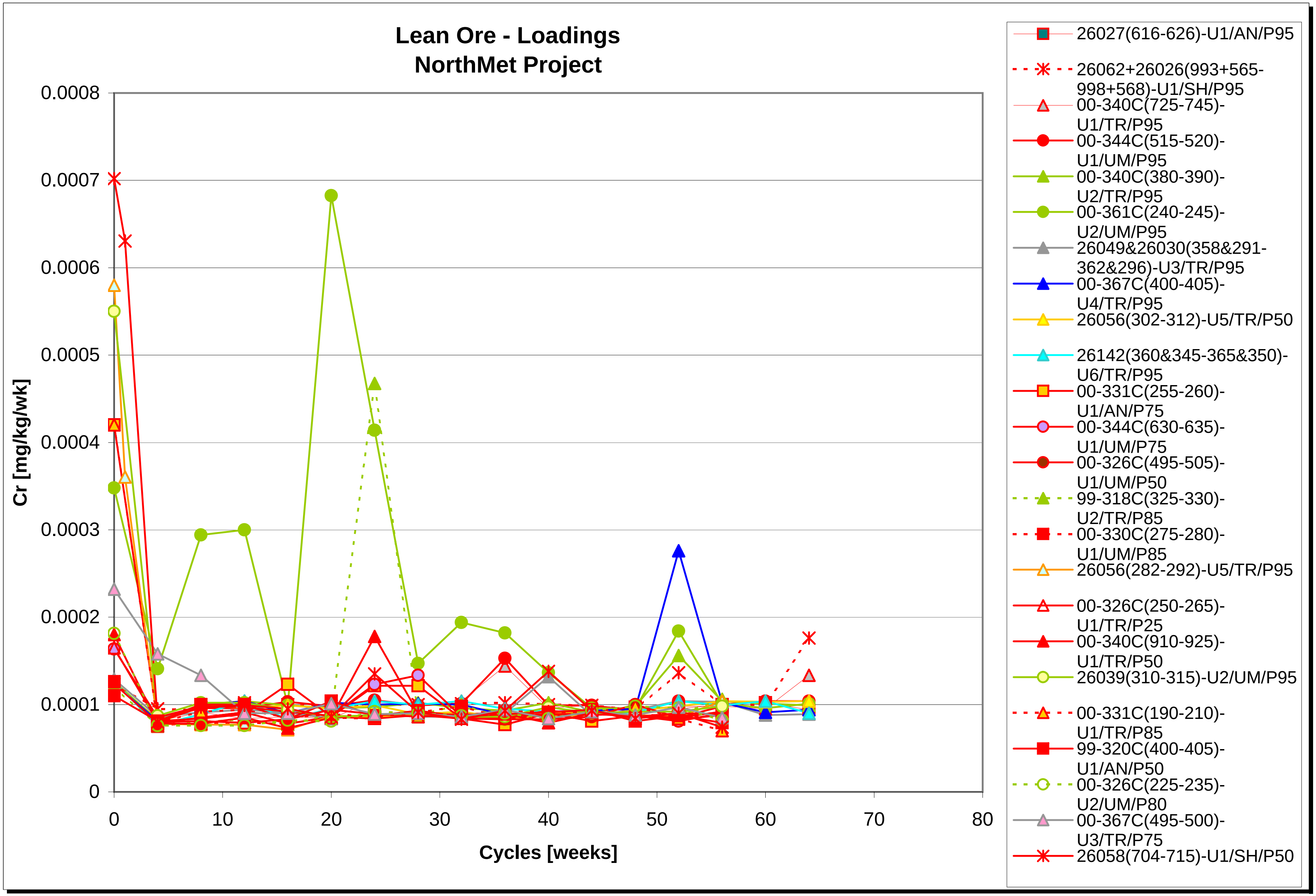

Lean Ore - Loadings
NorthMet Project
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Be [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

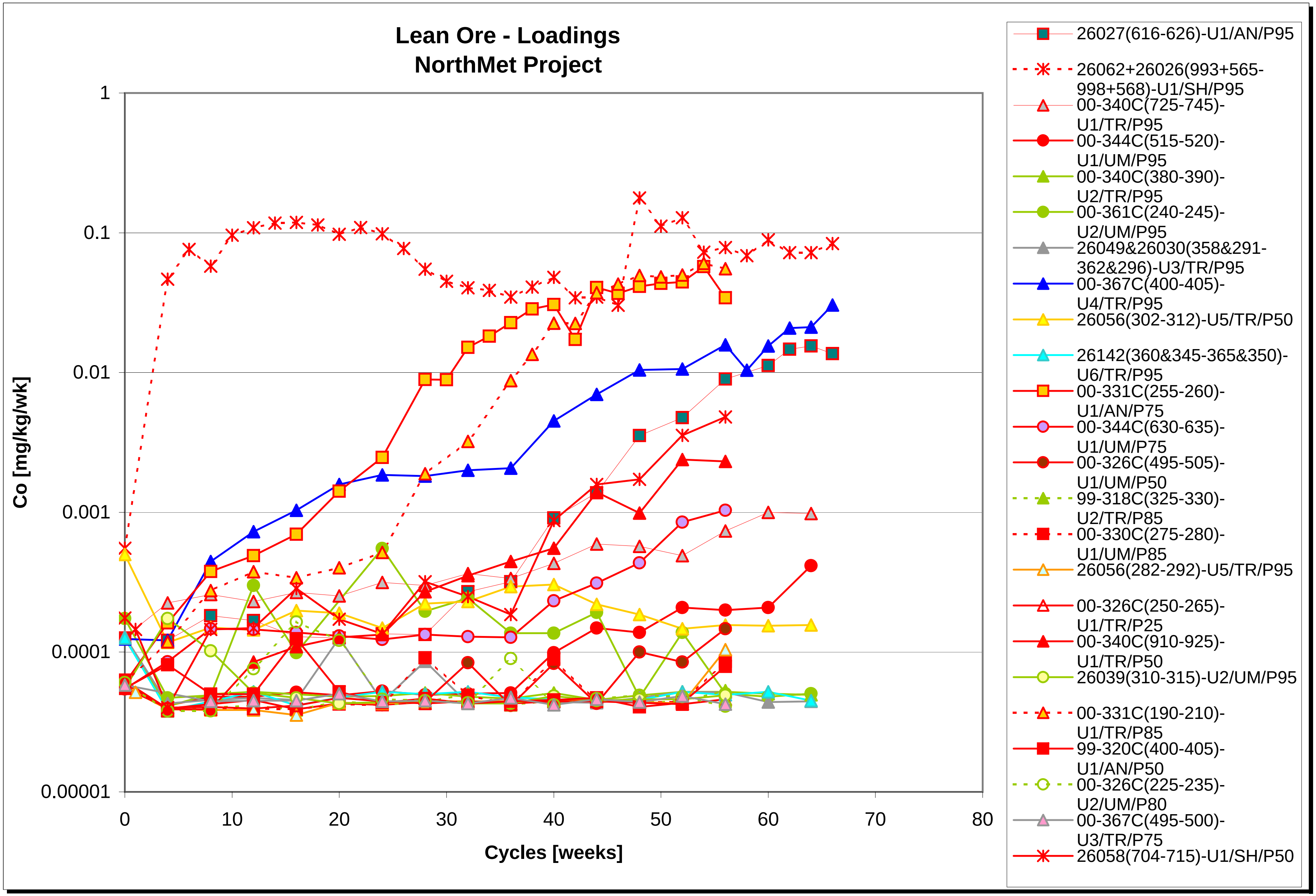

Lean Ore - Loadings
NorthMet Project
Bi [mg/kg/wk]
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Cycles [weeks]
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

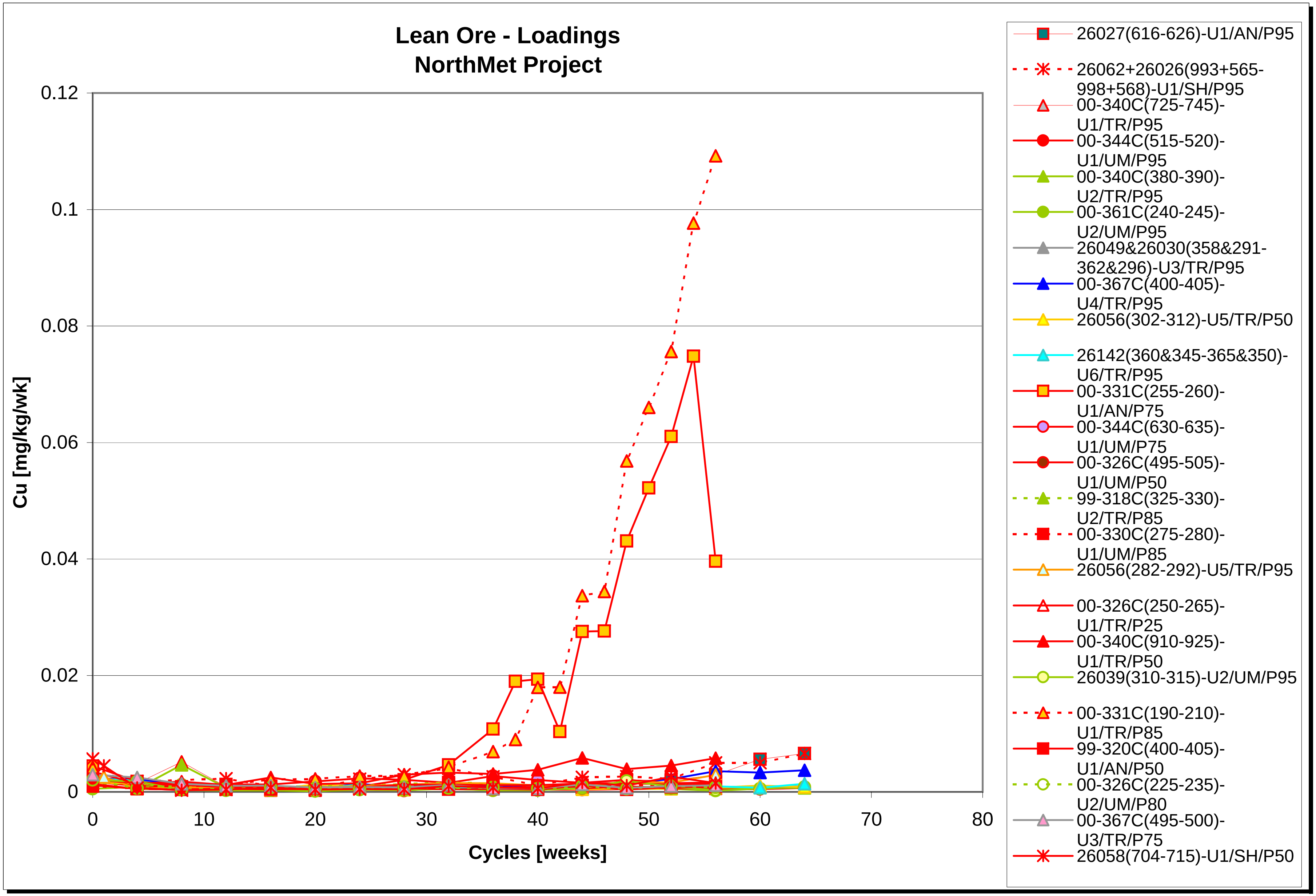

Lean Ore - Loadings
NorthMet Project
10
1
0.1
0.01
0.001
0.0001
B [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

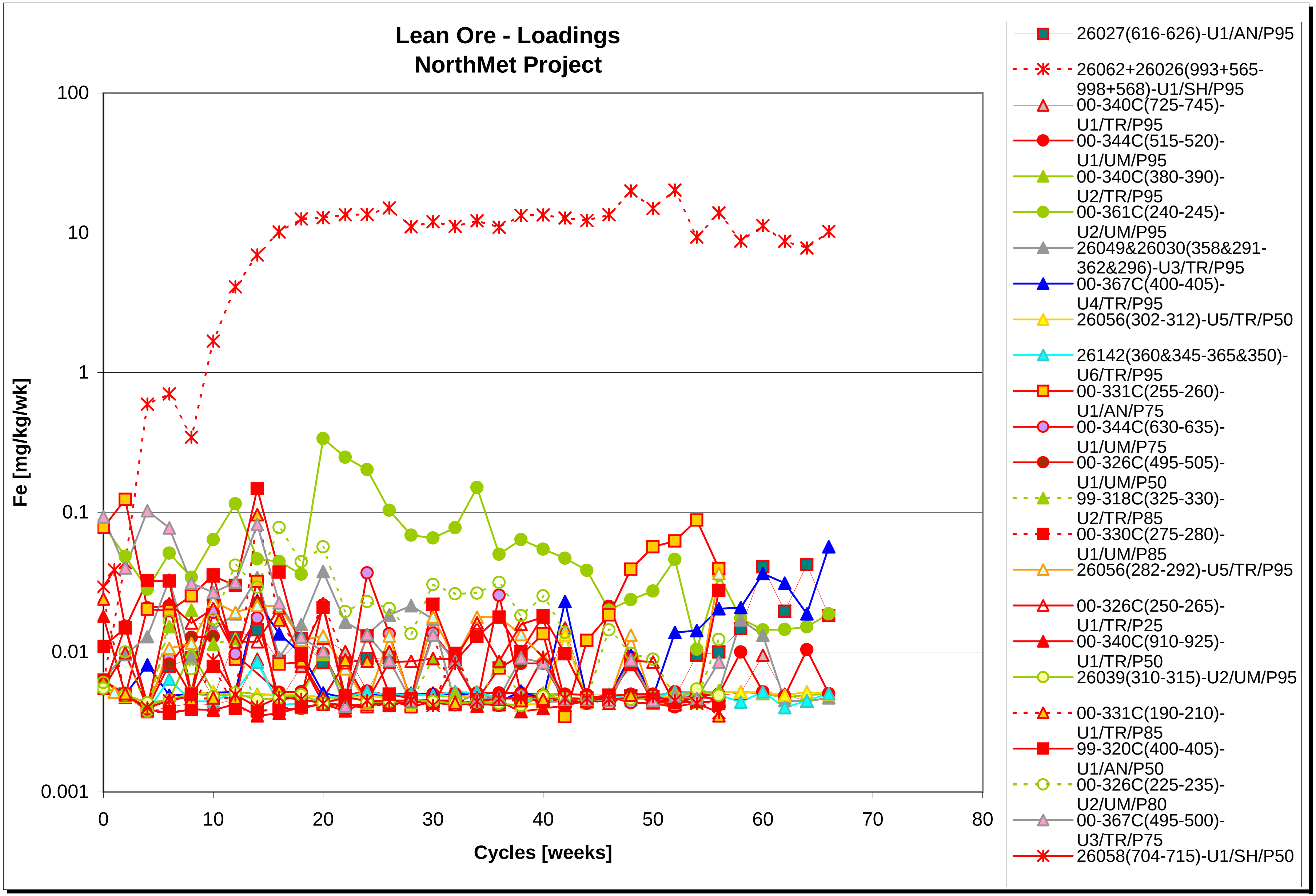

Lean Ore - Loadings
NorthMet Project
Cd [mg/kg/wk]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

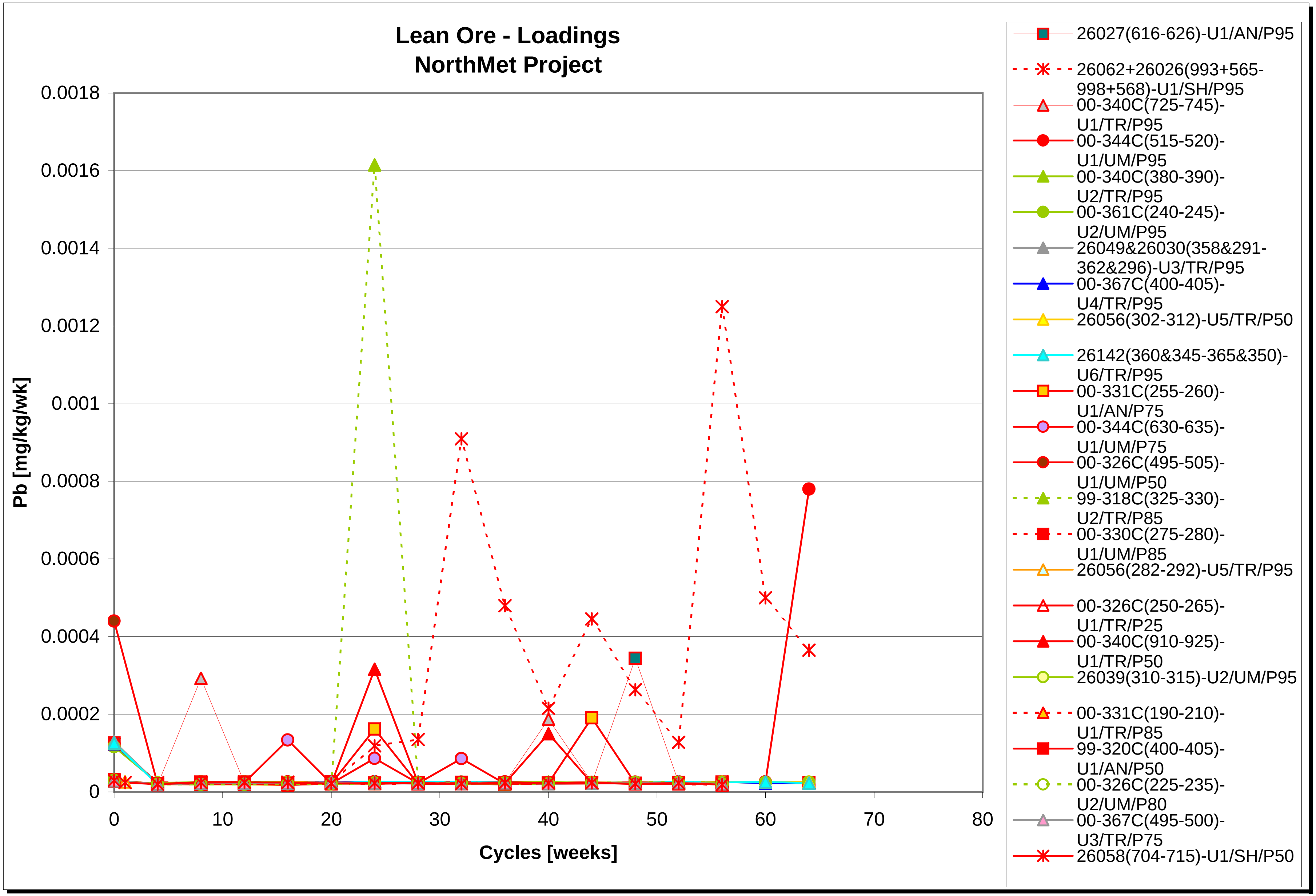

Lean Ore - Loadings
NorthMet Project
Ca [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

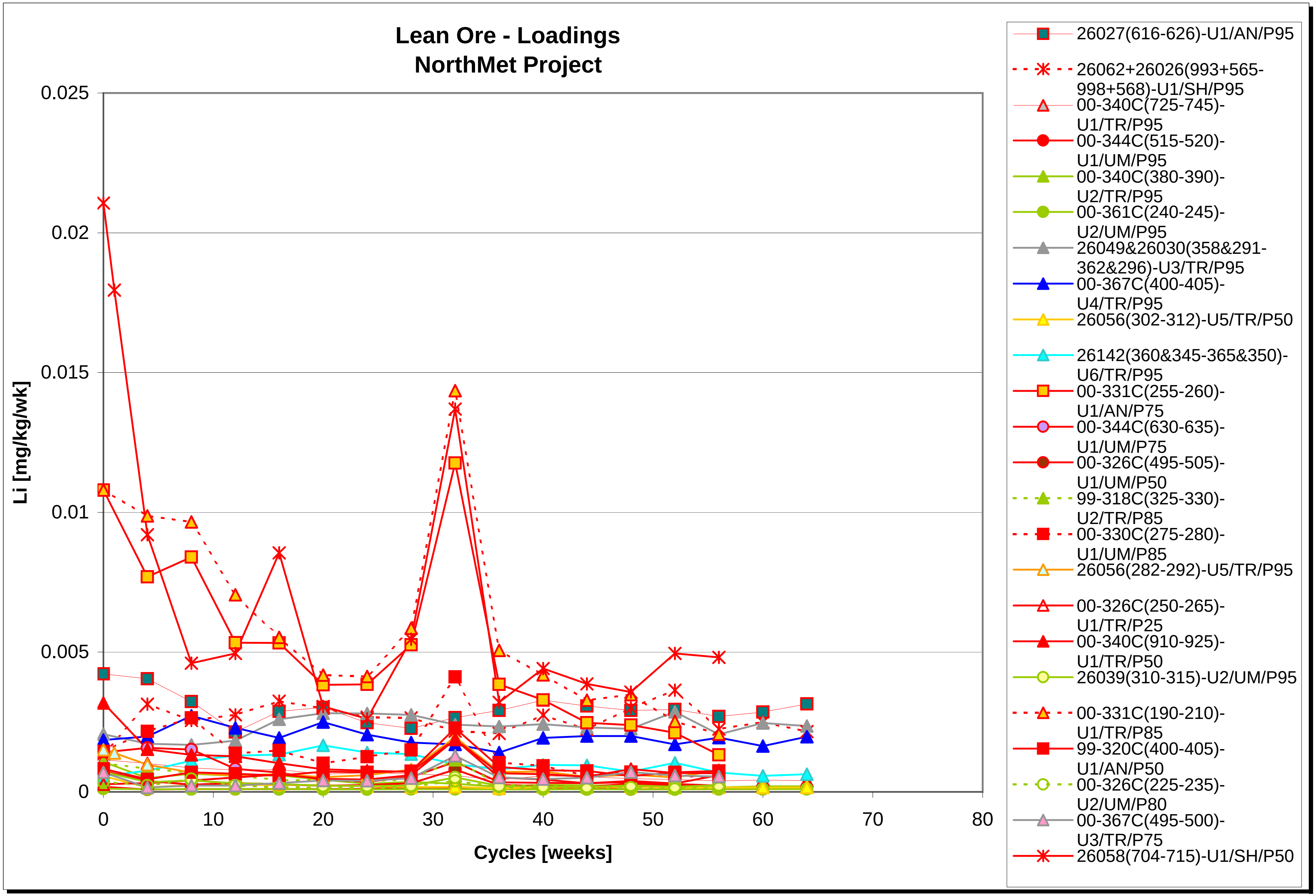

Lean Ore - Loadings
NorthMet Project
Cr [mg/kg/wk]
Cycles [weeks]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

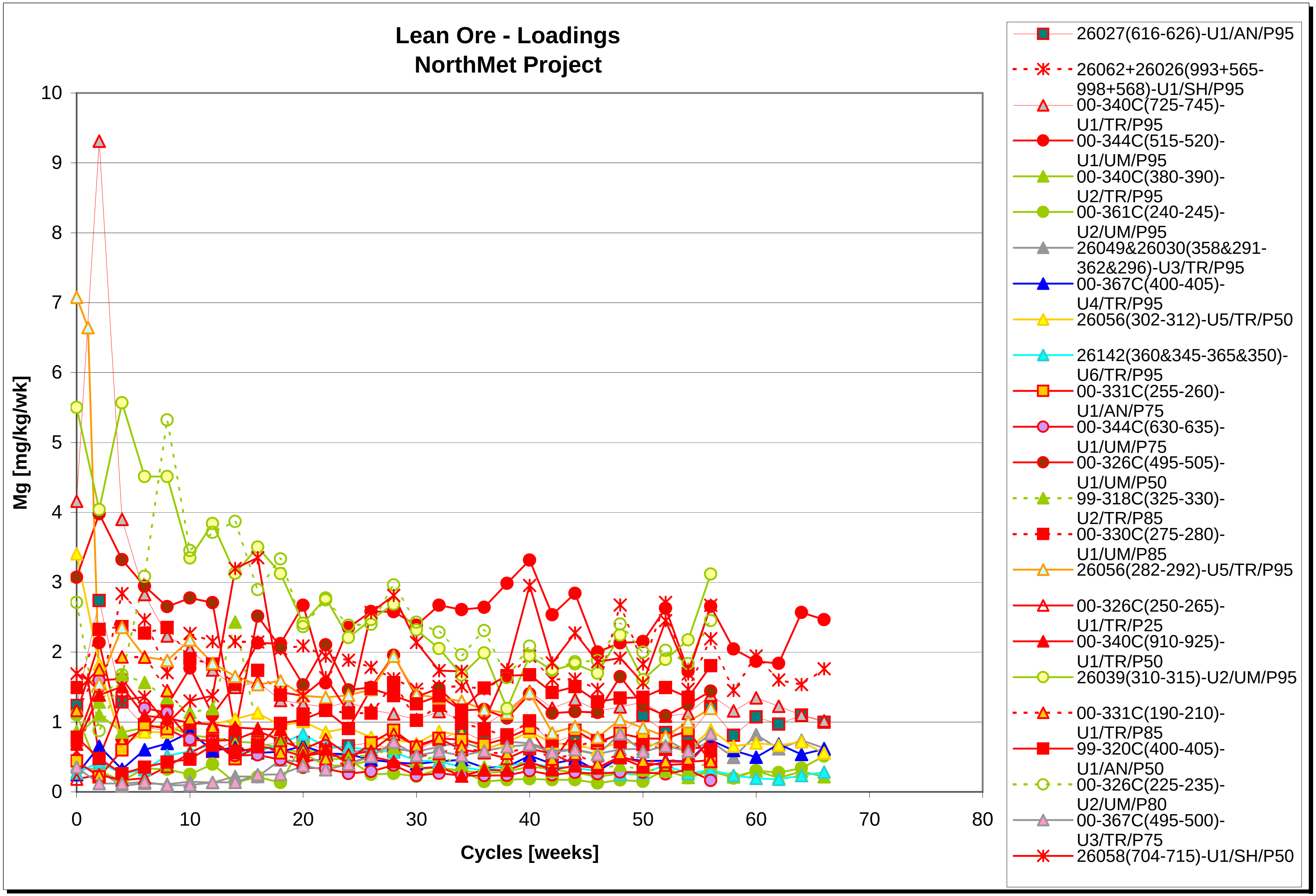

Lean Ore - Loadings
NorthMet Project
Co [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

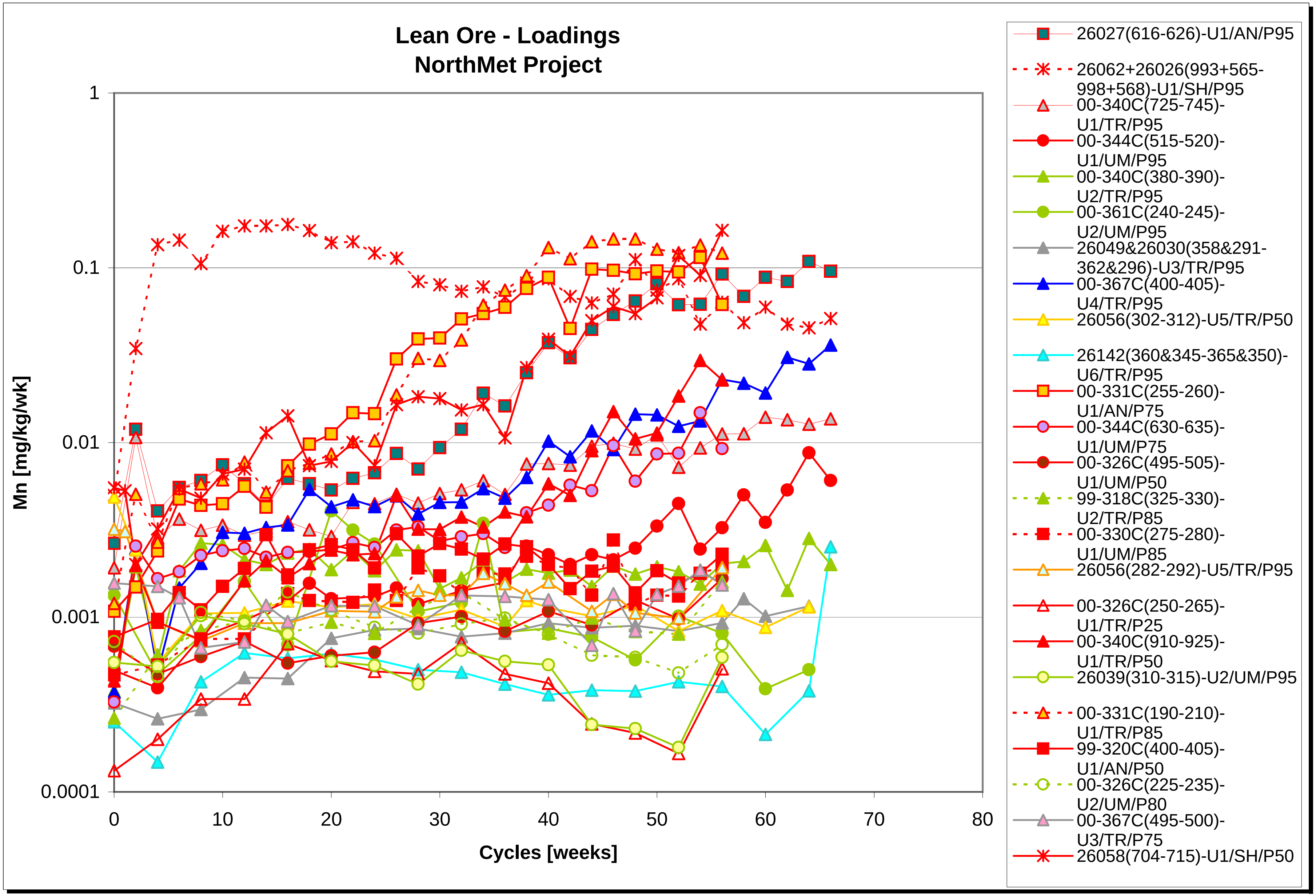

Lean Ore - Loadings
NorthMet Project
Cu [mg/kg/wk]
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

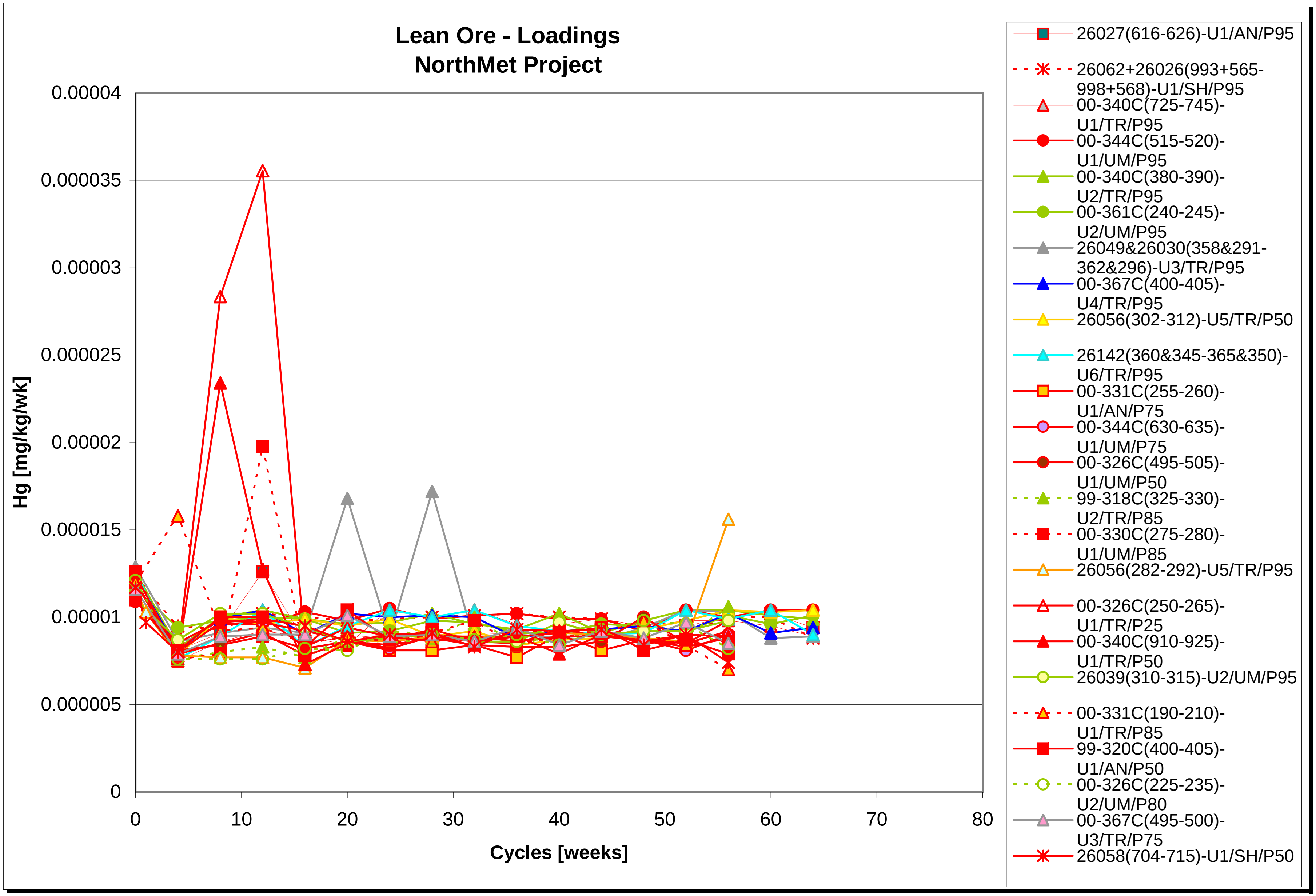

Lean Ore - Loadings
NorthMet Project
Fe [mg/kg/wk]
100
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

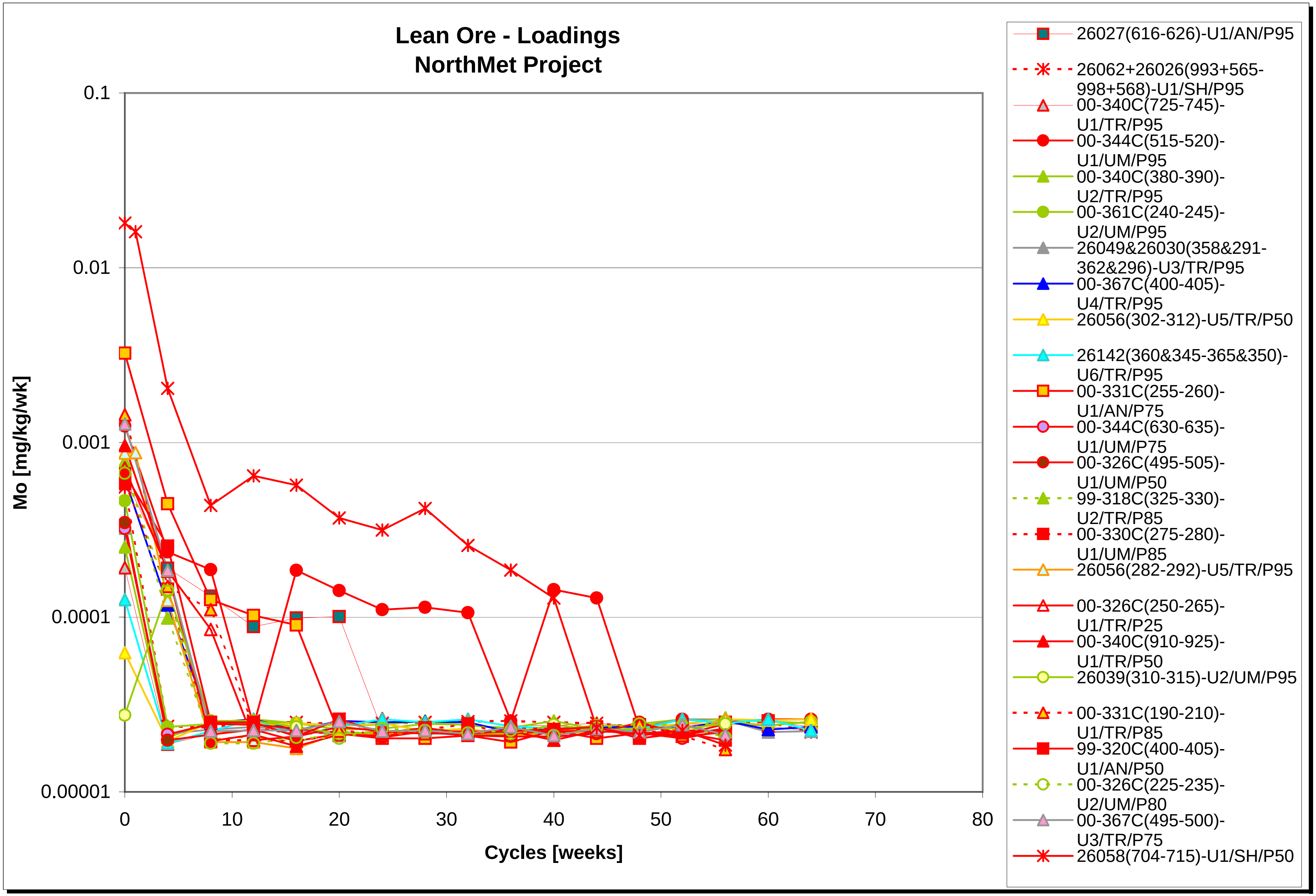

Lean Ore - Loadings
NorthMet Project
Pb [mg/kg/wk]
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

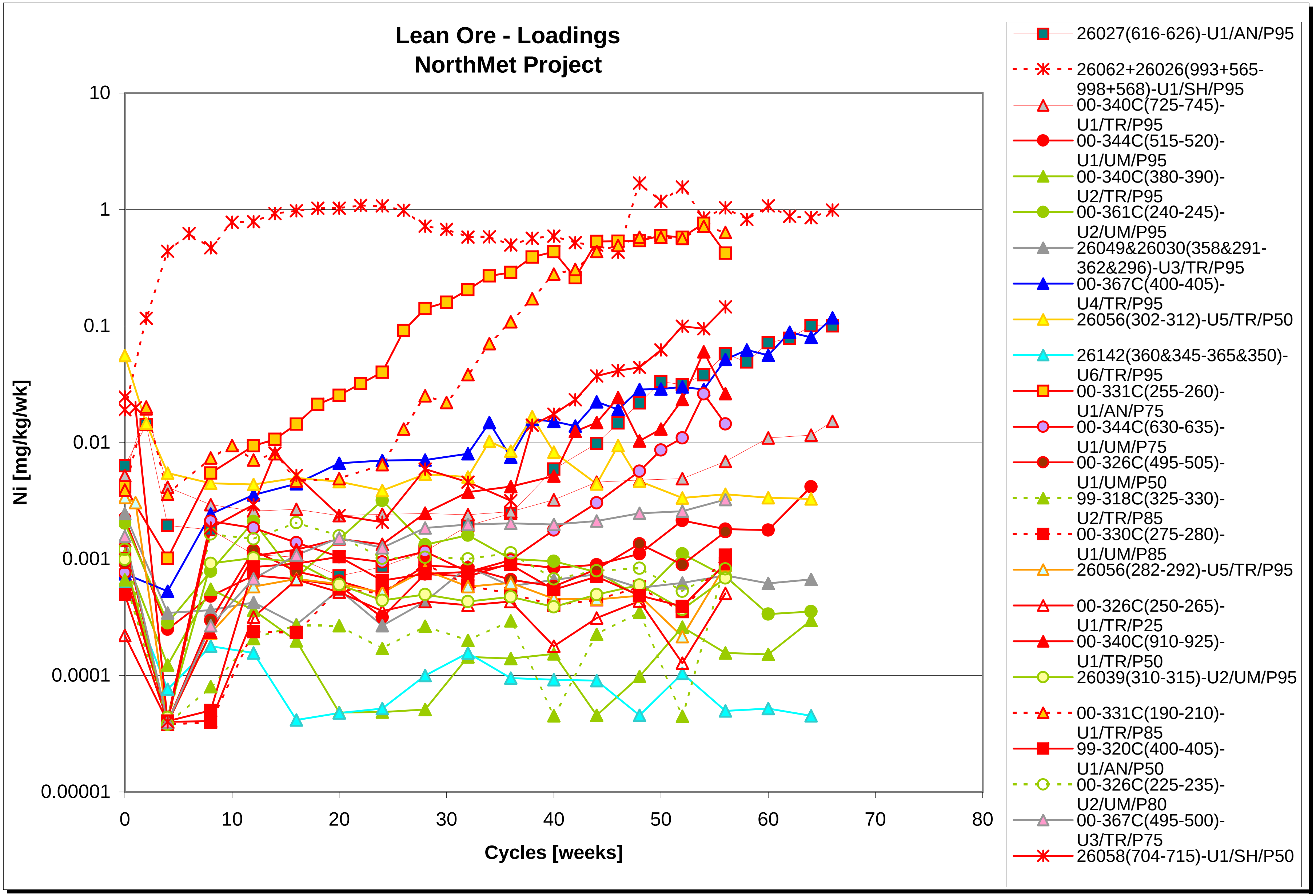

Lean Ore - Loadings
NorthMet Project
Li [mg/kg/wk]
0.025
0.02
0.015
0.01
0.005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

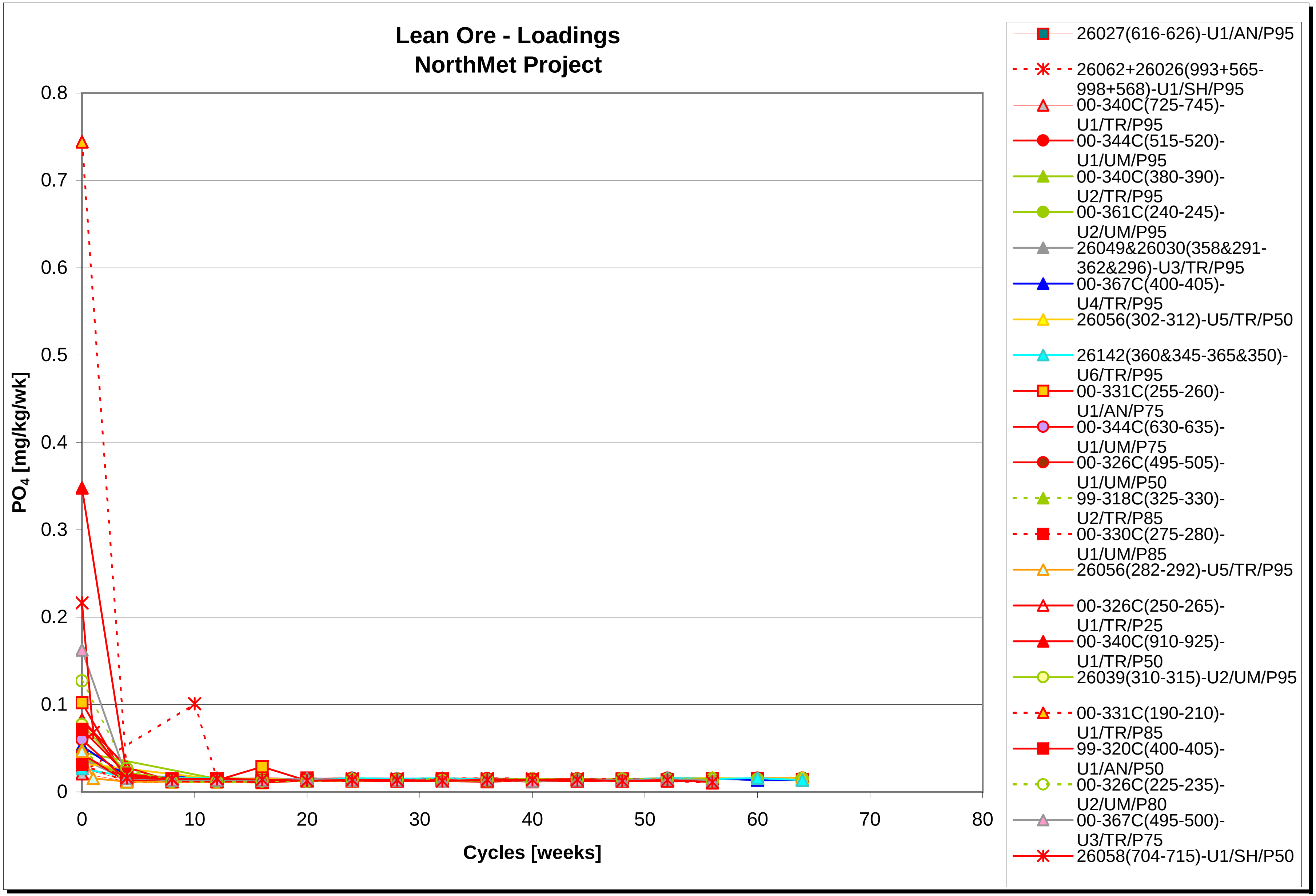

Lean Ore - Loadings
NorthMet Project
Mg [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
8
9
10
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

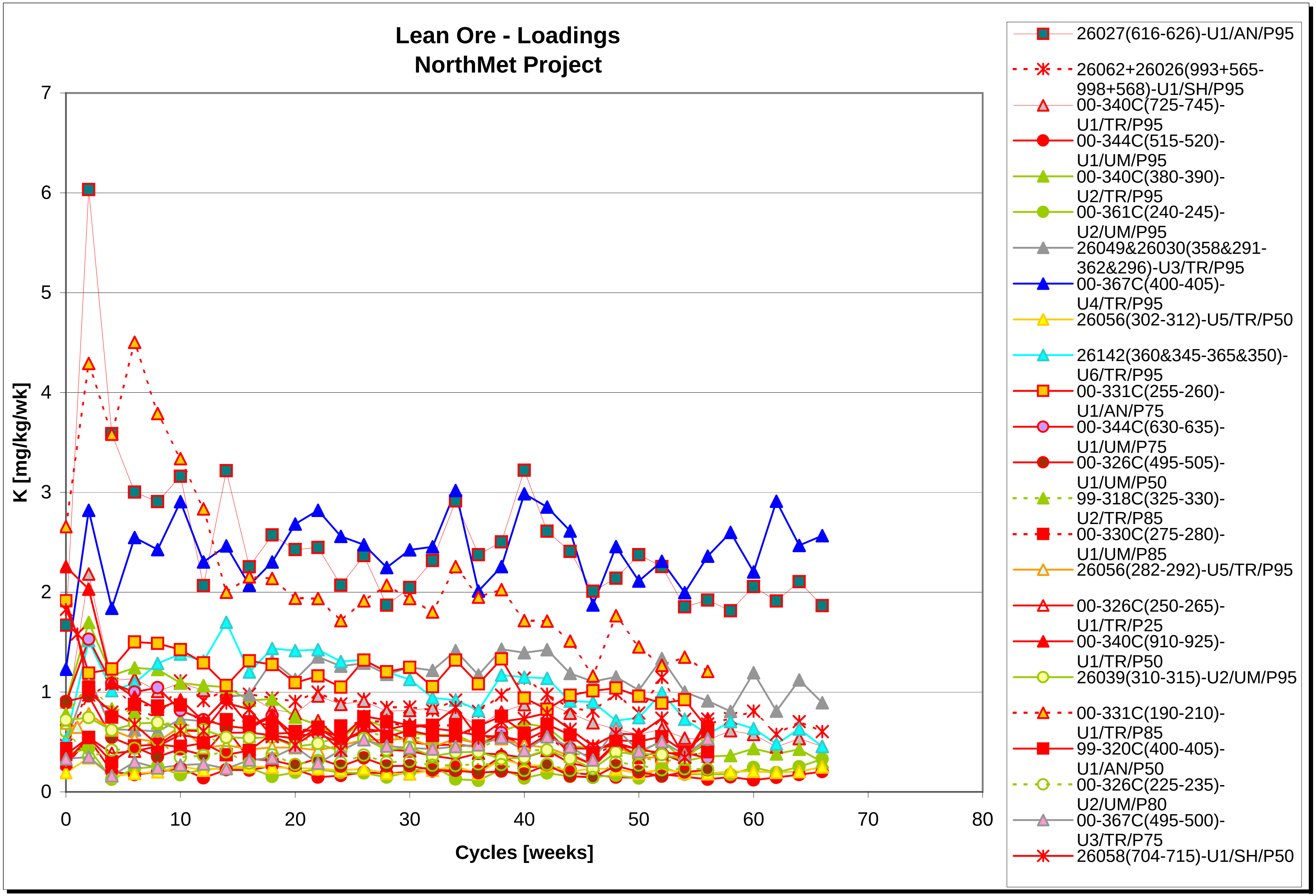

Lean Ore - Loadings
NorthMet Project
Mn [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

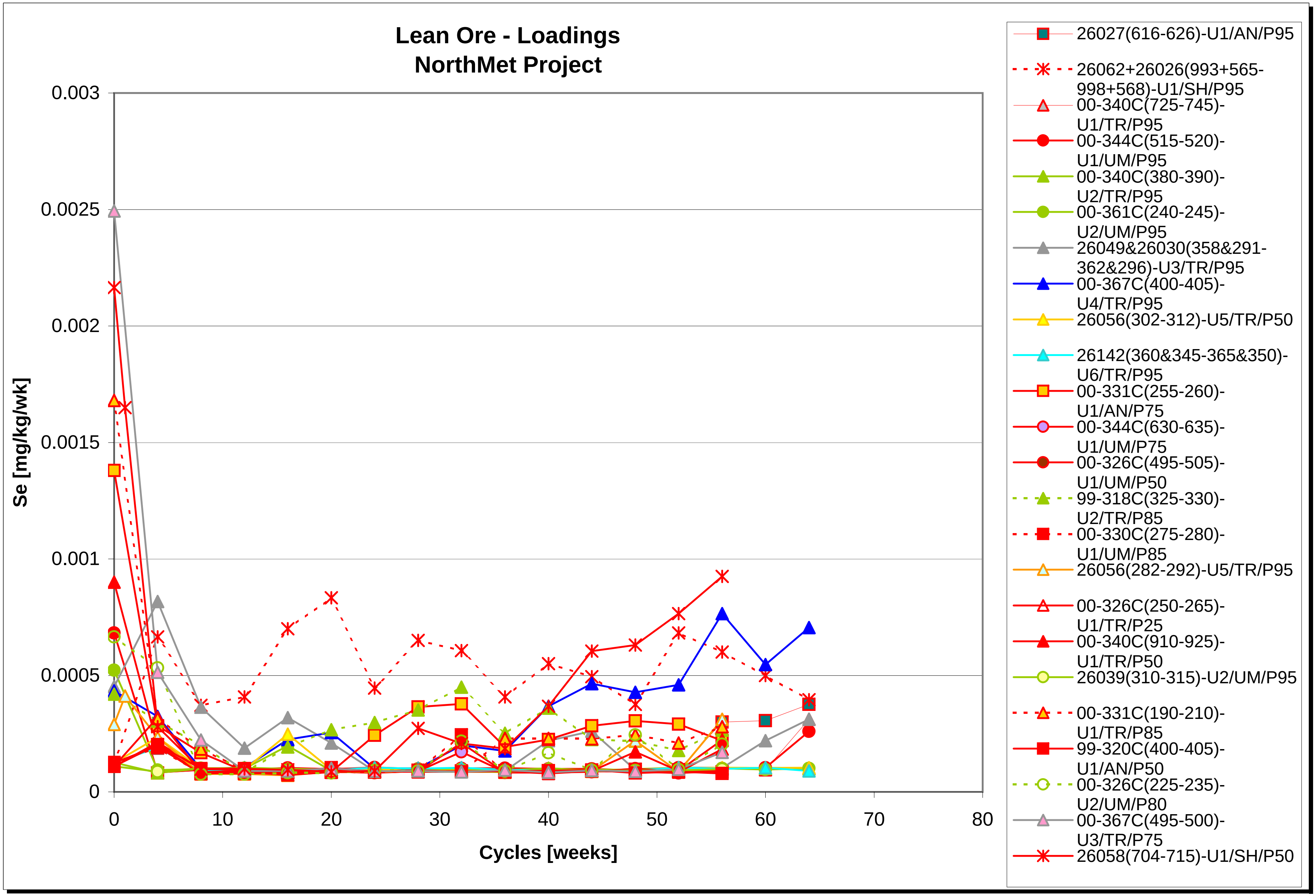

Lean Ore - Loadings
NorthMet Project
Hg [mg/kg/wk]
0.00004
0.000035
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

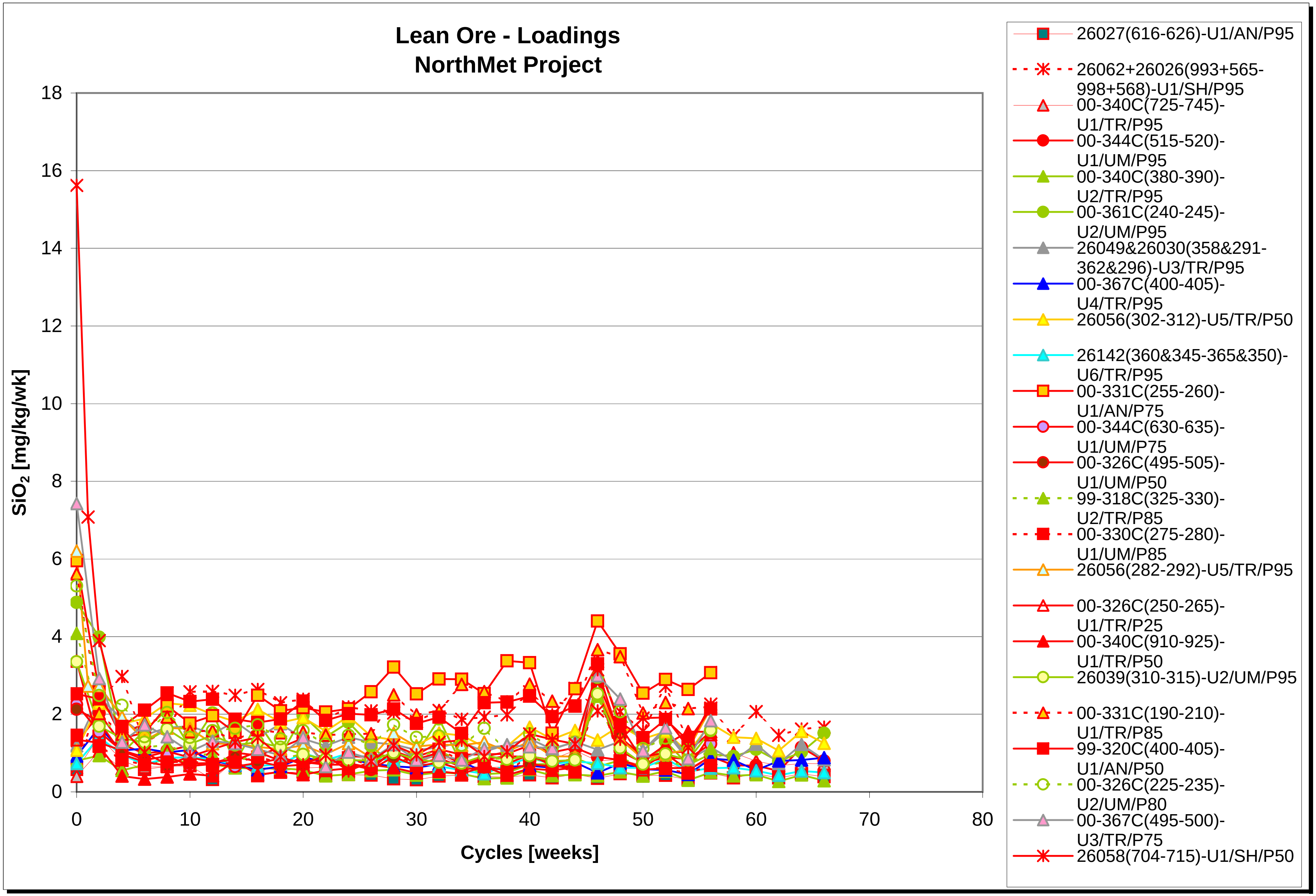

Lean Ore - Loadings
NorthMet Project
Mo [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

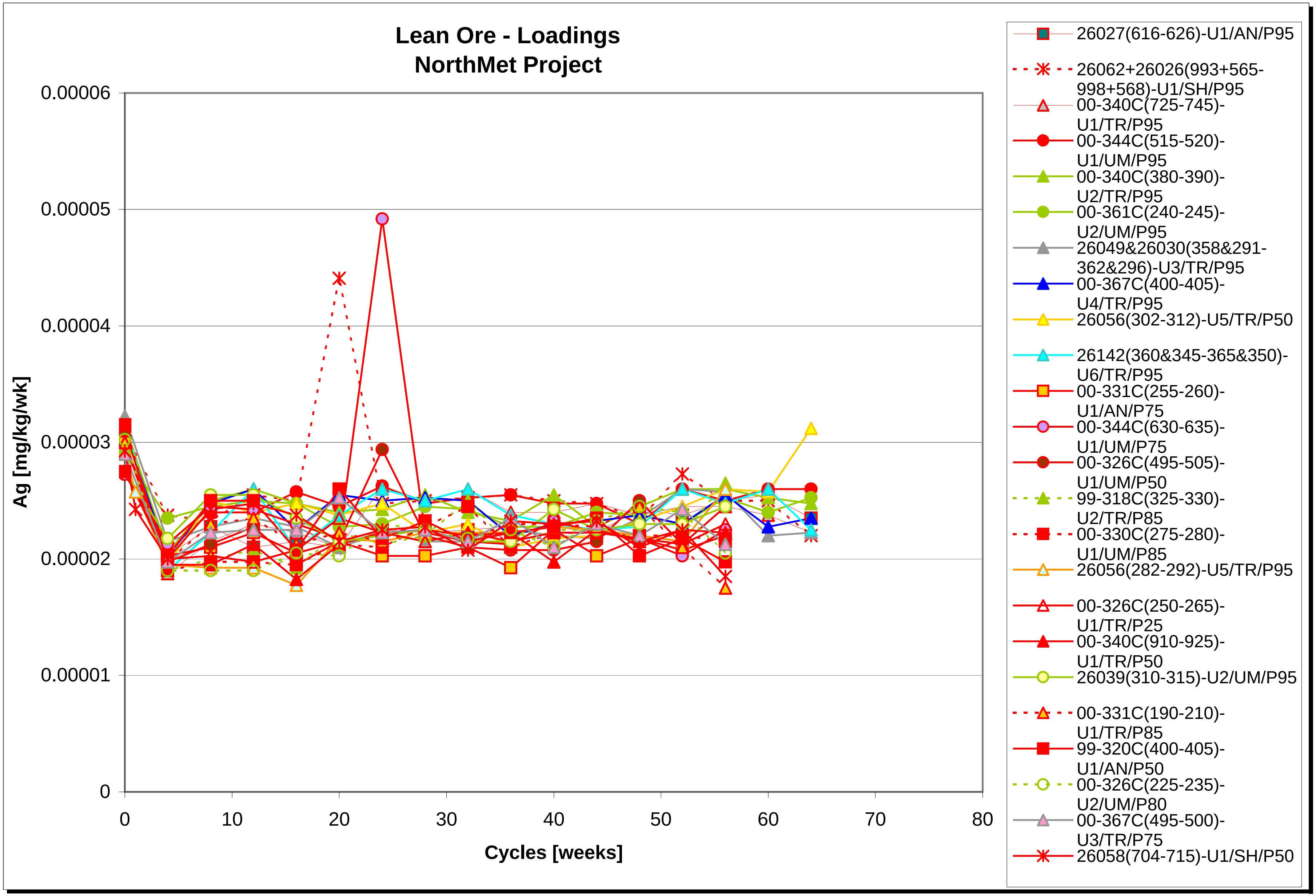

Lean Ore - Loadings
NorthMet Project
Ni [mg/kg/wk]
10
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

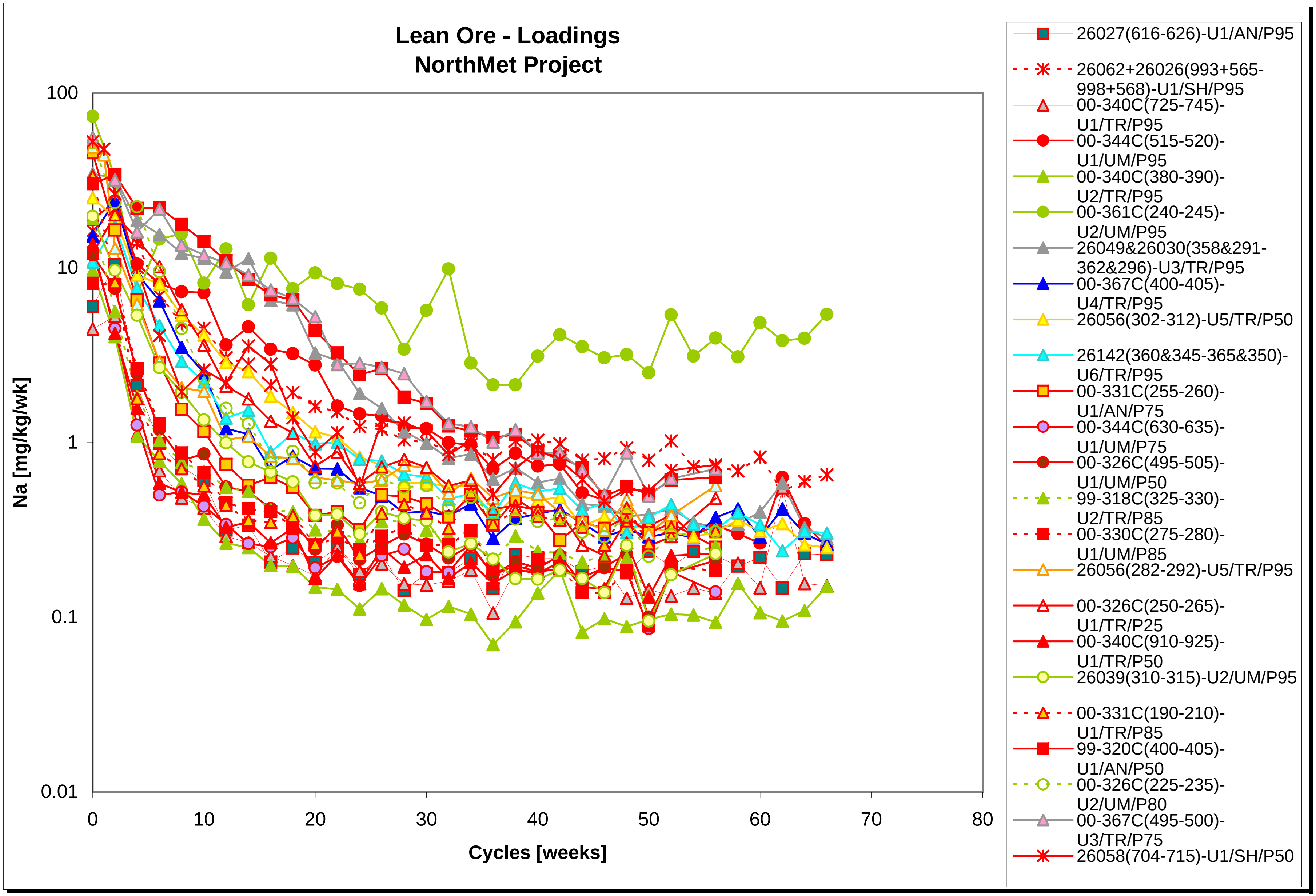

Lean Ore - Loadings
NorthMet Project
PO4 [mg/kg/wk]
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

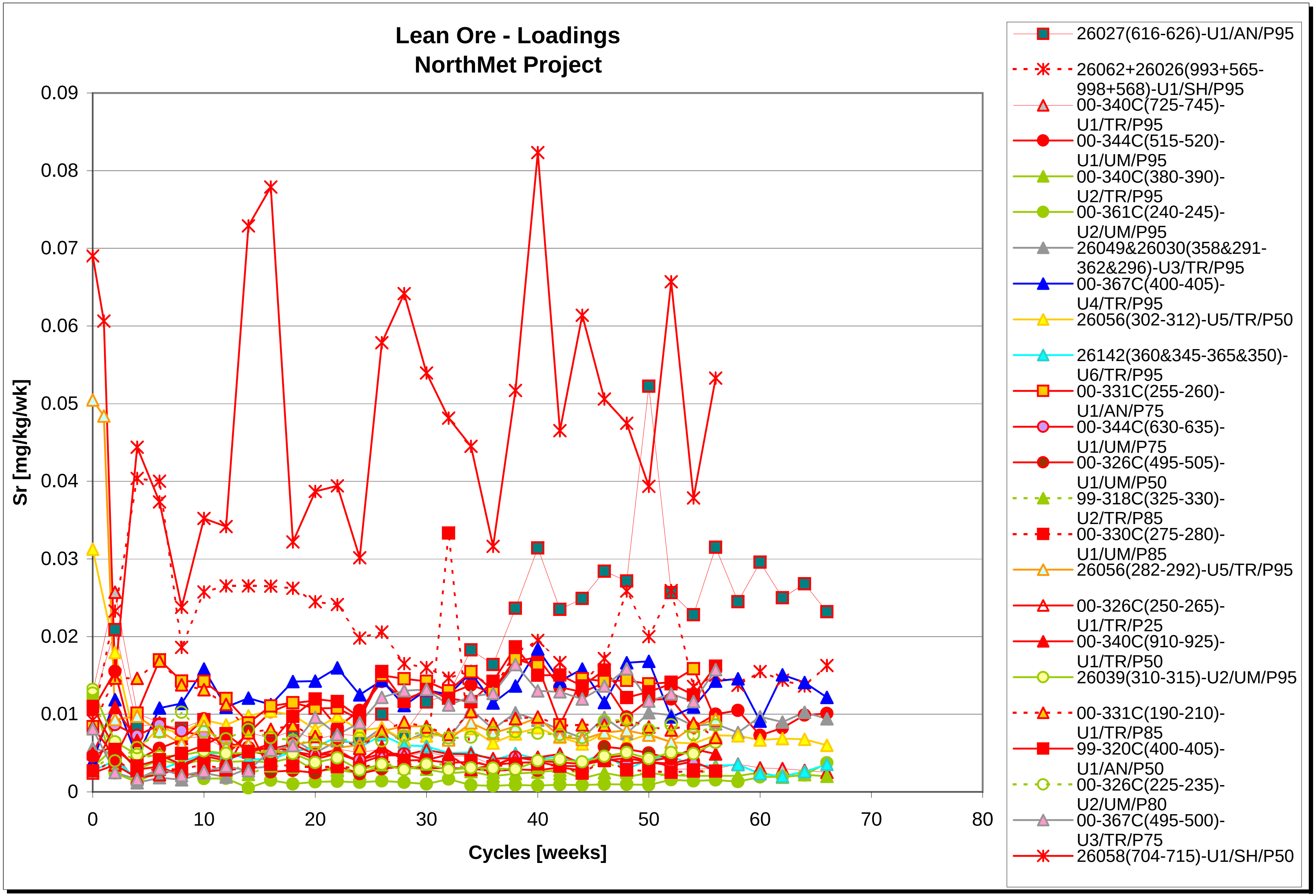

Lean Ore - Loadings
NorthMet Project
K [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

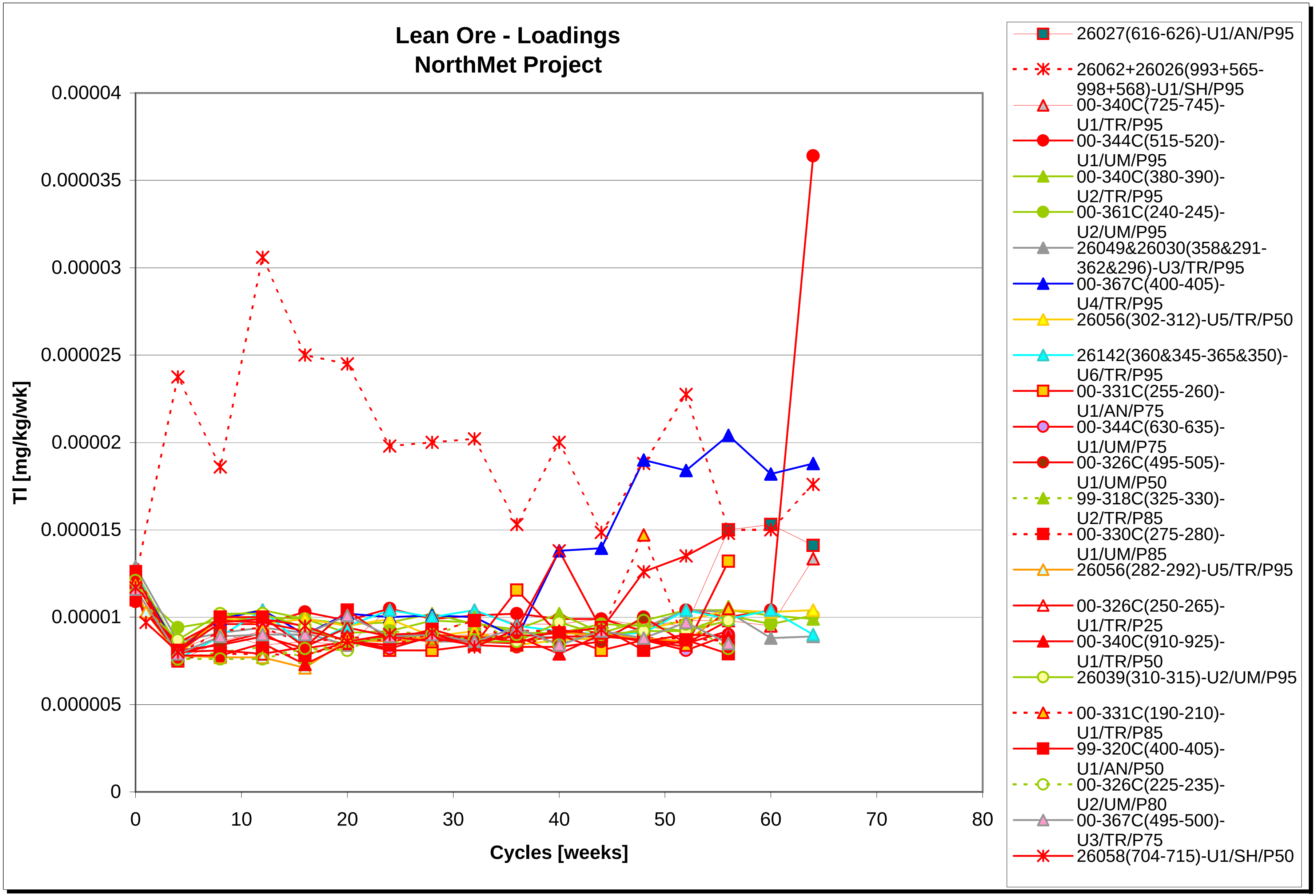

Lean Ore - Loadings
NorthMet Project
Se [mg/kg/wk]
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50


Lean Ore - Loadings
NorthMet Project
SiO2 [mg/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50


Lean Ore - Loadings
NorthMet Project
Ag [mg/kg/wk]
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0
Cycles [weeks]
0
10
20
30
40
50
60
70
80
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

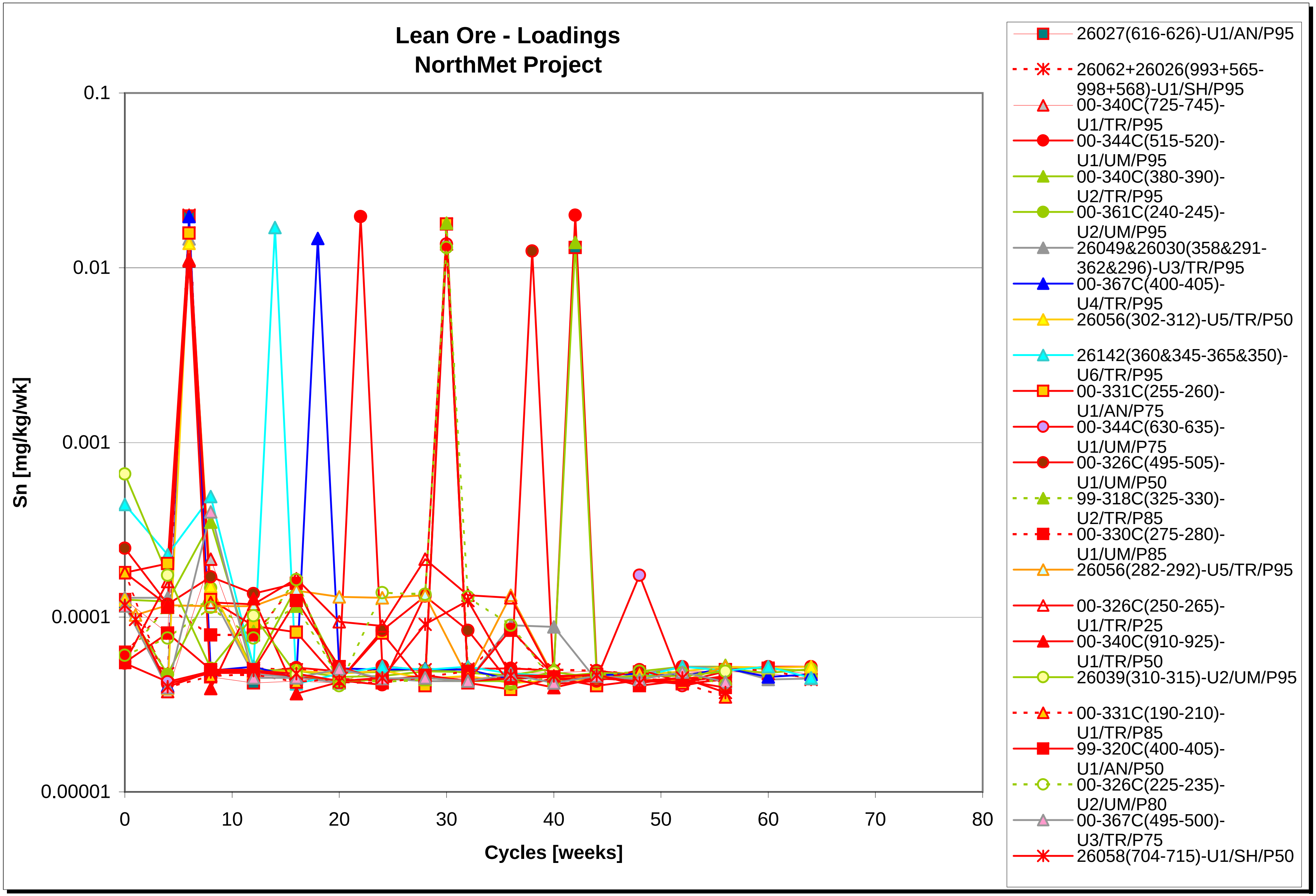

Lean Ore - Loadings
NorthMet Project
100
10
1
0.1
0.01
Na [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

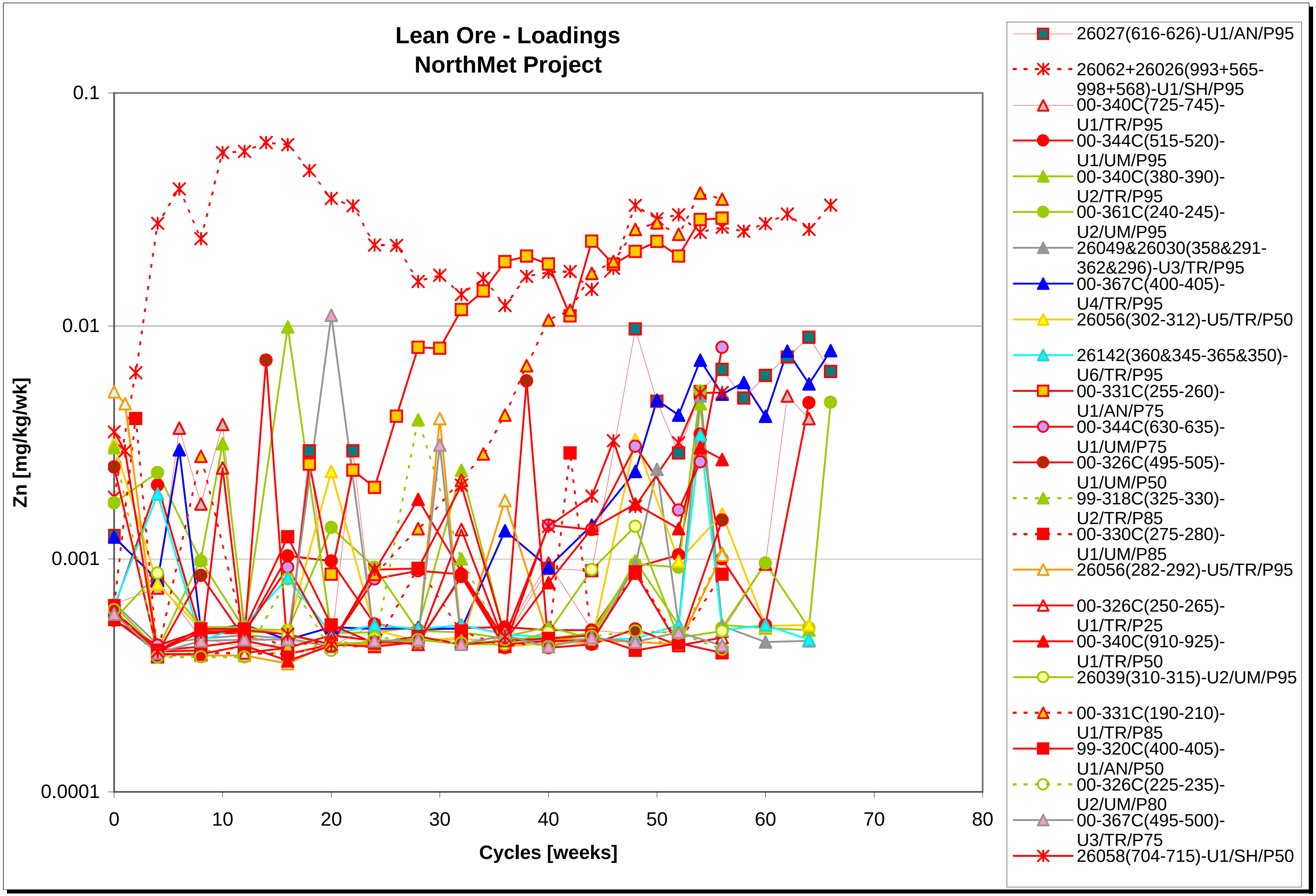

Lean Ore - Loadings
NorthMet Project
Sr [mg/kg/wk]
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50


Lean Ore - Loadings
NorthMet Project
Tl [mg/kg/wk]
0.00004
0.000035
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

Appendix E.3
Lean Ore

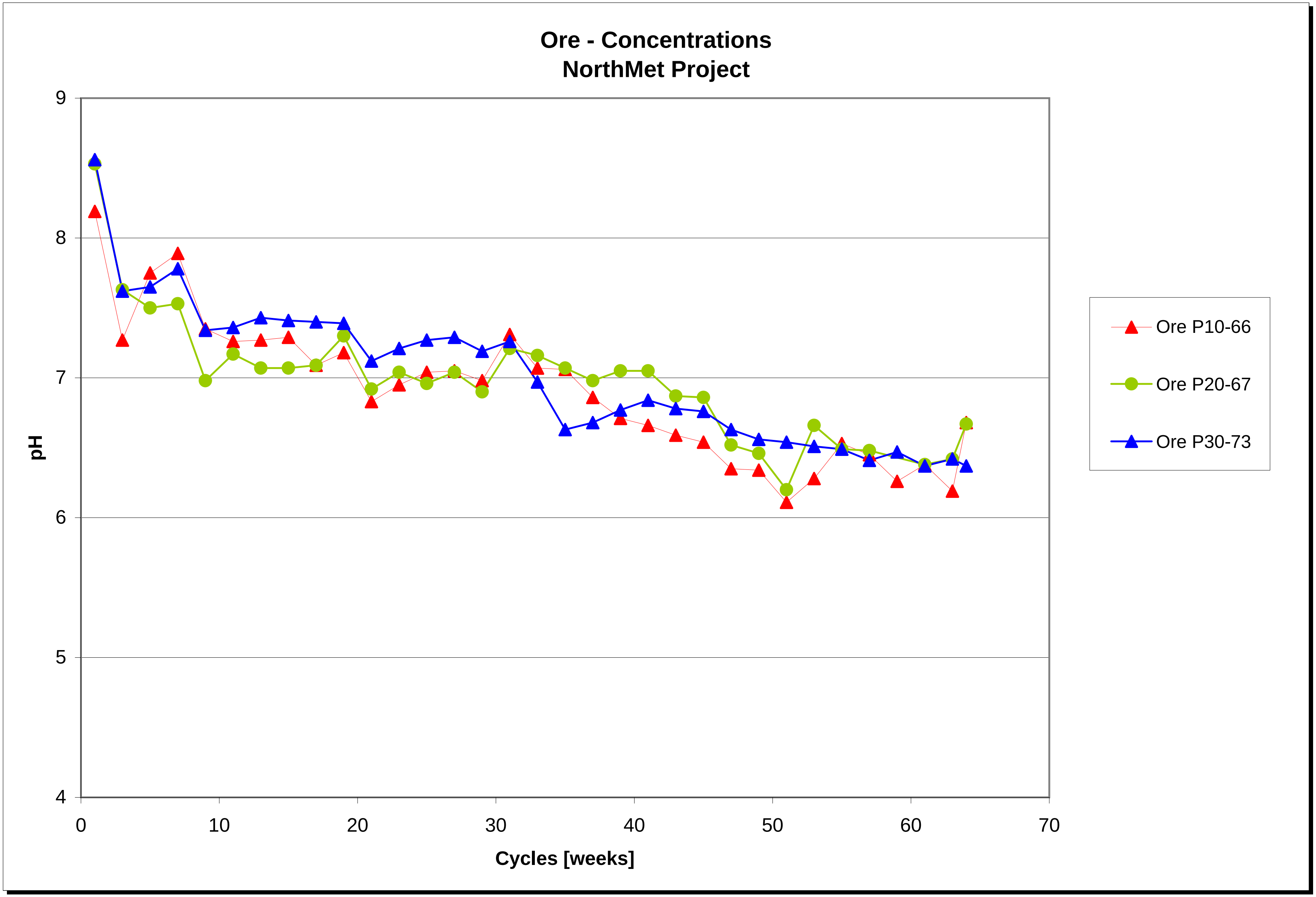
Graph E.3.40

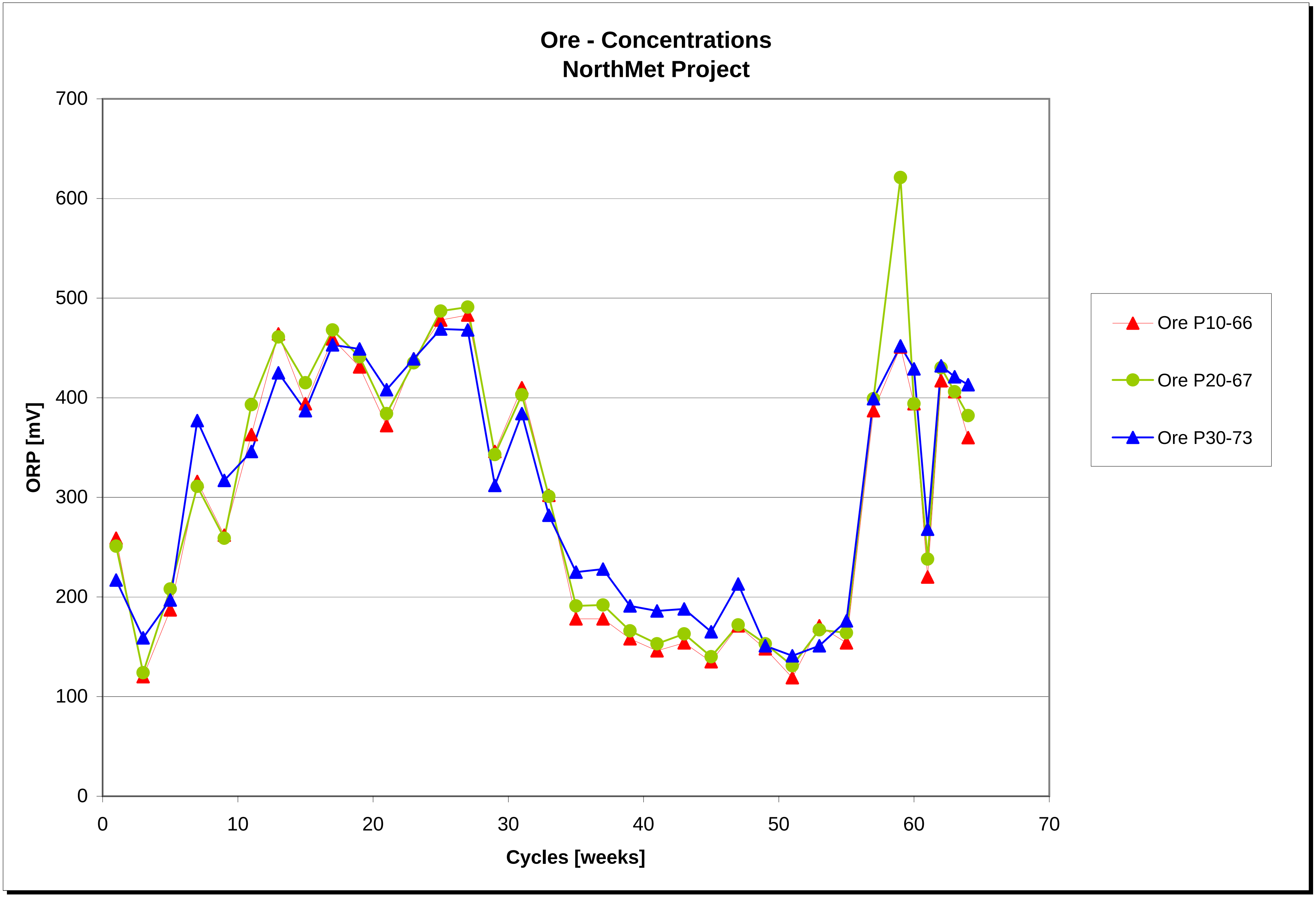


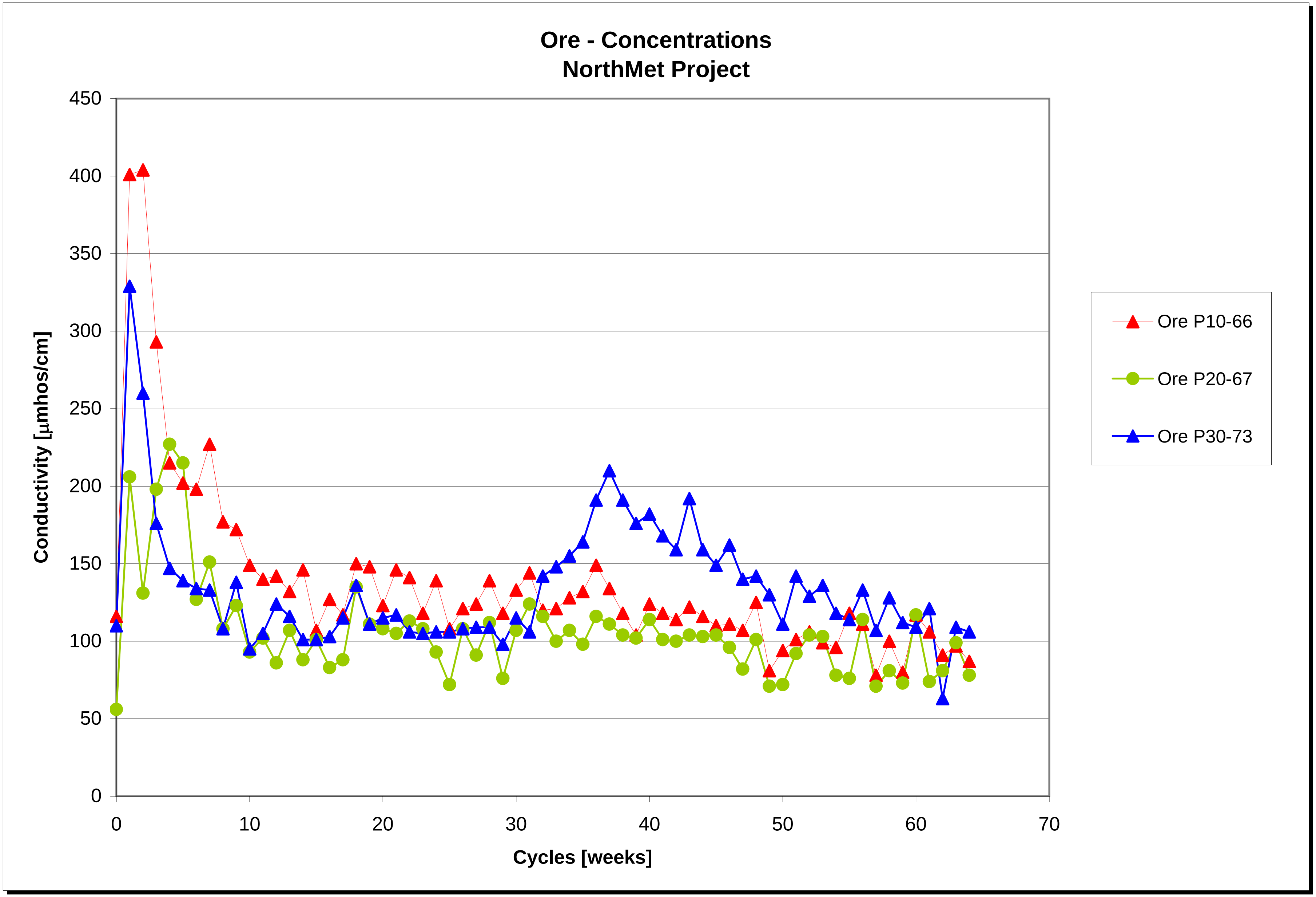

Lean Ore - Loadings
NorthMet Project
Zn [mg/kg/wk]
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
26027(616-626)-U1/AN/P95
26062+26026(993+565-998+568)-U1/SH/P95
00-340C(725-745)-U1/TR/P95
00-344C(515-520)-U1/UM/P95
00-340C(380-390)-U2/TR/P95
00-361C(240-245)-U2/UM/P95
26049&26030(358&291-362&296)-U3/TR/P95
00-367C(400-405)-U4/TR/P95
26056(302-312)-U5/TR/P50
26142(360&345-365&350)-U6/TR/P95
00-331C(255-260)-U1/AN/P75
00-344C(630-635)-U1/UM/P75
00-326C(495-505)-U1/UM/P50
99-318C(325-330)-U2/TR/P85
00-330C(275-280)-U1/UM/P85
26056(282-292)-U5/TR/P95
00-326C(250-265)-U1/TR/P25
00-340C(910-925)-U1/TR/P50
26039(310-315)-U2/UM/P95
00-331C(190-210)-U1/TR/P85
99-320C(400-405)-U1/AN/P50
00-326C(225-235)-U2/UM/P80
00-367C(495-500)-U3/TR/P75
26058(704-715)-U1/SH/P50

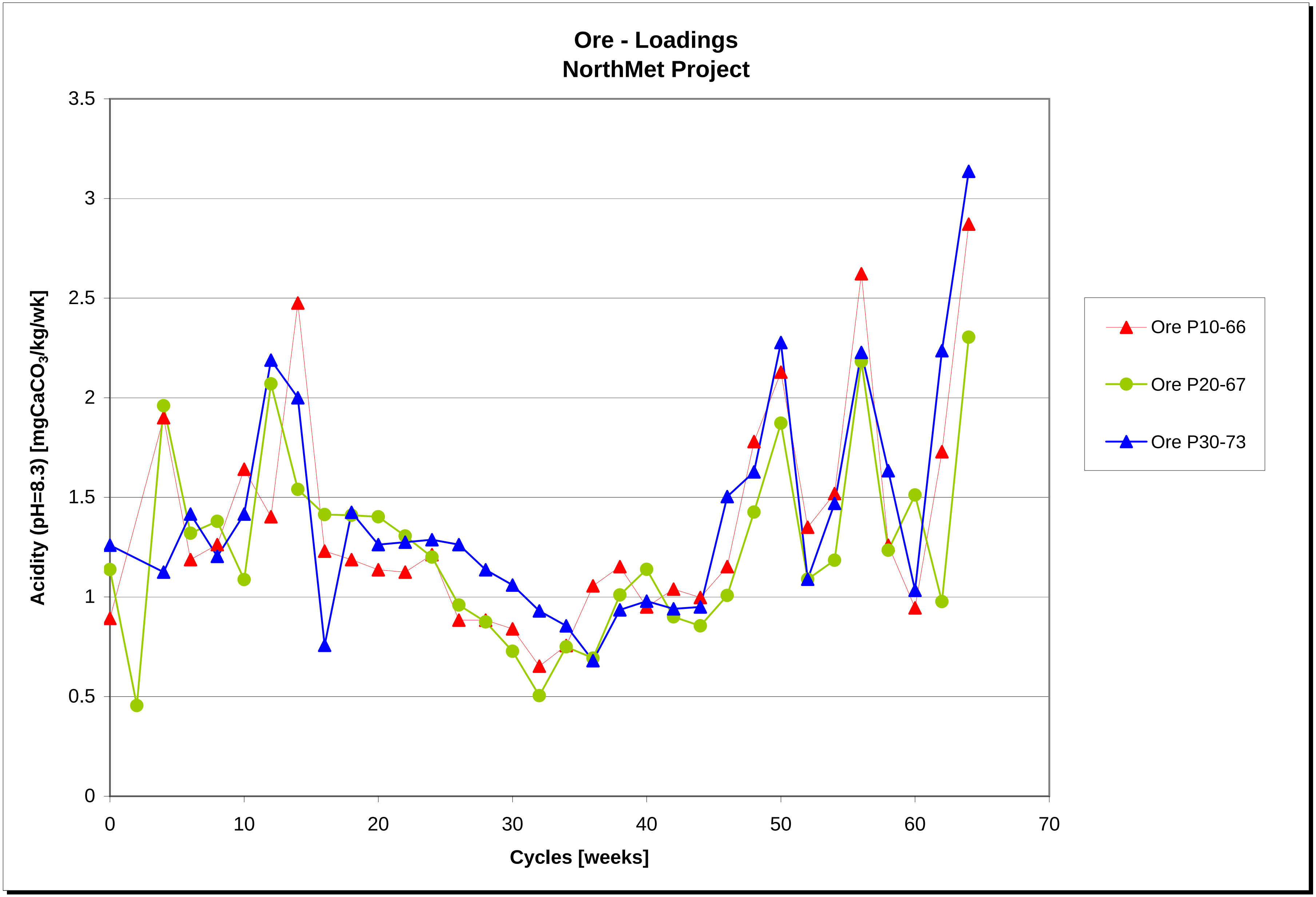
Appendix E.4

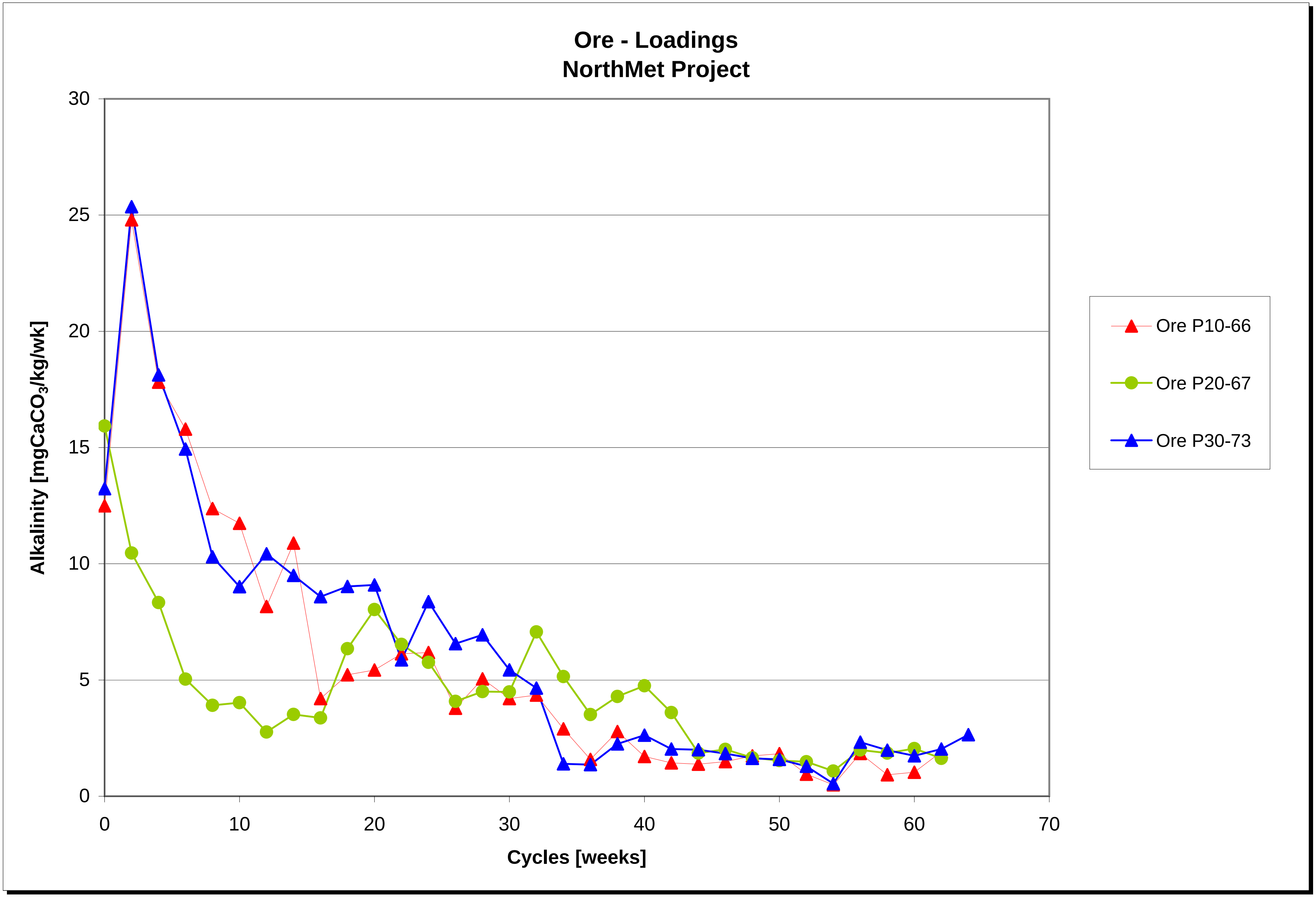
Ore

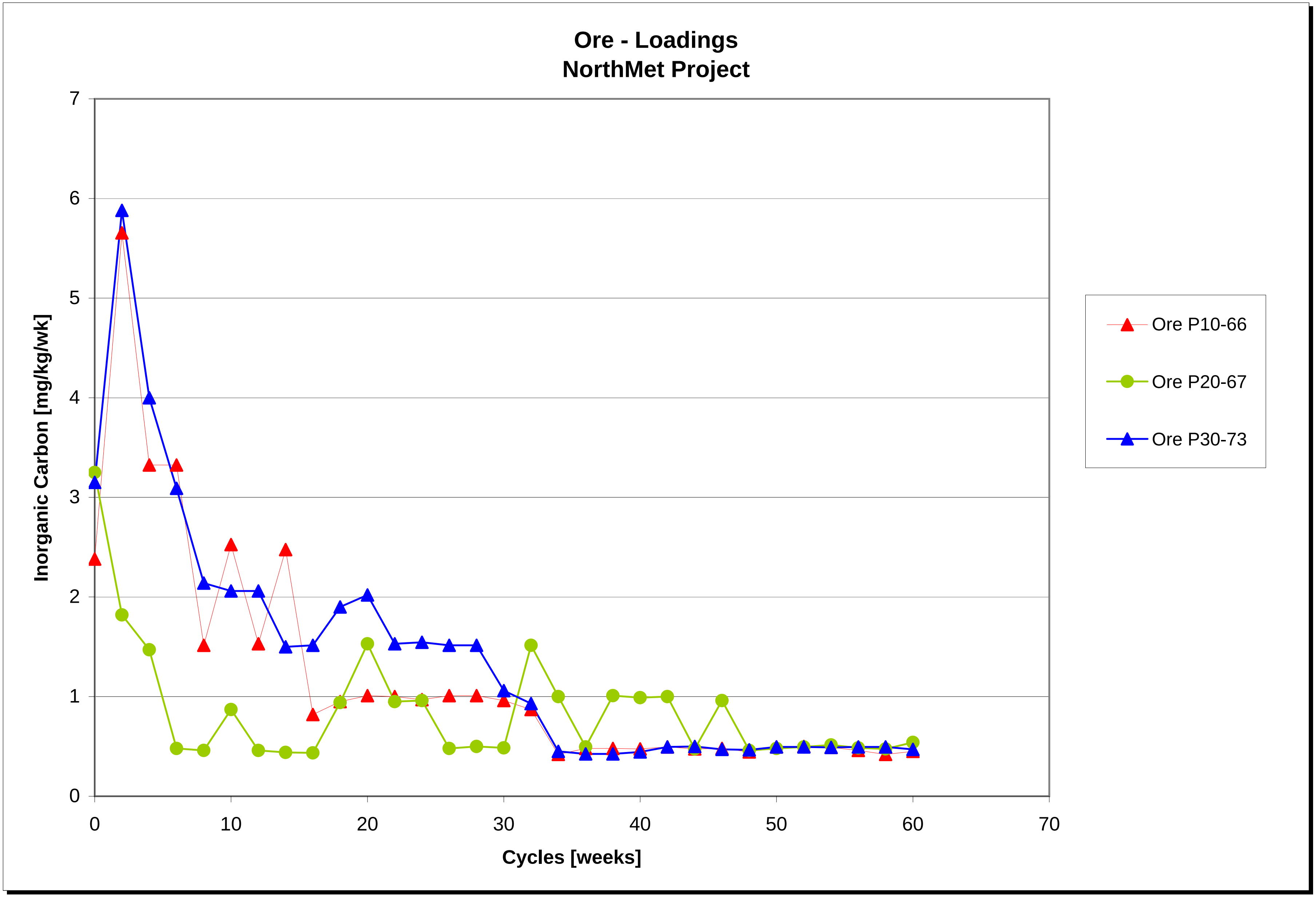

Ore - Concentrations
NorthMet Project
pH
Cycles [weeks]
9
8
7
6
5
4
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

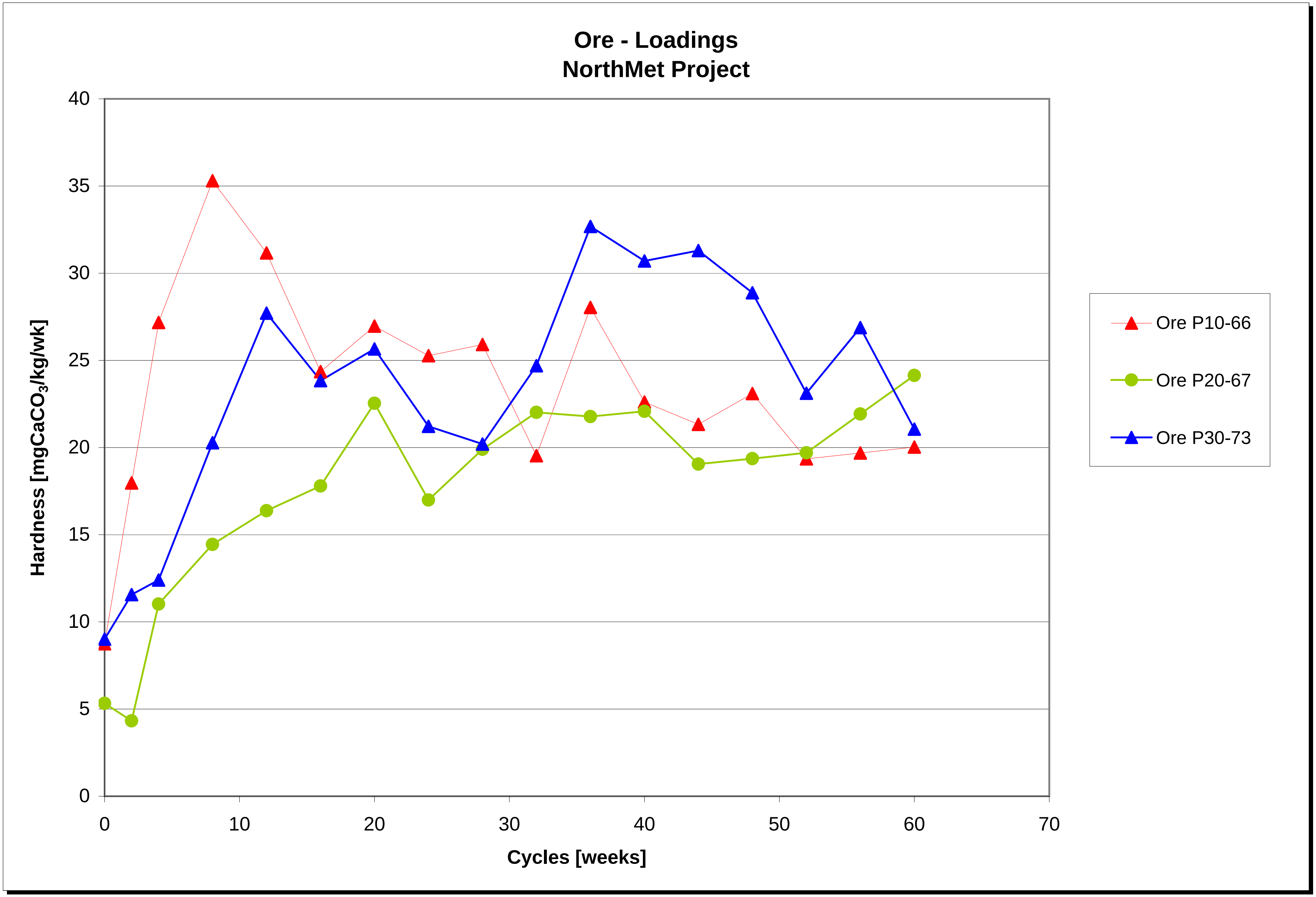

Ore - Concentrations
NorthMet Project
ORP [mV]
700
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

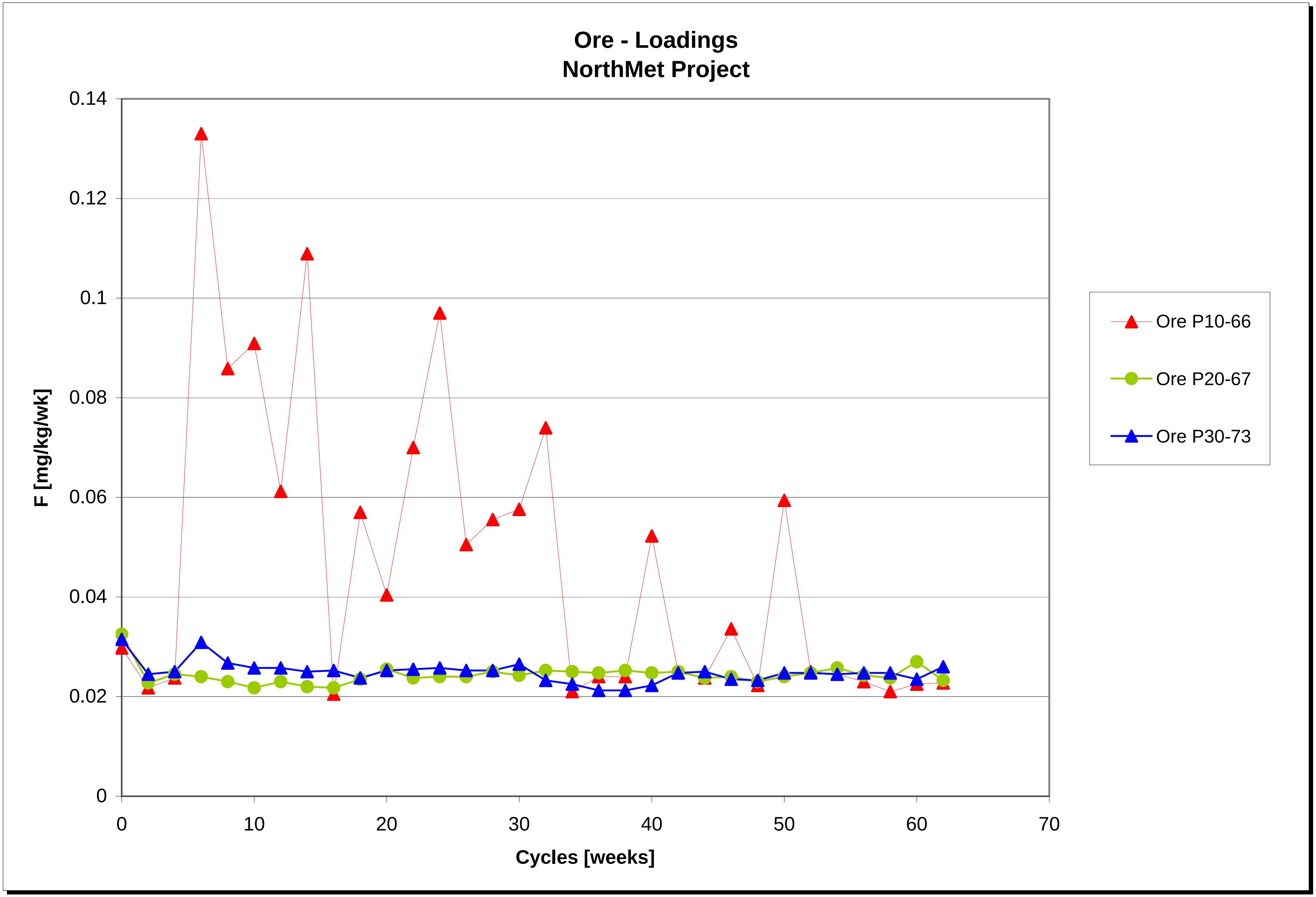

Ore - Concentrations
NorthMet Project
Conductivity [µmhos/cm]
450
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

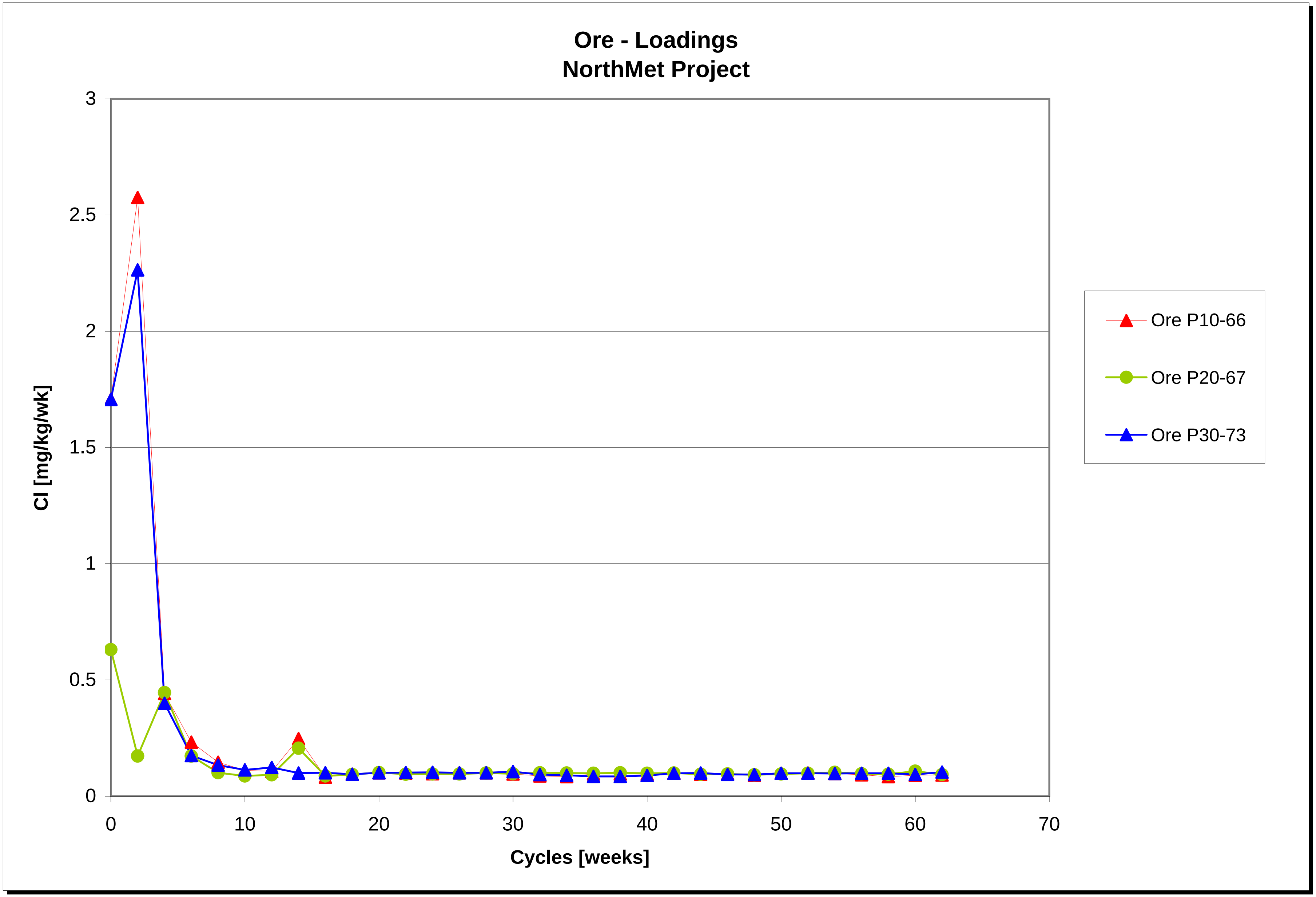

Ore - Loadings
NorthMet Project
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
3.5
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

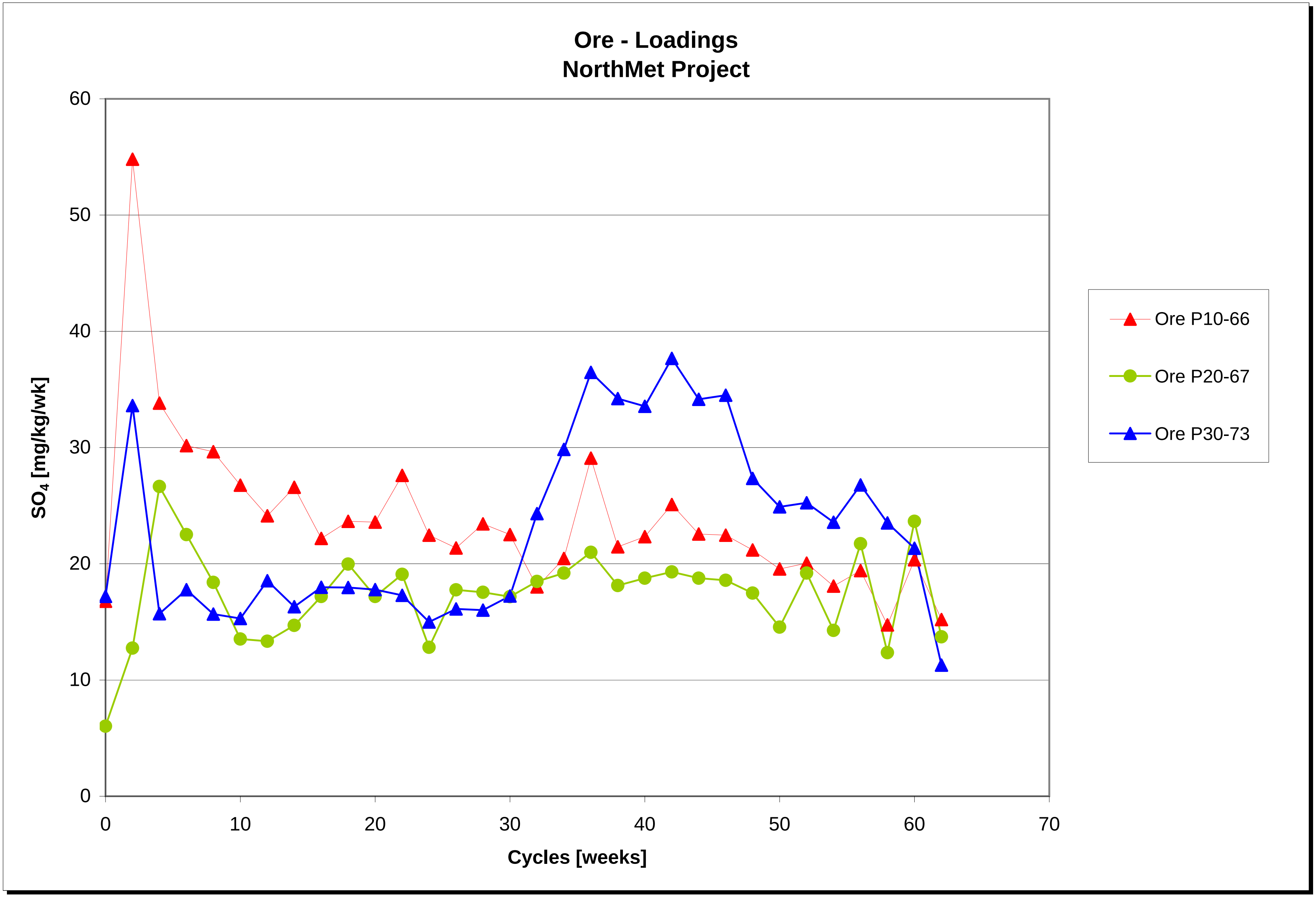

Ore - Loadings
NorthMet Project
Alkalinity [mgCaCO3/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

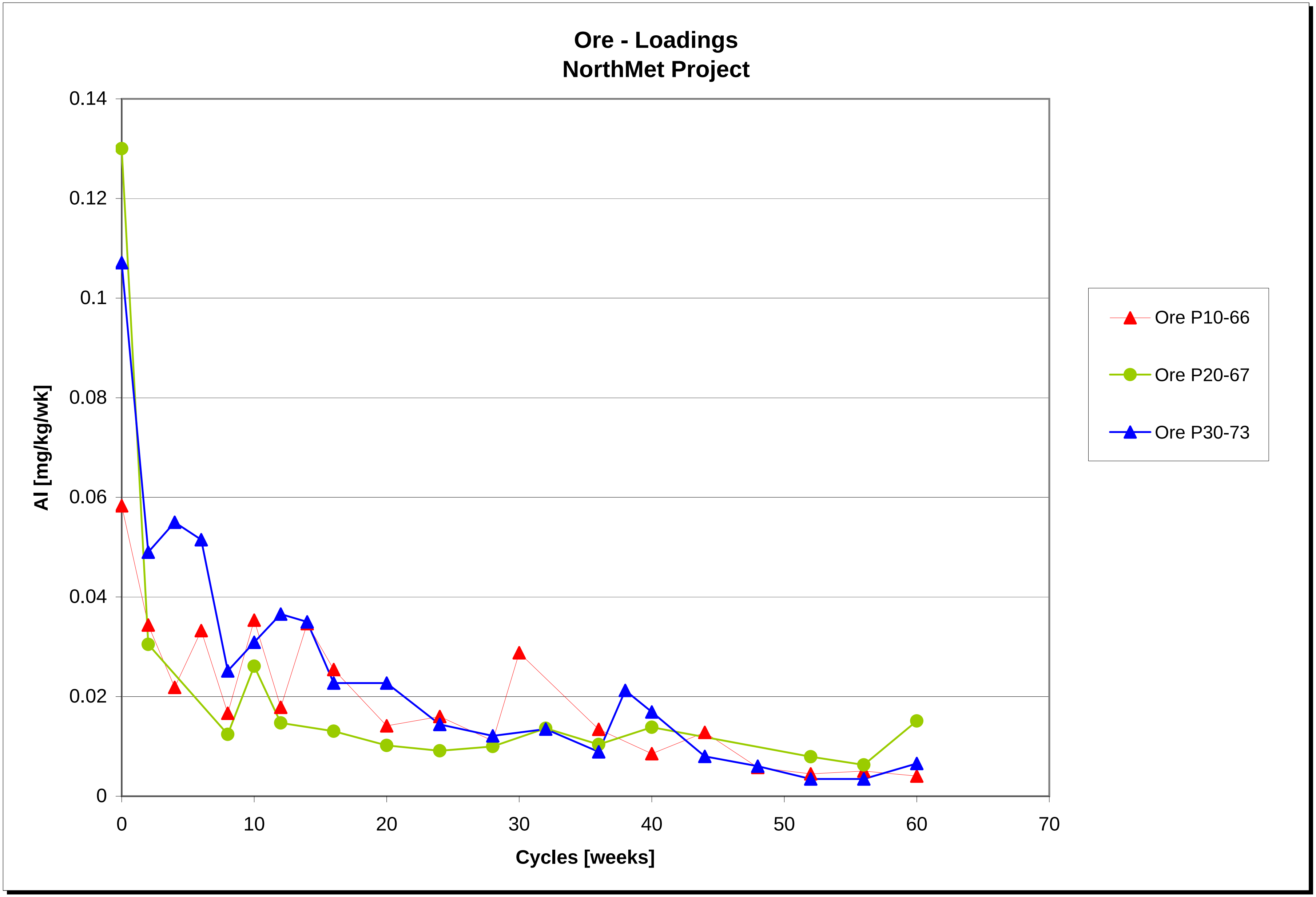

Ore - Loadings
NorthMet Project
Inorganic Carbon [mg/kg/wk]
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70

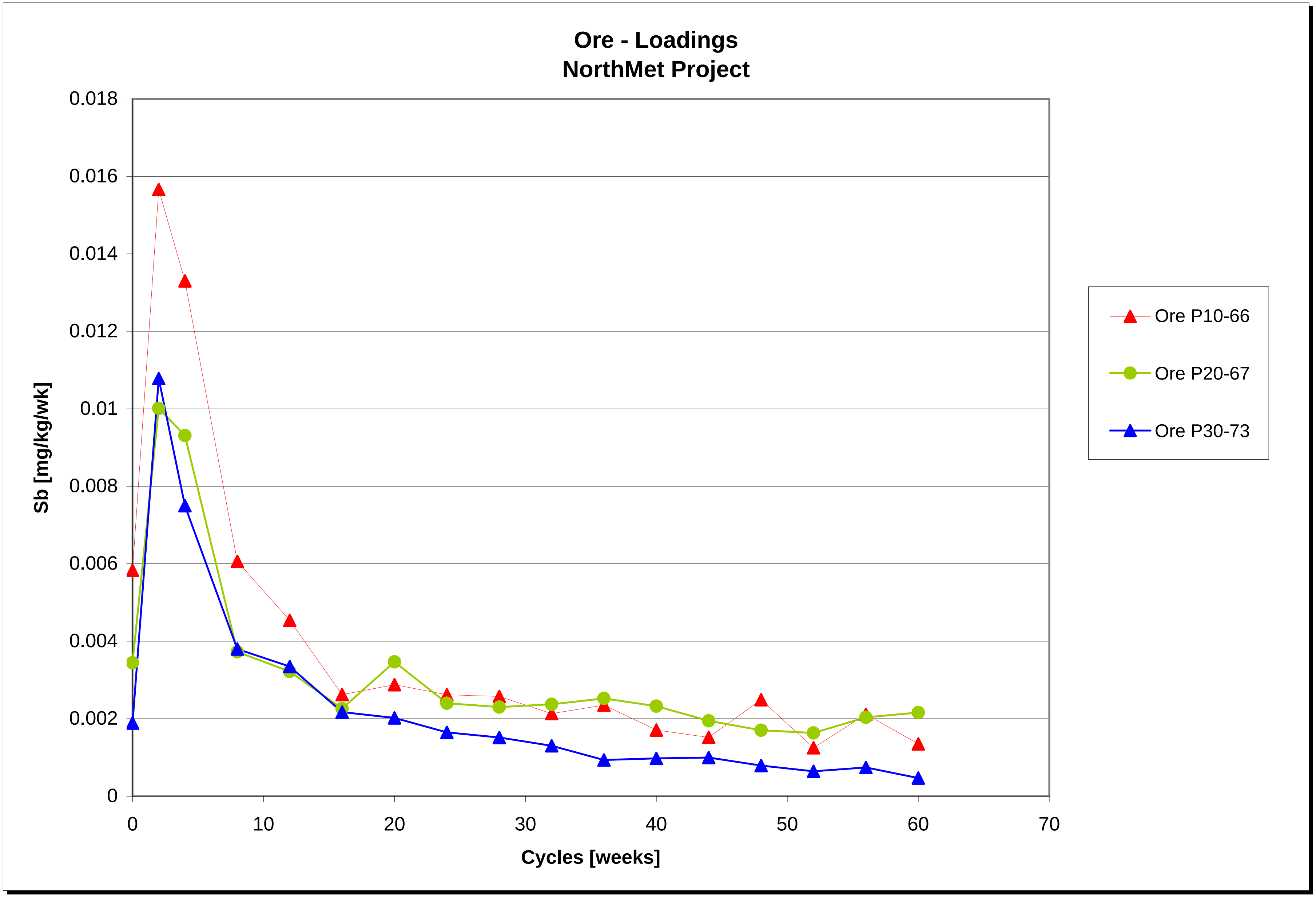

Ore - Loadings
NorthMet Project
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

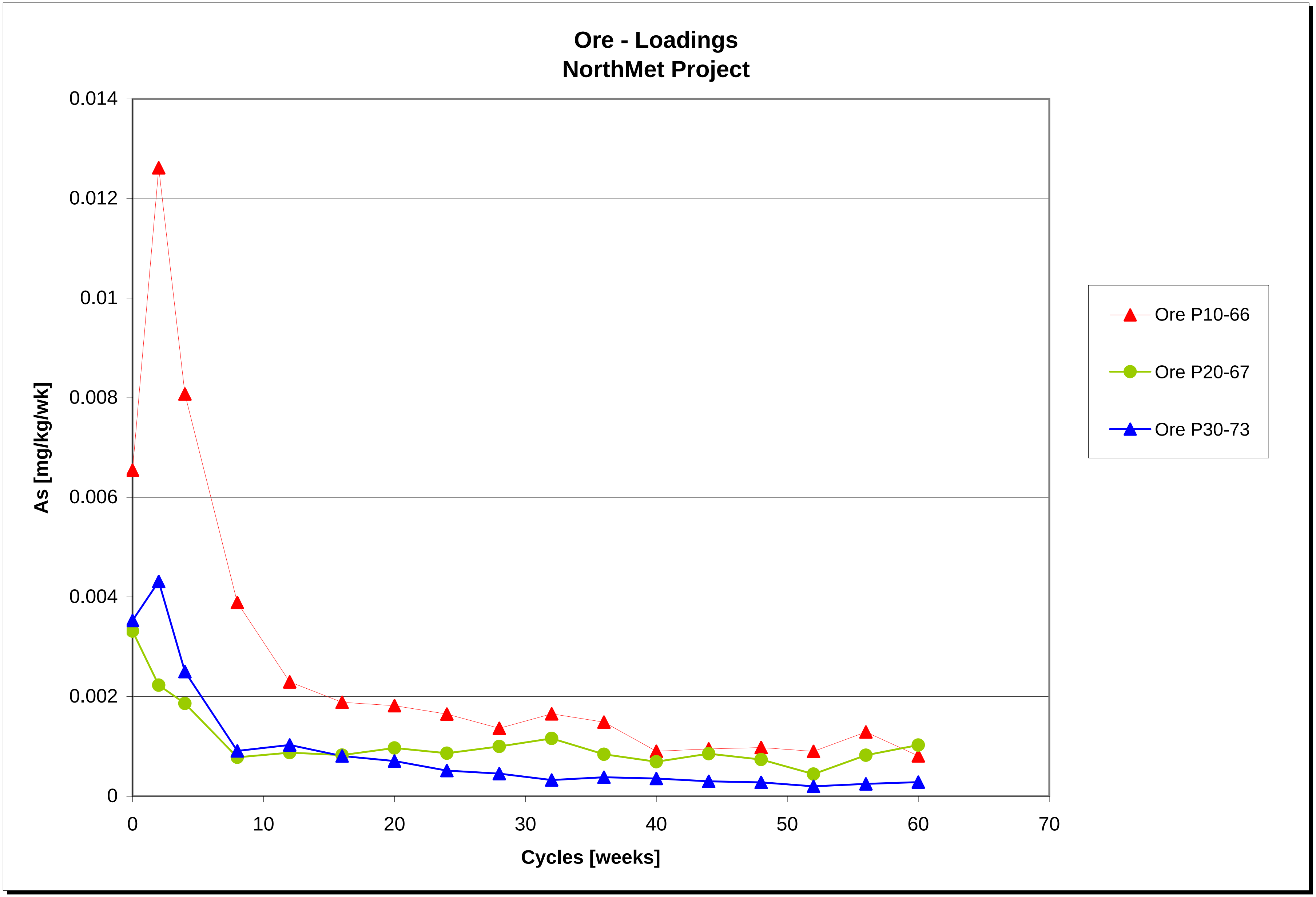

Ore - Loadings
NorthMet Project
F [mg/kg/wk]
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

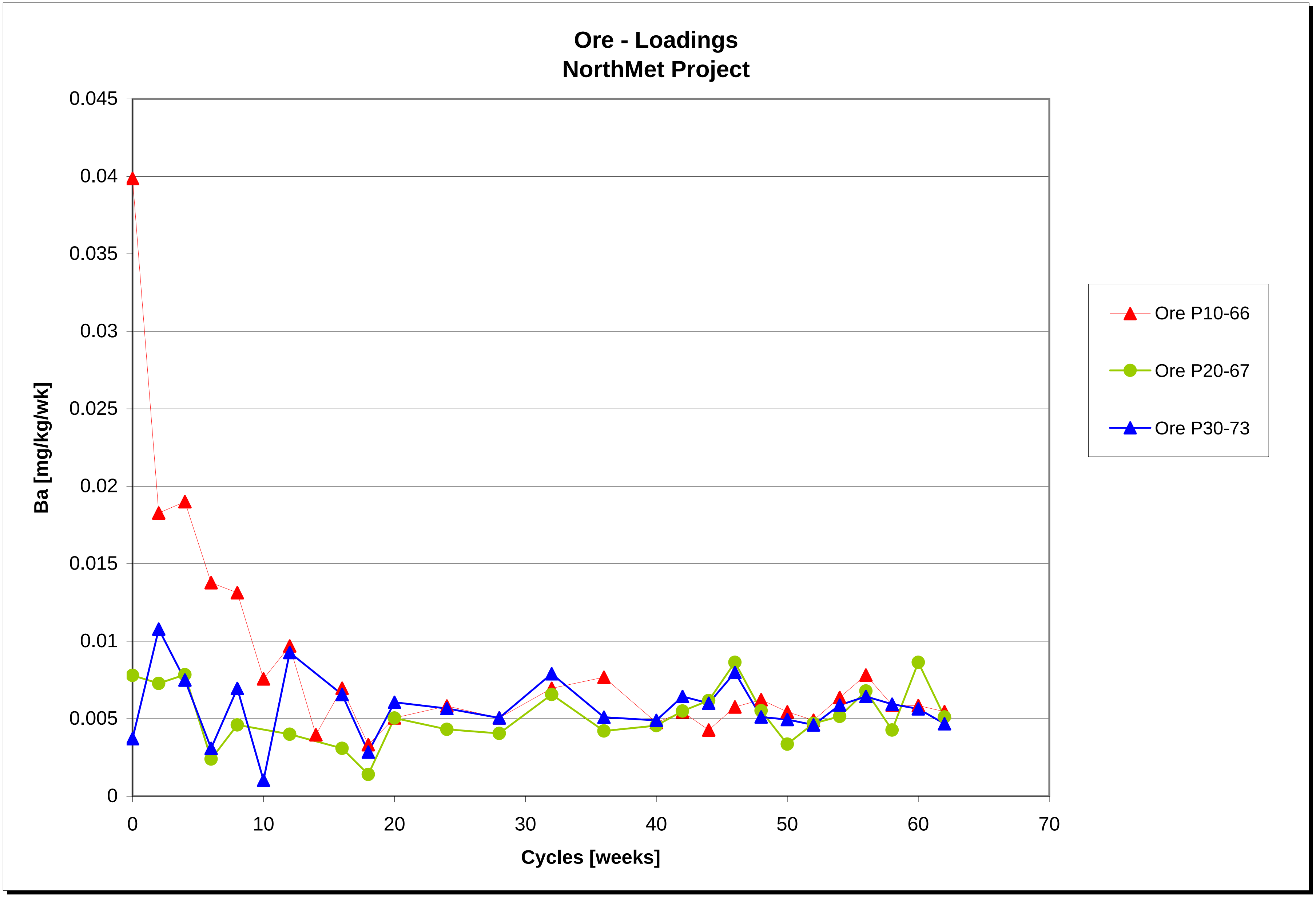

Ore - Loadings
NorthMet Project
Cl [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

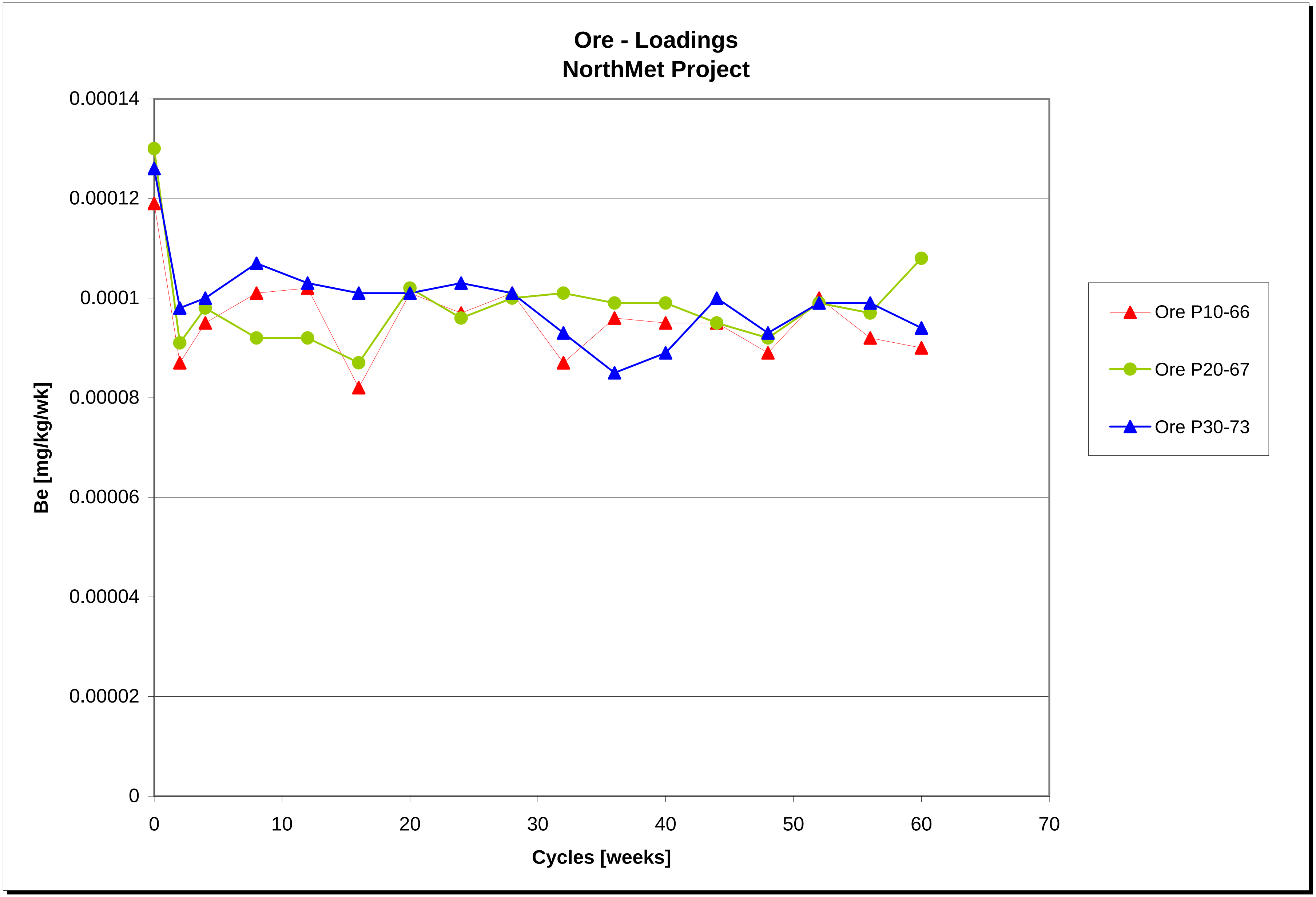

Ore - Loadings
NorthMet Project
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
SO_4 [mg/kg/wk]
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

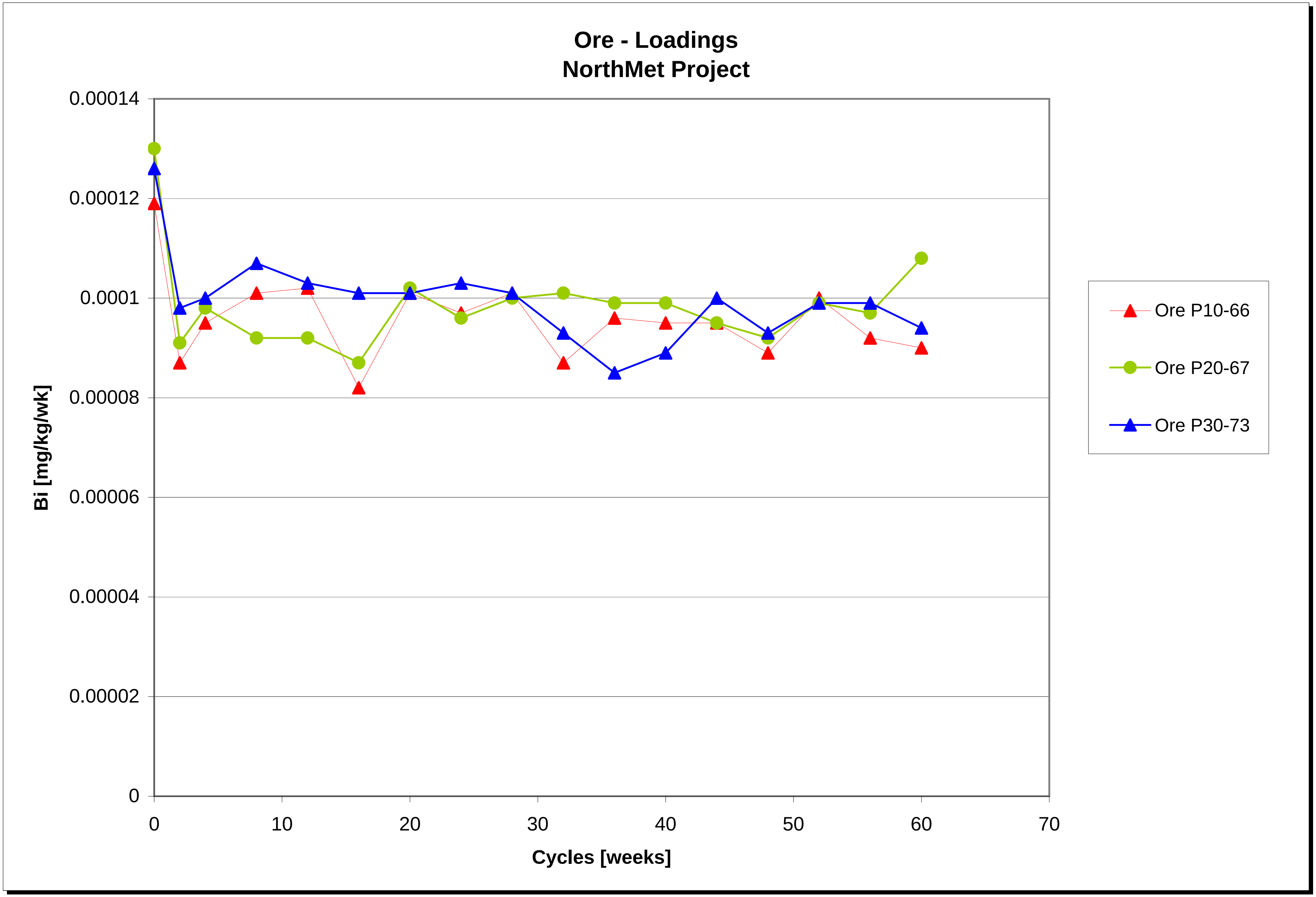

Ore - Loadings
NorthMet Project
Al [mg/kg/wk]
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

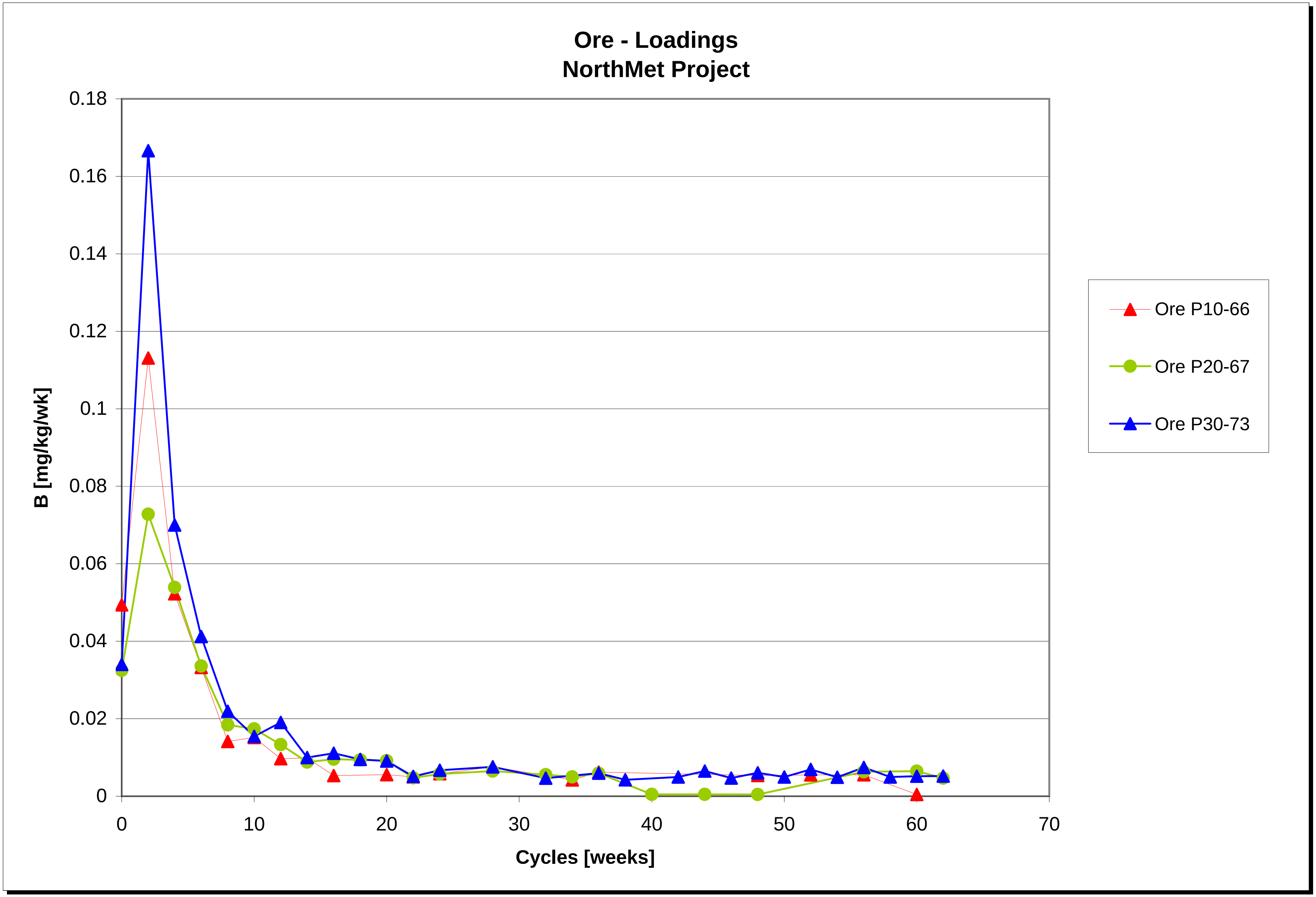

Ore - Loadings
NorthMet Project
Sb [mg/kg/wk]
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

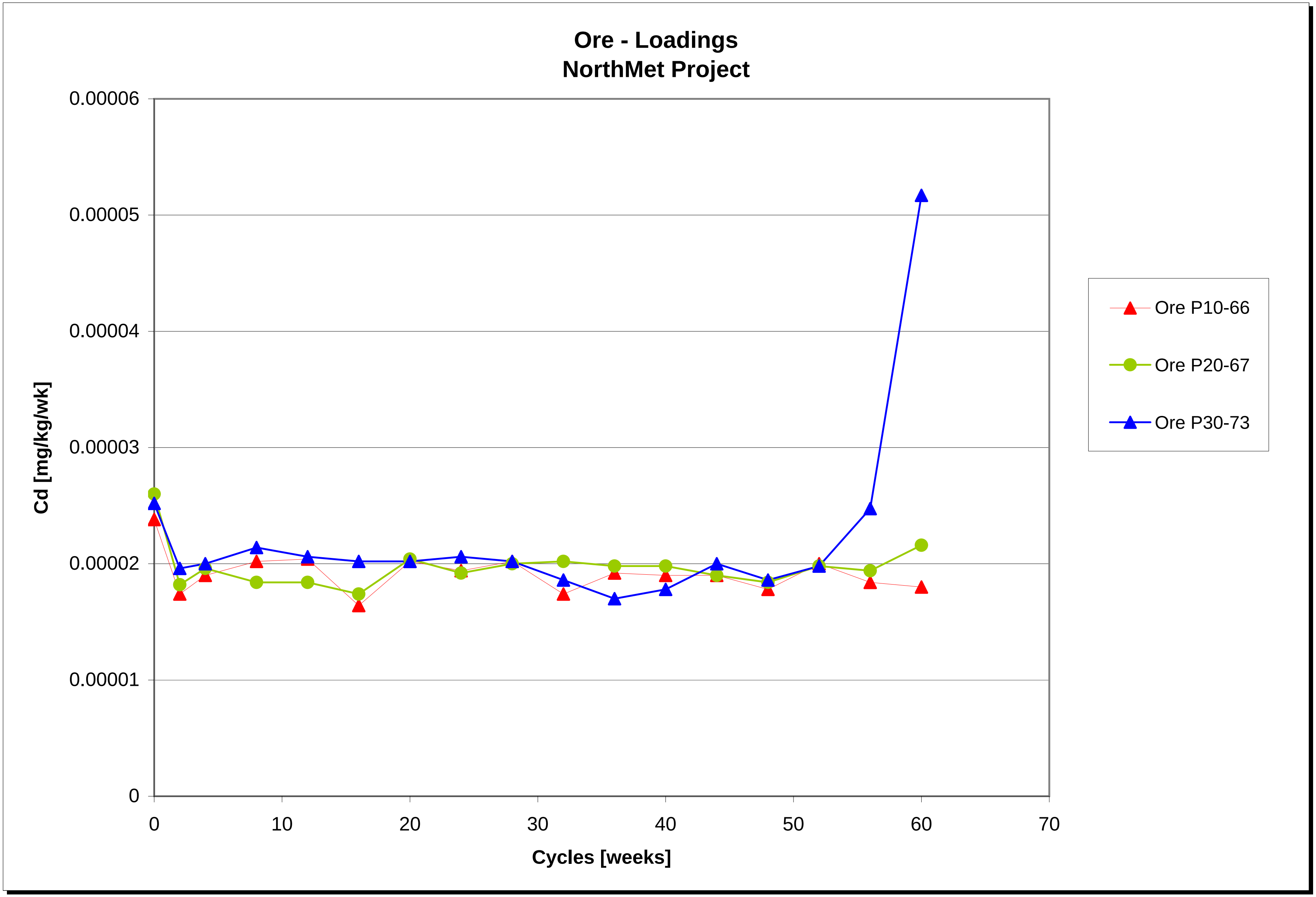

Ore - Loadings
NorthMet Project
As [mg/kg/wk]
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

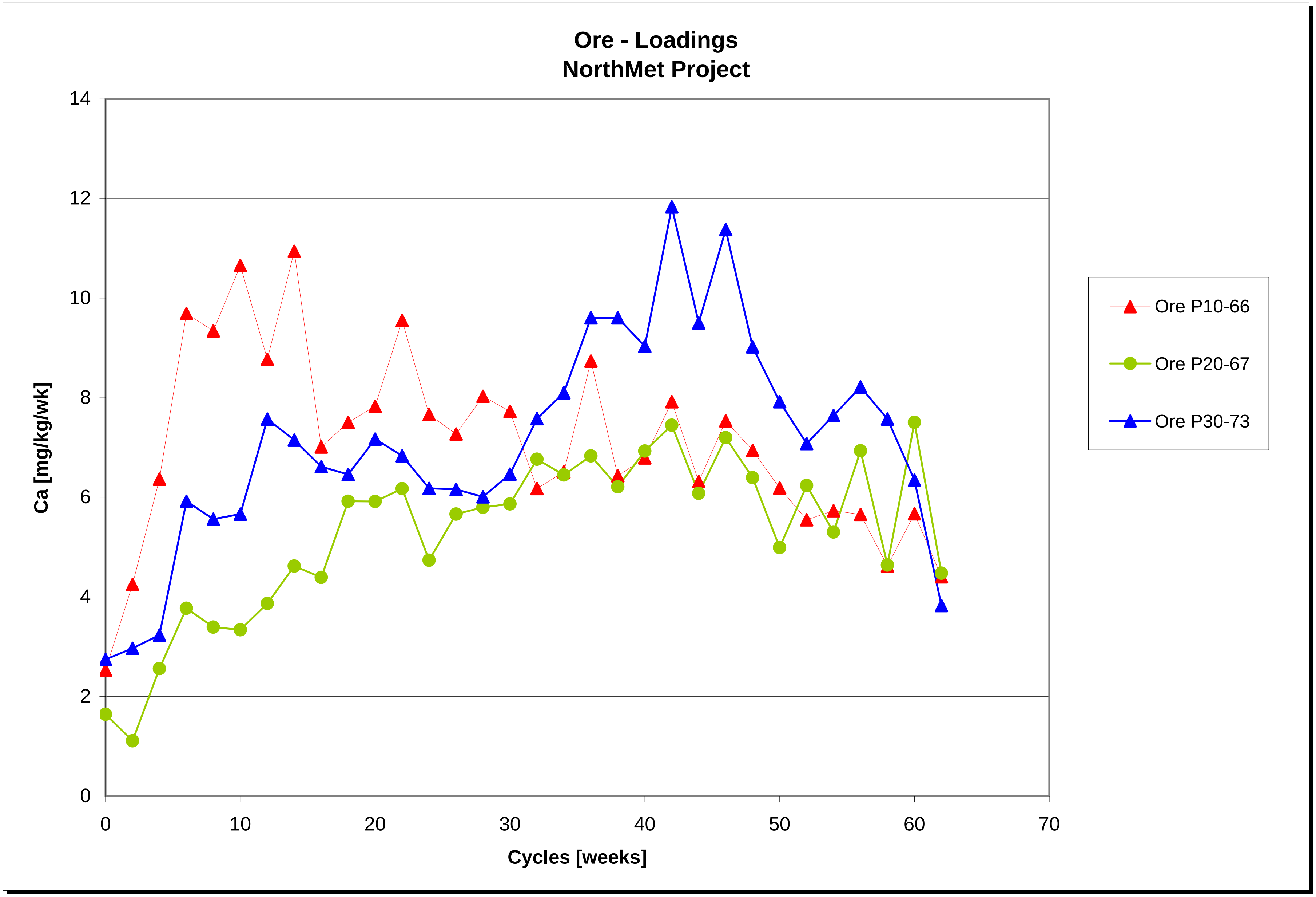

Ore - Loadings
NorthMet Project
0.045
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Ba [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

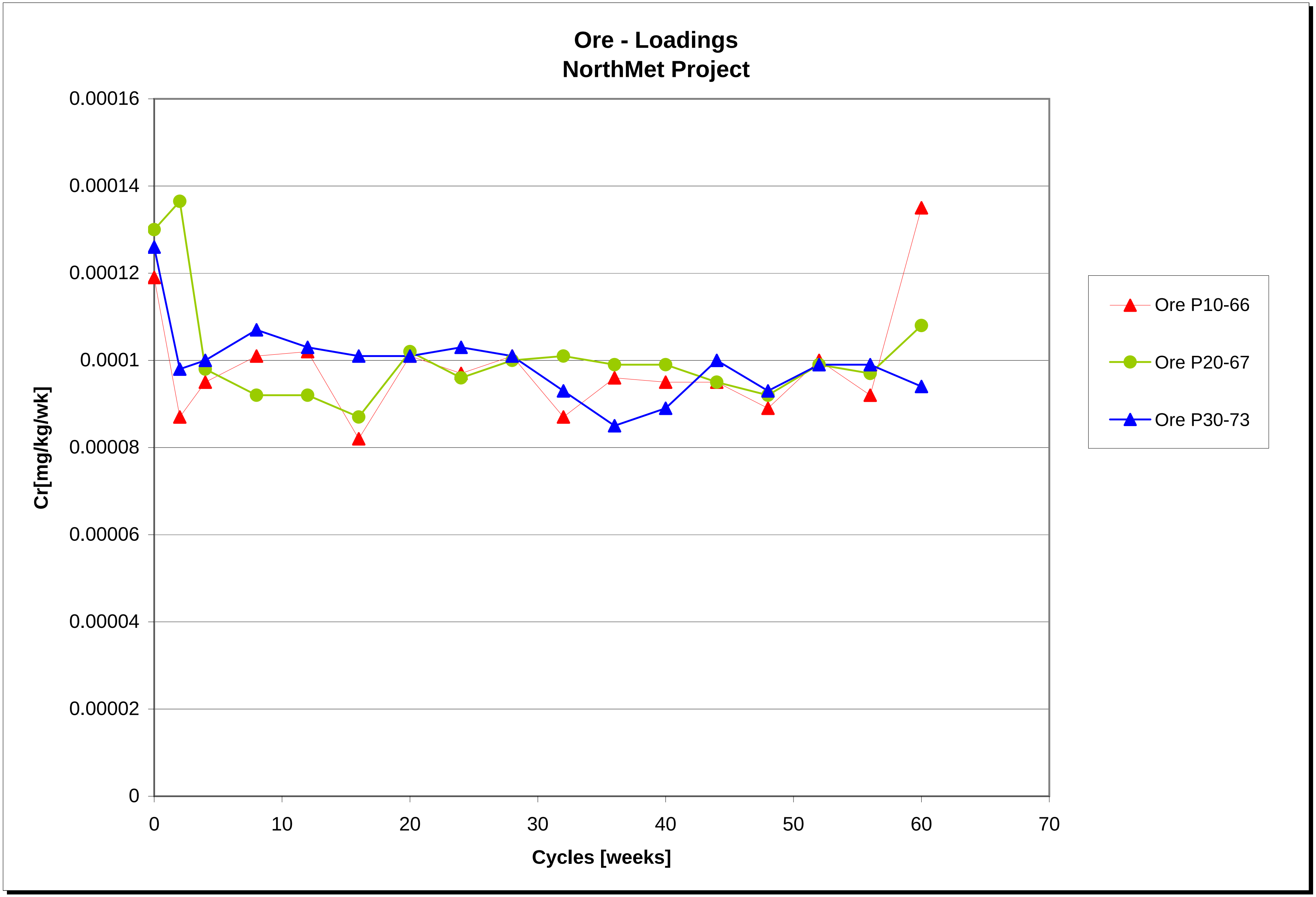

Ore - Loadings
NorthMet Project
Be [mg/kg/wk]
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

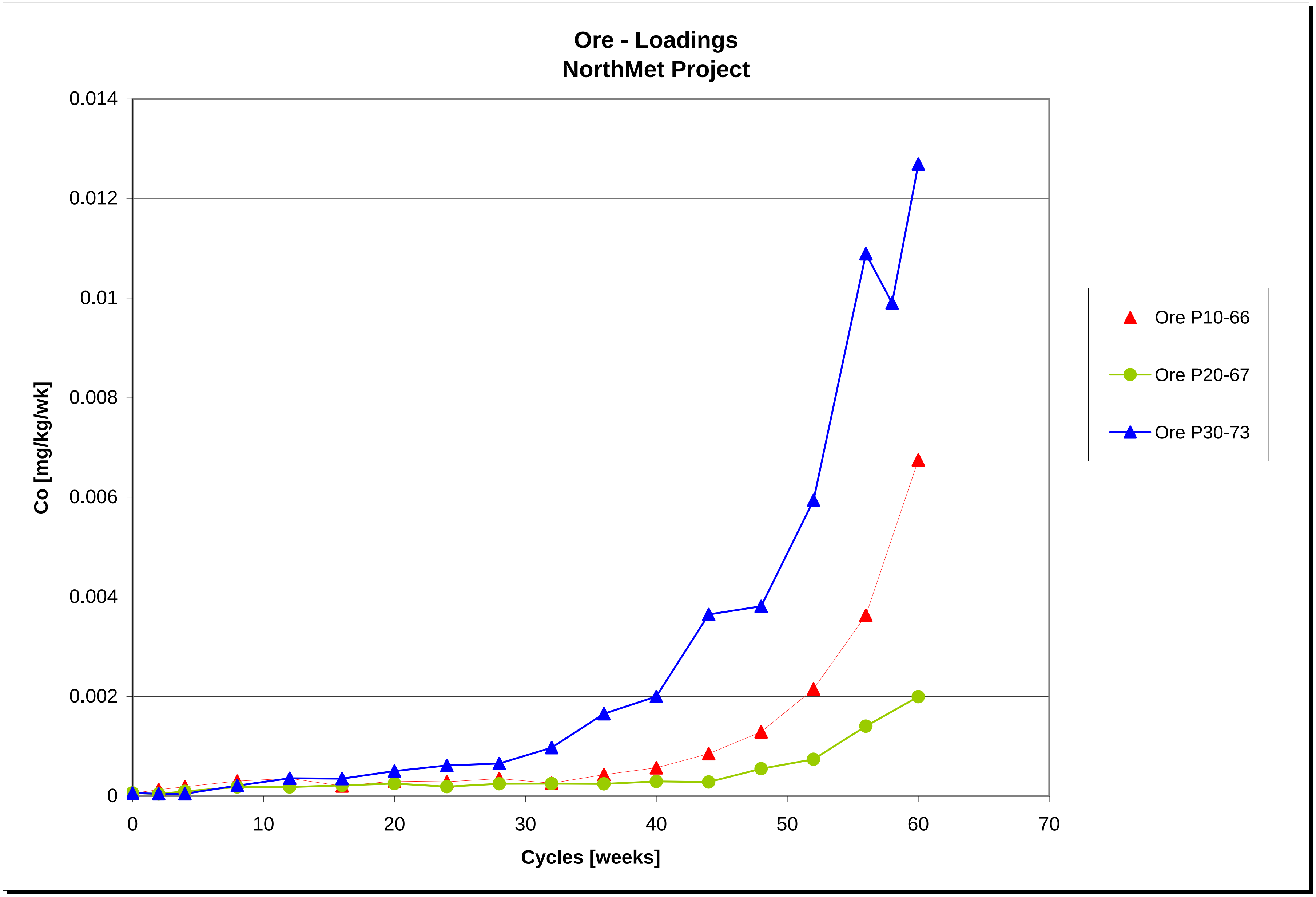

Ore - Loadings
NorthMet Project
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Bi [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

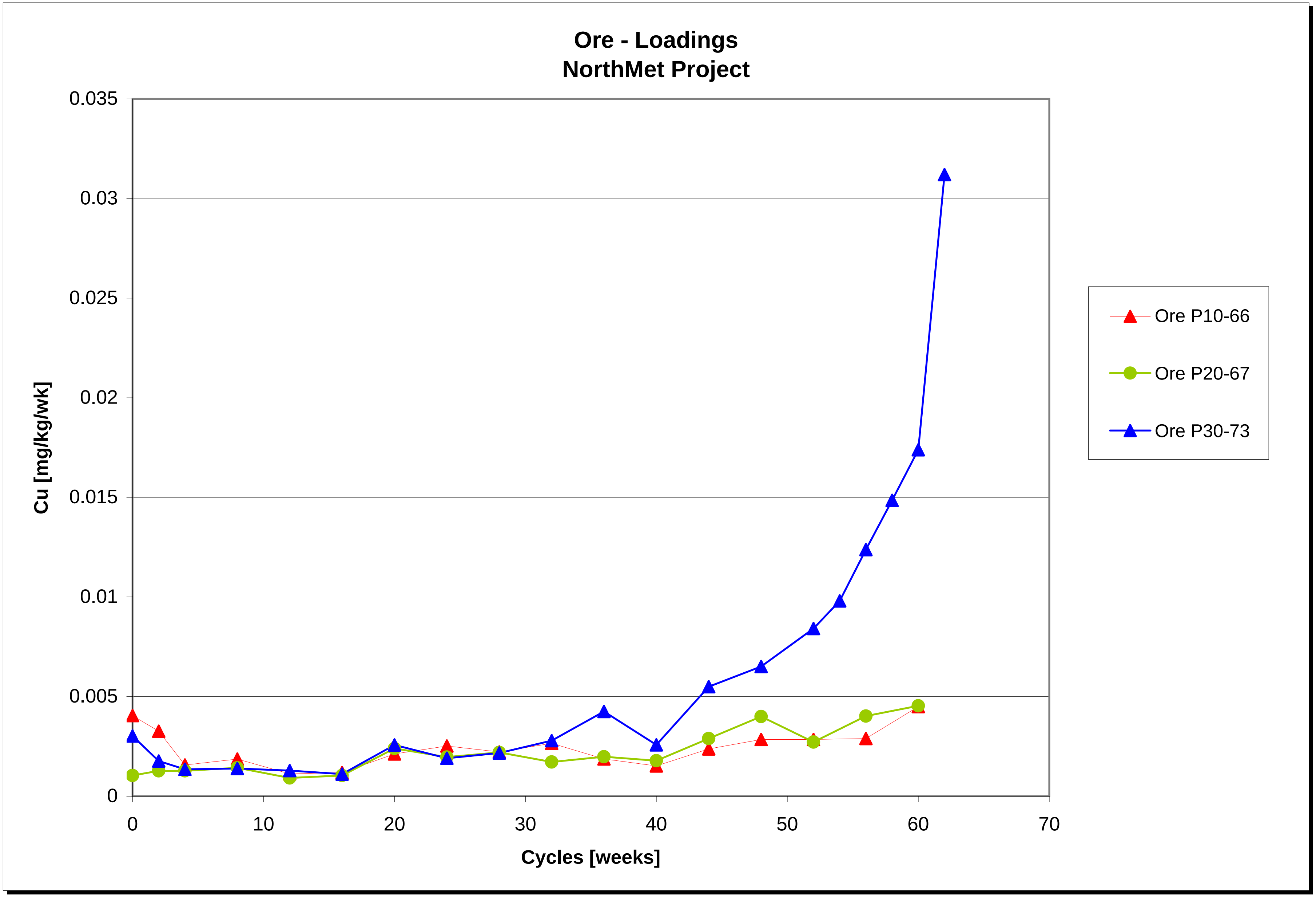

Ore - Loadings
NorthMet Project
B [mg/kg/wk]
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

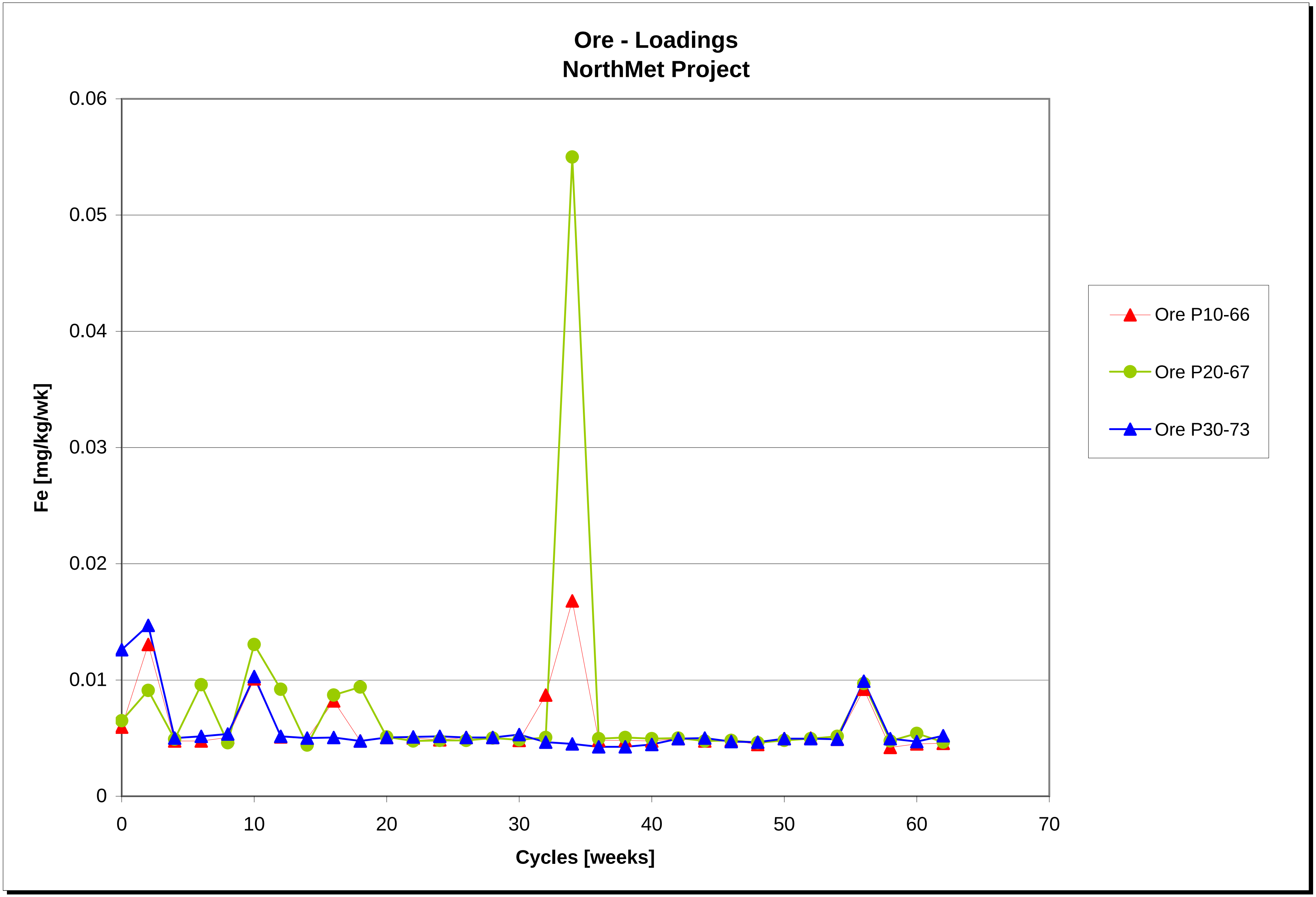

Ore - Loadings
NorthMet Project
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0
Cd [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

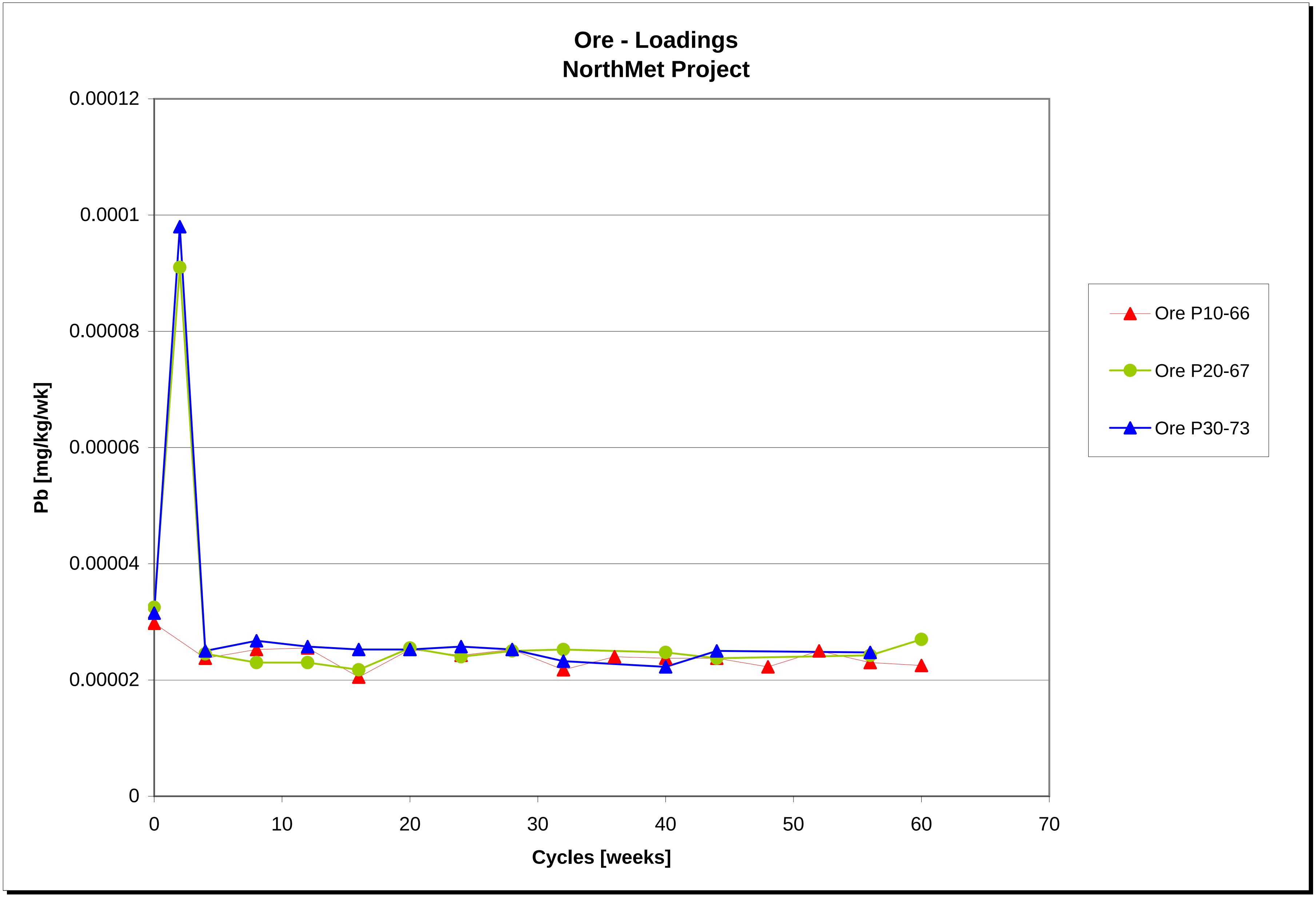

Ore - Loadings
NorthMet Project
Ca [mg/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

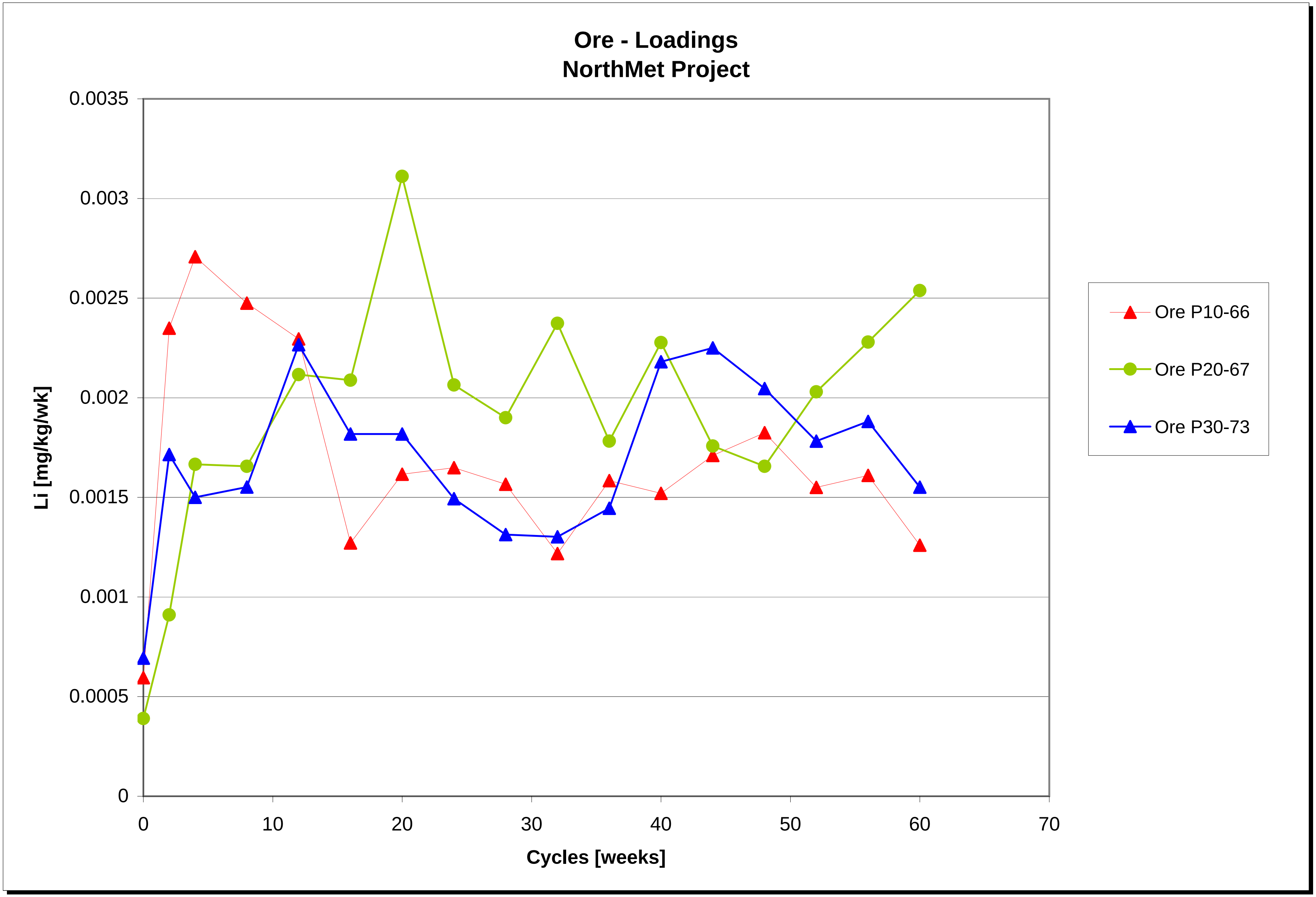

Ore - Loadings
NorthMet Project
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Cr[mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

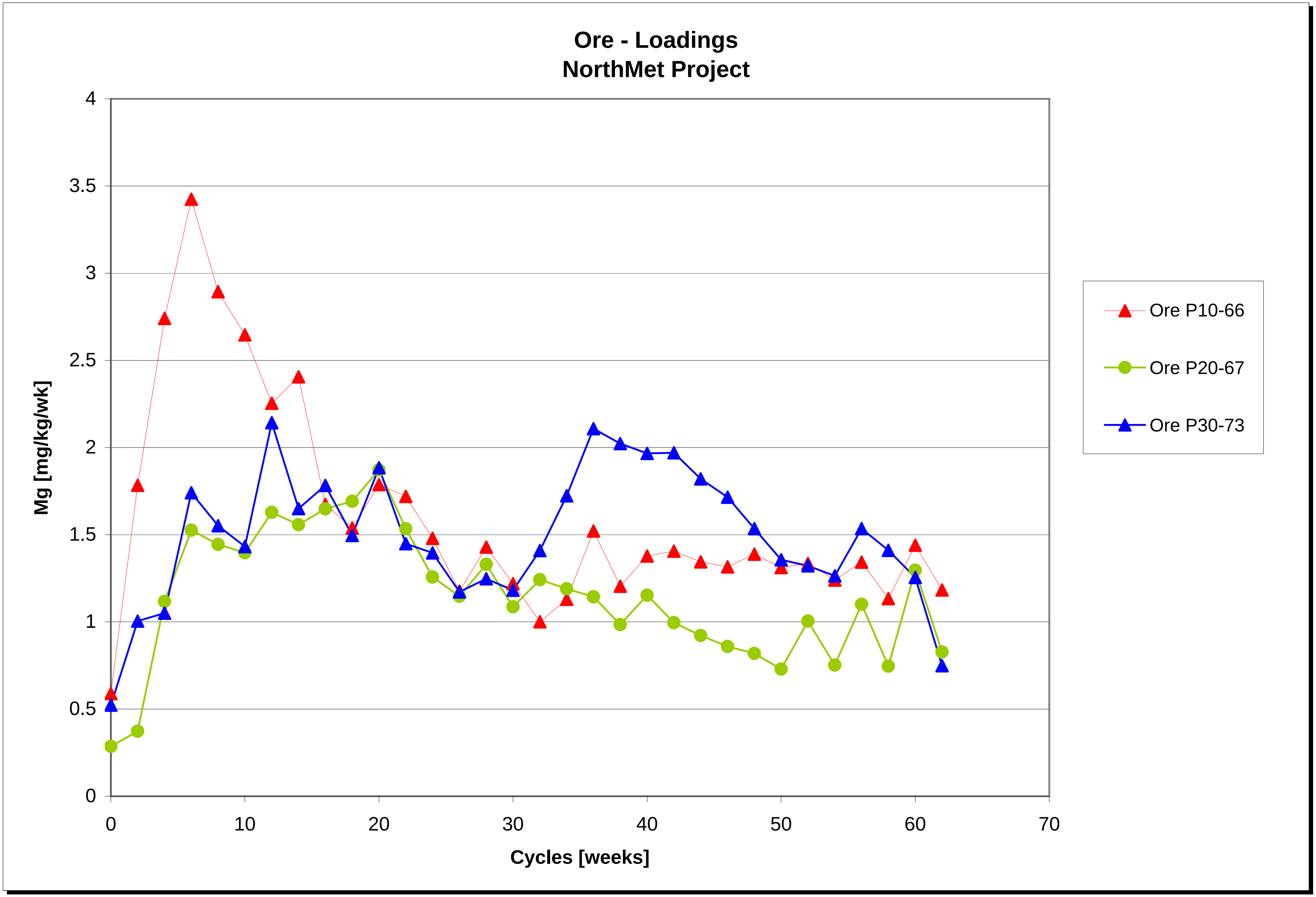

Ore - Loadings
NorthMet Project
Co [mg/kg/wk]
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

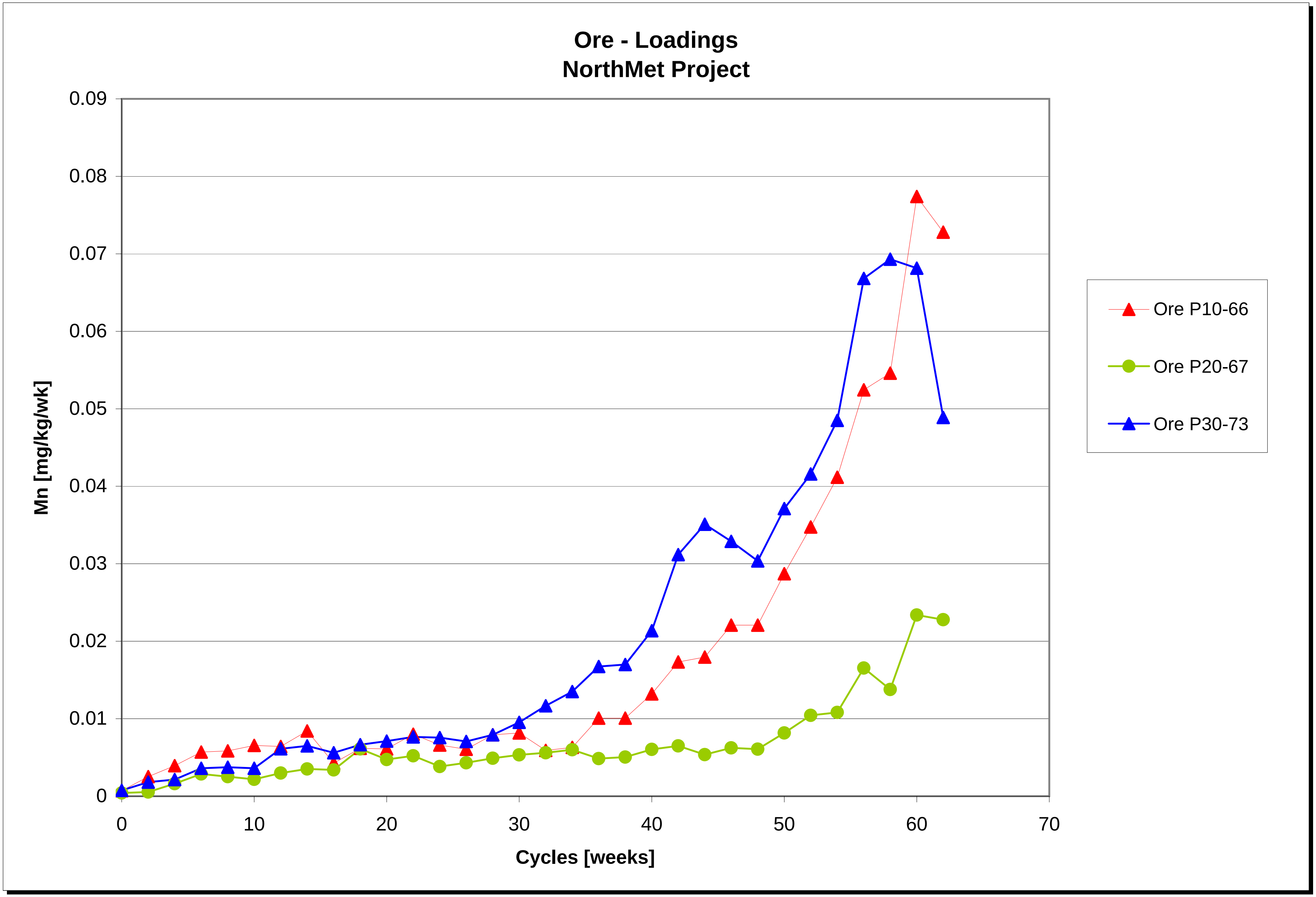

Ore - Loadings
NorthMet Project
Cu [mg/kg/wk]
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

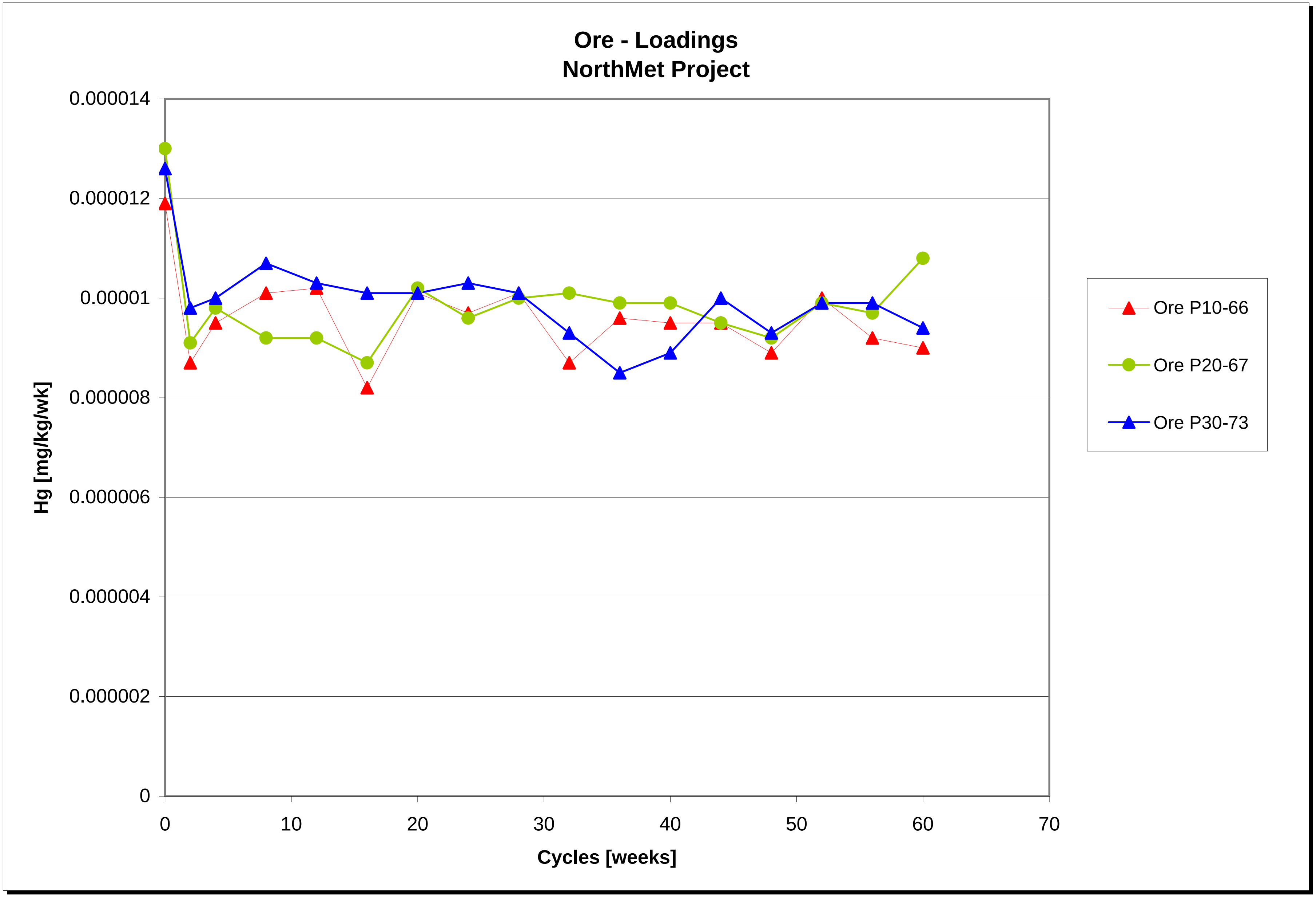

Ore - Loadings
NorthMet Project
Fe [mg/kg/wk]
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

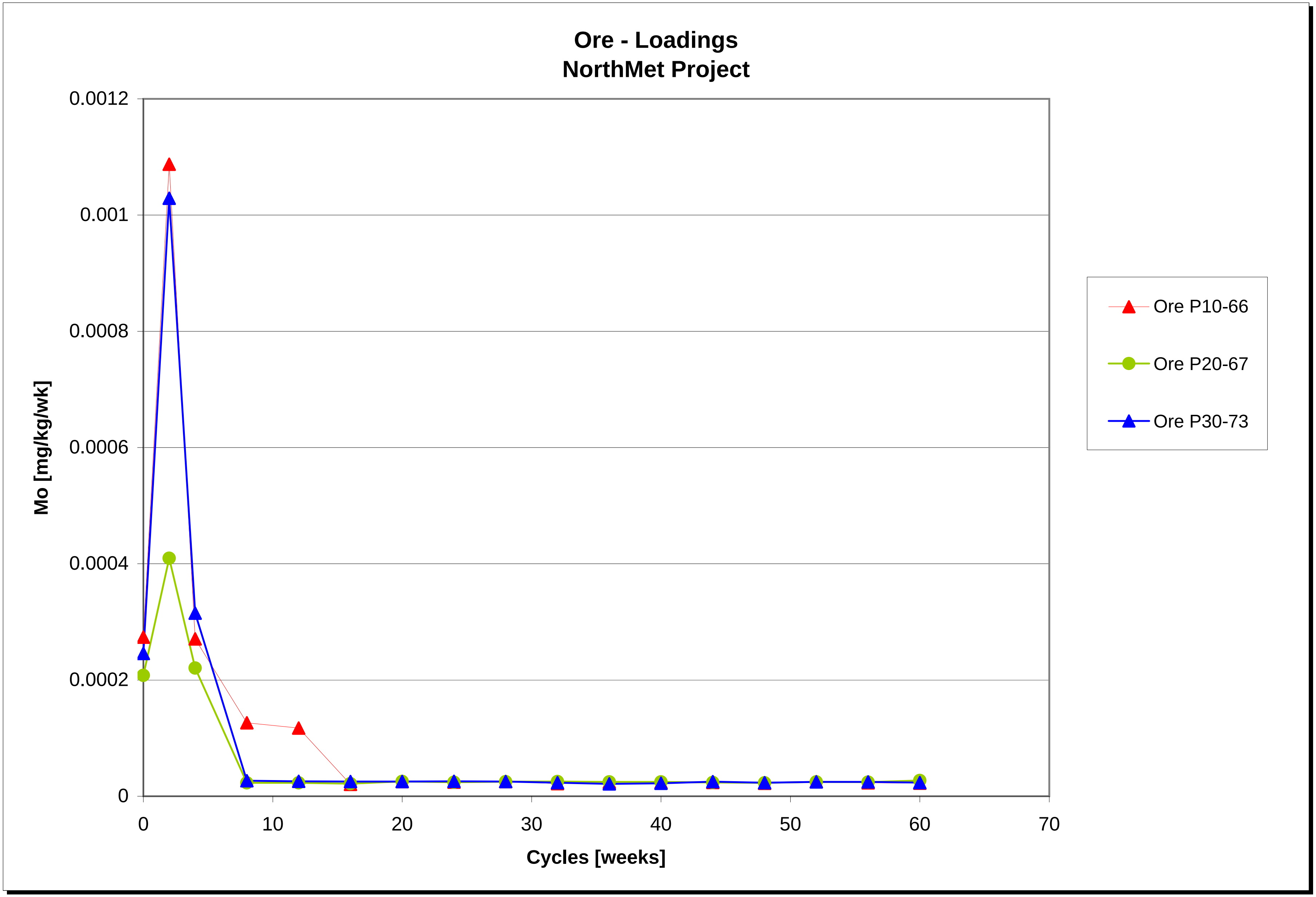

Ore - Loadings
NorthMet Project
Pb [mg/kg/wk]
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

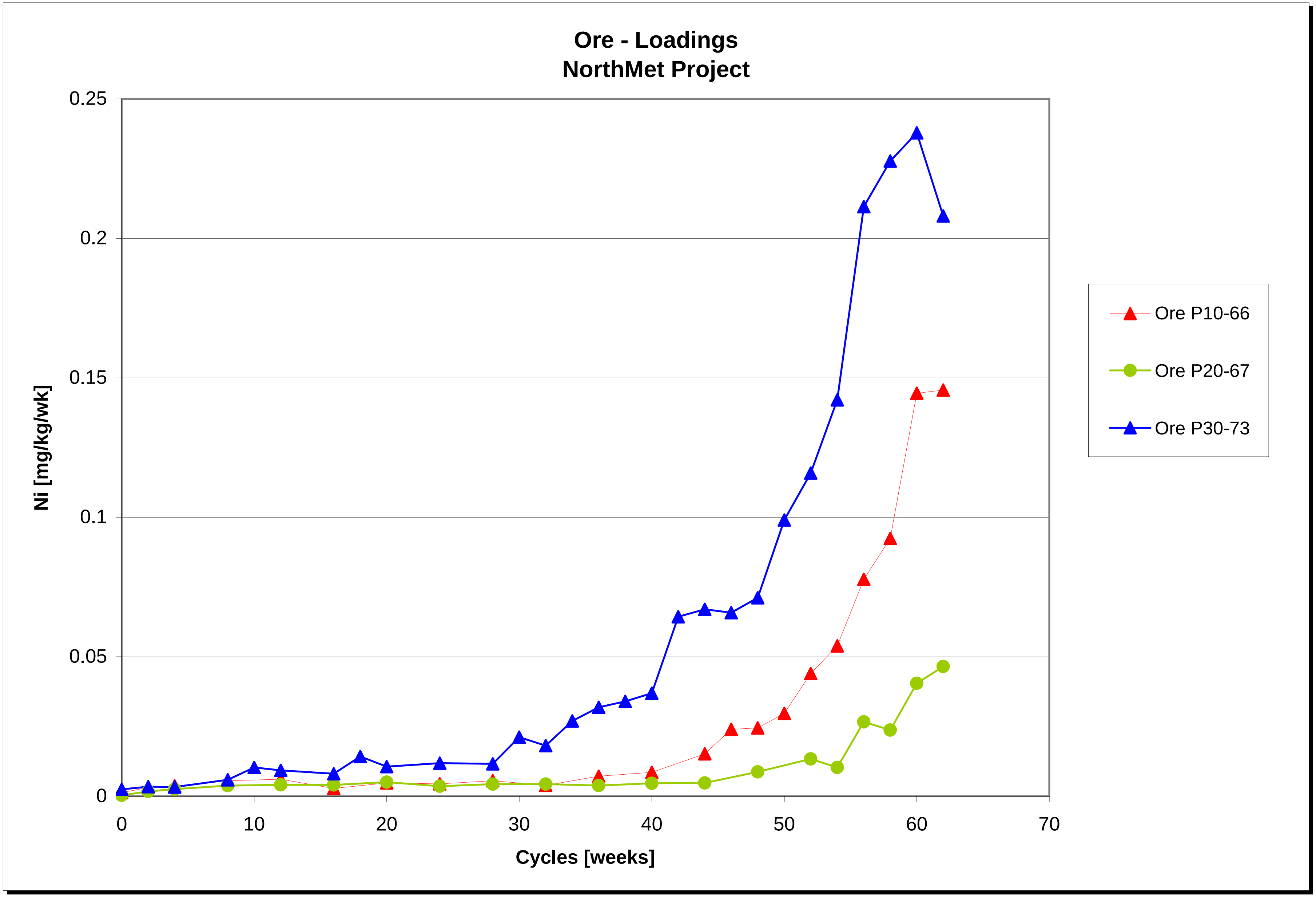

Ore - Loadings
NorthMet Project
Li [mg/kg/wk]
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

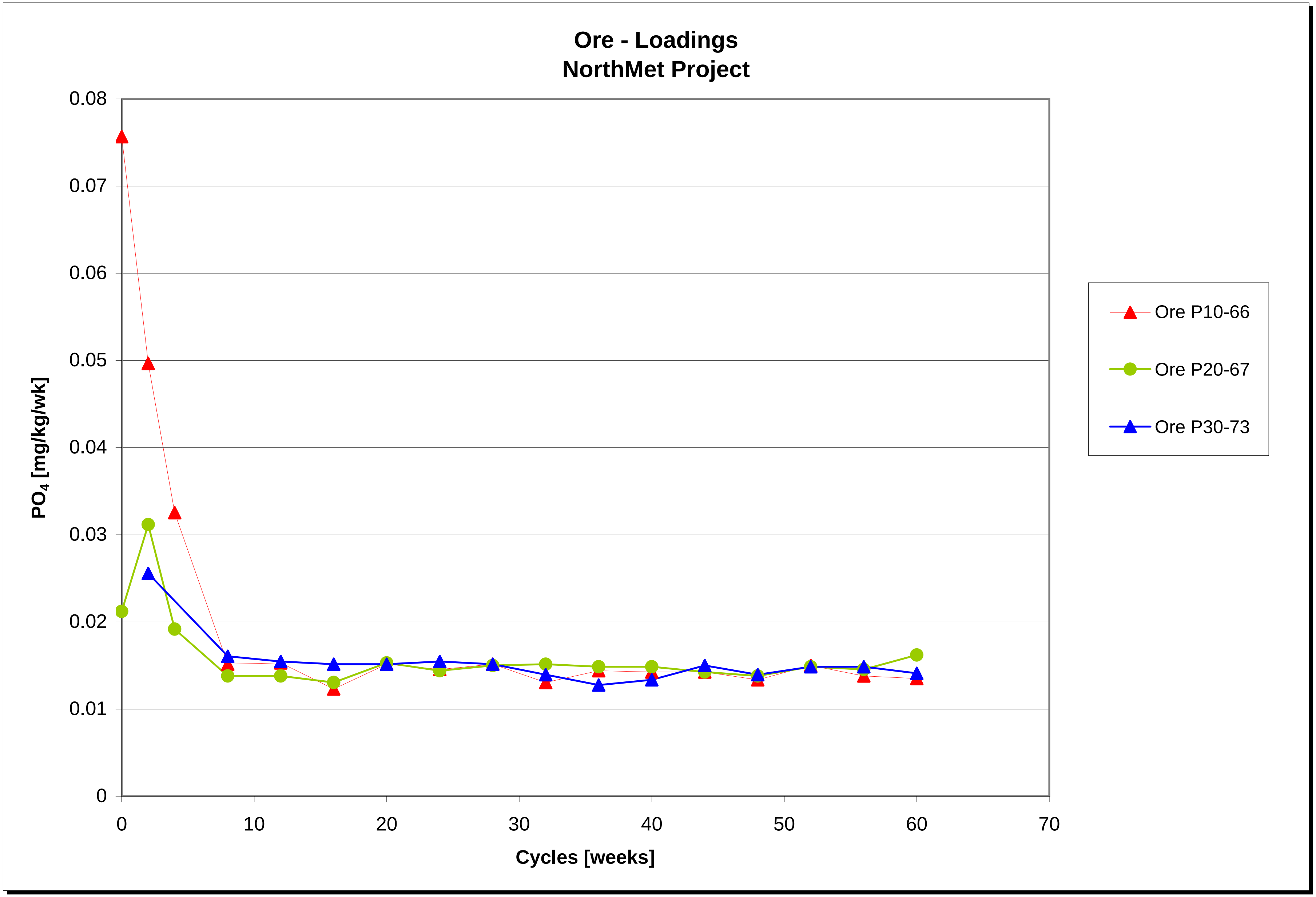

Ore - Loadings
NorthMet Project
Mg [mg/kg/wk]
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73
0
0.5
1
1.5
2
2.5
3
3.5
4
0
10
20
30
40
50
60
70

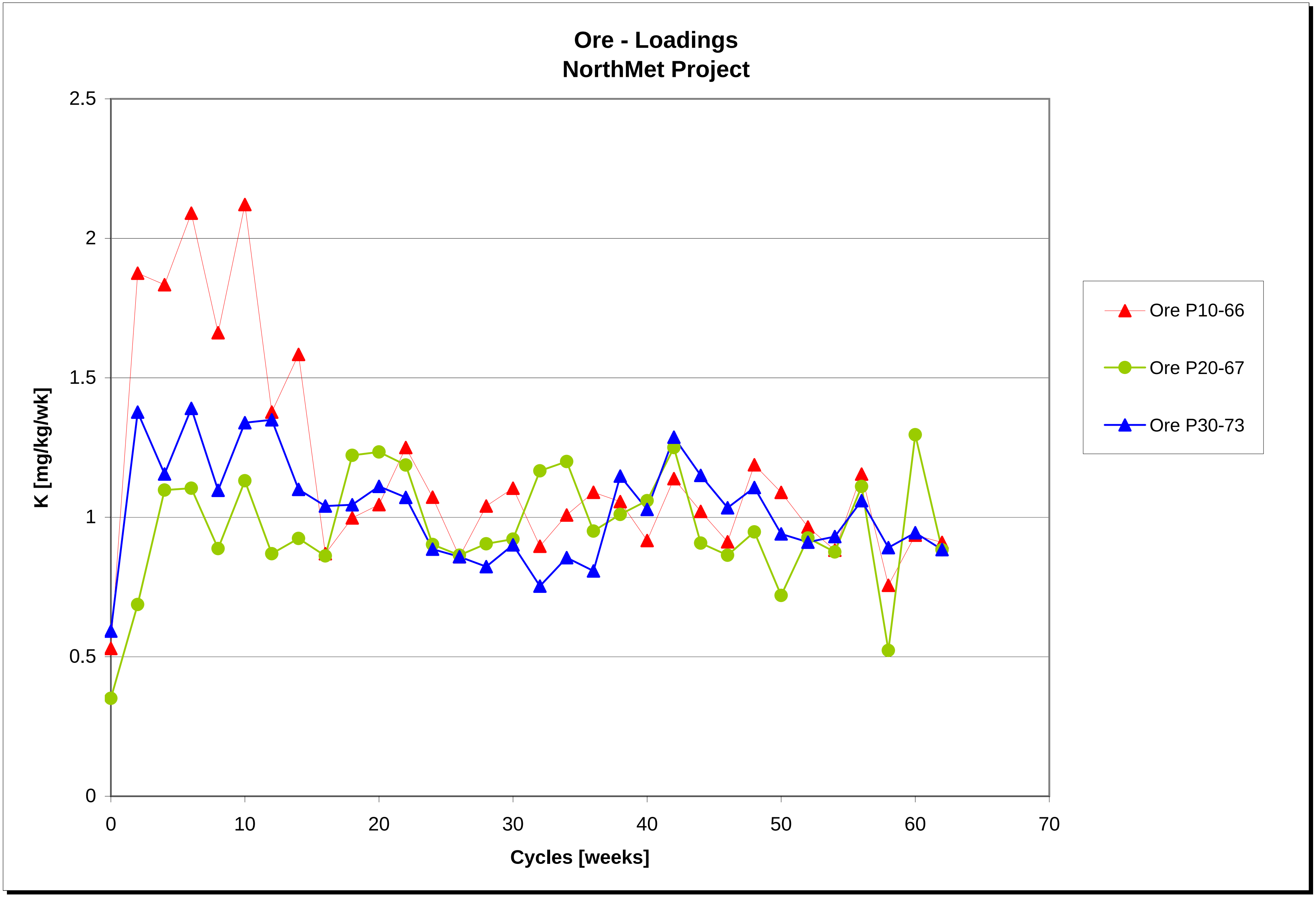

Ore - Loadings
NorthMet Project
Mn [mg/kg/wk]
Cycles [weeks]
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

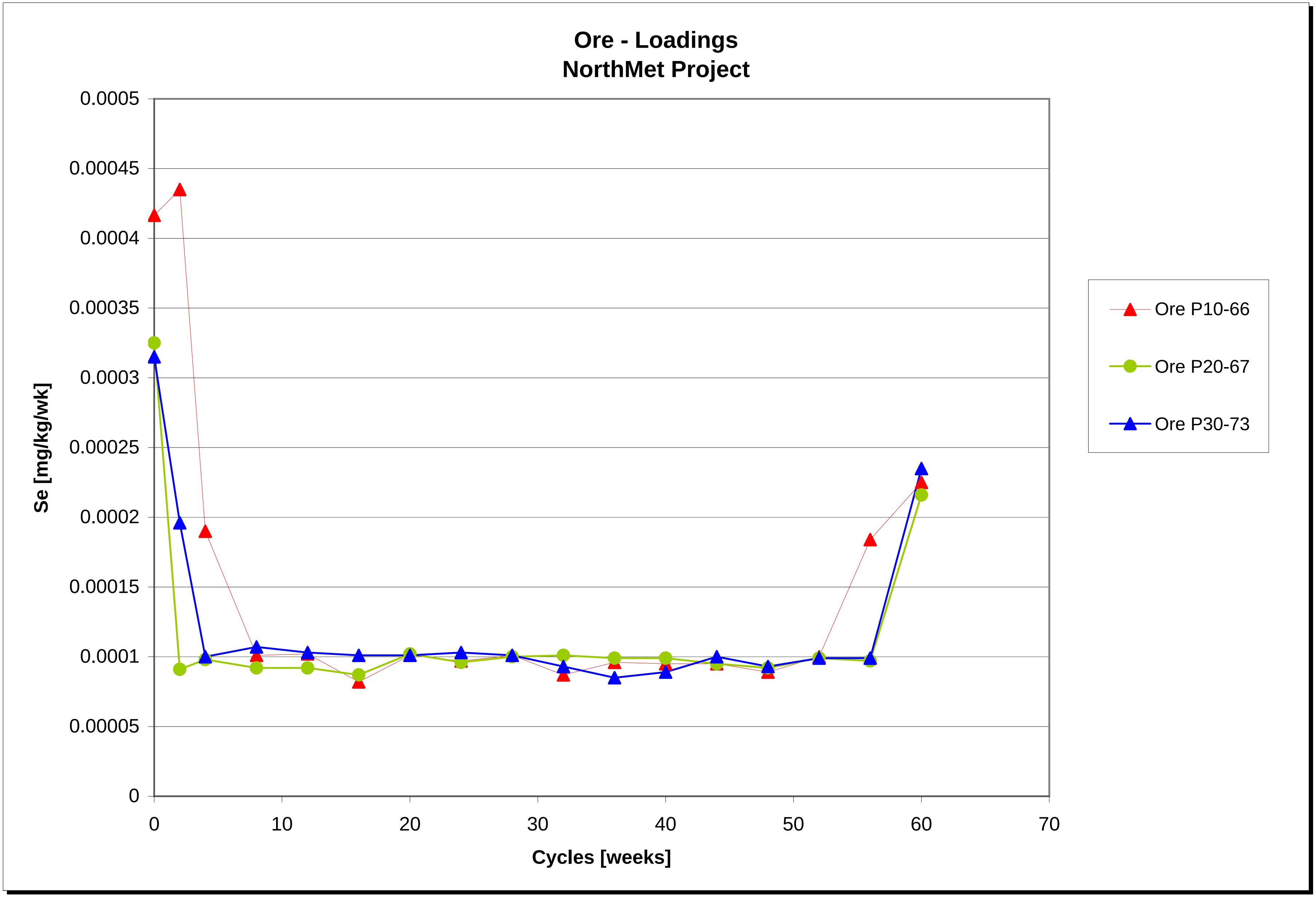

Ore - Loadings
NorthMet Project
Hg [mg/kg/wk]
0.000014
0.000012
0.00001
0.000008
0.000006
0.000004
0.000002
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

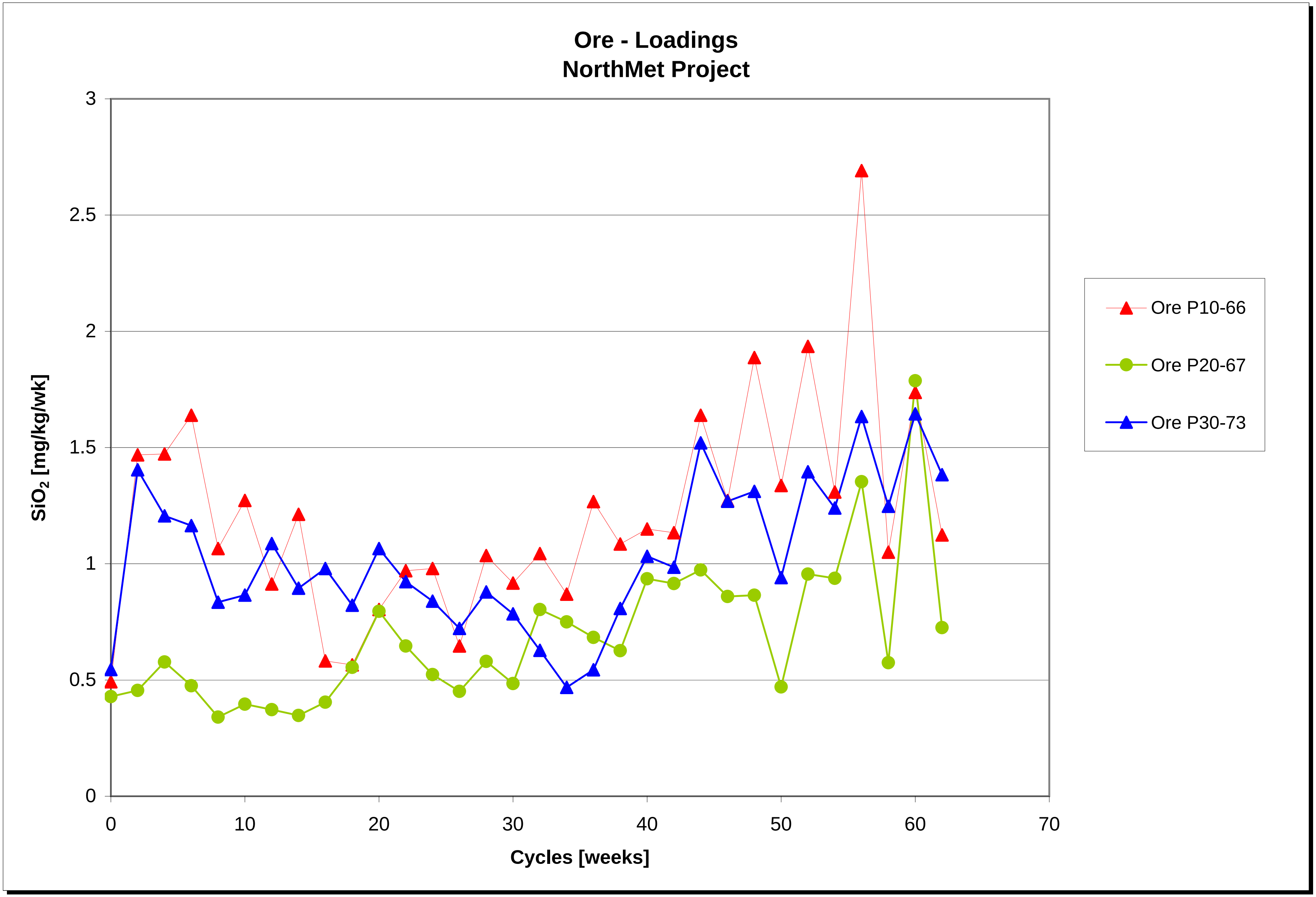

Ore - Loadings
NorthMet Project
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Mo [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

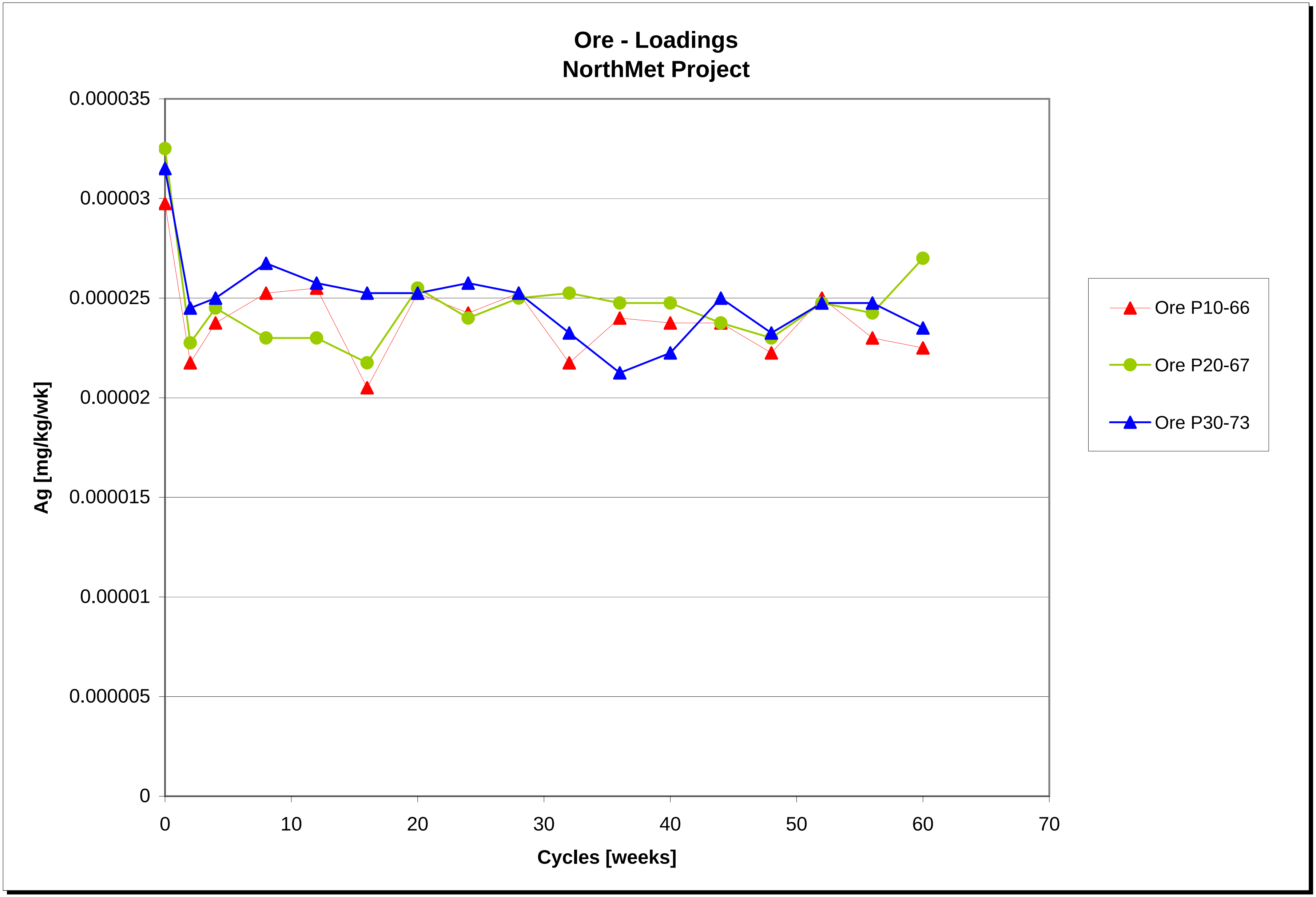

Ore - Loadings
NorthMet Project
Ni [mg/kg/wk]
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

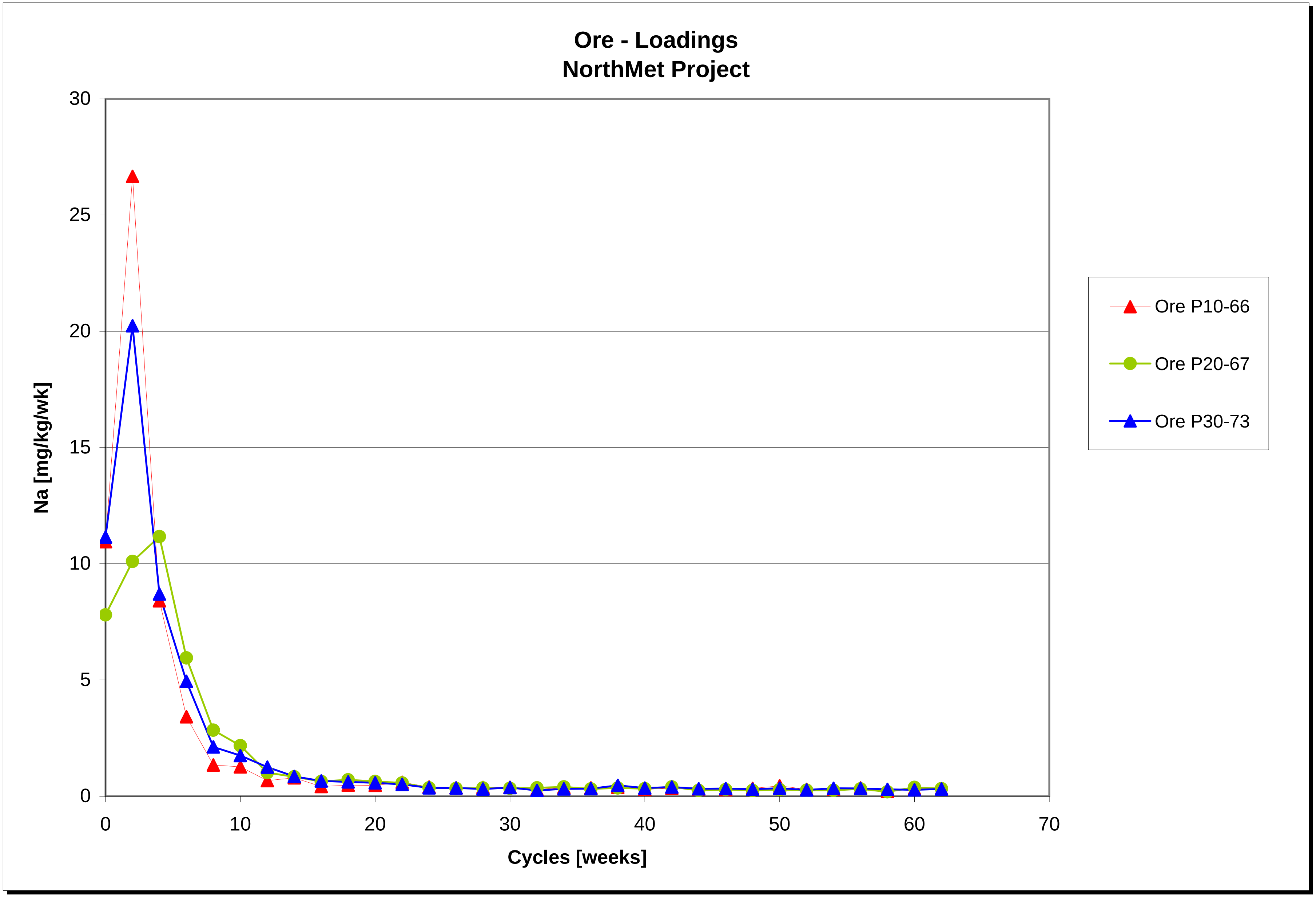

Ore - Loadings
NorthMet Project
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
PO_4 [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

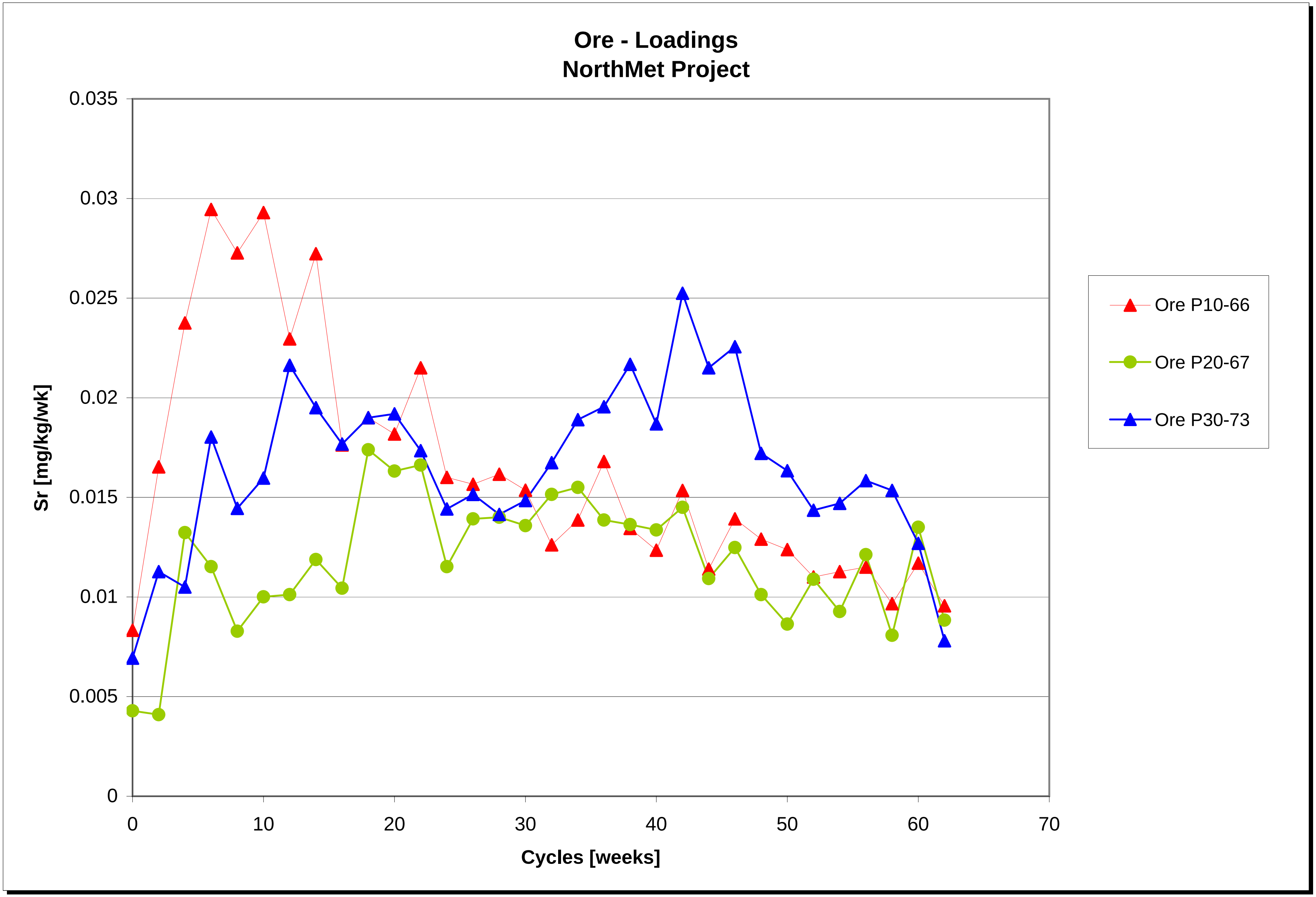

Ore - Loadings
NorthMet Project
K [mg/kg/wk]
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73
0
0.5
1
1.5
2
2.5
0
10
20
30
40
50
60
70

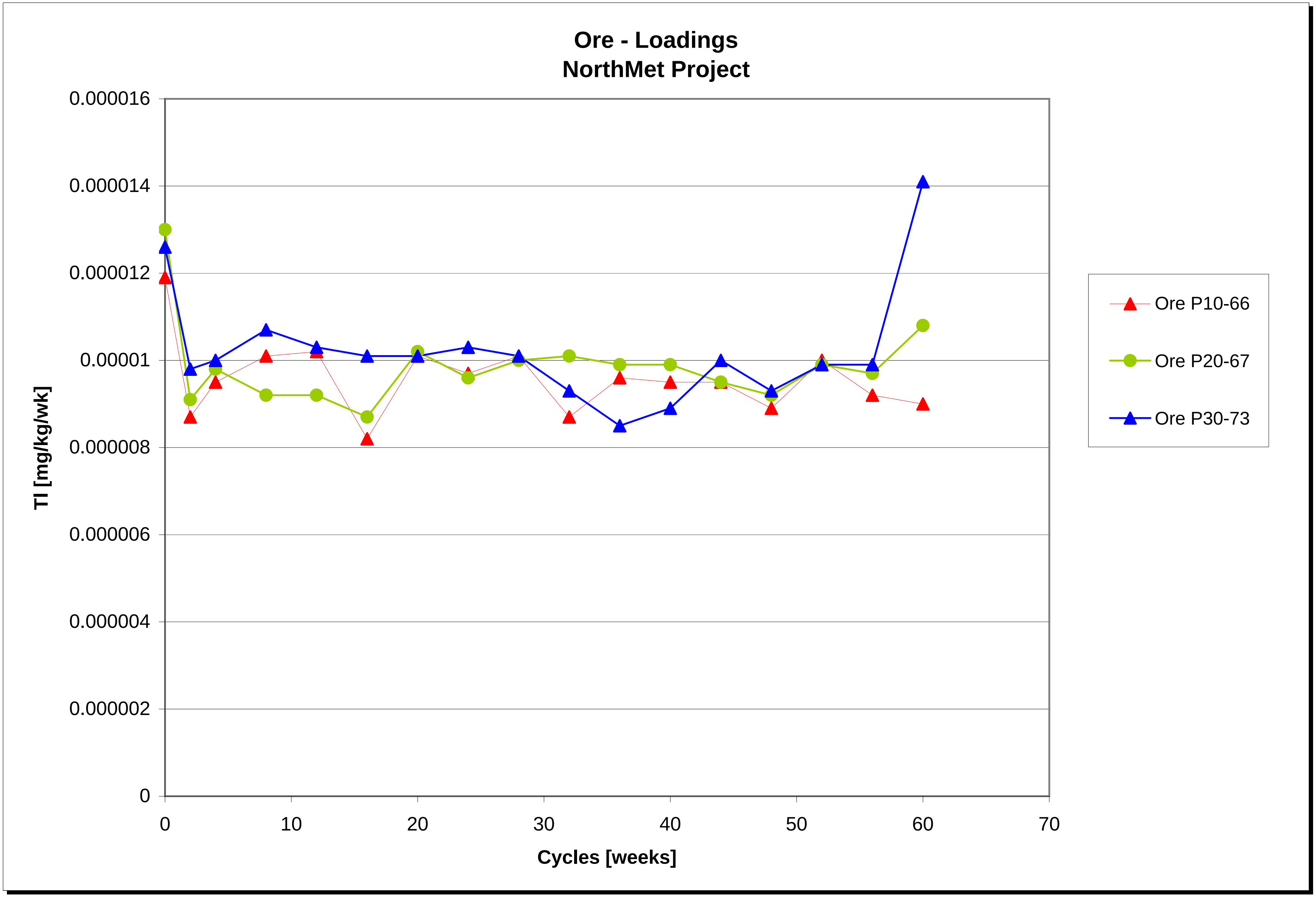

Ore - Loadings
NorthMet Project
Se [mg/kg/wk]
0.0005
0.00045
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

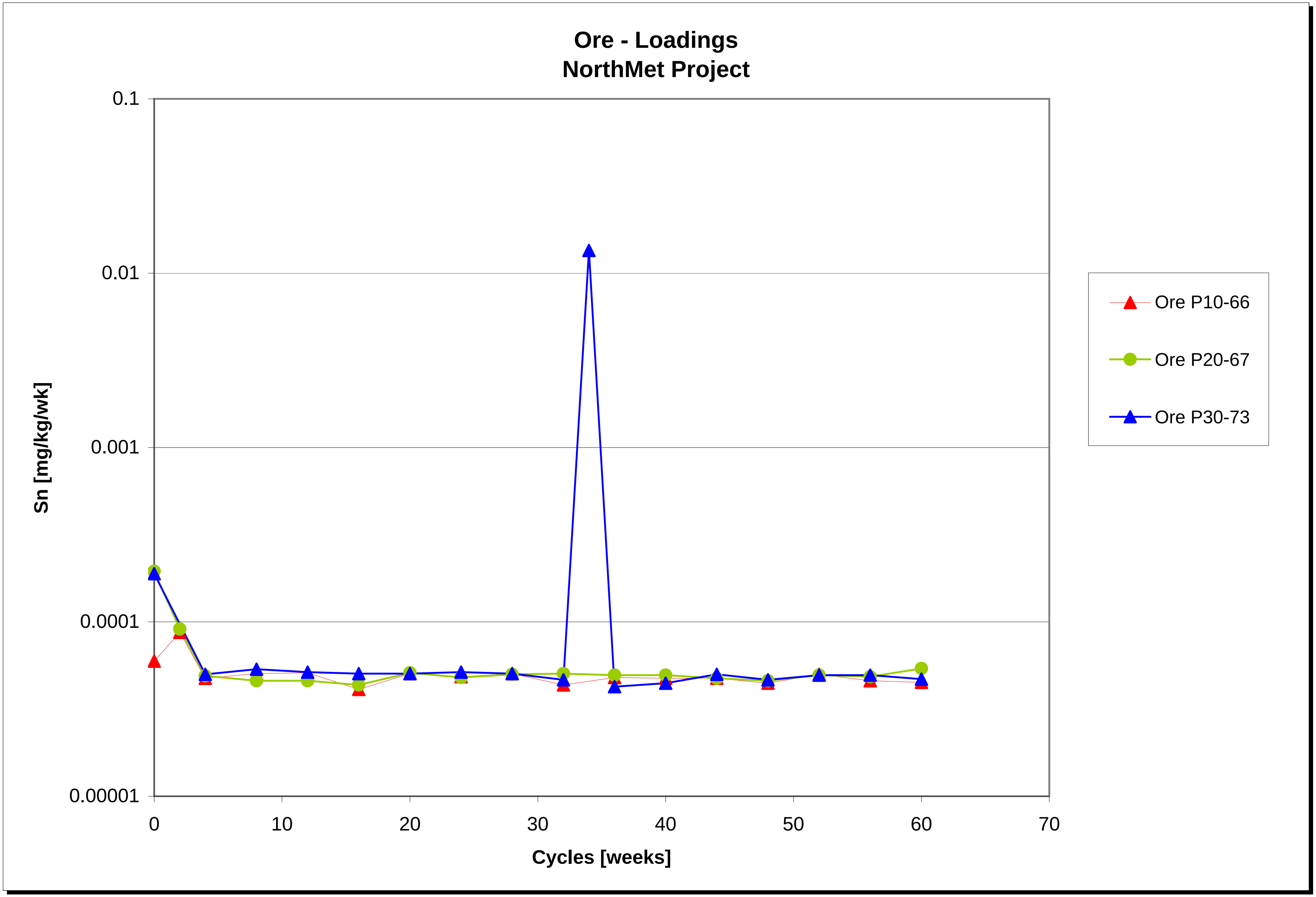

Ore - Loadings
NorthMet Project
SiO2 [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73

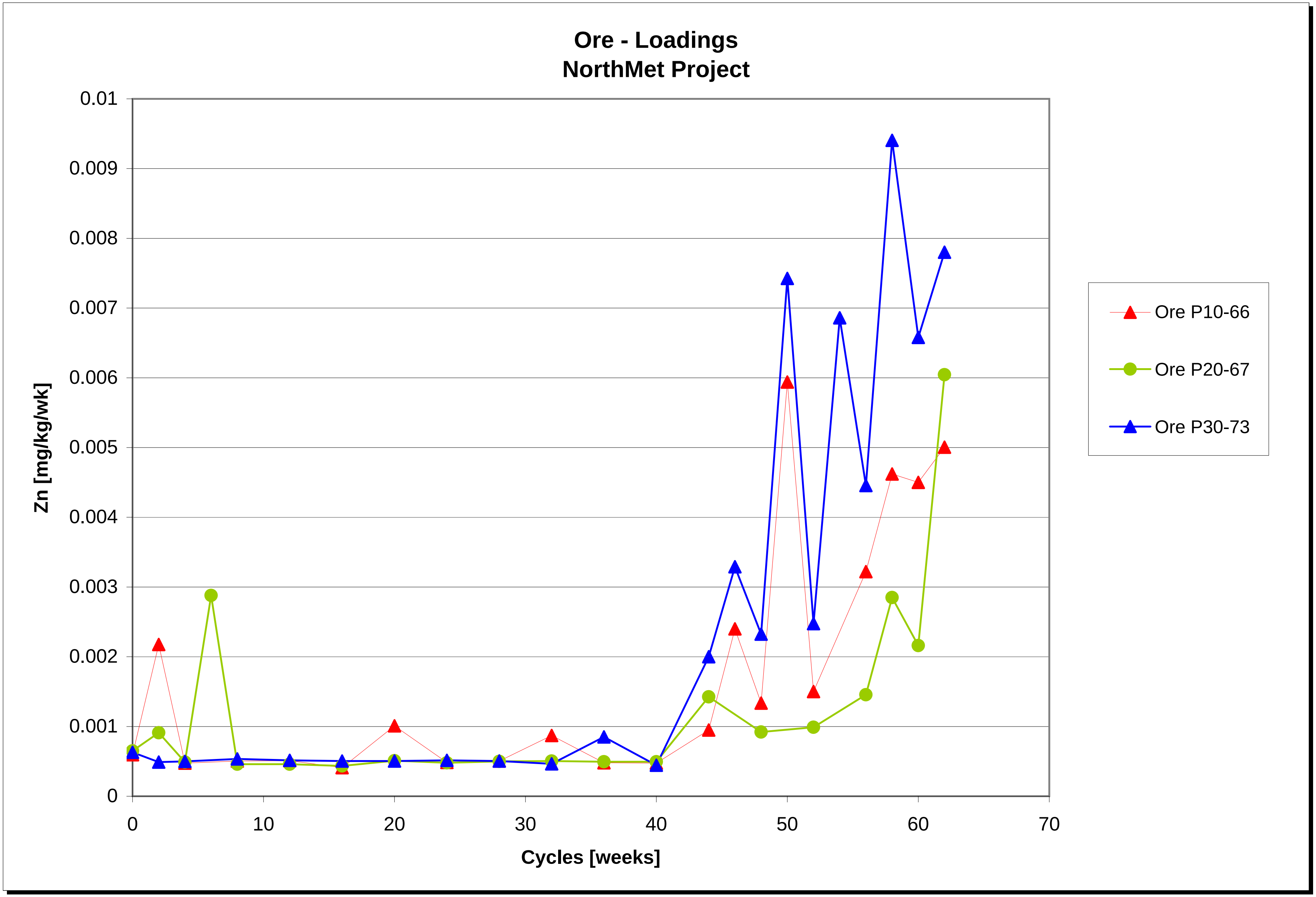

Ore - Loadings
NorthMet Project
Ag [mg/kg/wk]
0.000035
0.00003
0.000025
0.00002
0.000015
0.00001
0.000005
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73


Ore - Loadings
NorthMet Project
Na [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
Ore P10-66
Ore P20-67
Ore P30-73


Ore - Loadings
NorthMet Project
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Sr [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

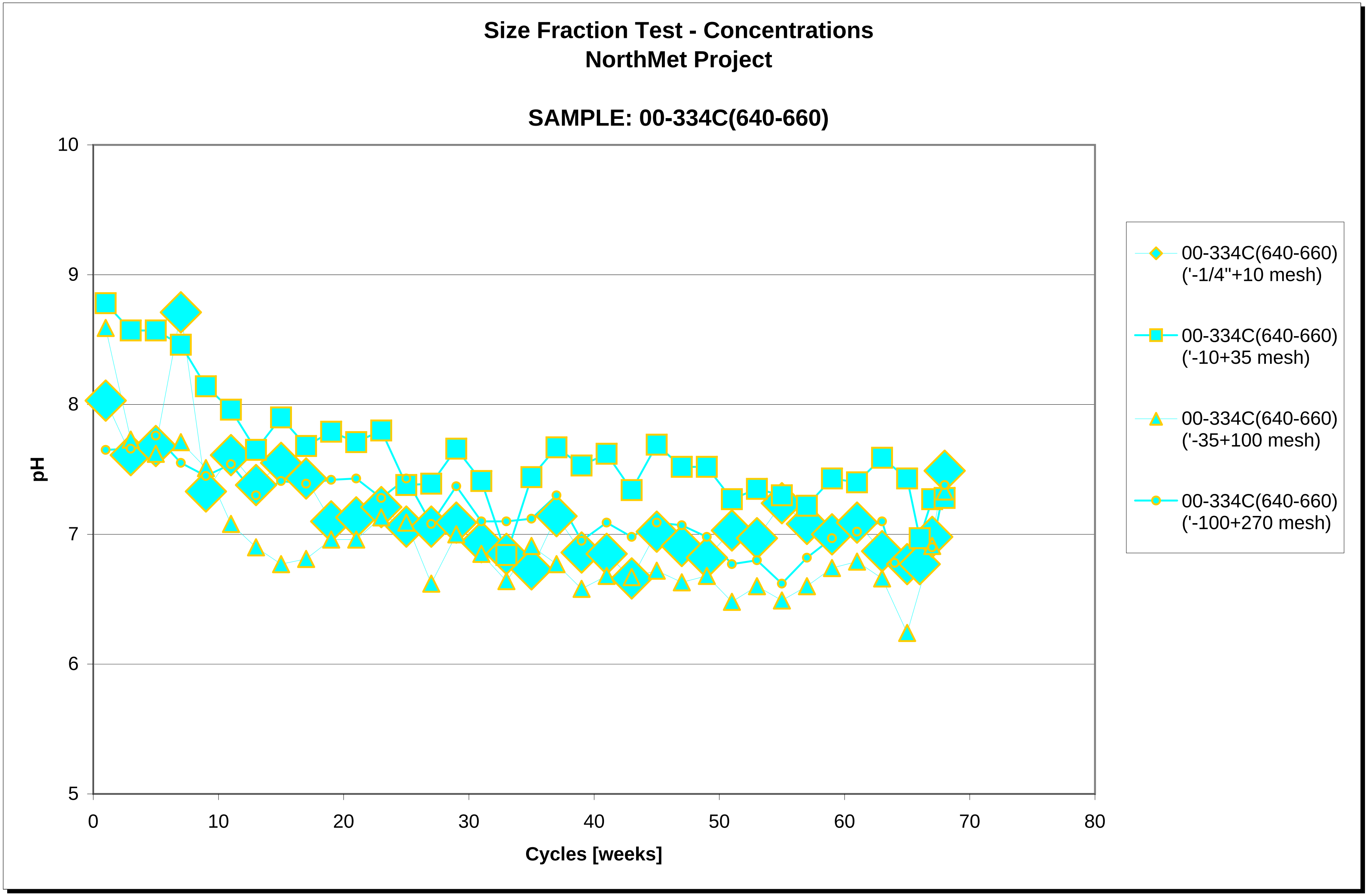

Ore - Loadings
NorthMet Project
0.000016
0.000014
0.000012
0.00001
0.000008
0.000006
0.000004
0.000002
0
Tl [mg/kg/wk]
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

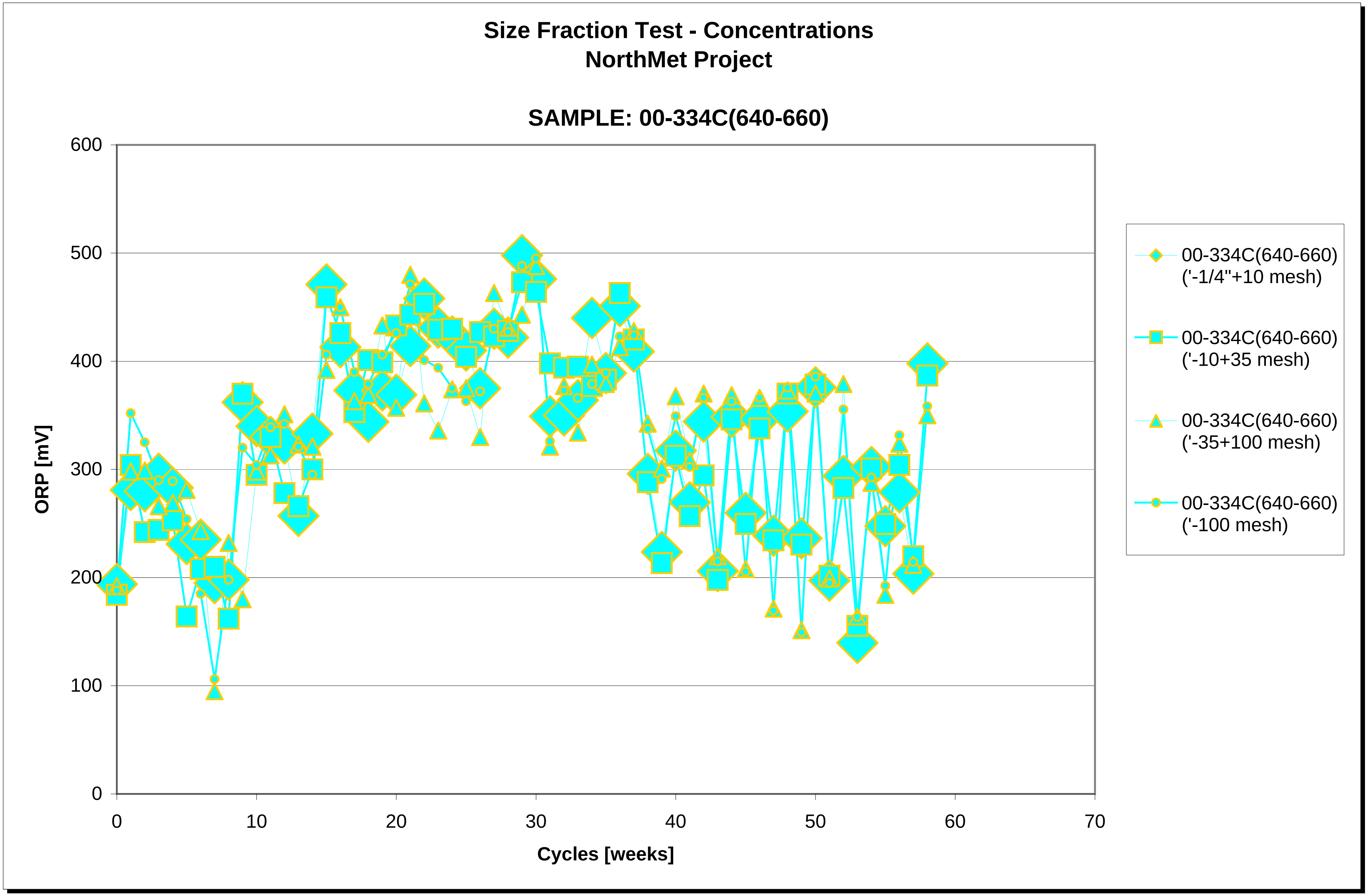

Ore - Loadings
NorthMet Project
Sn [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

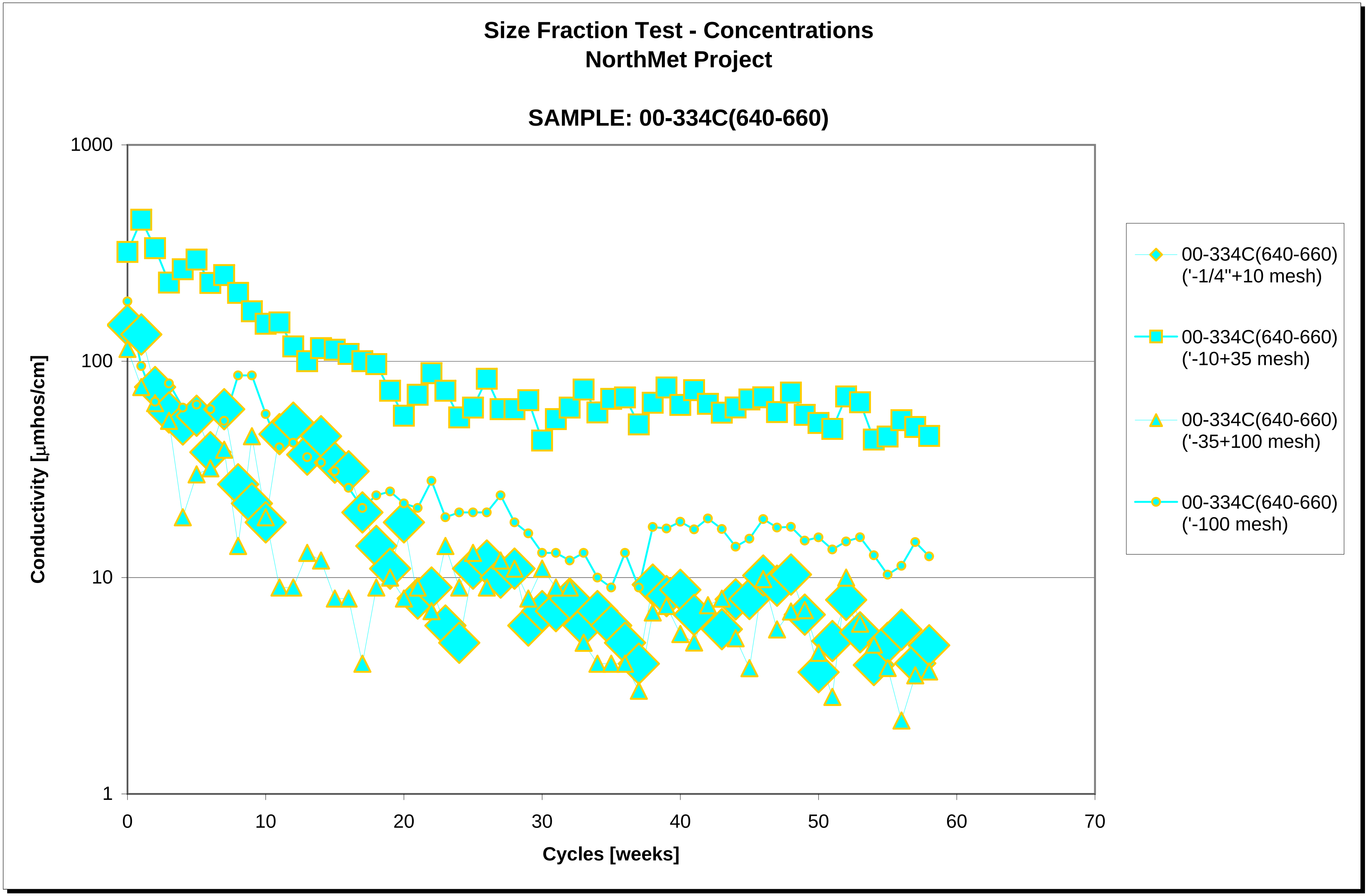

Ore - Loadings
NorthMet Project
Zn [mg/kg/wk]
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
Cycles [weeks]
Ore P10-66
Ore P20-67
Ore P30-73

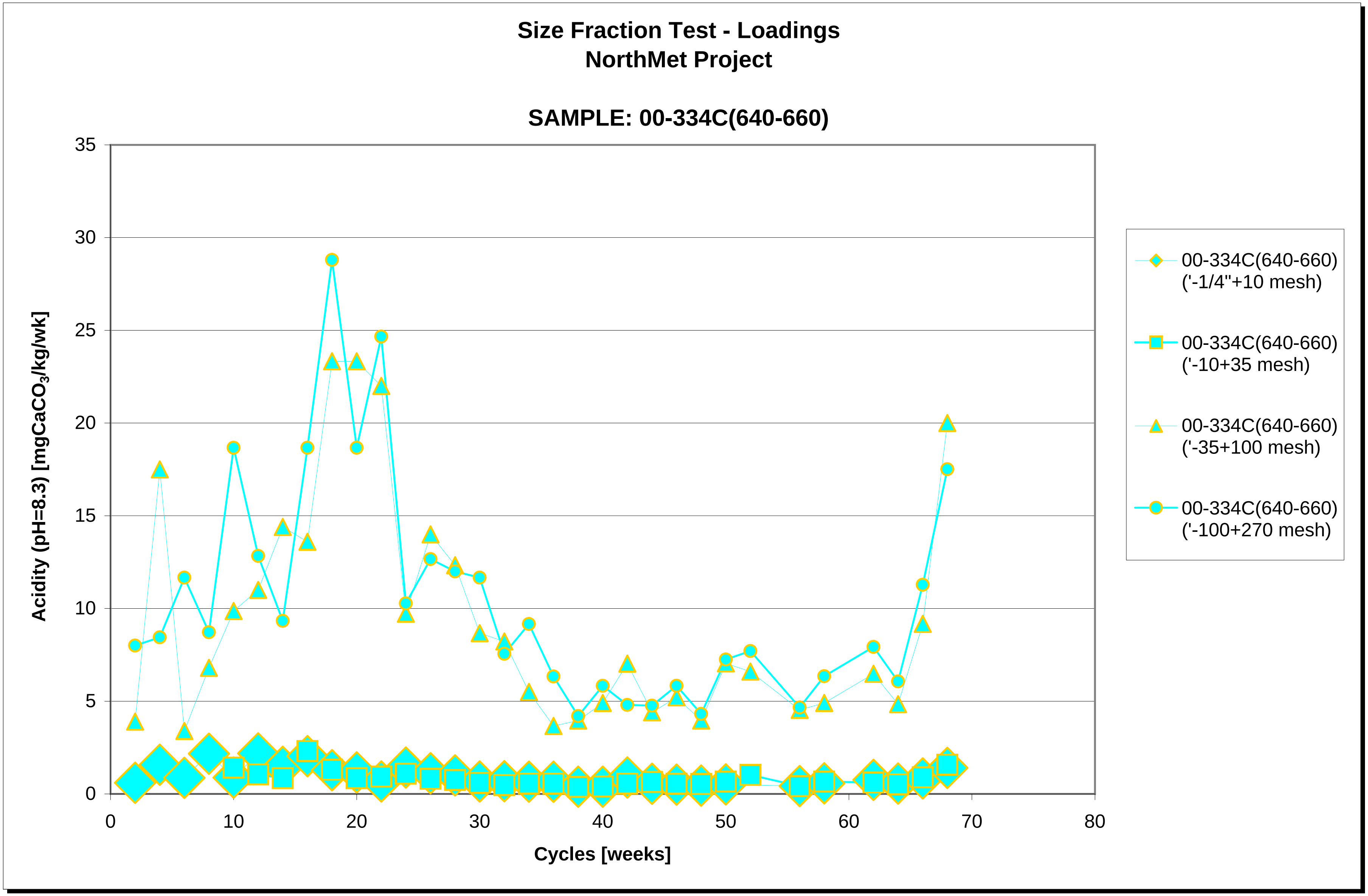
Appendix F

Charts of Dissolution Testwork Results (Size Fraction Tests)


Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-334C(640-660)
pH
10
9
8
7
6
5
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-334C(640-660)
ORP [mV]
Cycles [weeks]
0
100
200
300
400
500
600
0
10
20
30
40
50
60
70
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100 mesh)


Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-334C(640-660)
Conductivity [µmhos/cm]
1000
100
10
1
0
10
20
30
40
50
60
70
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100 mesh)

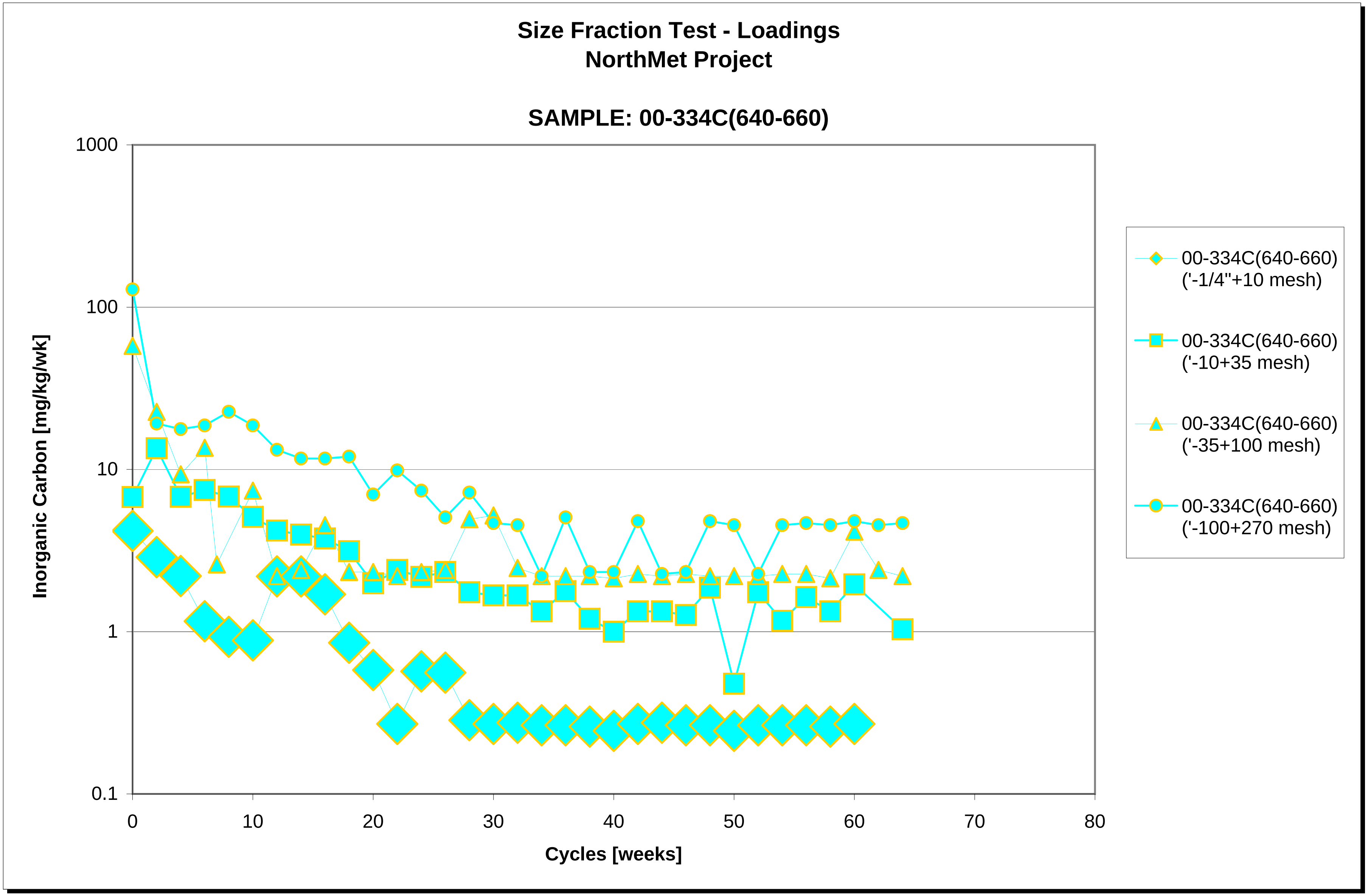

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

Appendix F.1
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-334C(640-660)

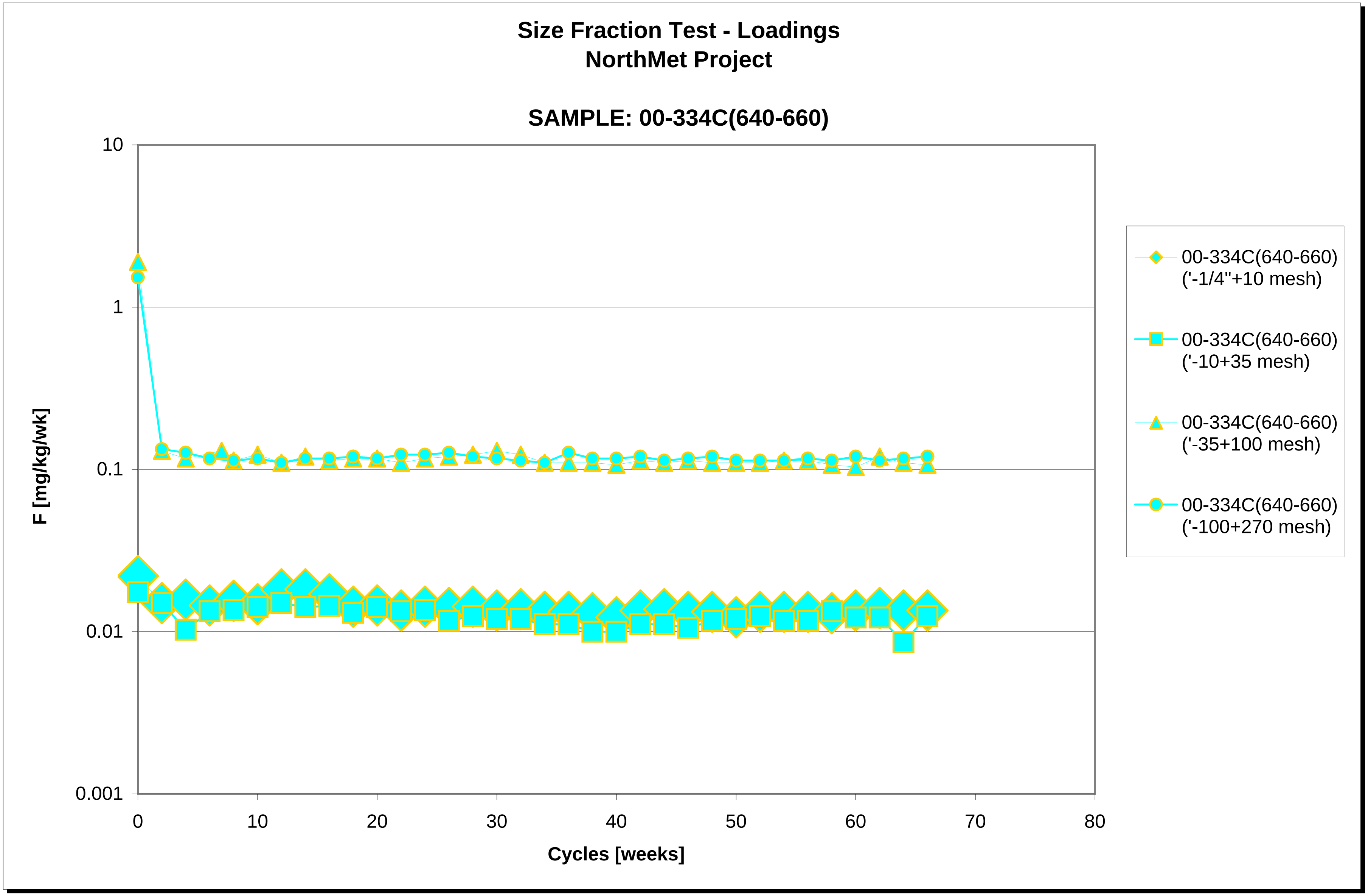
Chart F.1.5

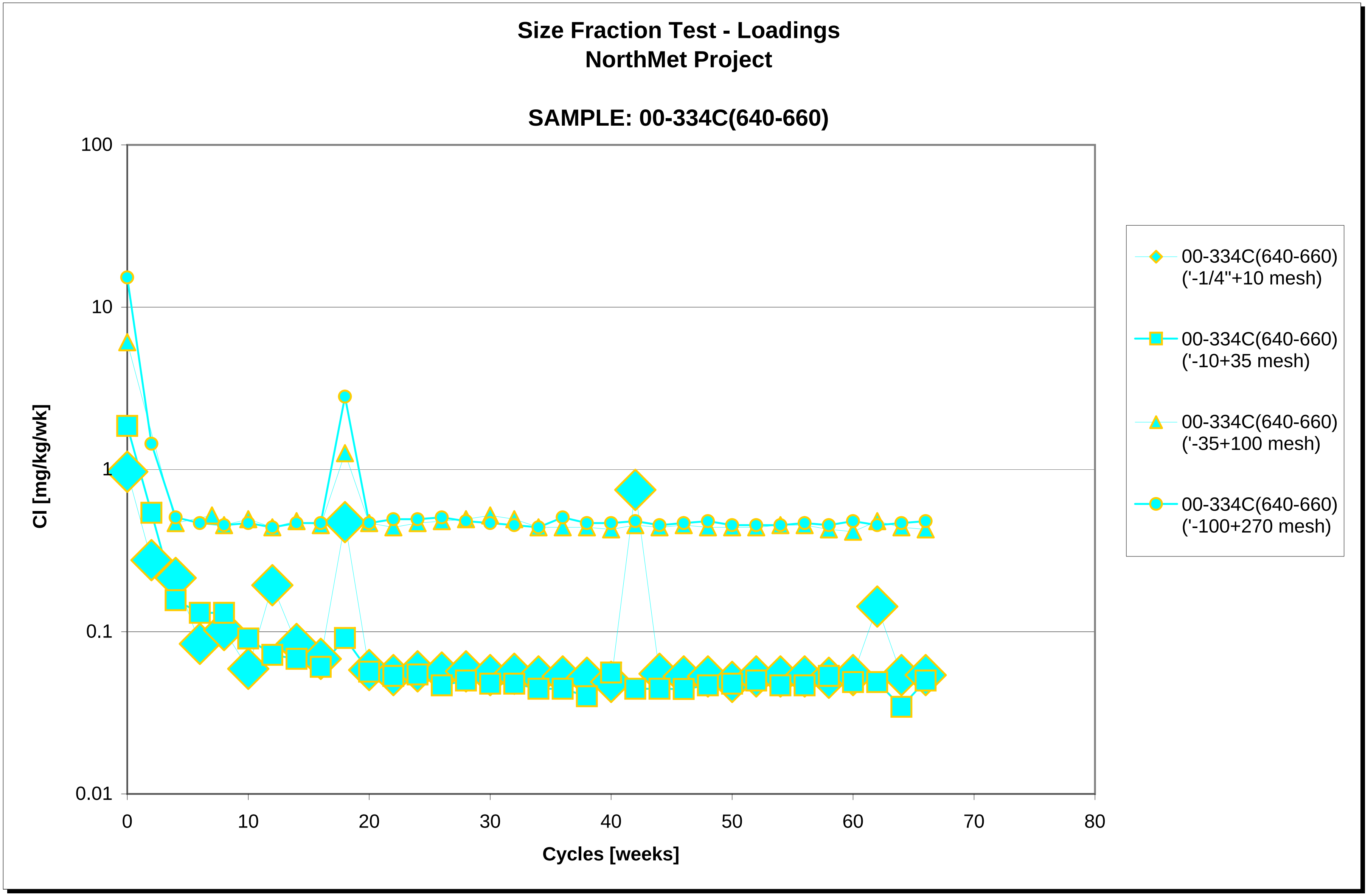
Appendix F.1
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-334C(640-660)

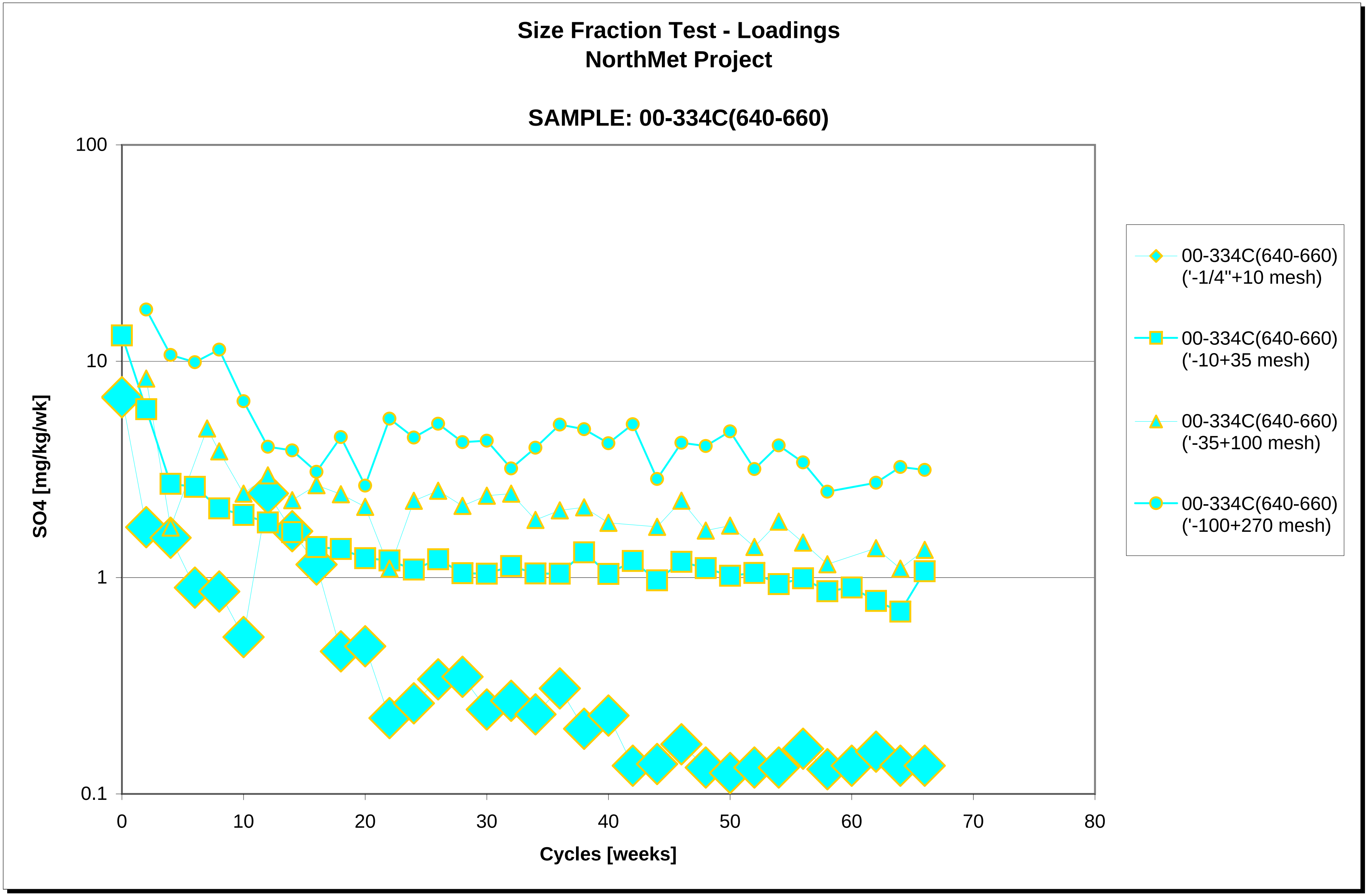
Chart F.1.6




Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Hardness [mgCaCO3/kg/wk]
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
10
1
0.1
0.01
0.001
F [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

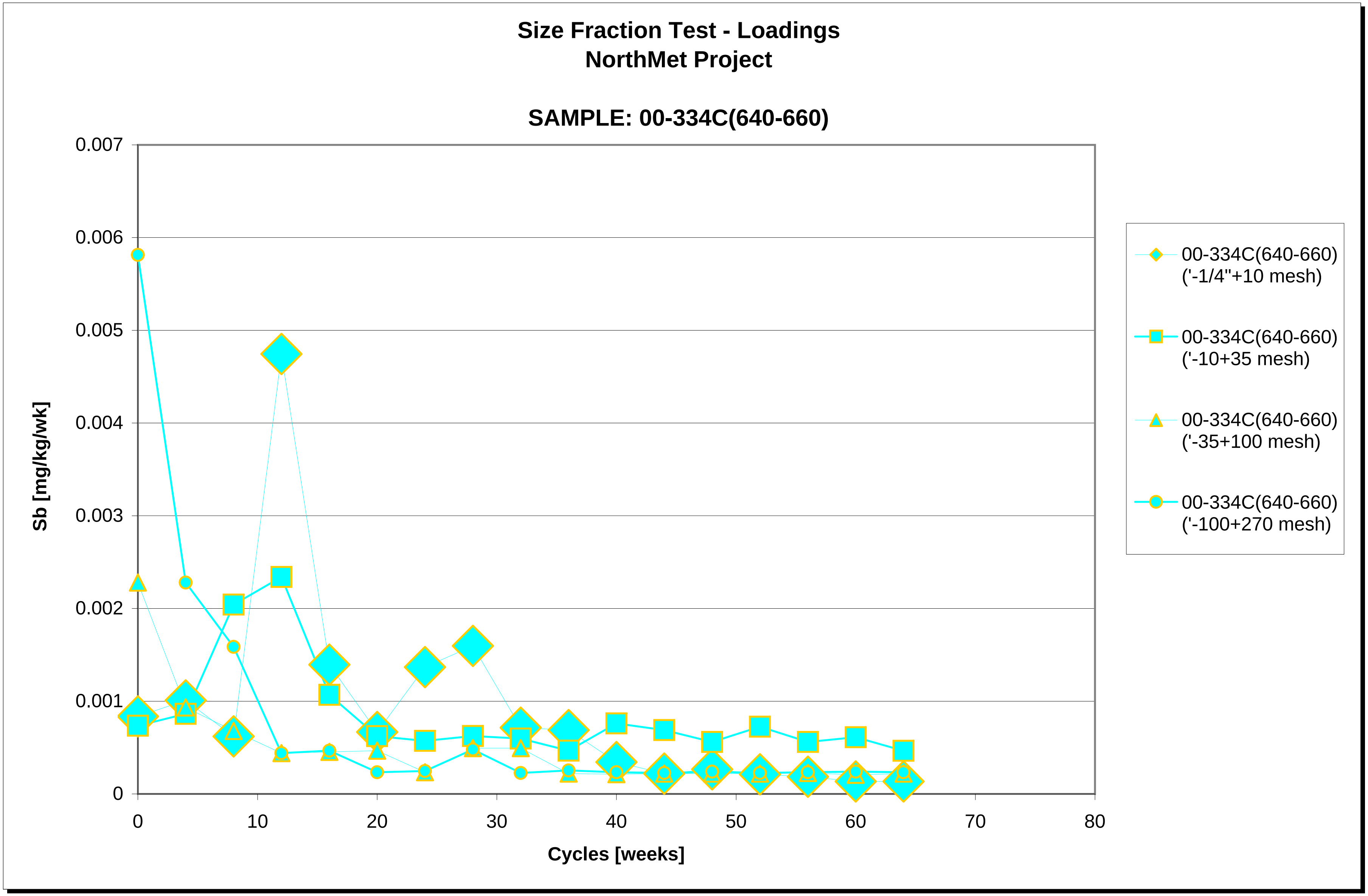

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Cl [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
SO4 [mg/kg/wk]
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
10
1
0.1
0.01
0.001
Al [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

Appendix F.1
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-334C(640-660)

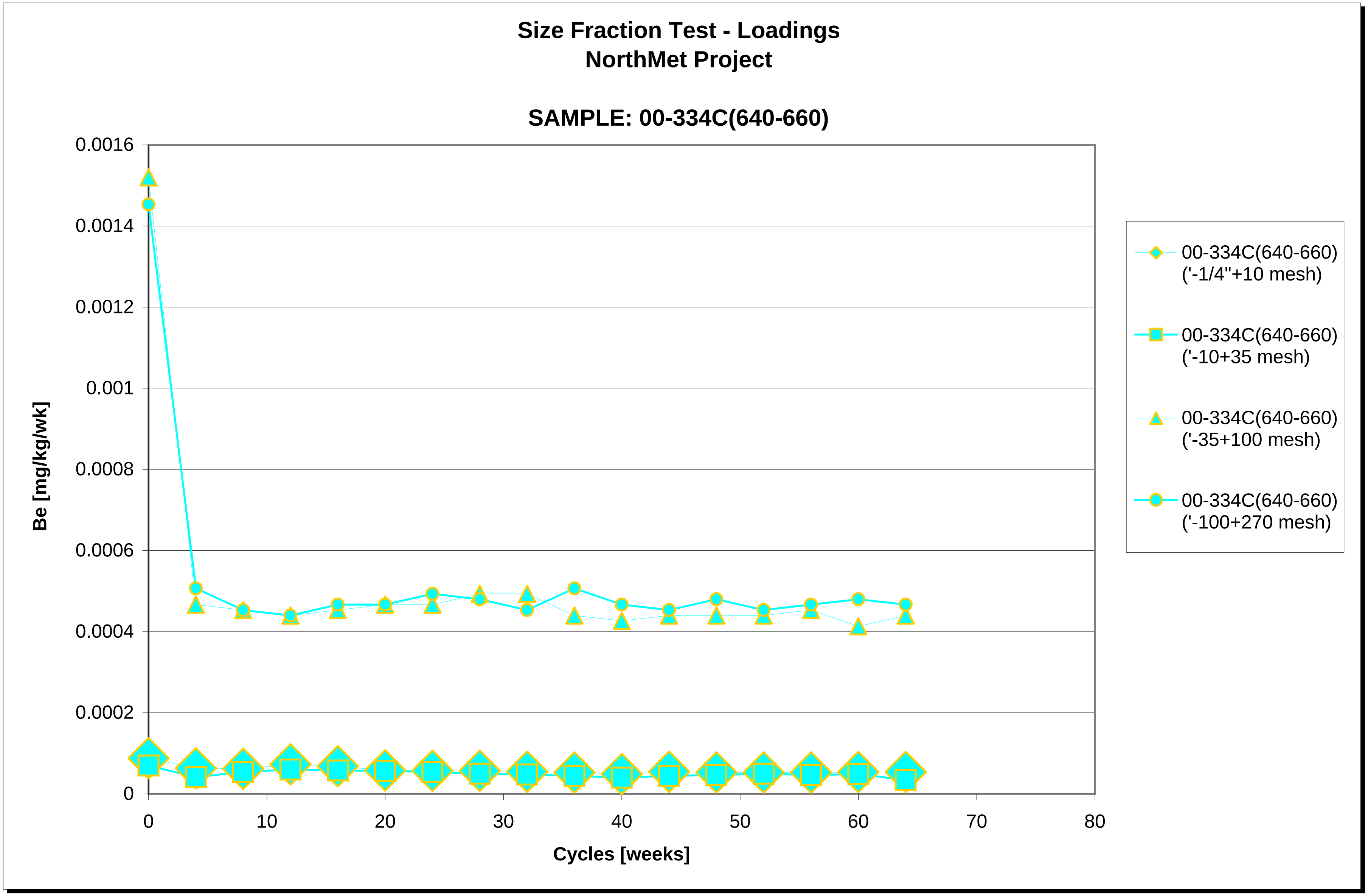
Chart F.1.12

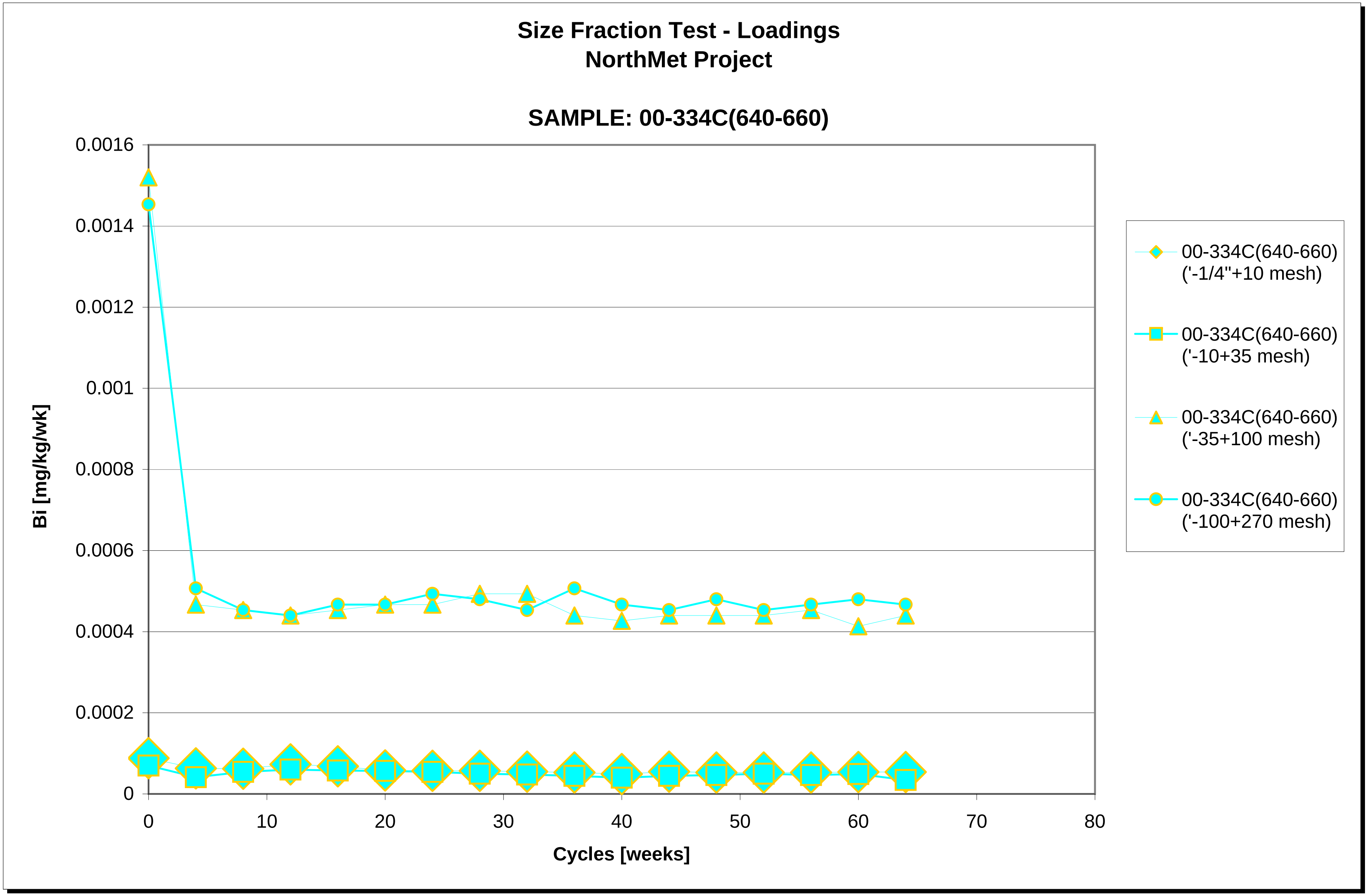


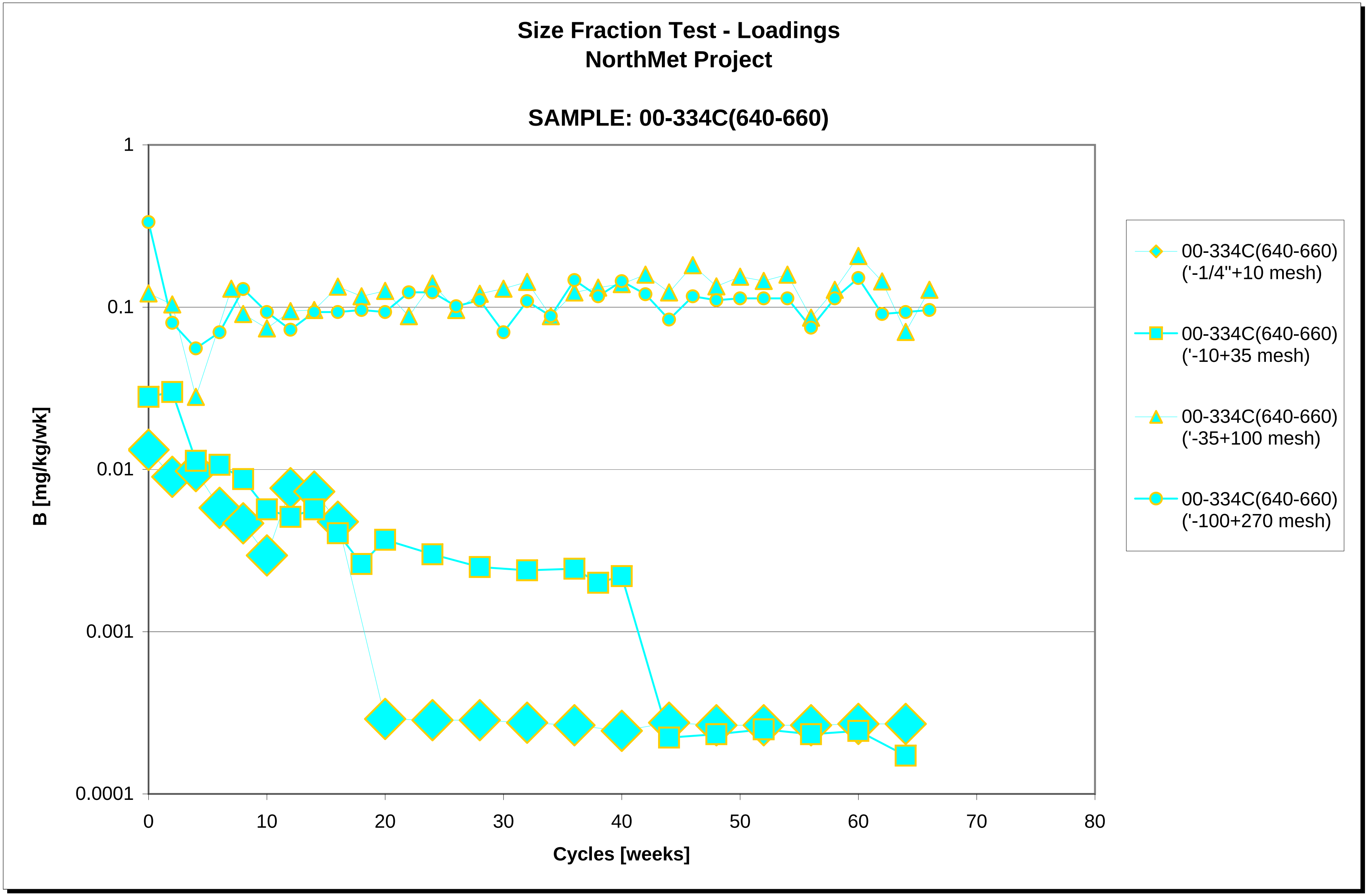
SRK Consulting
February 2007

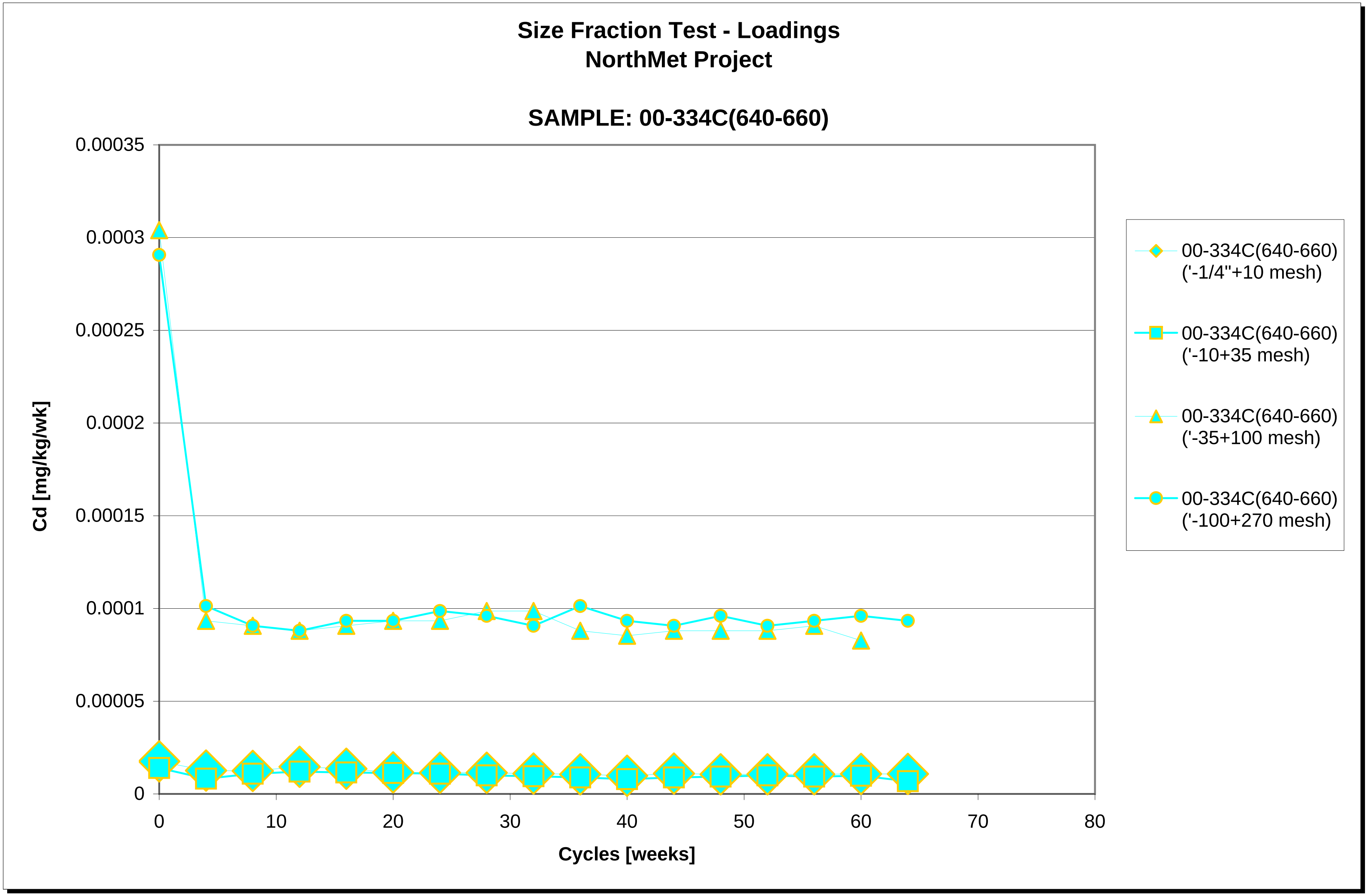

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
As [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Ba [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

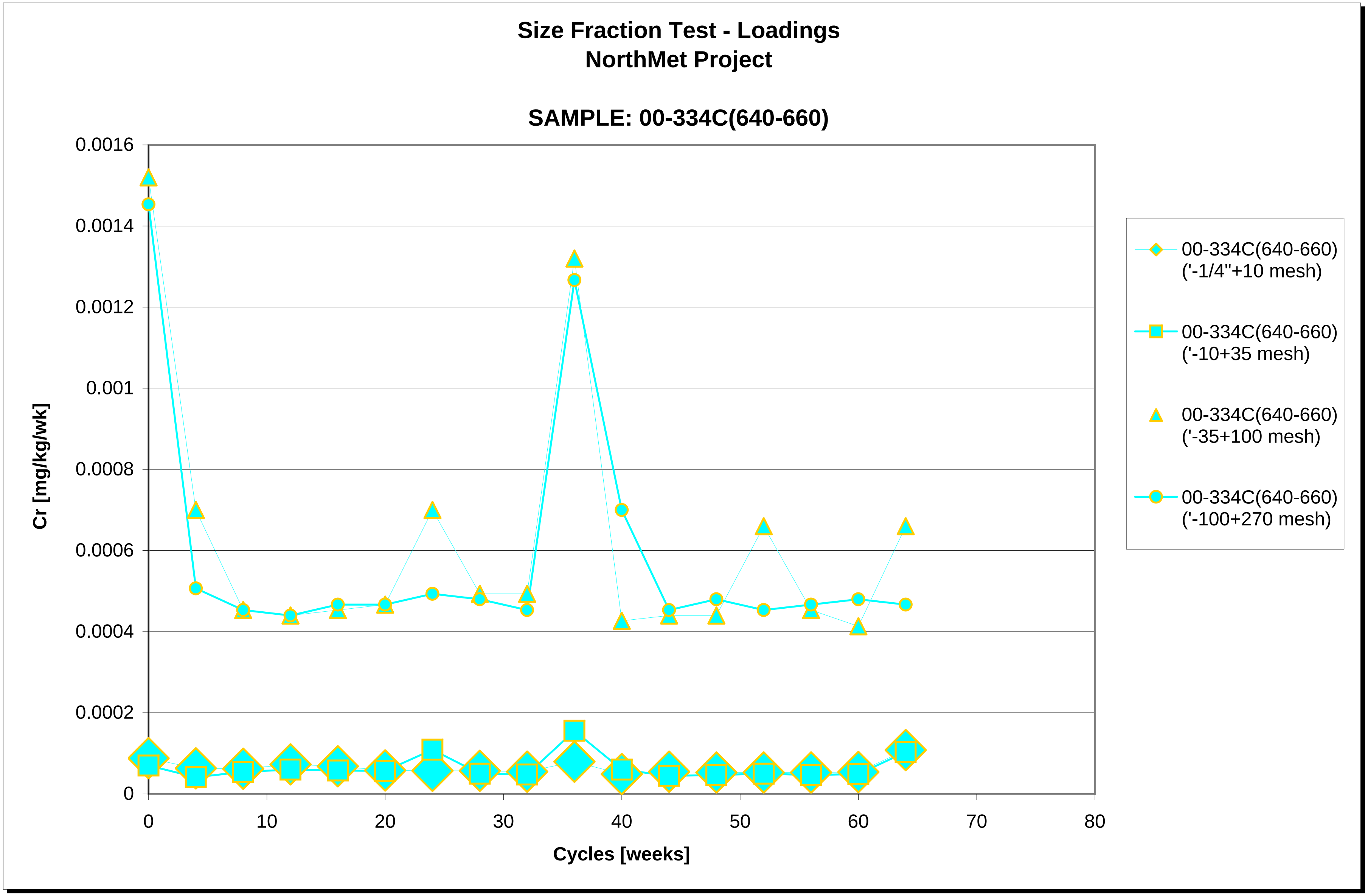

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Be [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

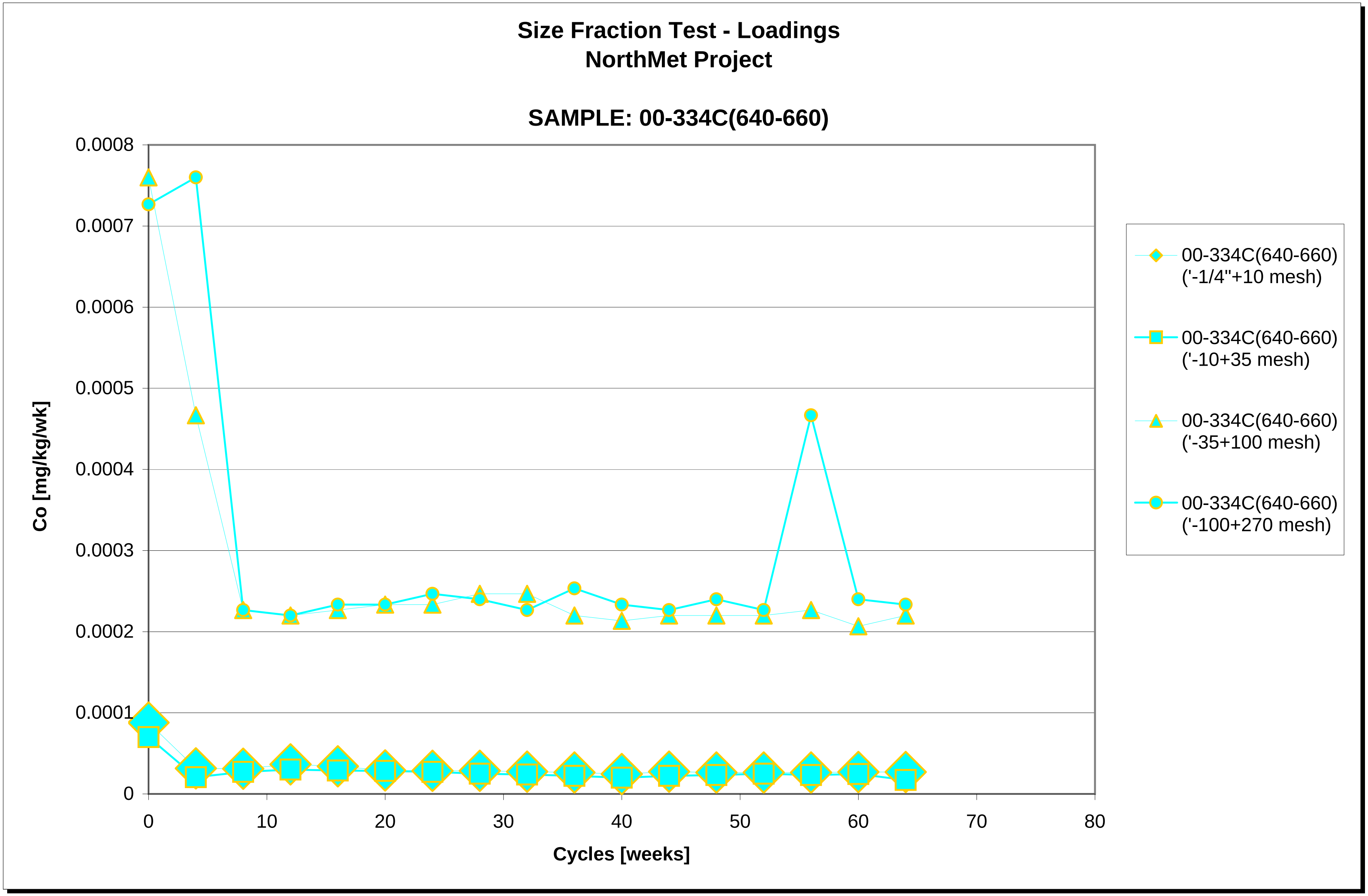

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Bi [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
B [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

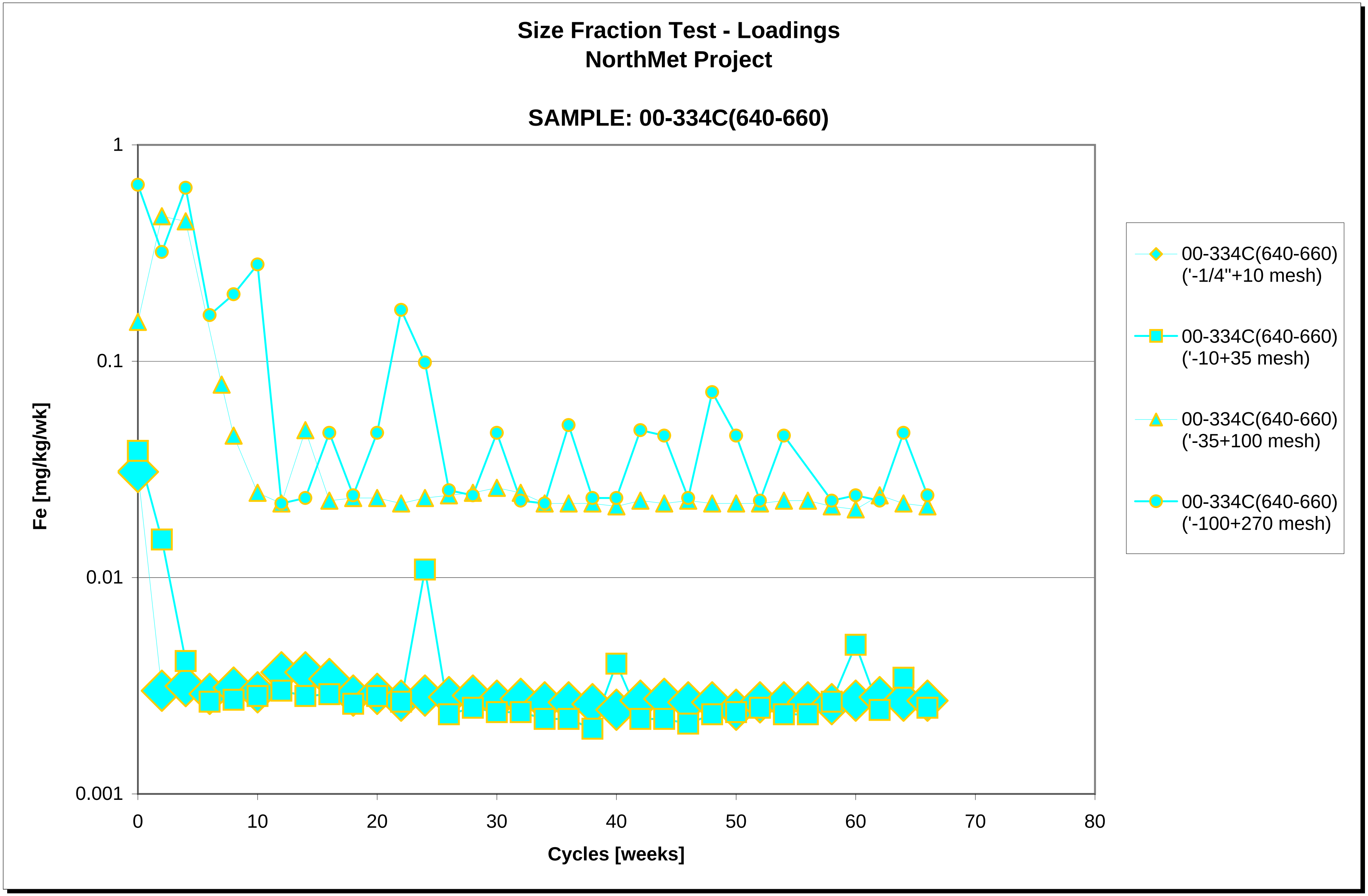

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Cd [mg/kg/wk]
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

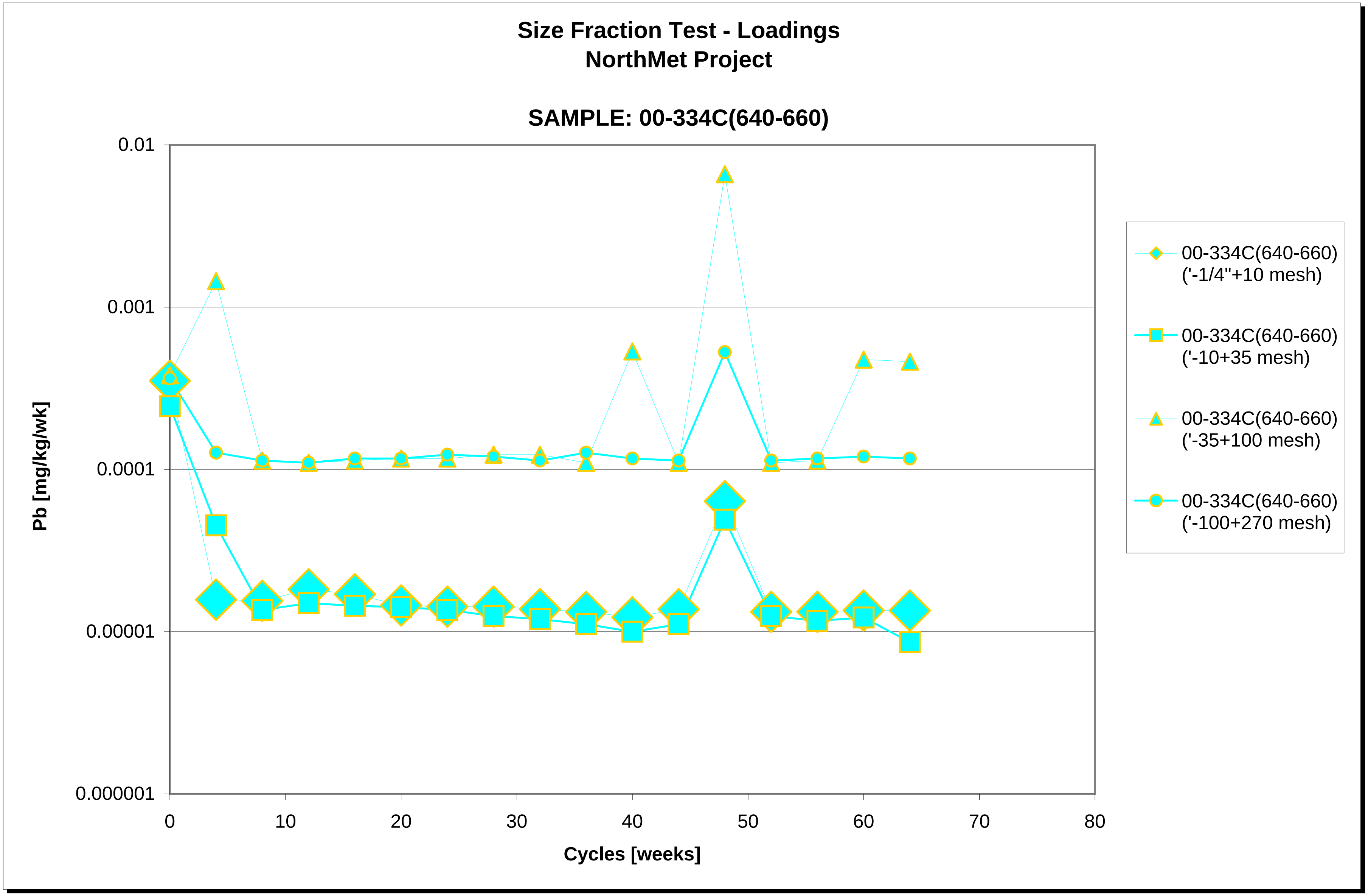

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Ca [mg/kg/wk]
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

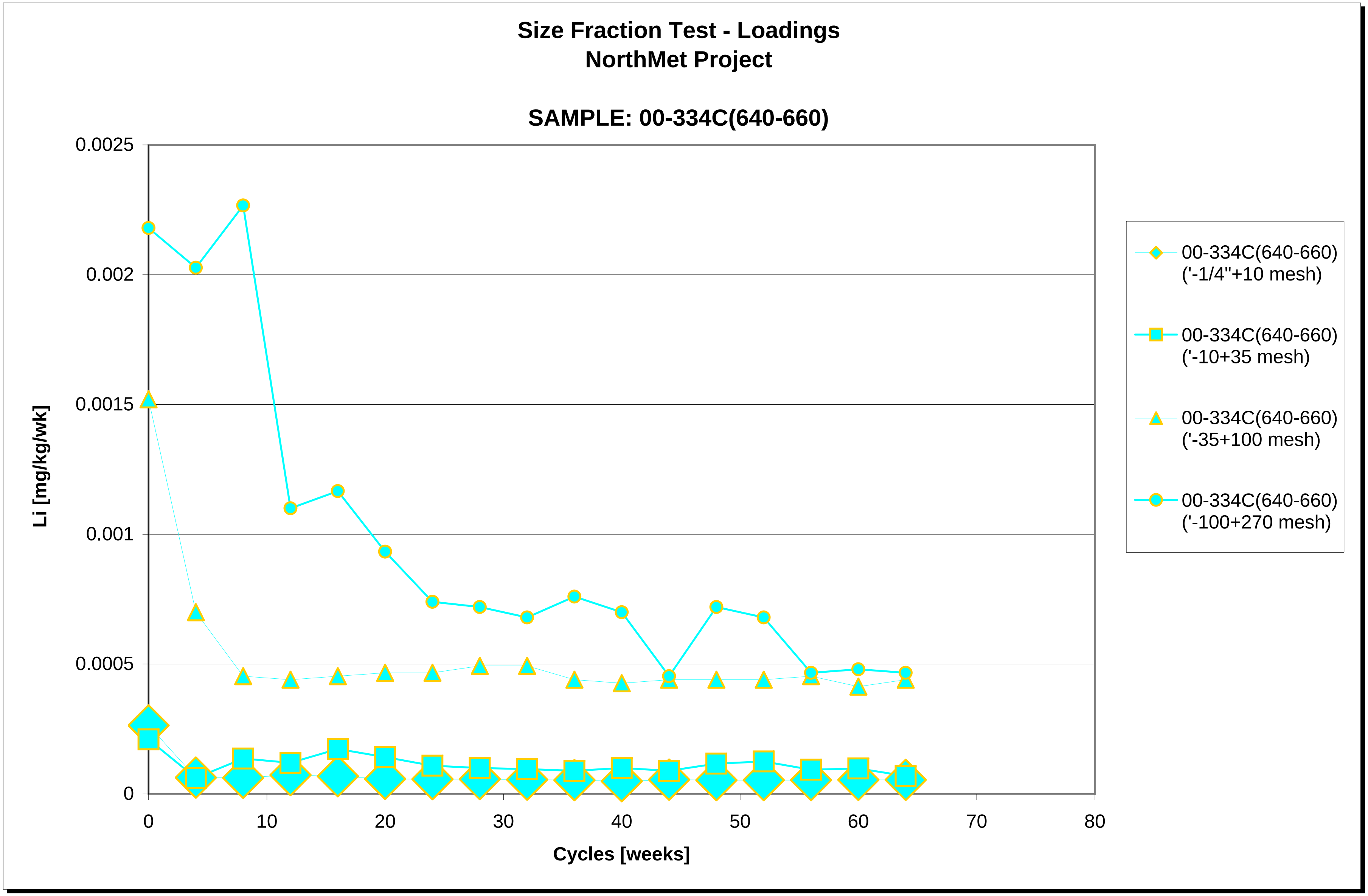

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Cr [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Co [mg/kg/wk]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Cu [mg/kg/wk]
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

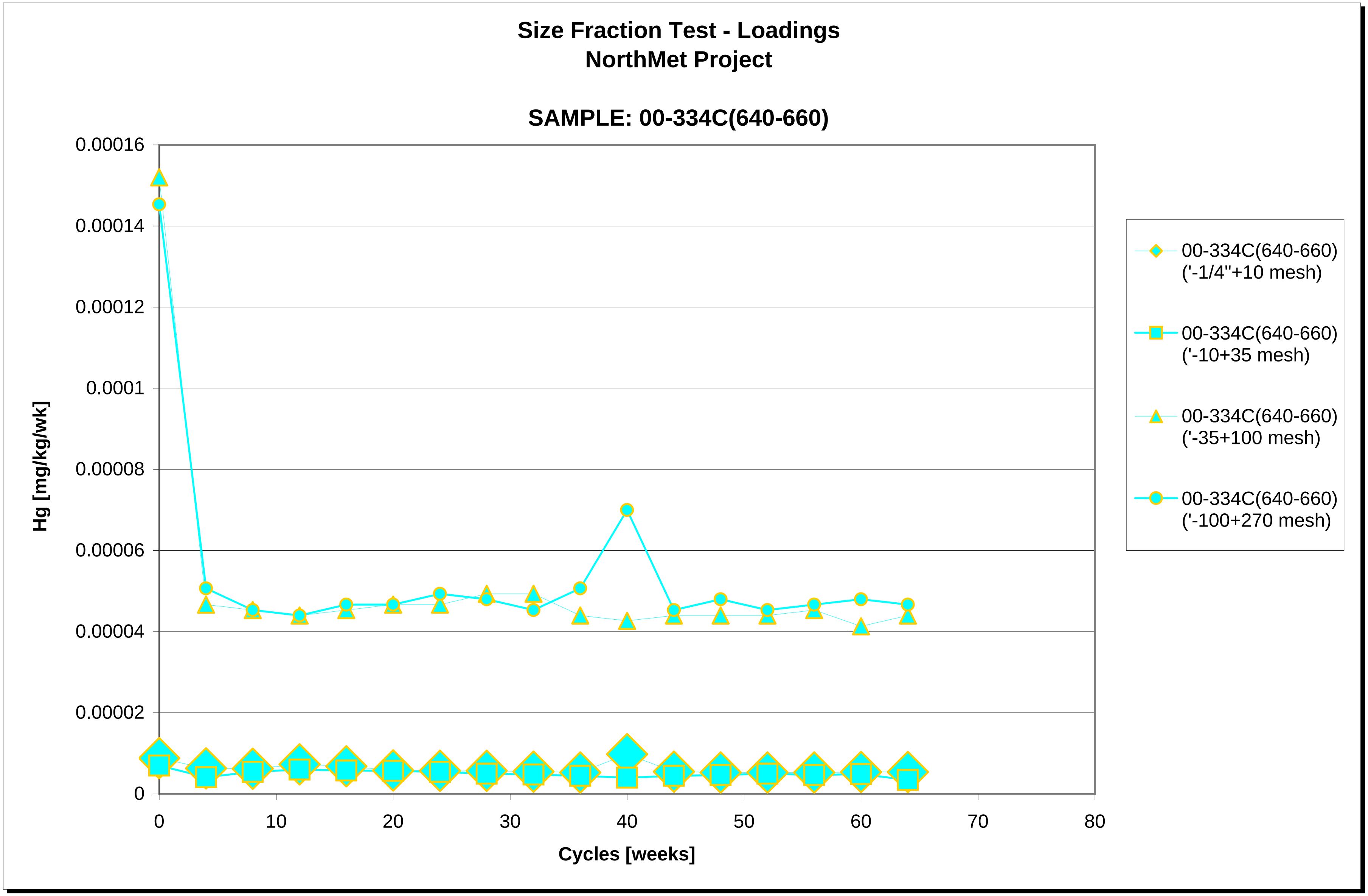

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Fe [mg/kg/wk]
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

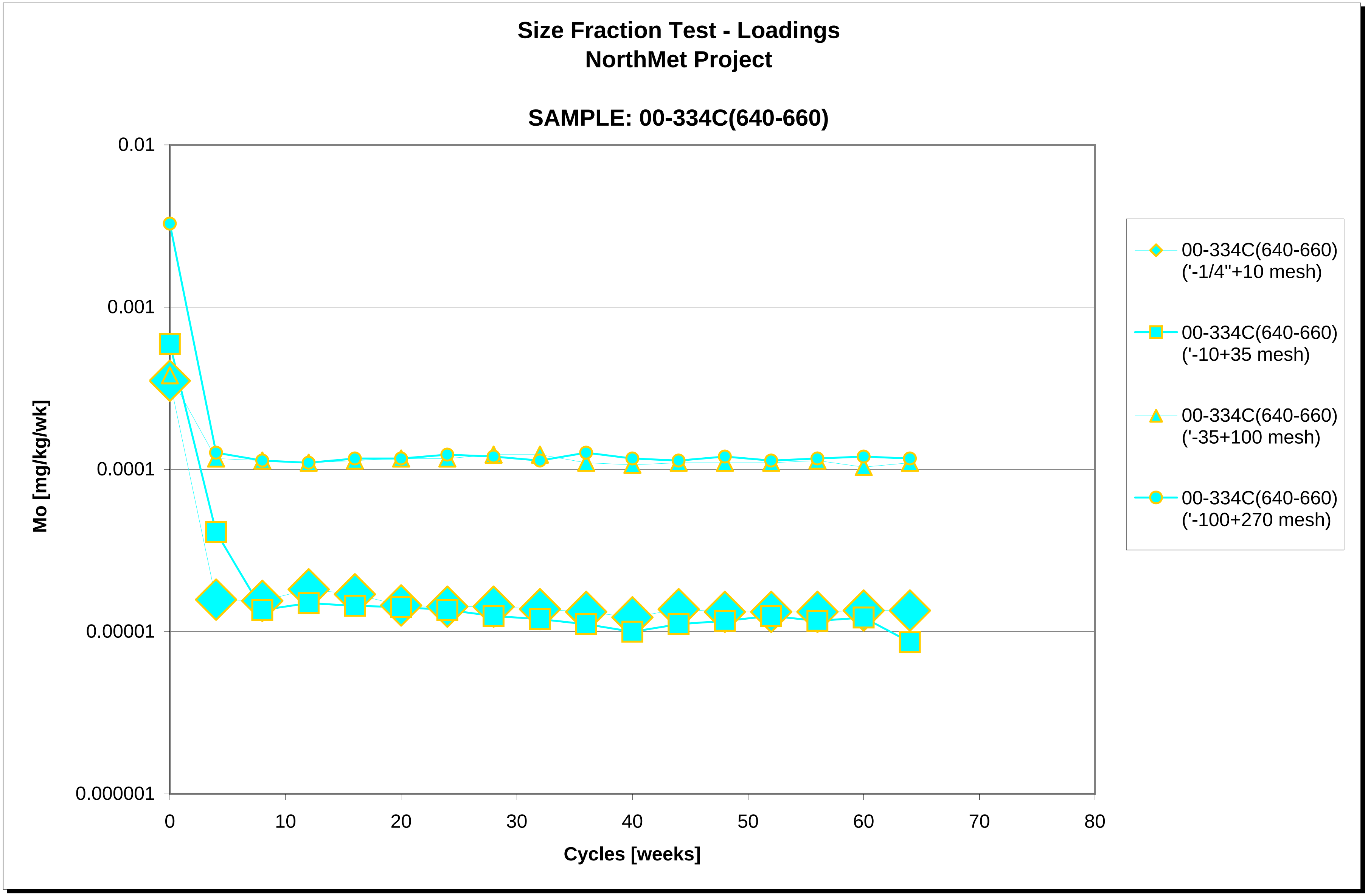

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Pb [mg/kg/wk]
0.01
0.001
0.0001
0.00001
0.000001
Cycles [weeks]
0
10
20
30
40
50
60
70
80
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Li [mg/kg/wk]
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

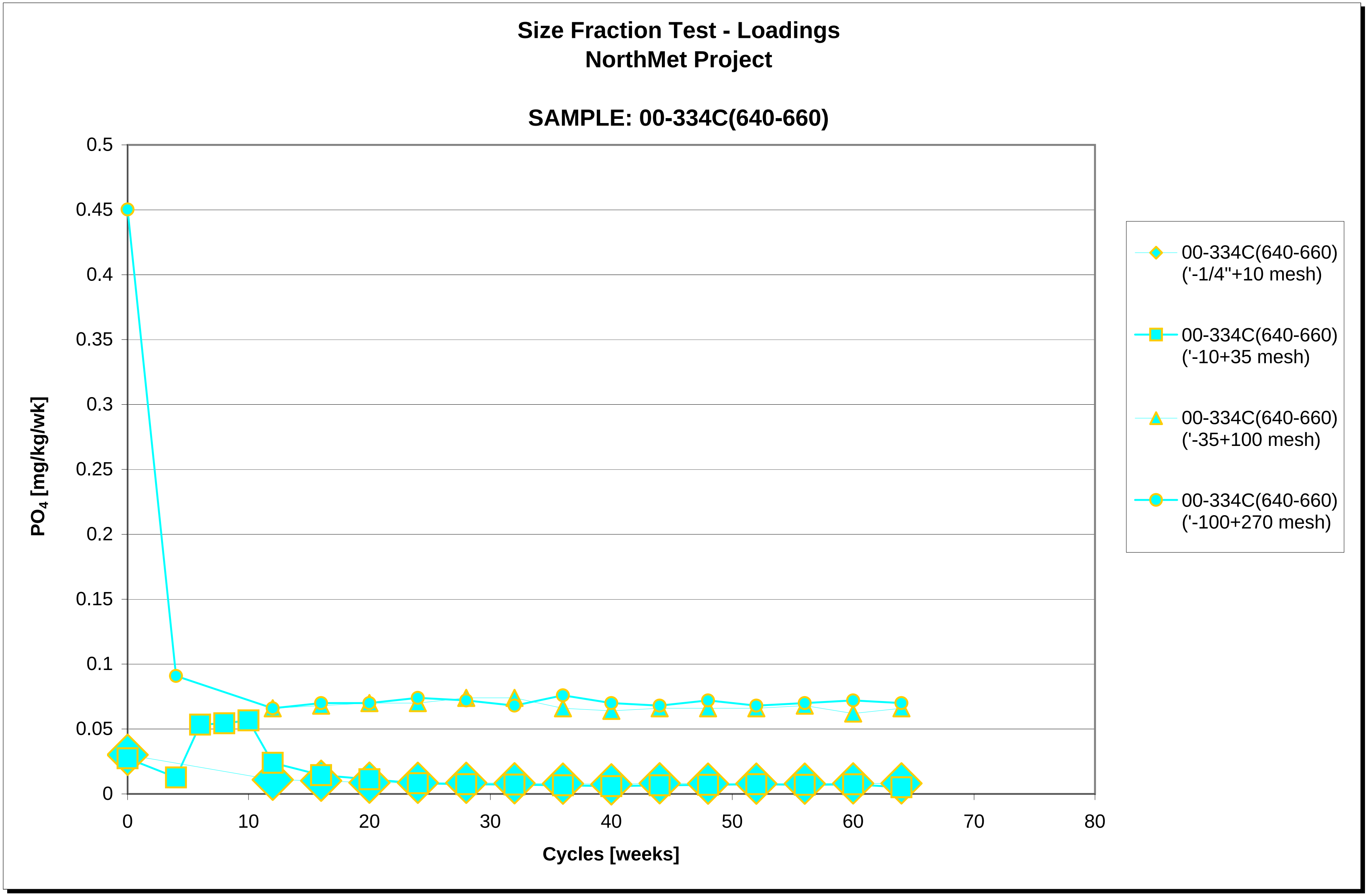

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Mg [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
0
10
20
30
40
50
60
70
80
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Mn [mg/kg/wk]
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

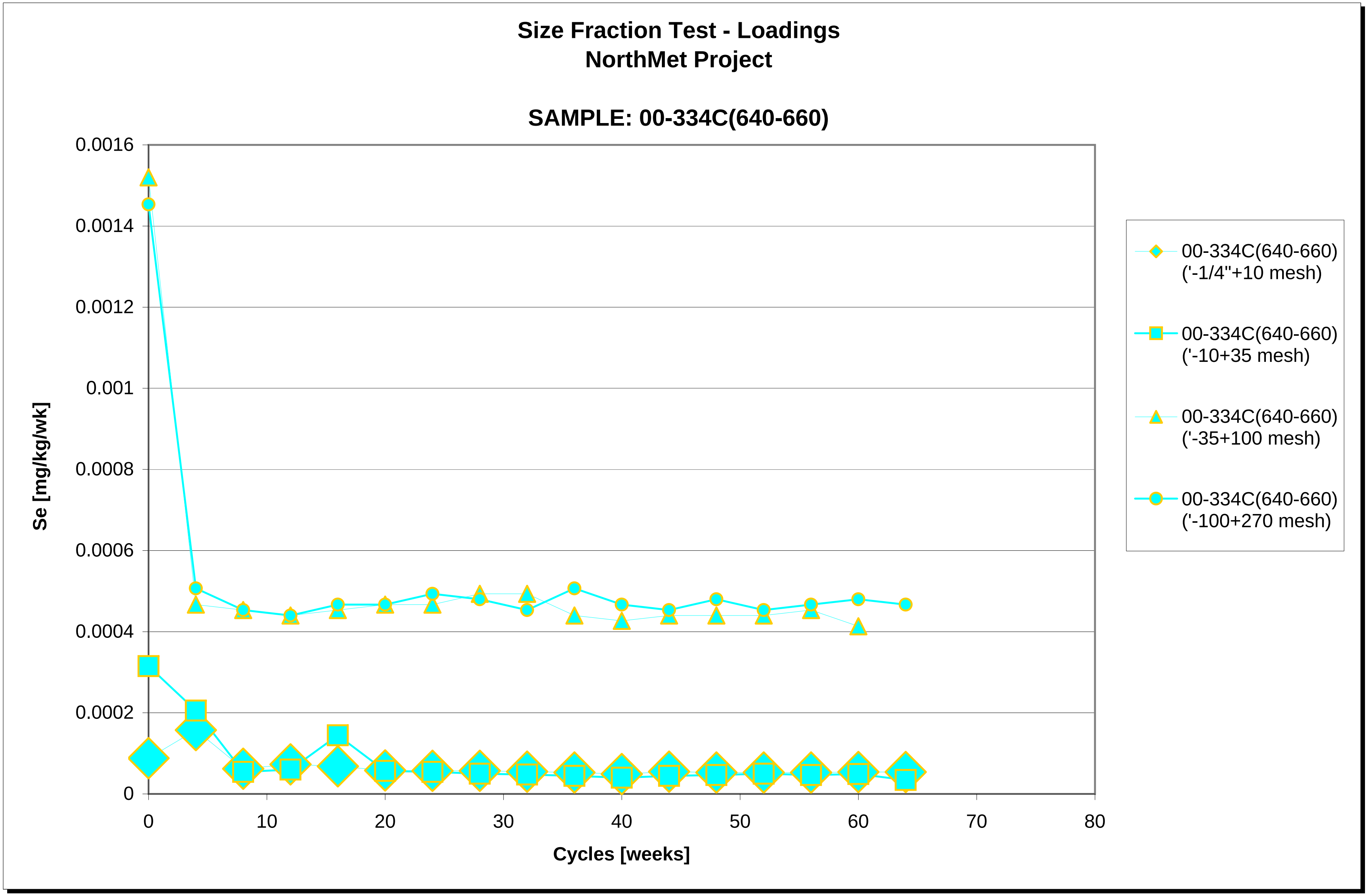

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Hg [mg/kg/wk]
0
0.00002
0.00004
0.00006
0.00008
0.0001
0.00012
0.00014
0.00016
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
0.01
0.001
0.0001
0.00001
0.000001
Mo [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

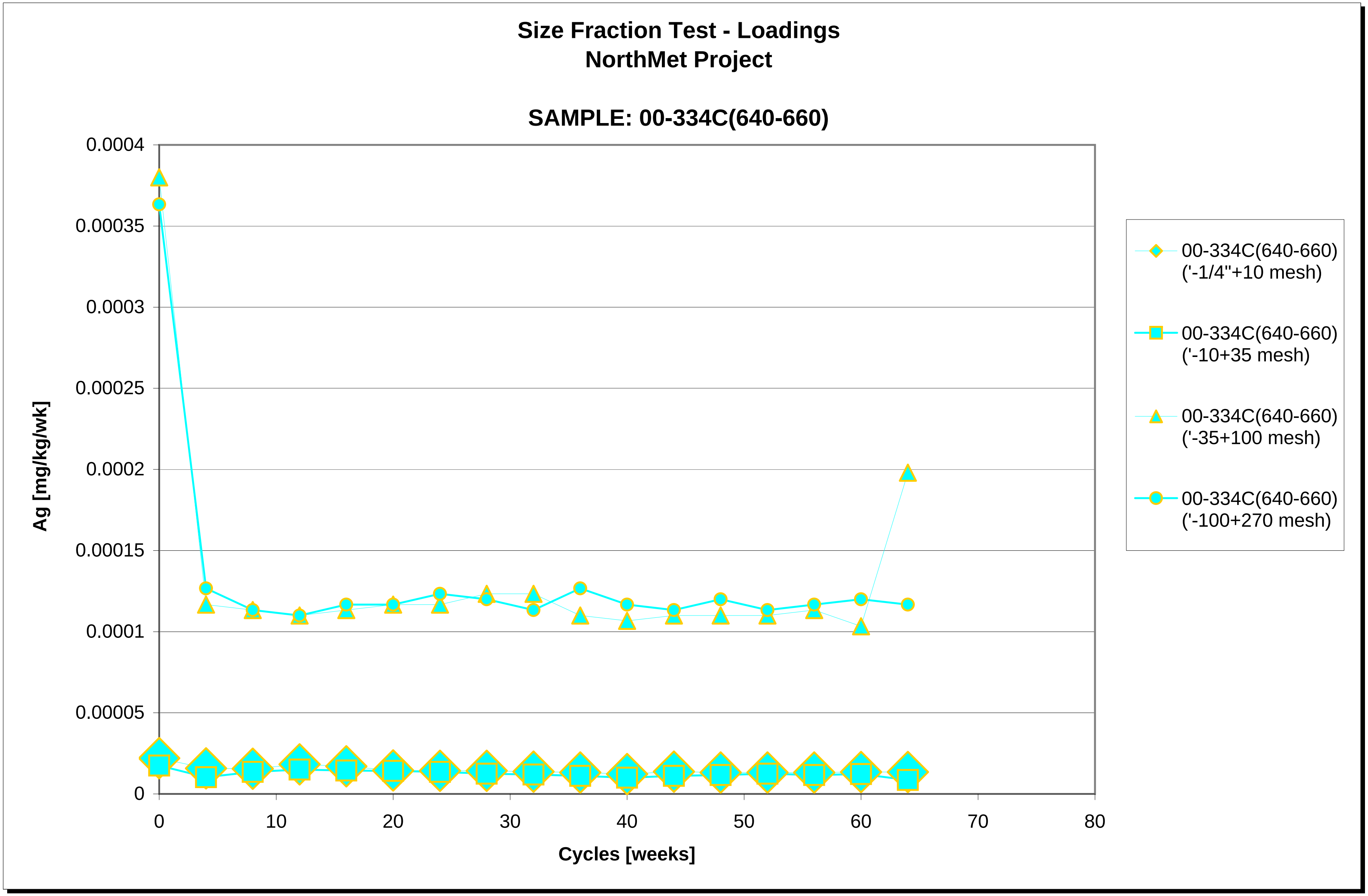

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Ni [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
PO4 [mg/kg/wk]
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
K [mg/kg/wk]
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Se [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

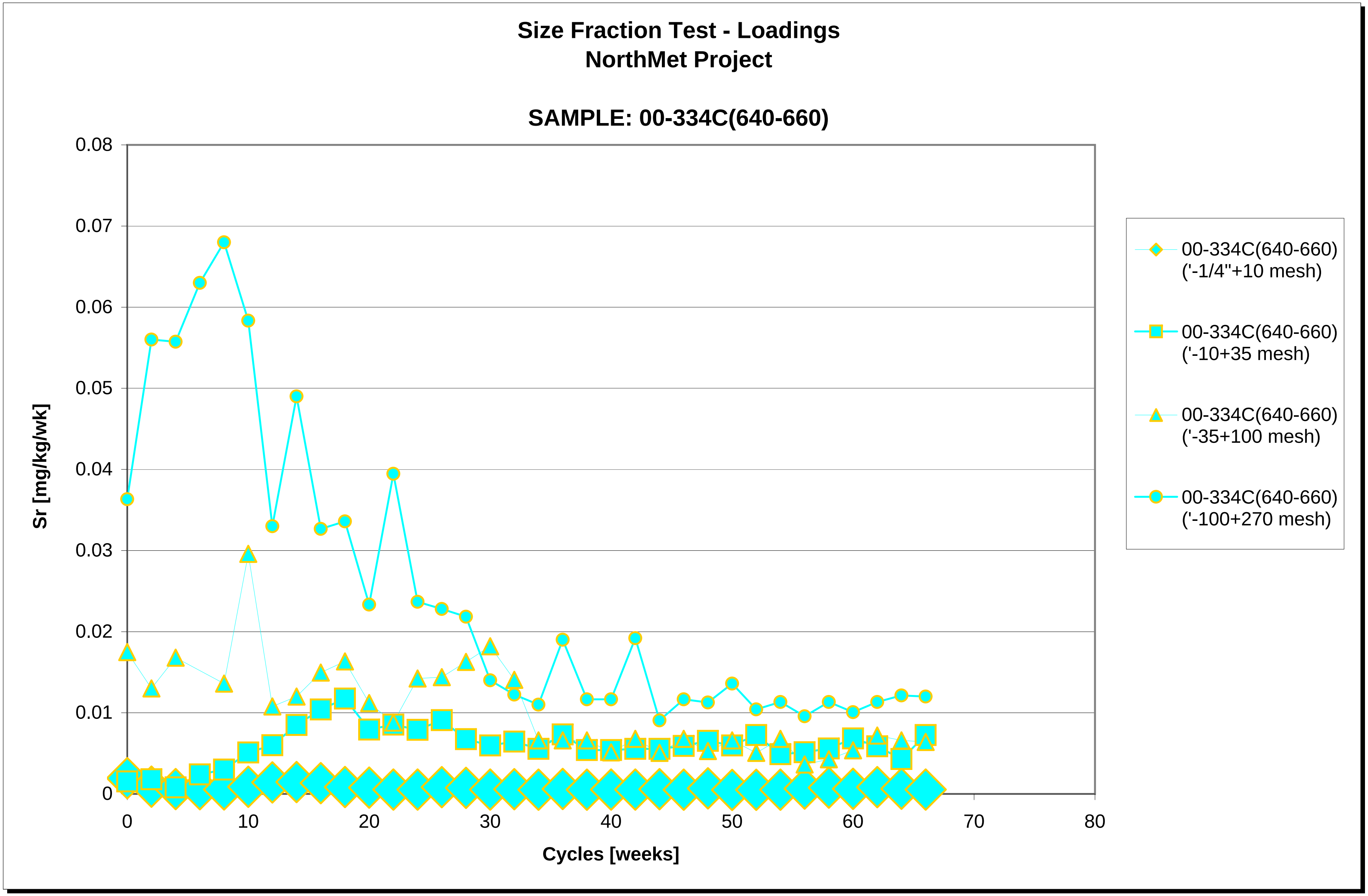

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
100
10
1
0.1
0.01
SiO_2 [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

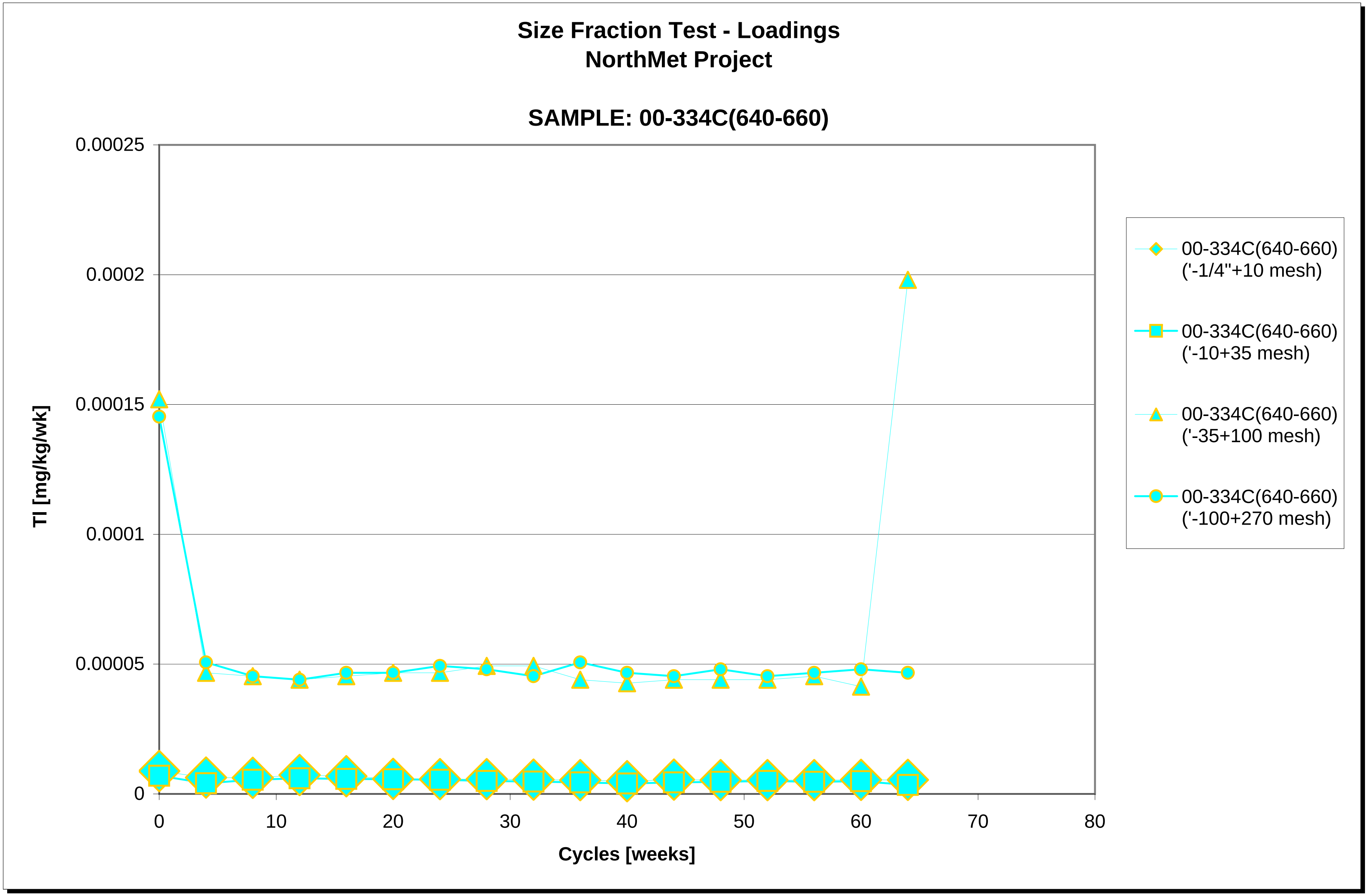

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Ag [mg/kg/wk]
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

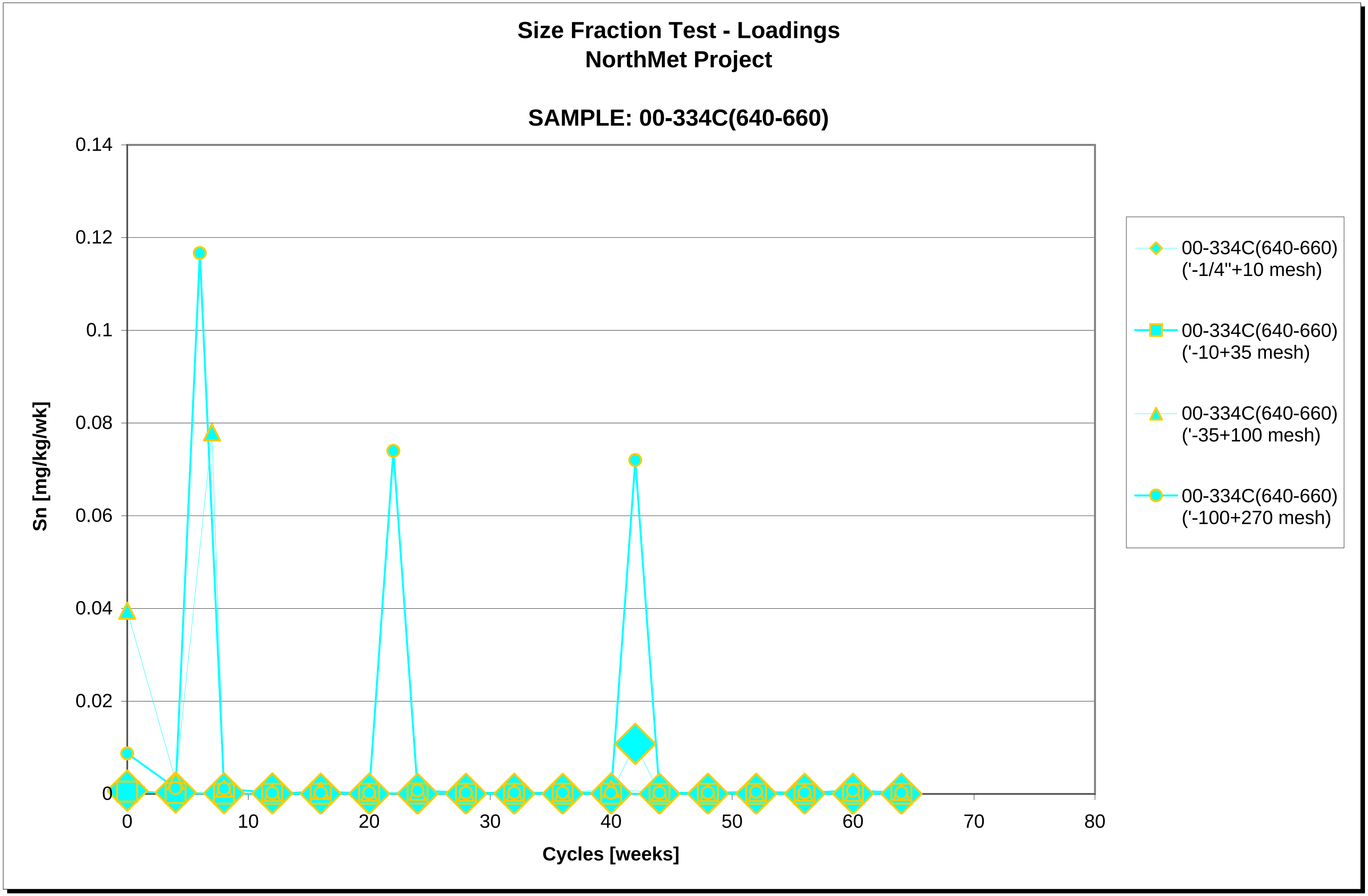

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Na [mg/kg/wk]
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

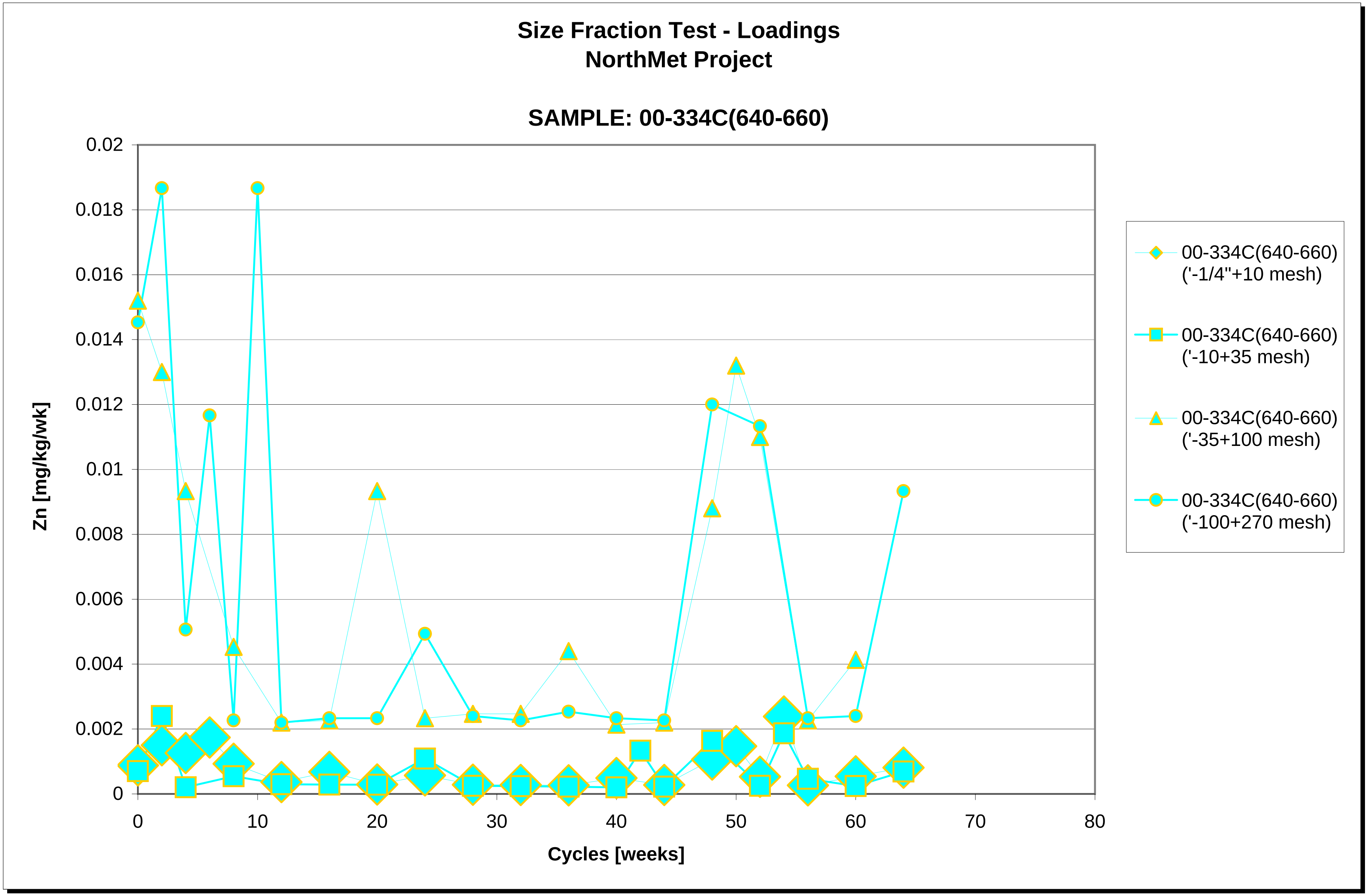
Appendix F.1
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-334C(640-660)

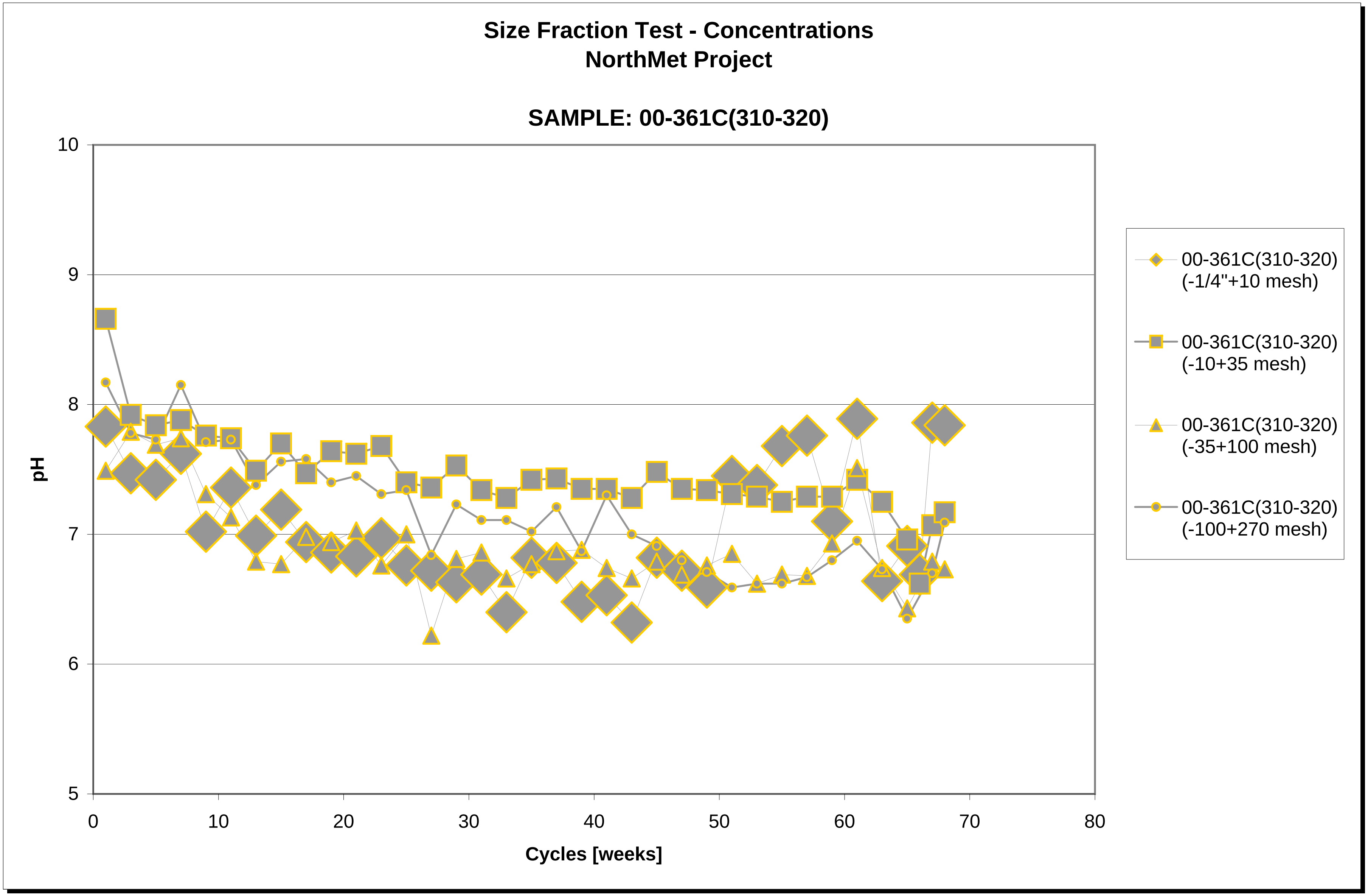
Chart F.1.37

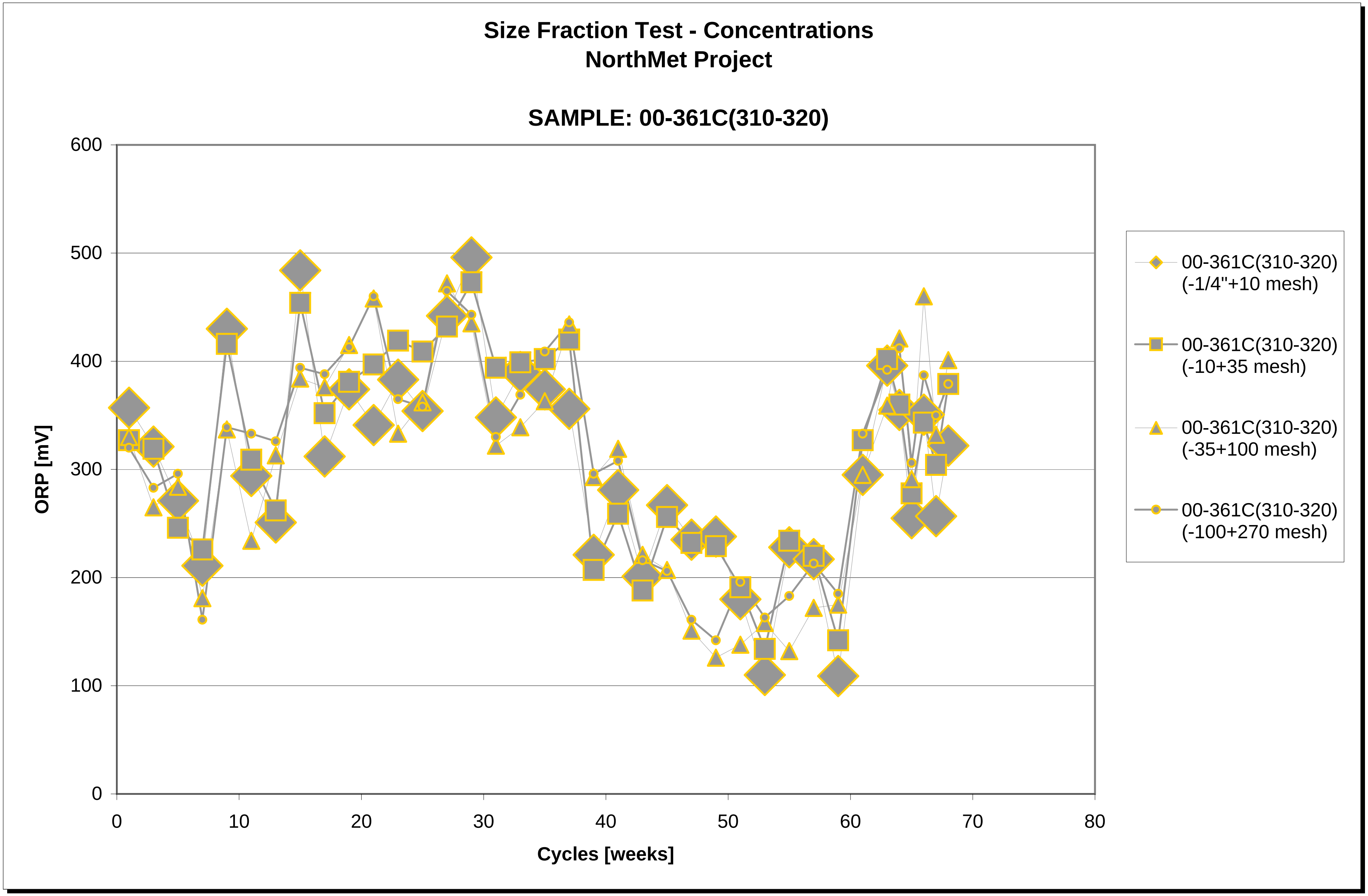


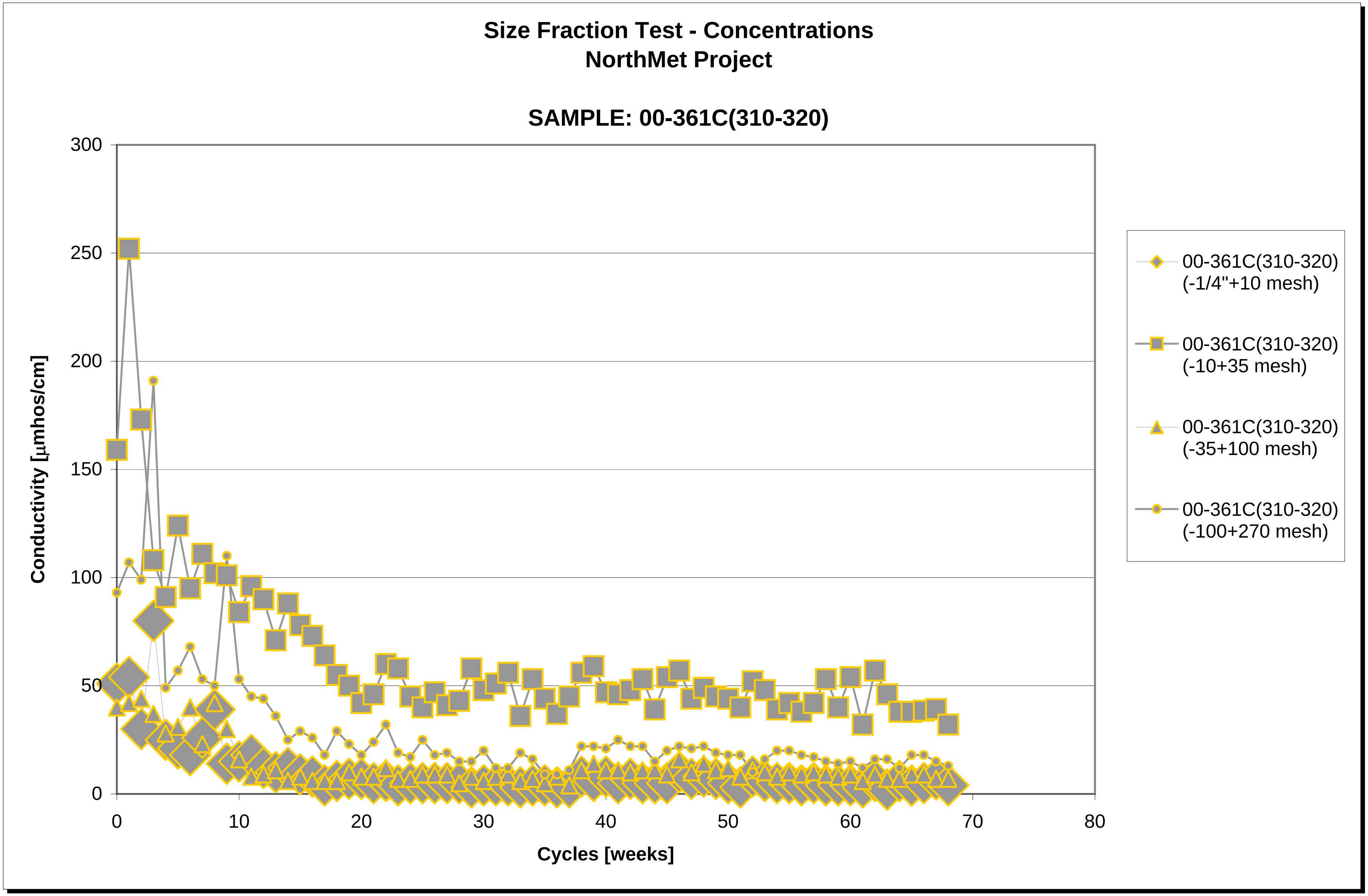

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Tl [mg/kg/wk]
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

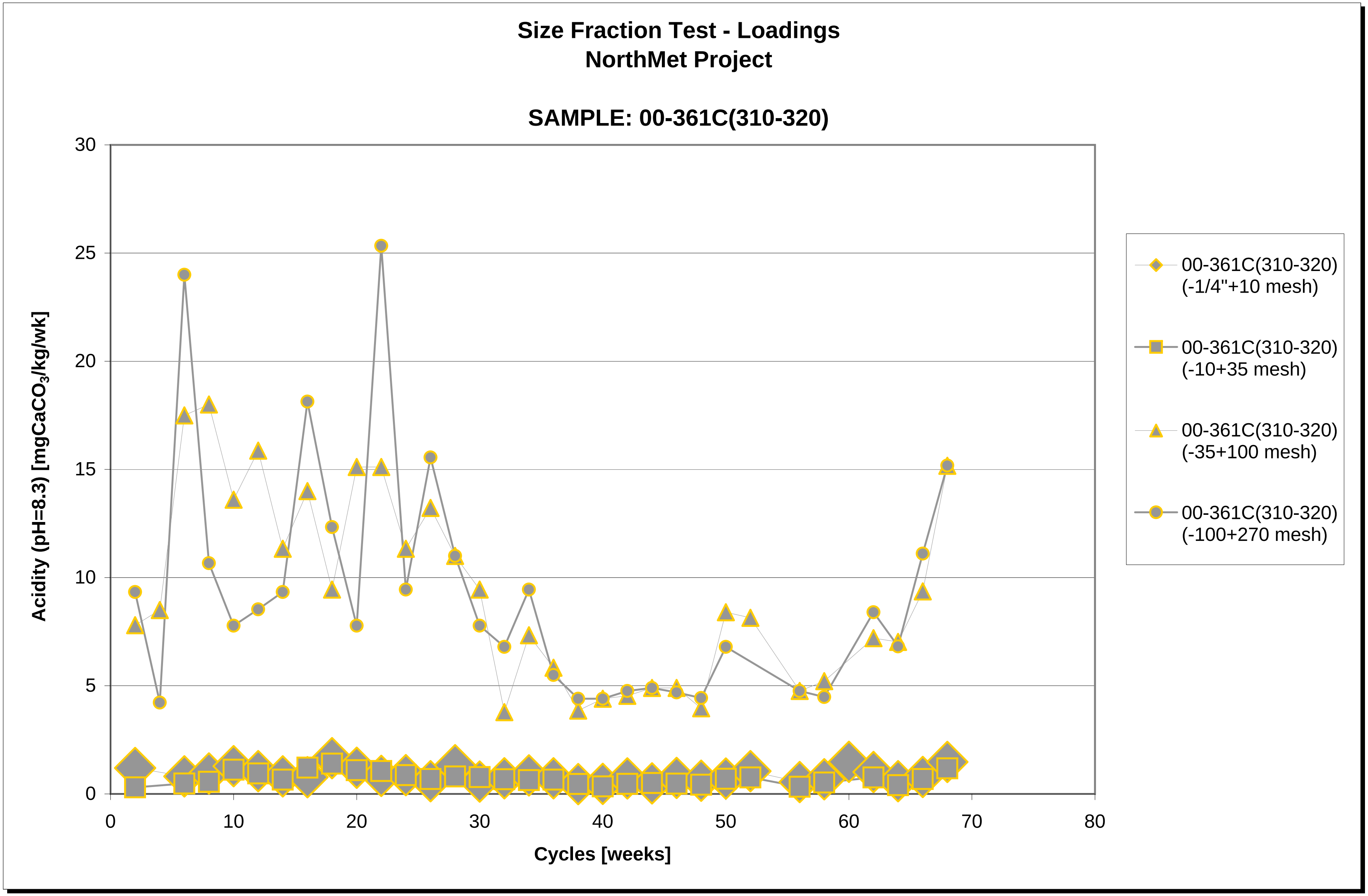

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Sn [mg/kg/wk]
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

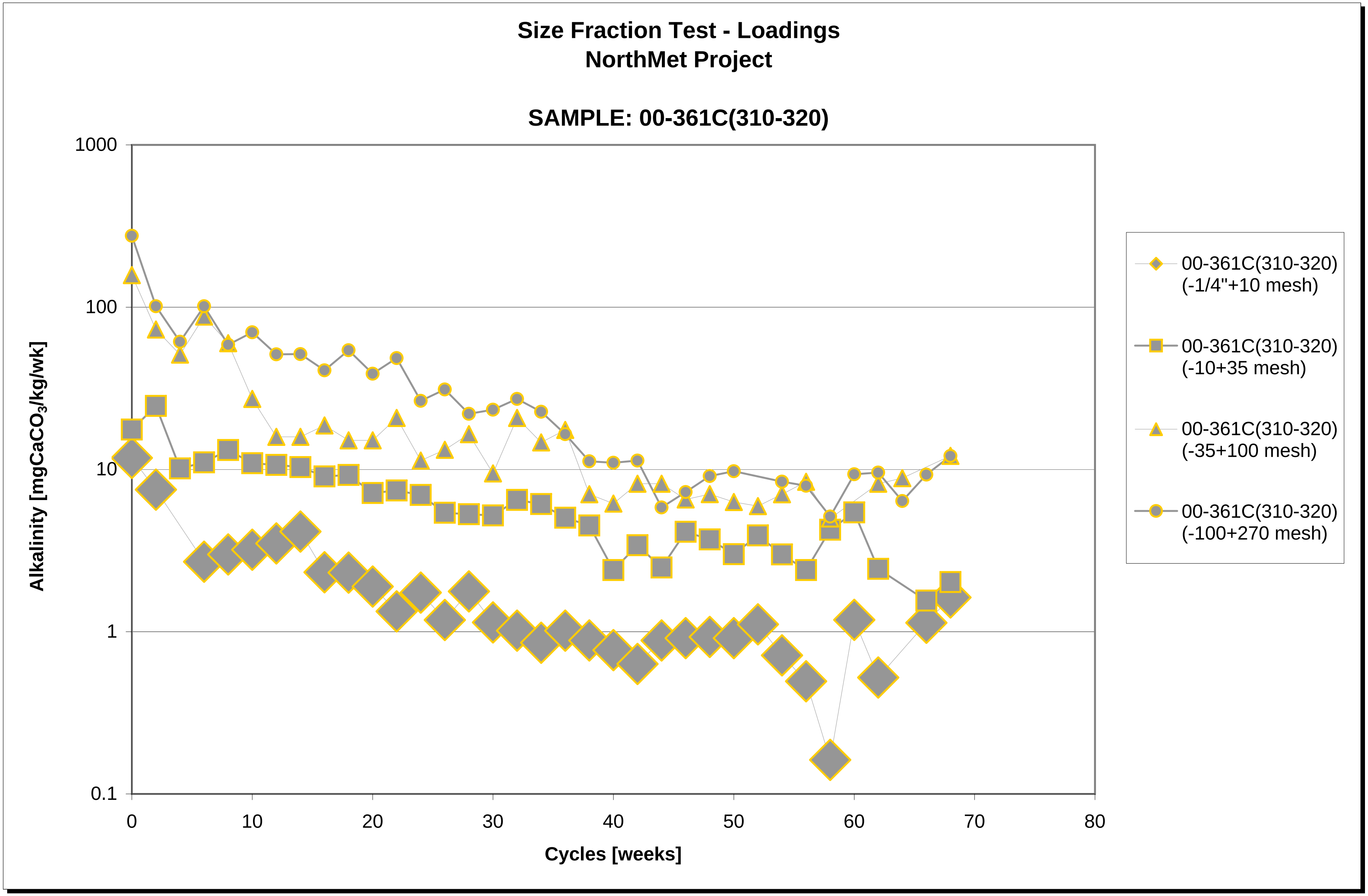

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-334C(640-660)
Zn [mg/kg/wk]
Cycles [weeks]
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02
0
10
20
30
40
50
60
70
80
00-334C(640-660) ('-1/4"+10 mesh)
00-334C(640-660) ('-10+35 mesh)
00-334C(640-660) ('-35+100 mesh)
00-334C(640-660) ('-100+270 mesh)

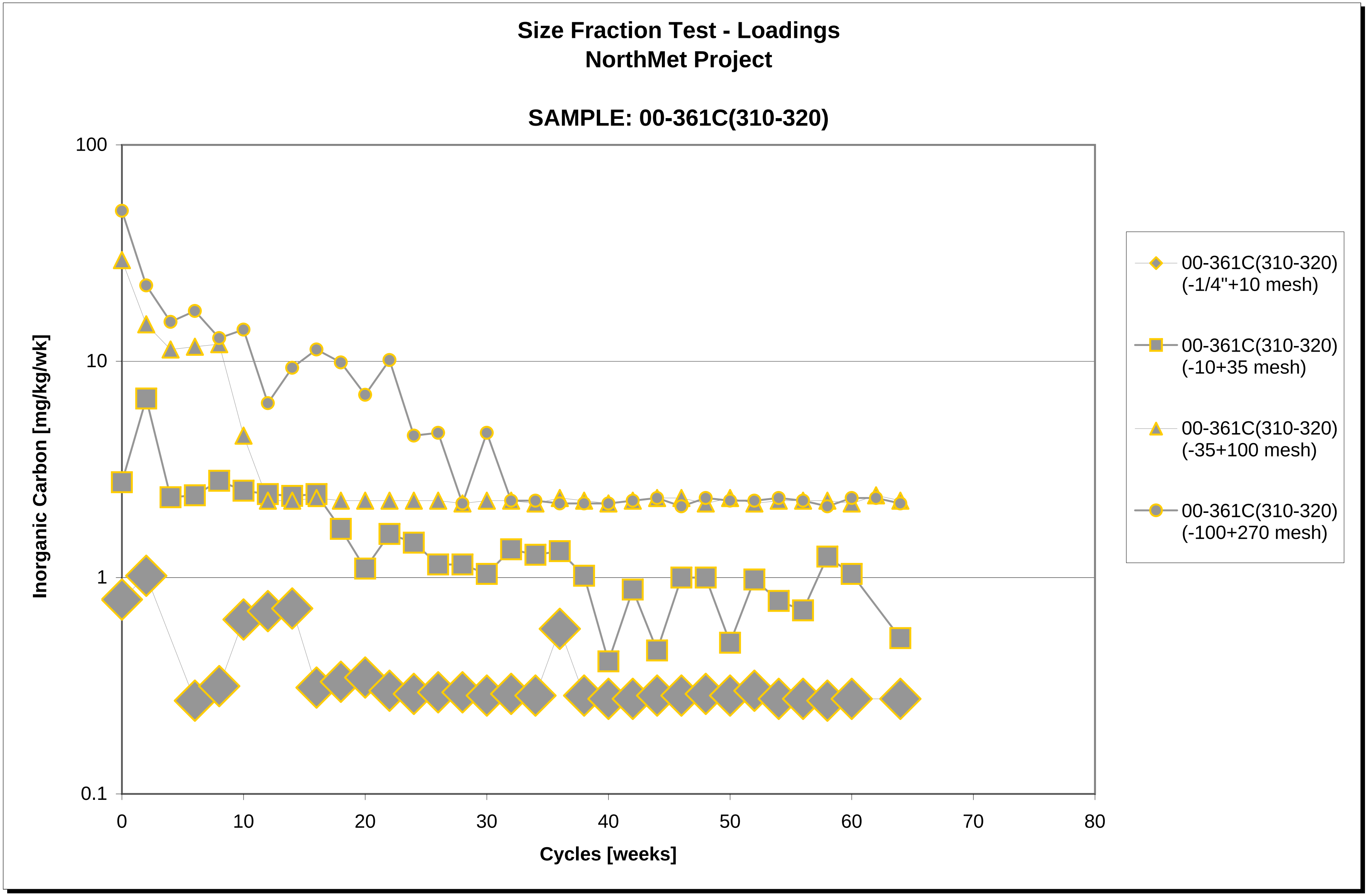

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-361C(310-320)
pH
Cycles [weeks]
10
9
8
7
6
5
0
10
20
30
40
50
60
70
80
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

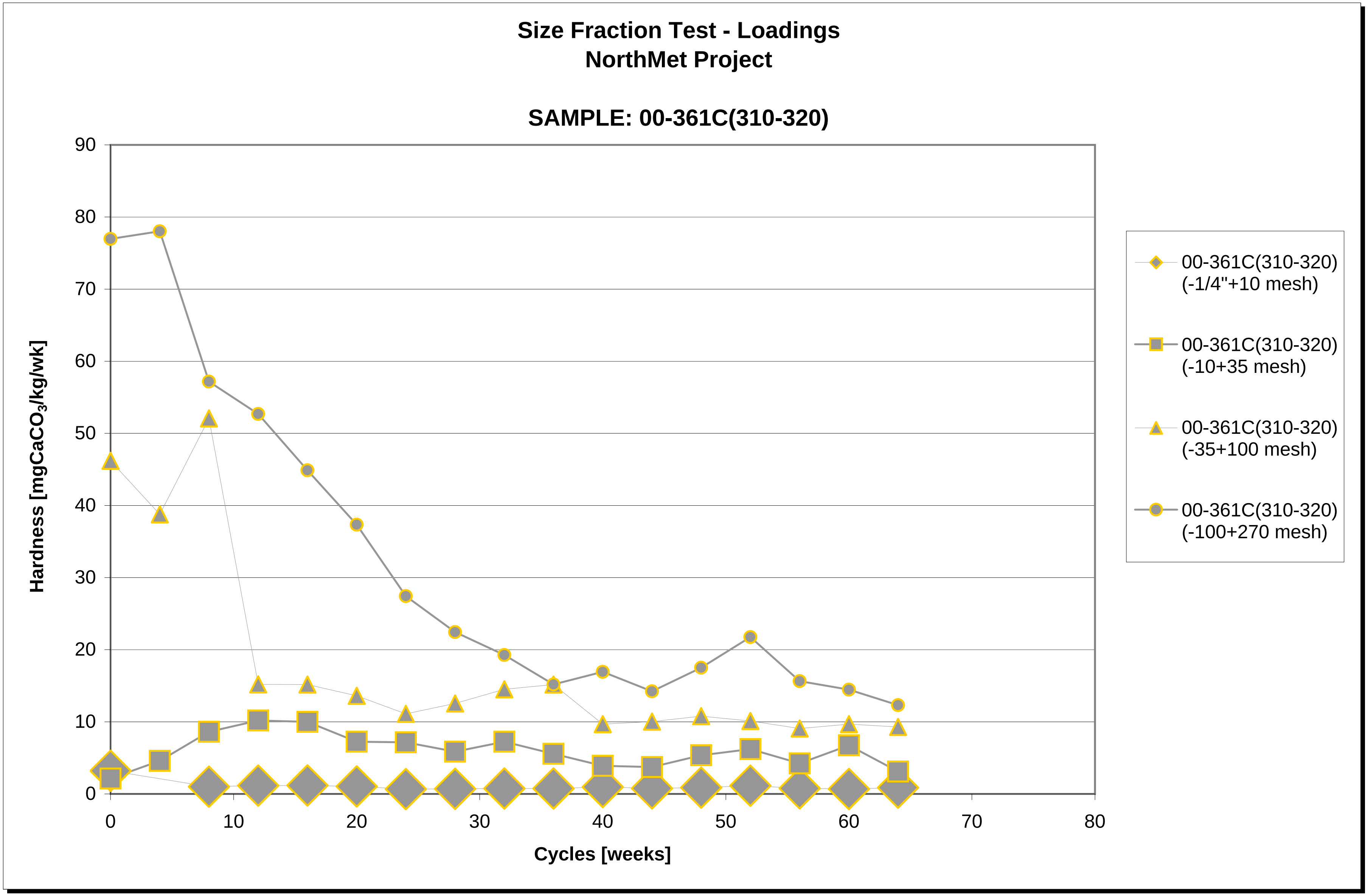

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-361C(310-320)
ORP [mV]
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

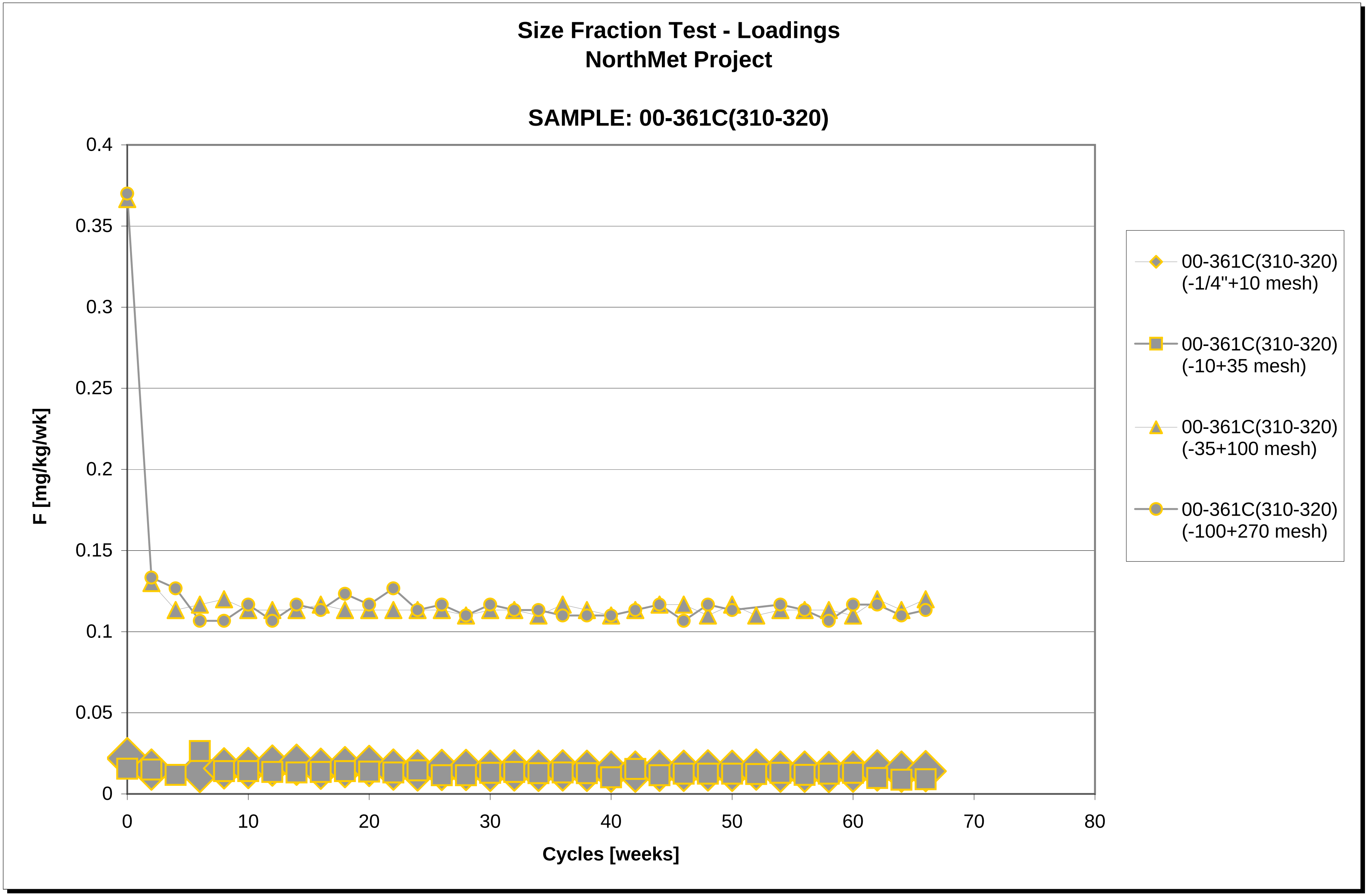

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-361C(310-320)
Conductivity [µmhos/cm]
Cycles [weeks]
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

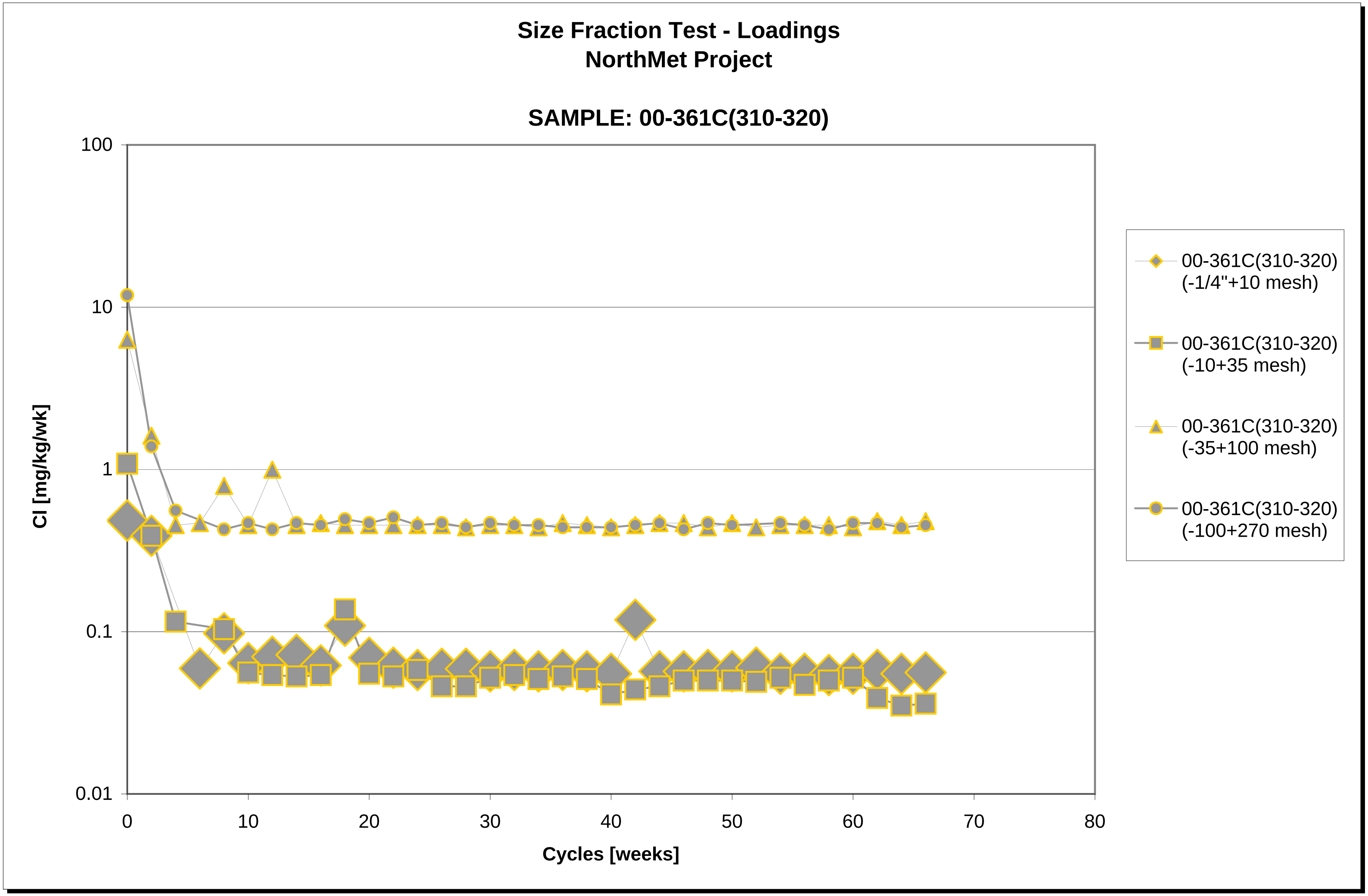

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
30
25
20
15
10
5
0
Acidity (pH=8.3) [mgCaCO3/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

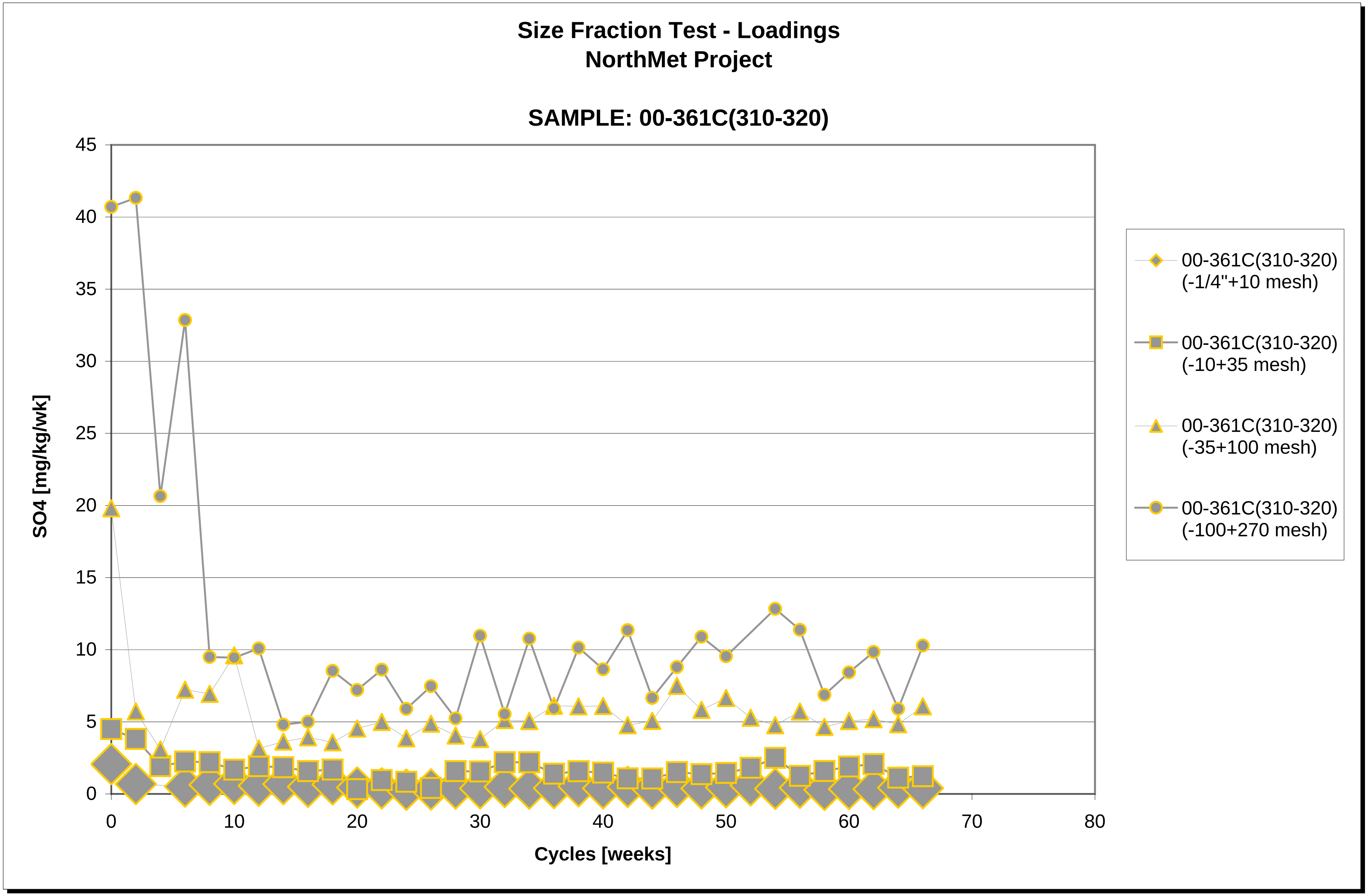

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Alkalinity [mgCaCO3/kg/wk]
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

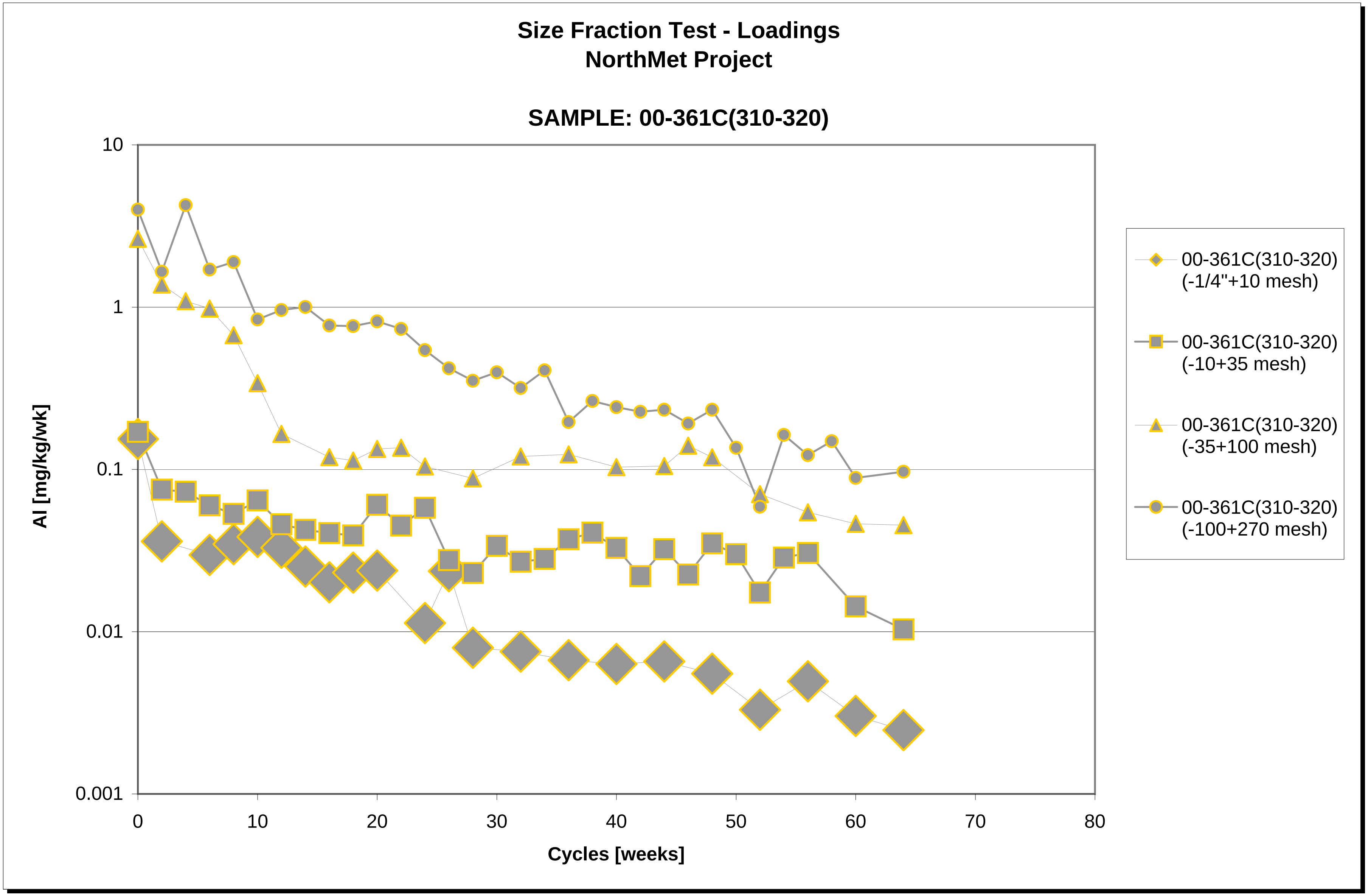

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Inorganic Carbon [mg/kg/wk]
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

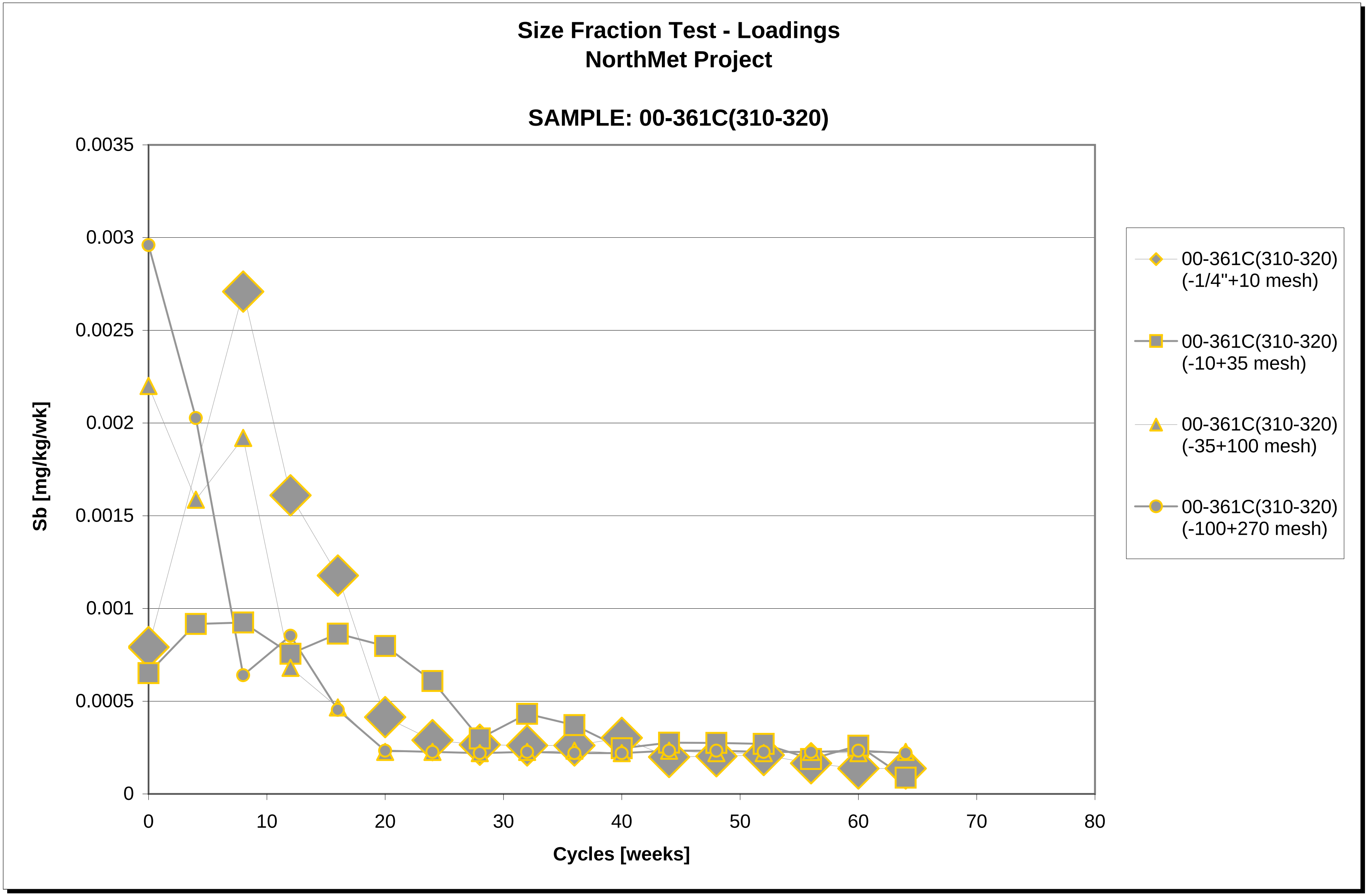

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
80
90
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

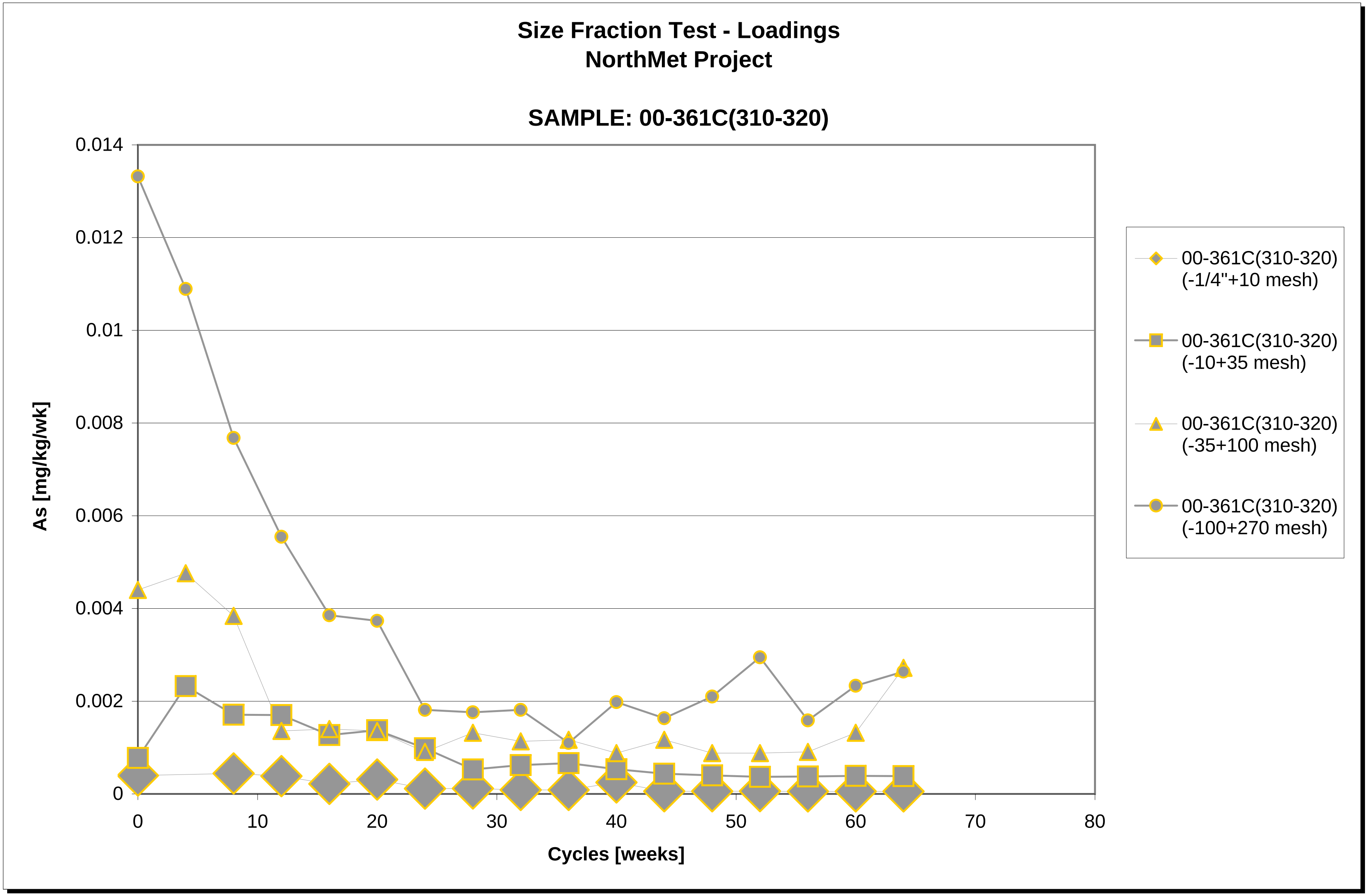

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
F [mg/kg/wk]
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

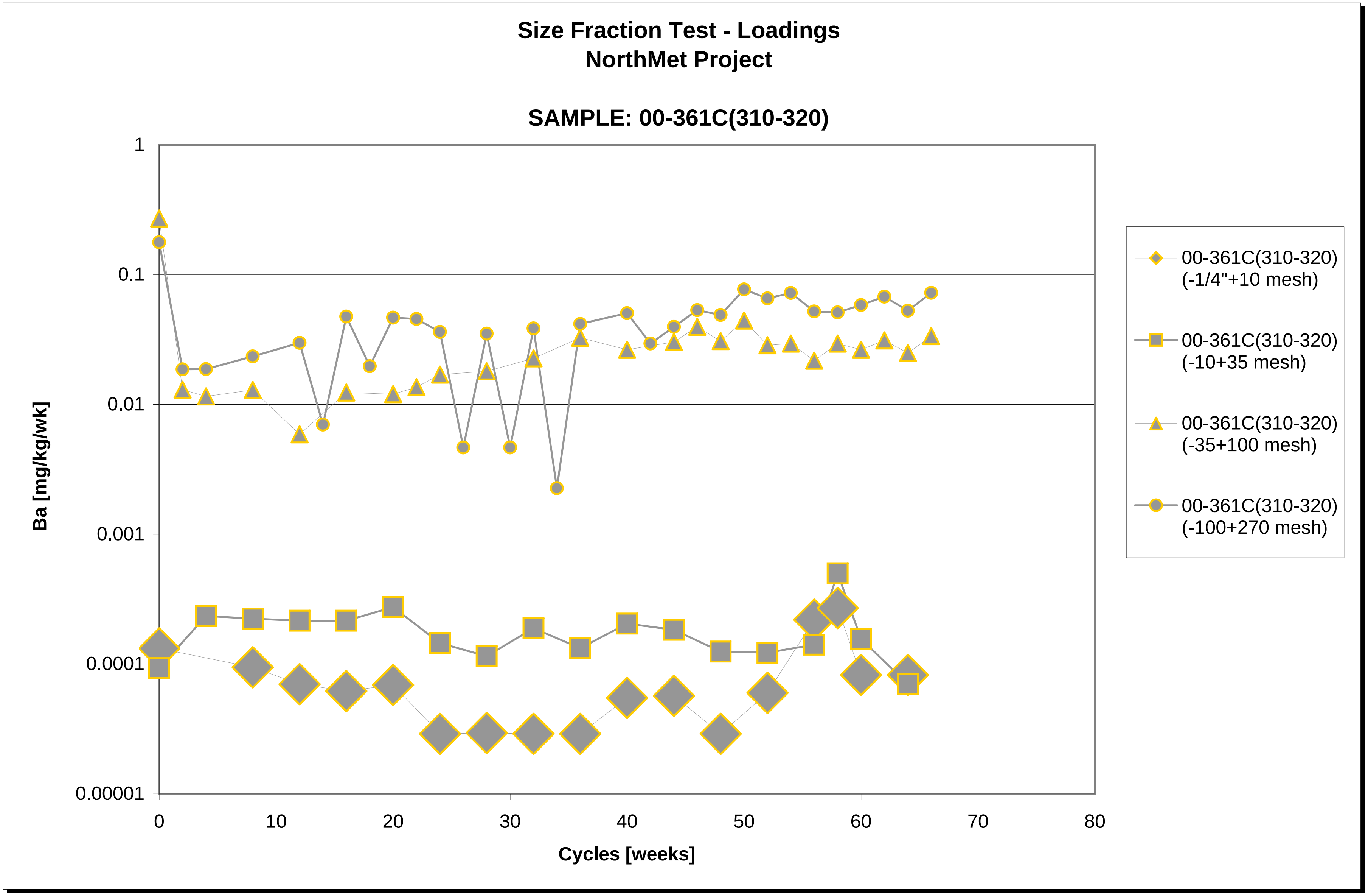

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Cl [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

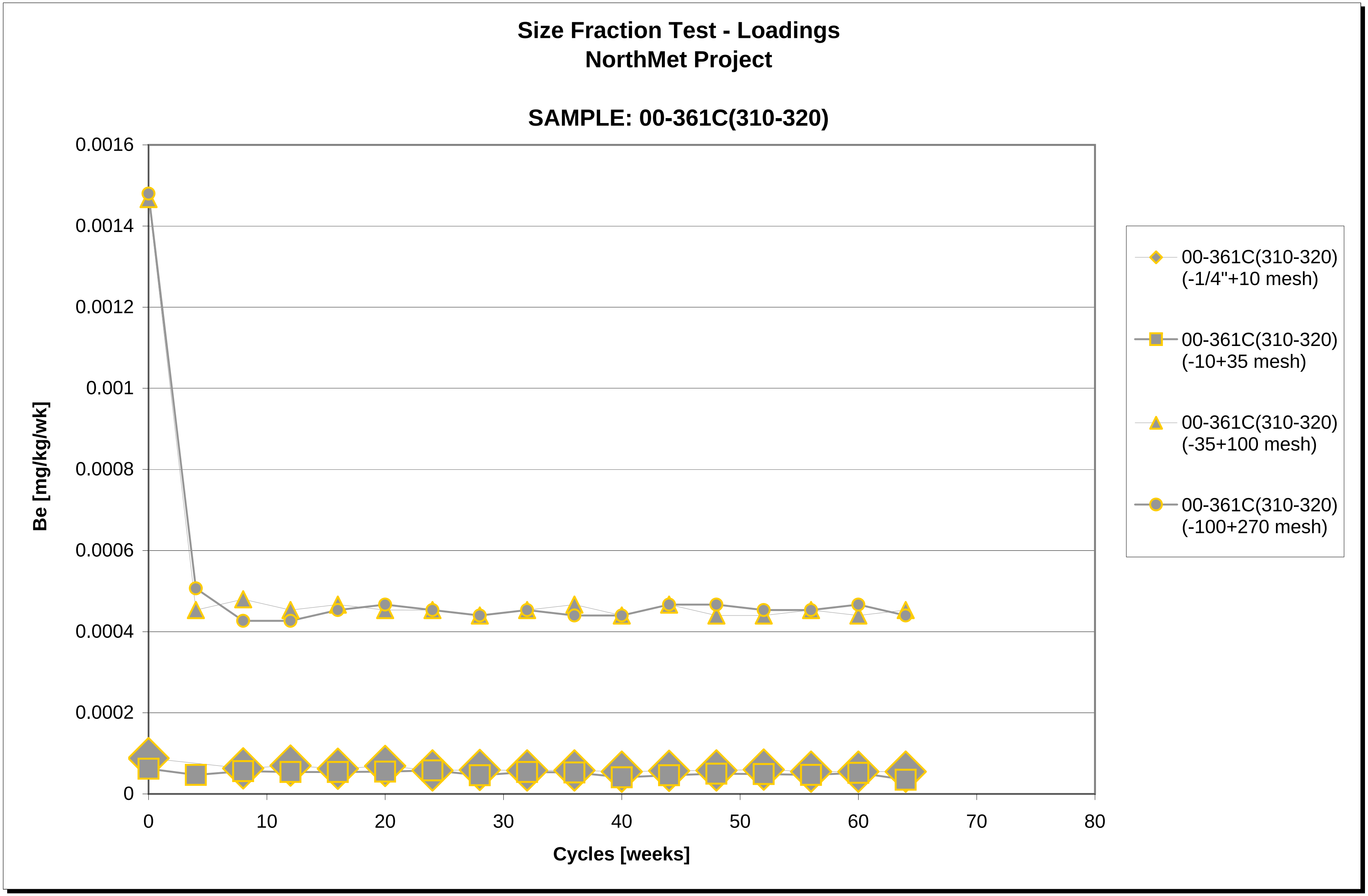

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
SO4 [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

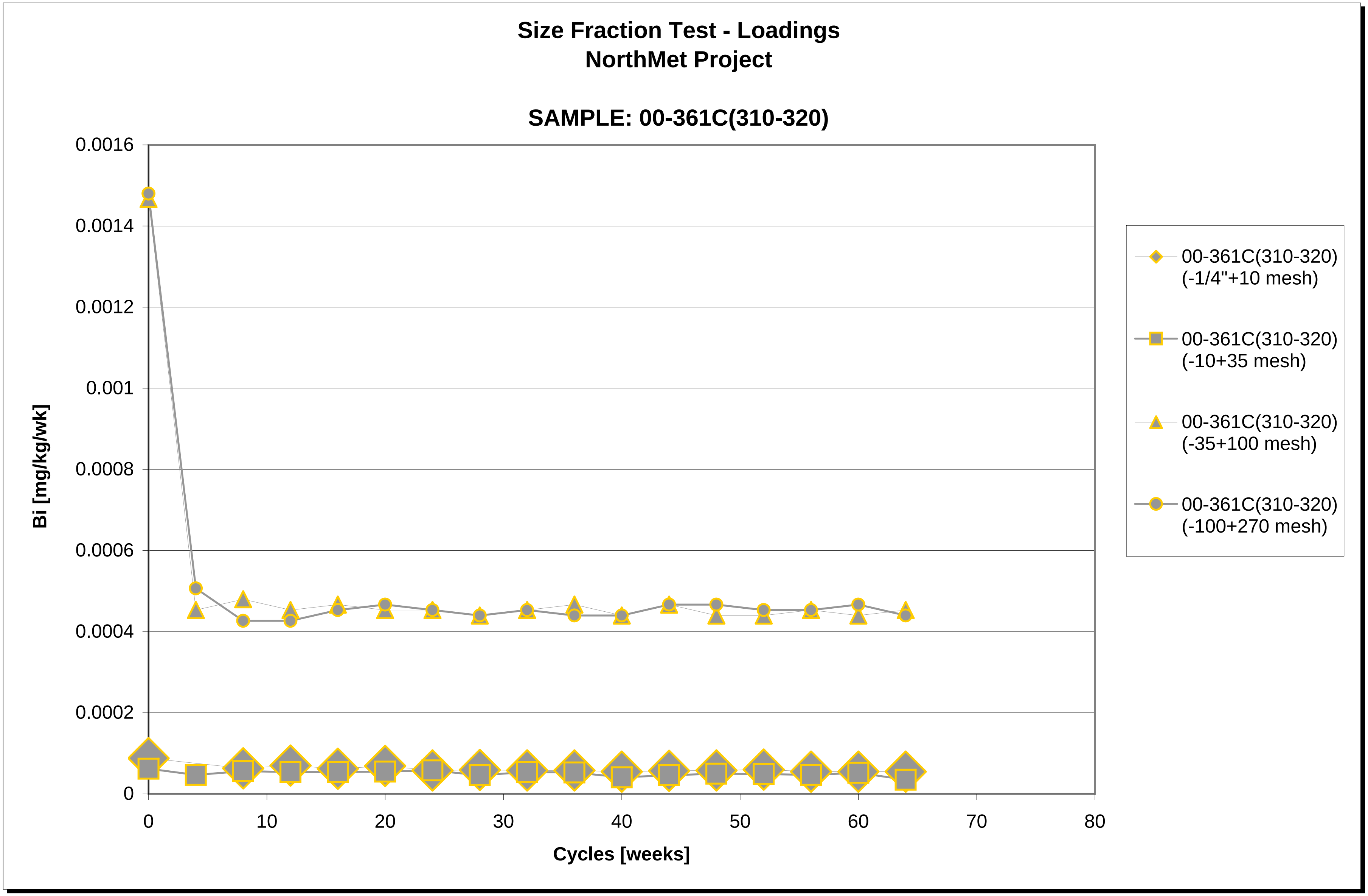

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Al [mg/kg/wk]
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

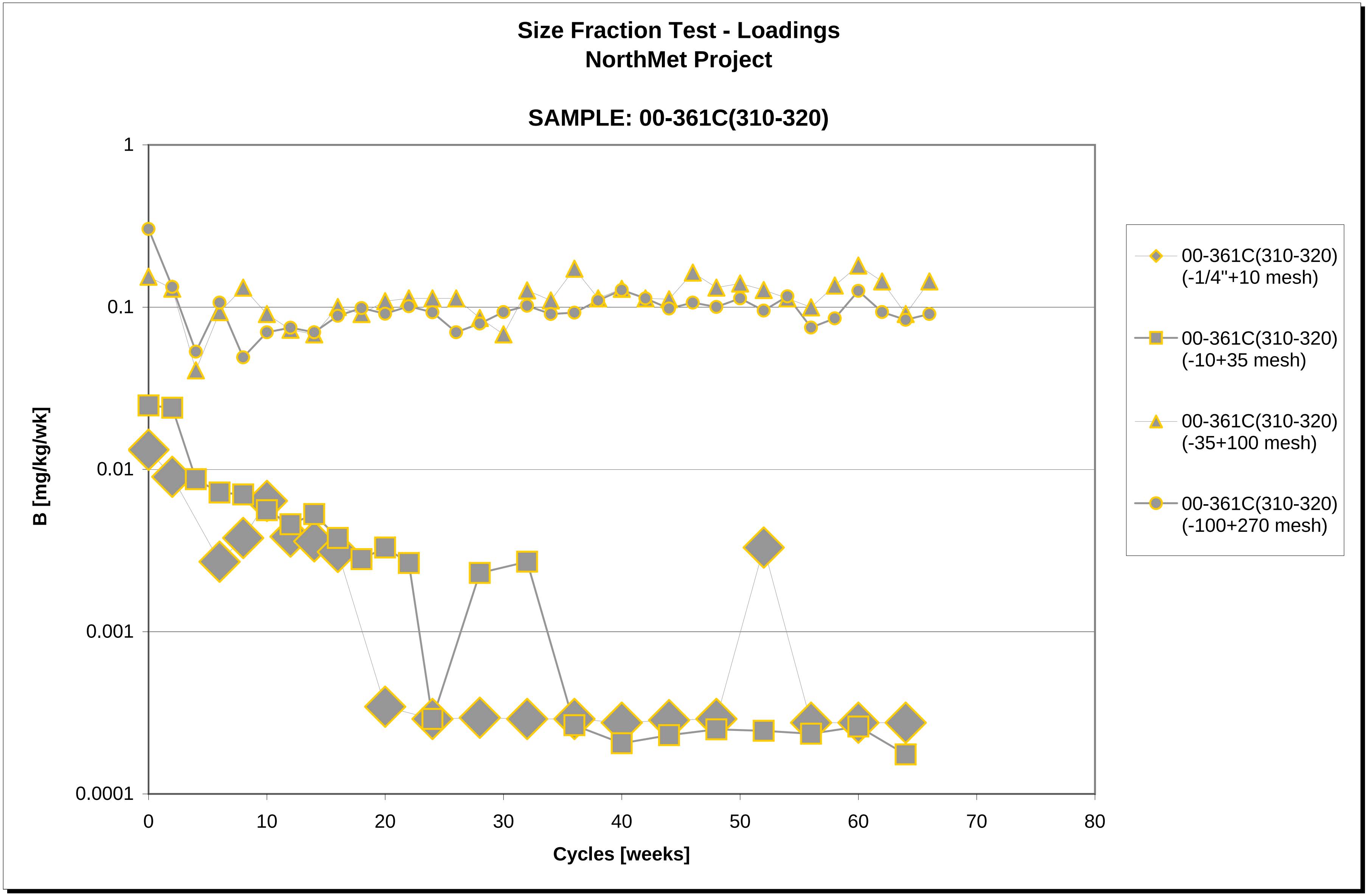

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Sb [mg/kg/wk]
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

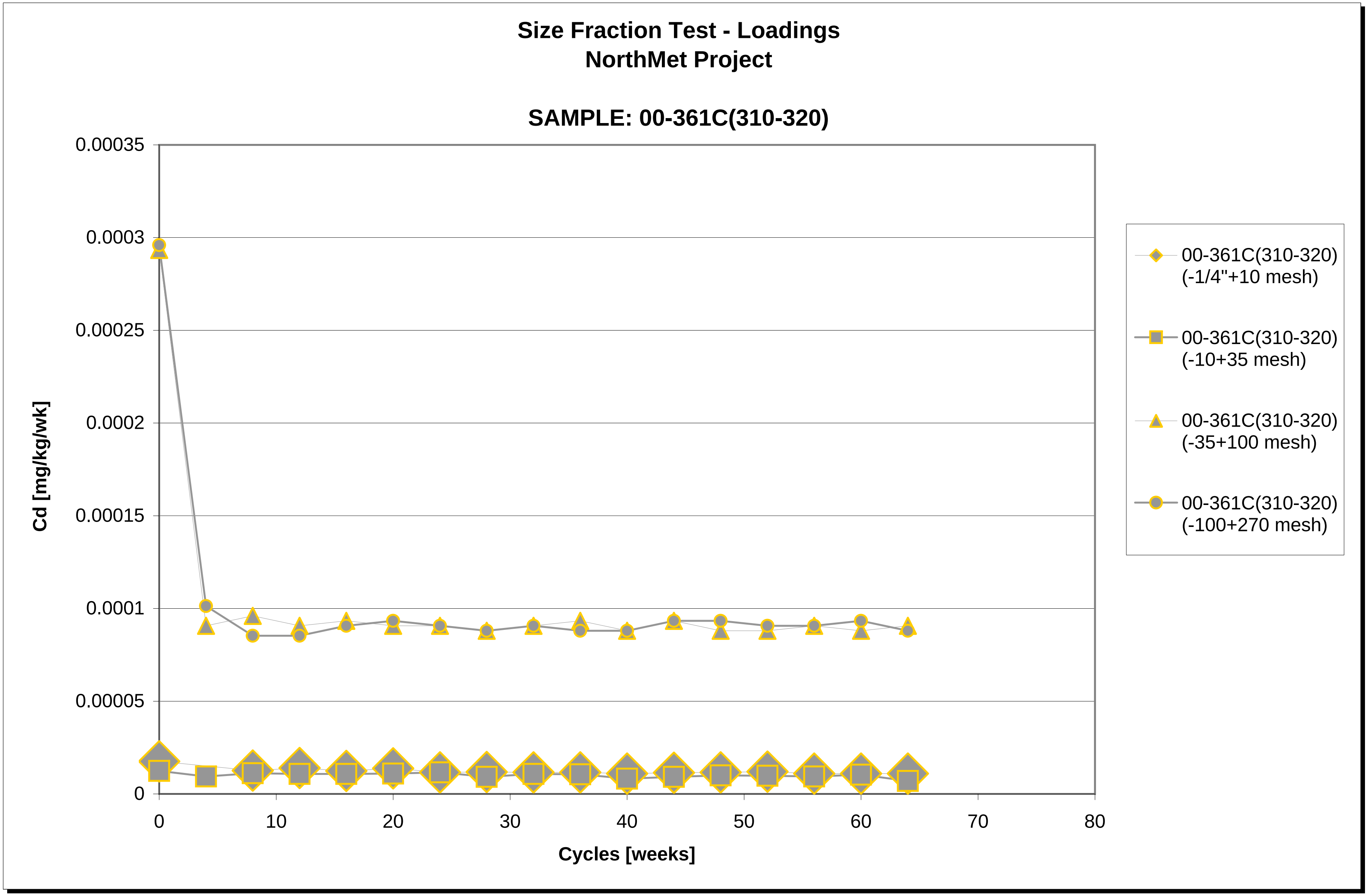

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
As [mg/kg/wk]
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

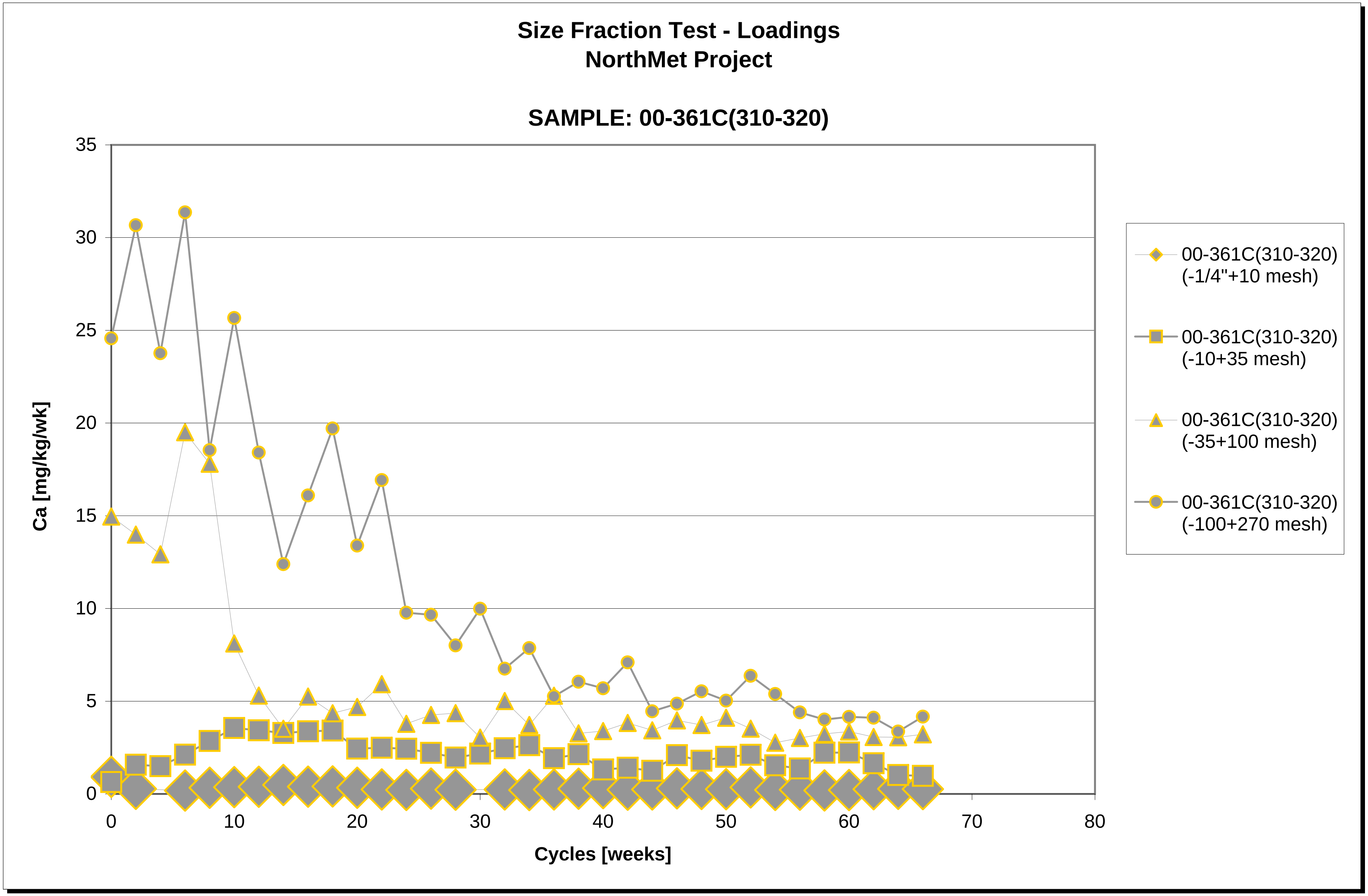

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Ba [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

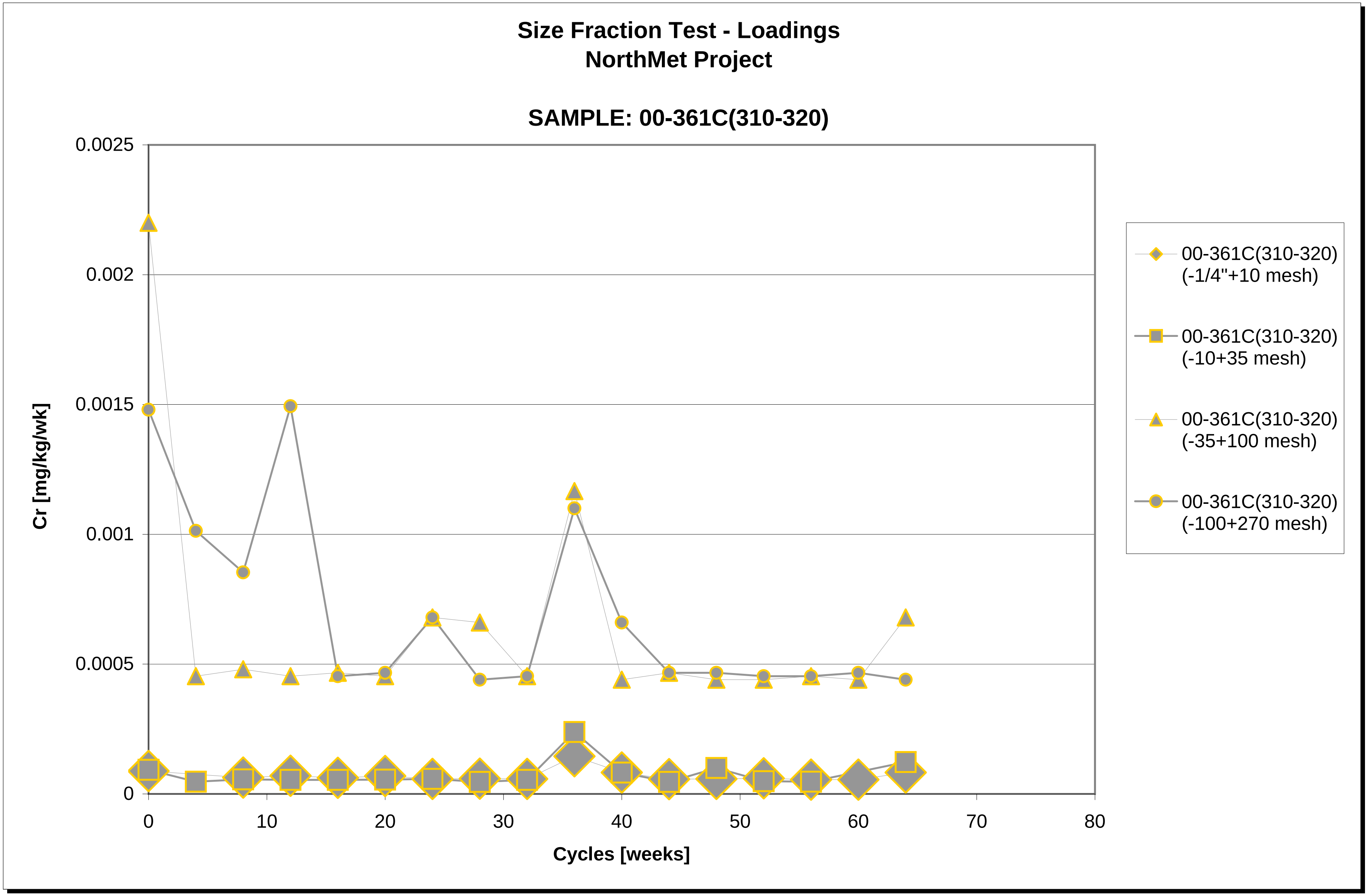

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Be [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

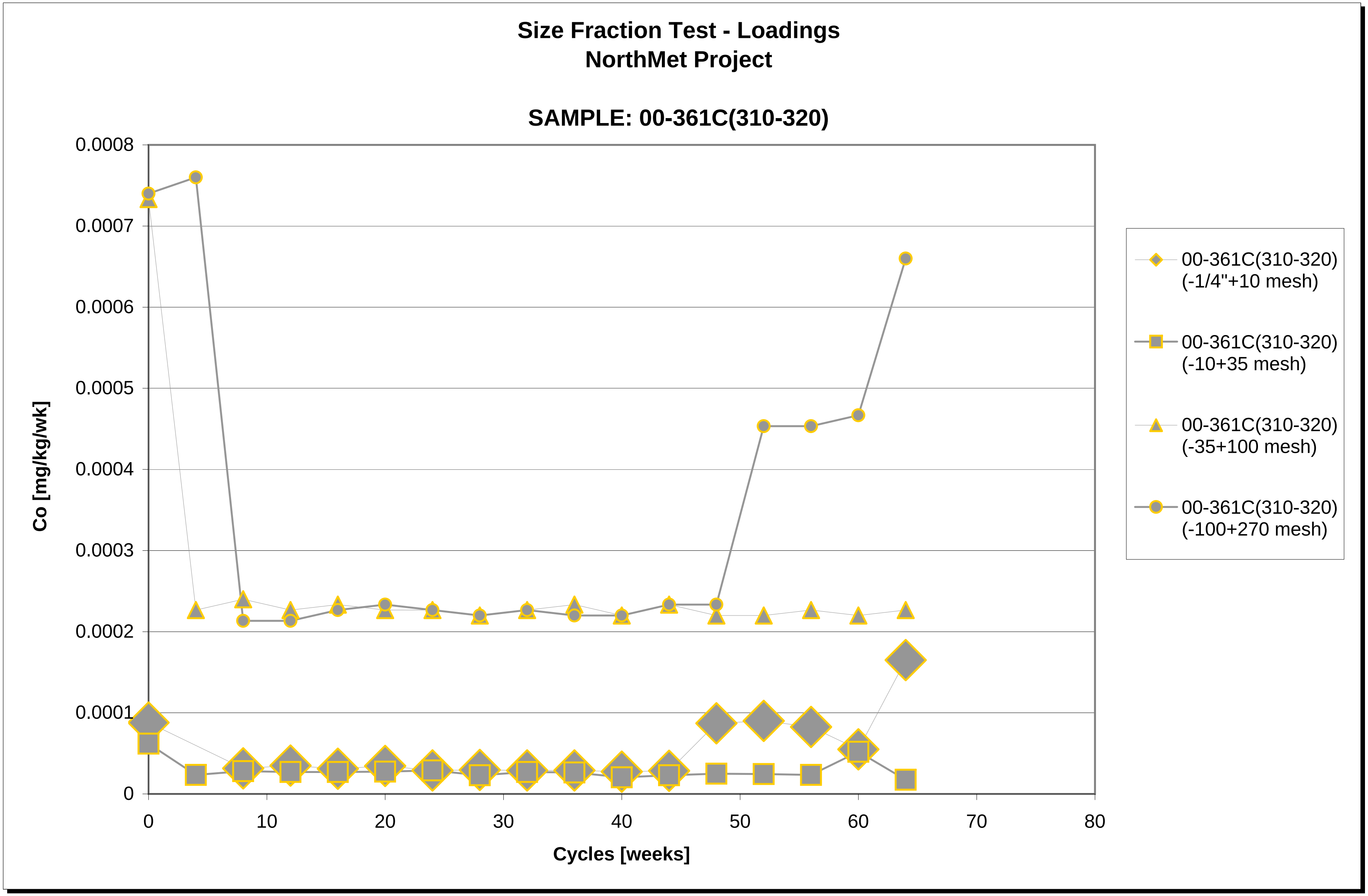

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Bi [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

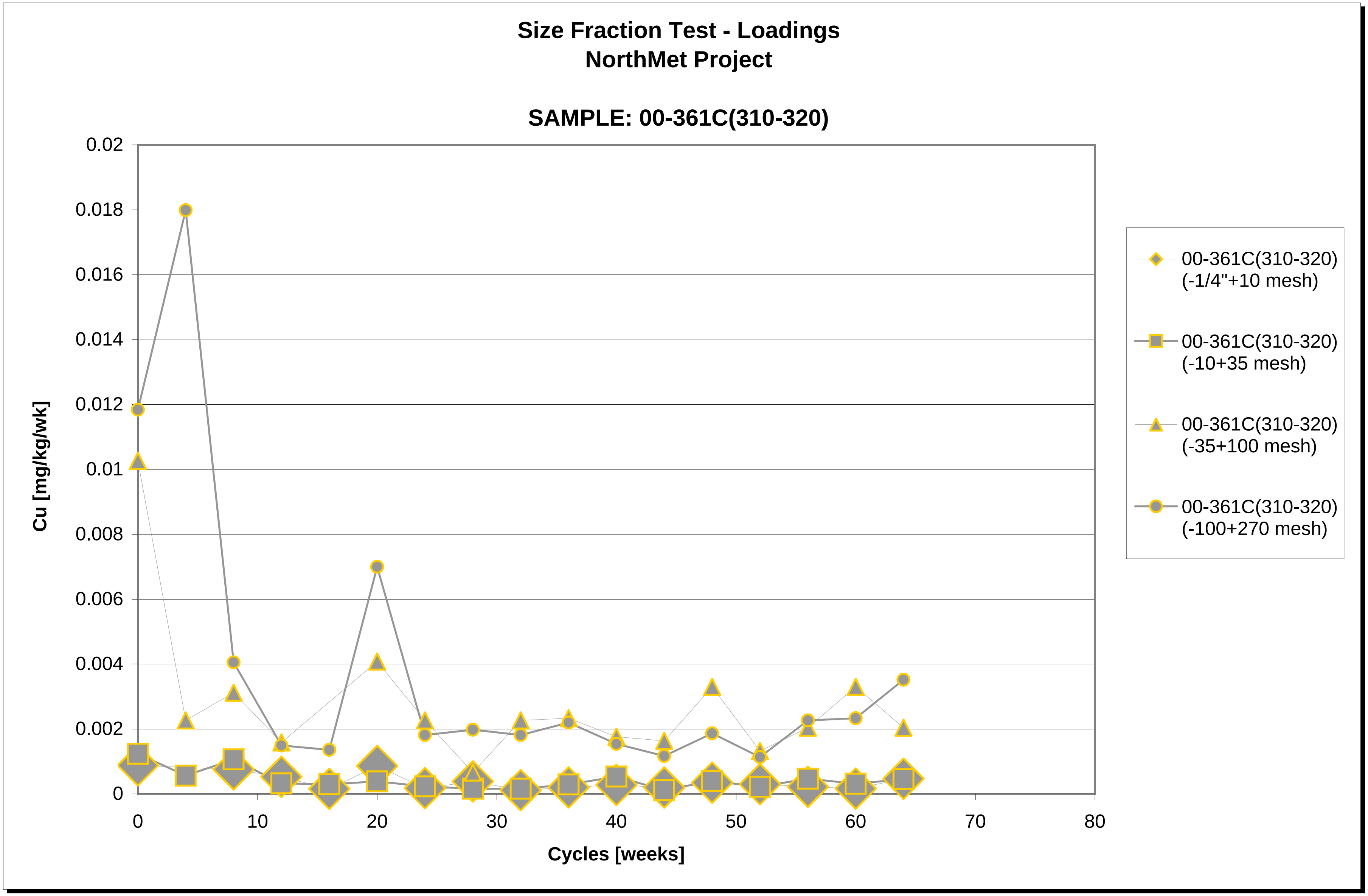

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
B [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

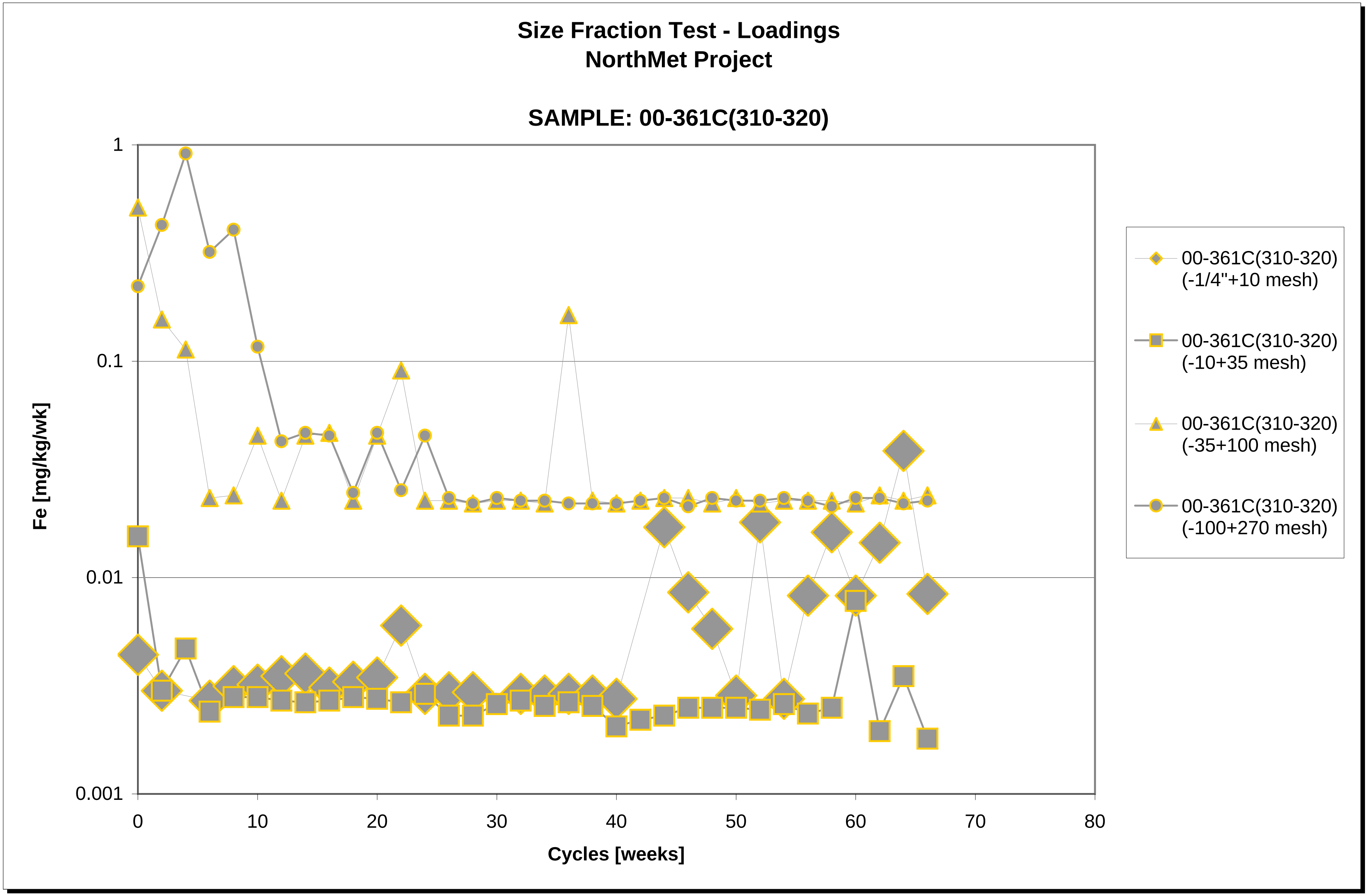

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Cd [mg/kg/wk]
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

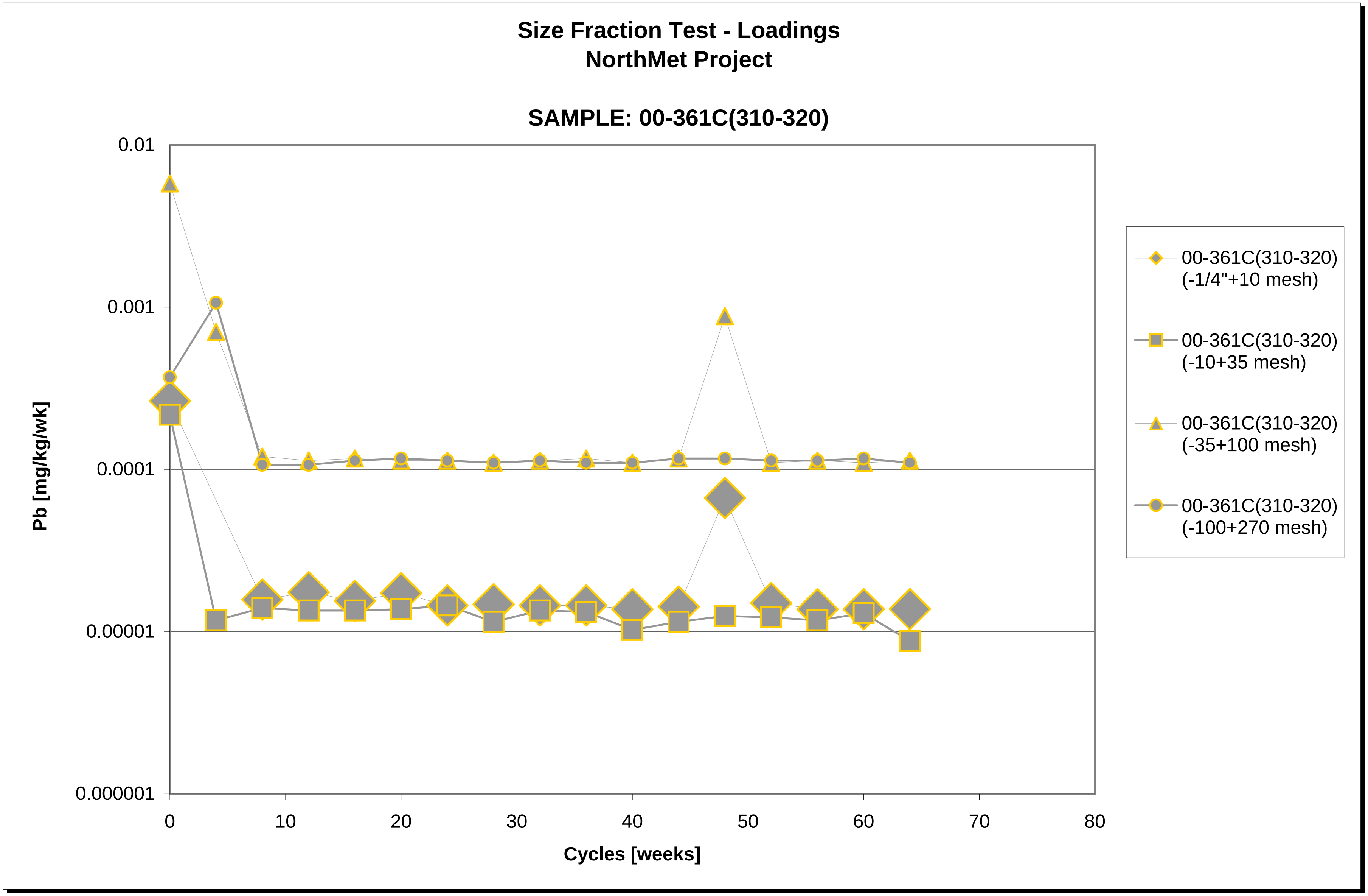

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Ca [mg/kg/wk]
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

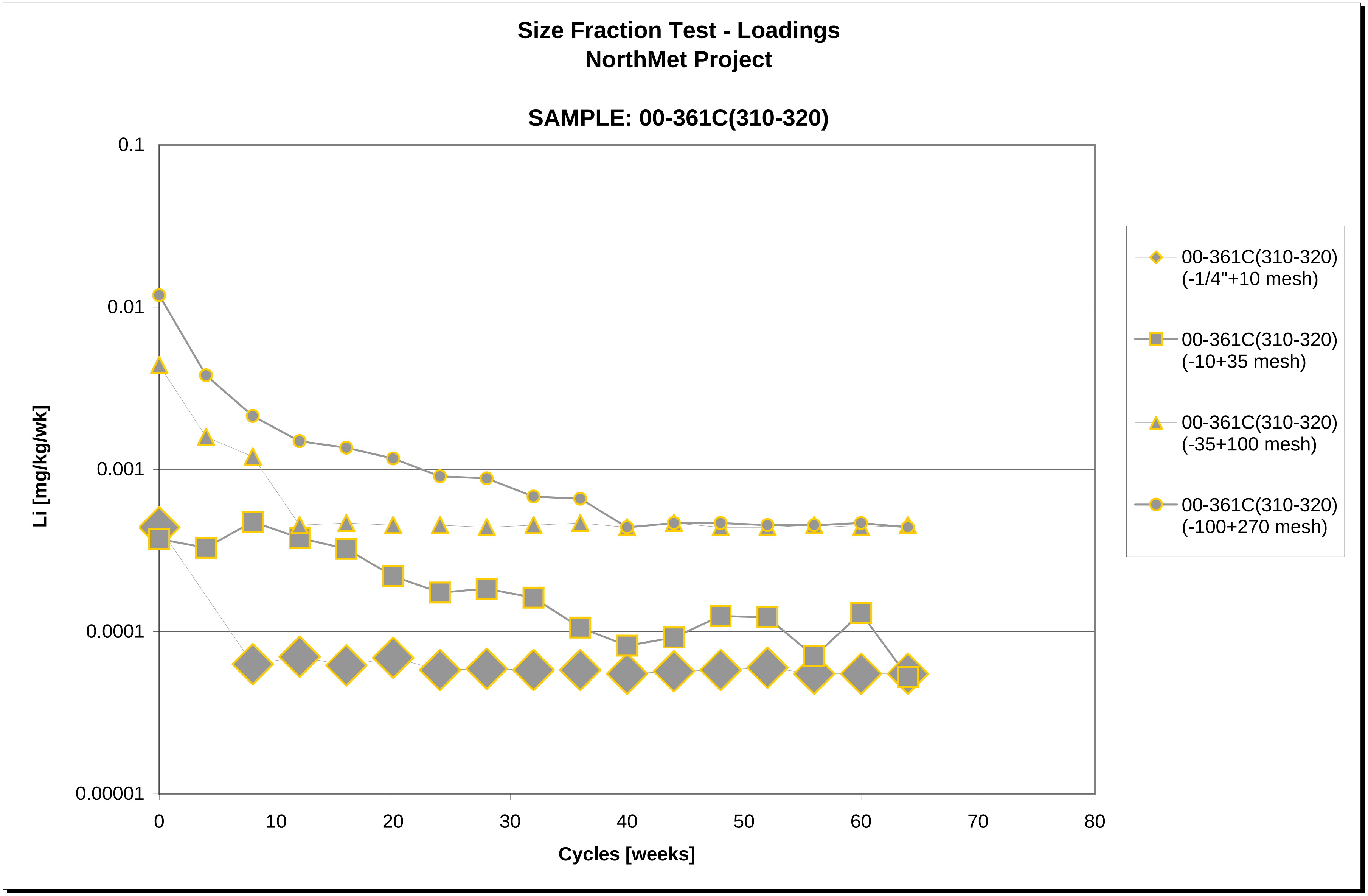

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
0.0025
0.002
0.0015
0.001
0.0005
0
Cr [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

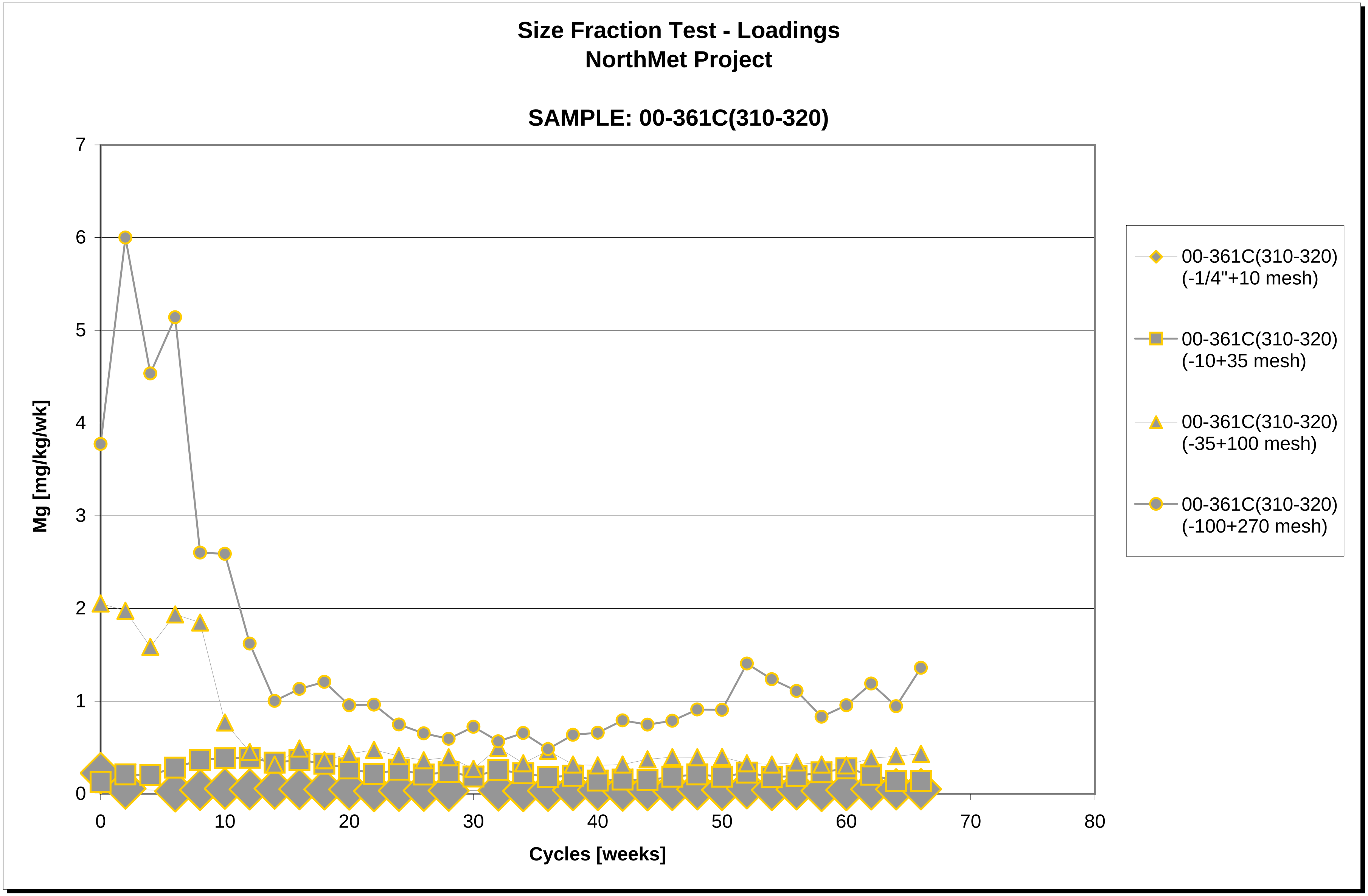

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Co [mg/kg/wk]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

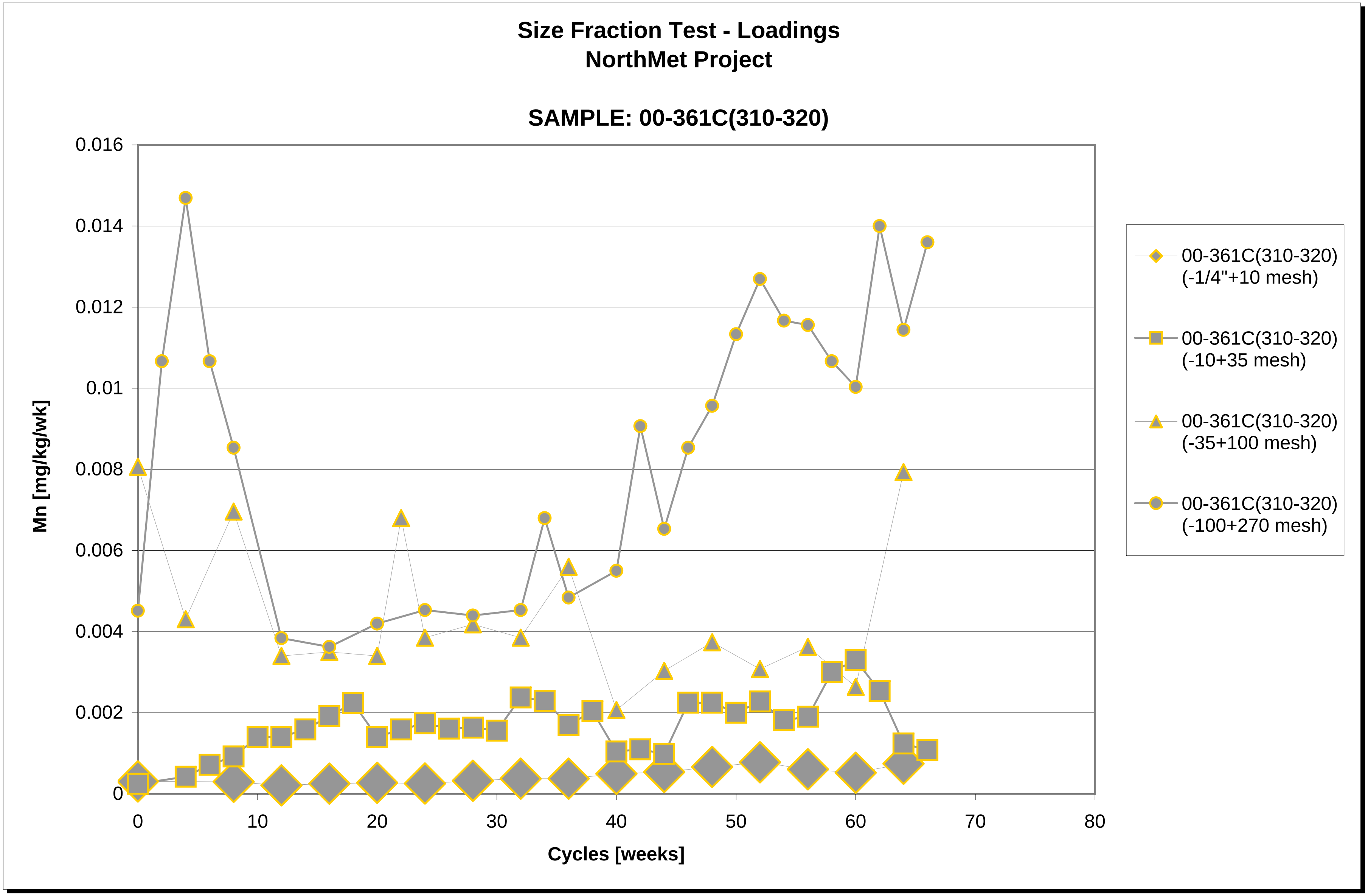

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Cu [mg/kg/wk]
0.02
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

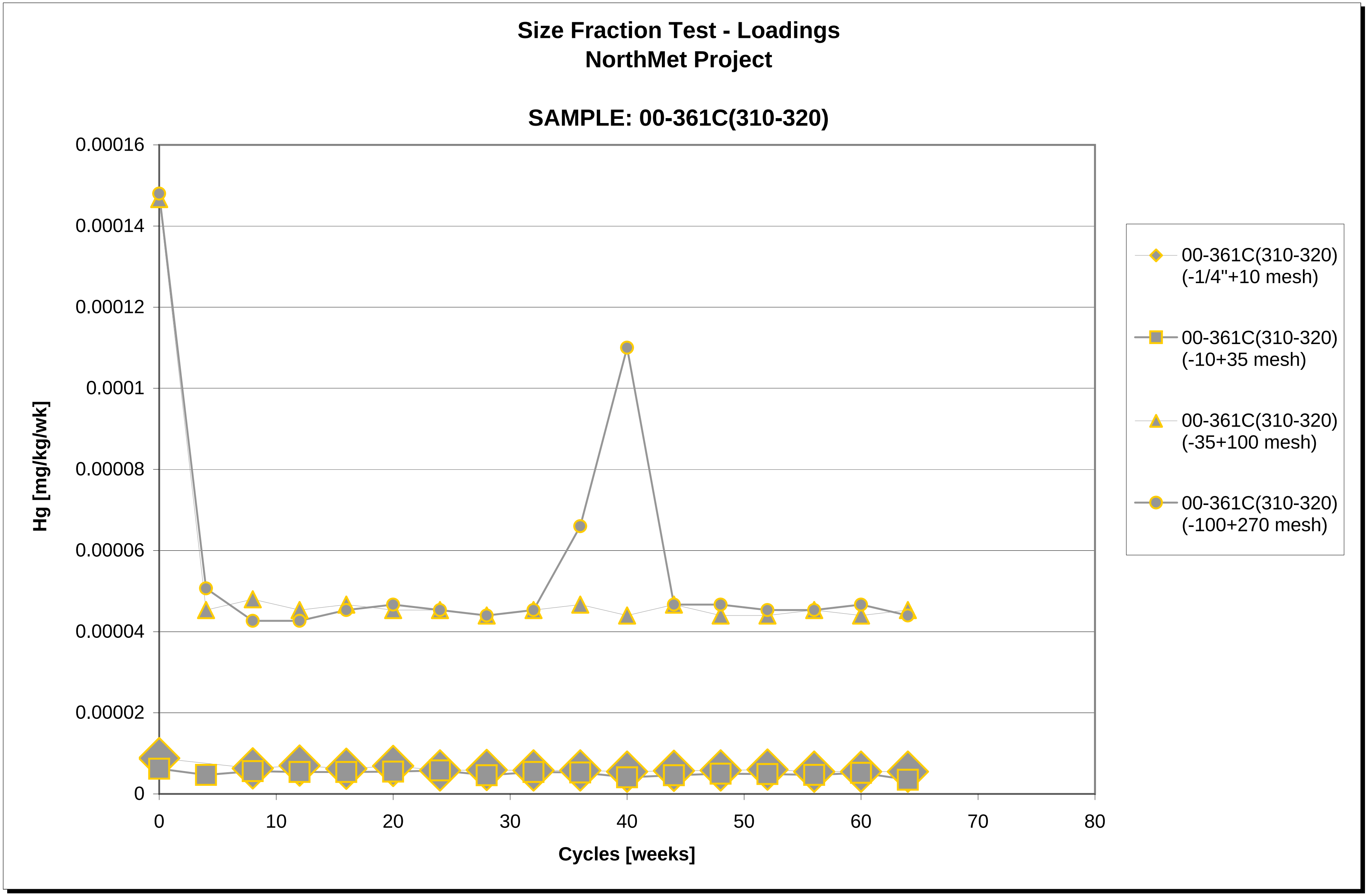

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Fe [mg/kg/wk]
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

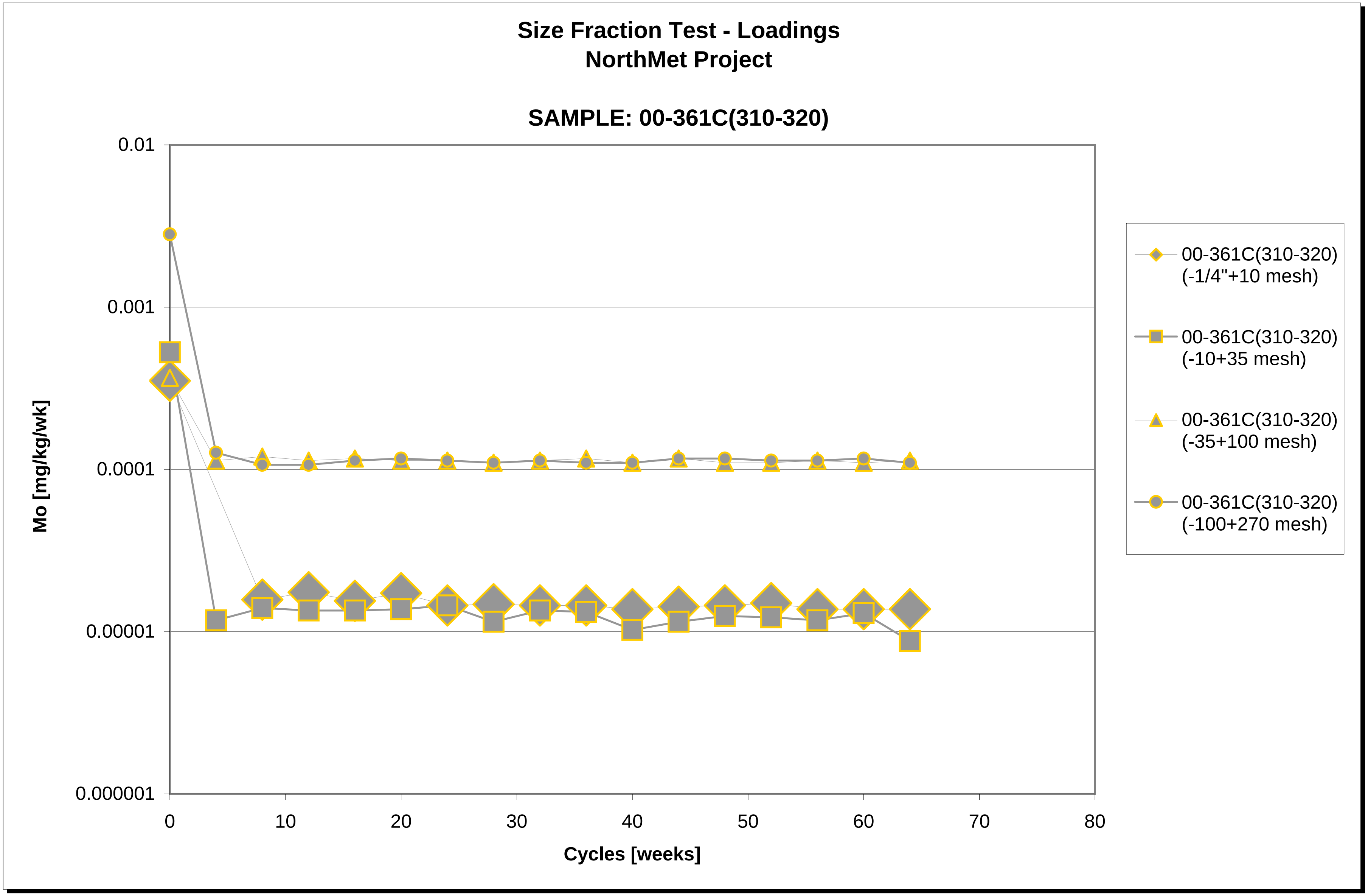

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Pb [mg/kg/wk]
0.01
0.001
0.0001
0.00001
0.000001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

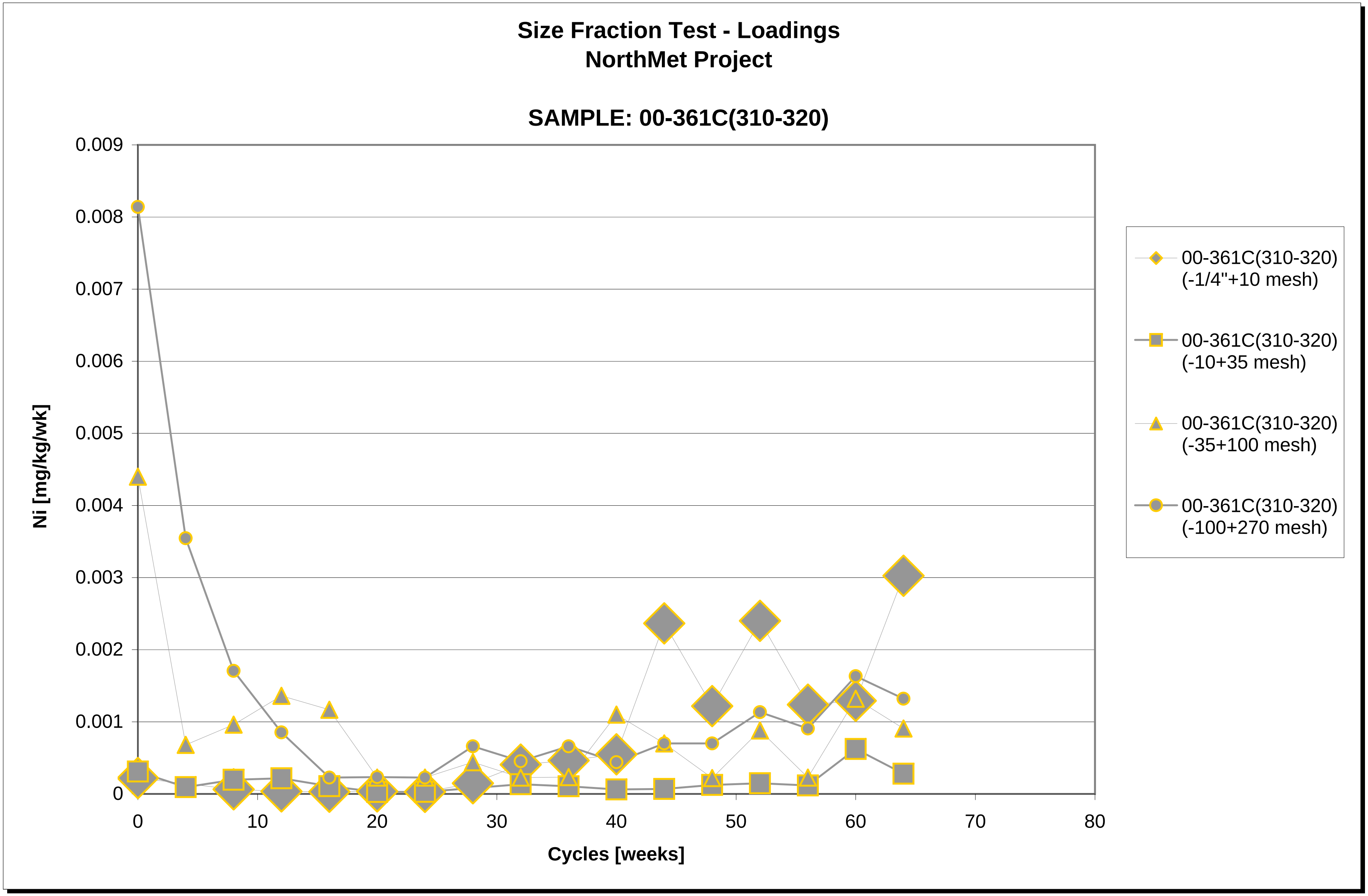

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Li [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Mg [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

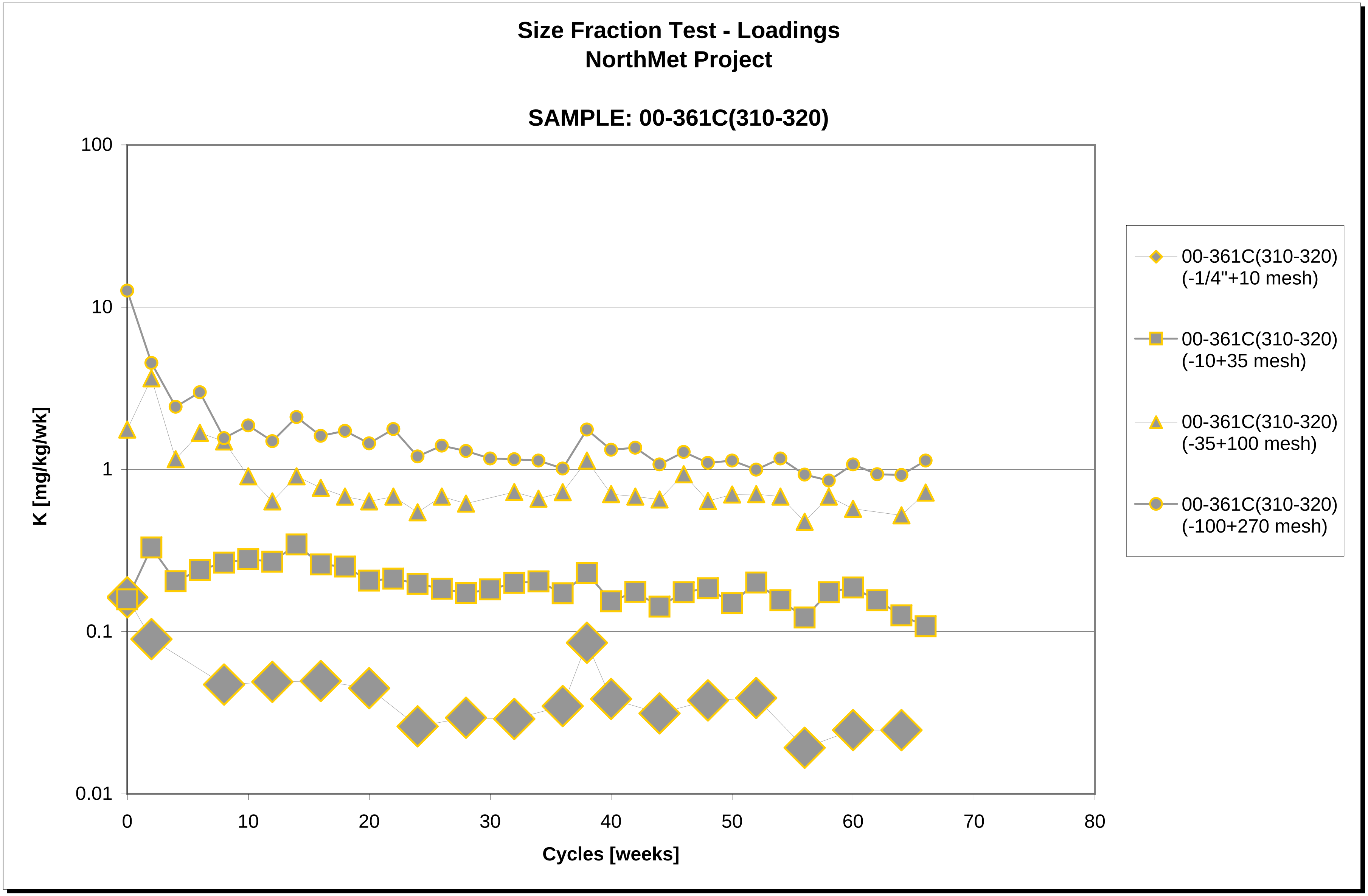

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Mn [mg/kg/wk]
Cycles [weeks]
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

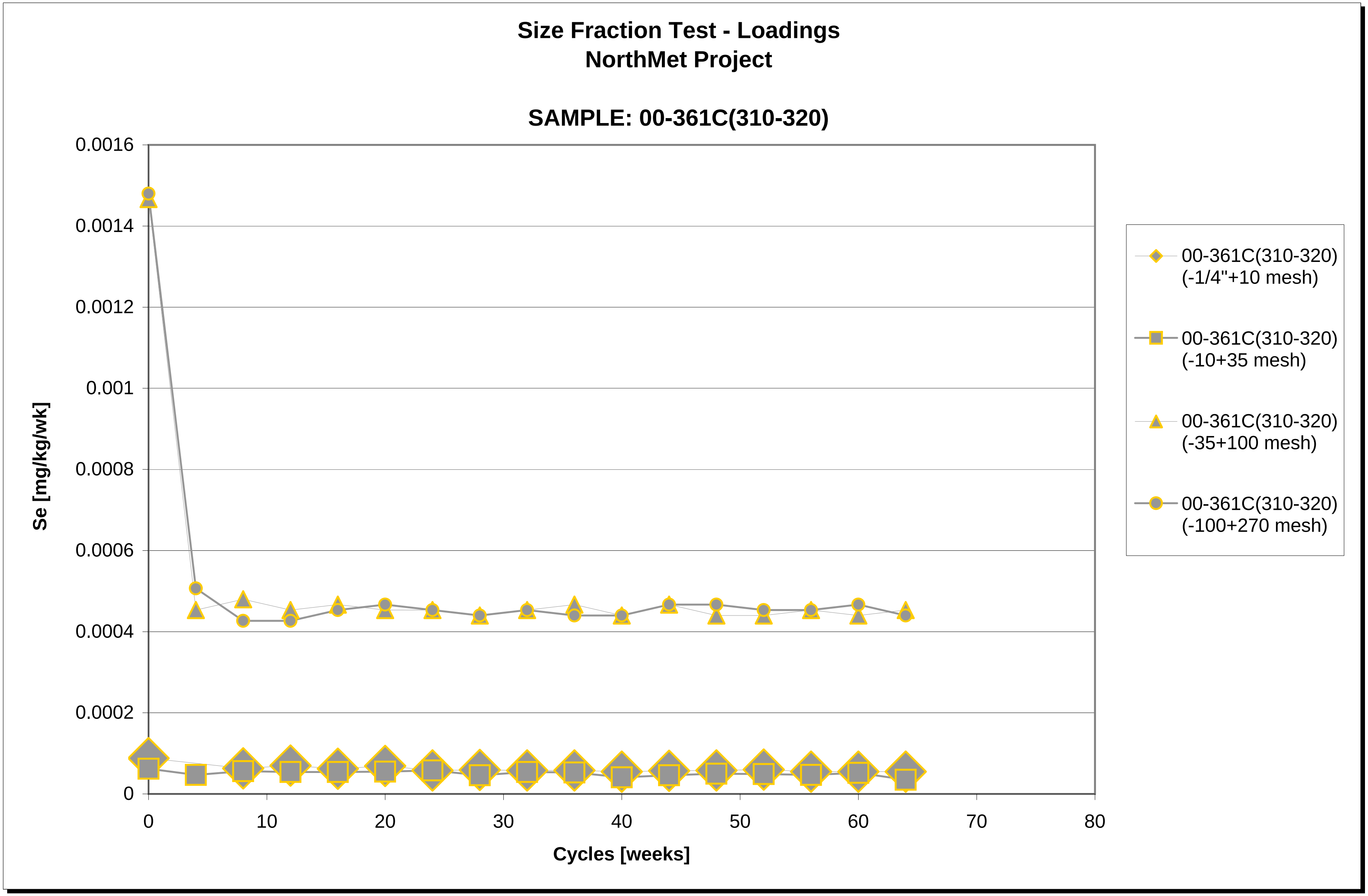

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Hg [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

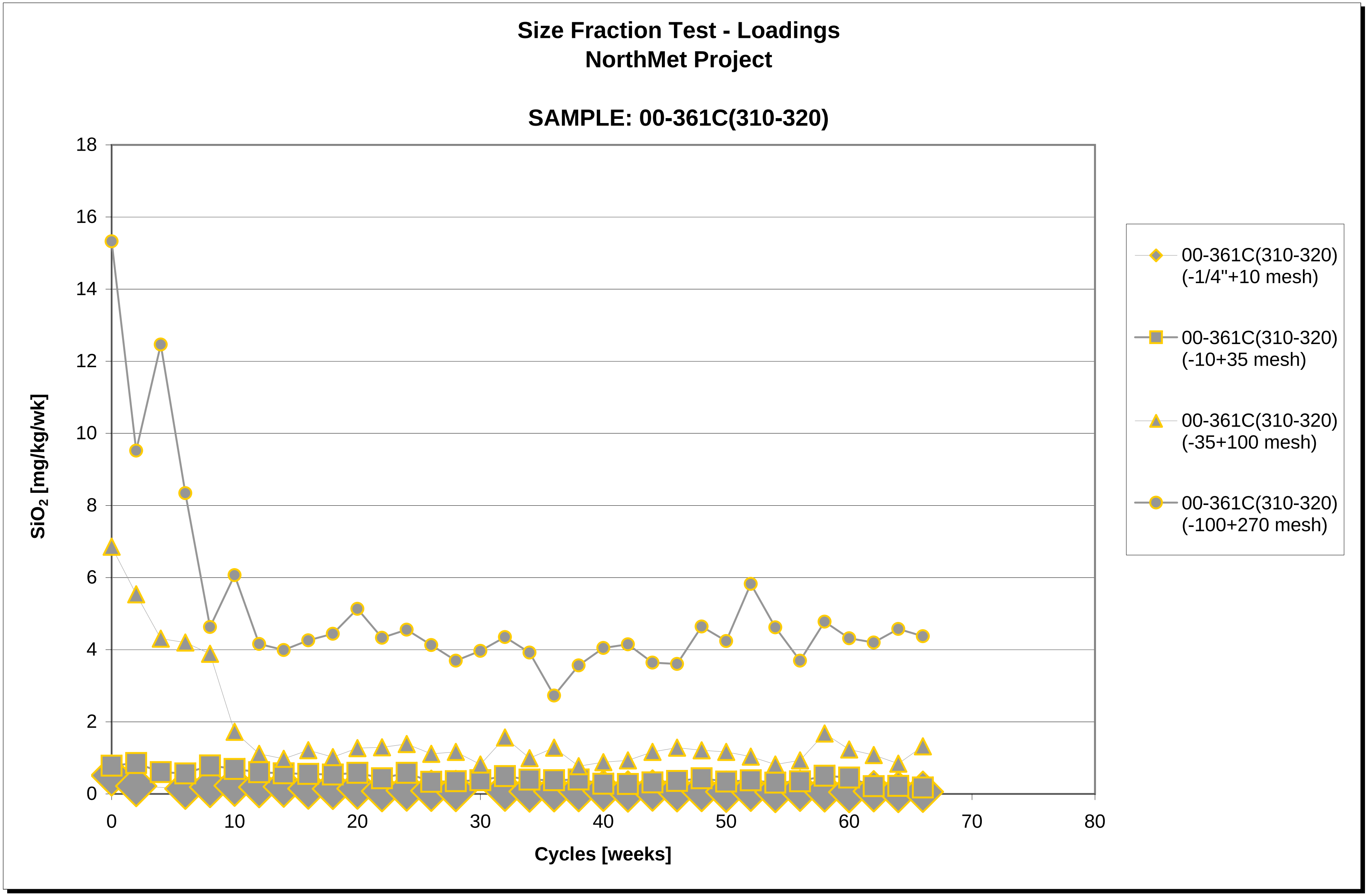

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
0.01
0.001
0.0001
0.00001
0.000001
Mo [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

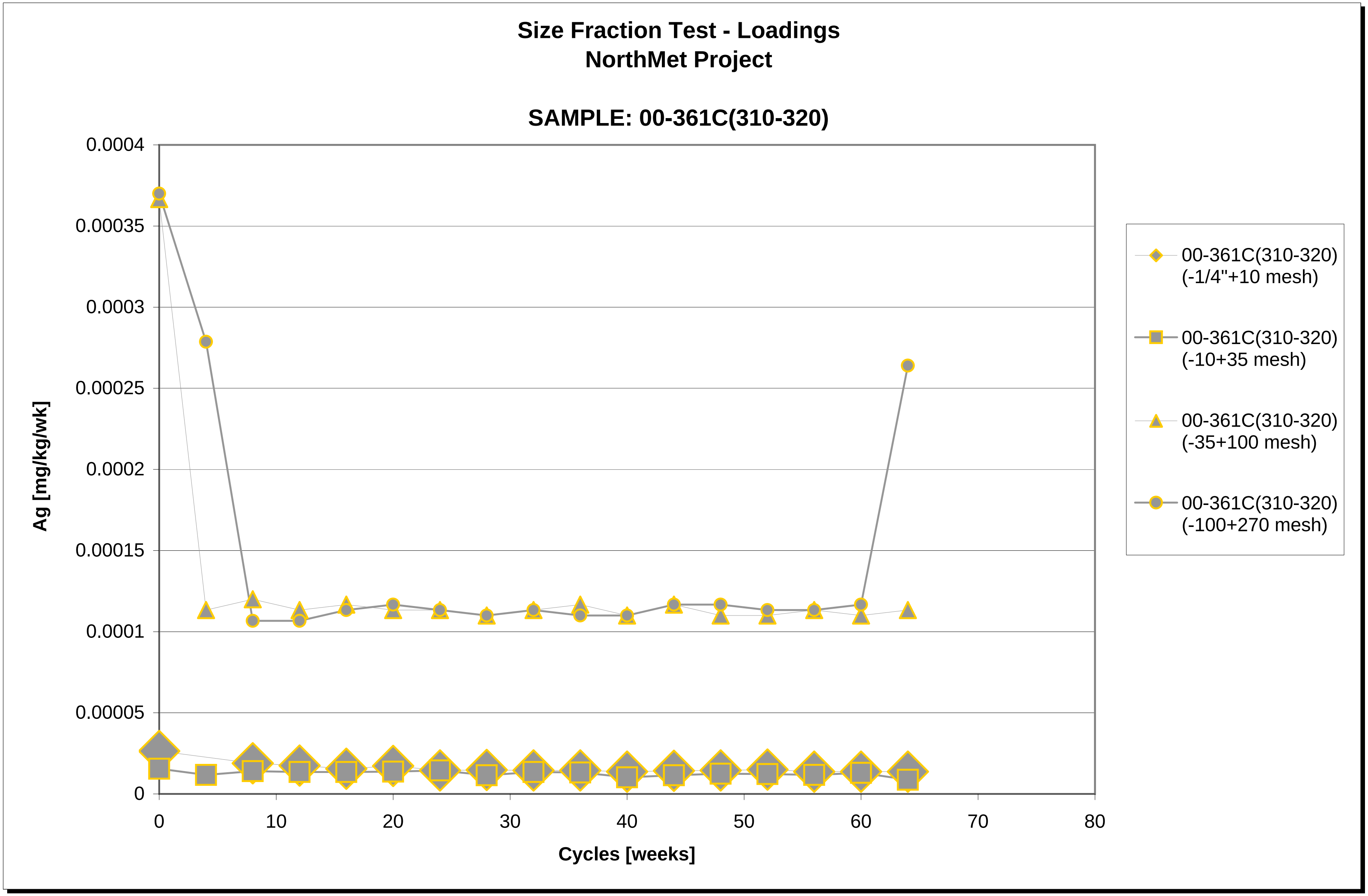

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Ni [mg/kg/wk]
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

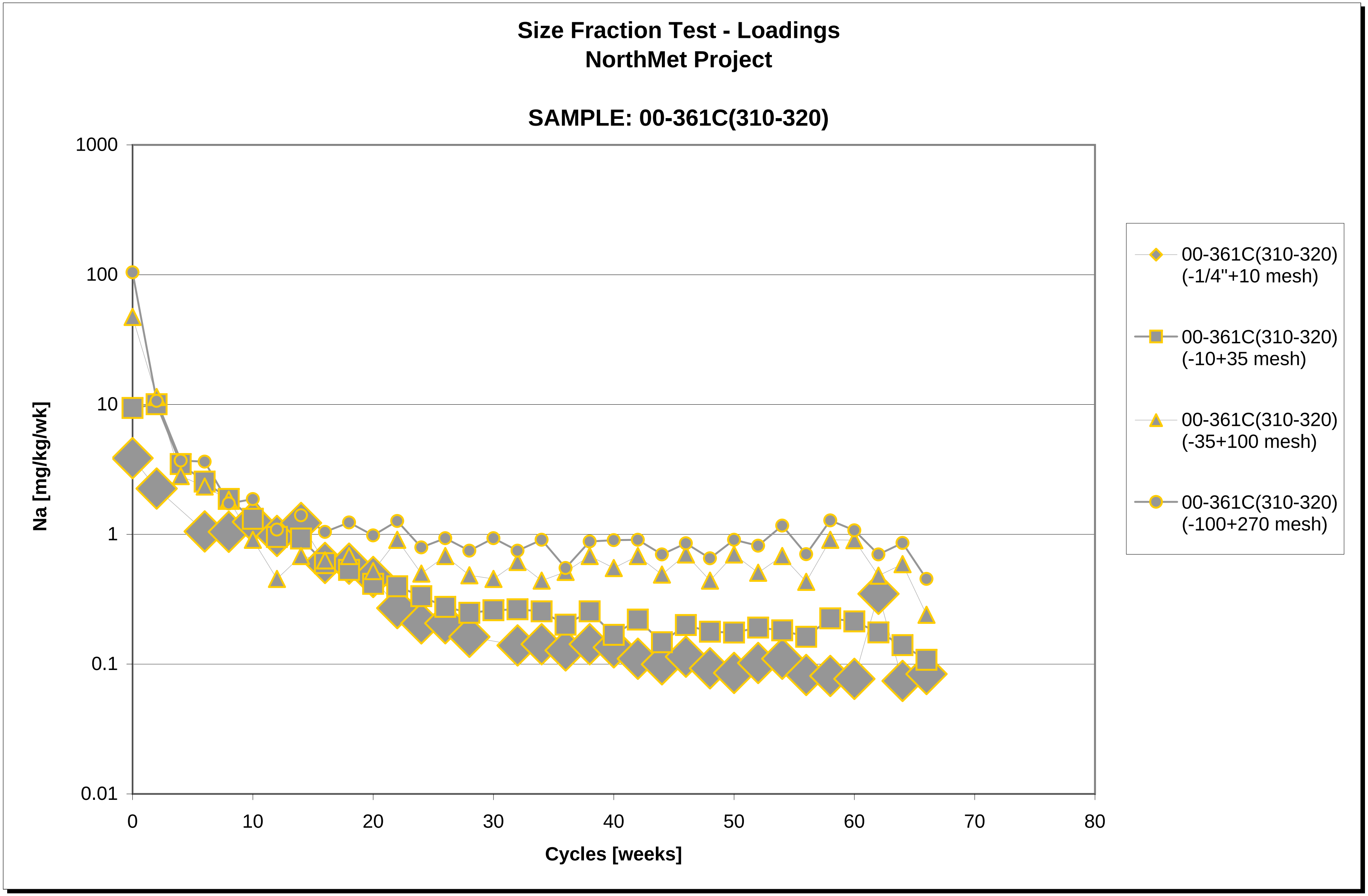

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
PO4 [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

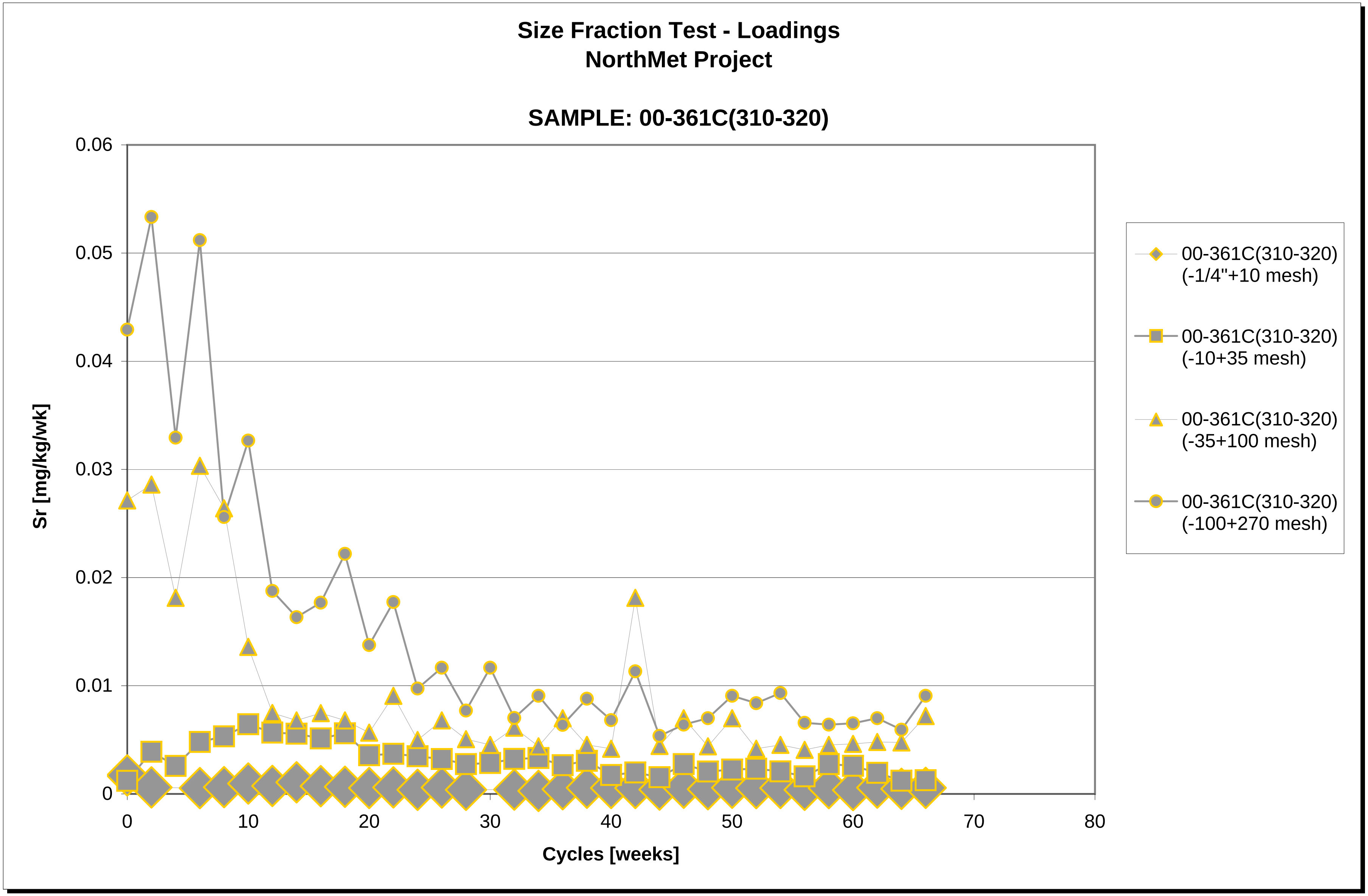

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
K [mg/kg/wk]
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

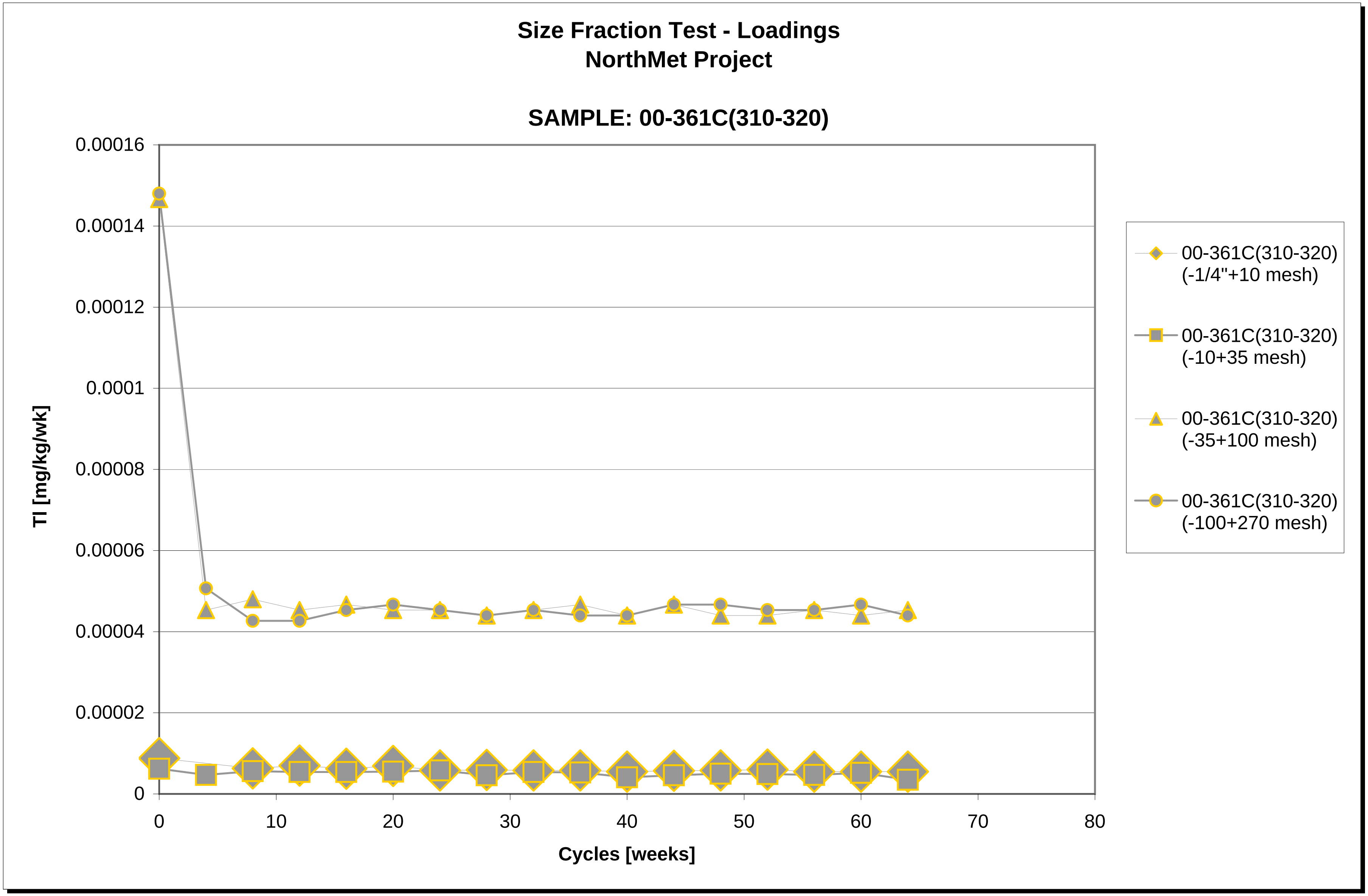

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Se [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

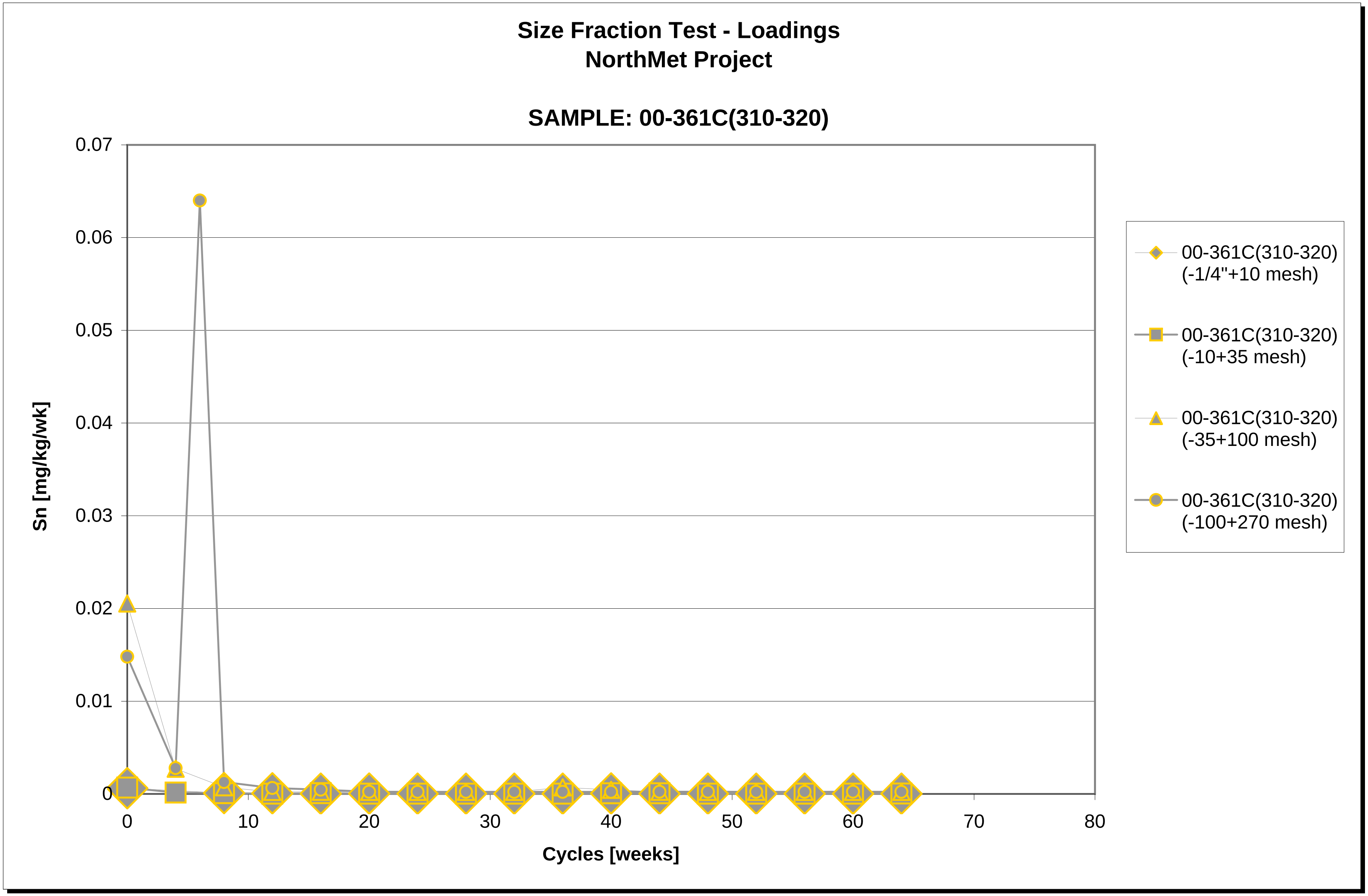

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
SiO2 [mg/kg/wk]
18
16
14
12
10
8
6
4
2
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

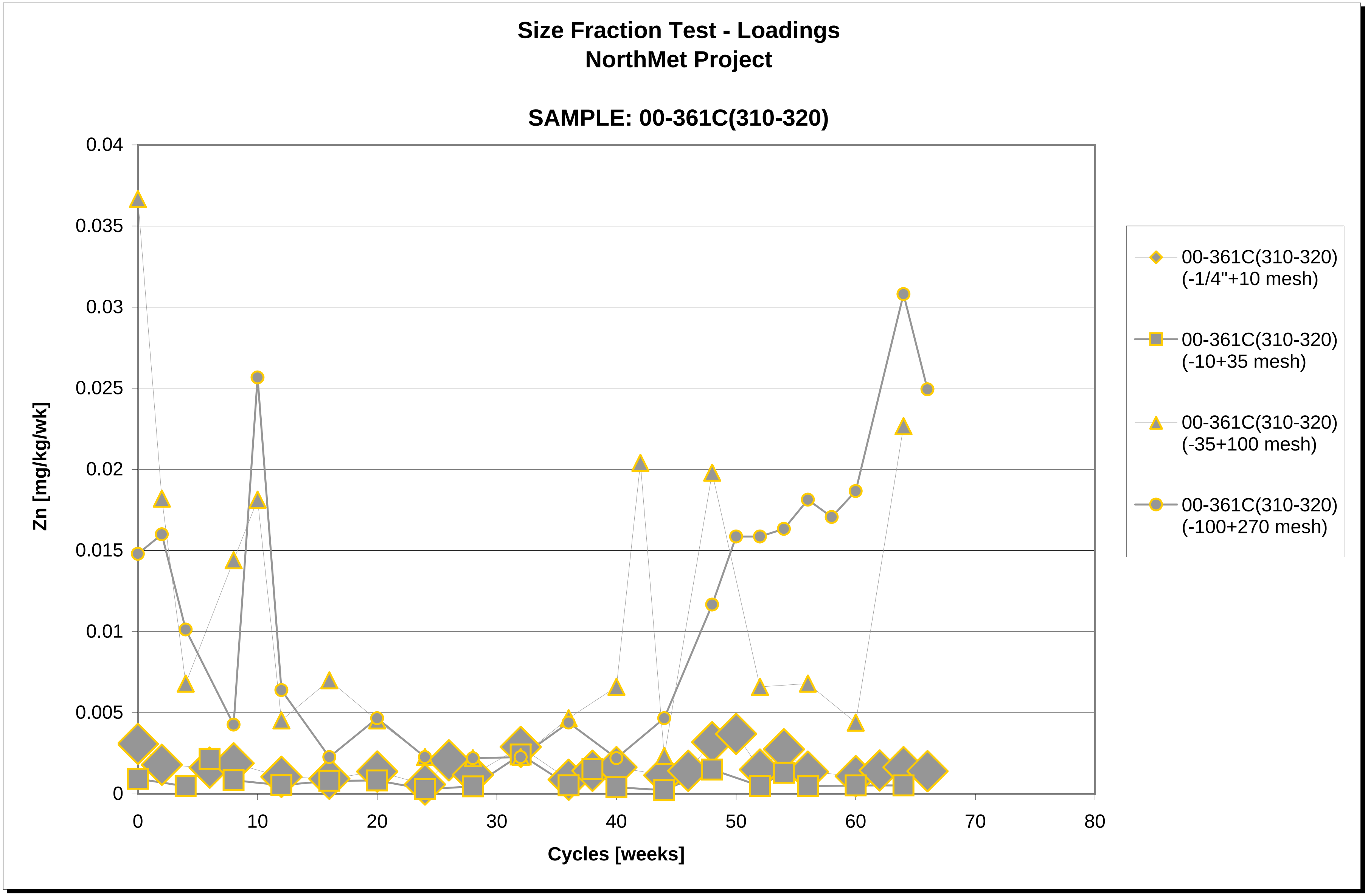

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Ag [mg/kg/wk]
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

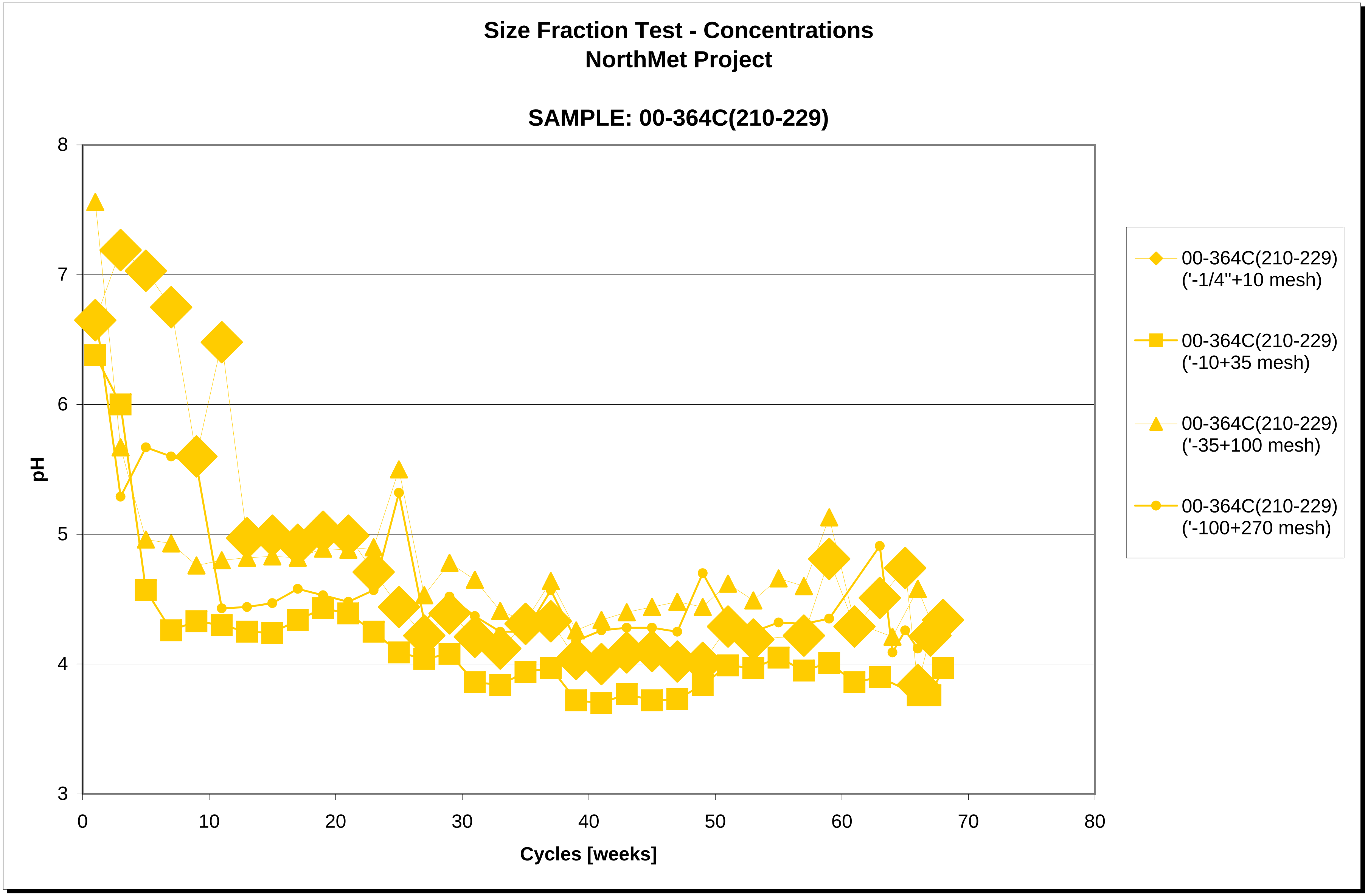

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Na [mg/kg/wk]
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

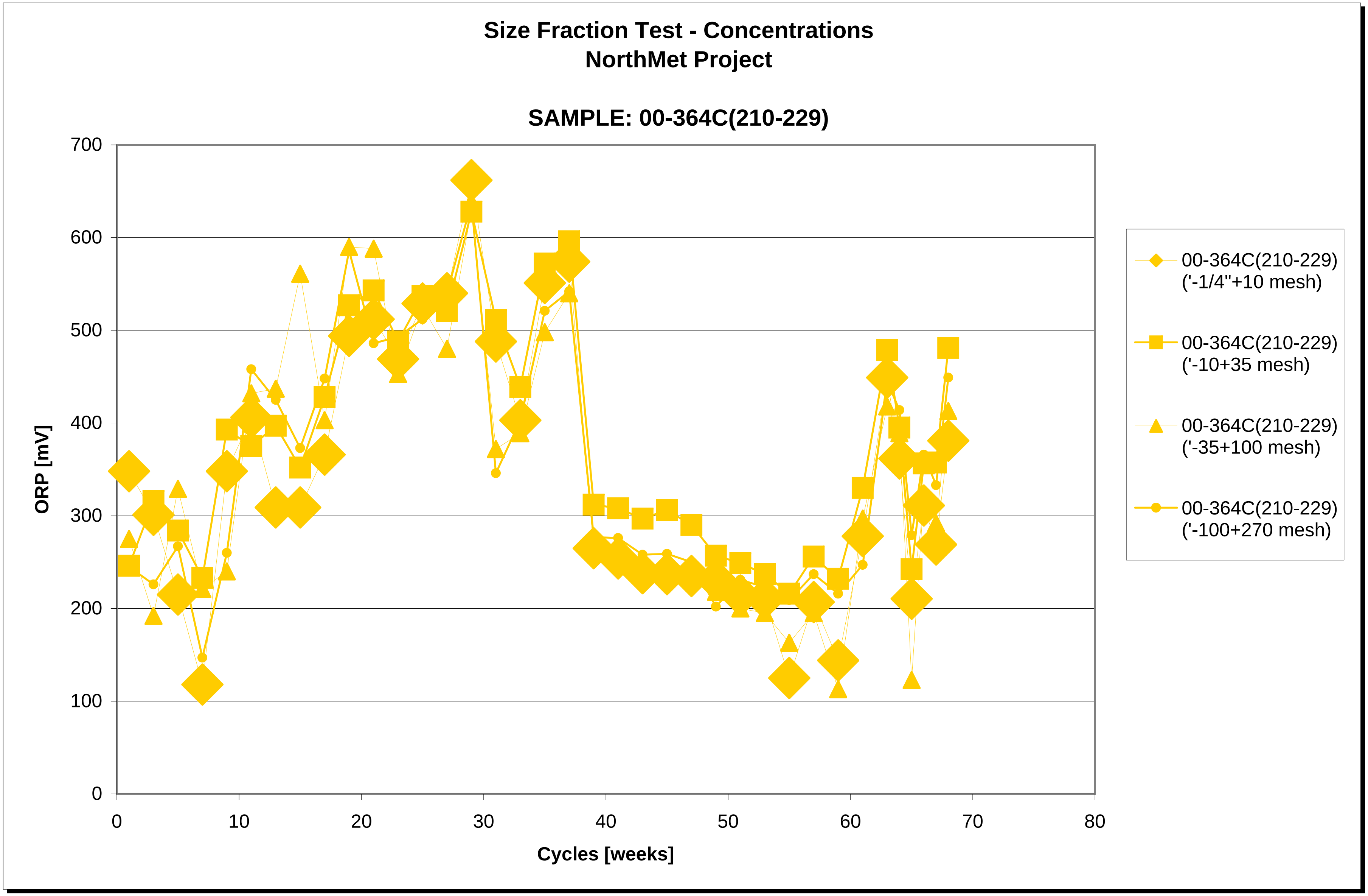

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Sr [mg/kg/wk]
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

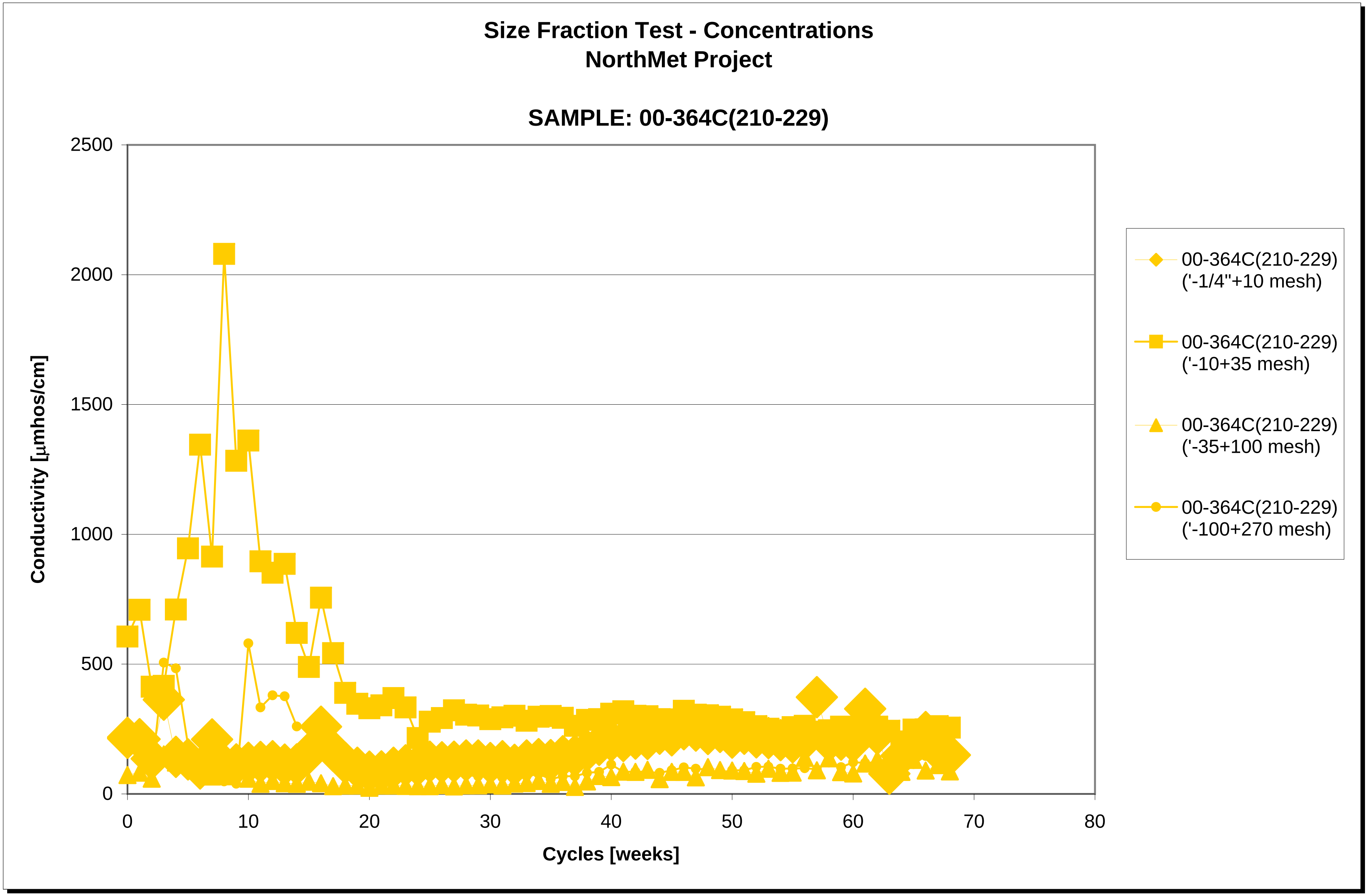

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Tl [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

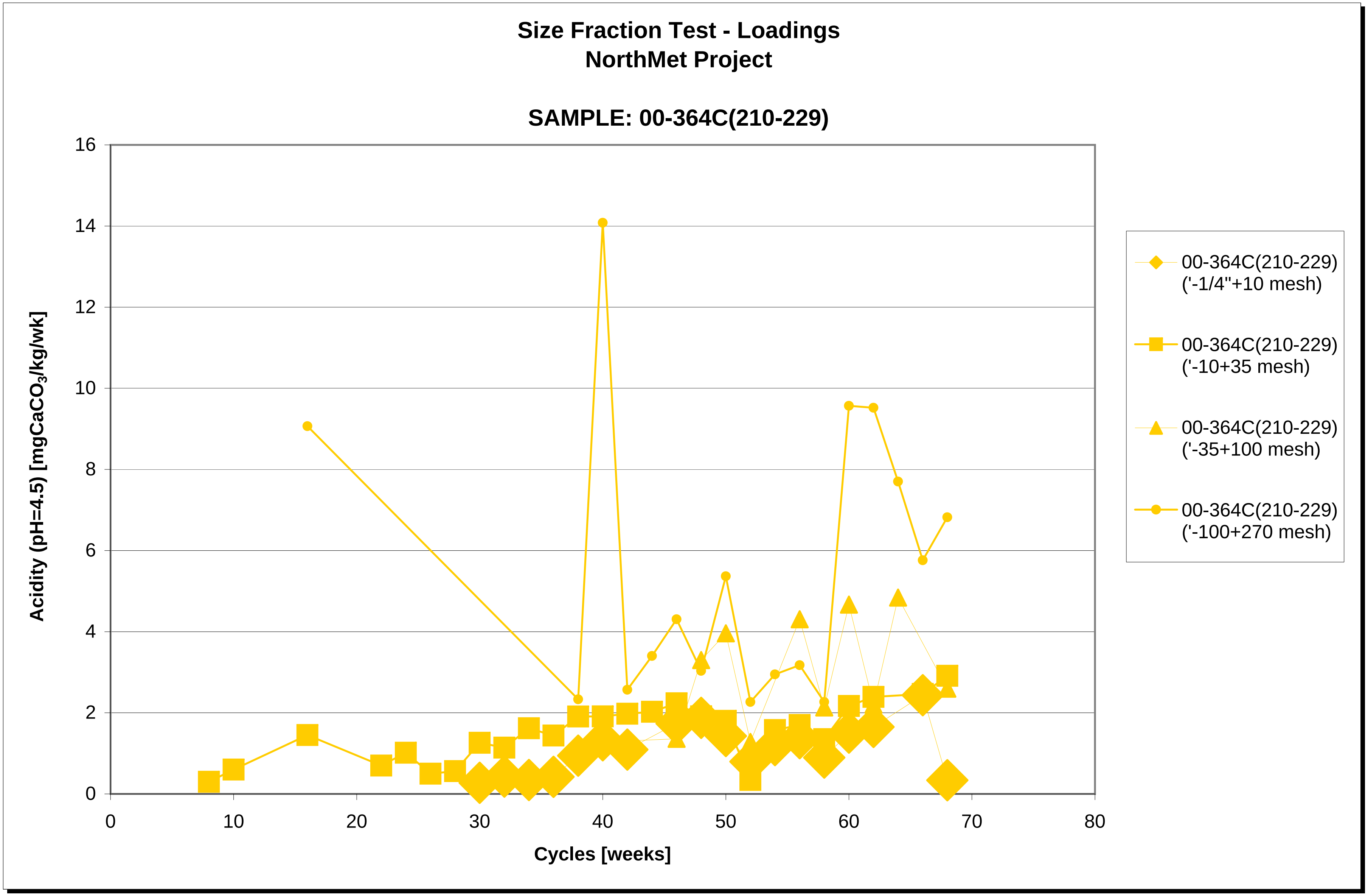

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Sn [mg/kg/wk]
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

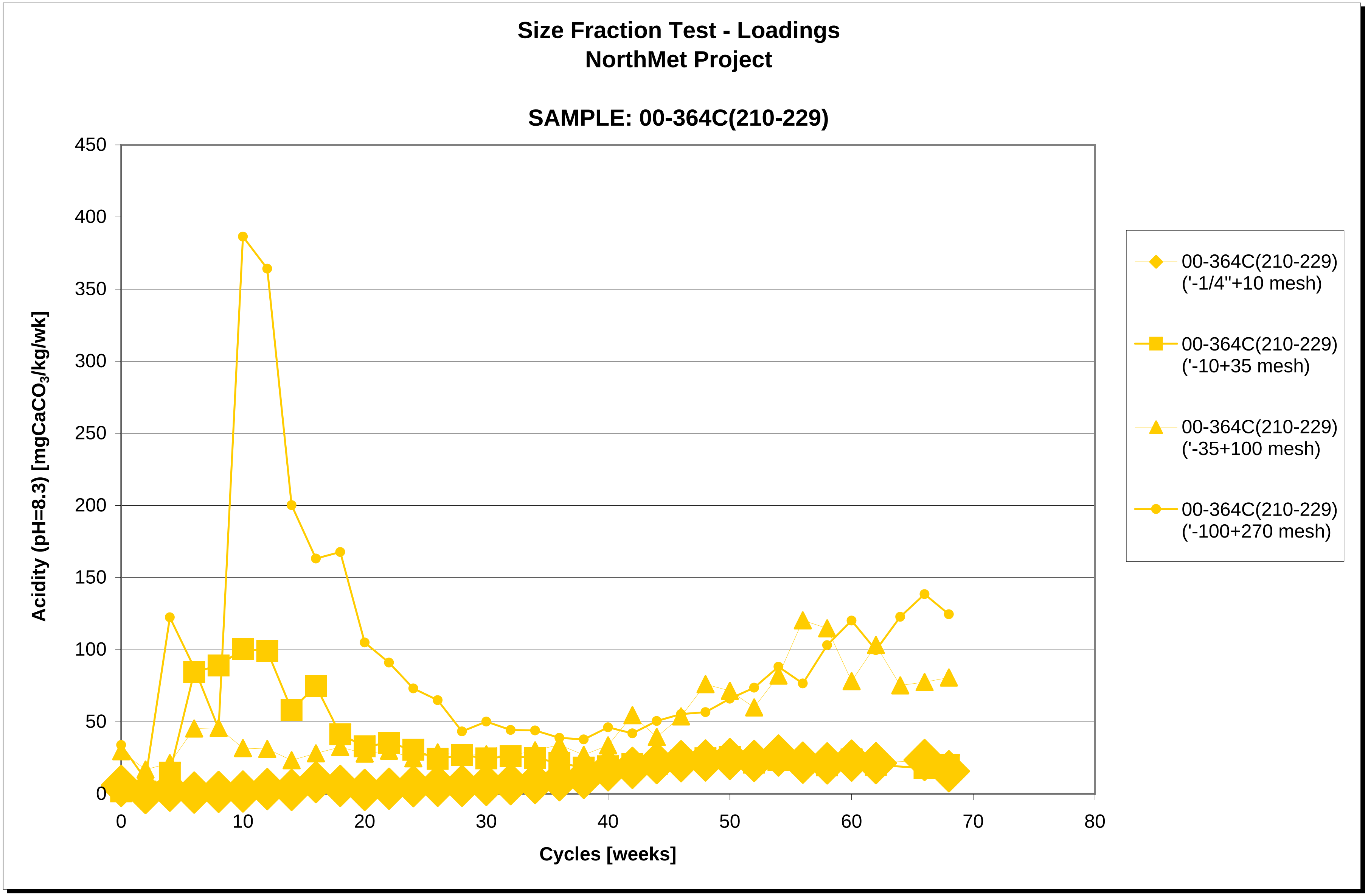

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-361C(310-320)
Zn [mg/kg/wk]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-361C(310-320) (-1/4"+10 mesh)
00-361C(310-320) (-10+35 mesh)
00-361C(310-320) (-35+100 mesh)
00-361C(310-320) (-100+270 mesh)

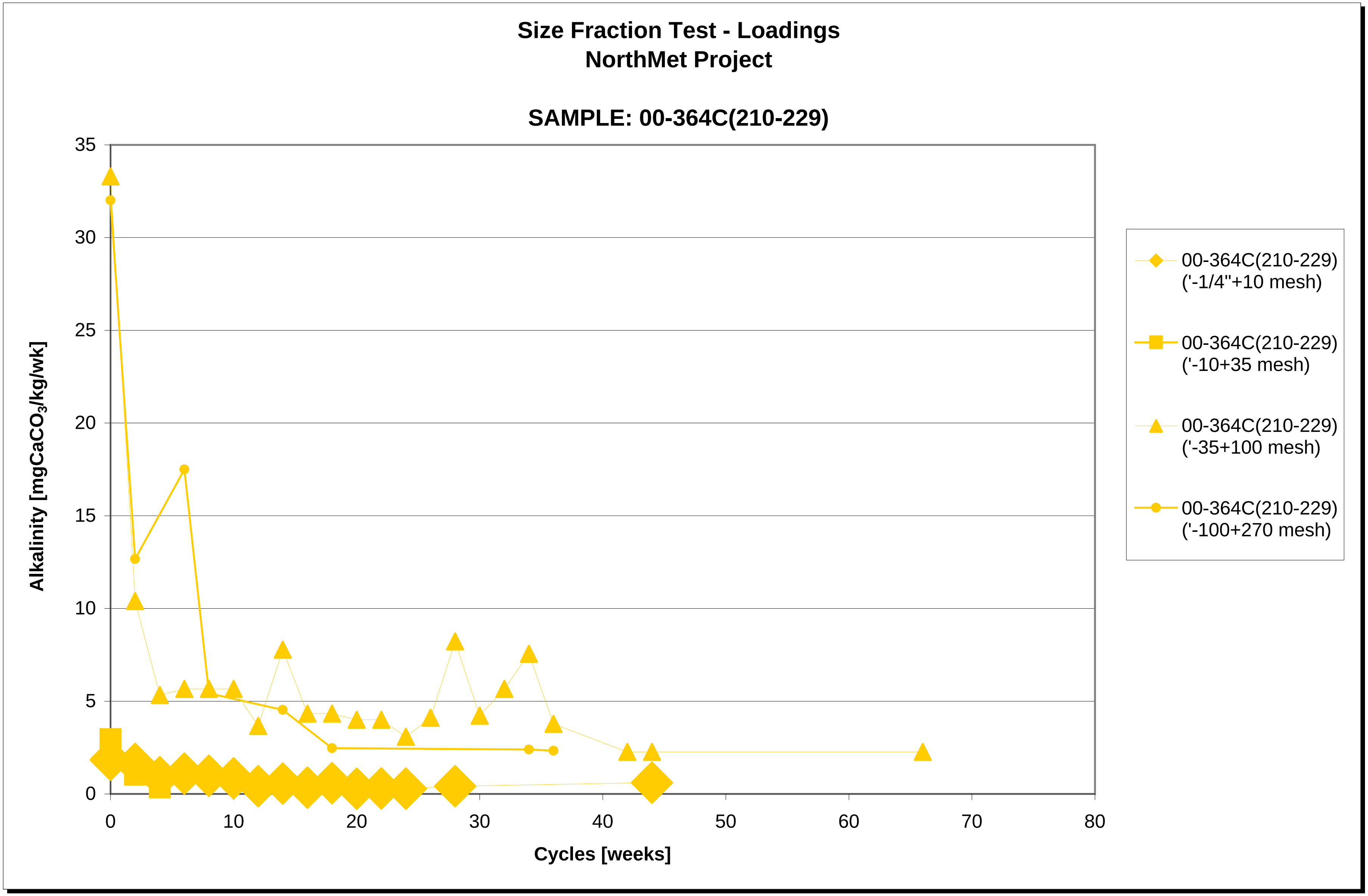

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-364C(210-229)
pH
Cycles [weeks]
0
10
20
30
40
50
60
70
80
3
4
5
6
7
8
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

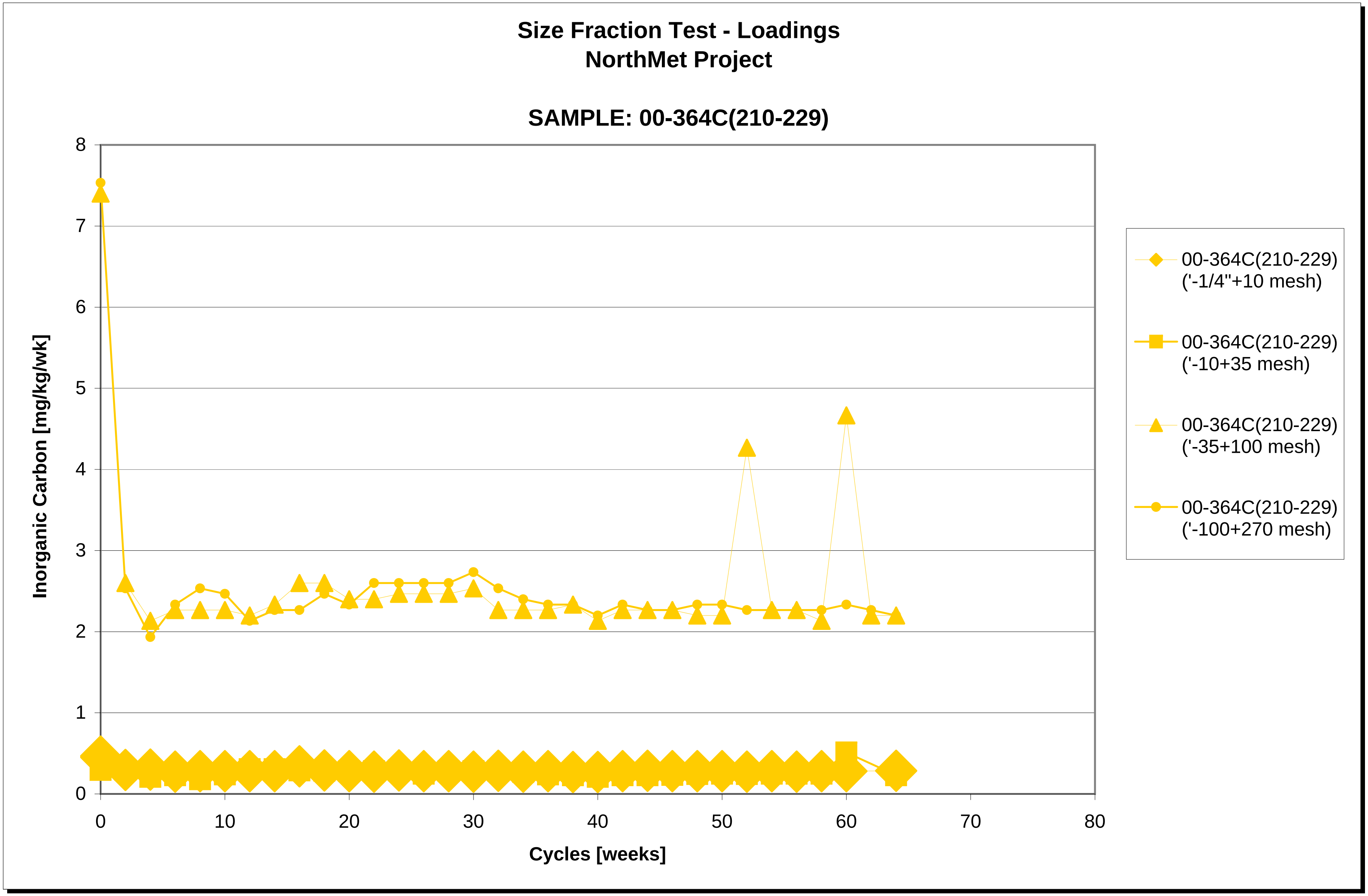

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-364C(210-229)
ORP [mV]
0
100
200
300
400
500
600
700
Cycles [weeks]
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

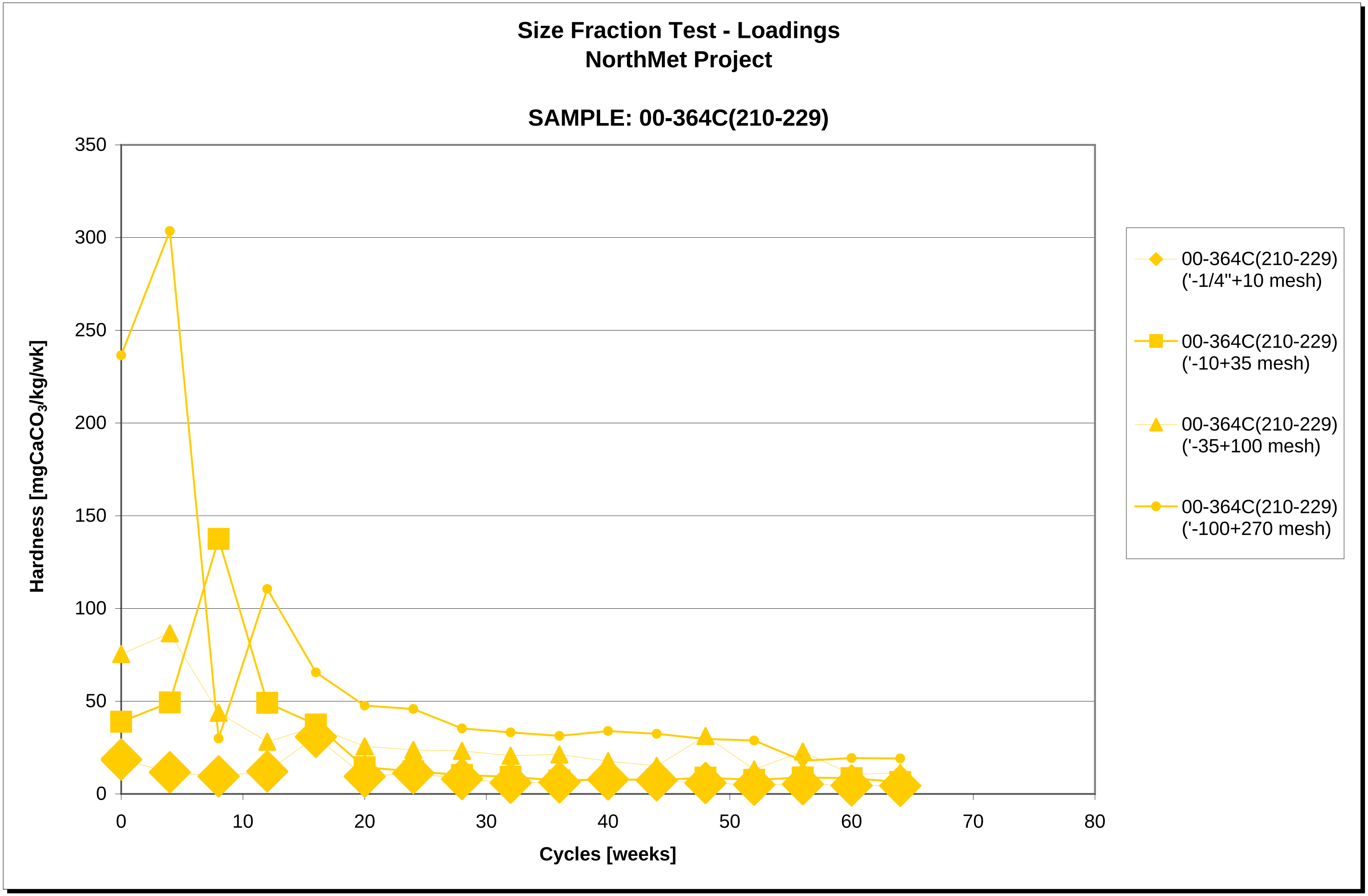

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-364C(210-229)
Conductivity [µmhos/cm]
Cycles [weeks]
0
500
1000
1500
2000
2500
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Acidity (pH=4.5) [mgCaCO3/kg/wk]
Cycles [weeks]
0
2
4
6
8
10
12
14
16
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

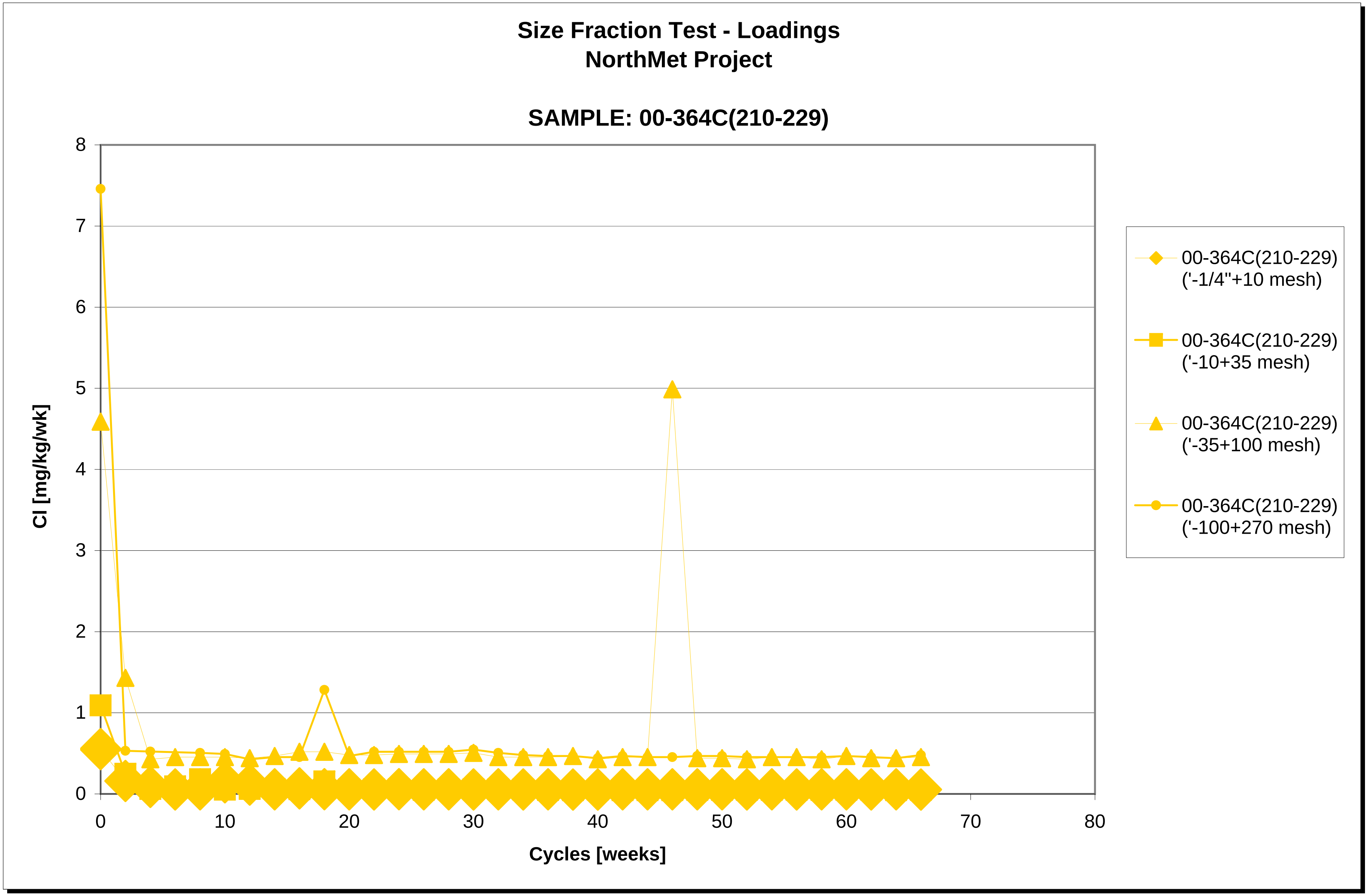

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Acidity (pH=8.3) [mgCaCO3/kg/wk]
450
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

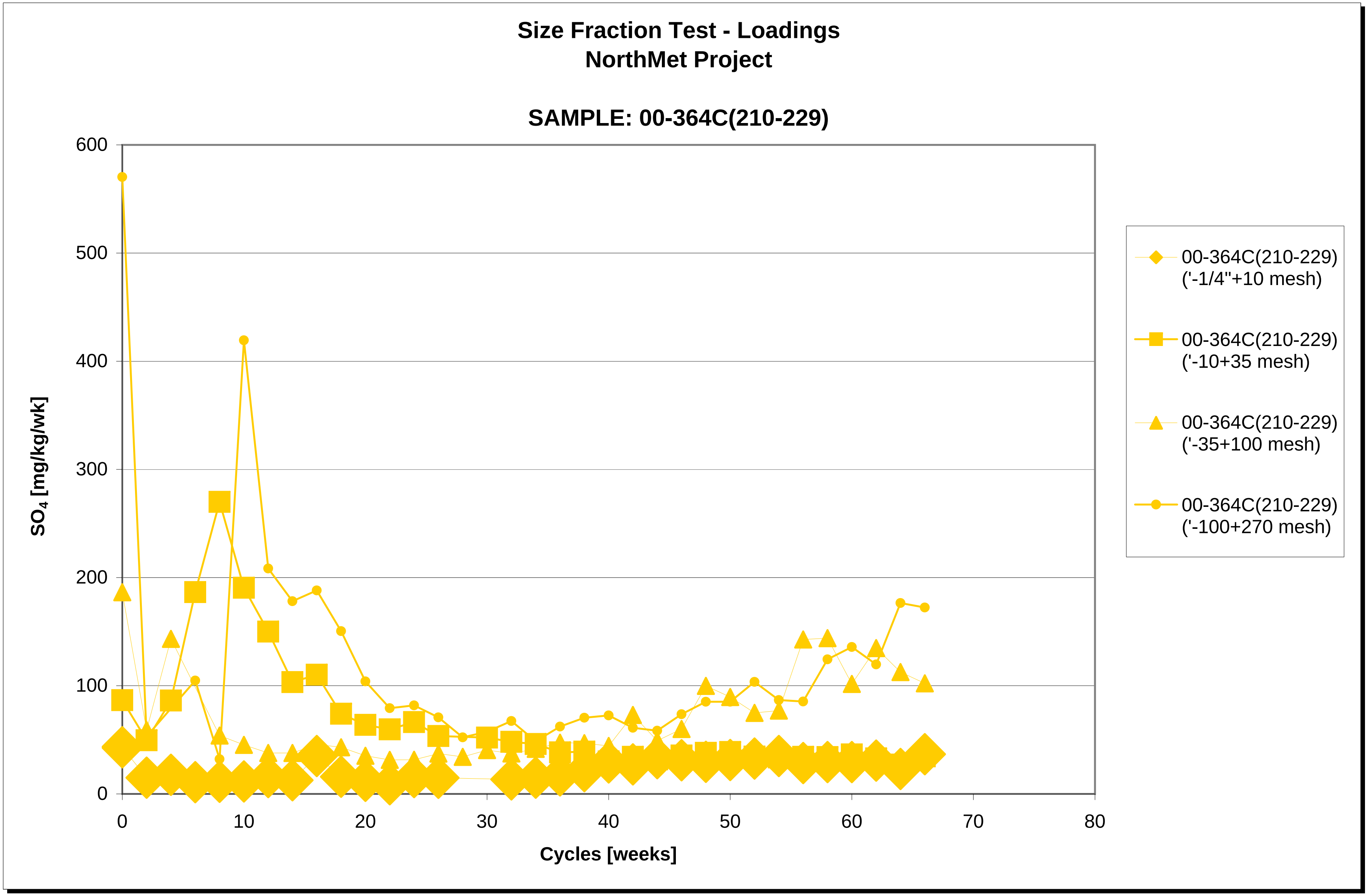

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Alkalinity [mgCaCO3/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

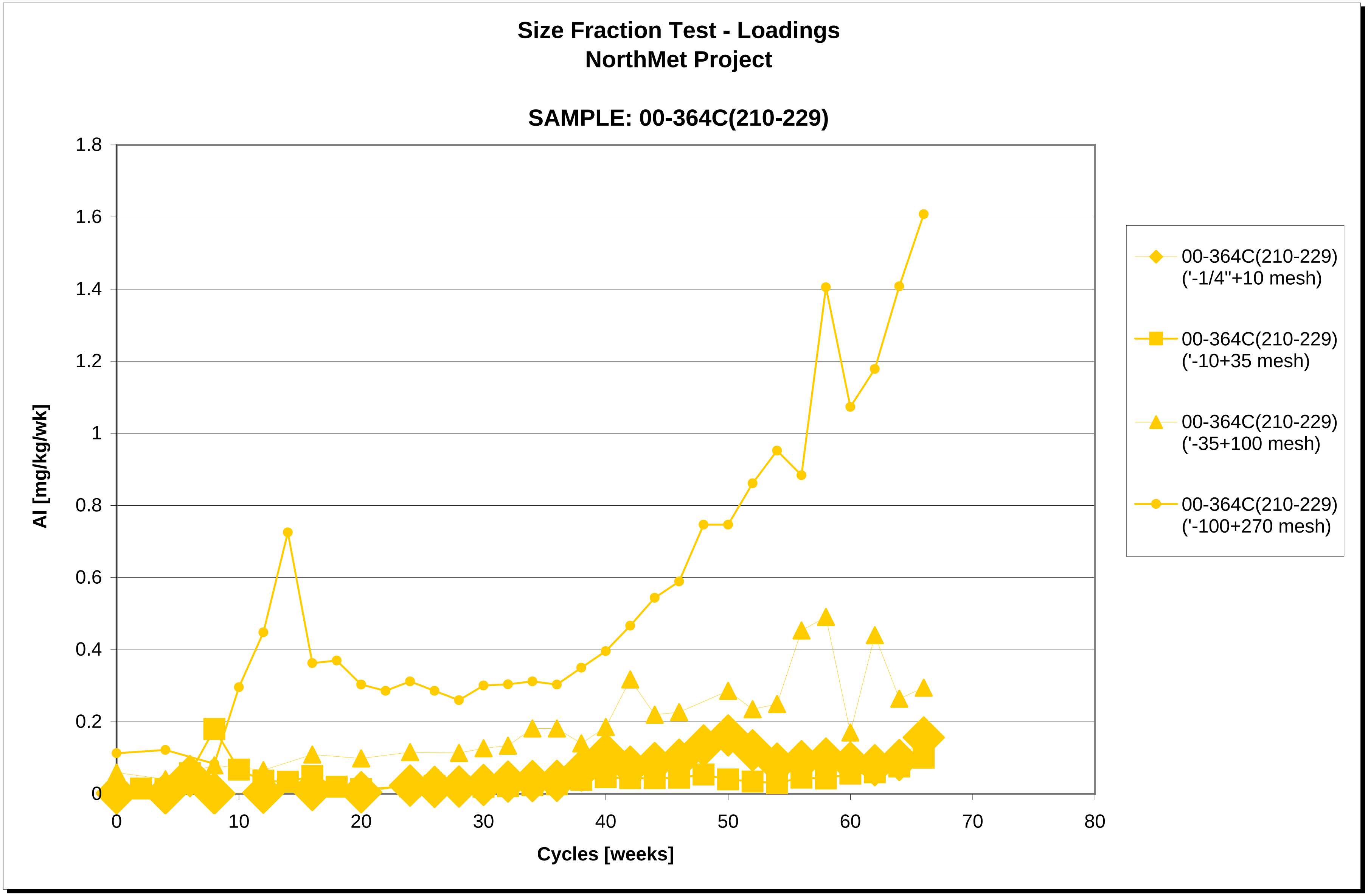

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Inorganic Carbon [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

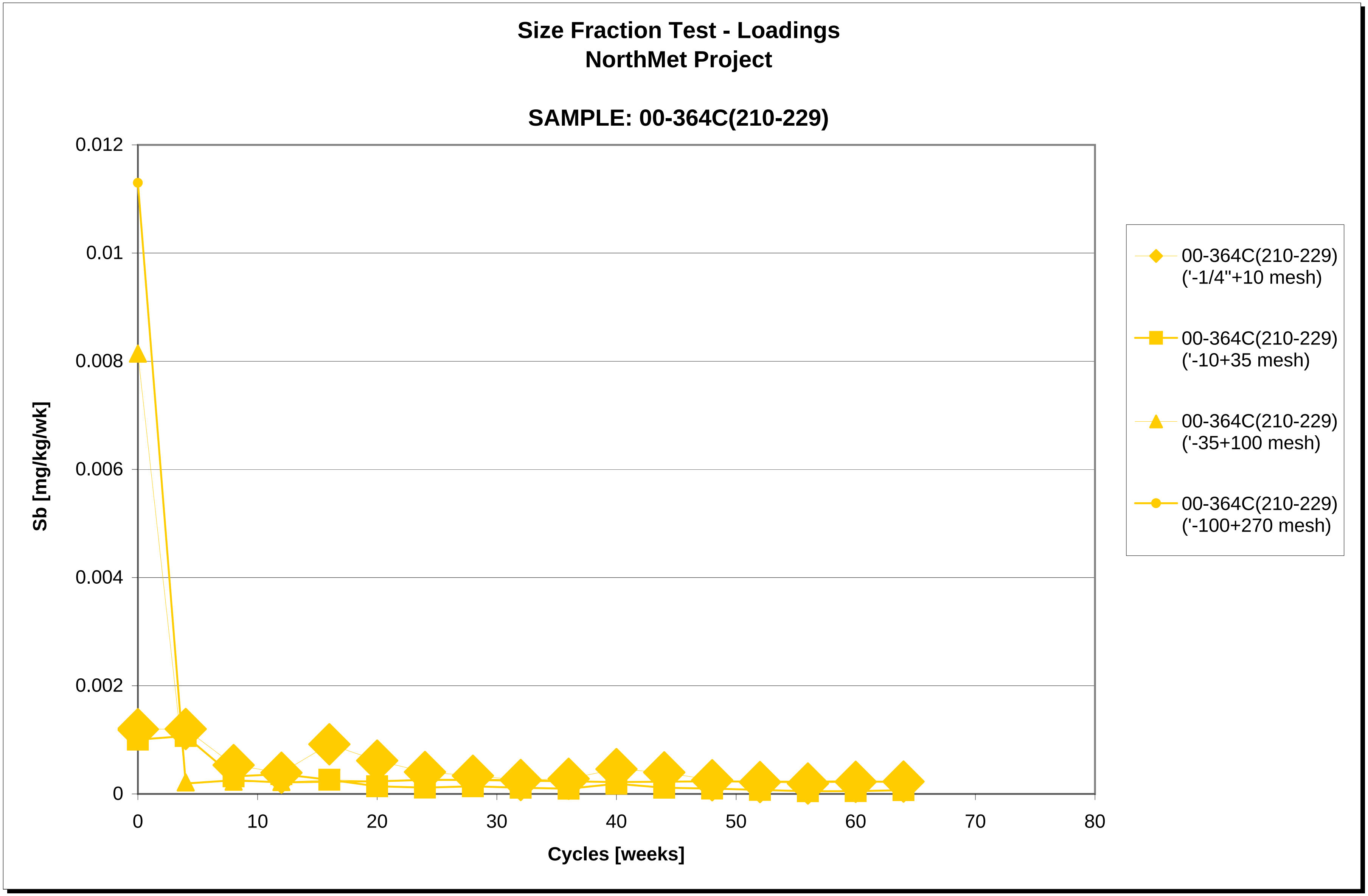

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Hardness [mgCaCO3/kg/wk]
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

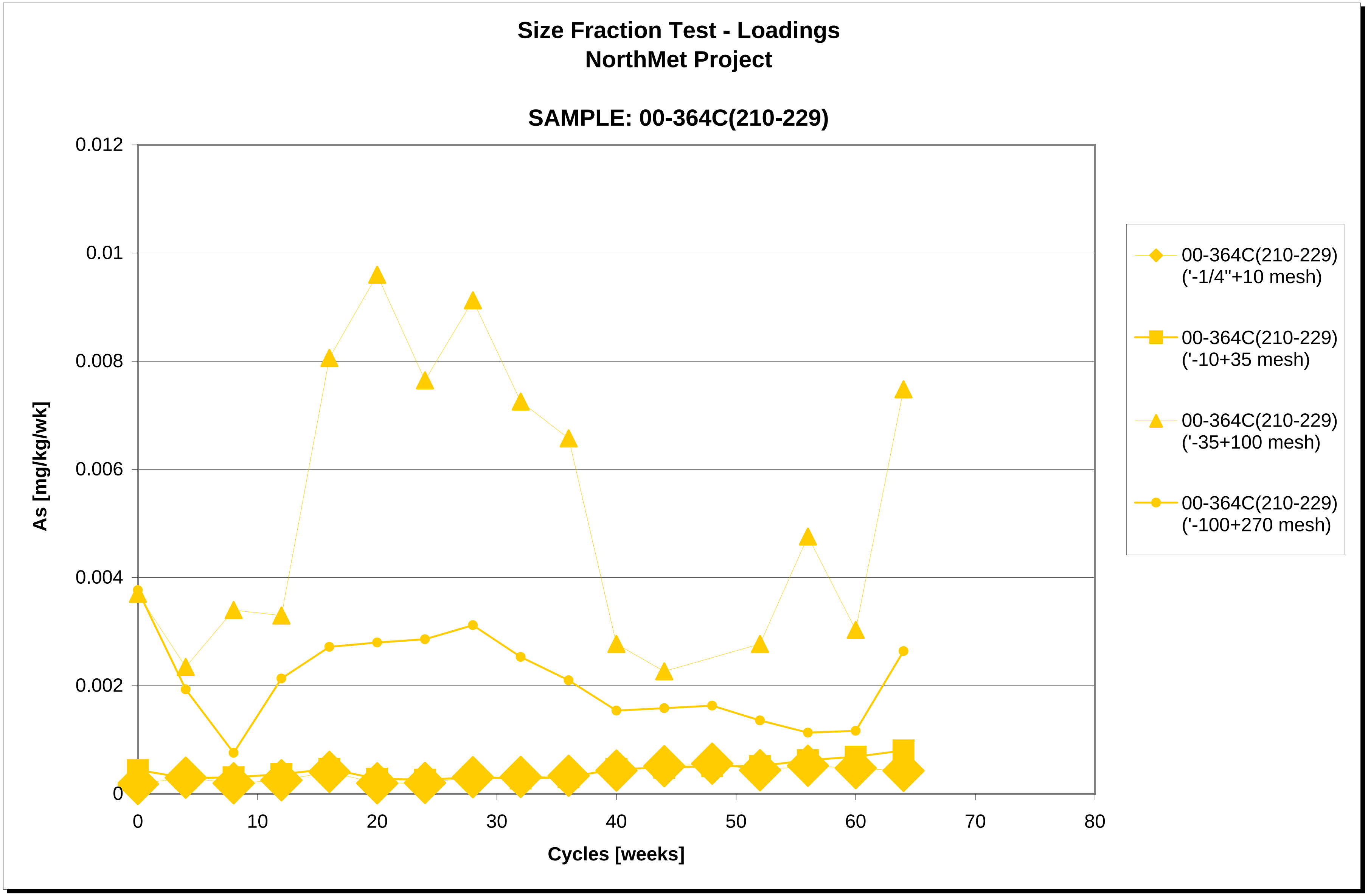

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
F [mg/kg/wk]
Cycles [weeks]
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

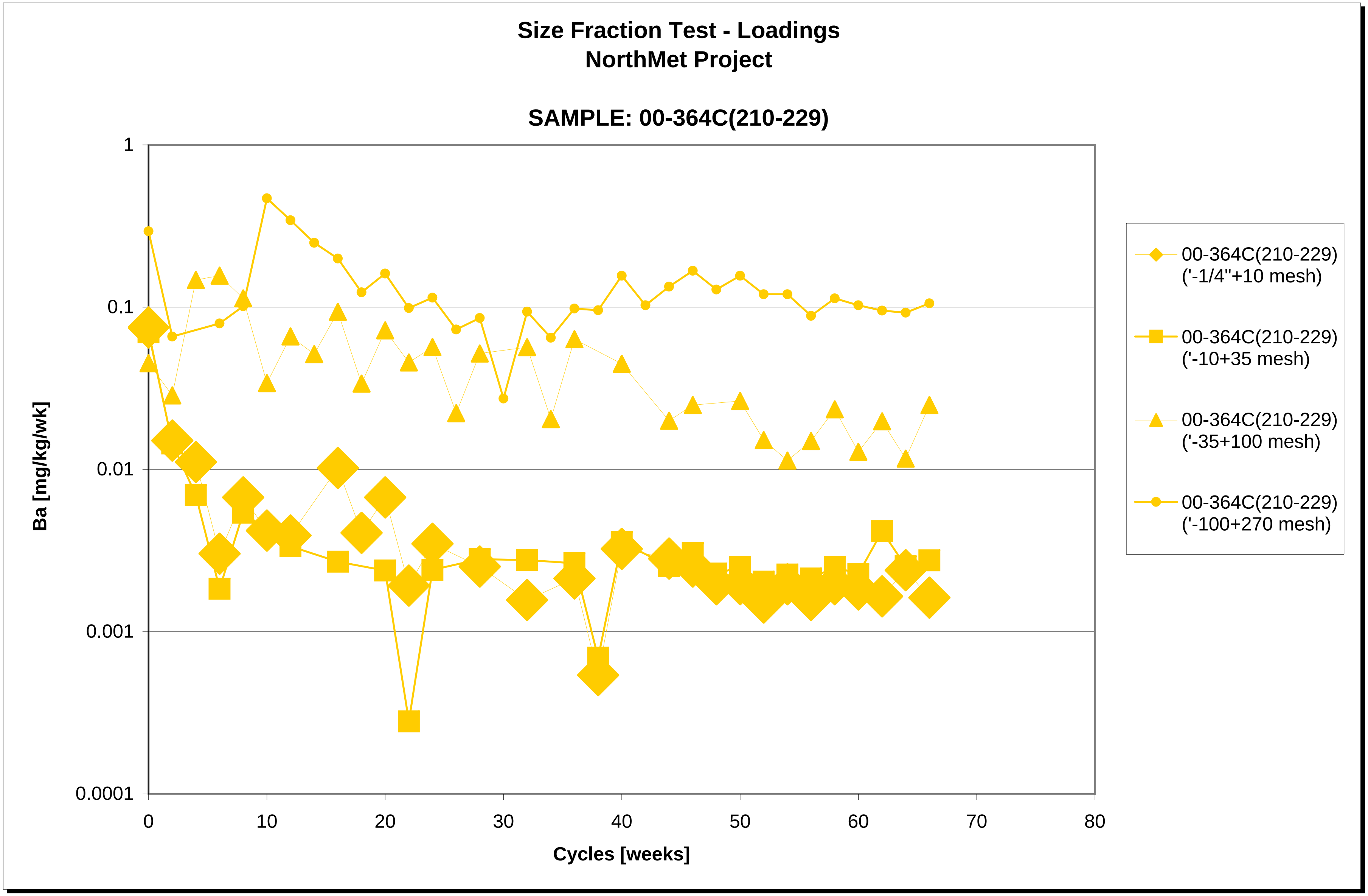

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Cl [mg/kg/wk]
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

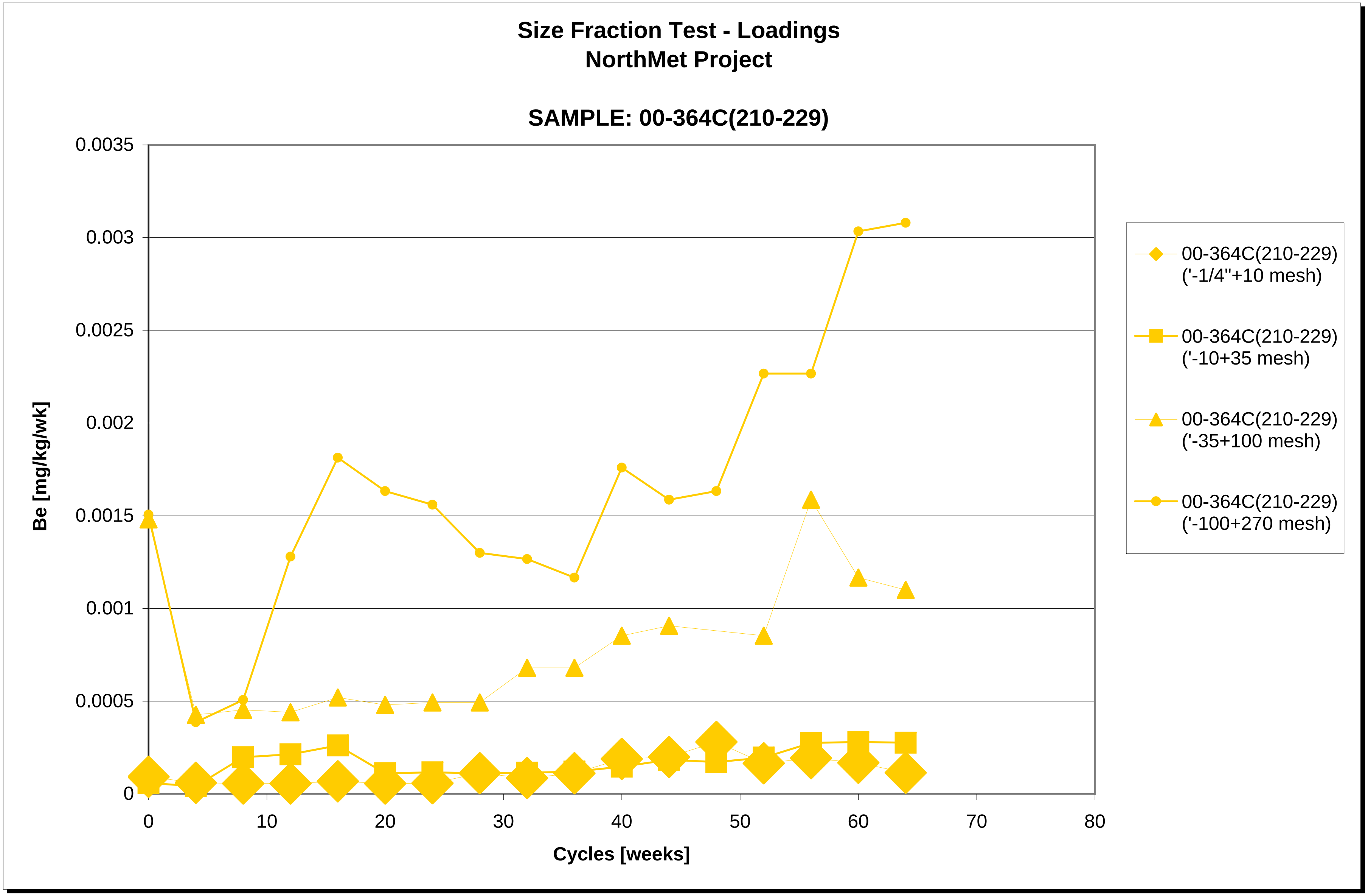

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
600
500
400
300
200
100
0
SO4 [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

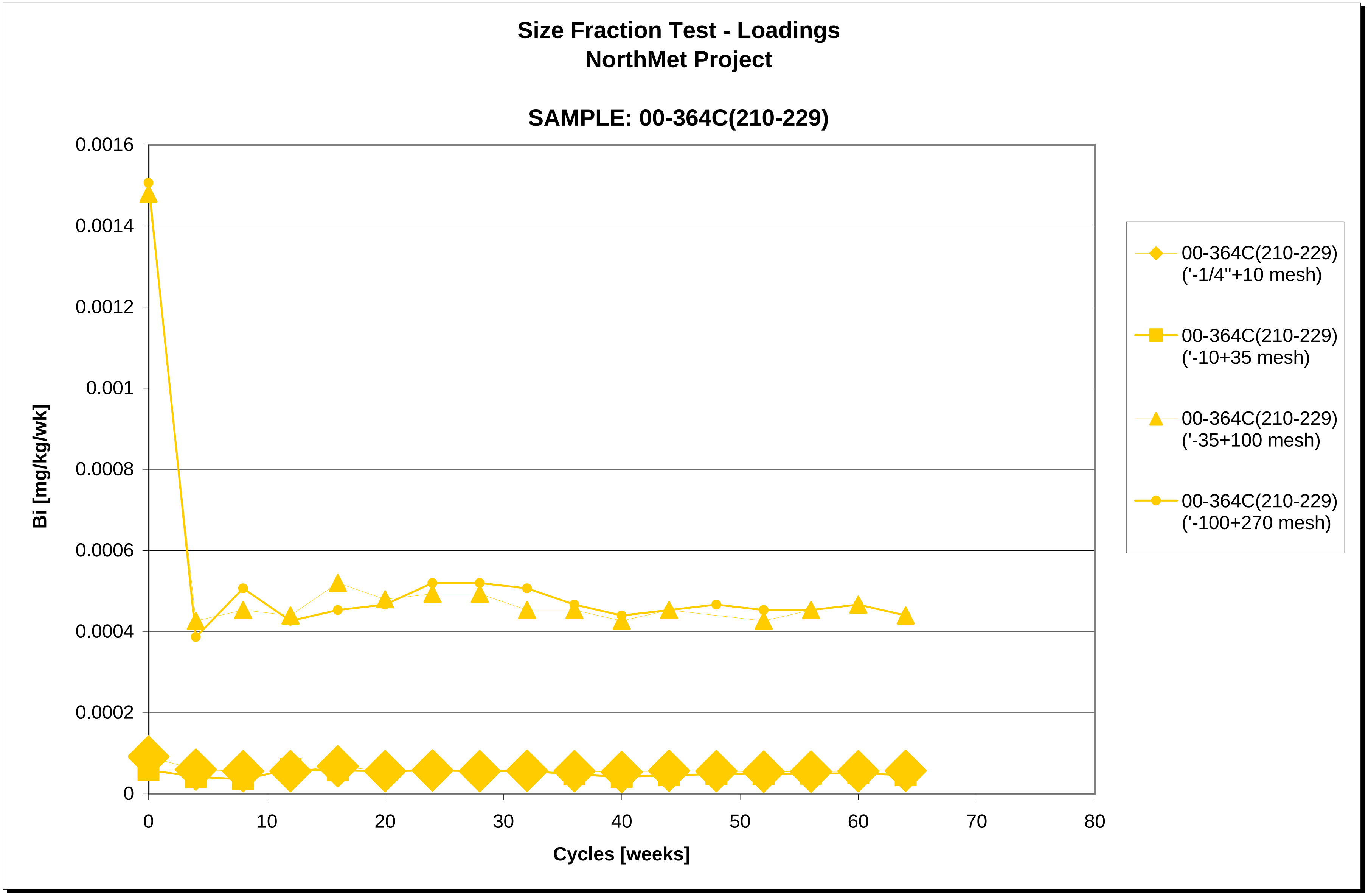

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Al [mg/kg/wk]
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

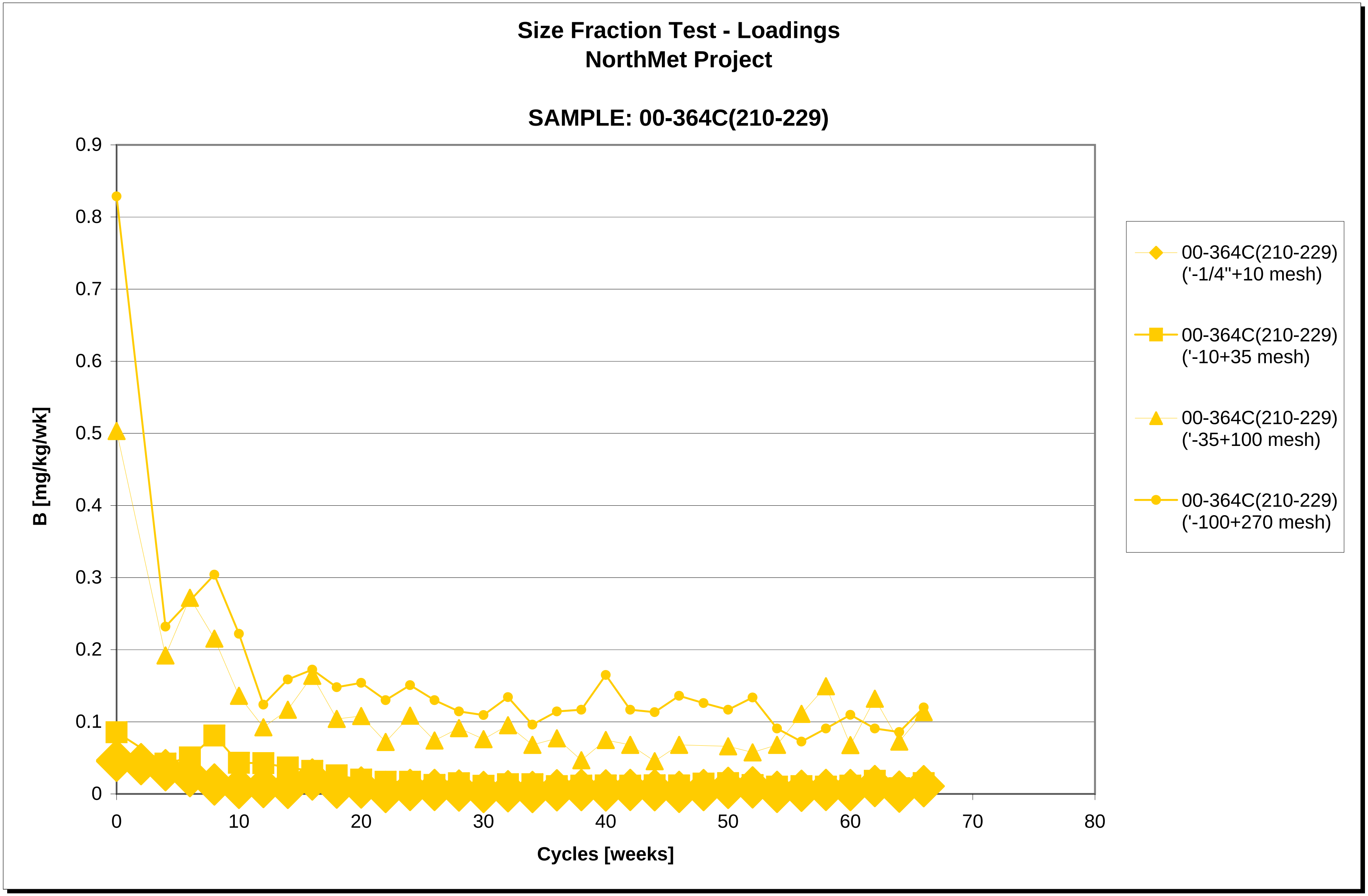

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Sb [mg/kg/wk]
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

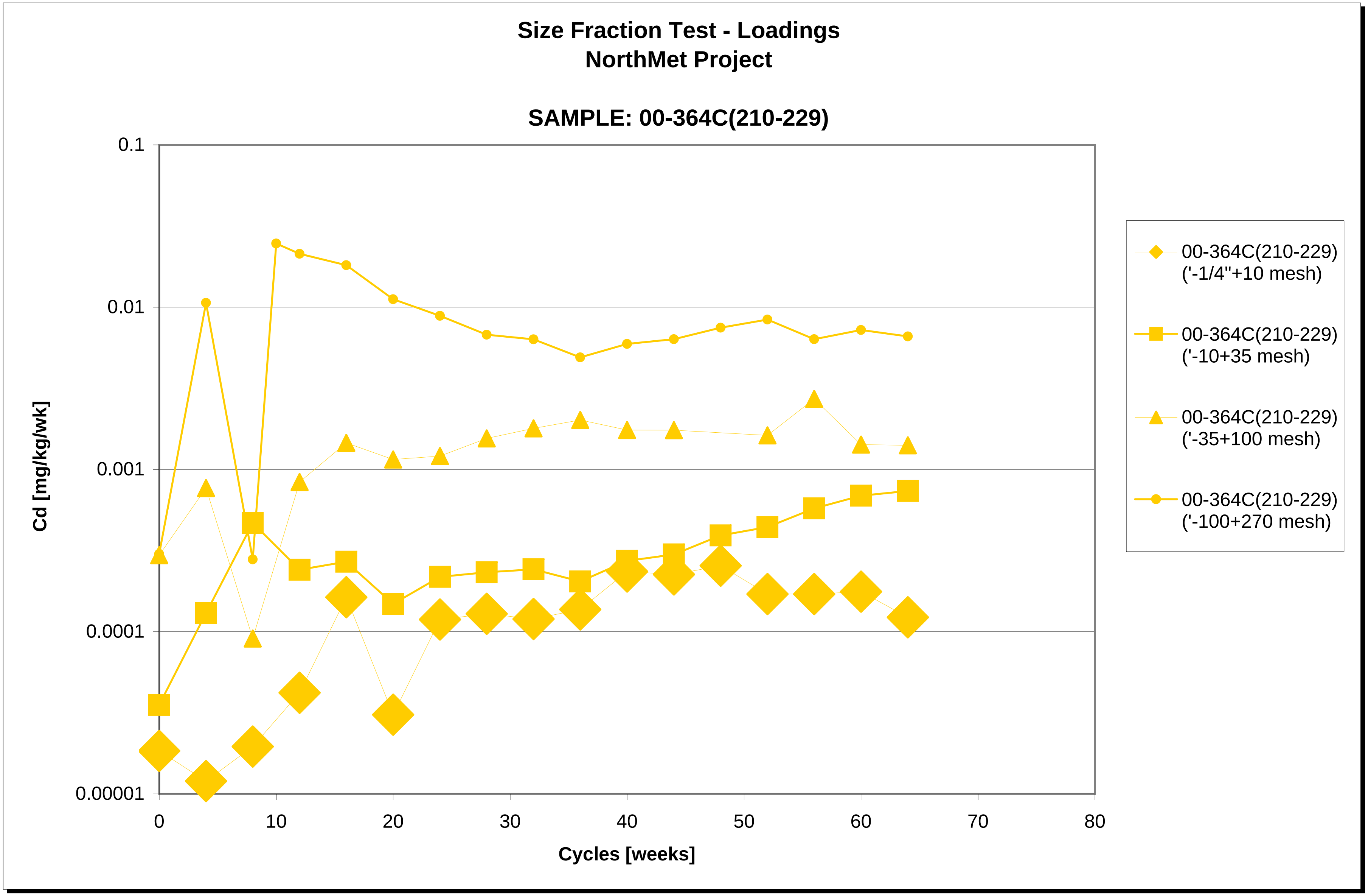

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
0.012
0.01
0.008
0.006
0.004
0.002
0
As [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

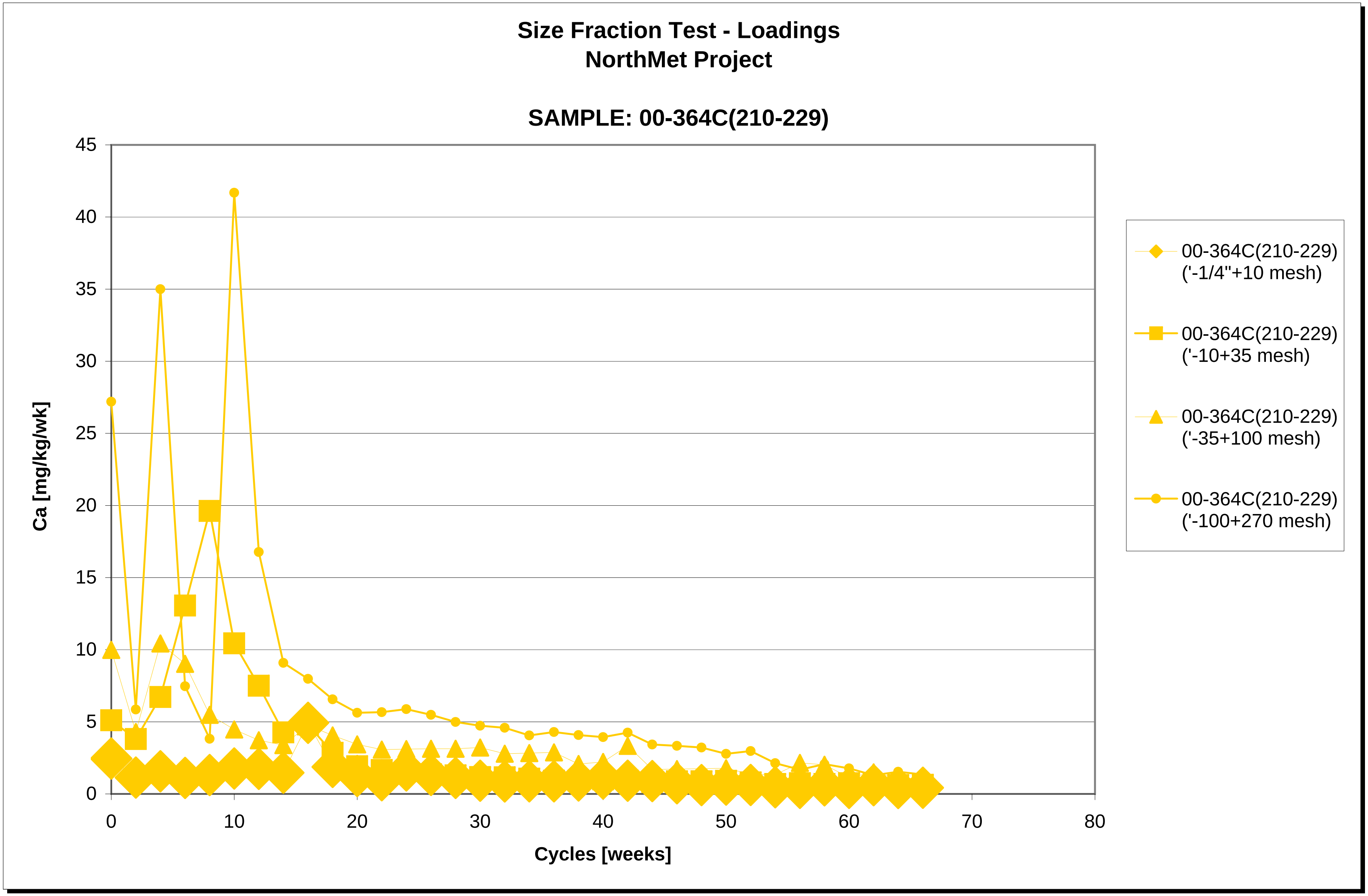

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Ba [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Be [mg/kg/wk]
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

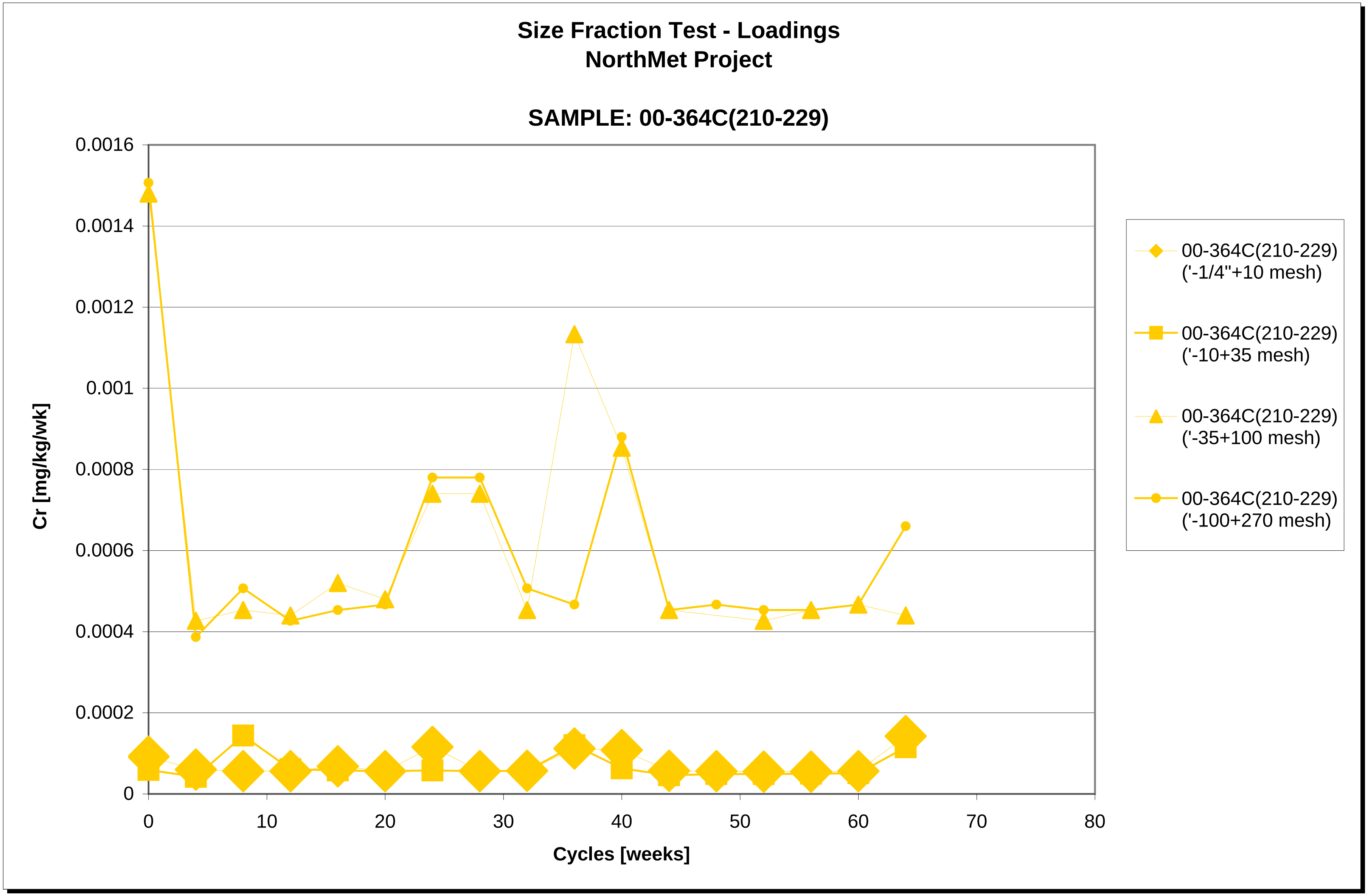

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
Bi [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

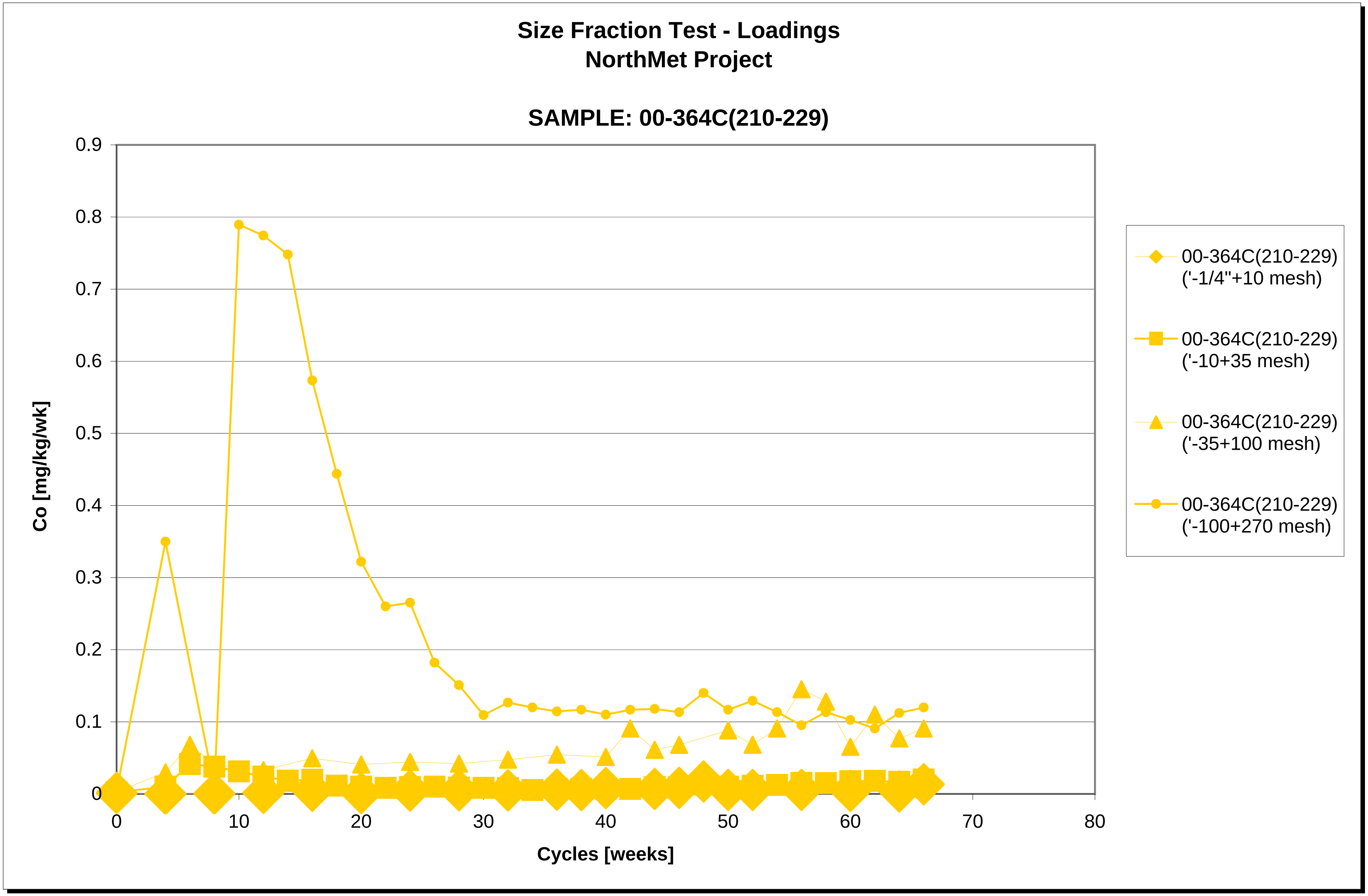

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
B [mg/kg/wk]
Cycles [weeks]
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

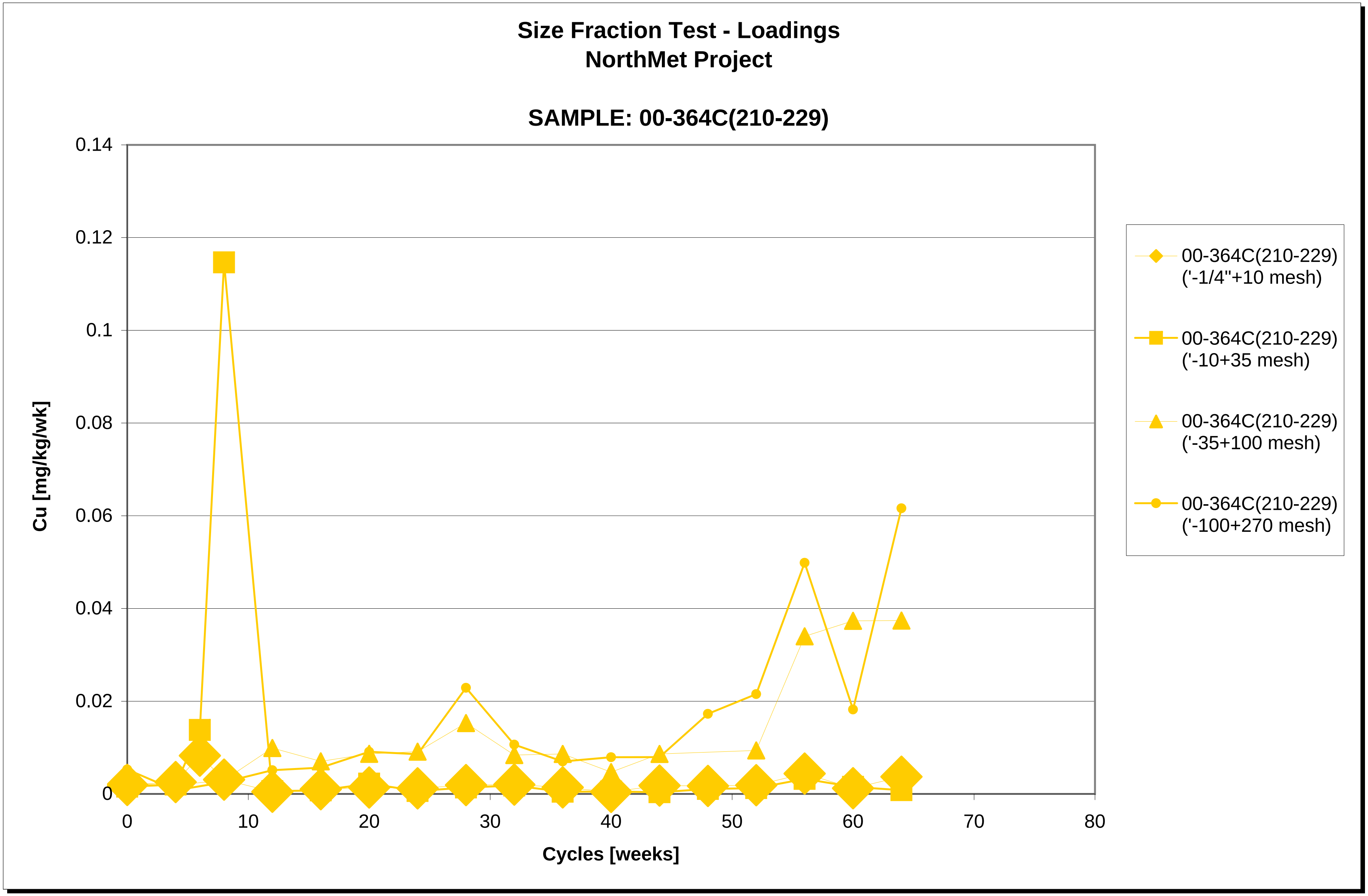

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Cd [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

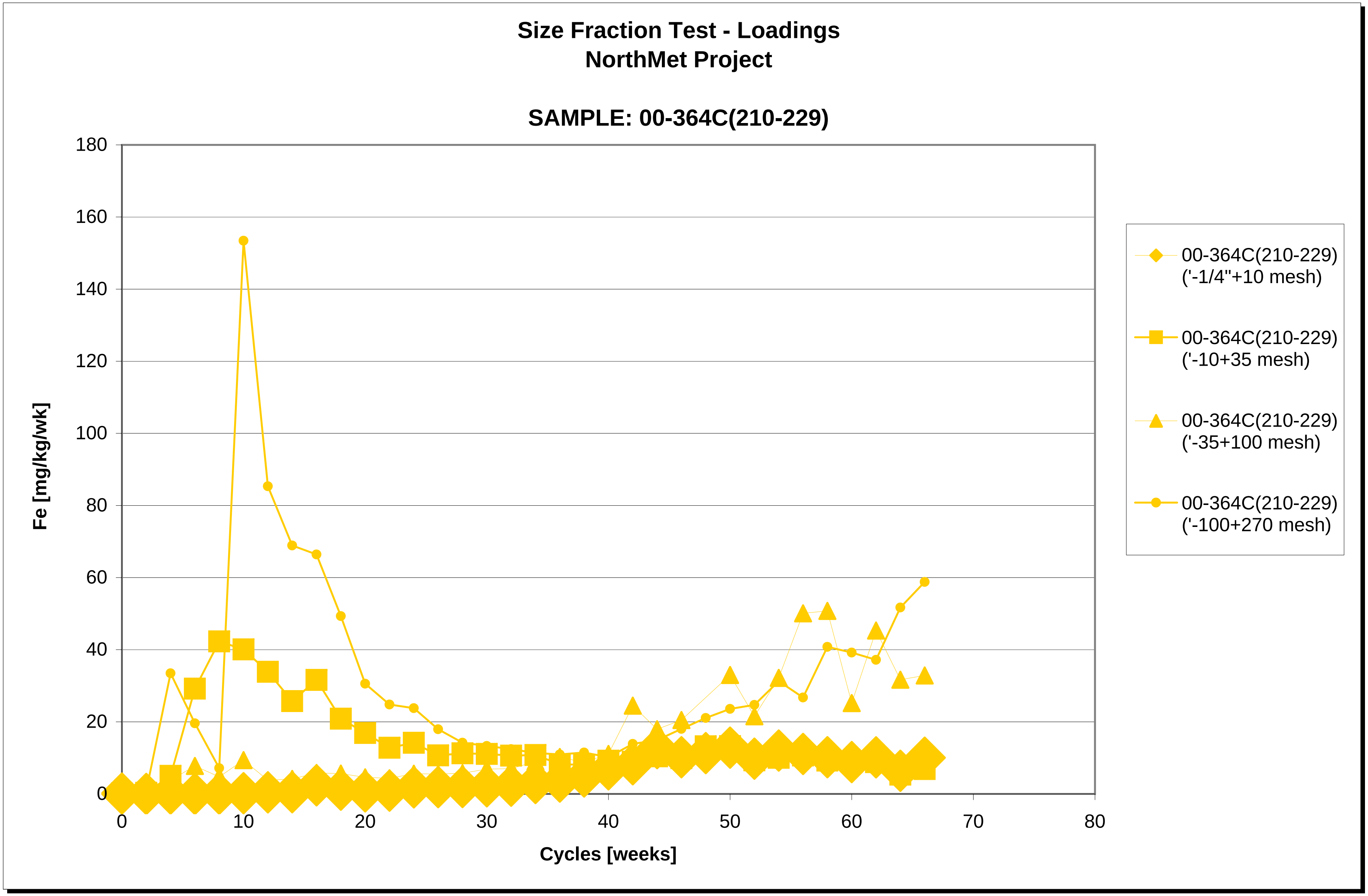


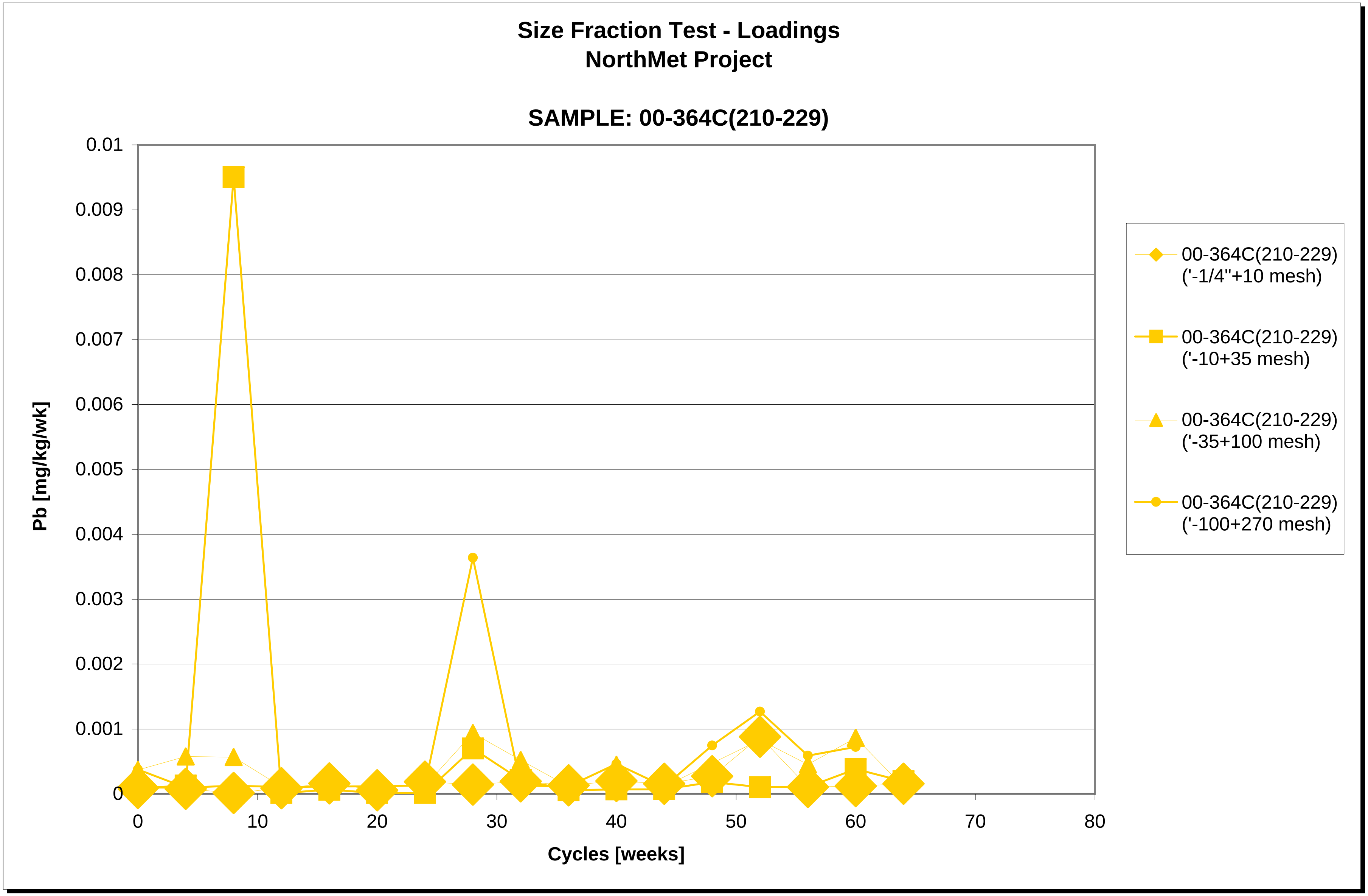
Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Ca [mg/kg/wk]
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

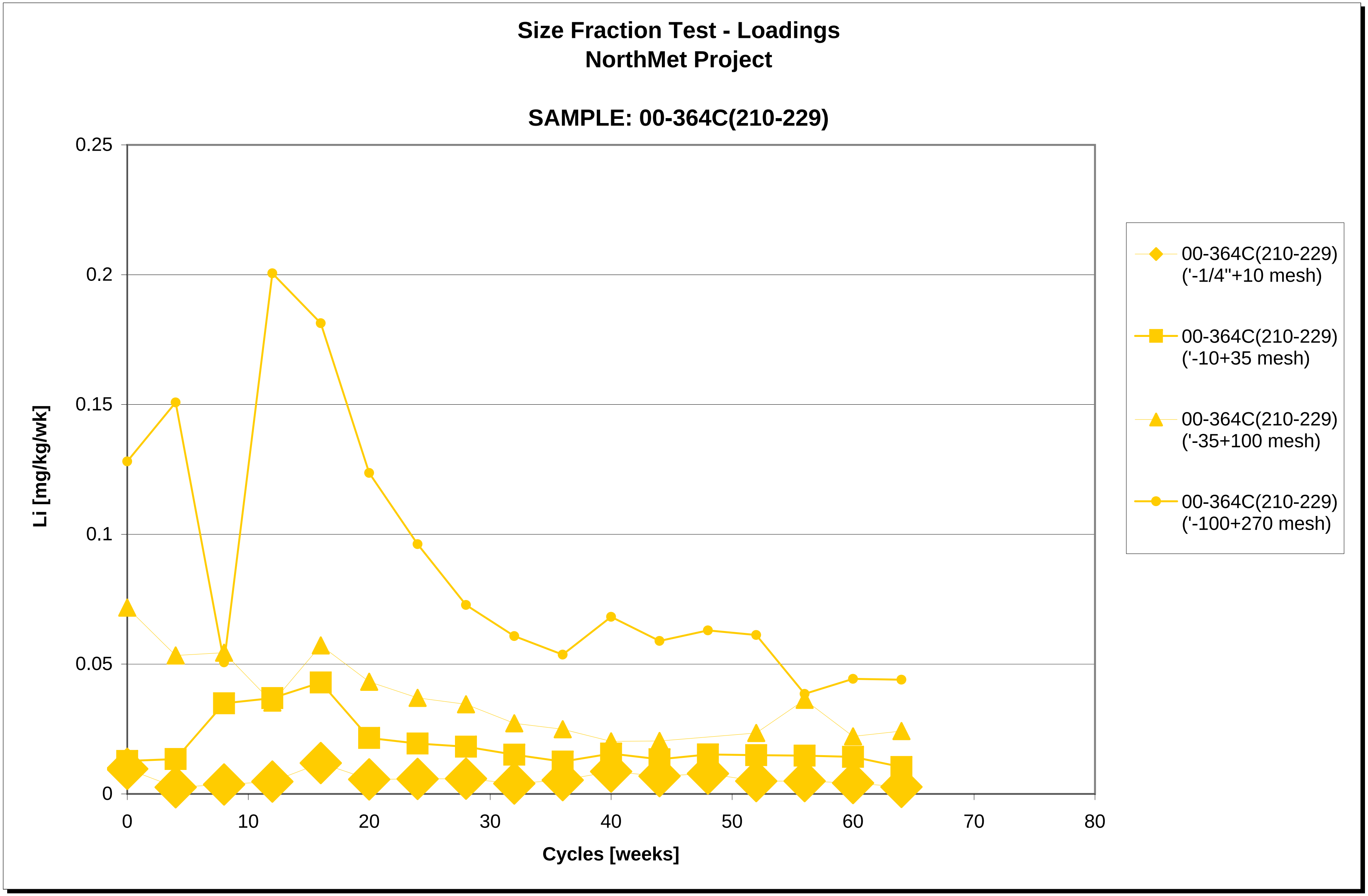

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Cr [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

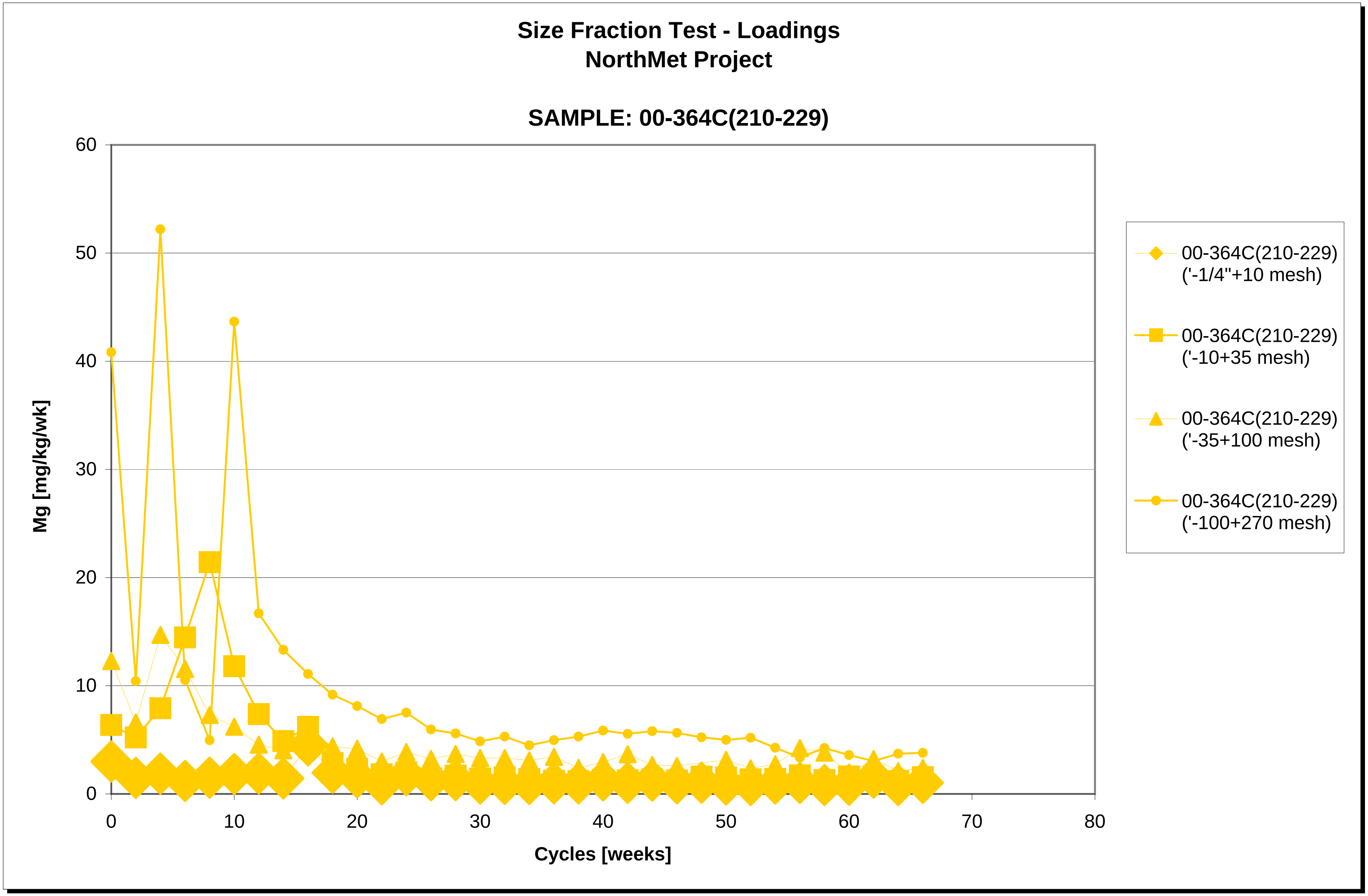

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Co [mg/kg/wk]
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

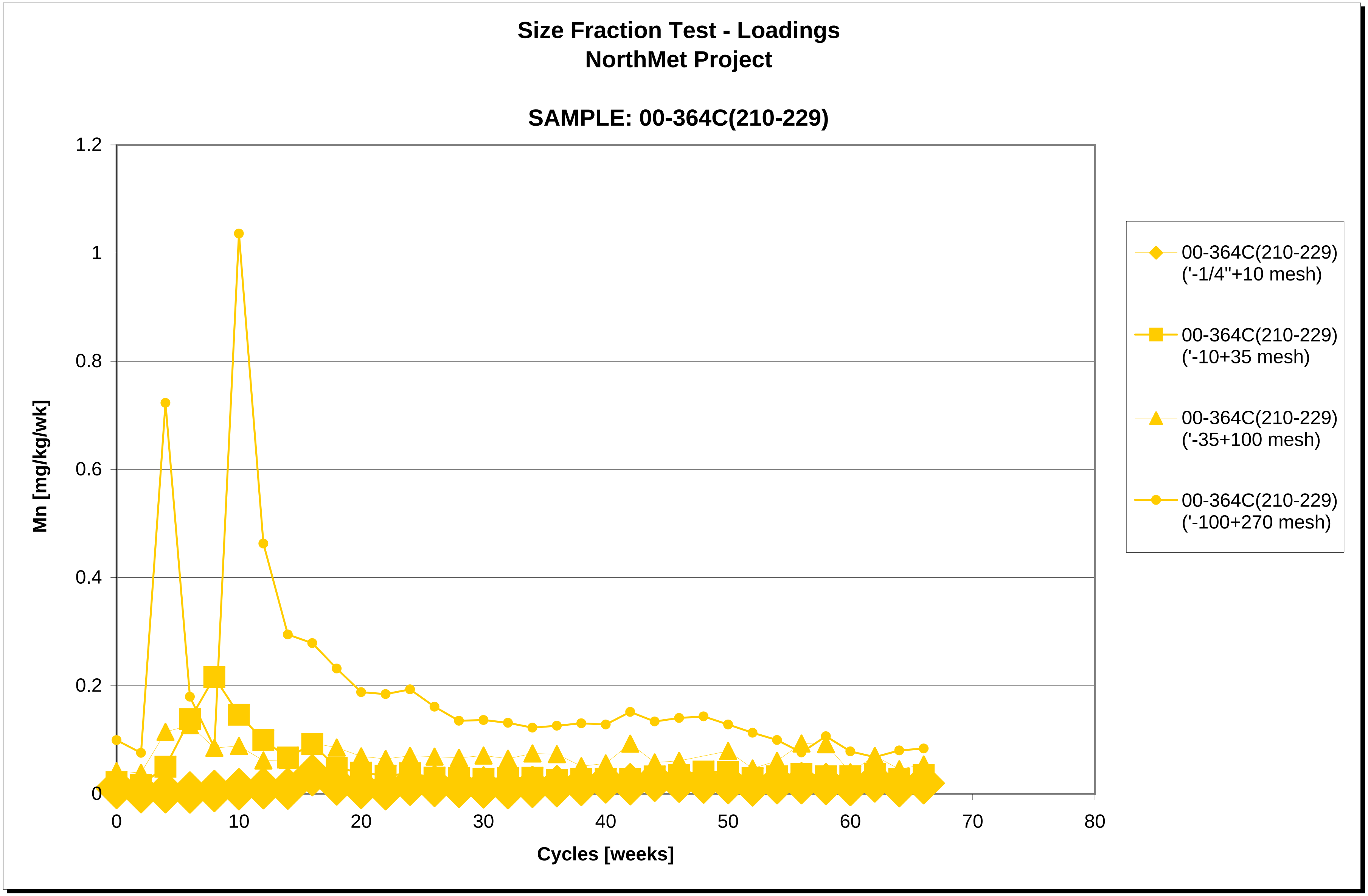

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Cu [mg/kg/wk]
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

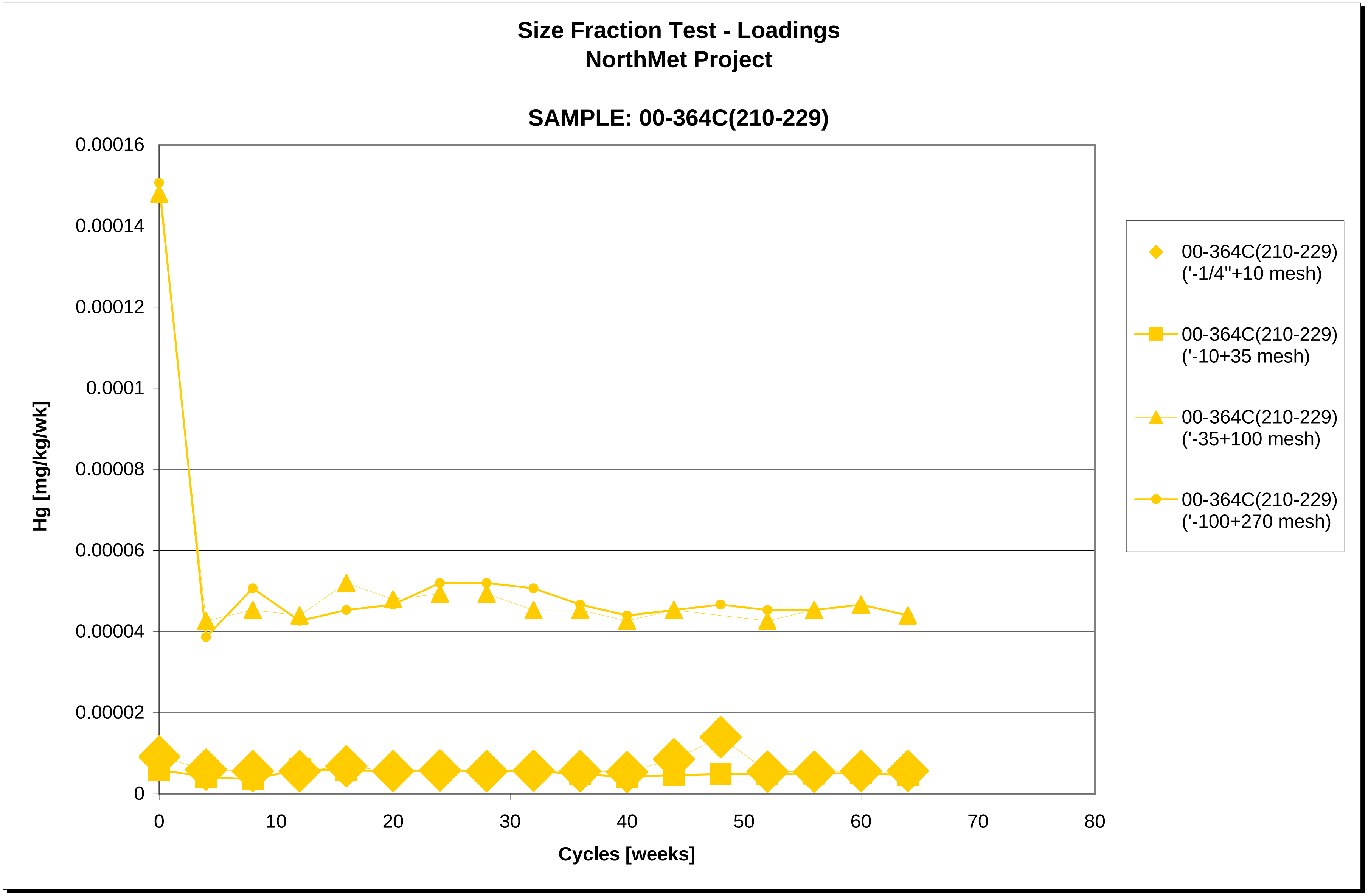

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Fe [mg/kg/wk]
180
160
140
120
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Pb [mg/kg/wk]
Cycles [weeks]
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

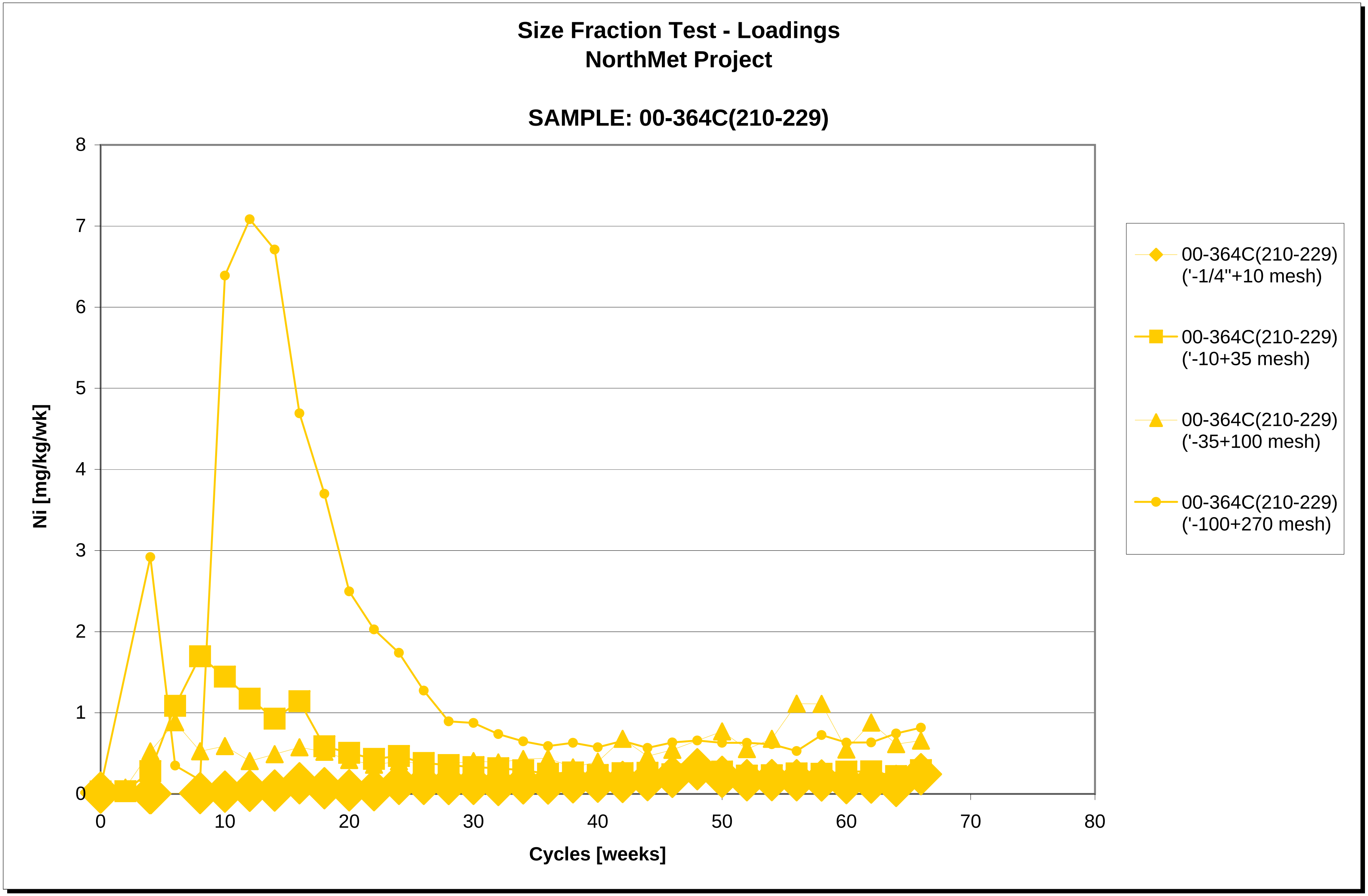

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
0.25
0.2
0.15
0.1
0.05
0
Li [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

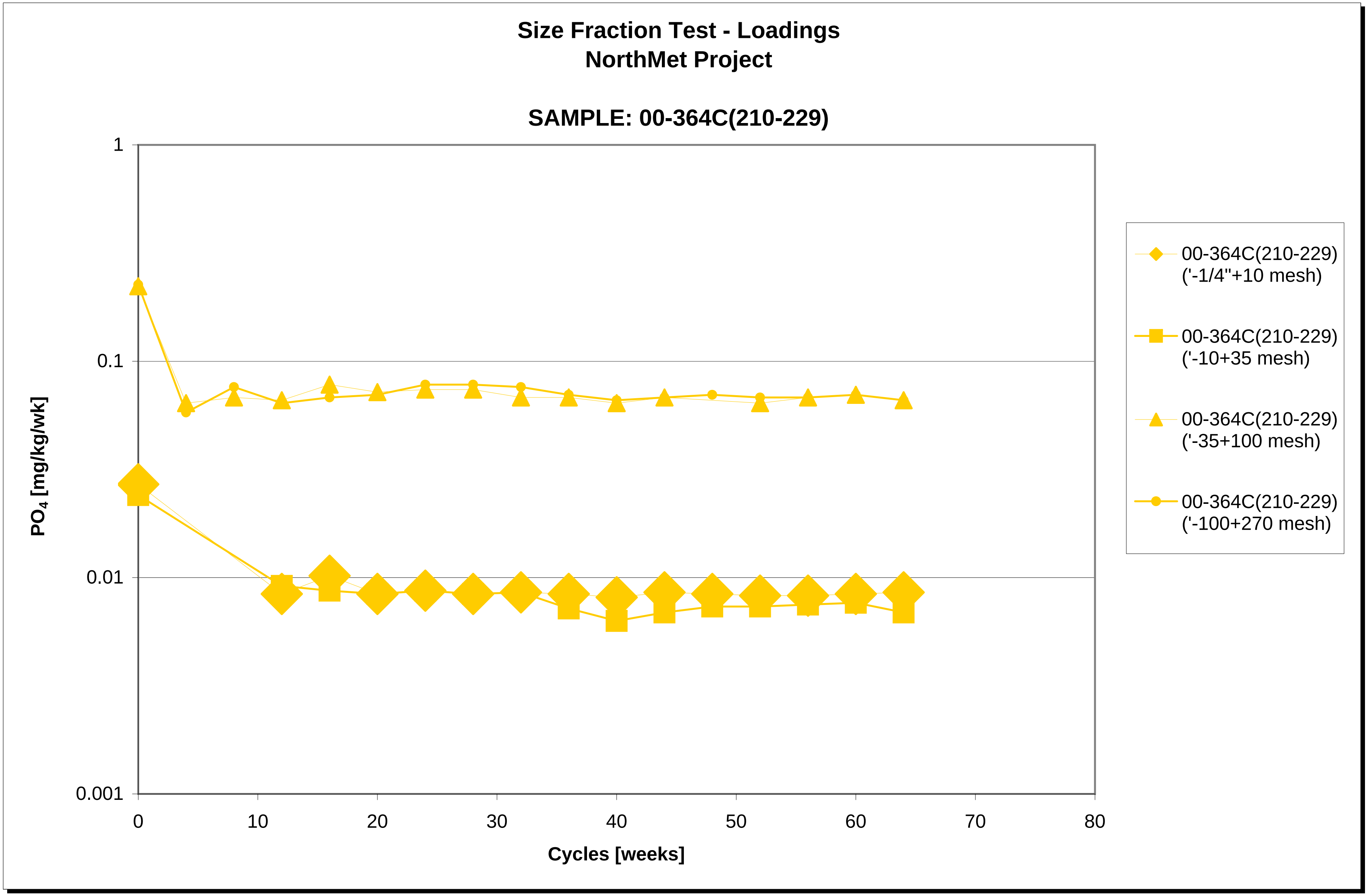

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Mg [mg/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

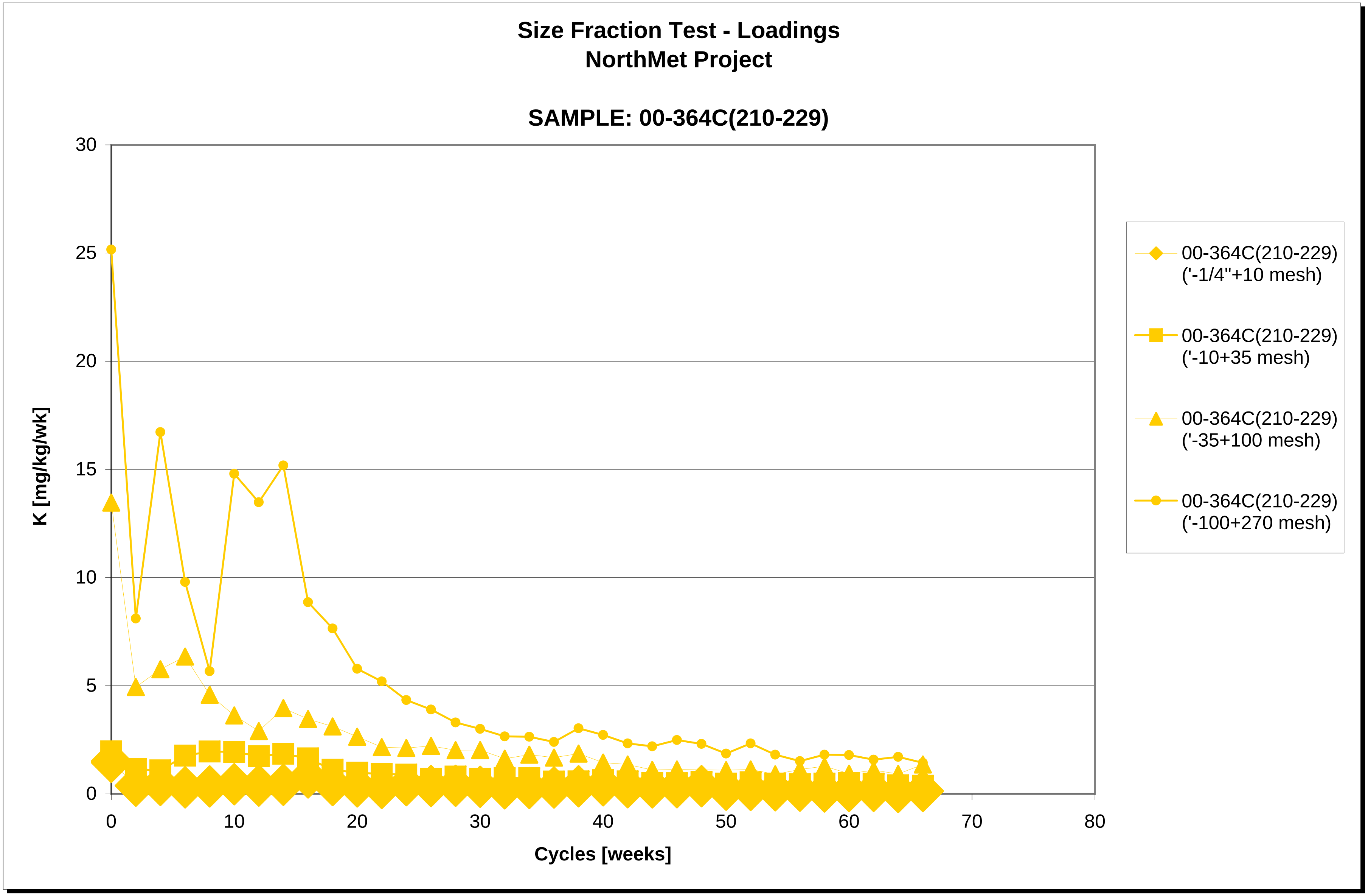

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Mn [mg/kg/wk]
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Hg [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Mo [mg/kg/wk]
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

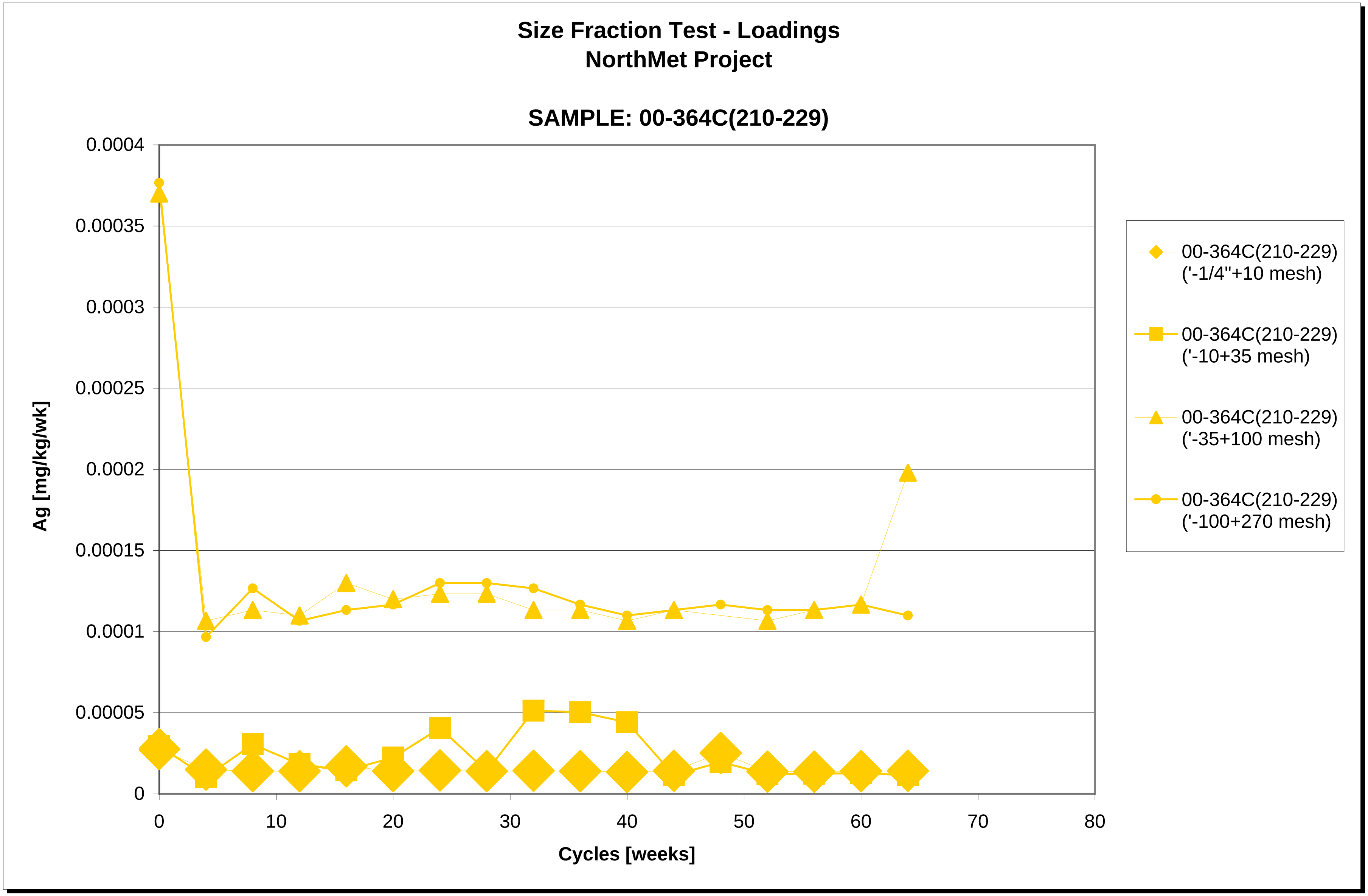

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Ni [mg/kg/wk]
Cycles [weeks]
0
1
2
3
4
5
6
7
8
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
1
0.1
0.01
0.001
PO4 [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
K [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

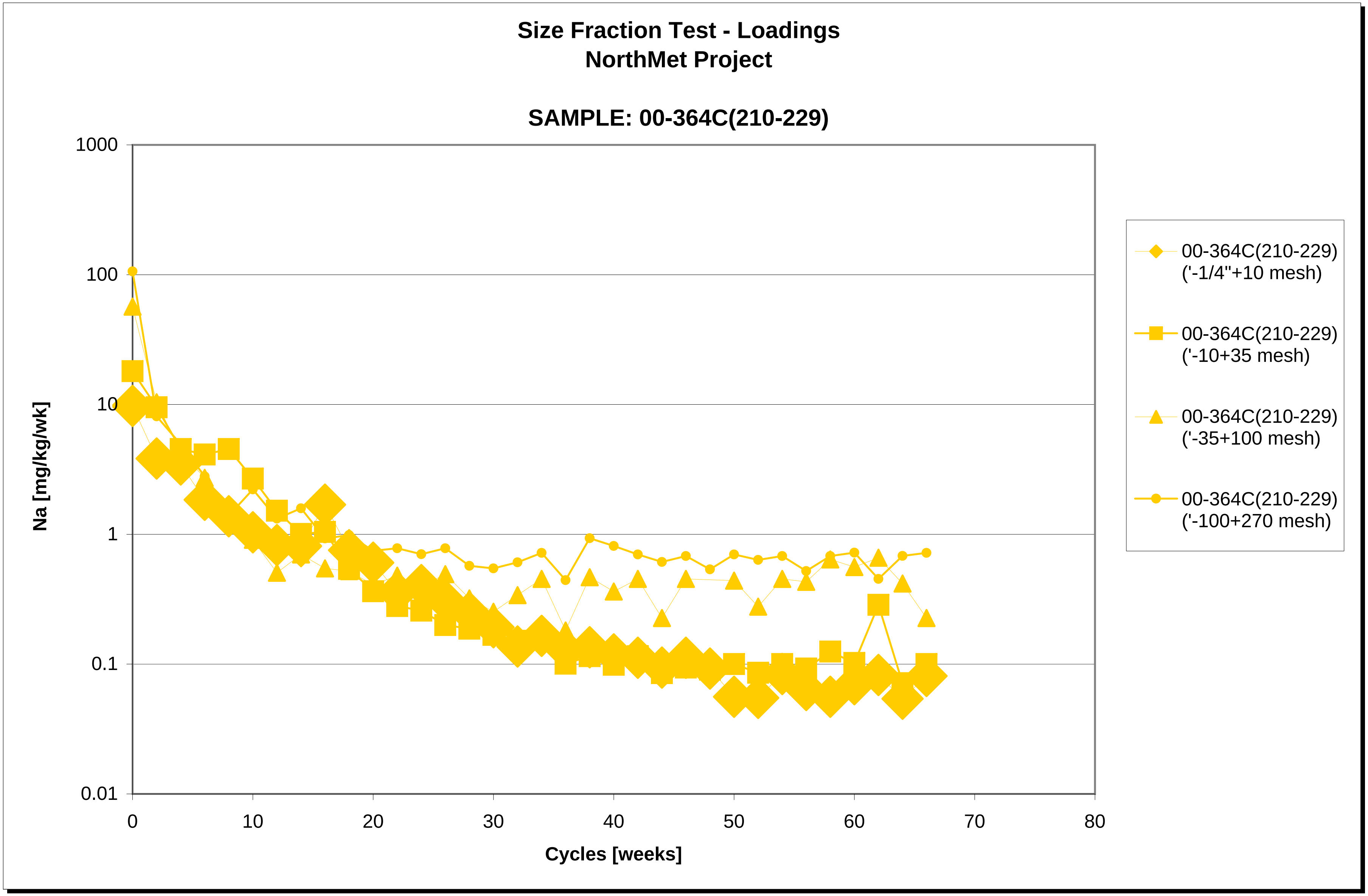

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Se [mg/kg/wk]
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

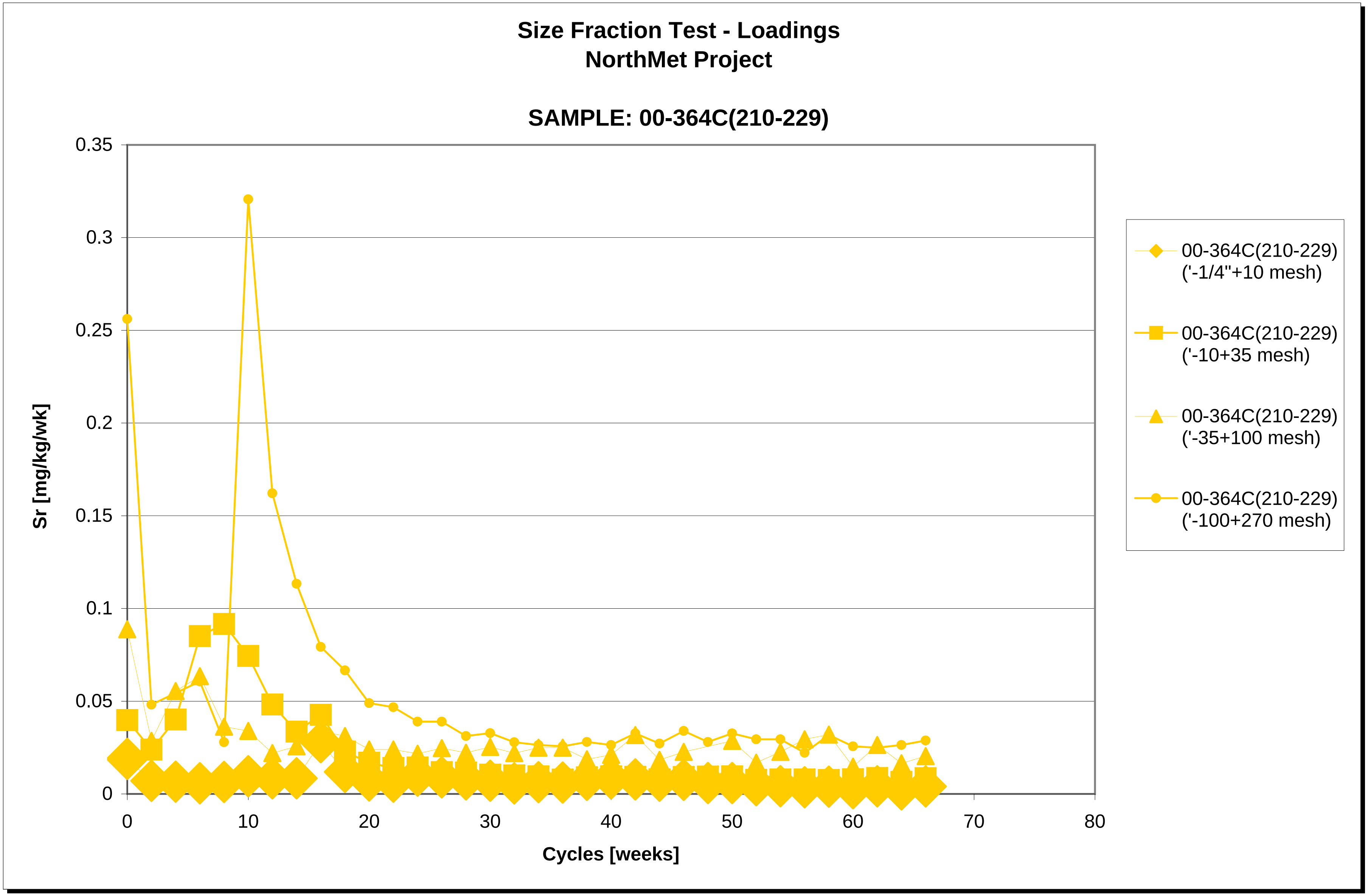

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
SiO2 [mg/kg/wk]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
Ag [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

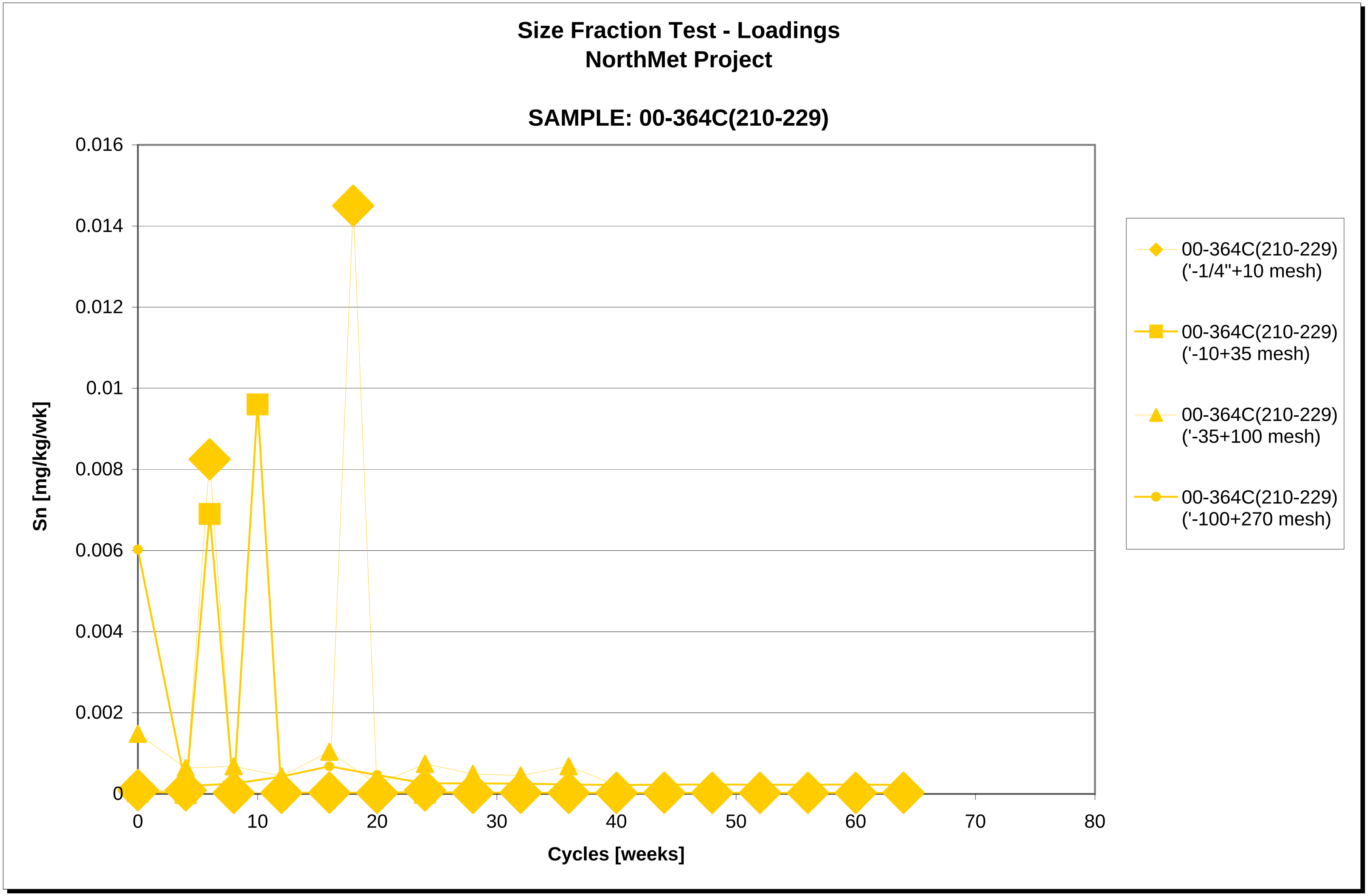
Appendix F
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-364C(210-229)

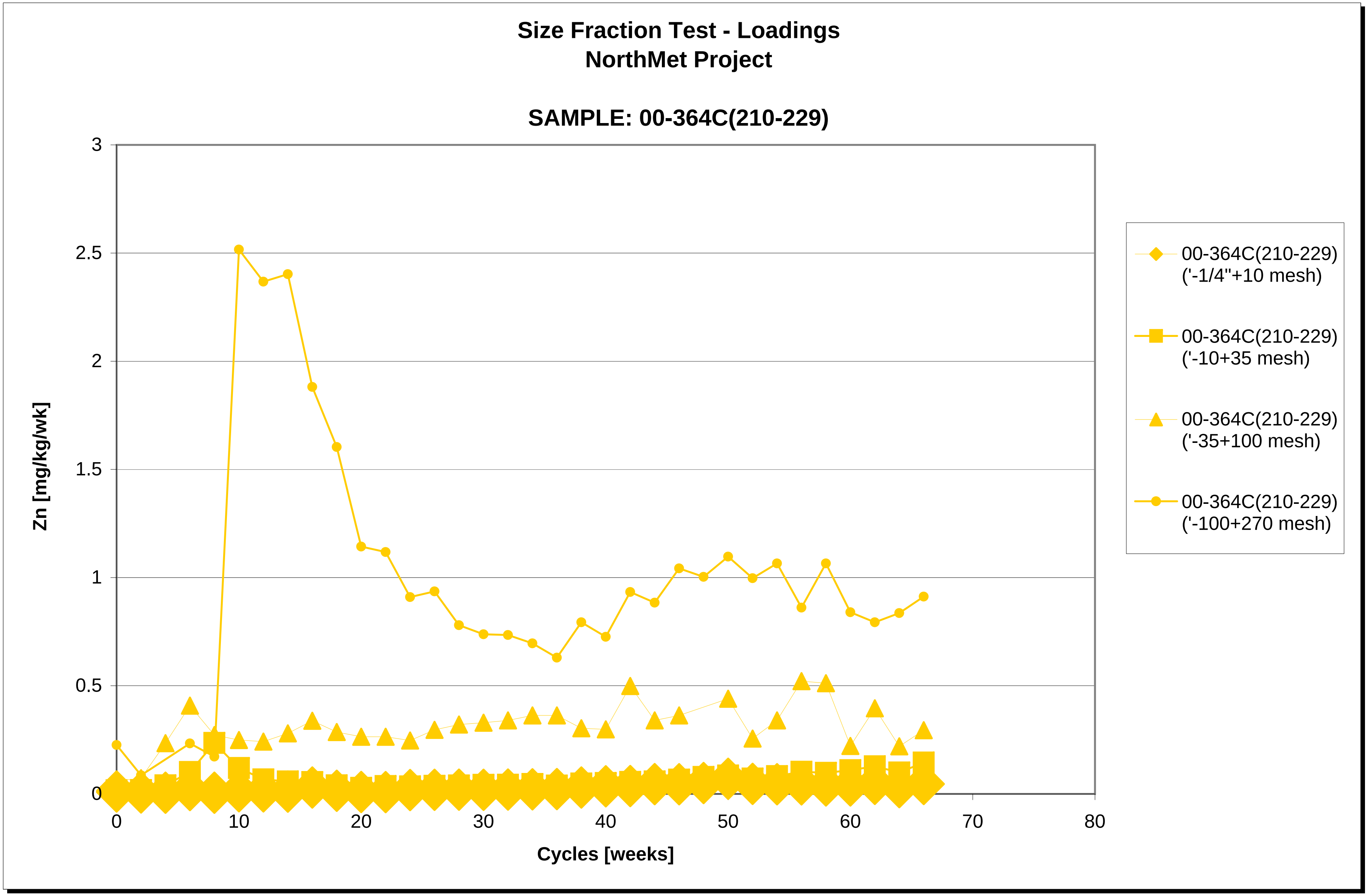
Chart F.3.37

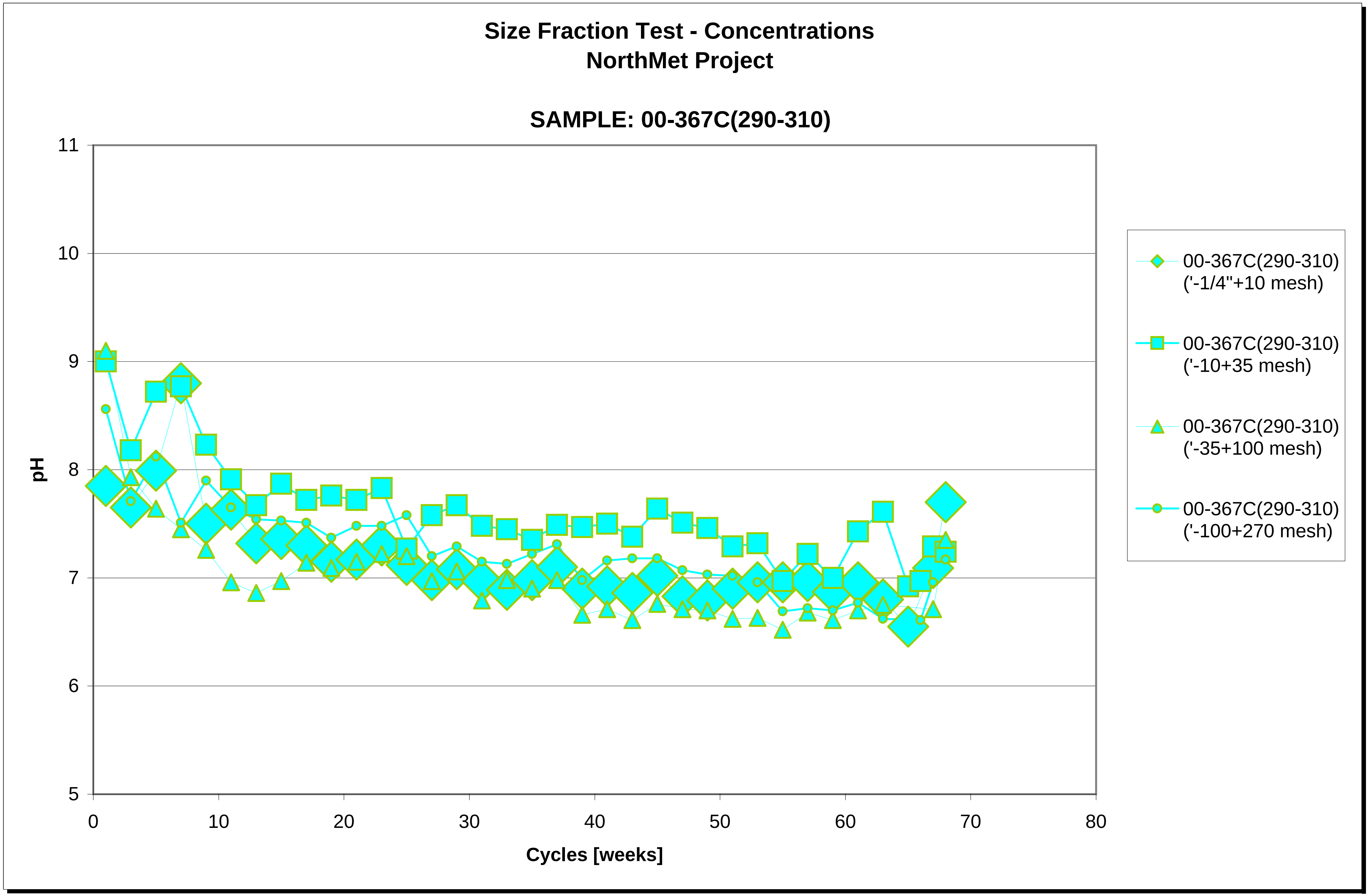


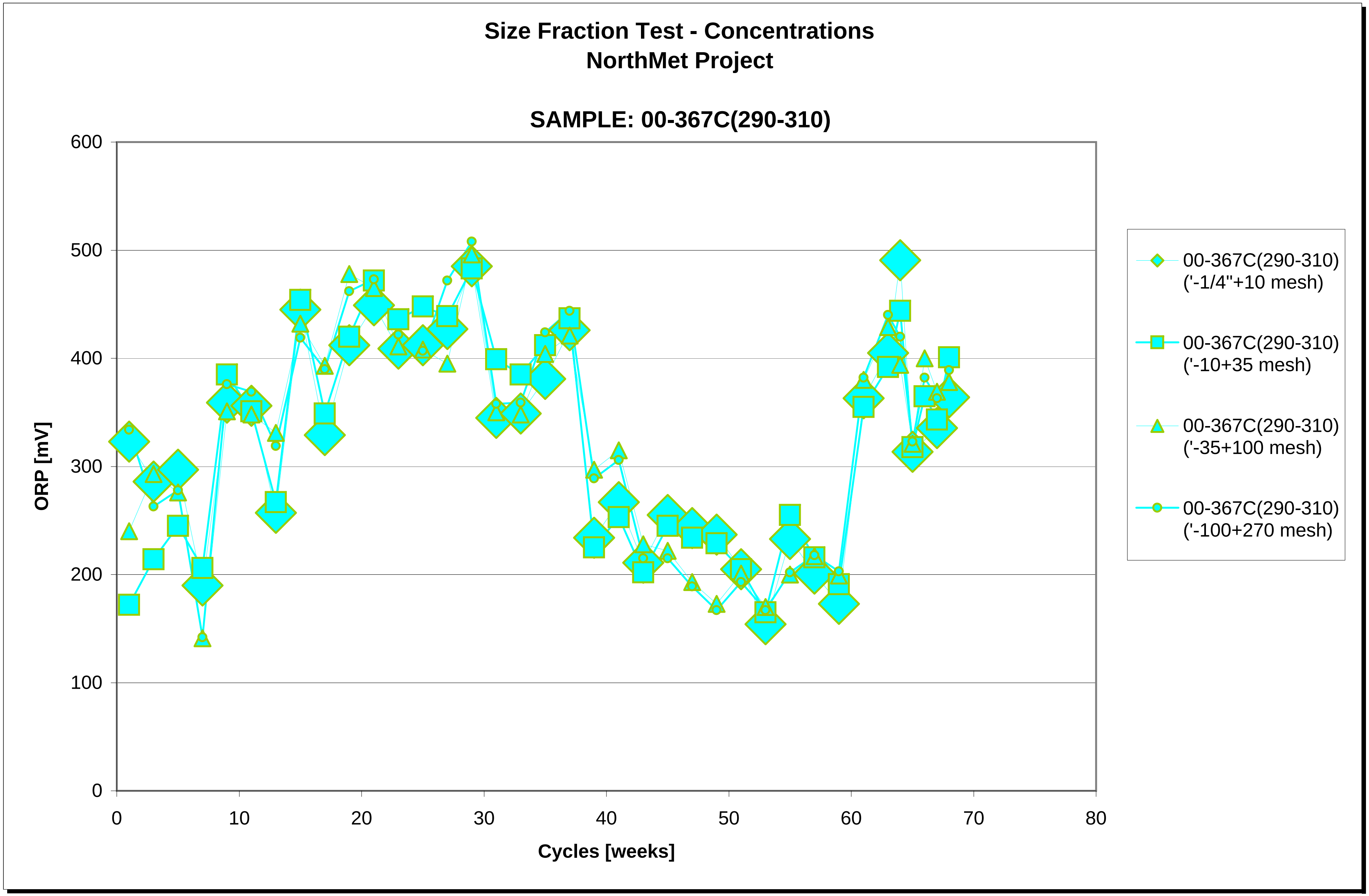

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Sr [mg/kg/wk]
Cycles [weeks]
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

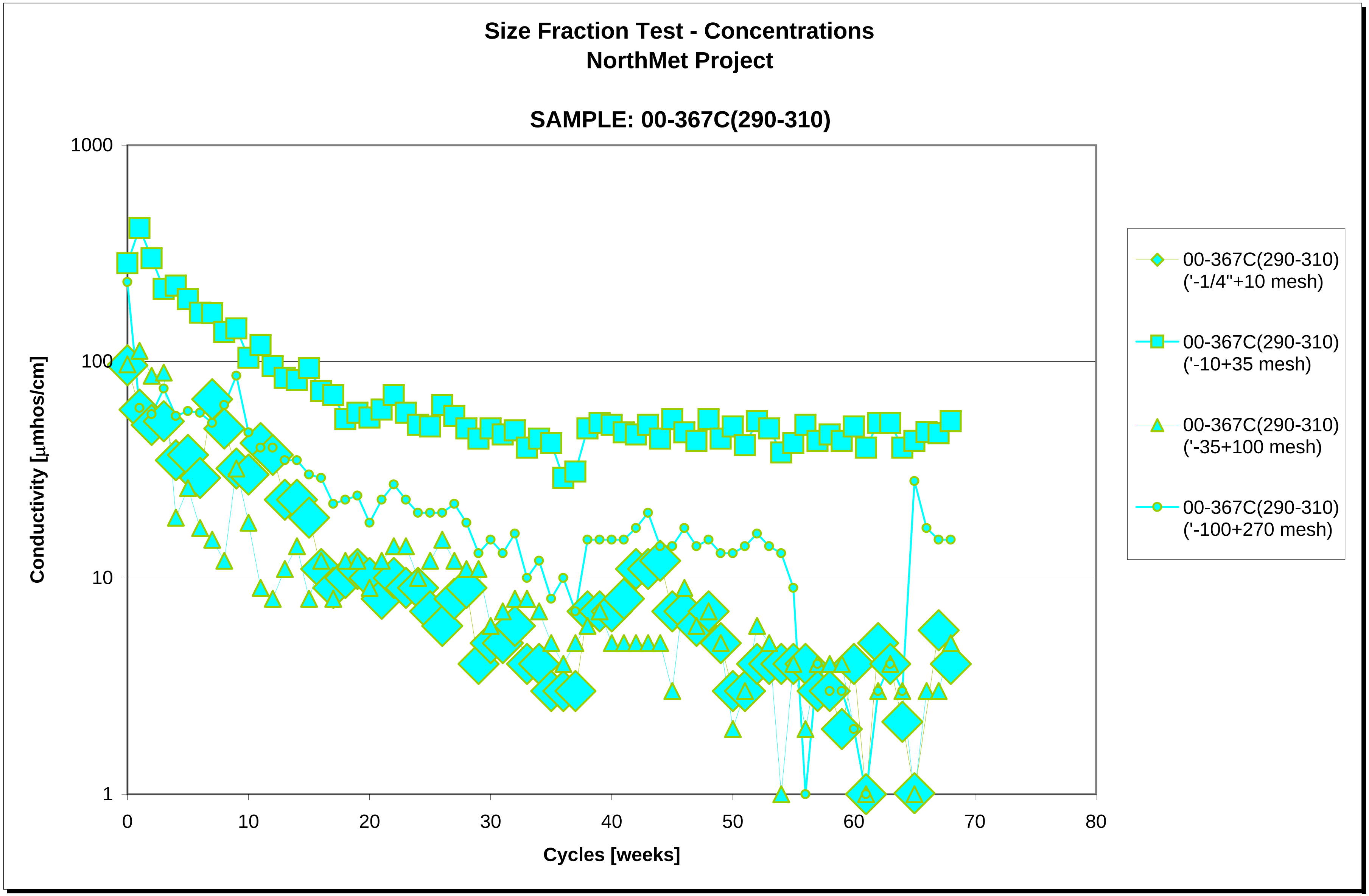

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Tl [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)

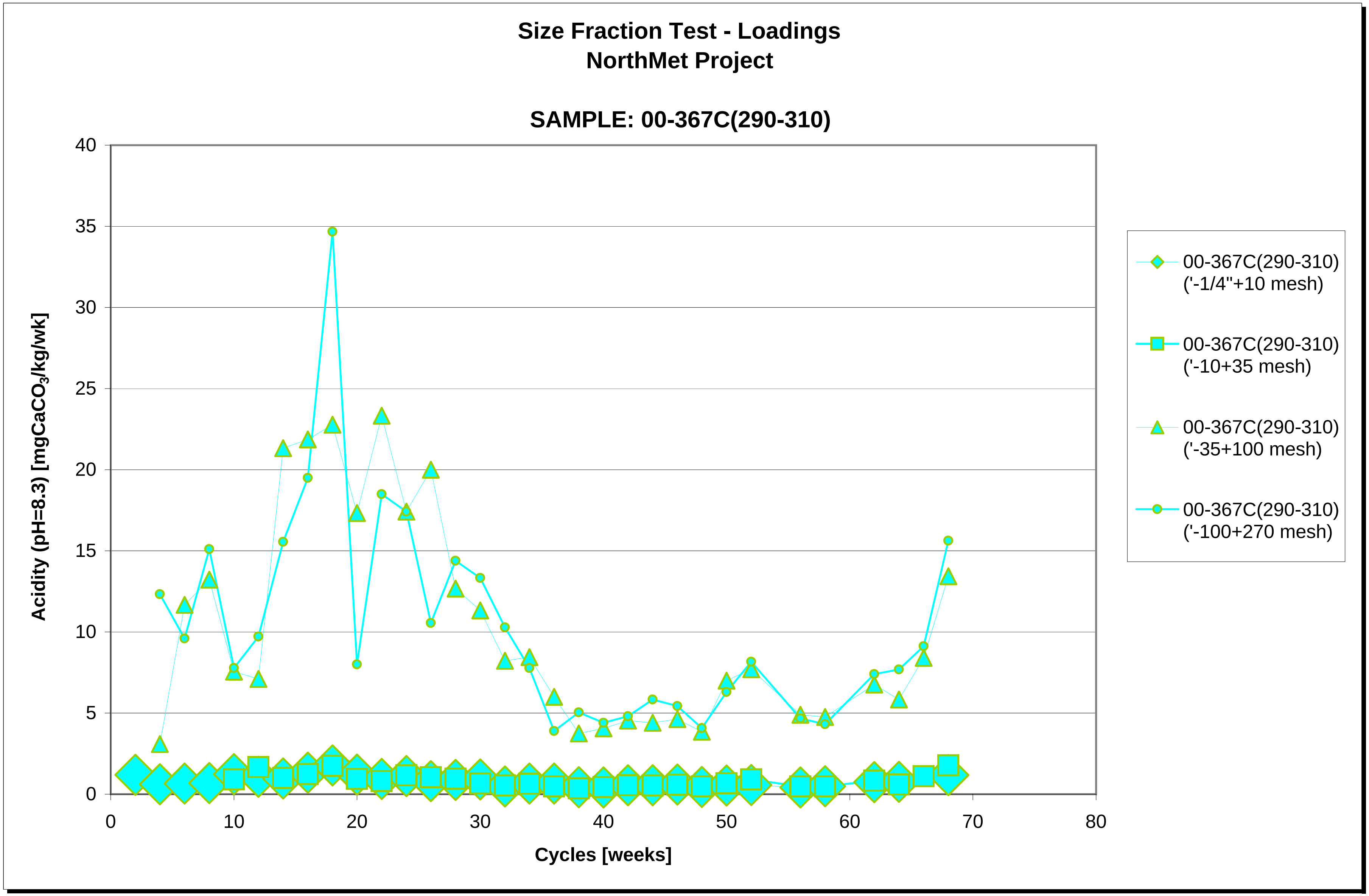

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Sn [mg/kg/wk]
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-364C(210-229)
Zn [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
0
10
20
30
40
50
60
70
80
00-364C(210-229) ('-1/4"+10 mesh)
00-364C(210-229) ('-10+35 mesh)
00-364C(210-229) ('-35+100 mesh)
00-364C(210-229) ('-100+270 mesh)


Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-367C(290-310)
pH
11
10
9
8
7
6
5
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-367C(290-310)
ORP [mV]
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-367C(290-310)
Conductivity [µmhos/cm]
1000
100
10
1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

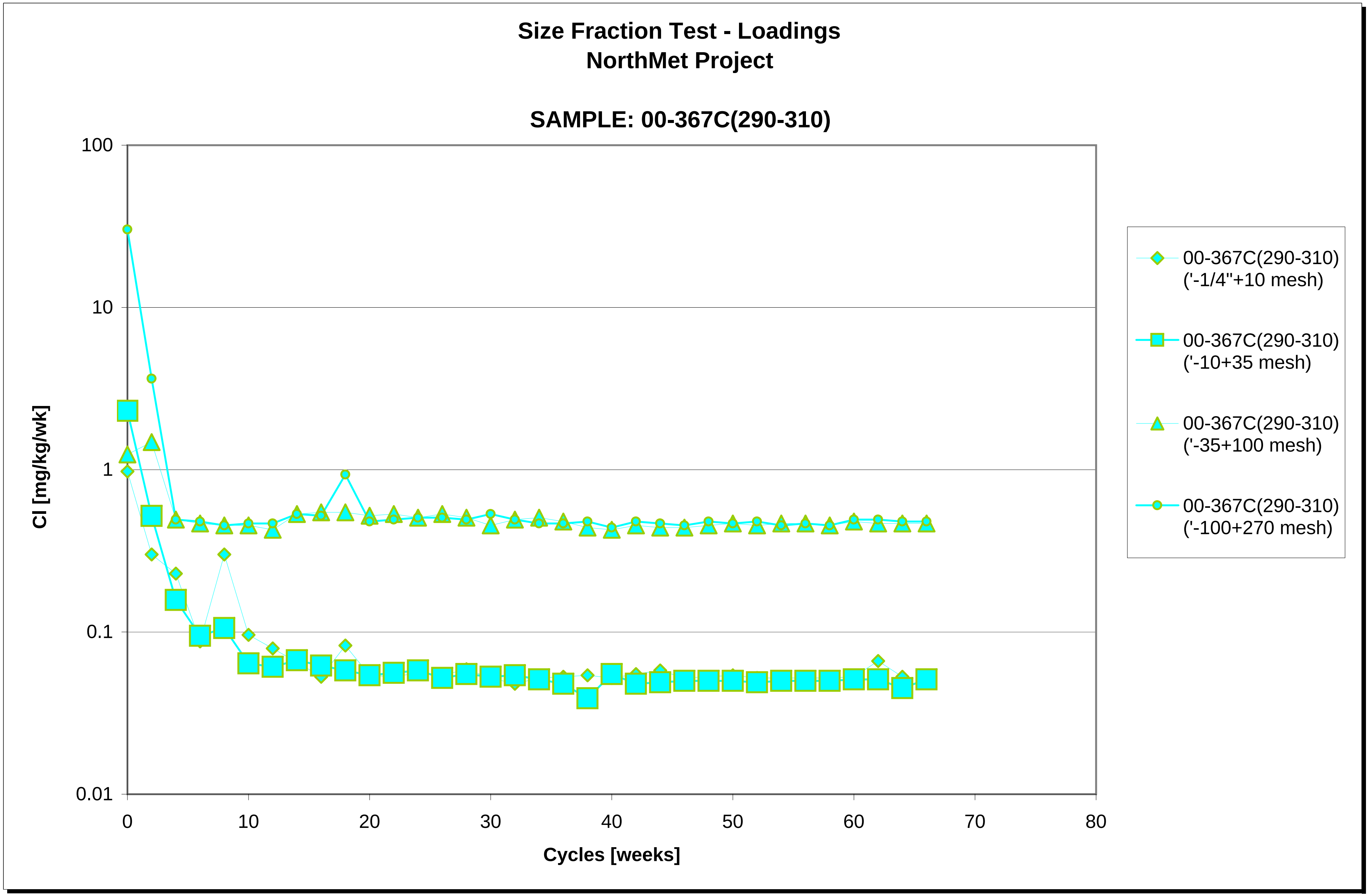

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
40
0
10
20
30
40
50
60
70
80
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

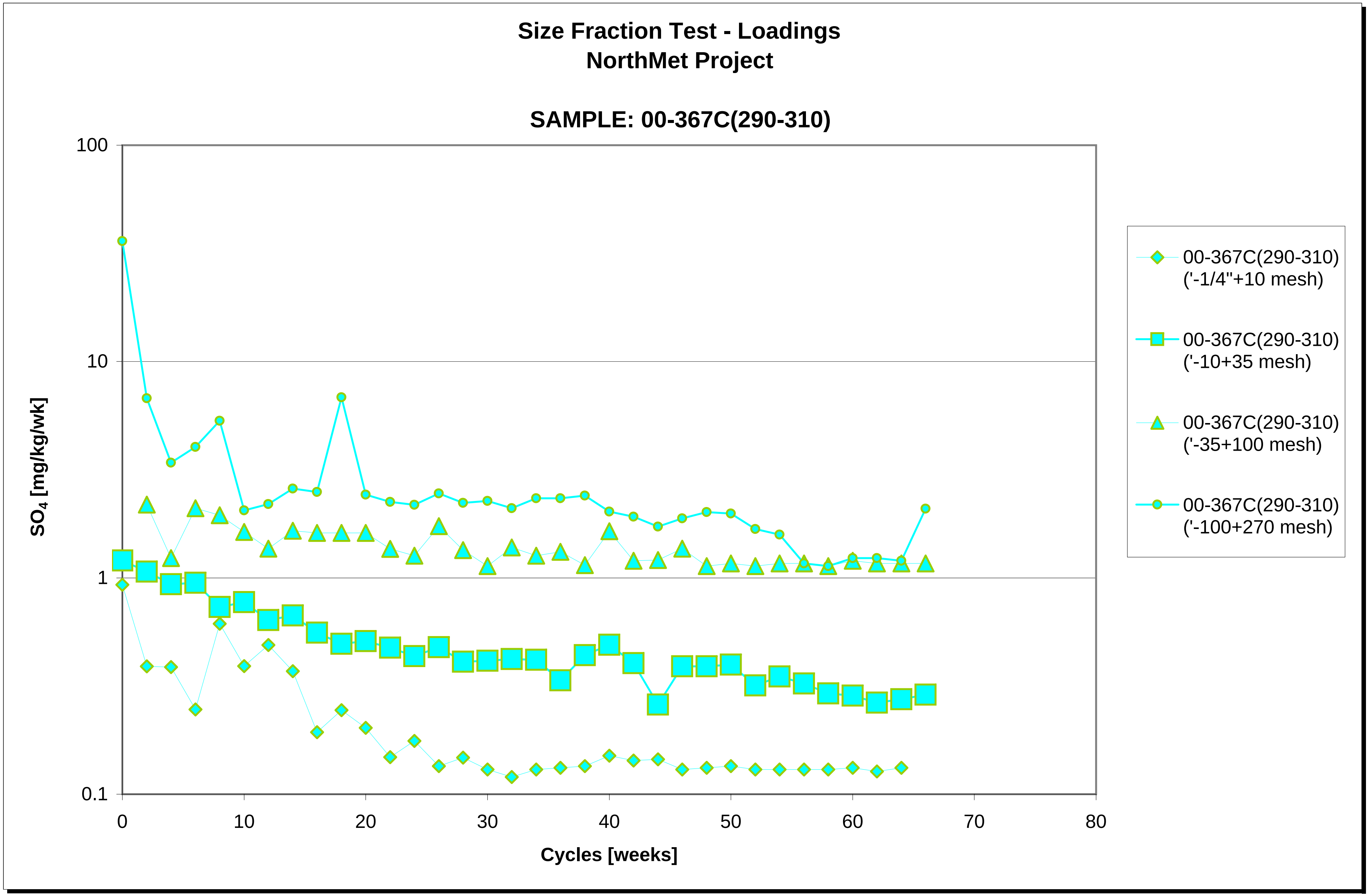

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Alkalinity [mgCaCO3/kg/wk]
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Inorganic Carbon [mg/kg/wk]
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

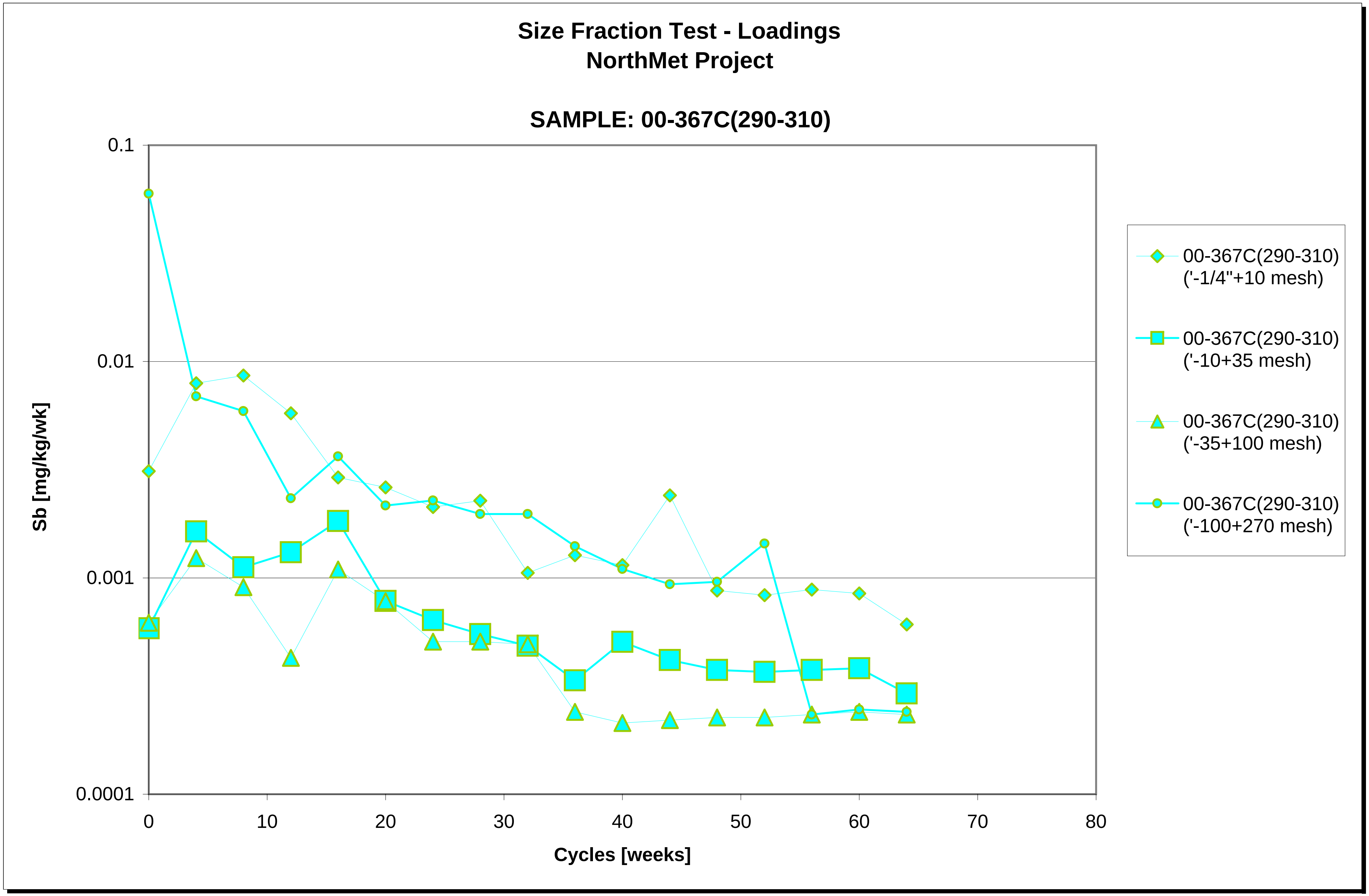

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
80
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
F [mg/kg/wk]
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

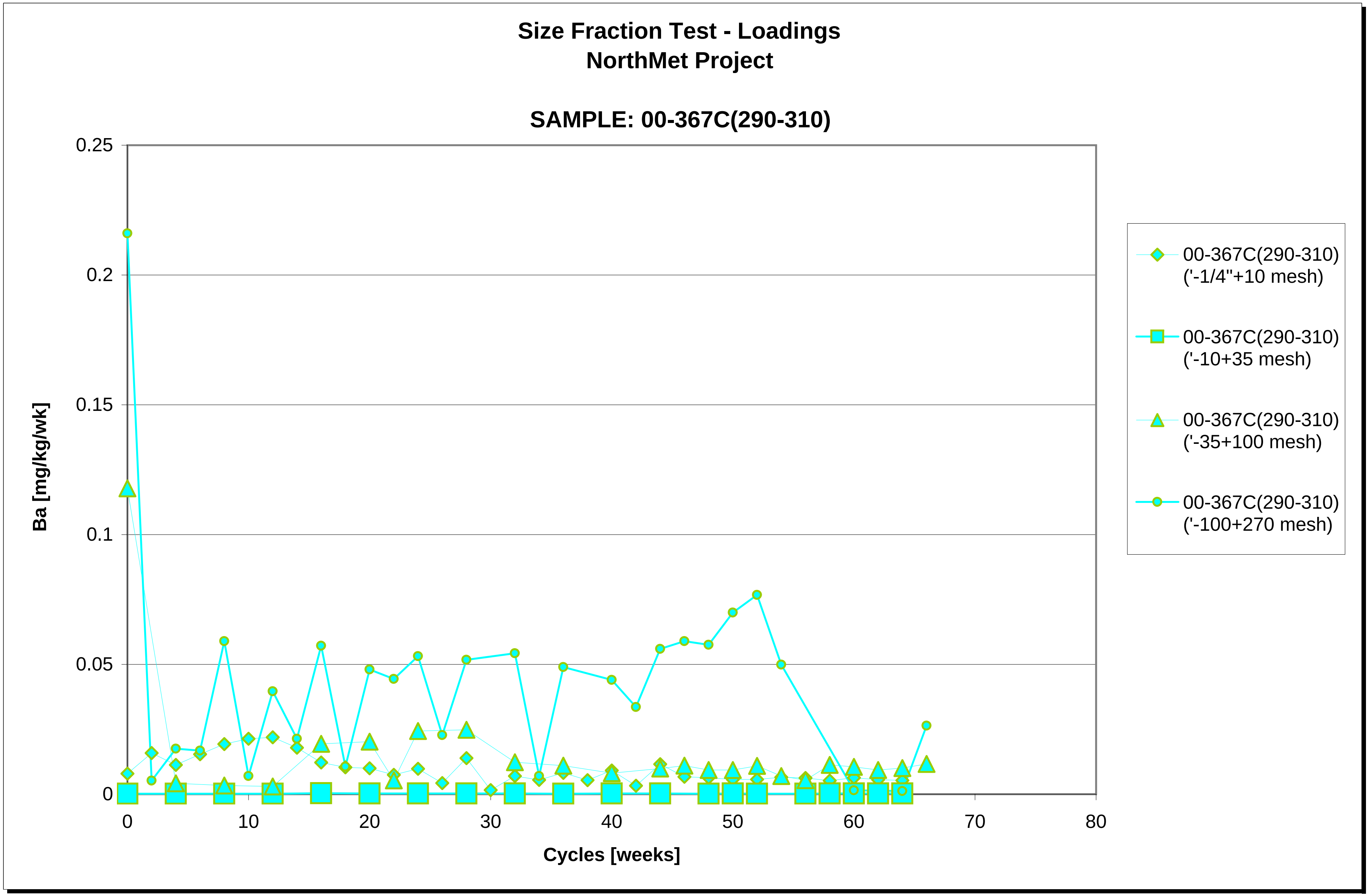

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Cl [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

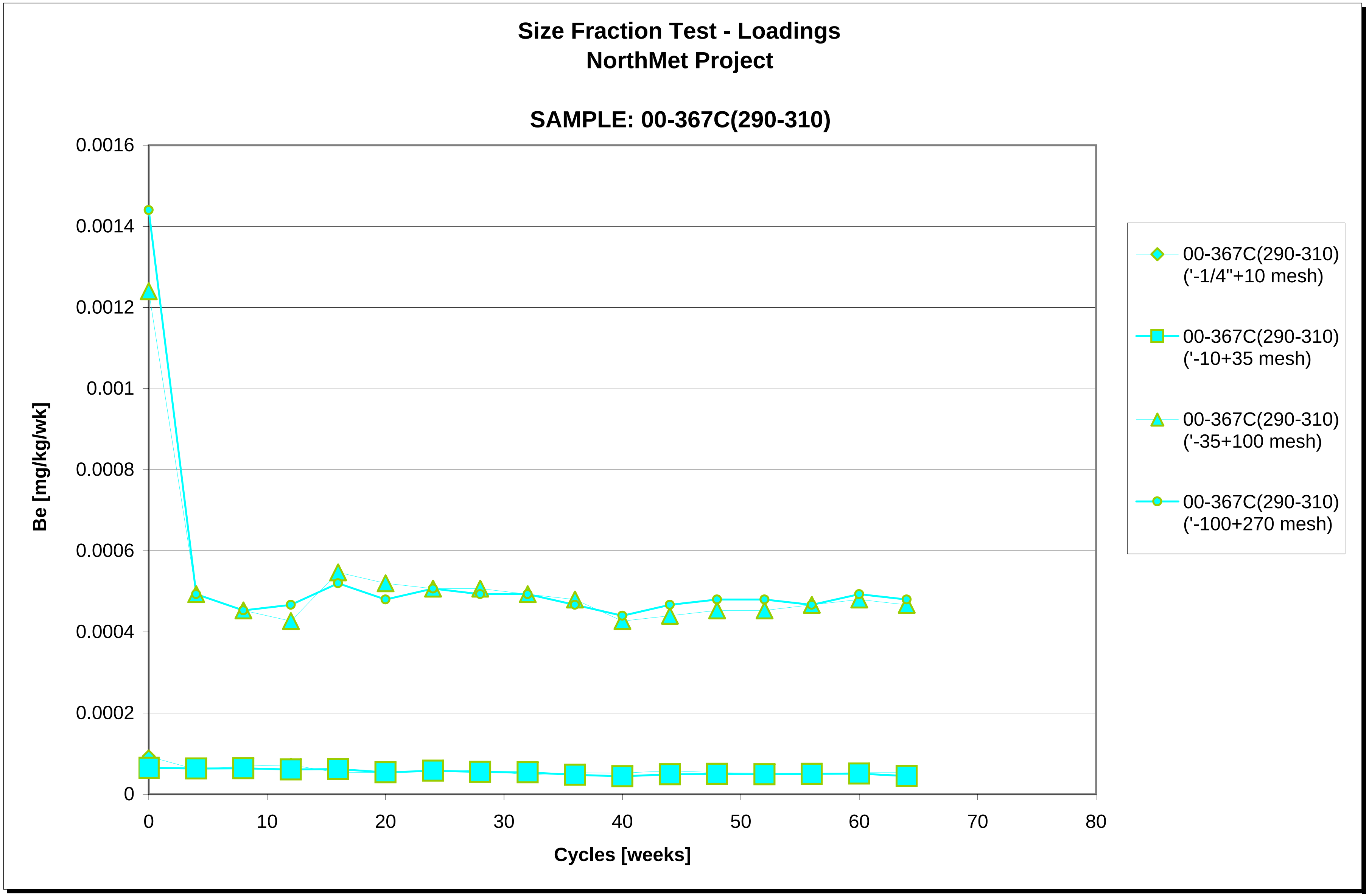

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
100
10
1
0.1
SO4 [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

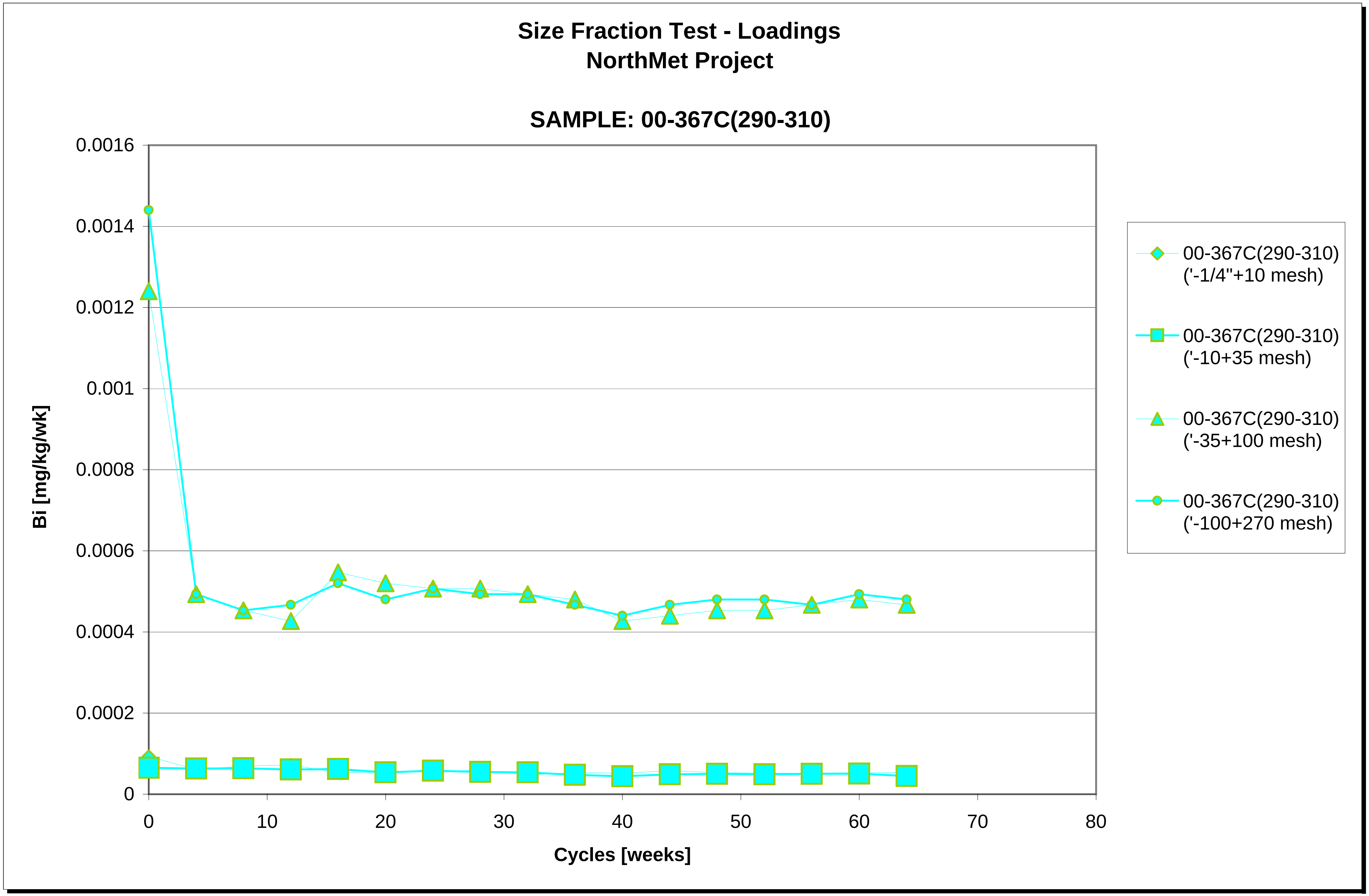

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Al [mg/kg/wk]
10
1
0.1
0.01
0.001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
0.1
0.01
0.001
0.0001
Sb [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

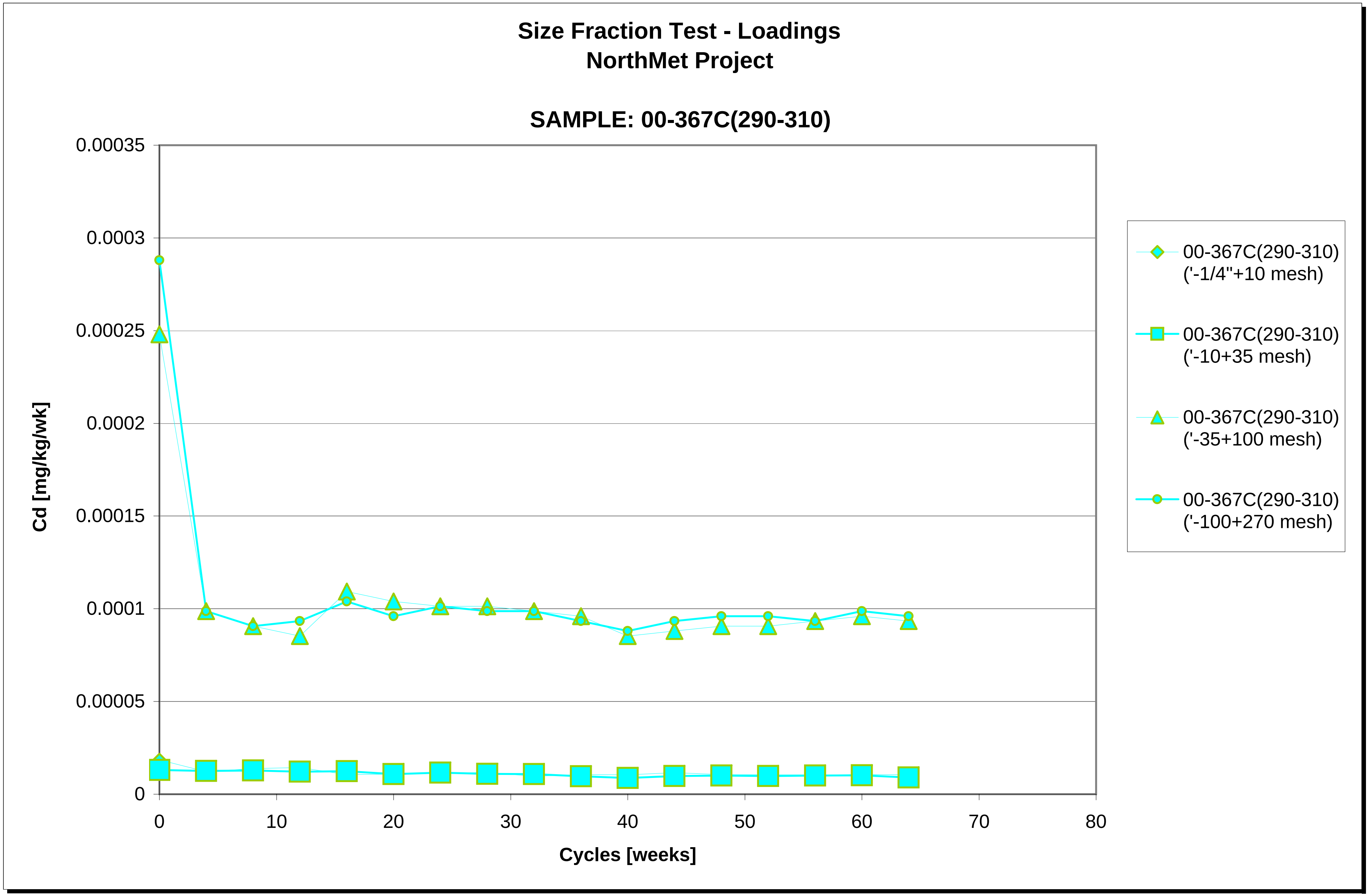

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
0.1
0.01
0.001
0.0001
0.00001
As [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Ba [mg/kg/wk]
0.25
0.2
0.15
0.1
0.05
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

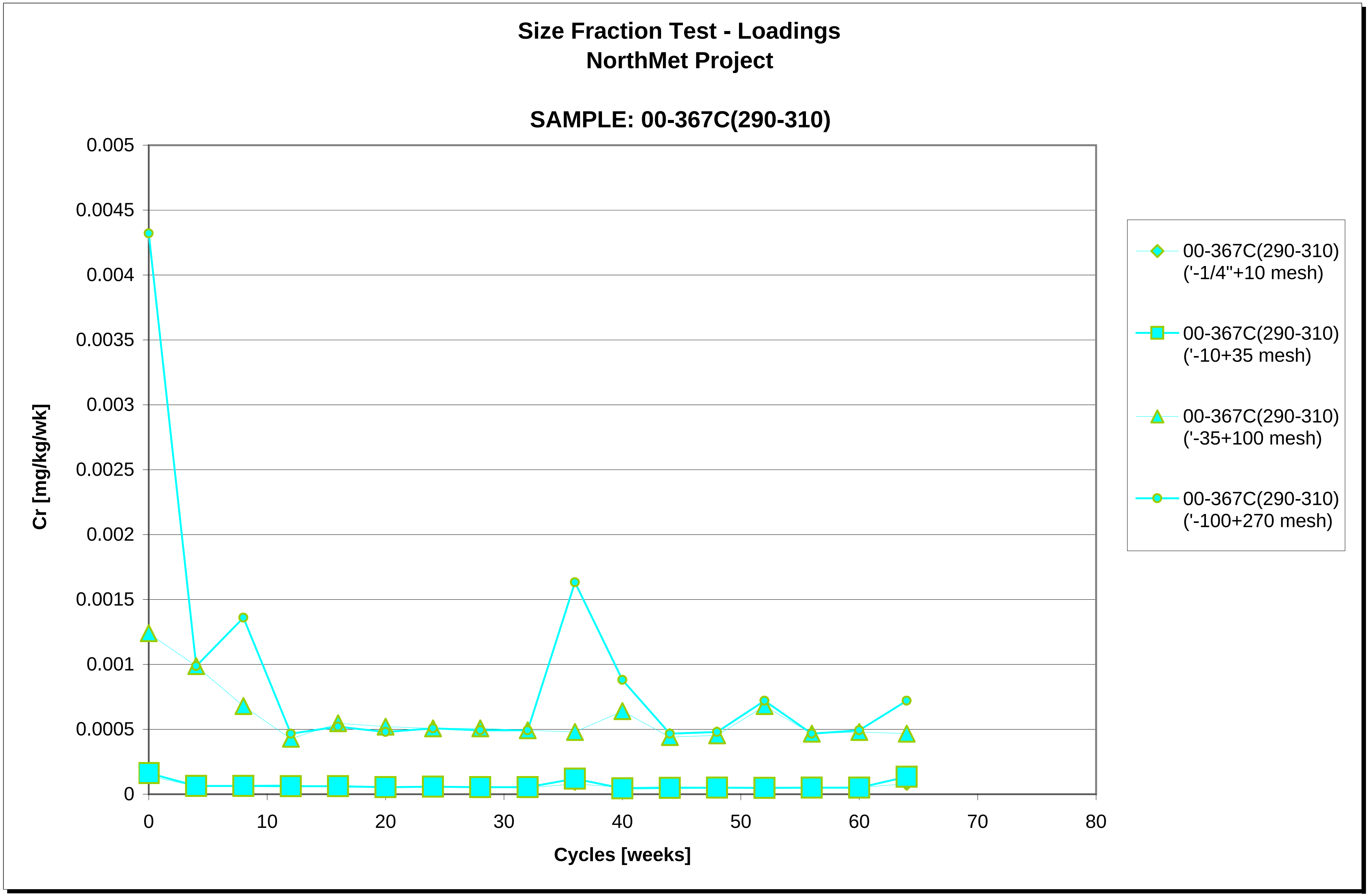

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Be [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

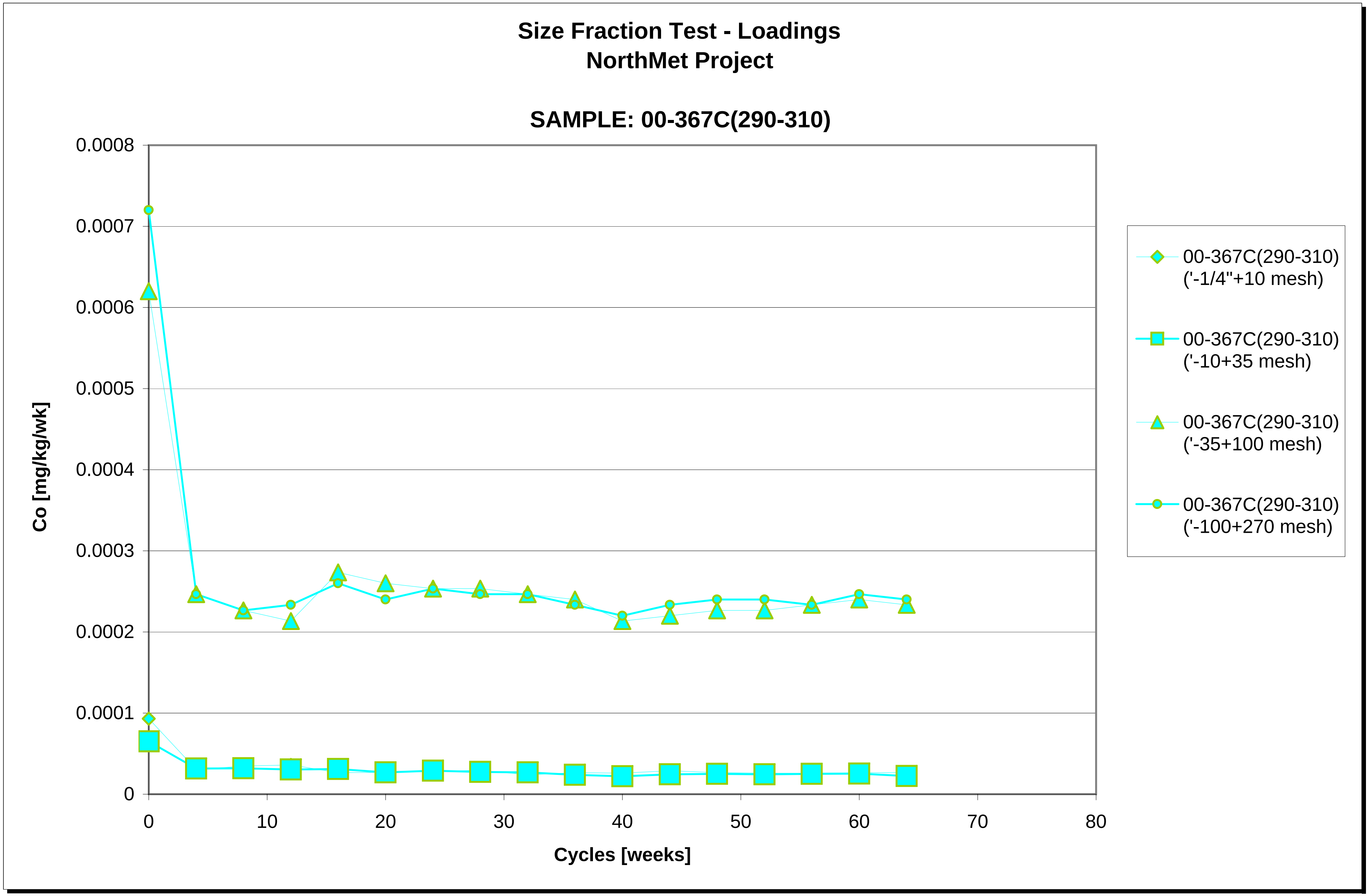

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Bi [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
B [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Cd [mg/kg/wk]
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

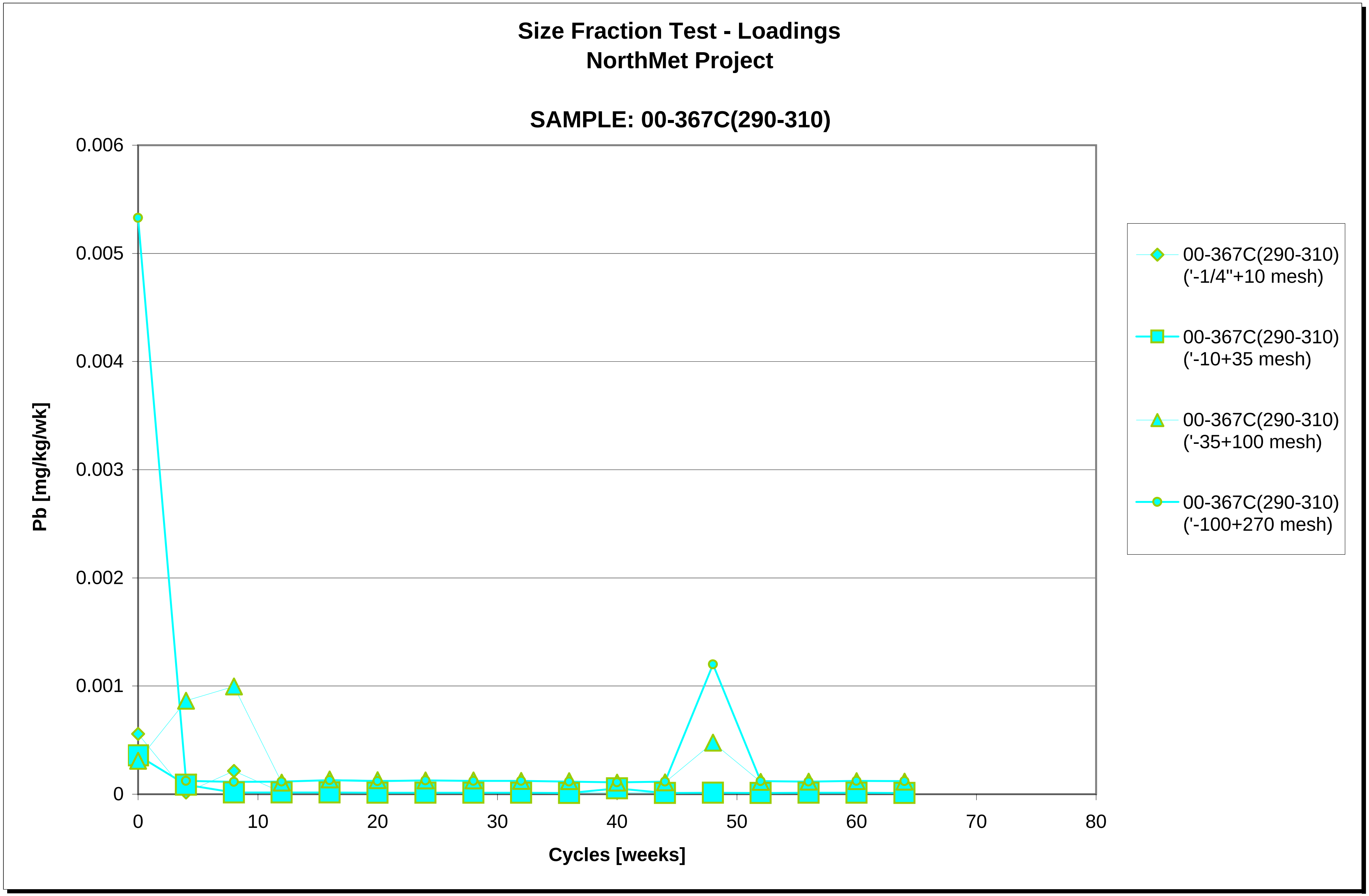

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Ca [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

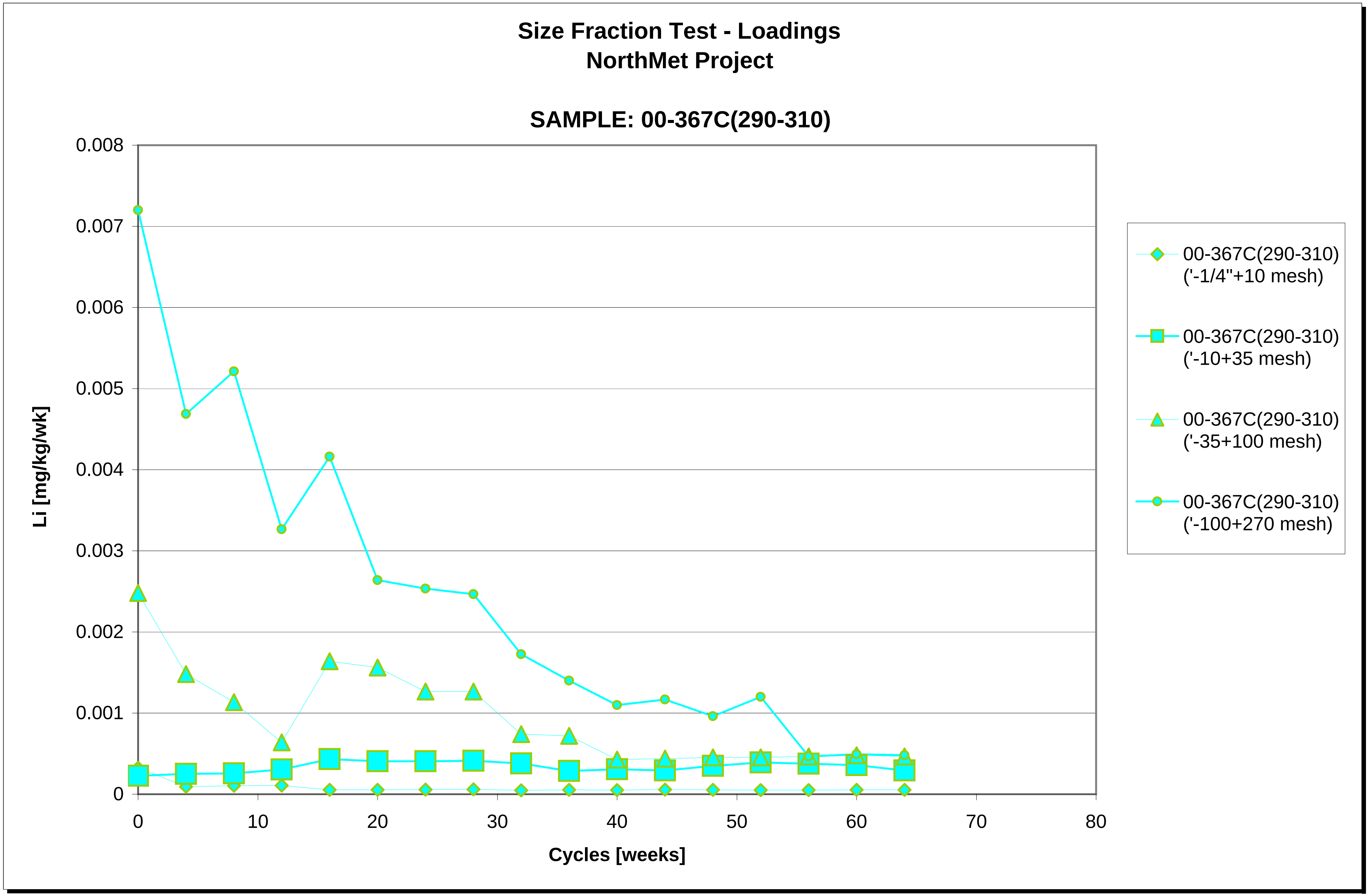

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Cr [mg/kg/wk]
0.005
0.0045
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Co [mg/kg/wk]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

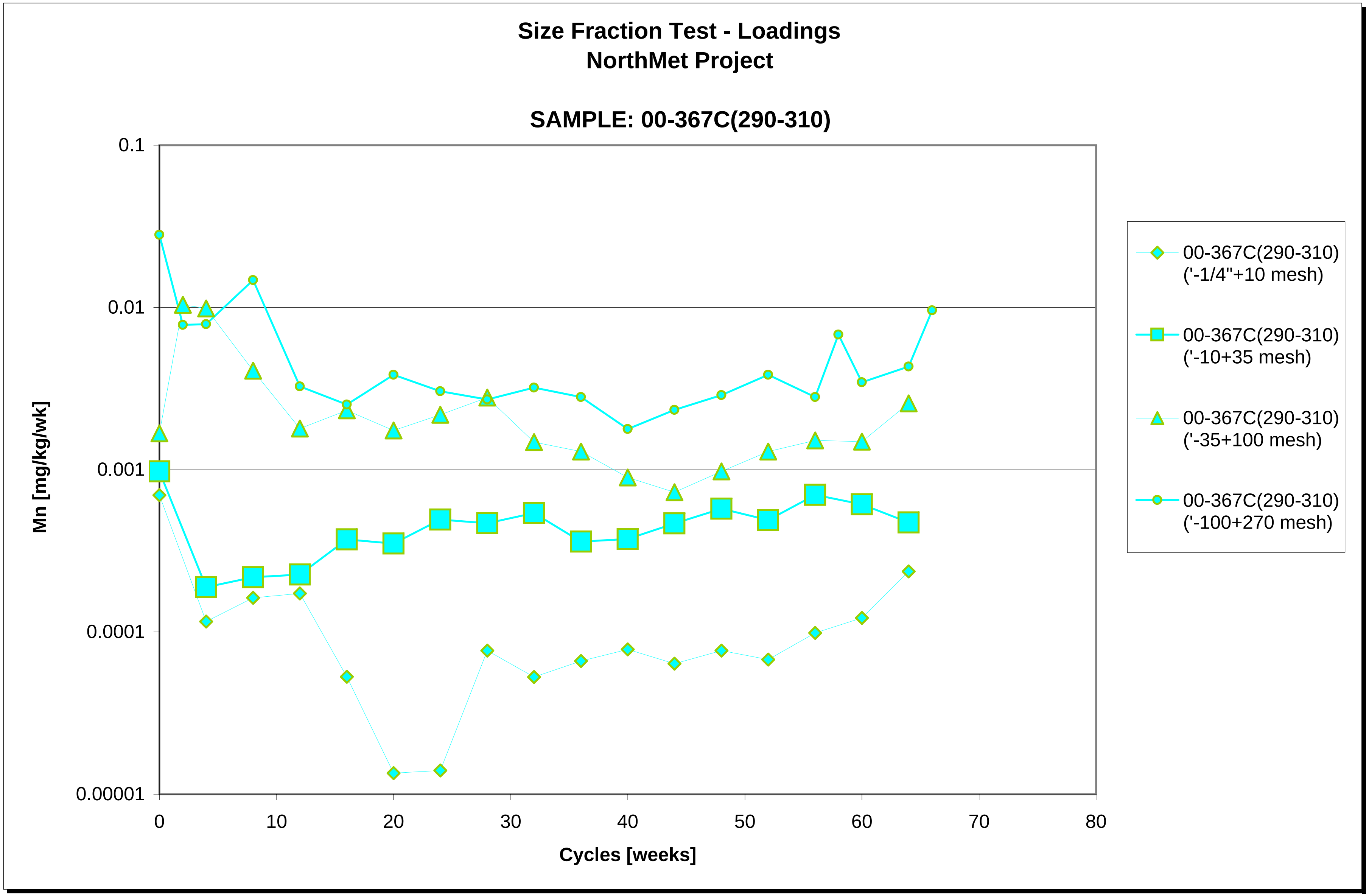

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Cu [mg/kg/wk]
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

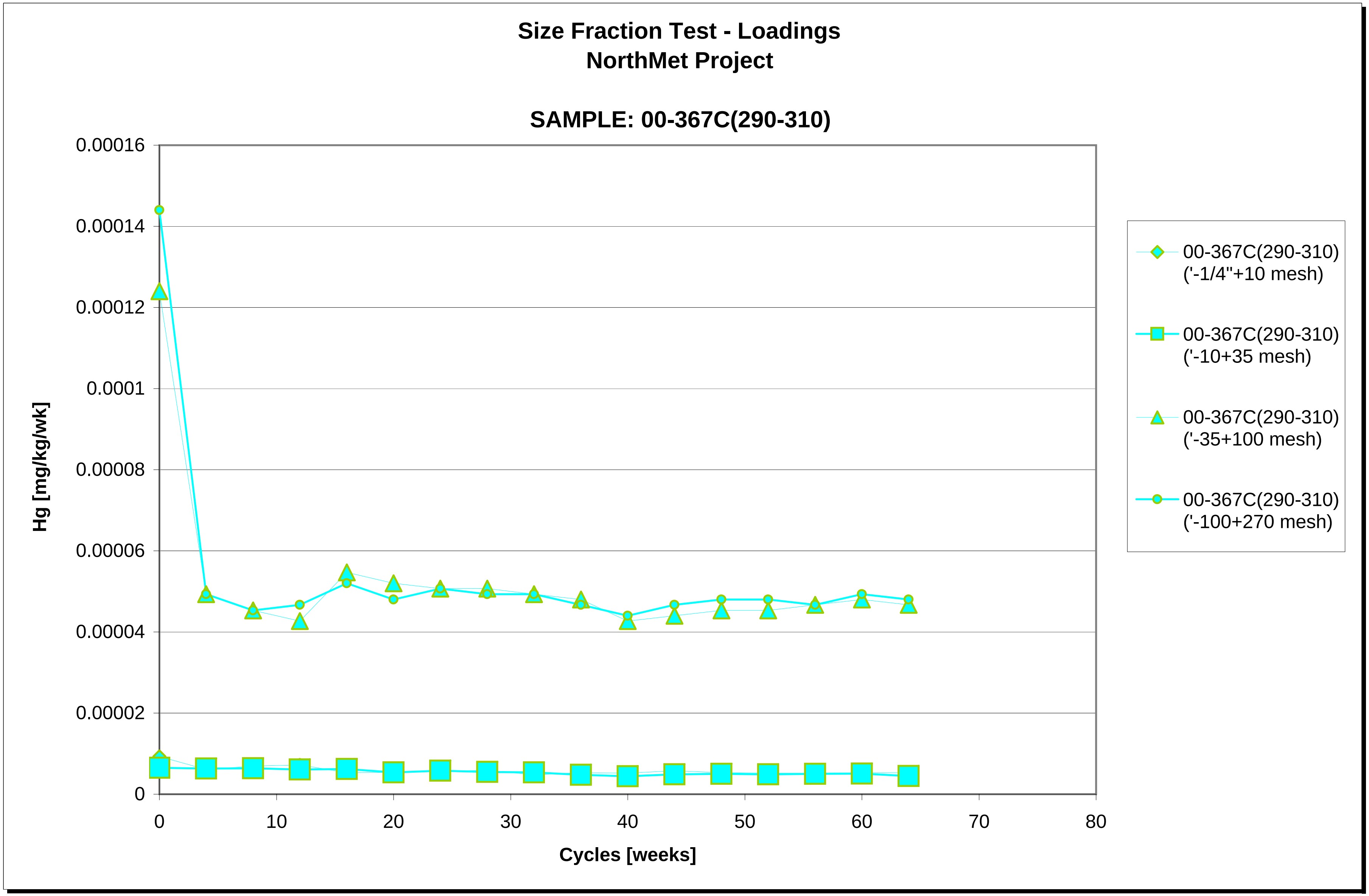

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
10
1
0.1
0.01
0.001
Fe [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Pb [mg/kg/wk]
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

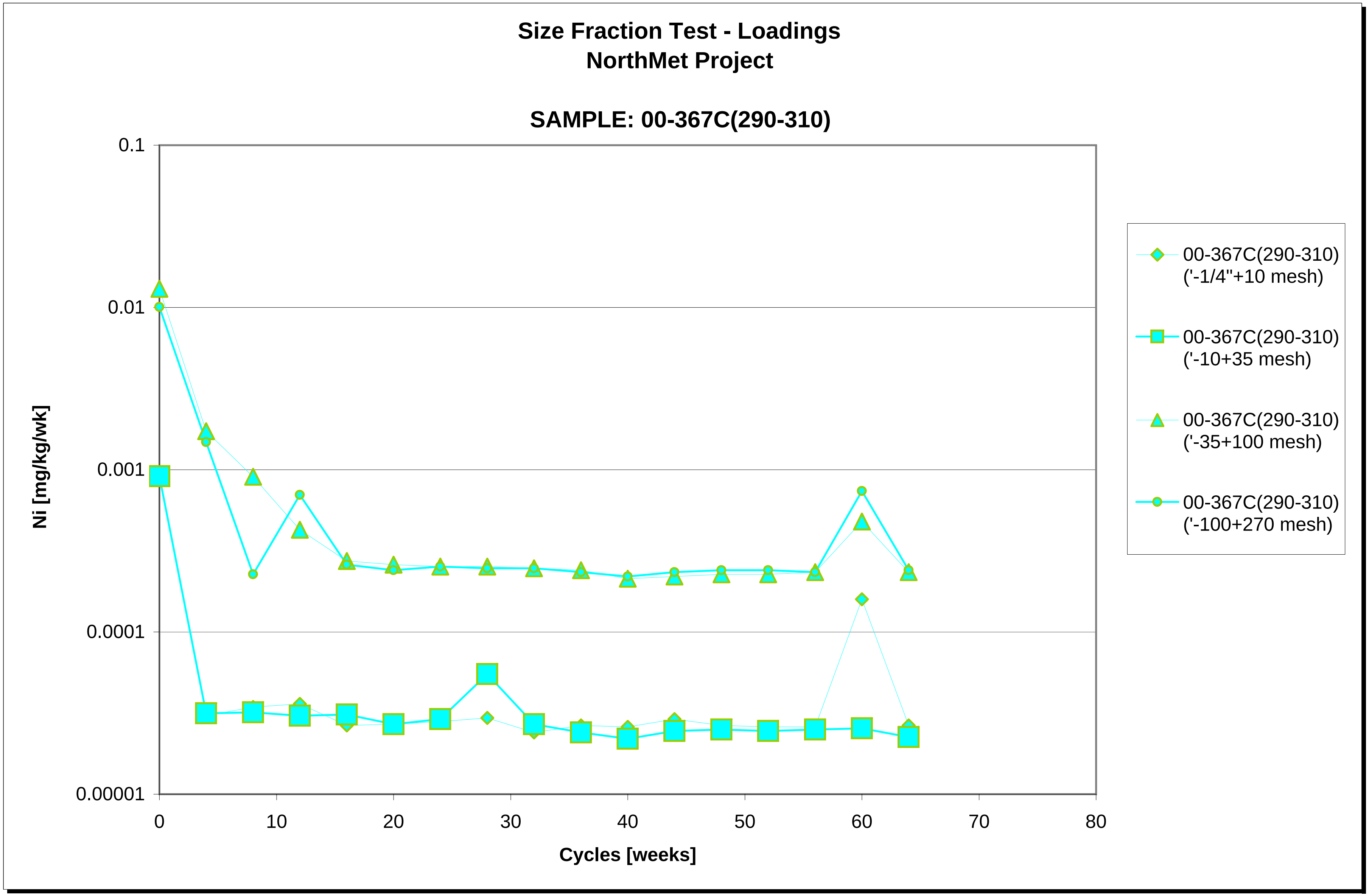

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Li [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

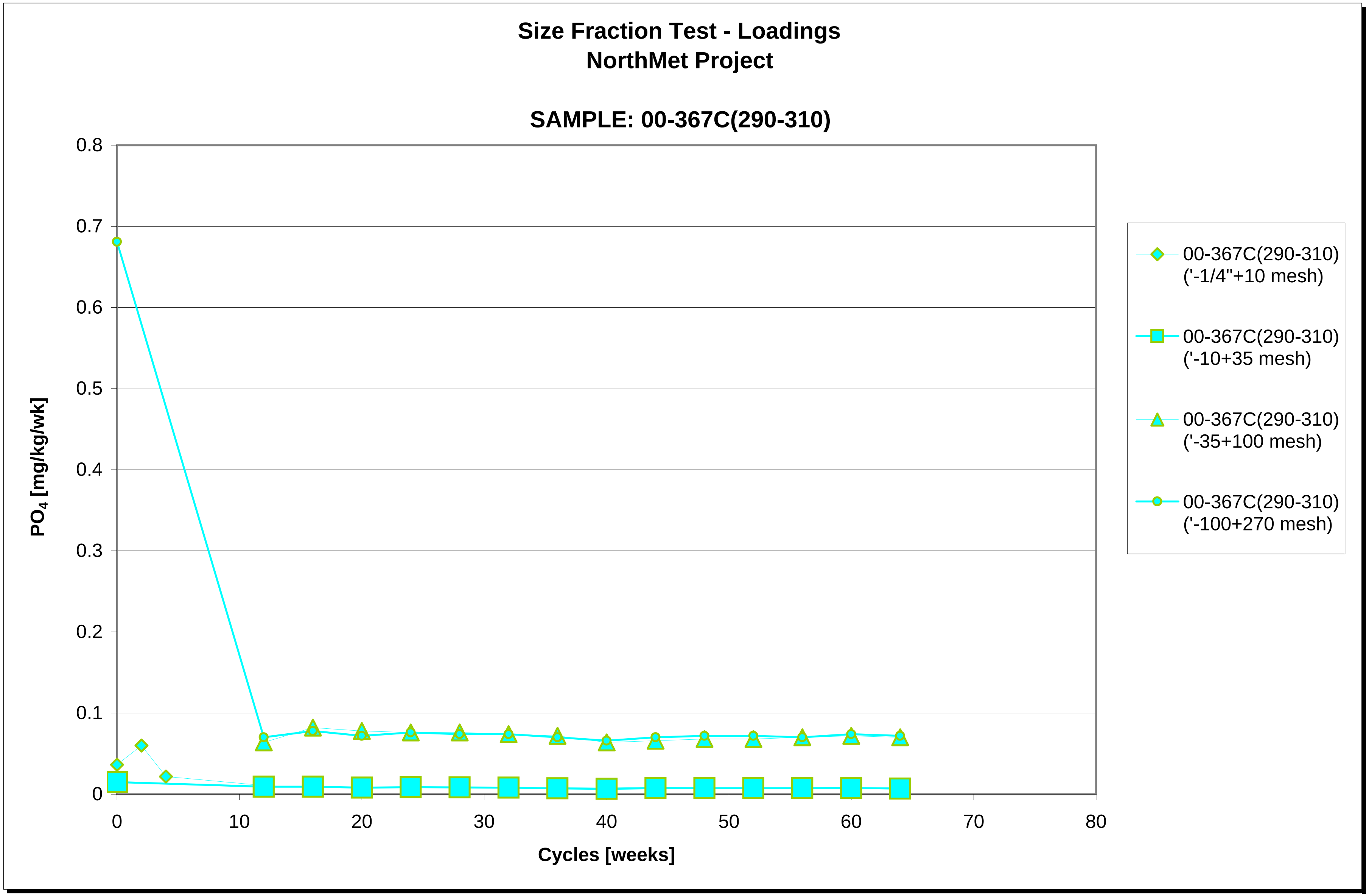

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Mg [mg/kg/wk]
Cycles [weeks]
3.5
3
2.5
2
1.5
1
0.5
0
0
10
20
30
40
50
60
70
80
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Mn [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

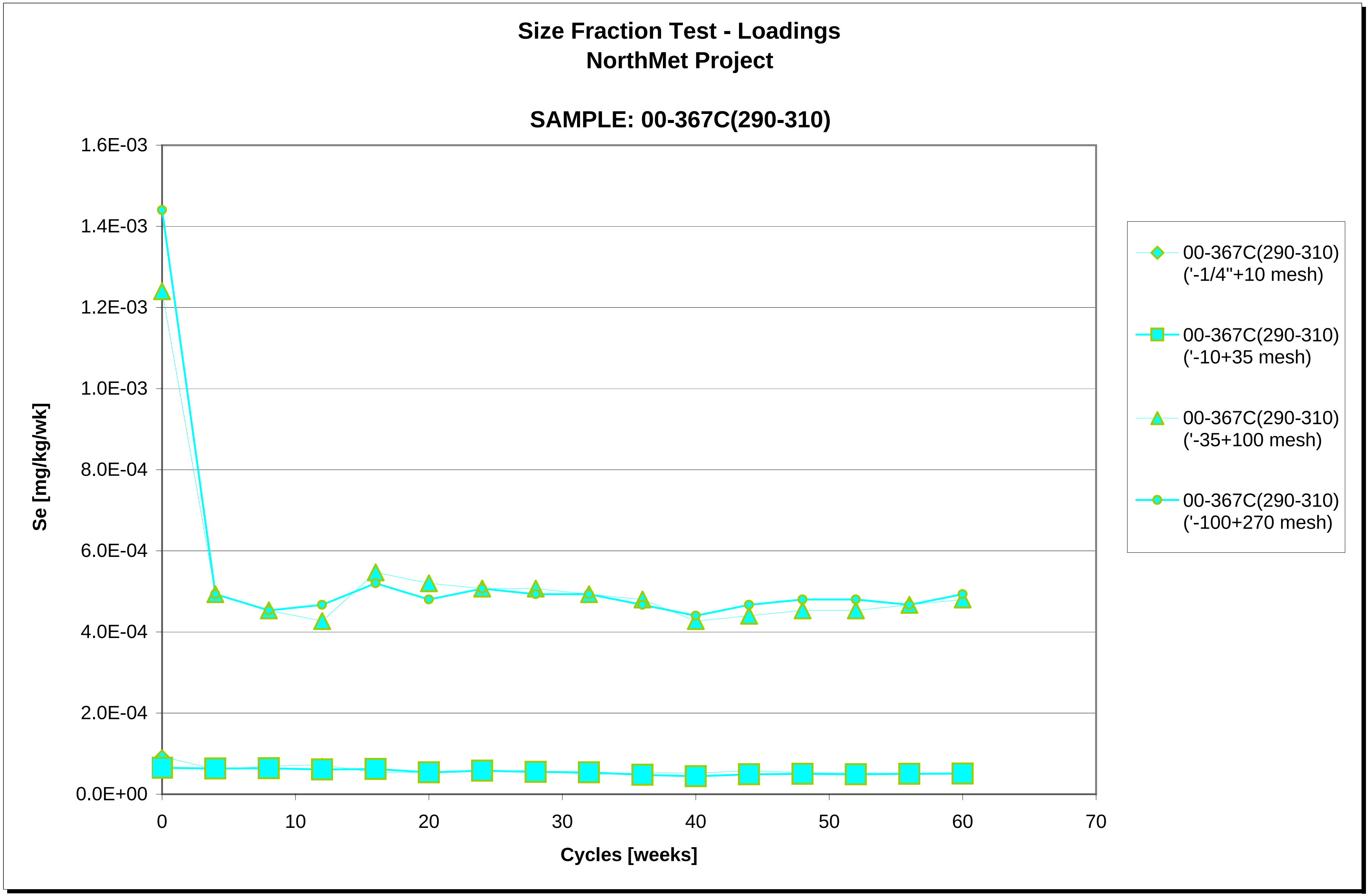

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Hg [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Mo [mg/kg/wk]
Cycles [weeks]
0.004
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

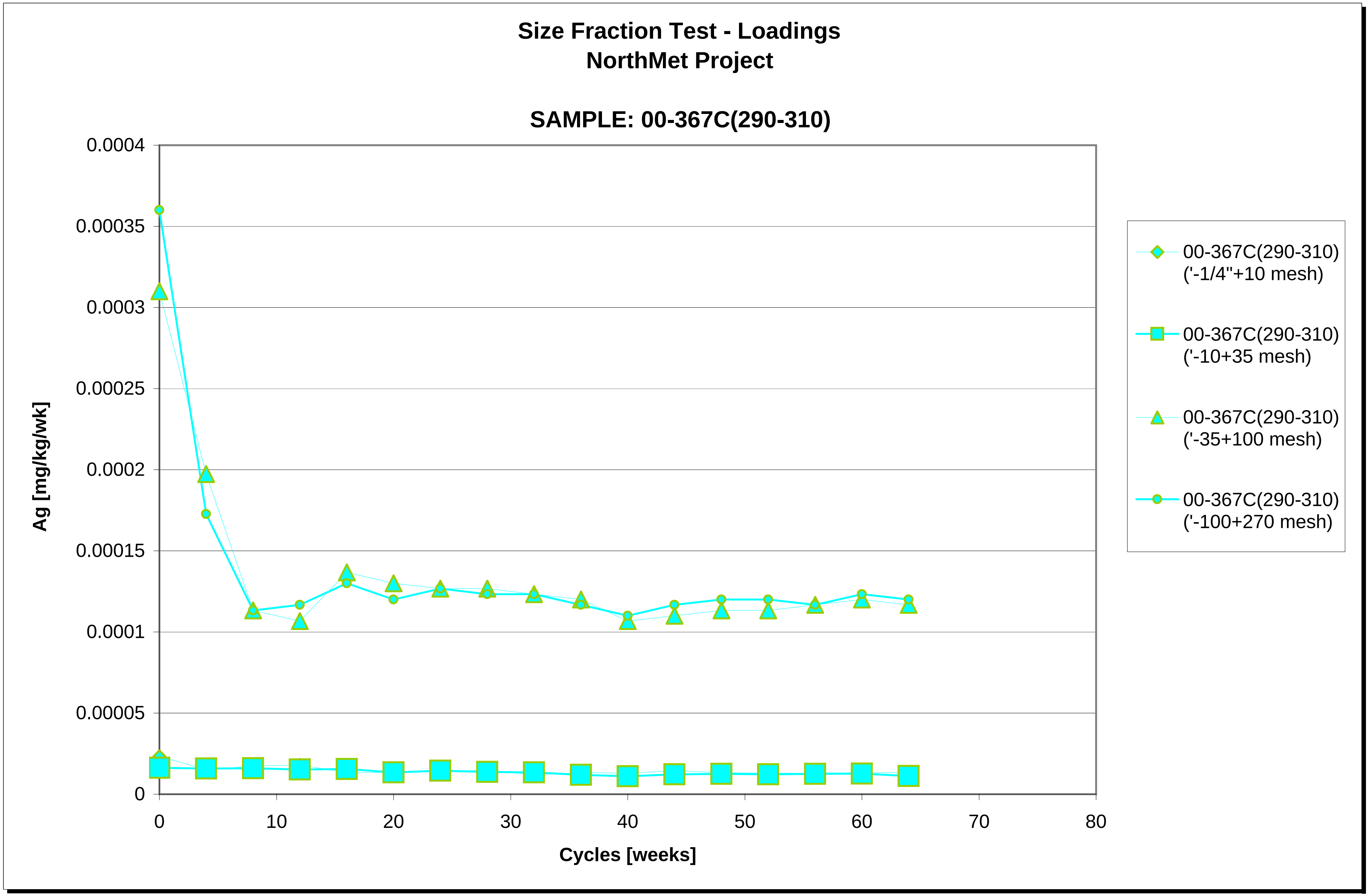

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Ni [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

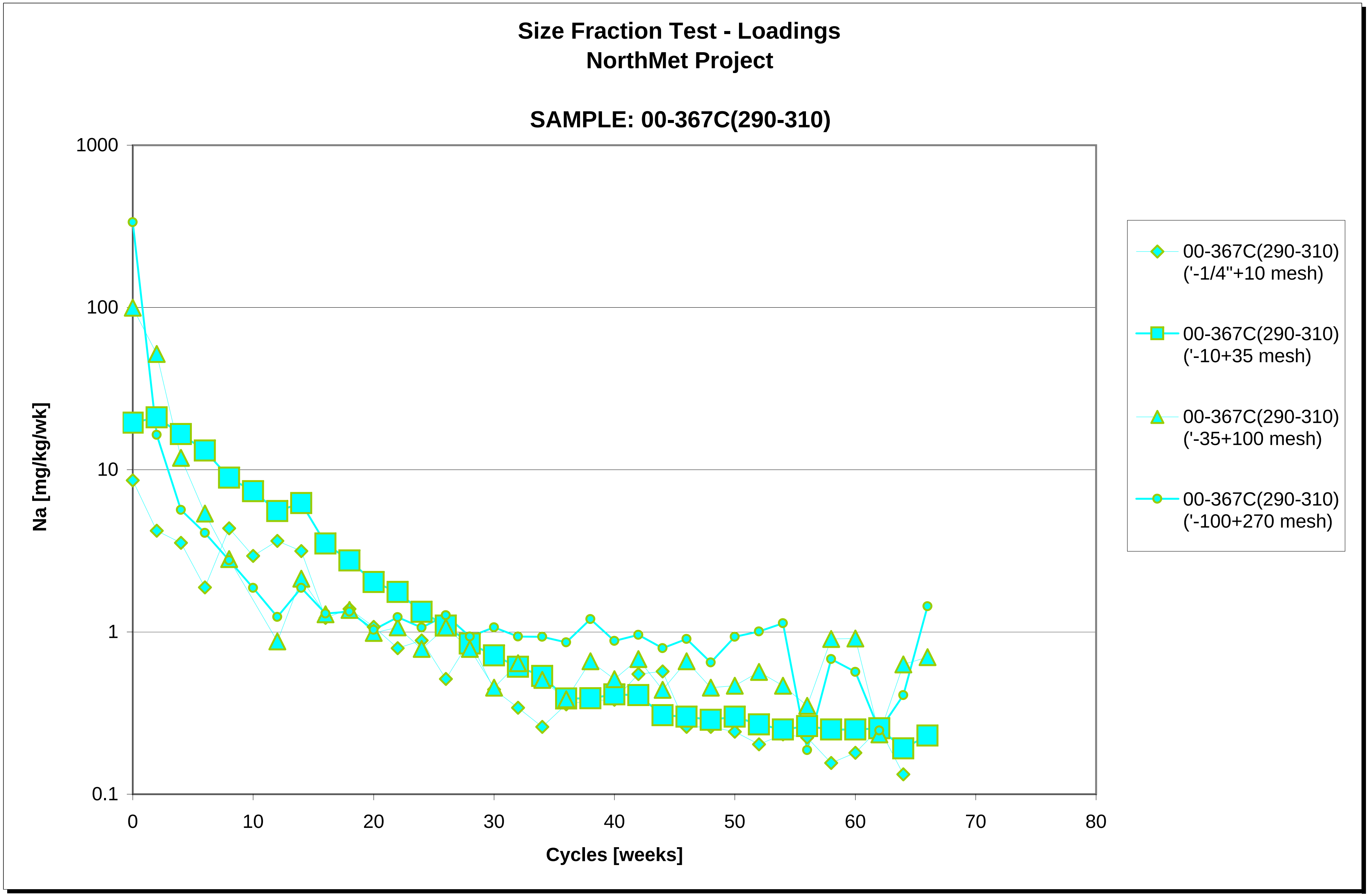

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
PO4 [mg/kg/wk]
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
K [mg/kg/wk]
0
2
4
6
8
10
12
0
10
20
30
40
50
60
70
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

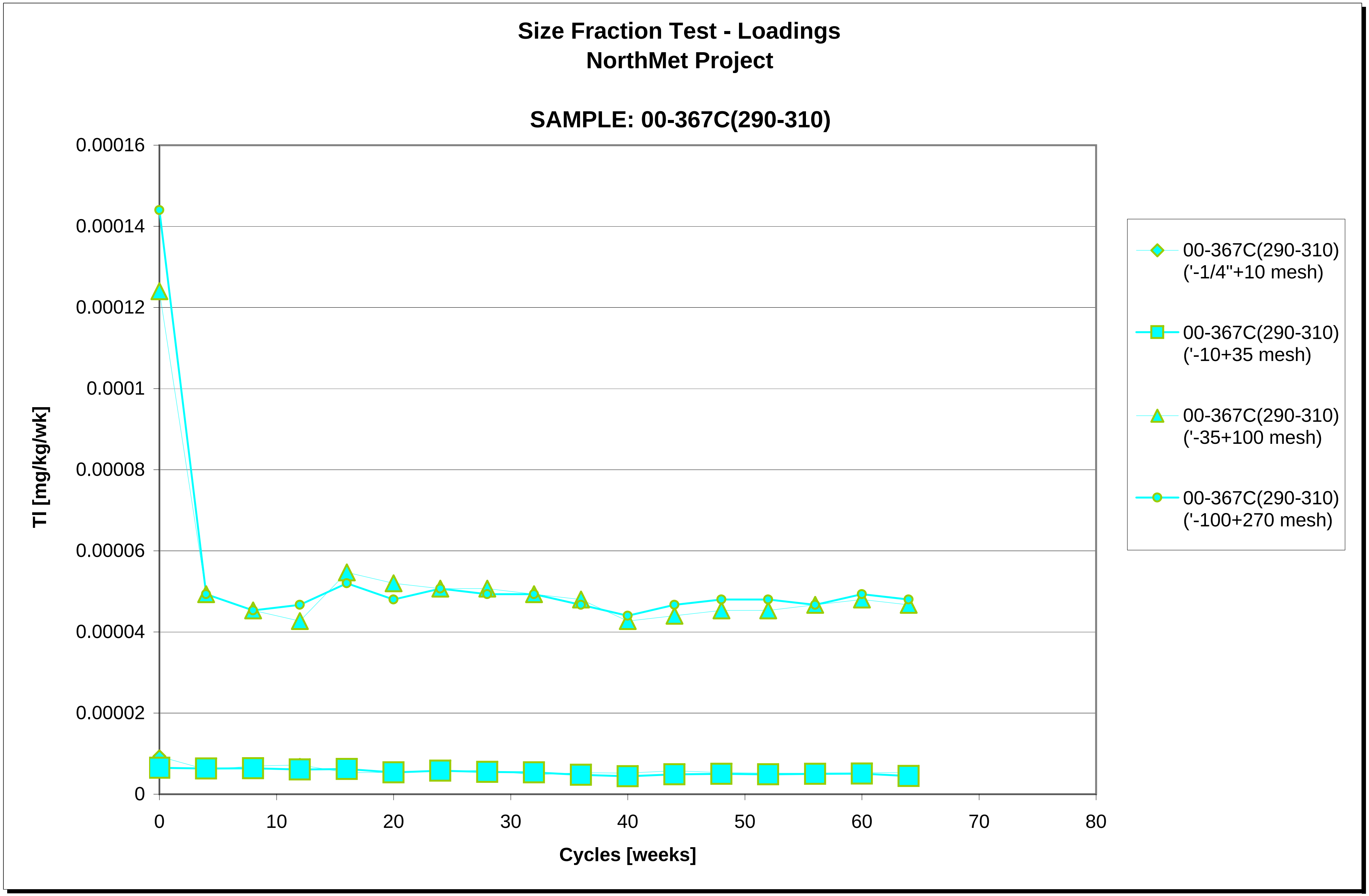

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Se [mg/kg/wk]
1.6E-03
1.4E-03
1.2E-03
1.0E-03
8.0E-04
6.0E-04
4.0E-04
2.0E-04
0.0E+00
0
10
20
30
40
50
60
70
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

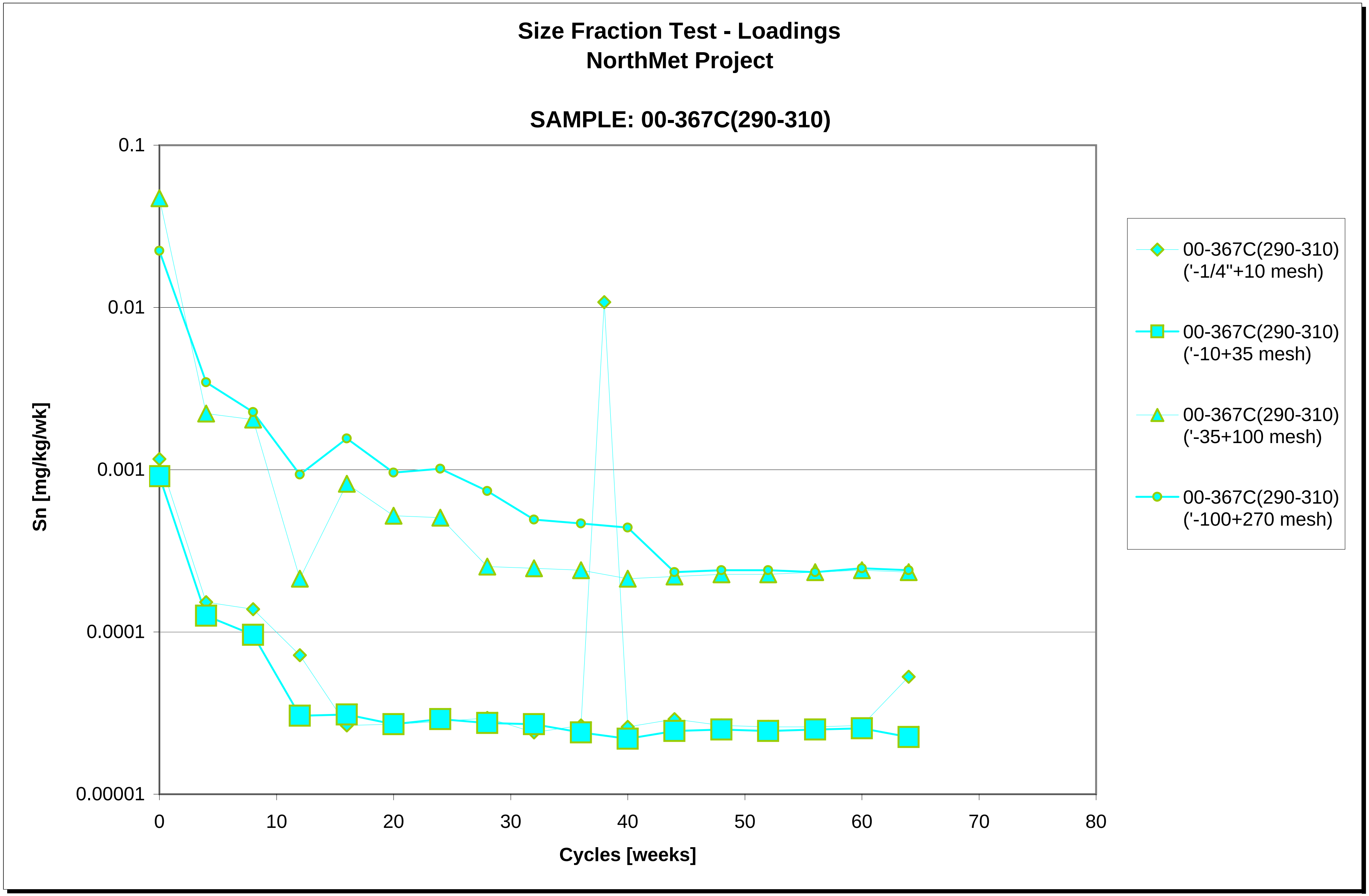

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
SiO2 [mg/kg/wk]
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Ag [mg/kg/wk]
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
1000
100
10
1
0.1
Na [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

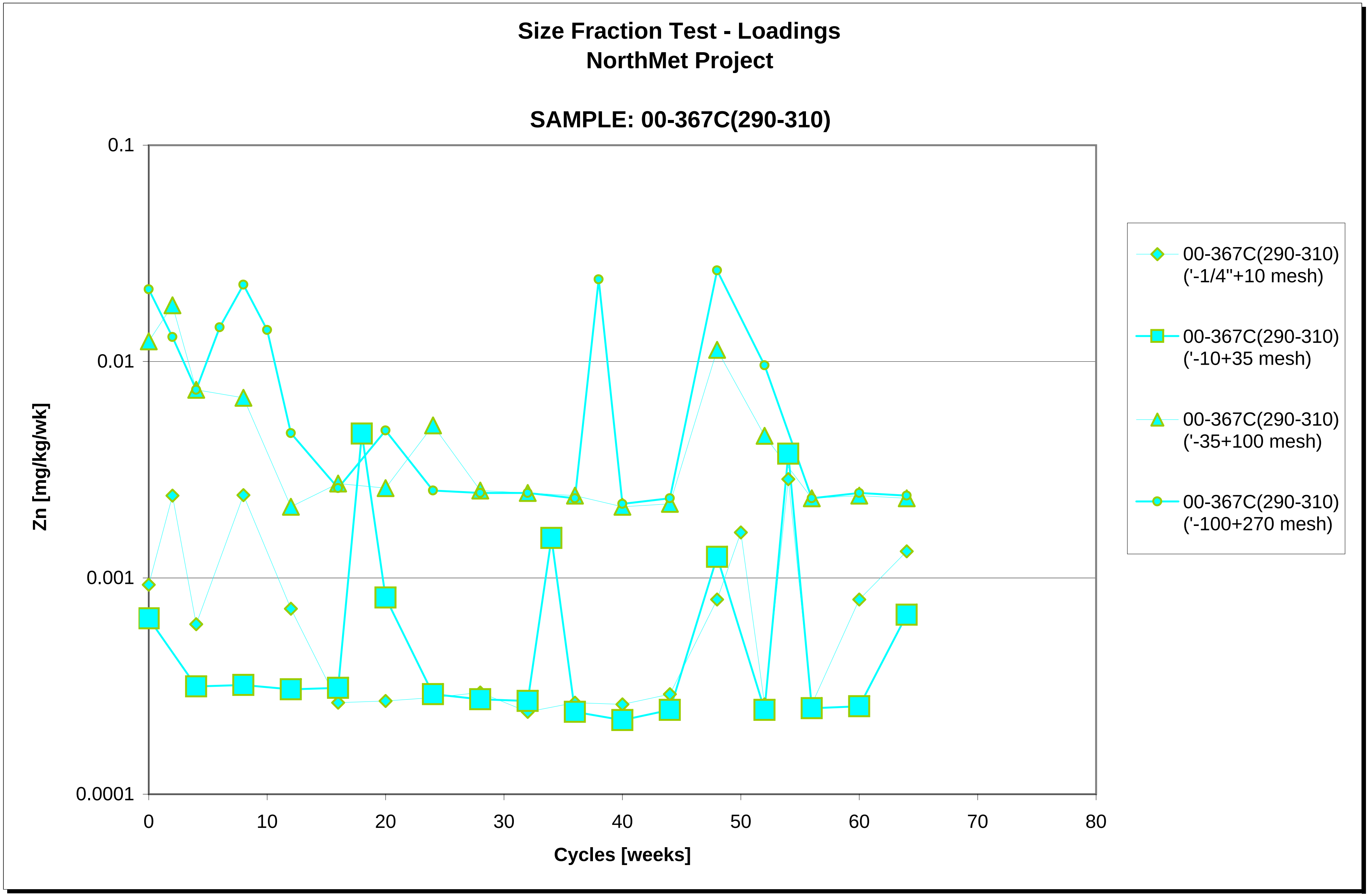

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Sr [mg/kg/wk]
0.06
0.05
0.04
0.03
0.02
0.01
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

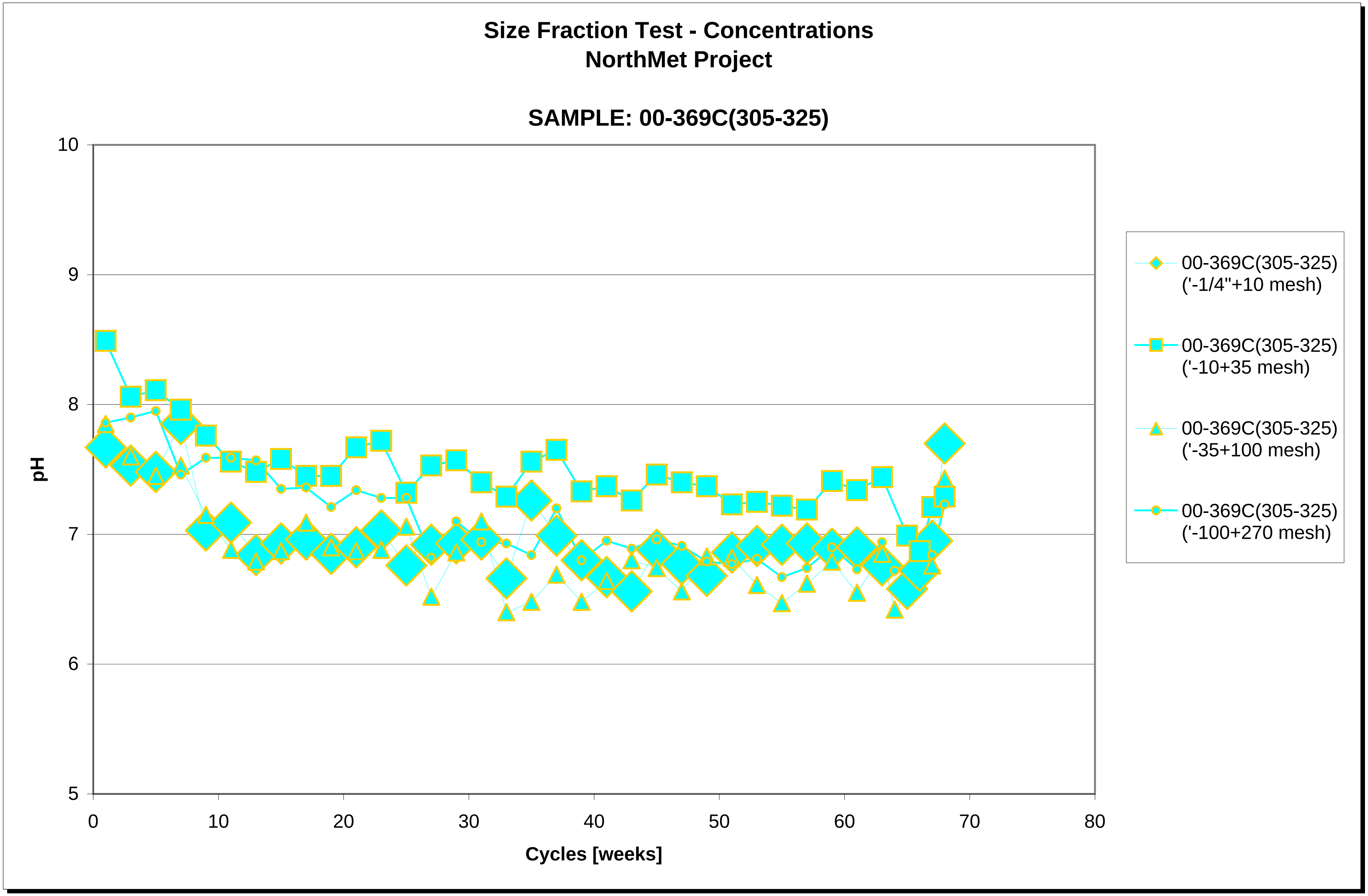

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Tl [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

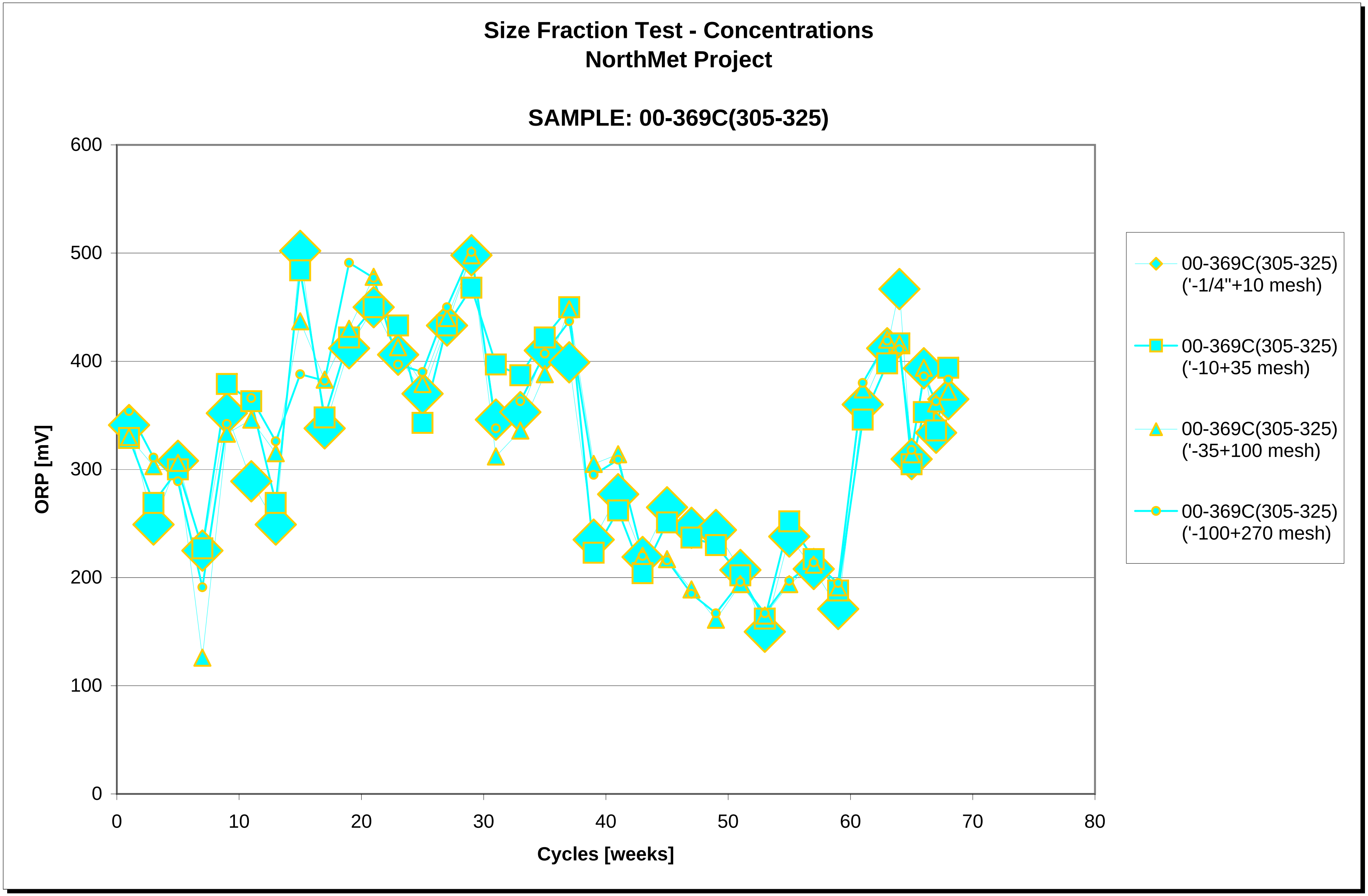

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-367C(290-310)
Sn [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-367C(290-310) ('-1/4"+10 mesh)
00-367C(290-310) ('-10+35 mesh)
00-367C(290-310) ('-35+100 mesh)
00-367C(290-310) ('-100+270 mesh)

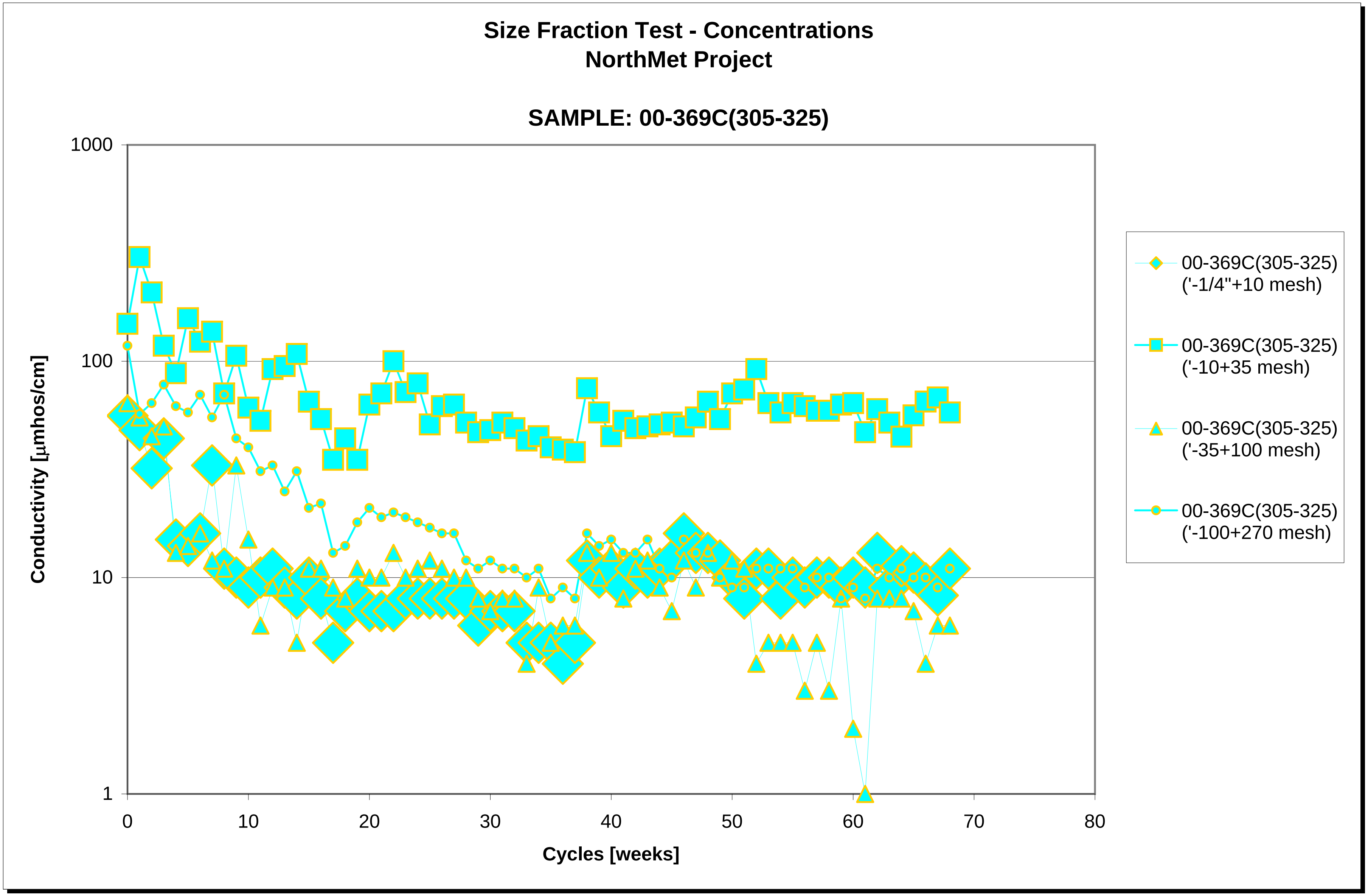
Appendix F
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-367C(290-310)

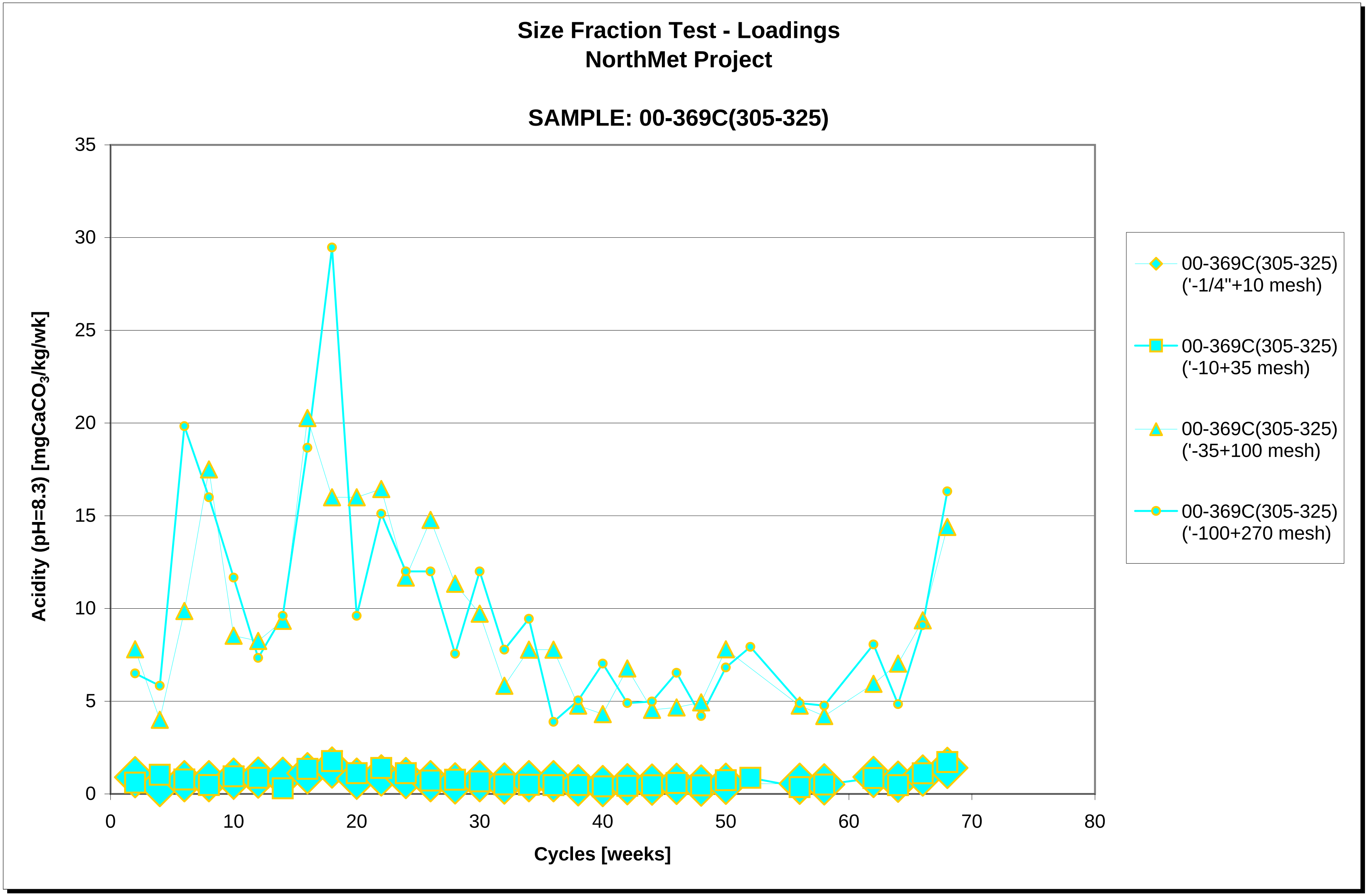
Chart F.4.40



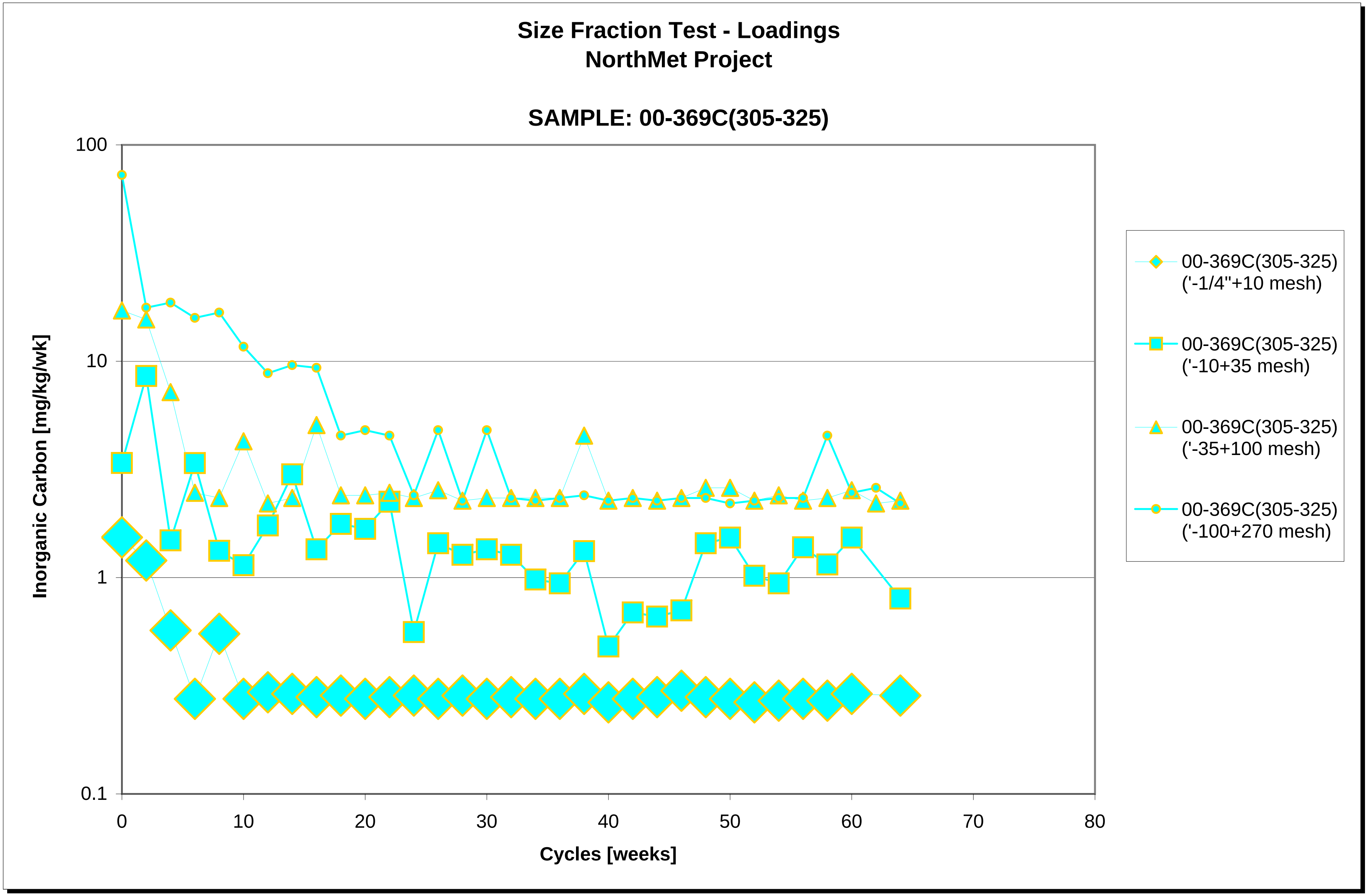

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-369C(305-325)
pH
Cycles [weeks]
10
9
8
7
6
5
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

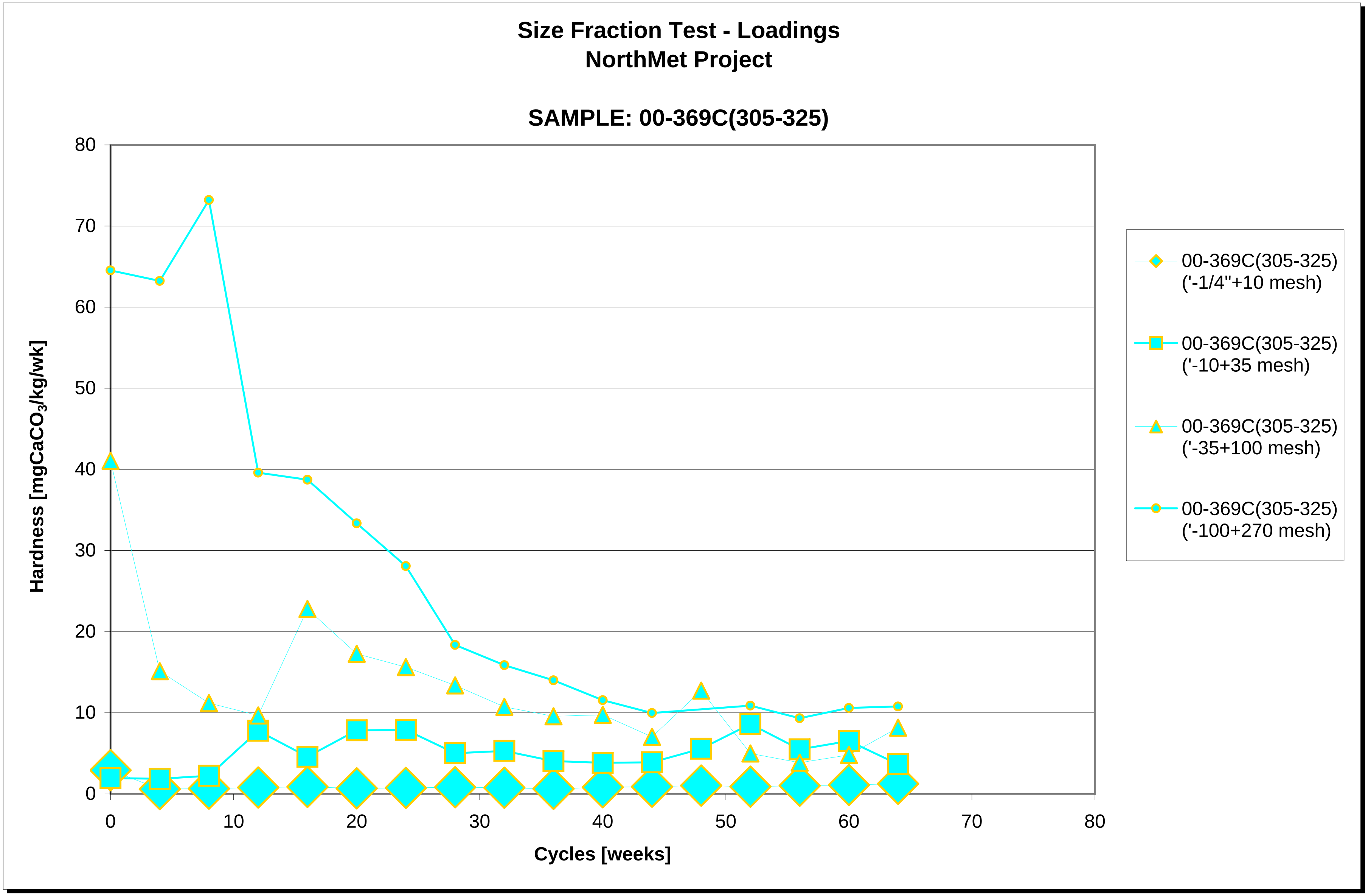

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-369C(305-325)
ORP [mV]
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

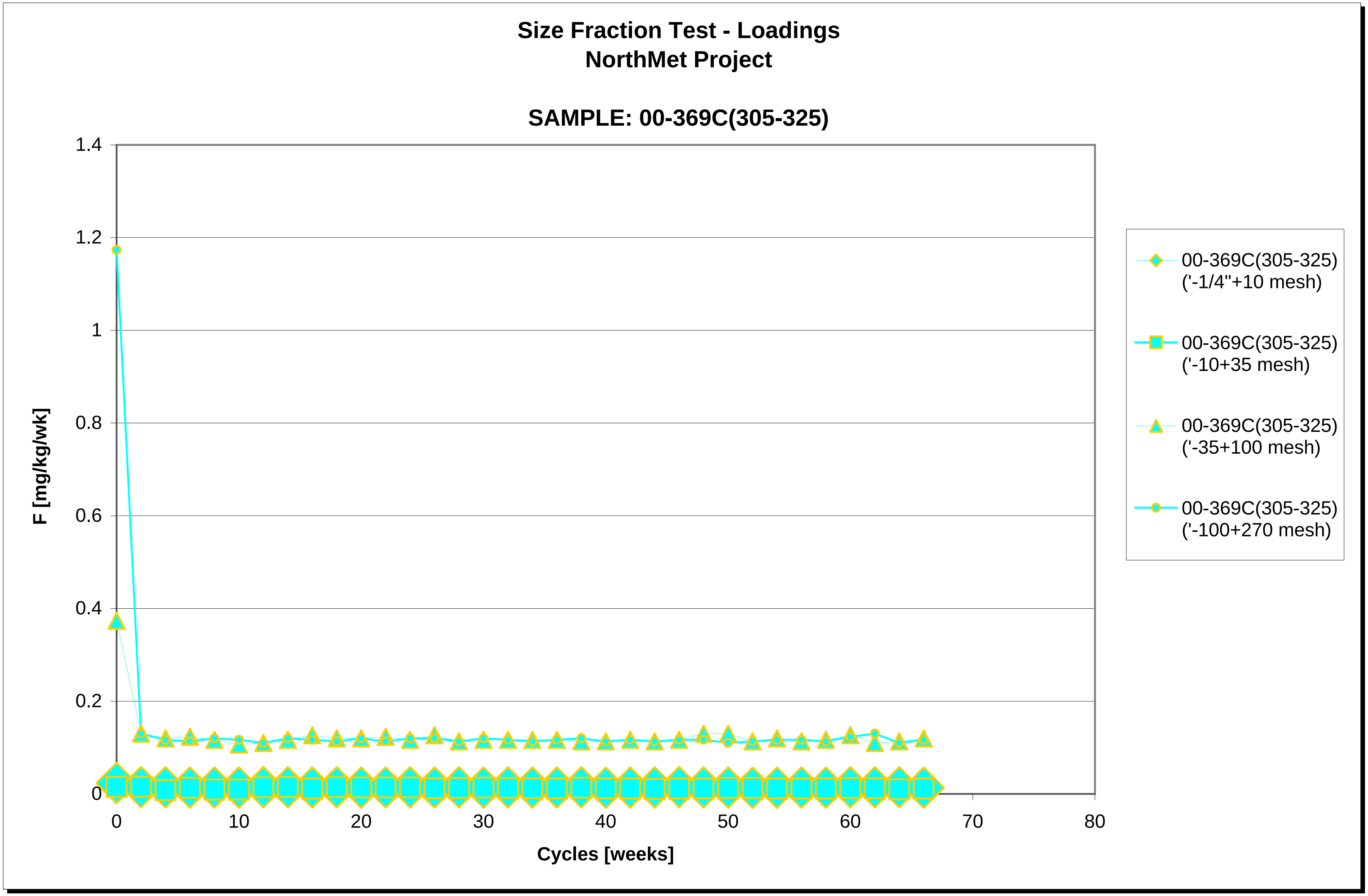

Size Fraction Test - Concentrations
NorthMet Project
SAMPLE: 00-369C(305-325)
Conductivity [µmhos/cm]
1000
100
10
1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

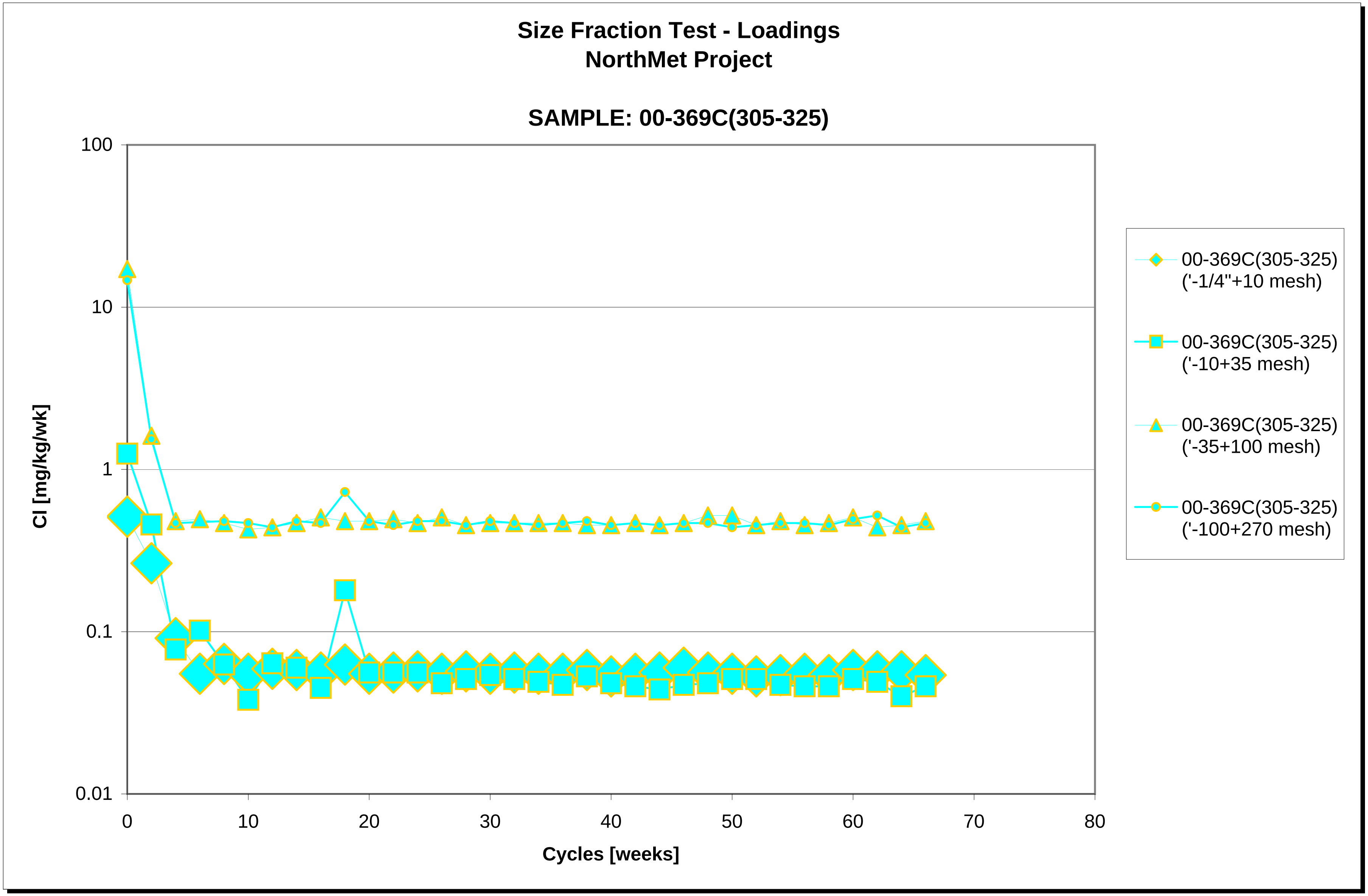

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Acidity (pH=8.3) [mgCaCO3/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Alkalinity [mgCaCO3/kg/wk]
1000
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Inorganic Carbon [mg/kg/wk]
100
10
1
0.1
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

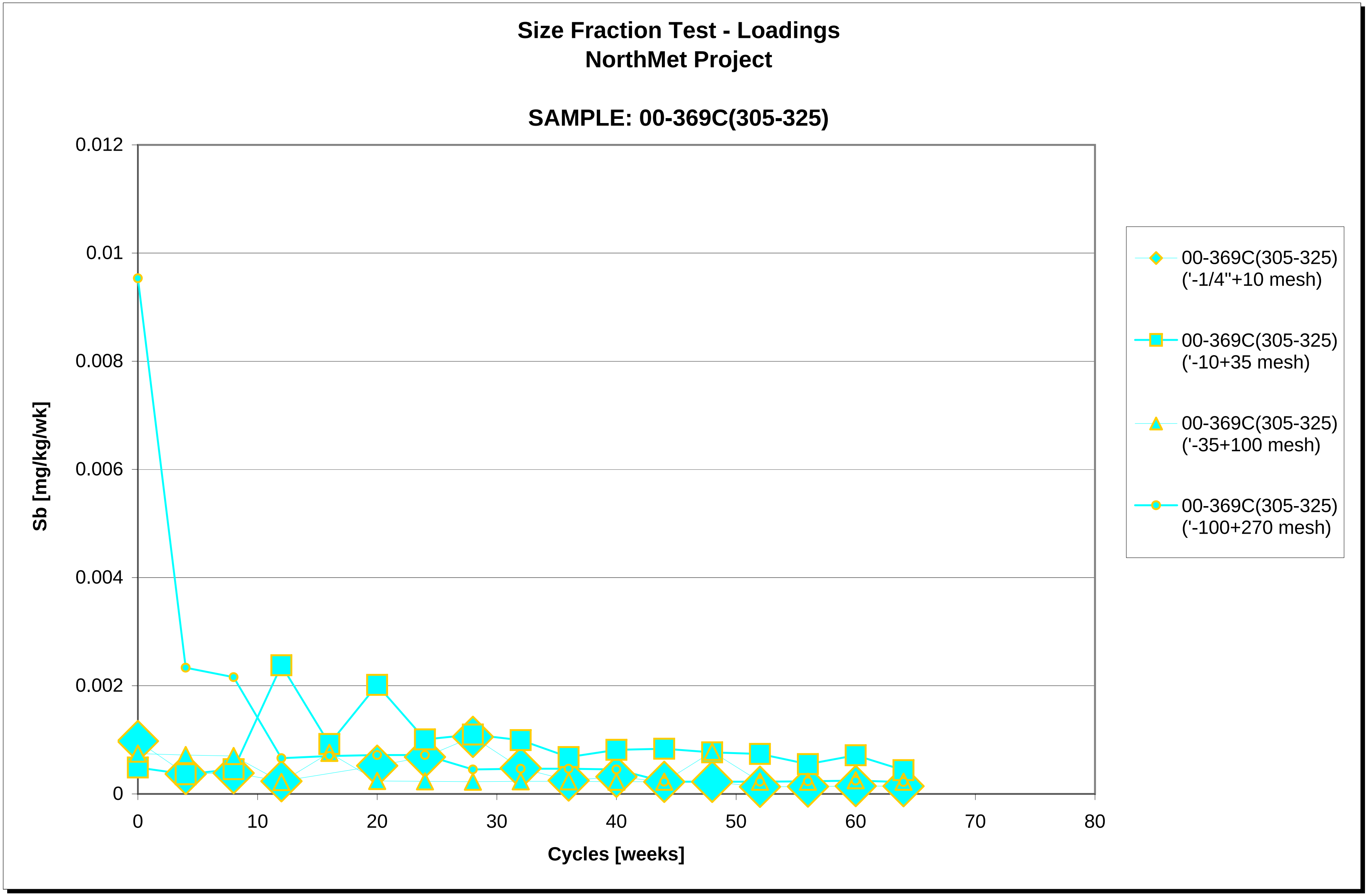

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Hardness [mgCaCO3/kg/wk]
Cycles [weeks]
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

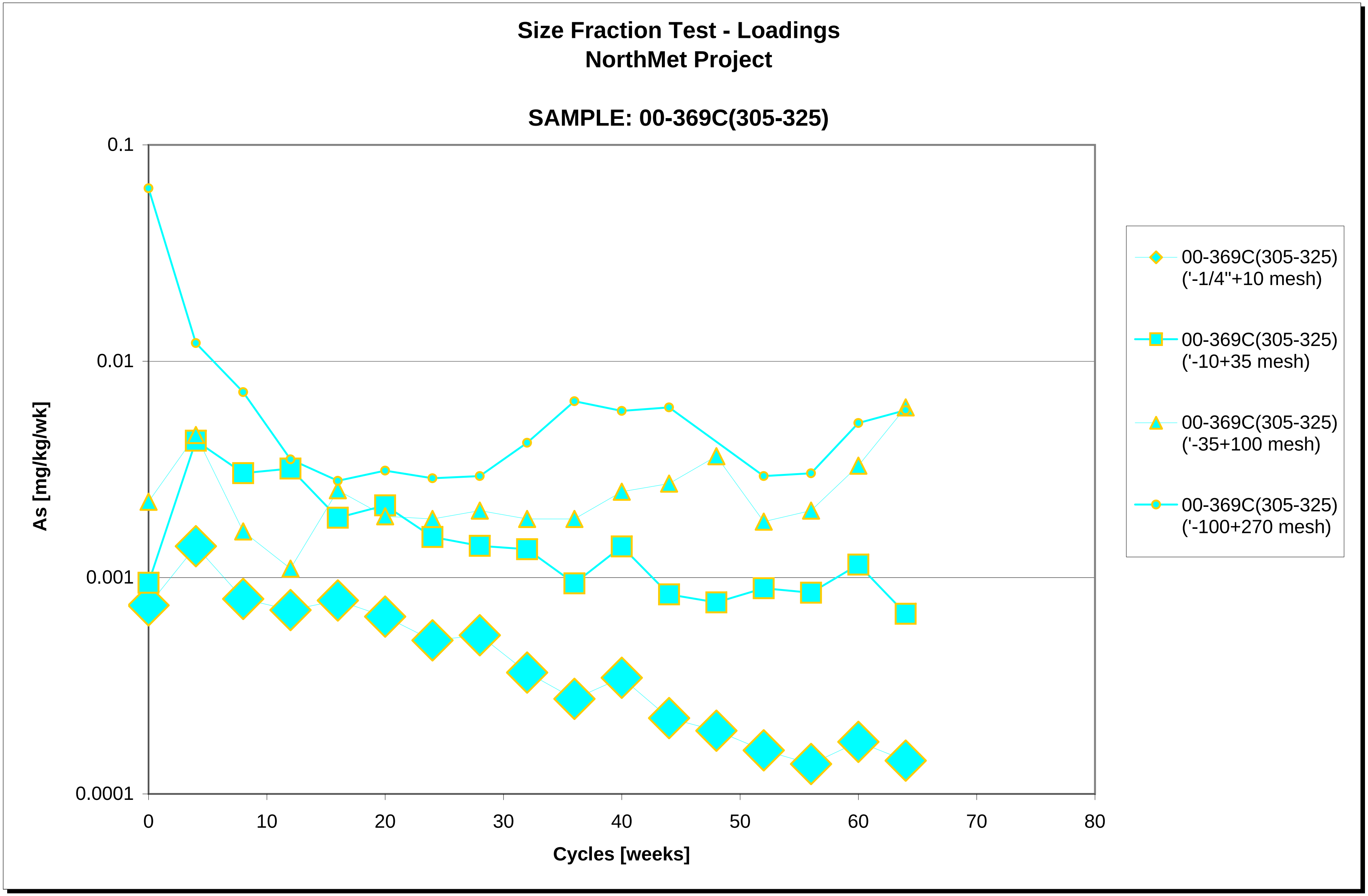

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
F [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
100
10
1
0.1
0.01
Cl [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

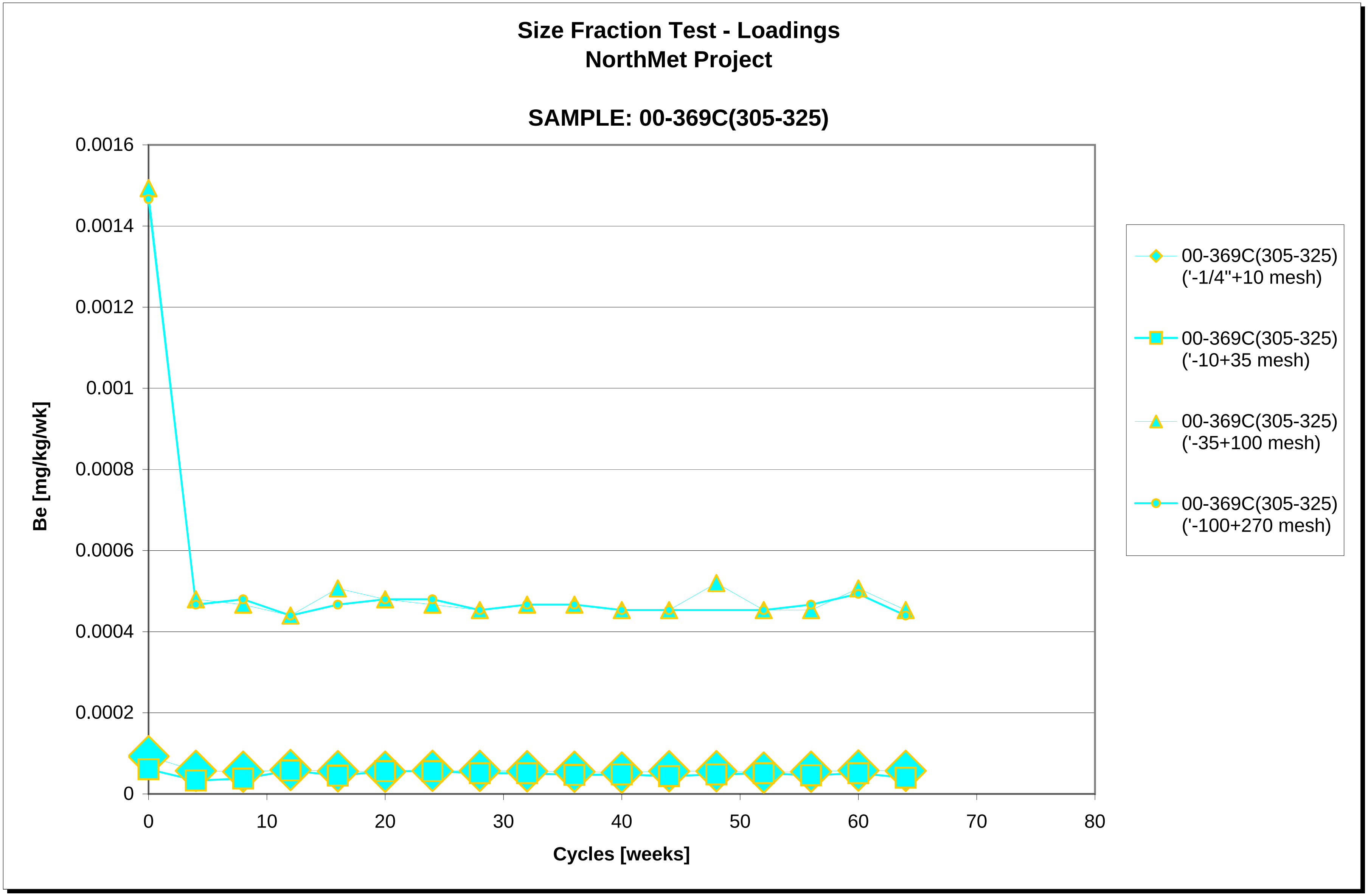

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
SO4 [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

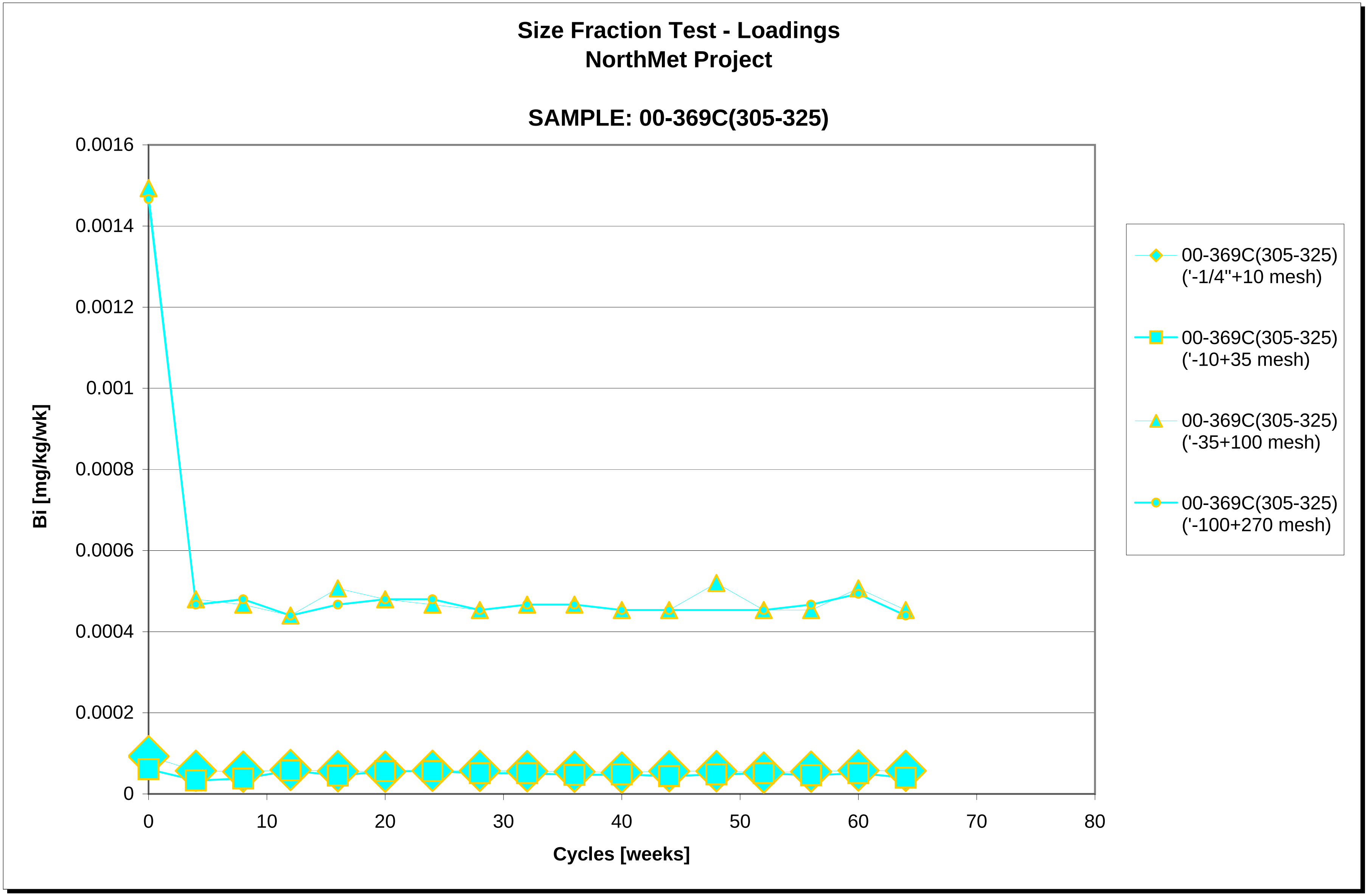

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
10
1
0.1
0.01
0.001
Al [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Sb [mg/kg/wk]
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
0.1
0.01
0.001
0.0001
As [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

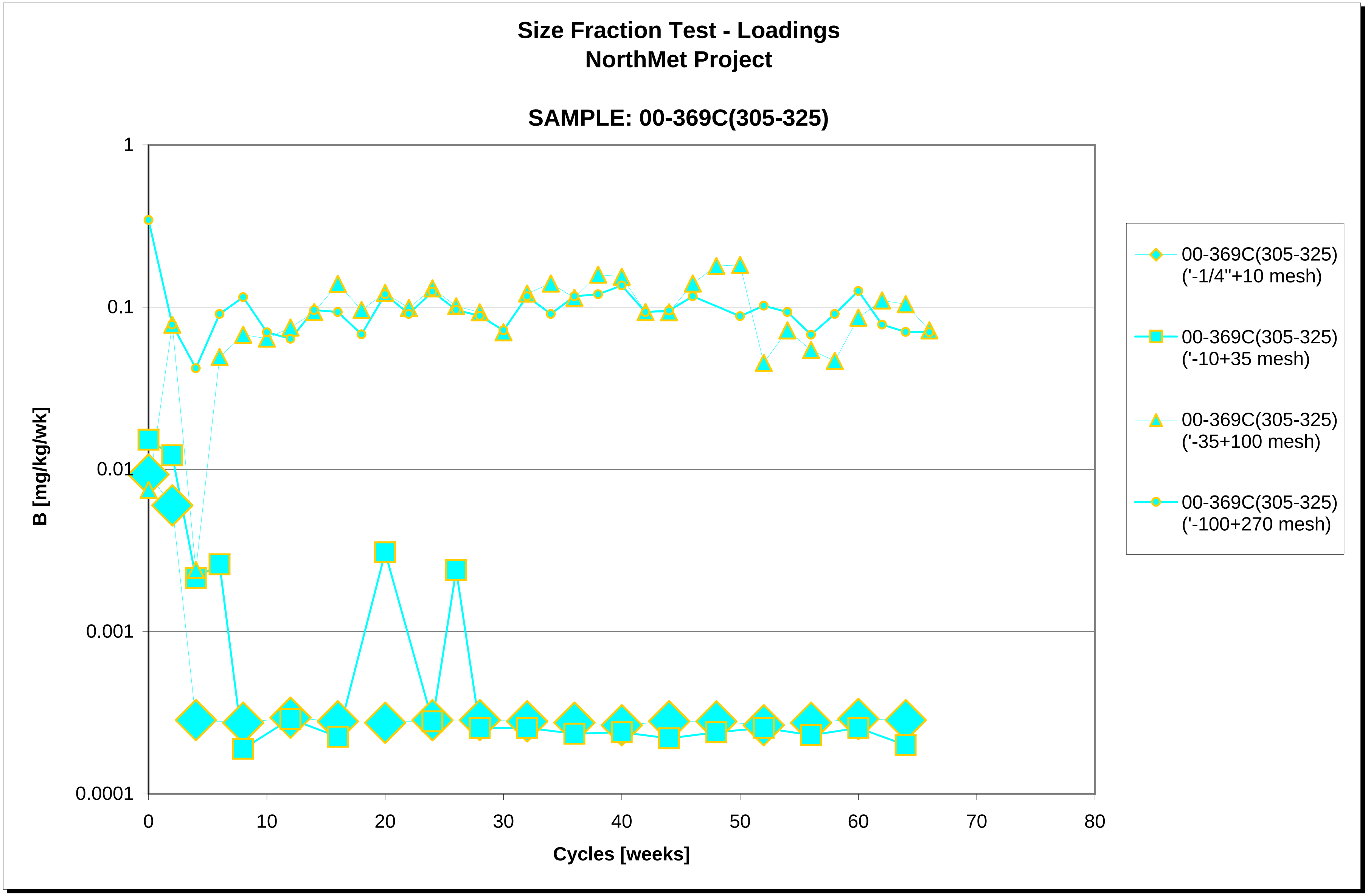

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Ba [mg/kg/wk]
1
0.1
0.01
0.001
0.0001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

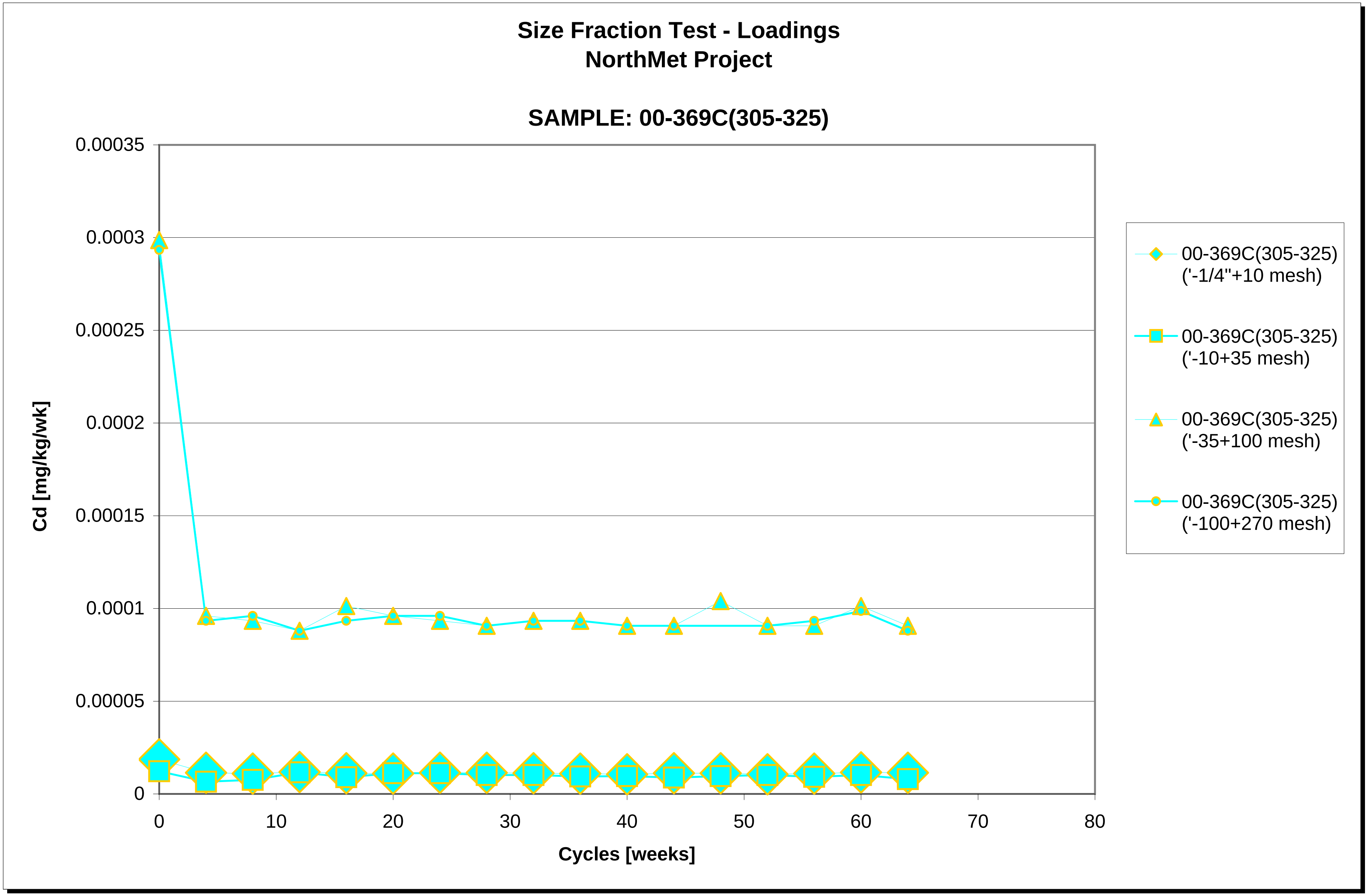

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Be [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Bi [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

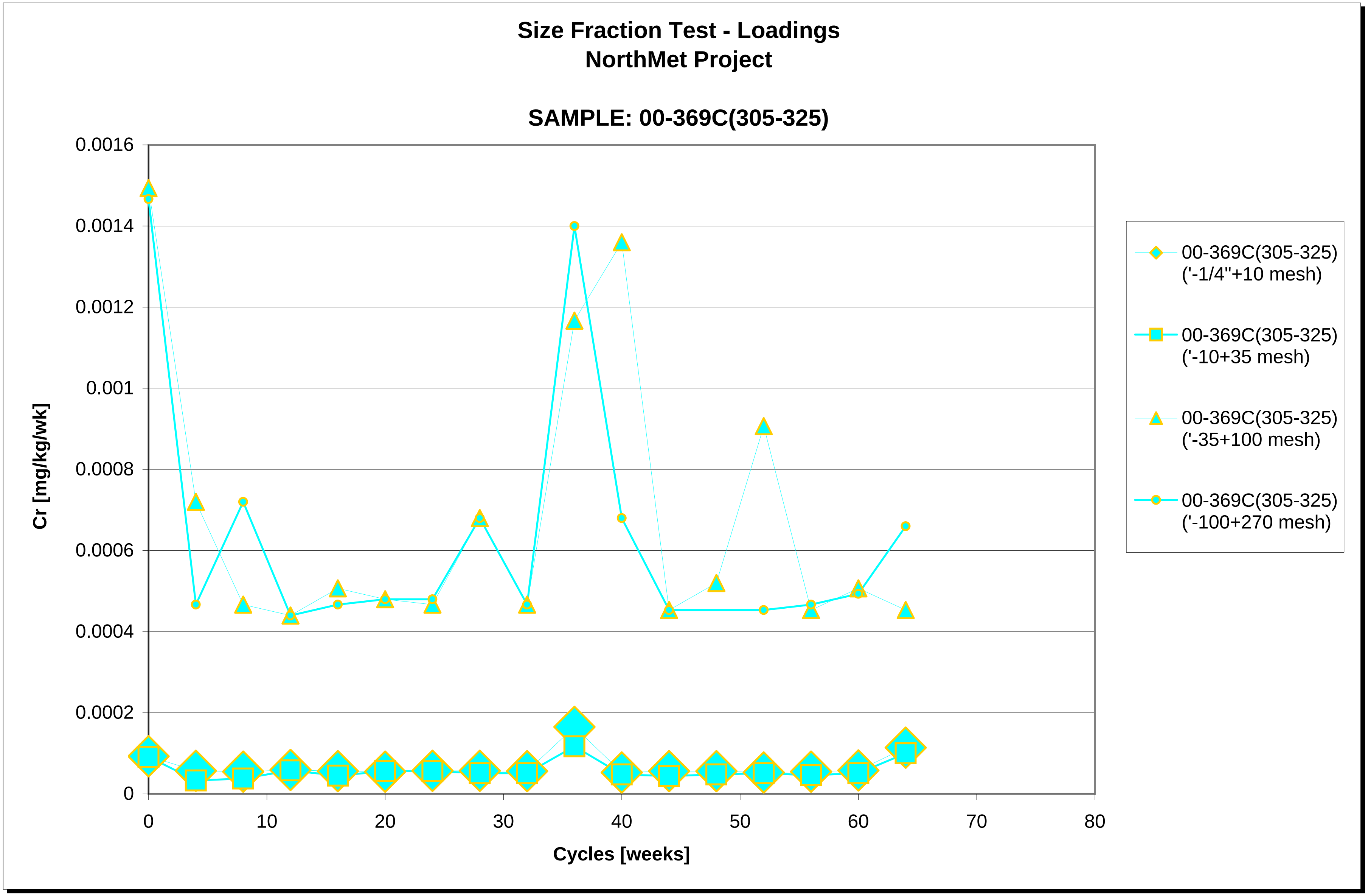
Appendix F
Charts of Dissolution Testwork Results (Size Fraction Tests)
00-369C(305-325)

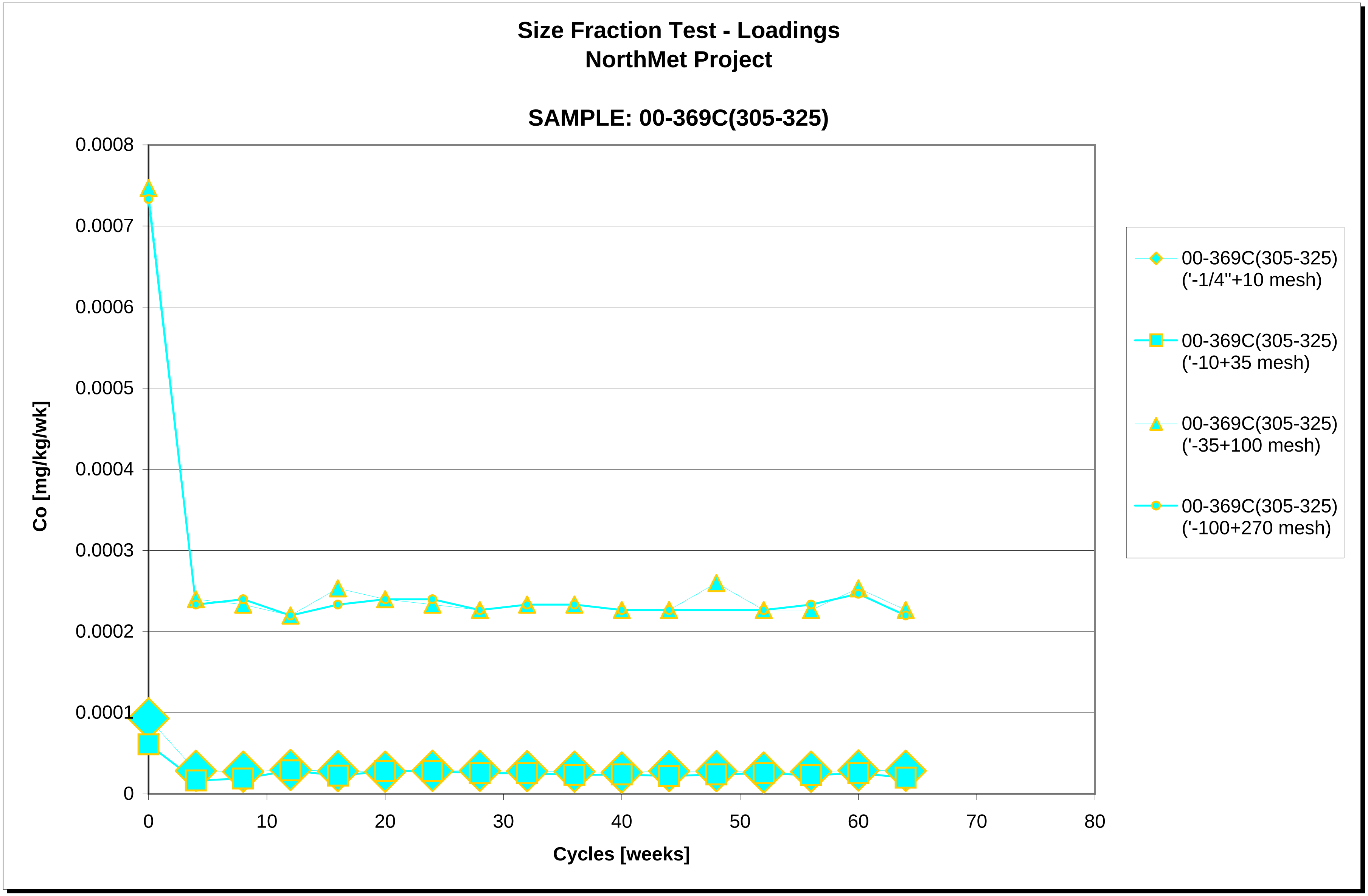
Chart F.5.17

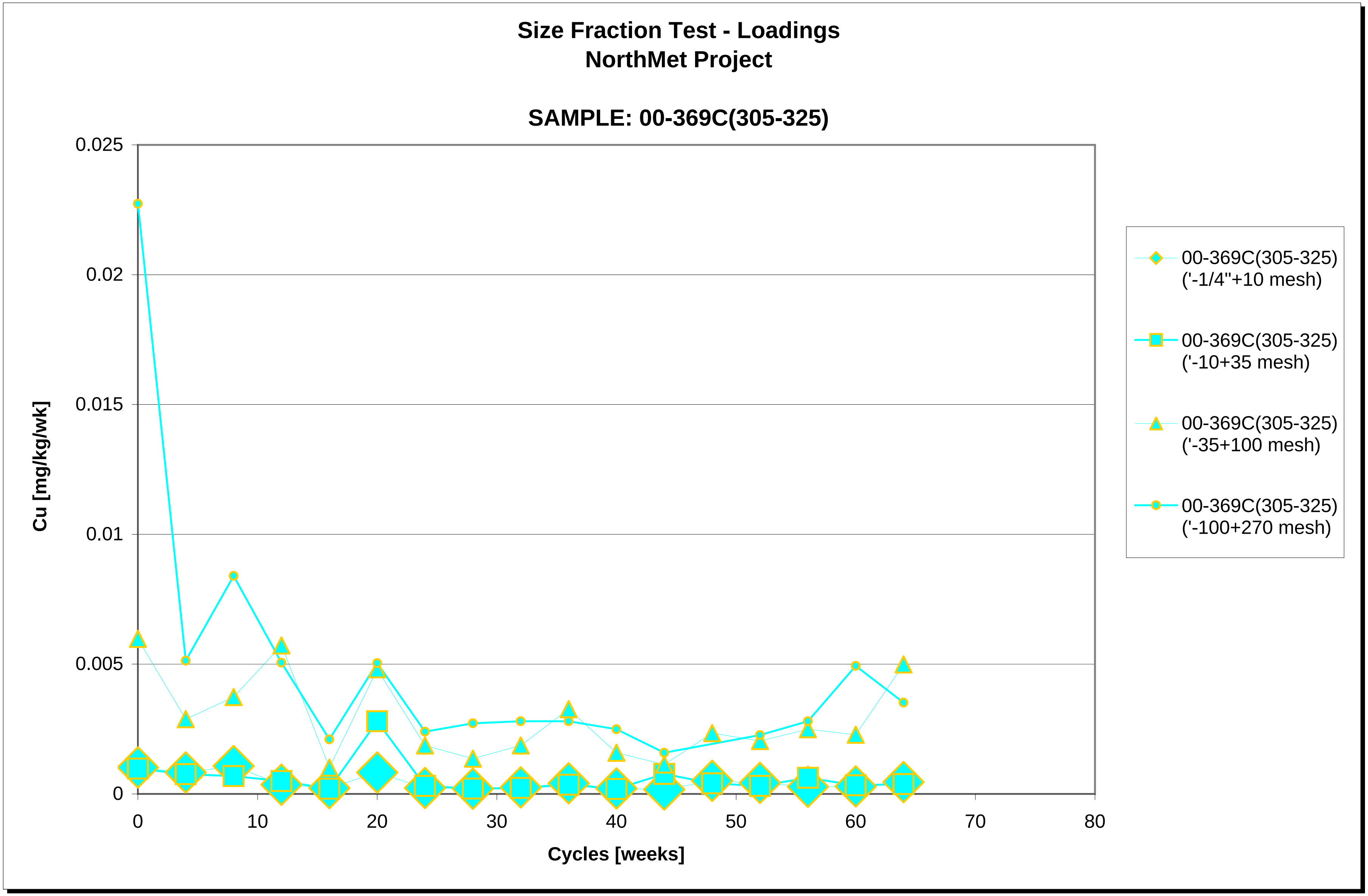


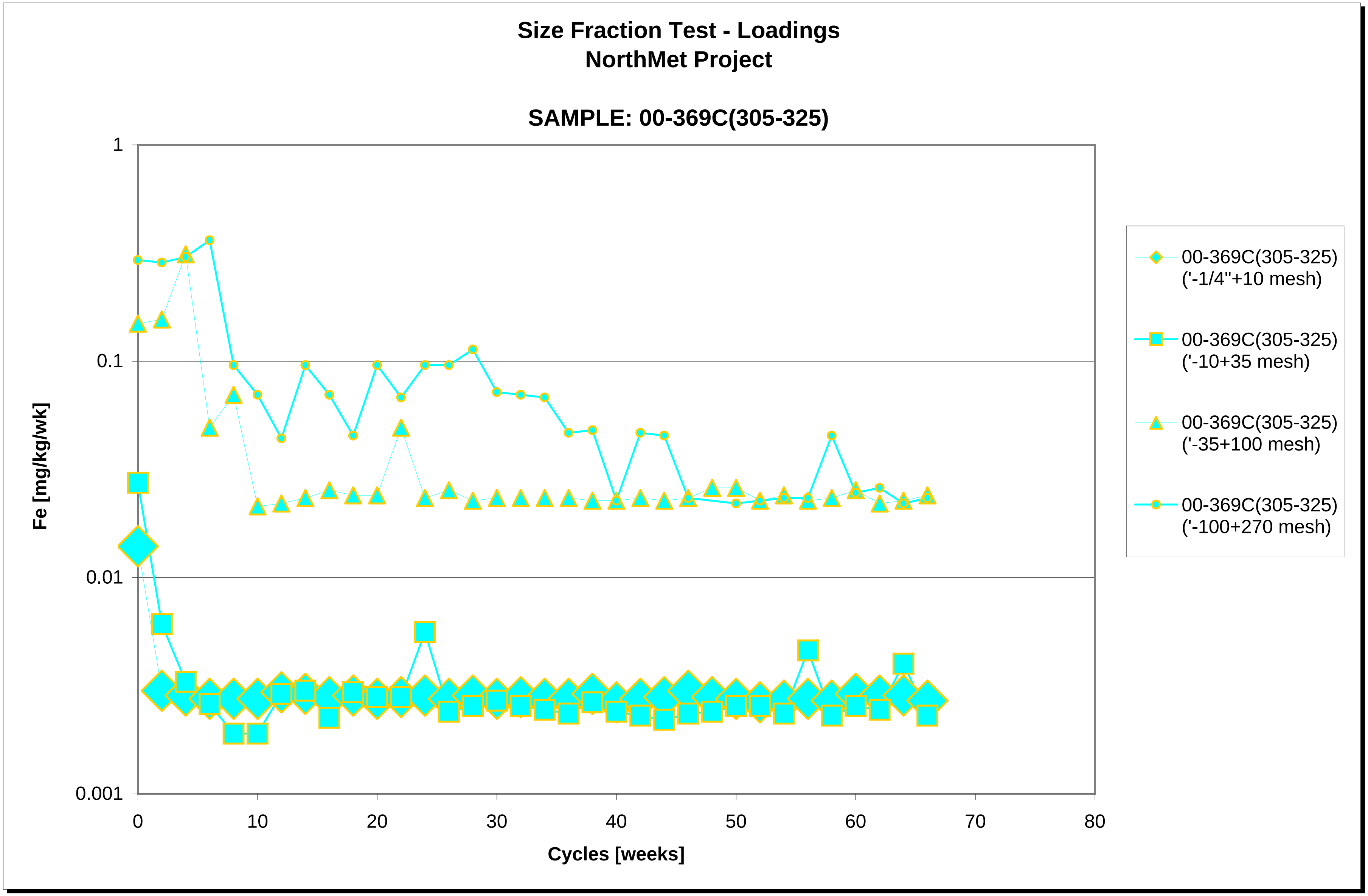

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Cd [mg/kg/wk]
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

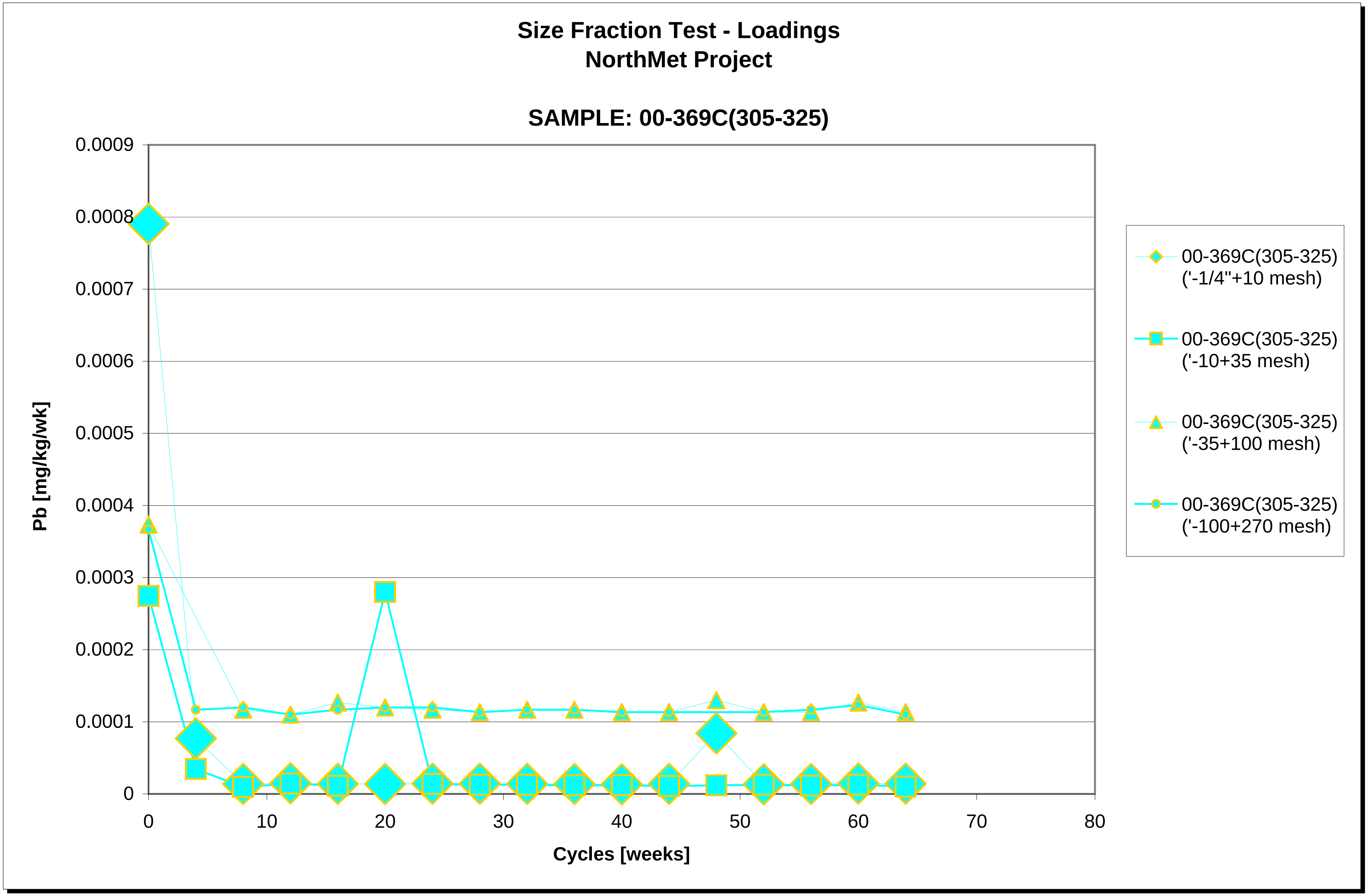

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Ca [mg/kg/wk]
Cycles [weeks]
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

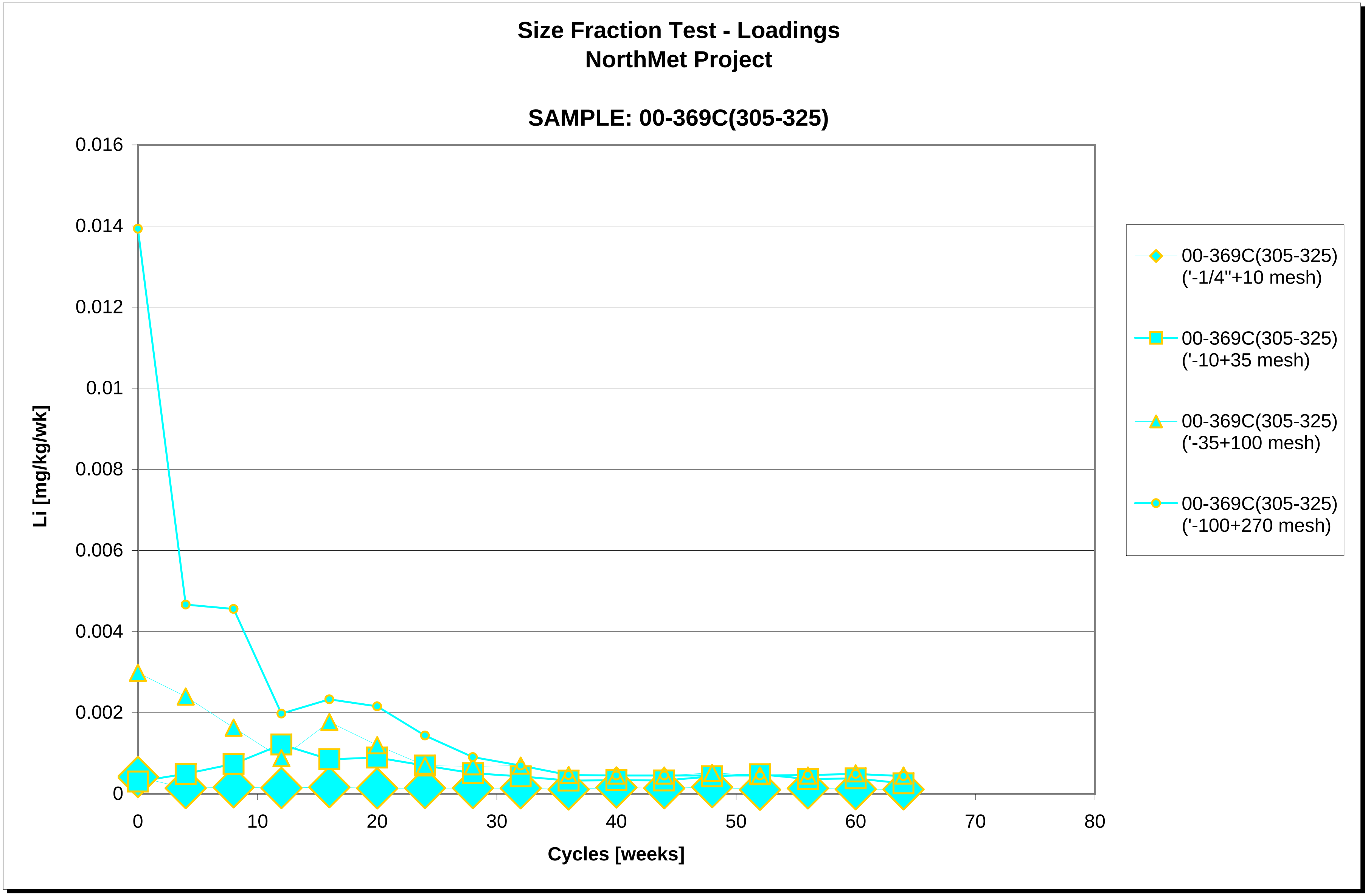

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Cr [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Co [mg/kg/wk]
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Cu [mg/kg/wk]
0.025
0.02
0.015
0.01
0.005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

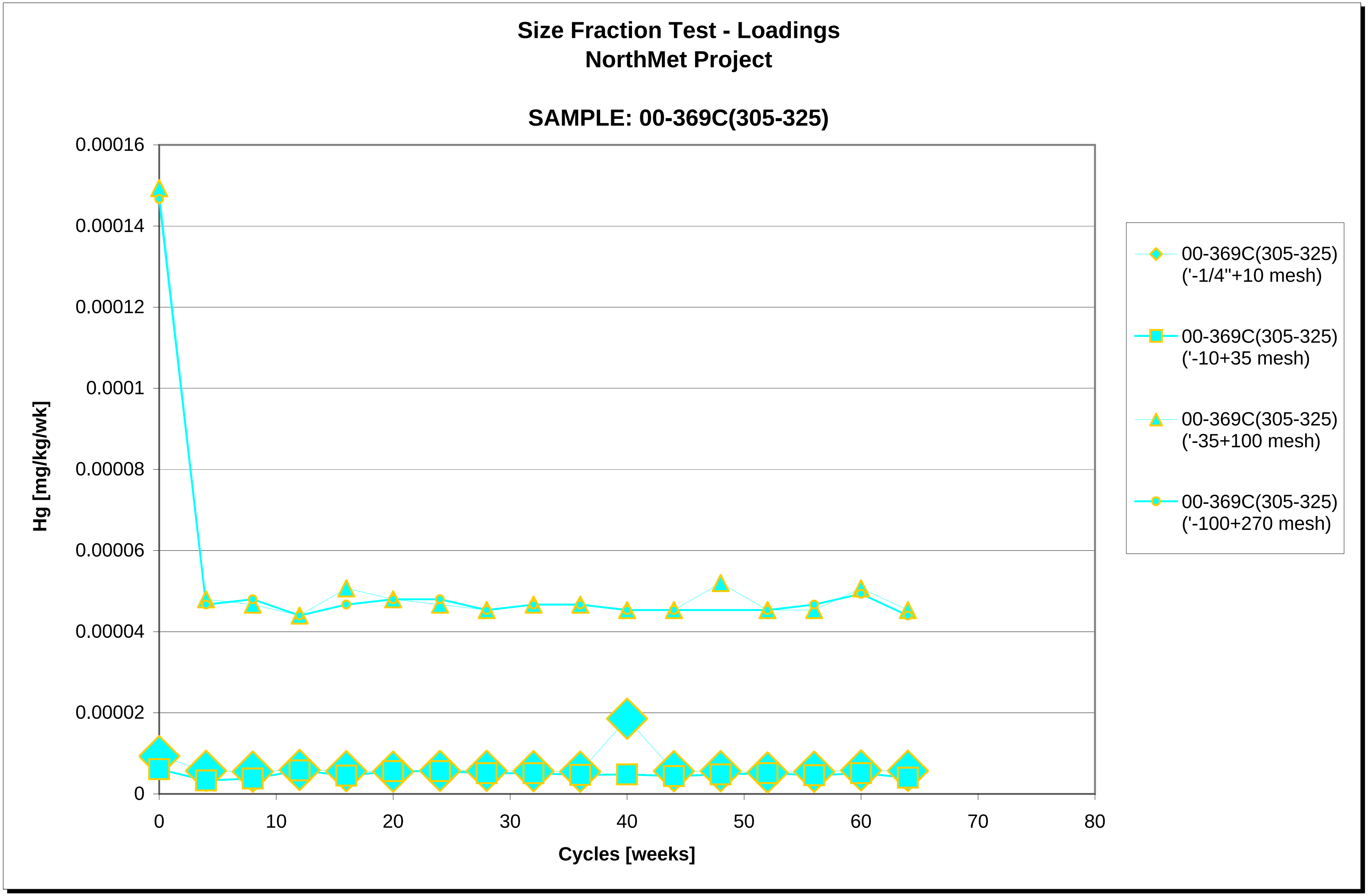

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
1
0.1
0.01
0.001
Fe [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Pb [mg/kg/wk]
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

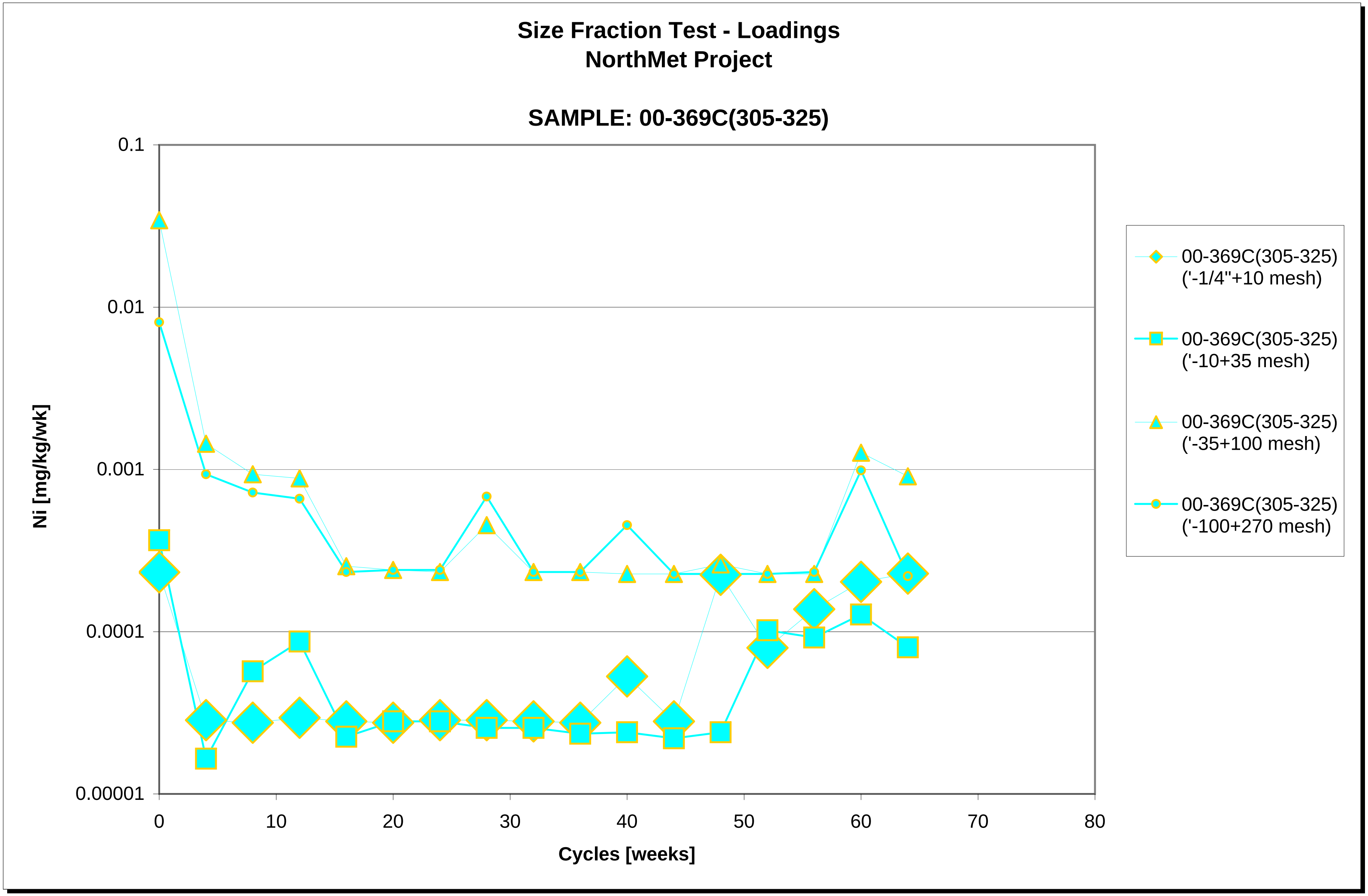

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Li [mg/kg/wk]
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

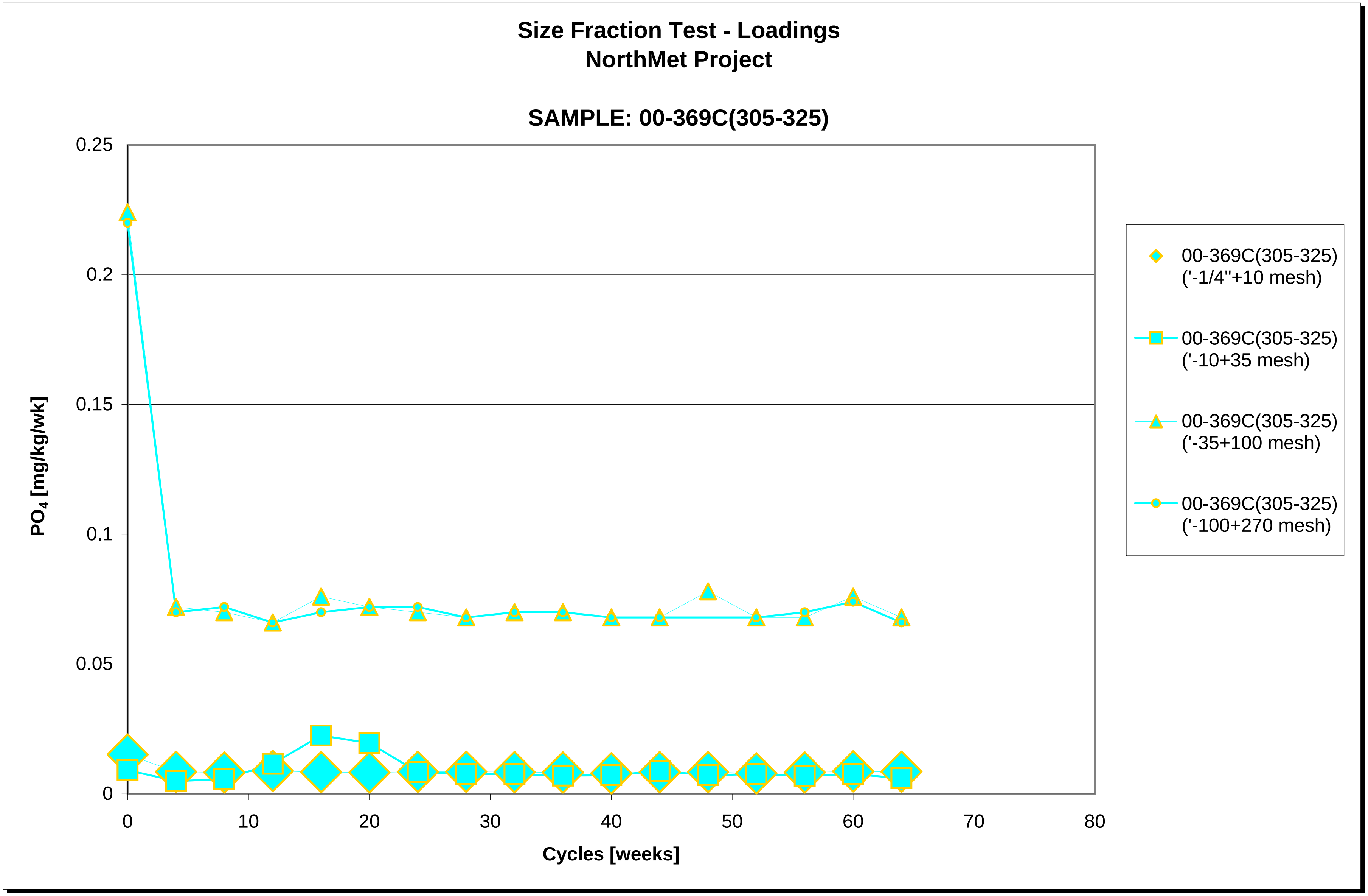

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Mg [mg/kg/wk]
Cycles [weeks]
0
0.5
1
1.5
2
2.5
3
3.5
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

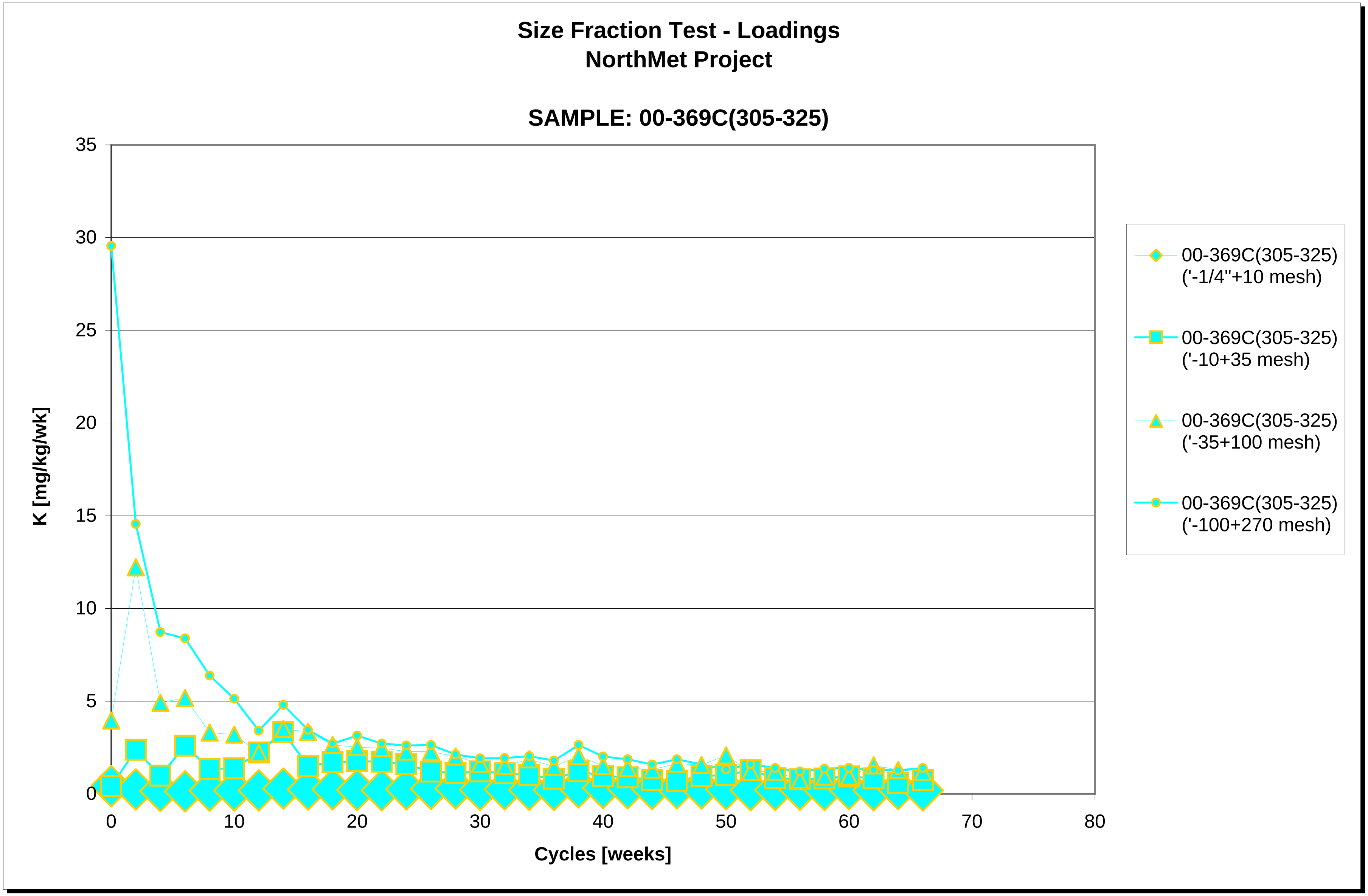

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Mn [mg/kg/wk]
0.01
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

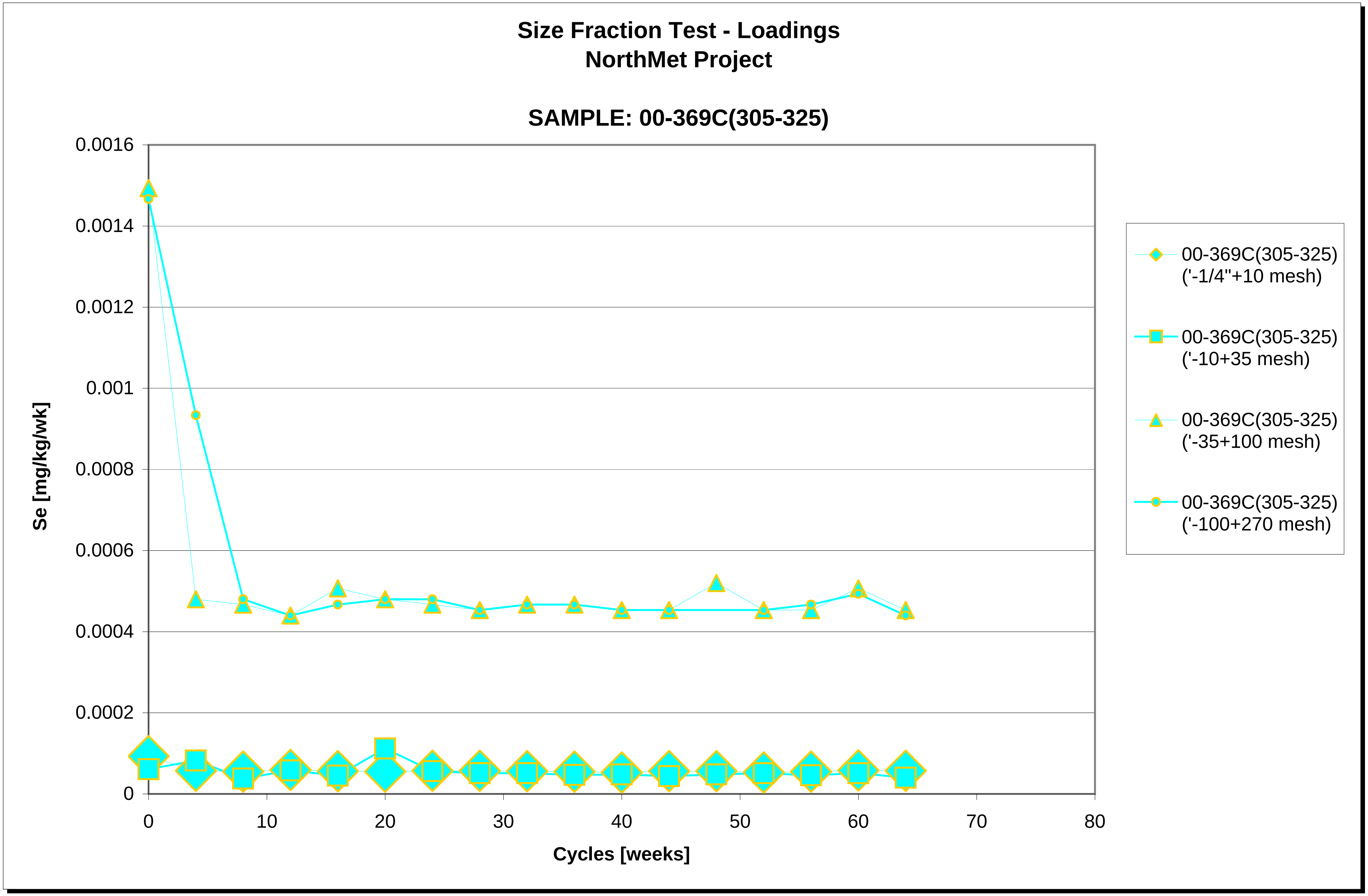

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Hg [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Mo [mg/kg/wk]
0.0035
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

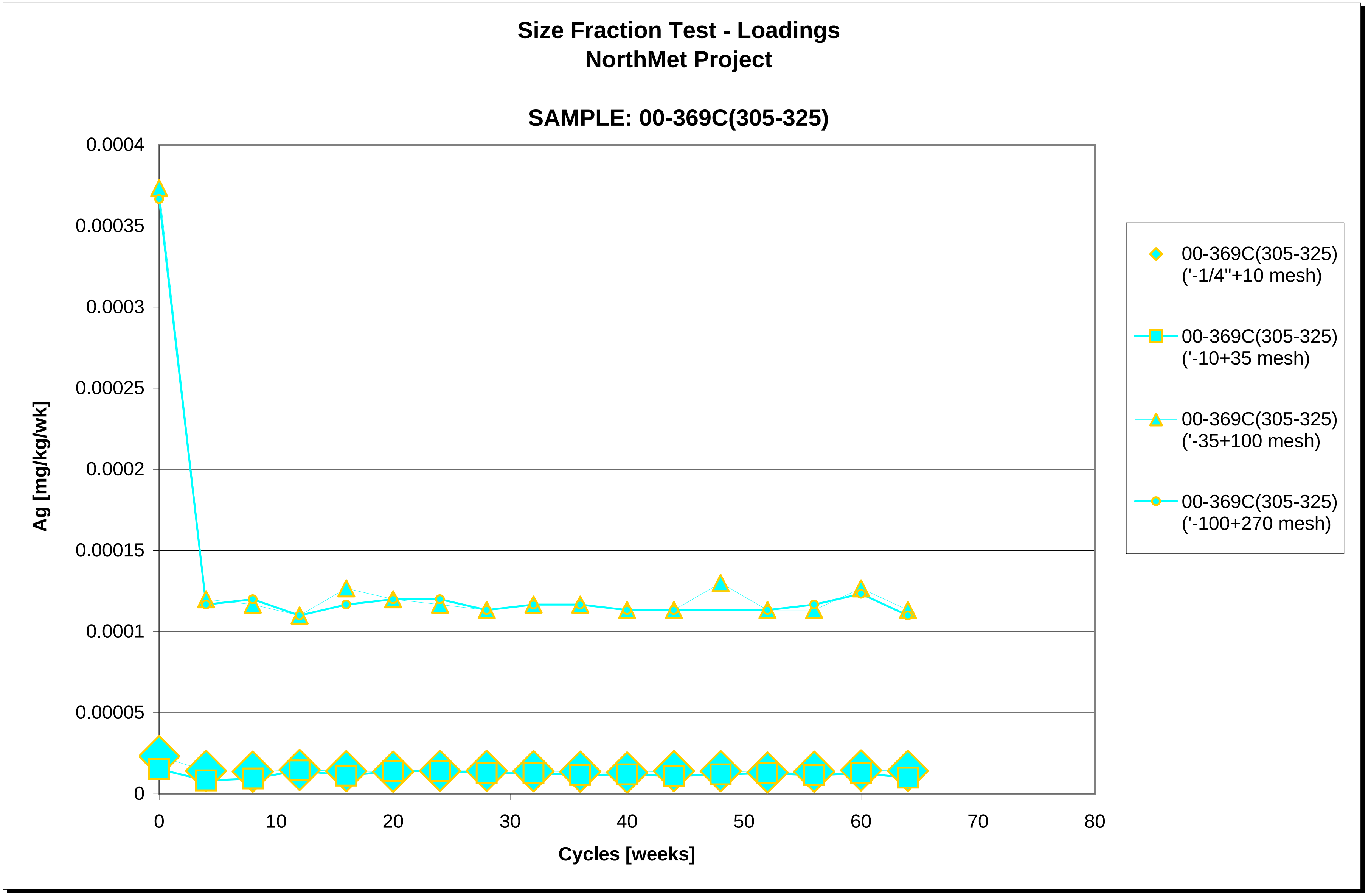

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Ni [mg/kg/wk]
0.1
0.01
0.001
0.0001
0.00001
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

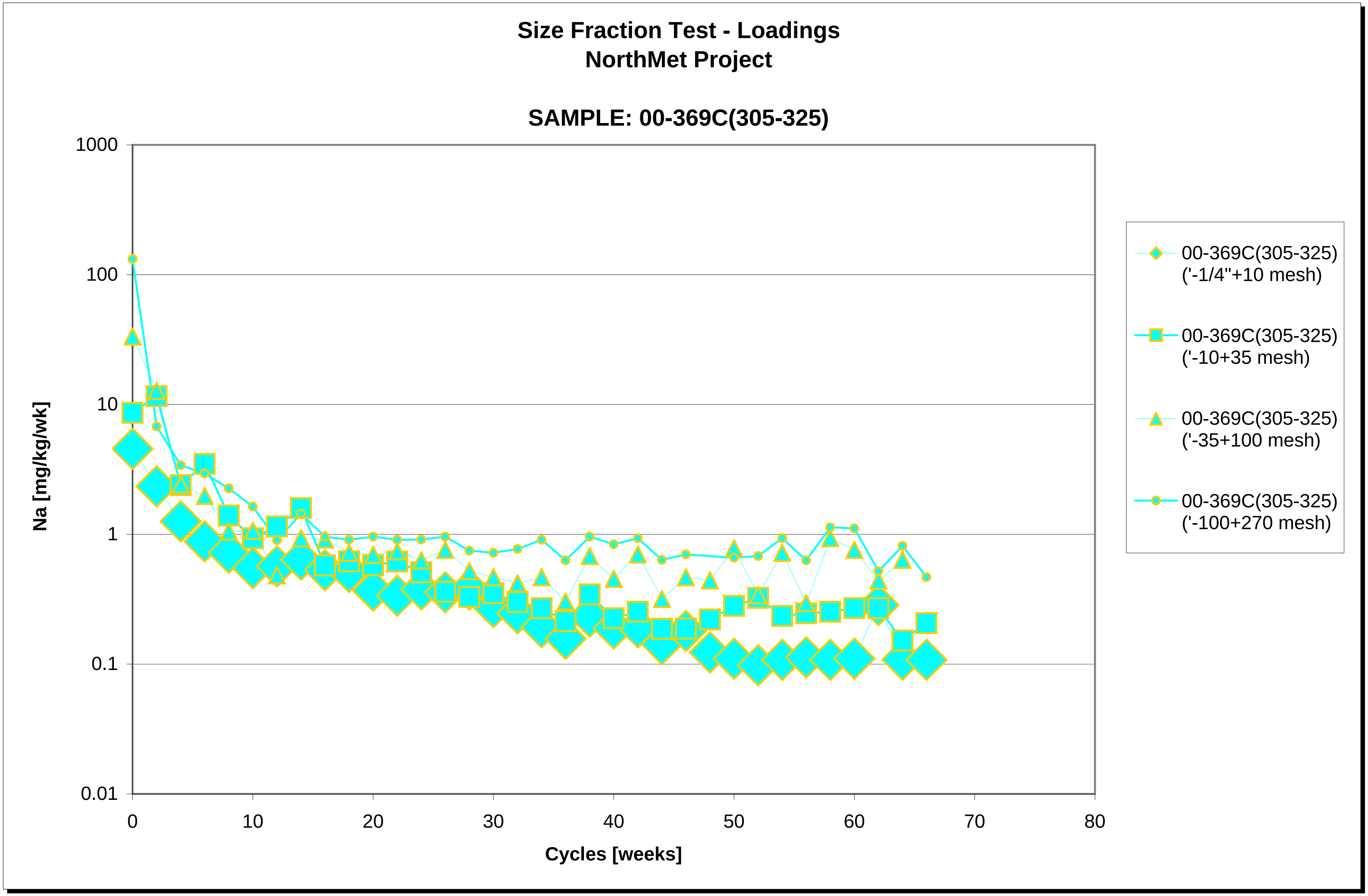

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
0.25
0.2
0.15
0.1
0.05
0
PO$_4$ [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

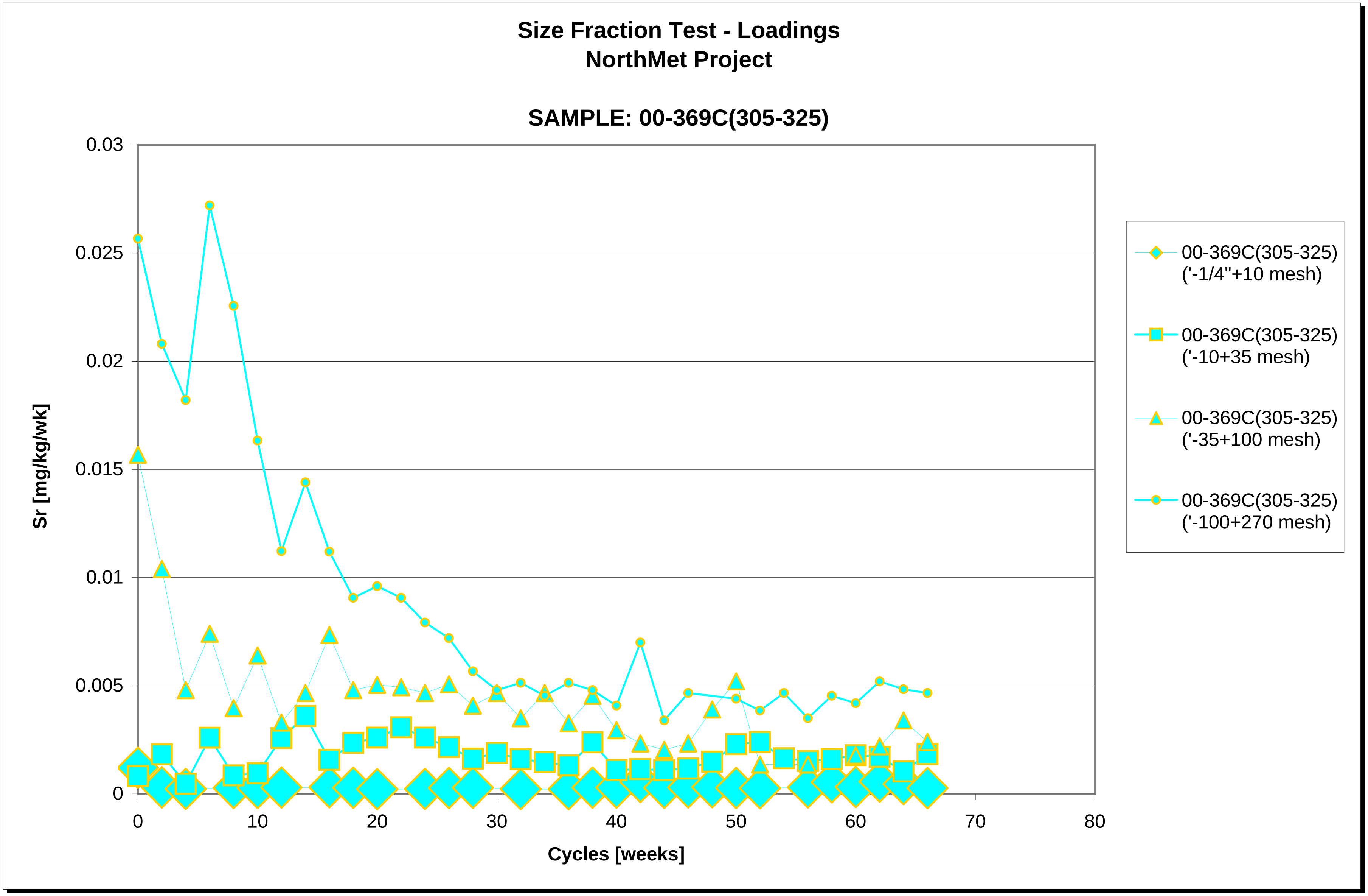

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
K [mg/kg/wk]
Cycles [weeks]
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

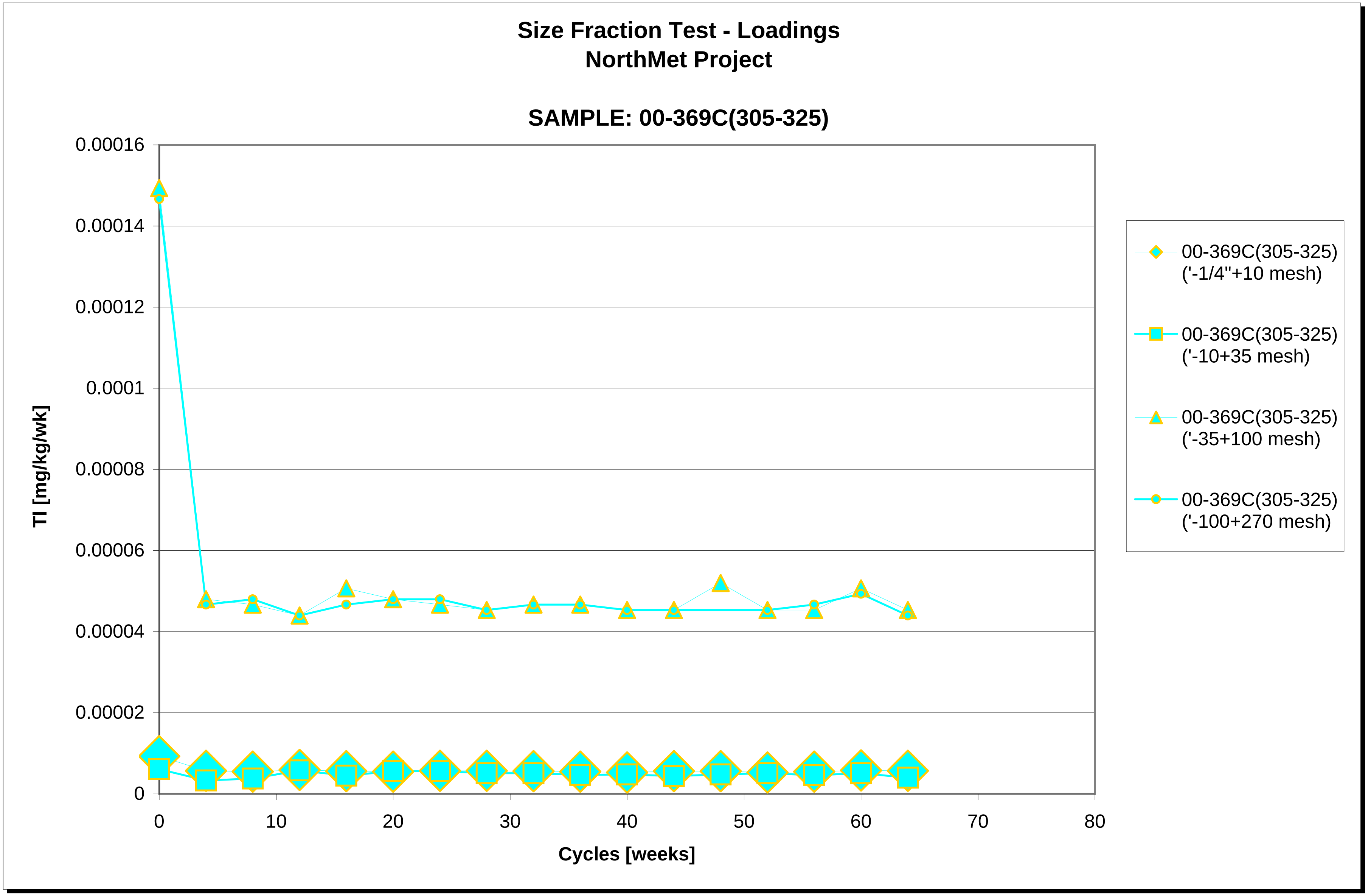

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Se [mg/kg/wk]
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

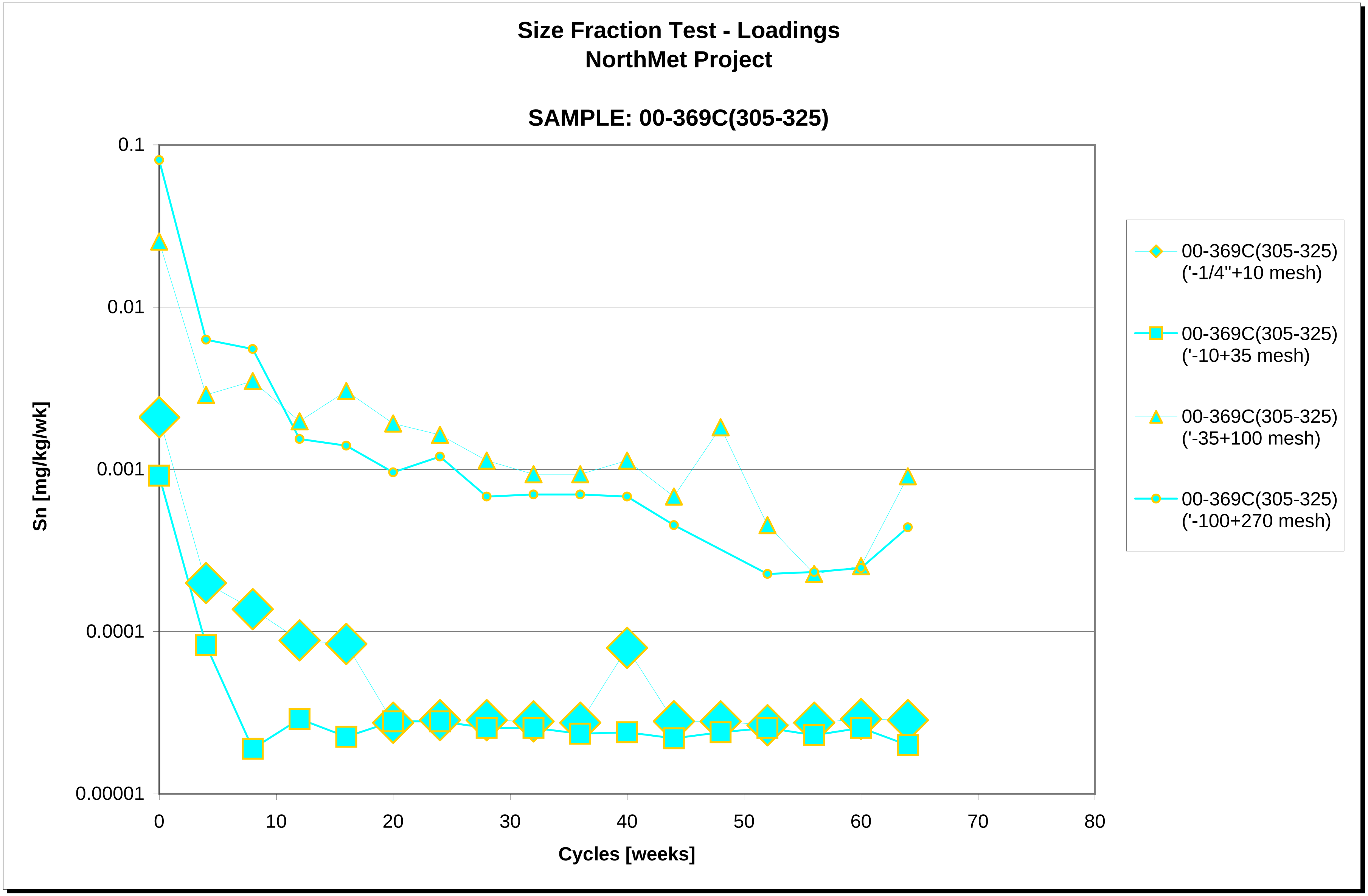

Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
SiO2 [mg/kg/wk]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Ag [mg/kg/wk]
0.0004
0.00035
0.0003
0.00025
0.0002
0.00015
0.0001
0.00005
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Na [mg/kg/wk]
1000
100
10
1
0.1
0.01
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
0.03
0.025
0.02
0.015
0.01
0.005
0
Sr [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Tl [mg/kg/wk]
0.00016
0.00014
0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
0.1
0.01
0.001
0.0001
0.00001
Sn [mg/kg/wk]
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)


Size Fraction Test - Loadings
NorthMet Project
SAMPLE: 00-369C(305-325)
Zn [mg/kg/wk]
0
0.005
0.01
0.015
0.02
0.025
0
10
20
30
40
50
60
70
80
Cycles [weeks]
00-369C(305-325) ('-1/4"+10 mesh)
00-369C(305-325) ('-10+35 mesh)
00-369C(305-325) ('-35+100 mesh)
00-369C(305-325) ('-100+270 mesh)

Appendix G

Tabulated Results for Low Level Analyses

Appendix G.1

Cobalt and Nickel

Appendix G.1
Low Level Cobalt and Nickel Analyses

Humidity Cell ID	Cycle Composite	Cobalt (mg/L)	Nickel (mg/L)
DDH-99-320C(830-850)-1	1 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-361C(310-320)-2	2 Cycle 20+22	< 0.0001	0.0003
DDH-00-361C(345-350)-3	3 Cycle 20+22	< 0.0001	-
DDH-00-343C(240-250)-4	4 Cycle 16+18	0.0003	-
DDH-26030(1047-1052)-5	5 Cycle 20+22	< 0.0001	-
DDH-26061(1218-1233)-6	6 Cycle 20+22	< 0.0001	0.0005
DDH-00-340C(990-995)-7	7 Cycle 20+22	< 0.0001	0.0002
DDH-00-340C(965-974.5)-8	8 Cycle 20+22	< 0.0001	< 0.0001
DDH-99-320C(830-850)-9D	9D Cycle 20+22	< 0.0001	< 0.0001
DDH-00-340C(765-780)-10D	10D Cycle 12+14	0.0002	-
DDH-00-340C(595-615)-13	13 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-334C(580-600)-14	14 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-334C(640-660)-15	15 Cycle 20+22	< 0.0001	0.0003
DDH-00-347C(795-815)-16	16 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-350C(580-600)-17	17 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-327C(225-245)-18	18 Cycle 20+22	0.0002	0.0004
DDH-00-371C(435-440)-19	19 Cycle 12+14	0.0003	-
DDH-00-340C(765-780)-20	20 Cycle 12+14	< 0.0001	-
DDH-00357C(335-340)-21	21 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-357C(535-540)-23	23 Cycle 20+22	< 0.0001	-
DDH-99-318C(725-735)-24	24 Cycle 20+22	< 0.0001	0.0005
DDH-99-317C(460-470)-25	25 Cycle 20+22	< 0.0001	0.0004
DDH-00-366C(185-205)-26	26 Cycle 20+22	< 0.0001	0.0002
DDH-00-366C(230-240)-27	27 Cycle 20+22	< 0.0001	< 0.0001
DDH-99-320C(165-175)-28	28 Cycle 20+22	< 0.0001	< 0.0001
DDH-99-318C(250-370)-29	29 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-373C(95-115)-30	30 Cycle 20+22	< 0.0001	0.0005
DDH-00-373C(75-95)-31	31 Cycle 20+22	< 0.0001	0.0002
DDH-00-357C(110-130)-32	32 Cycle 20+22	< 0.0001	< 0.0001
DDH-99-320C(315-330)-33	33 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-369C(335-345)-34	34 Cycle 20+22	< 0.0001	0.0002
DDH-00-368C(460-465)-35	35 Cycle 12+14	0.0002	-
DDH-26055(940-945)-36	36 Cycle 20+22	< 0.0001	0.0004
DDH-00-368C(125-145)-37D	37D Cycle 20+22	< 0.0001	< 0.0001
DDH-00-369C(305-325)-38D	38D Cycle 20+22	< 0.0001	0.0002
DDH-26098&00-337C(145&105-148.5&110)-39	39 Cycle 20+22	< 0.0001	-
DDH-00-334C(30-50)-40	40 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-368C(125-145)-41	41 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-368C(20-40)-42	42 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-366C(35-55)-43	43 Cycle 20+22	< 0.0001	0.0002
DDH-00-334C(110-130)-44	44 Cycle 20+22	< 0.0001	-
DDH-00-347C(155-175)-45	45 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-347C(280-300)-46	46 Cycle 20+22	< 0.0001	0.0004
DDH-00-326C(60-70)-47	47 Cycle 20+22	< 0.0001	0.0005
DDH-00-369C(305-325)-48	48 Cycle 20+22	< 0.0001	0.0002
DDH-00-367C(50-65)-49	49 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-367C(260-280)-50	50 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-367C(290-310)-51	51 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-370C(20-30)-52	52 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-369C(20-30)-53	53 Cycle 20+22	< 0.0001	0.0015
DDH-00-367C(170-175)-54	54 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-367C(395-400)-55	55 Cycle 20+22	< 0.0001	0.0007
DDH-26064(44-54)-56	56 Cycle 20+22	< 0.0001	0.0006

Low Level Cobalt and Nickel Analyses

Humidity Cell ID	Cycle Composite	Cobalt (mg/L)	Nickel (mg/L)
DDH-00-367C(290-310)-57D	57D Cycle 20+22	< 0.0001	< 0.0001
DDH-26064(264&146-269&156)-59	59 Cycle 20+22	< 0.0001	< 0.0001
DDH-26056(110-125)-60	60 Cycle 20+22	< 0.0001	0.0005
DDH-00-361C(240-245)-61D	61 Cycle 8+10	0.0003	-
DDH-00-361C(737-749)-62	62 Cycle 20+22	< 0.0001	0.0008
DDH-00-344C(515-520)-70	70 Cycle 20+22	< 0.0001	-
DDH-00-340C(380-390)-71	71 Cycle 20+22	< 0.0001	0.0006
DDH-00-361C(240-245)-72	72 Cycle 20+22	0.0008	-
26029(interval 815-825)-74	74 Cycle 16+18	< 0.0001	< 0.0001
DDH-26030&26049(291&358-296&362)-75	75 Cycle 16+18	< 0.0001	-
26056(135-153)-78	78 Cycle 14+16	< 0.0001	0.0004
DDH-26142(360&345-365&350)-80	80 Cycle 20+22	< 0.0001	0.0002
00-331C(255-260)-93	93 Cycle 0+2	< 0.0001	-
00-344C (630-635)-94	94 Cycle 0+2	< 0.0001	-
00-344C (630-635)-94	94 Cycle 4+6	-	0.0054
00-326C(495-505)-95	95 Cycle 4+6	< 0.0001	0.002
99-318C(325-330)-96	96 Cycle 4+6	< 0.0001	0.0011
00-330C(275-280)-97	97 Cycle 8+10	< 0.0001	0.0011
26056(282-292)-98	98 Cycle 4+6	< 0.0001	0.0028
00-326C (250-265)-99	99 Cycle 8+10	< 0.0001	0.0011
00-340C(910-925)-100	100 Cycle 4+6	< 0.0001	0.0024
26039(310-315)-101	101 Cycle 10+12	0.0002	-
26039(310-315)-101	101 Cycle 4+6	-	0.0032
00-331C(190-210)-102	102 Cycle 0+2	0.0004	-
99-320C(400-405)-103	103 Cycle 8+10	< 0.0001	0.0014
00-326C(225-235)-104	104 Cycle 4+6	< 0.0001	0.0035
00-367C(495-500)-105	105 Cycle 10+12	< 0.0001	-
00-367C(495-500)-105	105 Cycle 4+6	-	0.0033
26058(704-715)-106	106 Cycle 4+6	0.0003	0.0049
DDH-00-361C(310-320)(+10mm)	81 Cycle 20+22	< 0.0001	0.0007
DDH-00-361C(310-320)(-10mm +35mm)	82 Cycle 20+22	< 0.0001	0.0005
DDH-00-334C(640-660)(+10mm)	83 Cycle 20+22	< 0.0001	0.0004
DDH-00-334C(640-660)(-10mm +35mm)	84 Cycle 20+22	< 0.0001	-
DDH-00-369C(305-325)(+10mm)	85 Cycle 20+22	< 0.0001	0.0006
DDH-00-369C(305-325)(-10mm +35mm)	86 Cycle 20+22	< 0.0001	0.0003
DDH-00-367C(290-310)(+10mm)	87 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-367C(290-310)(-10mm +35mm)	88 Cycle 20+22	< 0.0001	0.0002
DDH-00-367C(290-310)(+10mm) Duplicate	91 Cycle 20+22	< 0.0001	< 0.0001
DDH-00-367C(290-310)(-10mm +35mm) Duplicate	(92D) Cycle 20+22	0.0005	0.0004

Appendix G.2

Mercury

Appendix G.2
Low Level Mercury Analyses

Sample	Hg (ng/L)
HC 1 Cycle 43	6.8
HC 2 Cycle 43	3.2
HC 3 Cycle 43	4.5
HC 4 Cycle 43	30.1
HC 5 Cycle 43	10.9
HC 6 Cycle 43	6.2
HC 7 Cycle 43	3.2
HC 8 Cycle 43	5.4
HC 9 Cycle 43	2.2
HC 10 Cycle 43	15.7
HC 11 Cycle 43	10.6
HC 12 Cycle 43	2.4
HC 13 Cycle 43	7.1
HC 14 Cycle 43	9.5
HC 15 Cycle 43	2.8
HC 16 Cycle 43	8.1
HC 17 Cycle 43	4.5
HC18 Cycle 43	11.5
HC 19 Cycle 43	19.2
HC 20 Cycle 43	5.9
HC 21 Cycle 43	6.4
HC 22 Cycle 43	5.1
HC 23 Cycle 43	6.4
HC 24 Cycle 43	9.9
HC 25 Cycle 43	7.1
HC 26 Cycle 43	3.4
HC 27 Cycle 43	5.4
HC 28 Cycle 43	3.2
HC 29 Cycle 43	2.1
HC 30 Cycle 43	3.3
HC 31 Cycle 43	11.4
HC 32 Cycle 43	6.1
HC 33 Cycle 43	4.9
HC 34 Cycle 43	7.2
HC 35 Cycle 43	3.1
HC 36 Cycle 43	5.6
HC 37 Cycle 43	3.8
HC 38 Cycle 43	7.2
HC 39 Cycle 43	4.2
HC 40 Cycle 43	2.5
HC 41 Cycle 43	3.6
HC 42 Cycle 43	3.2
HC 43 Cycle 43	2.6
HC 44 Cycle 43	2.7
HC 45 Cycle 43	3.7
HC 46 Cycle 43	4.1
HC 47 Cycle 43	4.5
HC 48 Cycle 43	6.9
HC 49 Cycle 43	4.5
HC 50 Cycle 43	2.2
HC 51 Cycle 43	8.4
HC 52 Cycle 43	5.0
HC 53 Cycle 43	6.3

Sample	Hg (ng/L)
HC 54 Cycle 43	5.2
HC 55 Cycle 43	6.8
HC 56 Cycle 43	6.8
HC 57 Cycle 43	8.7
HC 58 Cycle 43	4.6
HC 59 Cycle 43	4.9
HC 60 Cycle 43	6.0
HC 61 Cycle 43	2.7
HC 62 Cycle 43	2.5
HC 63Cycle 43	2.7
HC 64 Cycle 43	3.4
HC 65 Cycle 43	4.6
HC 66Cycle 39	3.1
HC 67 Cycle 39	11.0
HC 68 Cycle 43	4.3
HC 69 Cycle 43	3.3
HC 70 Cycle 43	6.7
HC 71 Cycle 43	4.3
HC 72 Cycle 43	<2.0
HC 73 Cycle 39	6.4
HC 74 Cycle 39	4.7
HC 75 Cycle 43	12.0
HC 76 Cycle 43	11.7
HC 77 Cycle 43	6.8
HC 78 Cycle 37	3.1
HC 80 Cycle 43	3.2
HC81 Cycles 42 & 43	4.2
HC82 Cycles 42 & 43	3.5
HC83 Cycles 42 & 43	9.2
HC84 Cycles 42 & 43	4.3
HC85 Cycles 42 & 43	9.9
HC86 Cycles 42 & 43	7.0
HC87 Cycles 42 & 43	7.2
HC88 Cycles 42 & 43	5.6
HC89 Cycles 42 & 43	21.7
HC90 Cycles 42 & 43	3.9
HC91D Cycles 42 & 43	15.3
HC92D Cycles 42 &43	7.6
HC 93 Cycle 31	5.0
HC 94 Cycle 31	2.3
HC 95 Cycle 31	6.7
HC 96 Cycle 31	5.1
HC 97 Cycle 31	14.6
HC 98 Cycle 31	12.5
HC 99 Cycle 31	8.4
HC 100 Cycle 31	4.0
HC 101 Cycle 31	2.0
HC 102 Cycle 31	3.7
HC 103 Cycle 31	3.4
HC 104 Cycle 31	5.2
HC 105 Cycle 31	3.0
HC 106 Cycle 31	14.8
TRAVEL BLANK	2.4

Appendix H

Water Chemistry Database

Appendix H.1

Results of Search for Sites with Water Relevant Water Quality Data

Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Different geology	Argentina	Bajo de la Alumbrera	Catamarca	Cu, Au	Producing	Minera Alumbrera Ltd	Open pit	Copper-gold porphyry. Porphyritic dacite intrudes volcanic andesite. ChPy main Cu mineral.		
No	Different geology	Argentina	Cerro Vanguardia	Santa Cruz	Au, Ag	Producing	AngloGold Ashanti	Open pit	Within a middle jurassic ignimbritic sequence, a fracture system hosts a swarm of epithermal, low-sulphidation veins of the sericite-andularia type.		
No	Different geology; perhaps no WR	Australia	Olympic Dam	Adelaide	Cu, U	Producing	BHP Billiton/ WMC Resources	Underground	Mineralization consists of medium-grained chalcopyrite, bornite and chalcocite, fine-grained disseminated pitchblende, gold, silver and rare earth minerals that occur in a magnetic hydrothermal breccia complex beneath 350m of overburden.	Used as backfill	
No	Different geology	Australia	Murrin Murrin	Leonora	Ni, Co	Producing	Minara Resources, Glencore International	Open cast	Laterite-hosted orebodies.		
No	Acidic	Australia	Gulf Creek Copper	New South Wales	Cu	Abandoned			Sulphide ore- Py, ChPy, Sph		pH 2.2-3.4
No	Different geology	Australia	McArthur River Mine	Northern Territory	Zn, Pb, Ag	Producing	ANT Minerals (Japanese consortium)	Underground	Stratiform deposit in Pyritic Shale Member. Package of inter-bedded pyritic siltstone, sedimentary breccia and tuff. Seven stacked sulphide orebodies are separated by dolomitic siltstones and sedimentary breccias.		
No	Different geology	Australia	Cannington	Queensland	Ag, Pb, Zn	Producing	BHP Billiton	Underground	In Mount Isa Block, within the metamorphics of the lower middle proterozoic eastern succession. Major economic sulphides are Gal and Sph. The Ag occurs mainly as freibergite but is also present in solid solution within galena.		
No	Different geology	Australia	Mount Isa Mines	Queensland	Pb, Zn, Ag	Producing	Xstrata	Underground	The ore mineralisation is stratiform, occurring in the 1,600 million-year-old Lower Proterozoic Urquhart Shale sequence.Comprising Gal and Sph with Py and Po, the lead-zinc-silver orebodies are concordant with carbonaceous dolomitic sediments, interfingering with the silica-dolomitic mass hosting copper.		
No	Too much Pentlandite	Botswana	Tati Nickel	Eastern Botswana	Ni, Cu, Pt, Pd	Producing	LionOre, Gov of Botswana	Open pit	Co-magmatic sulphide deposit hosted by a meta-gabbroic intrusion. Massive and disseminated sulphides. 70%Po, 20%Pt, 10%ChPy, sig PGM		
No	Different Geology	Canada	Bluebell	British Columbia	Ag, Zn, Pb, Cu, Cd, Au	Closed	Kettle River Resources	Underground	The Pb-Zn ore is contained in calcite marble with accessory tremolite, phlogopite and graphite. Hanging wall is a muscovite schist with interbedded dolomite marble. Footwall is a micaceous schist with quartzite layers. Sulphide minerals include Py, Po,Sph, AsPy, Gal, ChPy, and marcasite.	Limestone and micaceous schist	neutral
No	Abundant calcite	Canada	Bralorne	British Columbia	Cu, Ag, Au	Closed		Underground	Au-Quartz vein. Sulphides-Py, ChPy, AsPy, Sph, Gal, minor Po and tetrahedrite. Gangue - Qtz, calcite, mariposite, talc and scheelite.	>150 000 m3. Low S, abundant calcite and other carbonates. Diorite, gabbro, greenstone, sodic granite, serpentinite, and albite.	Alkaline Seep: pH 8.1, 62mg/L SO4, 2ug/L Ni Adit: pH 8.3, 97mg/L SO4, 14ug/L Ni
No	Different geology	Canada	Brittania	British Columbia	Cu, Zn, Pb, Ag, Au, Cd	Closed		Underground and open pit	Massive sulphide Cu-Pv-Zn deposit. Ore deposits were formed from hydrothermal solutions related to dacitic volcanism. The main mineralogy of orebodies is Pyrite (by far the most abundant), with less ChPy and Sph and minor erratically distributed Gal, tennanite, tetrahedrite and Po. The main nonmetallic minerals include quartz and muscovite (chlorite), anhydrite and siderite.		
No	Acidic	Canada	Duthie	British Columbia	Ag, Pb, Zn	Abandoned	Standard Silver Resources Inc.	Underground	Hydrothermal polymetallic vein; porphyritic granodiorite and quartz monzonite intrusions with associated quartz veining	contains qtz, carb, chalcedony, Gal, Sph, Tetrahedrite, Pyrargyrite, AsPy, ChPy, Py, Po; Tailings w/ 1-7% S;	pH 2-3 in surface seeps on tailings impoundment and pH 2-6 in monitoring wells within
No	Acidic	Canada	Equity Silver	British Columbia	Cu, Ag, Au, Sb, As	Closed	Placer Dome Inc.	Open pit, some UG	Sub-volcanic Cu-Ag-Au deposit in pyroclastic layer of brecciated dust tuffs and lapilli-ash tuffs. Sulphides - Py, ChPy, Po, tetrahedrite, and minor Gal, Sph, argentite, and sulphosalts. Veins and disseminations.	77 Mt over 110 ha.	Acidic. Dump seeps:1000000mg/L acidity, 100 mg/L Cu, 200 mg/L Zn

Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Different geology	Canada	Goldstream	British Columbia	Cu, Ag, Au, Zn, Cd, Sb	Producing?	Imperial Metals		Massive sulphide Cu-Zn deposit. Thin massive sulphide layer in sericitic quartzite and calcareous and chloritic phyllite within metavolcanic-phyllites. Sulphide layer contains mainly Po, ChPy, Sph with inclusions of Qtz, phyllite and carbonates.		
No	Different geology	Canada	Highland Valley	British Columbia	Cu, Mo	Producing	Teck Cominco	Open pit	Low-grade (0.4% Cu) porphyry copper-molybdenum deposit hosted in Qtz monzonite and granodiorite batholith. Feldspar and Qtz Feldspar porphyry dykes. Sulphides in veinlets and alteration zones. Sulphides - Bornite, ChPy, minor Py, Po, Moly, Sph, Gal, covellite.		
No	Different geology	Canada	Kitsault	British Columbia	Mo, Ag, Pb, Zn, Cu	Closed			Porphyry Mo; Polymetallic Ag-Pb-Zn+/-Au veins; Mineralization consists of molybdenite along fractures quartz veinlets that form a stockwork. They are cut by later quartz veins containing Py, Gal, Sph, neyite, scheelite, ChPy, tetrahedrite, Po, fluorite and gypsum. The main body is differentiated into a core of porphyritic qtz monzonite that grades outward through granodiorite to qtz diorite. It is cut by dykes and irregular masses of fine-grained alaskite.		
No	Different geology	Canada	Mt. Washington Copper	British Columbia	Cu, Au, Ag, As, Mo, Zn, Pb	Abandoned		Open pit	Porphyry-type deposit with a later superimposed epithermal Au-Cu-As event. The mineralized zone contains a stockwork of ChPy- Py-Qtz veins, and disseminated ChPy in the sediments and the sill. Bornite, covellite, realgar, orpiment, Po, AsPy, Moly, Sph and Gal are present. Qz-diorite stock that intrudes Nanaimo Group sediments (siltstones and argillite) and volcanic rocks. Carbonate as fracture filling and calcite veins in South pit.	Three WR dumps	North Pit - acid w/ very high Cu South Pit - neutral w/ high Cu and possibly As
No	Acidic	Canada	Myra Falls	British Columbia	Cu, Zn, Pb, Au, Ag, Cd	Closed	Breakwater (Prev. Boliden)	UG and open pit	Massive sulphide Cu-Pb-Zn; VMS	High S content (up to 7%). Contains ore and gange minerals. Ore - ChPy, Sph, Gal, Bx; Gangue - Qtz, Sericite, Chl, Py.	Acidic
No	Different geology	Canada	Nickel Plate	British Columbia	Au, Ag, Cu, As	Closed	Barrick Gold	UG and open pit	Skarn deposits. Hornblende porphyritic diorite intrusions in sedimentary country rocks (slst, lmst, congl). The deposit consists primarily of arsenopyrite, pyrrhotite and chalcopyrite, as disseminations and fracture-fillings, in a gangue of carbonate, pyroxene, scapolite, garnet and quartz.		
Yes	Acidic, but 1 neutral sample from adit	Canada	Pride of Emory	British Columbia	Ni ,Cu	Closed	Giant Mascot	UG, some small pits	intrusive ultramafic suite	Mostly trace pyrrhotite w/ no sulphide or carbonates; some with high sulphide incl pt	moderately acidic (~5.5) drainage; some neutral from adit
No	Abundant calcite.	Canada	QR	British Columbia	Au, Ag, Cu	Closed	Kinross Ltd	Open pit and UG	Hosted by a thick succession basaltic, volcanic, volcaniclastic and epiclastic rocks. The pyroclastic rocks contain 5 to 20 % Py. The sedimentary rocks contain up to 10 % Py. The whole sequence has been intruded by zoned, monzodiorite QR stock and hornblende porphyry dikes. The majority of the gold occurs in propylitically altered carbonate-rich rocks associated with pyrite mineralization. The West zone is composed of propylitized basaltic tuff, breccia and interbedded siltstone. Discontinuous seams and lenses of massive pyrite with subordinate Po, ChPy and trace Gal and AsPy.		URS report w/ primarily neutral drainage - mostly prediction data in report
No	No Pt, but different geology	Canada	Silver Standard	British Columbia	Ag, Au, Pb, Zn, Cu, Cd	Closed		Underground	Polymetallic Veins. The vein ore deposits are hosted in predominantly medium to fine-grained tuffaceous sandstones with minor beds of coarse-grained greywacke, and finer grained dark argillite. The veins consist mainly of milky white quartz that is generally massive and fractured, massive white calcite and buff siderite. Sulphide minerals present in the veins in approximate order of abundance are: Py, Sph, AsPy, Gal, Po, tetrahedrite and ChPy.		

Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Abundant calcite.	Canada	Snip	British Columbia	Au, Ag, Zn, Cu, Pb	Closed	Barrick Gold	Underground	Intrusion-related Au pyrrhotite veins. Sheared quartz-carbonate-sulphide vein that cuts through a massively bedded feldspathic greywacke-siltstone sequence. Associated w/ disseminated to massive sulphides: Py, Po, ChPy, Sph, Gal, Moly and AsPy. Abundant calcite occurs throughout the mineralized zone with sulphides		Drainage data from mine portal: slightly alkaline (pH ~8)
No	Different geology	Canada	Sullivan	British Columbia	Pb, Zn, Ag, Sn, Cu, Au, Ag, Fe, S, Sb, Cd, Bi, In	Closed	Cominco	UG, some open pit	Sedimentary exhalative Zn-Pb-Ag; Polymetallic Veins Ag-Pb Zn+/-Au. Princical ore minerals = Gal, Sph	Po and Py (ratio of 7:3) are most abundant sulphides, minor AsPy, ChPy. Non-sulphides incl Qtz, Cal, Chl.	
Yes		Canada	Sunro	British Columbia	Cu, Au, Ag, Mo, Ni, Co	Closed			Tholeiitic intrusion-hosted Ni-Cu deposit. Cu hosted in shears in basalts at contact with gabbros. Hornblende replacement. Ore zone contains ChPy, Po, Py, small amounts of Moly, trace Pt and native Cu.		No data
No	Different geology.	Canada	Birchtree	Manitoba	Ni, Cu, Co, Pt, Pd, Au, Ag	Producing	INCO Ltd	Underground	Sedimentary rocks (greywacke type) interfolded with schists and gneisses, and intruded by Alpine-type serpentinite. Low grade Ni deposits associated w/ serpentinite intrusions. High grade deposits lie within adjacent biotite schist. Pt, ChPy		Net alkaline (pH 8.4), average Ni is 5.1mg/L
No	Different geology.	Canada	Dumbarton	Manitoba	Ni, Cu, Pt		Canmine Resources		Series of volcanics (andesite&basalt), sedimentary (greywacke, quartzite, arkose, CGL, slate, and chert), and mafic (peridotite, pyroxenite, gabbros) intruded by qtz diorite, granite, and pegmatite. Metamorphism to shists.		No data
No	Different geology.	Canada	**Flin Flon** (includes Trout Lake and Centennial)	Manitoba	Cu, Ni		Hudson Bay Mining and Smelting		Lava flows (various) associated with pyroclastic breccias and gabbroic intrusions intruded by qtz-eye granite and unconformably overlain by CGL, greywacke, and arkose. Ore occurs in lenticular bodies of solid and dissemnated sulphides (Py,), qtz, and carbonate		
Maybe		Canada	**Lynn Lake** (includes Ruttan, Fox, "A" mine, Farley, "EL" mine)	Manitoba	Cu, Ni, Zn	Only Ruttan still open??	Sherritt Gordon Mines Ltd.	Underground	Ultramafic igneous pluton in Greenstone metasediments and metavolcanics.Tholeiitic in origin. Peridotite, amphibolite, norite pipes in gabbro host-rock.	Po-rich tailings	No data
Maybe		Canada	Maskwa Open Pit	Manitoba	Ni, Cu, Co		Canmine Resources	Open pit	Series of volcanics (andesite&basalt), sedimentary (greywacke, quartzite, arkose, CGL, slate, and chert), and mafic (peridotite, pyroxenite, gabbros) intruded by qtz diorite, granite, and pegmatite. Metamorphism to shists. Maskwa pit targeted Ni-Cu mineralization concetrated at base of mafic-ultrmafic sill.	Po, Py in silica enriched veins in basalt and peridote	No data
No	Different geology.	Canada	Namew Lake	Manitoba	Ni, Cu	Closed (1993)	Abandoned by Hudson Bay Minerals	Underground	Pyroxenite host emplaced as a sill in country rock gneisses.		
No	Different geology.	Canada	**Snow Lake** (includes Schist lake, Chisel, Ghost, Anderson, Stall and Osbourne)	Manitoba	Cu, Ni	Closed	Hudson Bay Mining and Smelting		Deposits occur in gneisses and schists. Most are associated w/ qtz veins that occur along shear zones in lavas and that cross dykes of qtz diorite, dacite porphyry, and qtz-feldspar-prophyry which cut the greenstones. Po, Py, Gal, Sph, AsPy, ChPy		
No	Different geology.	Canada	T-3 Mine	Manitoba	Ni, Cu	Producing	INCO Ltd		Sedimentary rocks (greywacke type) interfolded with schists and gneisses, and intruded by Alpine-type serpentinite. Low grade Ni deposits associated w/ serpentinite intrusions. High grade deposits lie within adjacent biotite schist. Pt, ChPy		
No	Different geology.	Canada	Thompson	Manitoba	Ni, Cu, Co, Pt, Pd, Au, Ag	Producing	INCO Ltd	Open pit and Underground	Sedimentary rocks (greywacke type) interfolded with schists and gneisses, and intruded by Alpine-type serpentinite. Low grade Ni deposits associated w/ serpentinite intrusions. High grade deposits lie within adjacent biotite schist. Pt, ChPy		

Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Different geology.	Canada	Brunswick	New Brunswick	Pb, Zn, Cu, Ag, Au, Bi, Sb, Cd	Producing	Noranda	Underground	Massive sulphide lenses within folded and uplifted lead-zinc, pyrite and copper zones. The metals occur as extremely fine-grained mixtures of ChPy, Gal, Sph and Py, together with Au, Ag and other metals.		Acid mine drainage is now treated in the new HDST plant at the No.12 site. A high-density lime (HDL) treatment process is used to reduce the acidity and water content.
No	Underwater disposal of tailings and waste rocks. Also high S content.	Canada	Voisey's Bay	Newfoundland	Cu, Ni, Co	Producing	INCO Ltd	Open pit and Underground	Ignous intrusions. Granite (felsic), anorthosite, diorite, and troctolite (mafic) are the predominant rock types. Area hosted by troctolite	High sulphide content. pyrrhotite, chalcopyrite, cubanite and pentlandite (also containig cobalt). Underwater disposal of tailings and WR.	NO
No	Different Geology	Canada	Lupin	Nunavat	Au	Closed	Kinross Gold Corp/ Wolfden Resources Ltd.	Underground	Banded Iron Formation. Greywacke and slate. Au is in thin AsPy zones within Po rich iron formation.	Po, AsPy	no stations
No	Carbonates present	Canada	Ekati	NWT	Diamonds	Producing	BHP Billiton	Open-pit, some UG	Kimberlite pipes;		neutral to slightly acidic. Some elevated Al
No	Different geology.	Canada	Campbell Gold	Ontario	Au	Producing	Placer Dome	Underground	Tholeiitic volcanic complex. The gold occurs as either free gold or is in sulphide minerals, mainly arsenopyrite, pyrite and pyrrhotite. A minor amount of silver occurs with the gold.		
No	Tailings very acidic; no WR info, but likely high %S	Canada	Copper Cliff	Ontario	Ni, Cu	Producing	INCO	Underground and ope	Sudbury Igneous Complex; noritic to gabbroic rocks containing up to 60% sulphides. Primary sulphides - Po, Pt, ChPy, Py, cubanite. Minor sulphides - cobalite, nickelite, Gal, millerite.	WR - ? Tailings - Approx 6% S, dominantly Po. Tailings are said to be representative of Ni-rich ores of the Sudbury area.	WR-? Tailings - Acidic with high Fe, Ni, Co. Ni up to 640mg/L.
No	Acidic tailings	Canada	Falconbridge Mill	Ontario	Ni, Cu	Closed	Falconbridge	n/a	Processed ore from Falconbridge Subdury operations.	New Tailings Area (NTA) contains ~7%S	WQ at Spillway and Decant Tower has pH ~8 and Ni ~1mg/L
No	Different geology	Canada	Kidd Creek	Ontario	Cu, Zn, In, Ag, Ni-Cu carbonate	Producing	Falconbridge	Underground, Open pit	Volcanogenic sulphide deposit hosted in felsic rocks cut by mafic intrusions; Ore types- massive, banded, bedded (MBB) ores (Py, Sph, ChPy, Gal, Po), breccia ores w/ fragments of MBB ores, ChPy stringers		
Yes		Canada	Lac des Iles	Ontario	PGE, Au, Cu, Ni	Producing	N.A Palladium	Open pit and UG	The Roby Zone deposit is hosted within an Archean suite of mafic/ultramafic intrusives called the Lac des Iles Intrusive Complex. Gabbroic intrusions. Roby zone ore body is dominated by varitextured gabbro containing pipes and pods of breccia of varying lithology. Mineralization occurs as: (1)PGE-Ni-Cu rich breccias; (2) mineralized dykes or sills; and (3) thick high grade Pd unit along eastern contact. Sulphide poor in the varitextured gabbro and gabbronorite, but 2-5% sulphides in gabbro breccia.		No data
Maybe		Canada	Montcalm	Ontario	Ni, Cu	Producing	Falconbridge		Montcalm Gabbro Complex in Abitibi Greenstone belt; intrusive, anorthosite-gabbro suite; Po(8%), Py, Pt, ChPy, violarite, minor magnatite		No data
No	Acidic	Canada	Nickel Rim	Ontario	Ni, Cu	Abandoned		Underground	Sudbury basin; Igneous intrusions of Qtz diorite and Qtz diorite breccia in norite and granite host rocks; sulphide lenses in quartz diorite & quartz diorite breccia. Ore- Po, Pt, ChPy, some Py. 3% S in tailings	Don't think there was WR dump. Tailings into lake (and WR?). 3% S in tailings	Acidic tailings porewater and ground water. High metal content.
Maybe		Canada	Redstone	Ontario	Ni, Cu, PGE		Black Hawk Mining, Pacific Metals, Nippon Steel		ultramafic volcanics (peridotite)		No data
Not Likely	Likely acidic if Copper Cliff is representative example of Sudbury area	Canada	Stobie	Ontario		Producing	INCO	Underground	Sudbury Igneous Complex		
Not Likely	Likely acidic if Copper Cliff is representative example of Sudbury area	Canada	Sudbury: Craig, Fraser, and Lindsley, Lockerby	Ontario	Ni, Cu, PGE	Producing	Falconbridge	Underground	Sudbury Igneous Complex; Astrobleme; intrusive gabbro suite; Sulphides - Po, Pt, ChPy, Py. Mineralization is typically associated with igneous breccias		

Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Different geology	Canada	Bouchard-Hebert	Quebec	Cu, Zn, Au, Ag	Closed (from Feb 2005)	Breakwater Resource Ltd	Open pit and Underground	Rhyolitic flows and felsic pyroclastic rocks in the Blake River Group. This consists of Archean felsic to mafic volcanic rocks in the southern part of the Abitibi Greenstone Belt. The Mine lies within a complex of andesitic and rhyolitic flows intercalated with minor basalt and andesitic, dacitic, and rhyolitic pyroclastic rocks.	Eight massive sulfide lenses containing zinc, copper, gold, and silver	
No	Different geology	Canada	Joe Mann	Quebec	Au, Cu	Producing	Campbell Resources (Meston Resources Inc)	Underground	Archean vein-type deposit with gold-copper mineralization hosted by quartz veining within three laterally continuous shear systems. In the mine area, the rocks consist predominantly of mafic lavas intruded by gabbro sills and feldspar porphyry dykes	Gold in greenstone belt hosted structural zones deposit	
No	Acidic	Canada	Lorraine	Quebec	Cu, Ni	Abandonded (1968)			pentlandite, chalcopyrite		Tailings drainage acidic w pH 2-3 and high metals
Yes	Neutral Ni leaching. The waste rock has pentlandite	Canada	Raglan	Quebec	Ni, Cu, Co (some precious metals)	Producing	Falconbridge	90% Underground. Also, open pit.	Tholeiitic and komatiitic basalts. Mafic to ultramafic flows and sills are abundant. Proterozoic in age.	Ultramafic bodies contain finely disseminated pyrrhotite and pentlandite. Ore contain pyrrhotite, pentlandite, chalcopyrite, magnetite. Cobalt and platinum groups are associated with sulphides.	Ni leachate at neutral pH
No	Different geology	Canada	Troilus	Quebec	Au, Cu	Producing	Inmet Mining Corporation	Open pit	In the Frotet-Evans greenstone belt. Low-grade, high-tonnage resource, hosted in Archean calc-alkaline intrusive rocks.	Disseminated gold-copper mineralization. Porphyry-type Cu-Au-Ag mineralization	
No	Different Geology	Canada	Cigar Lake	Saskatchewan	U		Cameco, AREVA, COGEMA Resources, et al.	Underground	Athabasca Group Unconformity; U deposit is confined to basal SST unit directly above the unconformity. Unconformity overlies gneisses, pelite, and meta-arkose. Deposit capped by hematized clay. Sulphides-Py, marcasite, ChPy, bornite, chalcocite, Sph, Gal and others	WR-? Not likely much WR. %S =0.02%, NP/AP=311. Contains minor Po, ChPy, AsPy and gersdoffite. Tailings (typically <0.01%S): *Leach residue* - qtz, illite, kaolinite *Neutralized raffinite* - dominantly gypsum, also hydroaluminite, calcite, metal oxides, and trace annabergite, jarosite, siderite, rutile, uranitite, scorodite.	Porewaters neutral to alkaline. Ni up to 0.2 mg/L. SO4 ~2000mg/L
No	Different Geology	Canada	Cluff Lake	Saskatchewan	U	Closed (2002)	AREVA, COGEMA	Open pit and UG	Carswell Structure surrounded by undisturbed Athabasca Fm rocks. Carswell Structure (meteor impact) is a concentric ring with outmost unit of stromatolitic dolomite, middle unit of fractured SST w/large bsmt rx, and inner core of basement gneisses. Mineralization in faults and vienlet associated with gneisses.		
No	Low S but different geology. No Po. Predicted mg/L Ni. Will likely be slighlty acidic, like other U mines in region.	Canada	Key Lake	Saskatchewan	U	Closed (just processing now)	Cameco, AREVA, COGEMA Resources	Open Pit	Athabasca Group Unconformity; Mineralization located in 3 rock units: in SST and CGL, in kaolinized residual regolith, and in basement gneisses. All overlain by SST and qtz CGL. Minor Py, Gal, Sph, saffrolite, Ch,Py, hematite, and magnetite.	Trace sulphides, primarily Py. Rare traces of Pt in basement rocks. ***Deilmann South WR pile:*** 67% till, 33% SST, <0.04%S ***Gaertner WR pile*** : 88% till, 11% SST,1%basement, <0.04%S SST composition: sand w/ minor Chl, sericite, hematite plus minor millerite, niccolite, gersdorffite, and lesser Py, Gal, ChPy, Sph, nickeline ***Deilmann North WR pile:*** -contains greater proportion of basement rocks.	No seepage data, just HC tests. Predicted chemistries: -***Deilmann South*** - Ni up to 1.6 mg/L, SO4 up to 319mg/L -***Gaertner*** - Ni up to 1.2mg/L, SO4 to 240mg/L Dewatering wells near WR piles: - ***Deilman South*** (2004) - Max Ni 0.7mg.L, max SO4 398mg/L -***Gaertner*** (1998)- Max Ni 0.2mg/L, max SO4 25mg/L. Groundwater sample at Deilmann North had 18.7mg/L Ni and ~1000mg/L SO4
No	Different Geology	Canada	McArthur River Mine	Saskatchewan	U	Producing	Cameco, AREVA, COGEMA Resources	Underground			

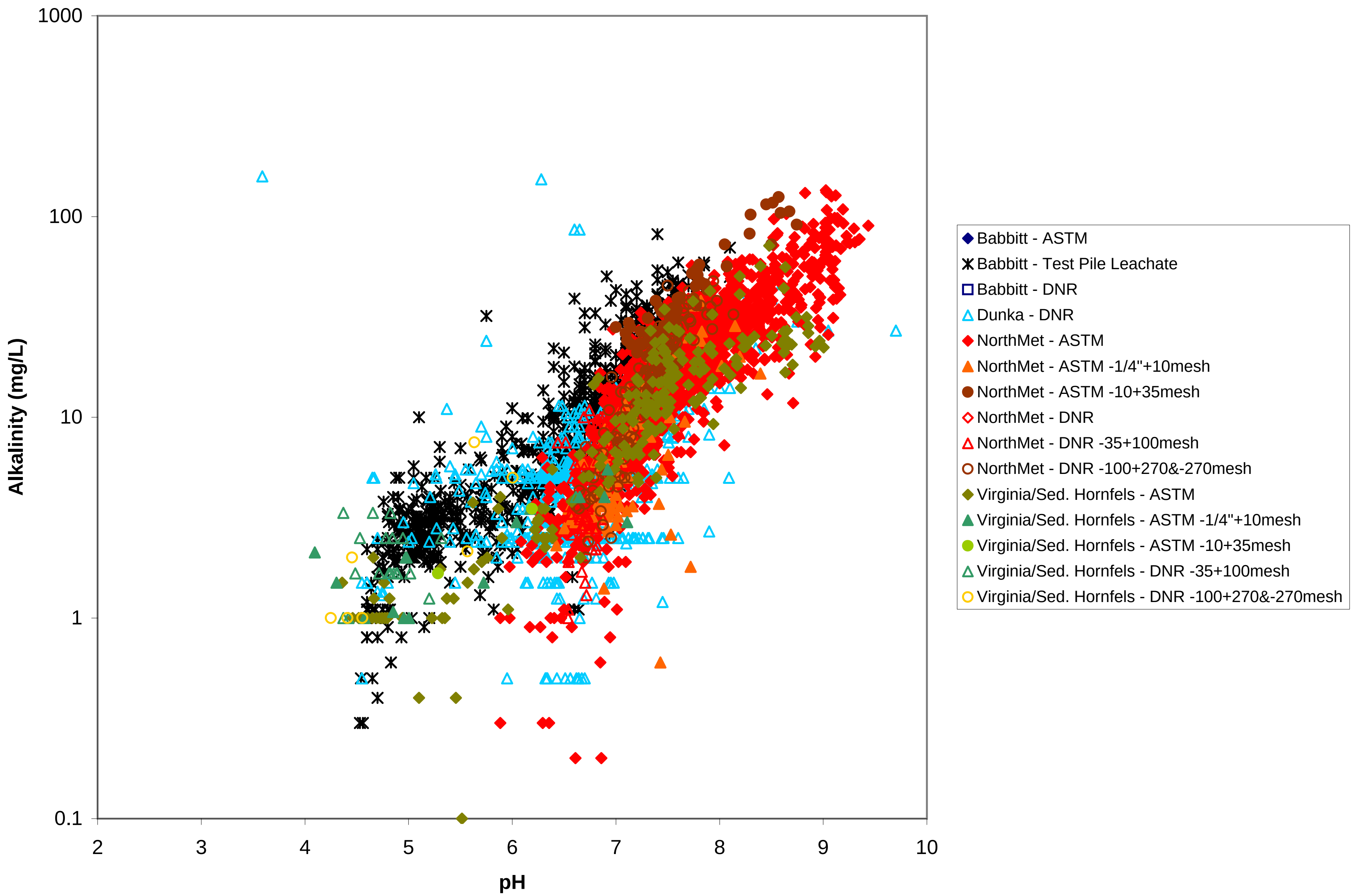
Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Different Geology	Canada	McLean Lake	Saskatchewan	U	Producing	AREVA, COGEMA, Denison Mines	Open pit and UG	Athabasca Group Unconformity;Mostly fault controlled deposits in red earth clays on or immediately above unconformity in SST. Basement graphitic gneisses. Some mineralization in veins in gneisses just below unconformity. Minor sulphides include Ni and Ag arsenides, Sph, Gal, ChPy.		
No	Different Geology	Canada	Midwest	Saskatchewan	U	Producing	AREVA, Denison Mines Ltd., Redstone Resources, OURD Ltd	Open pit and UG	Athabasca Group Unconformity; Host rocks are metapelites and Athabasca group MDST, SST, and CGL, some sericitization and strongly hematized. Contains Cu-Ni arsenides, Gal, Sph, ChPy, marcasite, with gangue of sericitic and hematitic clay, kaolinite, Chl, sercite.		
No		Canada	Rabbit Lake	Saskatchewan	U		Cameco	Open pit and UG	Athabasca Group Unconformity; Rabbit Lake deposit hosted in massive carbonate unit within a calc/non-calc feldspathic metasediments w/ interlayered calc-silicates and minor Bt paragenesis. Deposit overlain by hematized metasediments. Contains minor marcasite, Gal, Sph, Py, ChPy, bornite, chalcocite, nickelene, Qtz, calcite, dolomite, siderite, hematite, mg-chlorite. Gangue minerals predominantly Qtz, illite, koalinite, chlorite, and calcite.	B-Zone WR pile -54% SST, 15%.Basement rocks, 30%Till. %S<0.05% Tailings - Dominantly Qtz, gypsum, and illite. % S not give in paper.	B-Zone WR seeps (2003 data): pH 3.9-5.9, high Ni (0.7-68 mg/L) and As (0.02-63mg/L), and high SO4 (up to 715 mg/L)
No	Different geology	Chile	Minera Los Pelambres Copper	Choapa	Cu, Mo	Producing	Antofagasta, and consortiums	Open pit	Porphyry copper mineralisation - chalcopyrite, chalcocite, bornite, covellite and molybdenite		
No	Different geology	Chile	Collahuasi Copper	Northern Chile	Cu, soon Mo	Producing	Falconbridge, Anglo American, and a Japenese consortium	Open pit	Typical low-grade copper porphyry. The major ore minerals are chalcocite, chalcopyrite and bornite. Oxide mineralisation occurs mainly as chrysocolla with minor brochantite, native copper, and copper-iron-manganese oxides and hydroxides.		
No	Different geology	Chile	Escondida Copper	Northern Chile	Cu, Au, Ag	Producing	BHP Billiton, Rio Tinto, Japanese consortium	Open pit	Related geologically to three porphyry bodies. Primary hydrothermal sulphide ore grades at between 0.2% and 1% copper. Primary sulphide mineralisation includes pyrite, chalocopyrite and bornite, with covellite and chalcocite in the enriched zone. Some areas contain significant copper oxides overlying the sulphides.		
No	Different geology	Chile	Lomas Baya Copper	Northern Chile	Cu	Producing	Falconbridge	Open pit	Orebody is hosted by volcanic-arc rocks and associated back-arc sediments, which are intruded by a granodiorite batholith. Generally oxidised with a few zones of mixed oxide-sulphide.		
No	Different geology	Chile	Radomiro Tomic Copper	Northern Chile	Cu, Mo	Producing	Codelco Norte	Open pit	Hosted in porphyry, the economic mineralisation is differentiated by mineral assemblage into an Upper Oxide unit - with 40% by volume of atacamite, 31% copper clays and minor chrysocolla and copper wad - and the Lower unit with 70% atacamite and minor copper clays and chrysocolla. The orebody resulted from the oxidation of a secondary sulphide enrichment blanket.		
No	Different geology	Chile	Zaldivar Copper	Northern Chile	Cu	Producing	Placer Dome (Compania Minera Zalvidar)	Open pit	Large porphyry complex within the large west fissure structural system. Contains both sulphide and oxide Cu mineralisation. The majority of the Cu occurs in a supergene enrichment zone overlying deeper primary sulphide mineralisation. The main minerals are chalcocite, brochantite and chrysocolla, and mixed sulphide and oxide copper minerals. Primary sulphides are pyrite, chalcopyrite and molybdenite.		
No	Different geology	Dominican Republic	Falcondo		Ni	Producing	Falconbridge, Gov of DR, Newmont	Open Pit	Laterite Deposit		
Yes	near-neutral pH, low S, high Ni	Finland	Hitura	Western Finland	Ni	Producing	Outokumpu	Open pit and UG	intrusive ultrmafic suite (serpentinized); Pt, ChPy, Po, hollingworthite;	Pyrrhotite; No carb; low sulphides (1.7%); elevated Ni, Cl and SO4. May contain Pt.	near-neutral

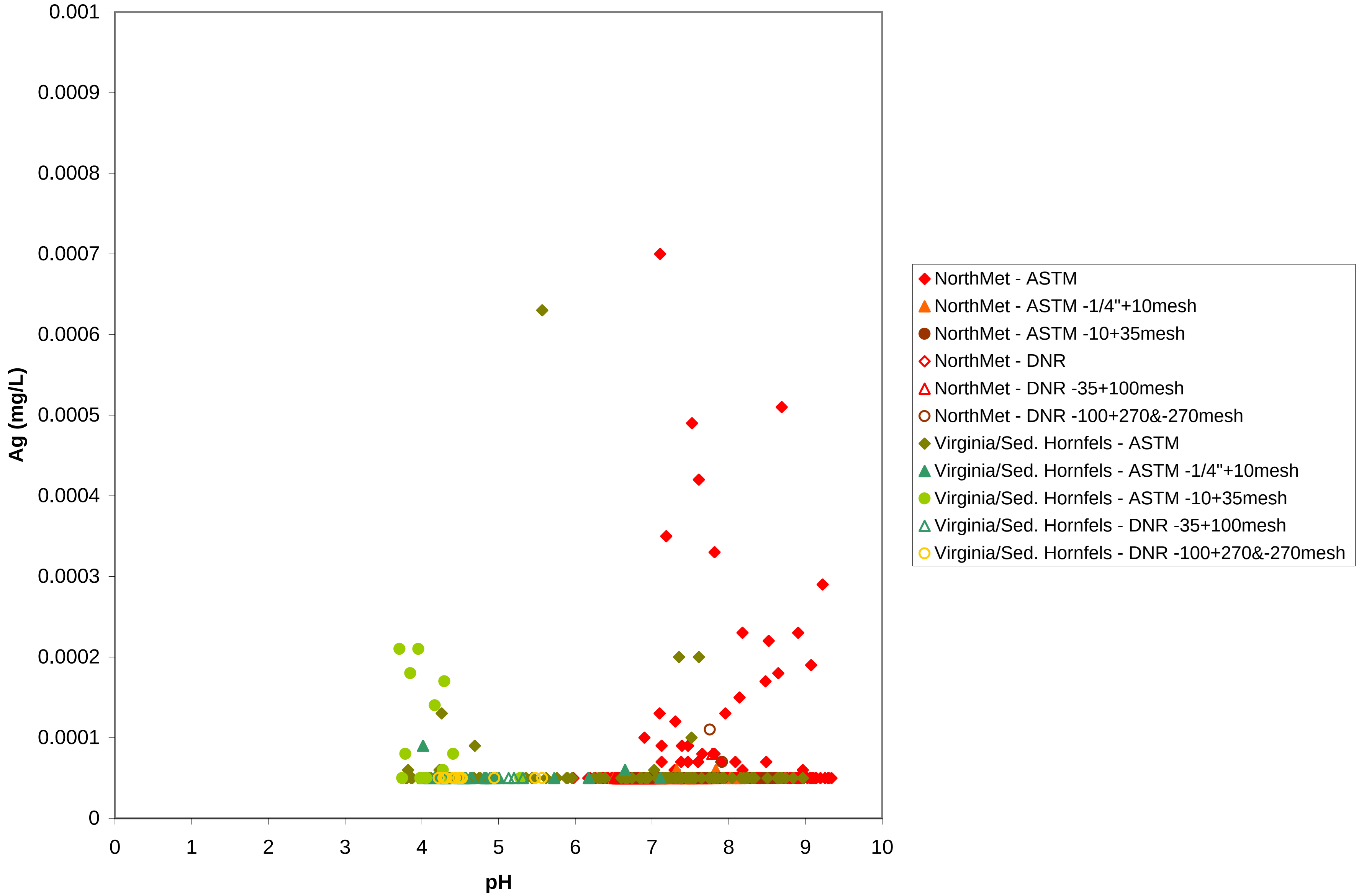
Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	No mention of Po; not mafic	Indonesia	Batu Hijau	Sumbawa Island	Cu, Au	Producing	Newmont, et al	Open pit	These gold-rich porphyries are overwhelmingly hosted by composite stocks of diorite to quartz-diorite and, to a much lesser degree, more felsic compositions such as tonalite and monzogranite. The deposits tend to be characterised by a strong correlation between the distribution of copper sulphides (chalcopyrite and bornite) and gold as the native metal in addition to having a notably higher magnetite content. Gold typically occurs as minute (<10-15 micron) inclusions in the copper sulphides.	WR - ? Tailings - by gravity from the process plant to the ocean where they are deposited 3km from the coast at a depth of about 108m. From there, the tailings, which are non-toxic and non-hazardous, migrate towards the Java Trench and are ultimately deposited at depths in excess of 4,000m.	
No	Different geology; No WR piles	Ireland	Galmoy	Kilkenny County	Pb, Zn	Producing	Arcon	Underground	Orebodies are breccia-hosted, generally stratabound lenses of predominantly massive sulphides consisting of sphalerite, argentiferous galena and pyrite / marcasite in variable combinations.	No visible WR in photo, just tailings ponds.	
No	Different geology	Ireland	Tara Lead and Zinc	Meath County	Pb, Zn	Producing	New Boliden	Underground	Orebody consists of several strata-bound, southwest-dipping, faulted lenses hosted in Lower Carboniferous limestones.		
Not likely	No WR piles?	Morocco	Hajar Metal Mine	South of Marrakesh; In Guemassa massif	Zn, Pb, Cu, Ag	Producing	ONA (Omnium Nord Africain)	Underground	Polymetallic sulphide deposit. Hydrothermal mineralisation occurs in the contact zone between a lower volcano-sedimentary series and an upper sedimentary formation. The upper part of a mineralised lens, comprising banded Po, Py, blende, galena and ChPy, is relatively Cu-rich.	Cement/tailings and waste rock used as backfill	
No	Different Geology	Namibia	Skorpion Zinc	SW Namibia	Zn	Producing	Anglo American	Open pit	The silicate-carbonate deposit occurs in Late Proterozoic volcano-sedimentary schists metamorphosed to Lower Greenschist facies grade. The unusual mineralisation comprises the clay sauconite, smithsonite, hemimorphite and hydrozincite.		
No	Different geology	Peru	Antamina Copper-Zinc	Andes Mountains	Cu, Zn, Mo	Producing	Noranda, Teck Cominco, BHP Billiton, Mitsubishi Corp.	Open pit	Polymetallic calcic skarn deposit. Quartz-monzonite porphyry intrusion. Limestone, marble, hornfels, ChPy, garnet		
No	Different geology	Peru	Minera Yanacocha Gold	Northern Peru	Au	Producing	Newmont Gold, Buenaventura	Open pit	Silicified andesitic domes w/ epithermal gold-bearing deposits. Extensive Argillitic alteration. Siliceous breccia pipes.		
No	Different geology	Poland	KGHM Copper Mining Combine	SW Poland	Cu, Pb, Ag, Au, Pt-Pd, Se	Producing	KGHM Polska Miedz SA	Underground	Stratiform mineralization. The proportions of carbonate, shale and sandstone ore types vary from mine to mine. Over 110 ore minerals have been identified within the deposits but chalcocite, bornite and chalcopyrite are the most important.		
Yes		Russia	Norilsk Mining Centre (Oktyabrskiy, Komsomolskiy, Taymirskiy, Skalistiy, and Glubokiy mines)	High Arctic	Cu, Ni, PGE	Producing	Norilsk Nickel	Underground	magmatic sulphide; intrusive gabbro suite (olivine gabbro)		No data
Yes		South Africa	Messina	Limpopo Province	PGM, Au, Ni, Cu, Co	Producing	Messina Ltd., Lonmin		Layered mafic-ultramafic intrusive hosted Pt-Pd-Au-Ni-Cu-Co deposit in NW portion of Bushveld Igneous Complex.		No data
Yes		South Africa	Nkomati Nickel	Mpumalanga Province	Ni, Cu, Pt, Pd	Producing	LionOre, African Minerals Ltd.	Underground		Sulphides - Py, Po 20% of WR materials classified as PAG. S% of up to 2%, mostly ~1%. Overall dump composition estimate at 0.3% S.	Kinetic testing predicts overall WR dumps may produce neutral to slighlty acidic drainage with Ni up to 5 mg/L, SO4 of 120mg/L.
Maybe		South Africa	Crocodile River (Krokodild	North West Province	PGM, Ni	Producing	Barplats, Impala Platinum (Implats)	Open pit and UG	Western limb of Bushveld Igneous Complex		No data
No	Different geology.	South Africa	Palabora	Northern Province	Cu, Ni, Fe ore, U	Producing	Anglo American, Palabora Mining Co, Rio Tinto	UG and Open pit	The pre-Cambrian carbonatite complex hosts a network of copper sulfide veins near the center of the intrusive.		
Not likely	Different geology.	South Africa	Samancor		Chromite, ferrochrome	Producing	BHP Billiton, Anglo American	UG and open pit	Bushveld layered intrusive complex; mafic-ultramafic; pyroxenite, chromite, anorthosite, norite; massive chromite, disseminated sulphide		

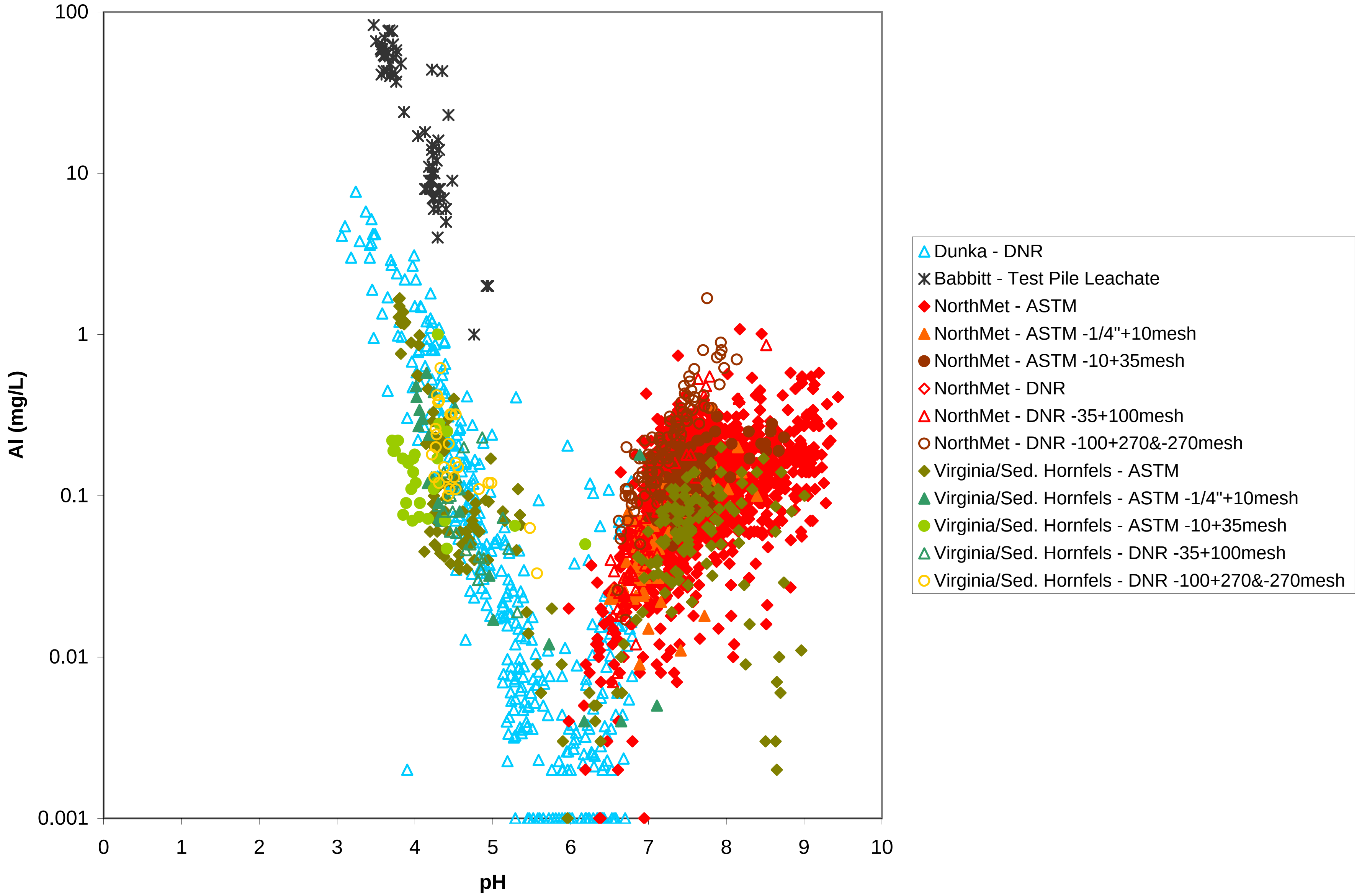
Useful?	Why	Country	Mine	Location (Prov/State)	Commodity	Mine State	Owner	Mine type	Ore Geology/Mineralogy	Waste Rock Mineralogy	Seepage Characteristics
No	Acidic	Sweden	Aitik	Northern Sweden	Cu, Au, Ag	Producing	Boliden	Open pit	Metamorphosed Cu-Au porphyry (low-grade)	Mix of Biotite gneiss, mica schist, skarn-banded gneiss, and low S pegmatite. Sulphides: dominantly Py & ChPy, with lesser amounts Po, Sph, Bor	Typically pH is 3.5-4.0
No	Different geology.	Sweden	Zinkgruvan		Zn, Pb, Ag	Producing	Lundin Mining Corp.	Underground	Tabular deposit bounded at each end by sub-vertical faults. Sheet-like orebodies occur within an area of precambrian intrusive activity.		
No	Different geology.	USA	Red Dog	Alaska	Pb, Zn, Ag	Producing	Northwest Alaska Native Association - leased and operated by Teck Cominco	Open pit	Deposits hosted by black, siliceous shale and chert. The stratabound accumulations consist of silica rock, barite and a main sulphide zone, all of which contain sulphides. Major sulphides are sphalerite, pyrite, marcasite and galena.		
No	Different geology.	USA	Morenci	Arizona	Cu	Producing	Phelps Dodge, Sumitomo Corp.	Open pit and UG	Major porphyry copper orebody. Both sulphide and oxide ores occur, with pyrite and chalcocite being the main sulphide minerals, and chrysocolla and malachite the predominant oxides. Molybdenite, galena and sphalerite are also present.	Waste is mainly used to backfill one of the pits (Morenci pit).	
No	Different geology.	USA	San Manuel	Arizona	Cu				Cu porphyry w/ Po in gangue		
No	Do they have WR piles? What is WR composition?	USA	Stillwater/ East Boulder	Montana	Pt, Pd	Producing	Stillwater Mining Co	Underground	Syngenetic, mafic/ultramafic layered complex containing bands of norite, gabbro, and anorthosite. Associated w/ Po, ChPy, Pt, Co sulphides, and PGE.	Po, ChPy, Pt WR- Waste not used for back-fill is transported to the surface and used in the rock embankment of the tailings dam or placed in the permanent WR disposal sites. Tailings - 55% used for backfill. The rest is placed in impoundment. No treatment of tailings.	No data
No	Different geology.	USA	Carlin Trend Gold	Nevada	Au	Producing	Newmont Gold	Open pit and UG	Carlin type' deposits comprise strata-bound disseminated gold mineralization, occurring in carbonate rocks that have been metamorphosed to varying extents. Mineralization may be predominantly oxides, sulphides, refractory or carbonaceous sulphides		
No	Different geology.	USA	Cortez Gold	Nevada	Au	Producing	Placer Dome, Rio Tinto	Open pit	Carlin-type disseminated gold deposits. The two principal lithological units are a sheared and altered thinly-bedded calcareous siltstone and quaternary alluvium varying from chert, argillite, siltstone, limestone and quartzite to fine sands and silts.		
No	No data.	USA	Nickel Mountain	Oregon	Ni	Closed since 98?	Glenbrook Nickel Co				
No	Not igneous, no seeps	USA	Celatom	Oregon	industrial mineral	Producing		Open pit	Diatomaceous earth deposit with interbedded layers of sulphides		neutral
Not likely	Different Geology	USA	Bingham Canyon	Utah	Cu, Mo, Au, Ag	Producing	Rio Tinto; operated by Kennecott Utah Copper Corp.	Open pit;	Major porphyry copper orebody w/ a fairly uniform distribution of sulphide mineralisation, mainly ChPy.		
Maybe		Zimbabwe	Ngezi Platimun	Harare	PGM, Ni, Cu, Co	Producing	Zimbabwe Platinum Mines (Zimplats) and Impala Platinum	Open pit and UG	Platinum-bearing deposits hosted in Zimbabwe's 'Great Dyke'. The Great Dyke is a 450km-long mafic and ultramafic intrusive structure that runs through central Zimbabwe, with a maximum width of just 11km. The sulphide ore is oxidised at the outcrop, but remains unweathered at depths of 20m or more.		
No	Acidic	Zimbabwe	Iron Duke	Mazowe					Greenstone Belts of Zimbabwe		pH at least 0.52 from waste rock pile

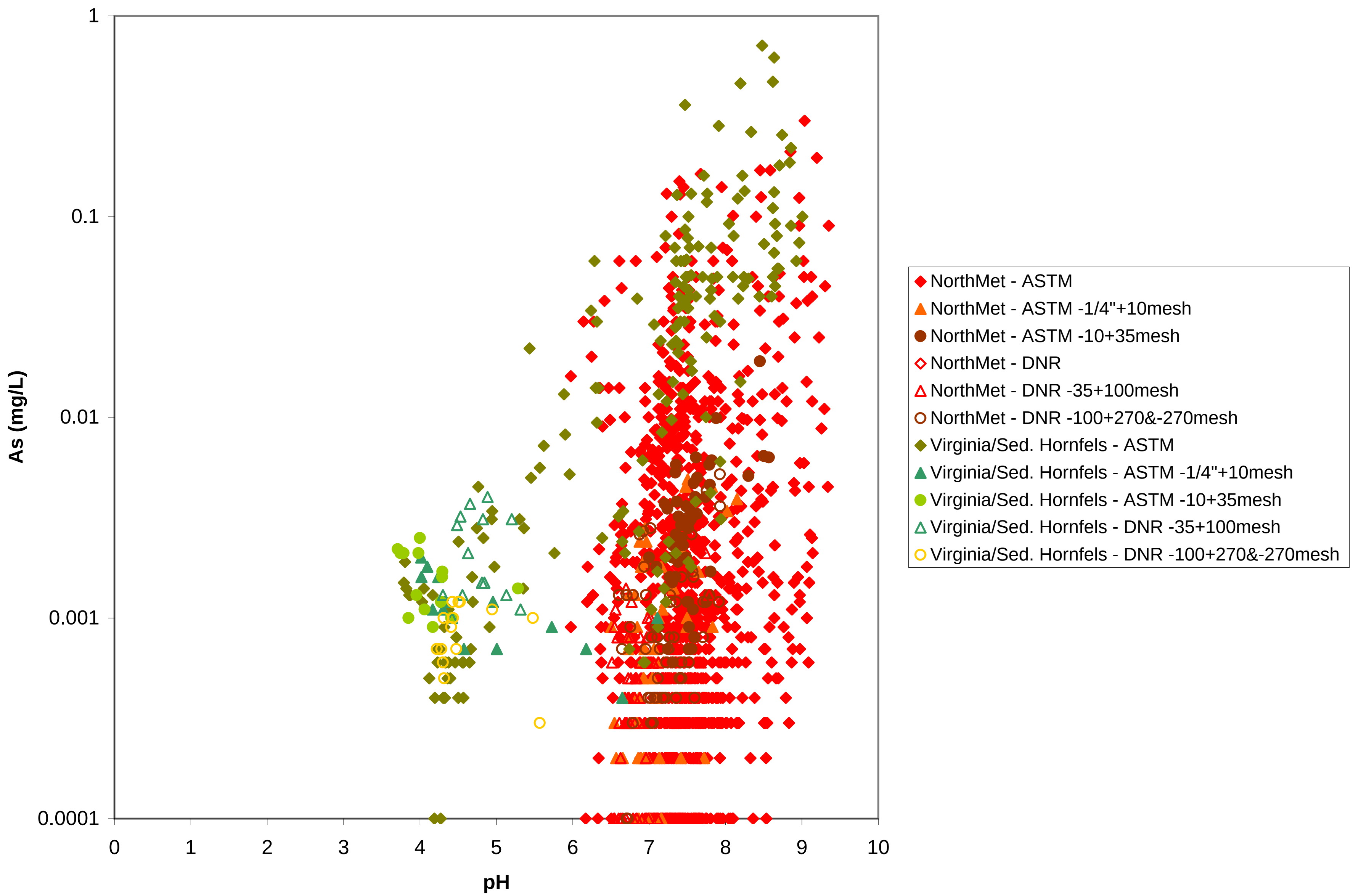
Appendix H.2

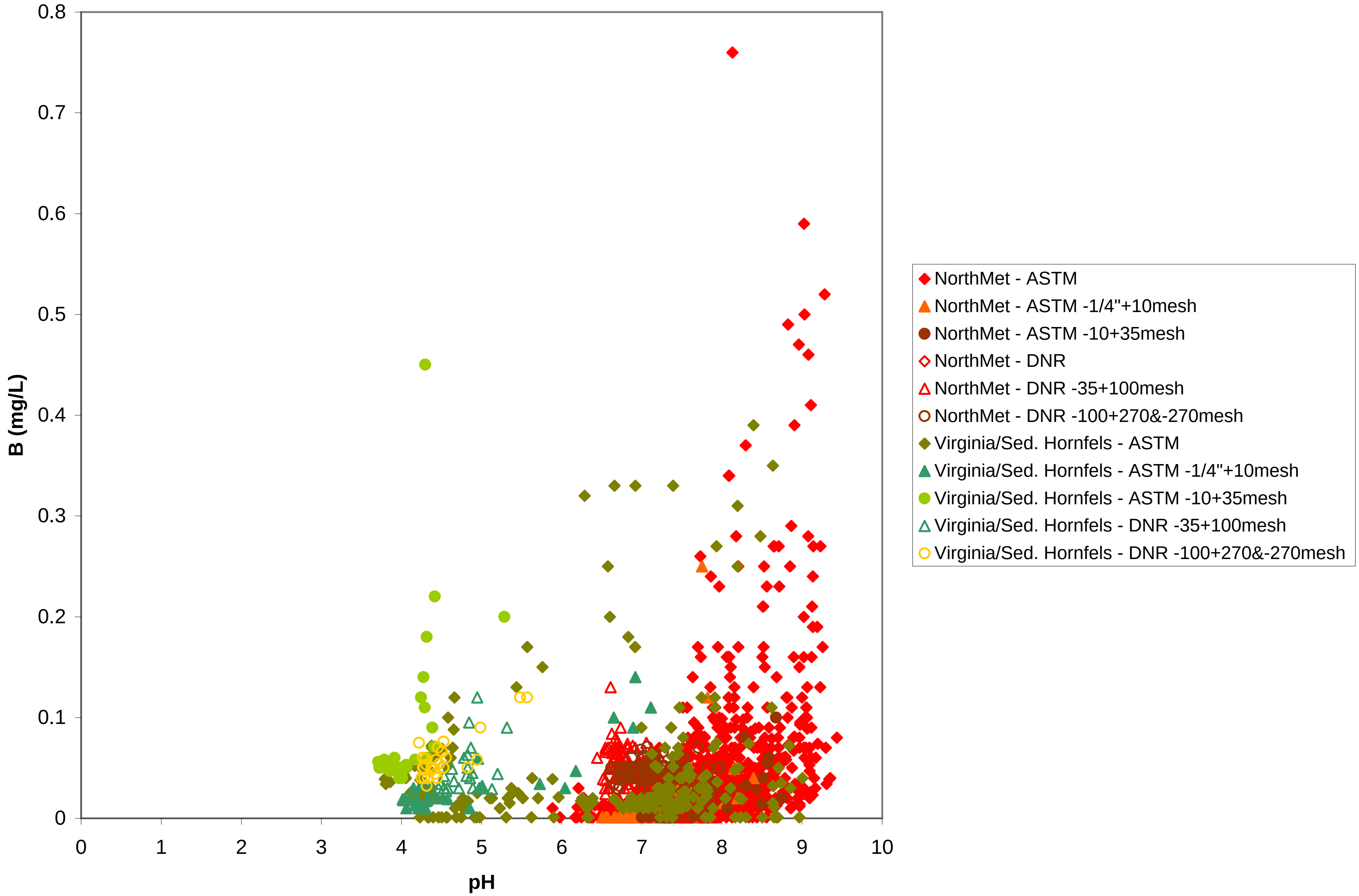
Charts Showing Metal Concentrations compared to pH

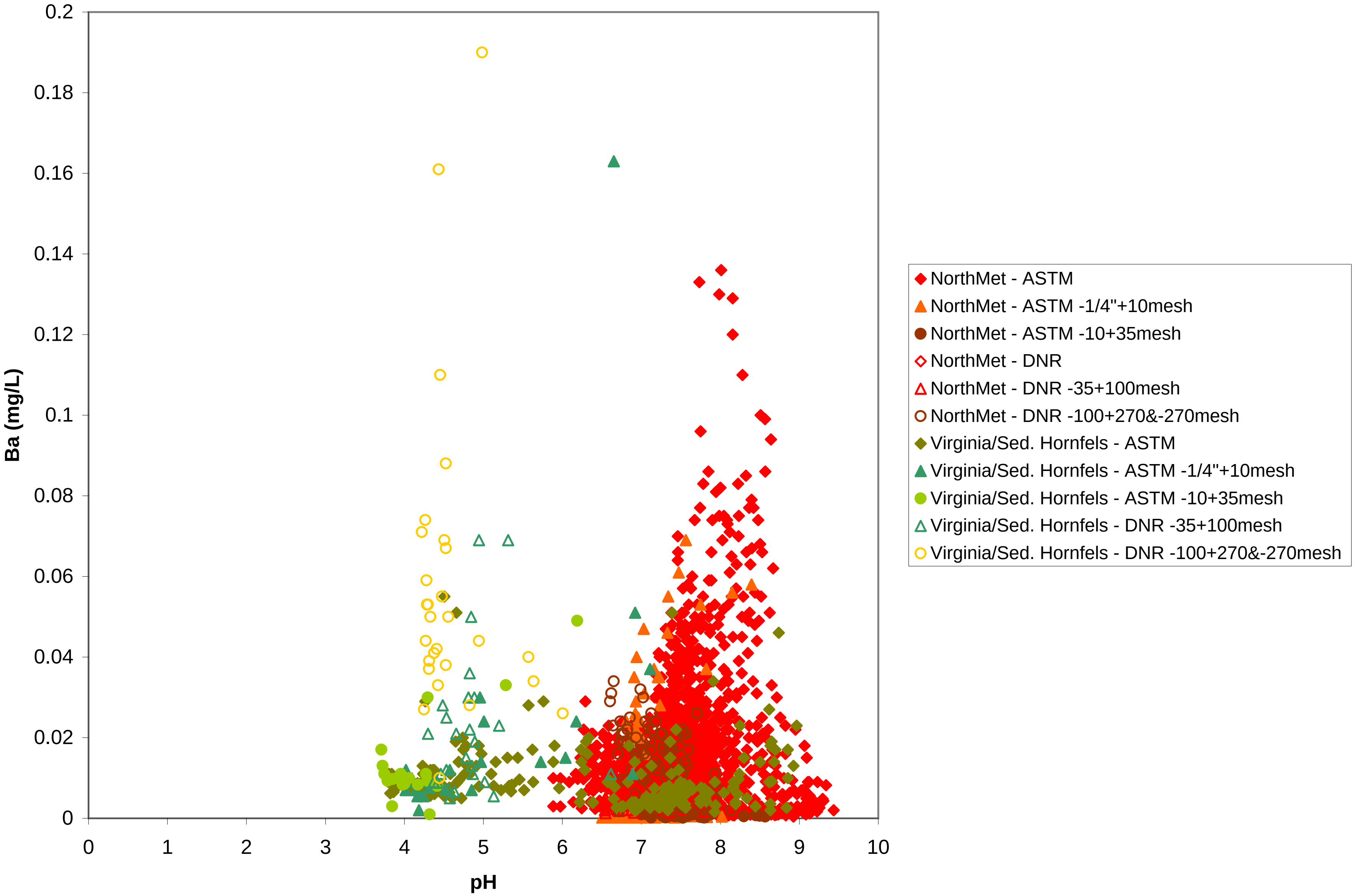

1000
100
10
1
0.1
Alkalinity (mg/L)
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

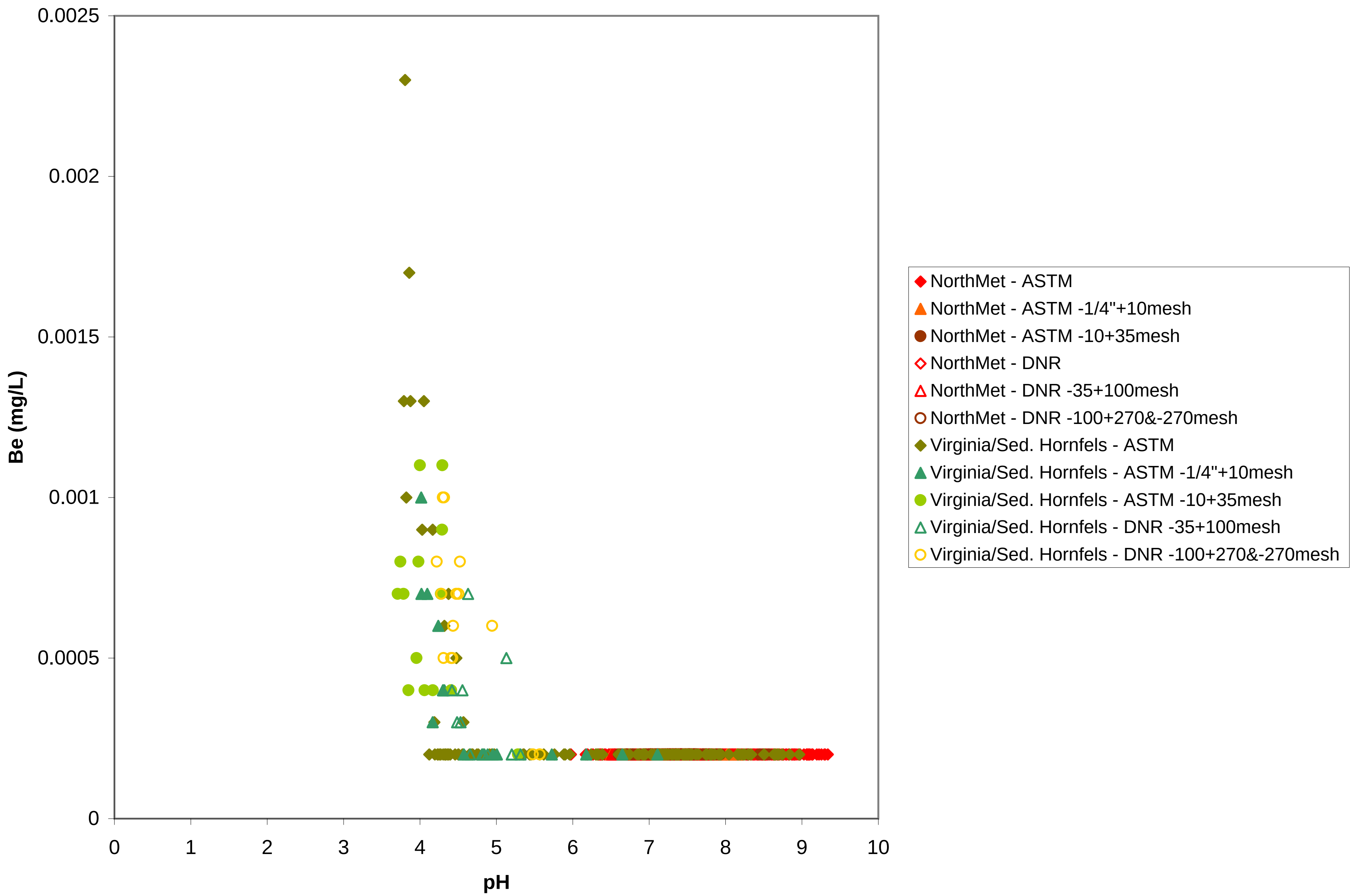

0.001
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0
Ag (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

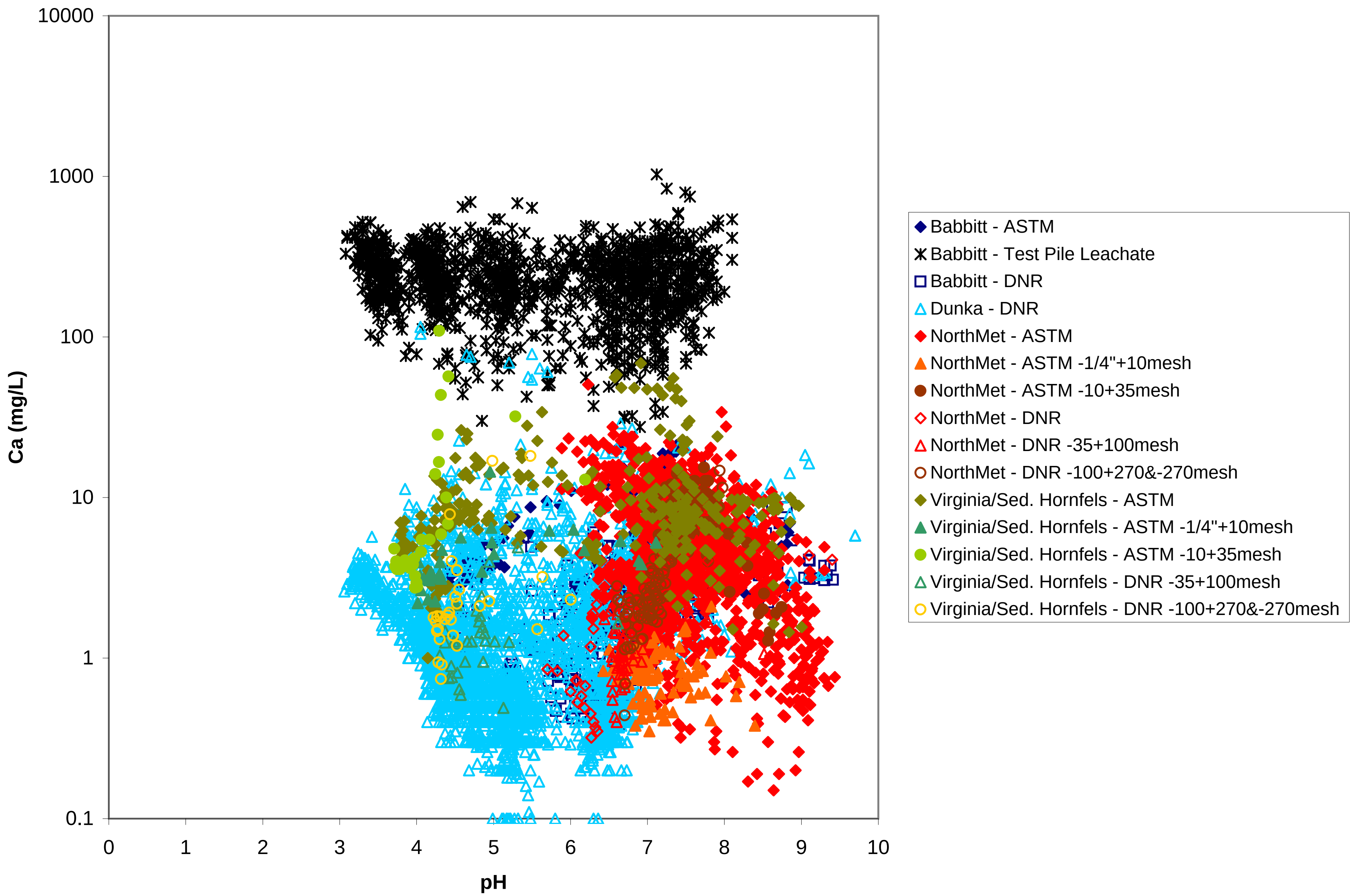

100
10
1
0.1
0.01
0.001
Al (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Dunka - DNR
Babbitt - Test Pile Leachate
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

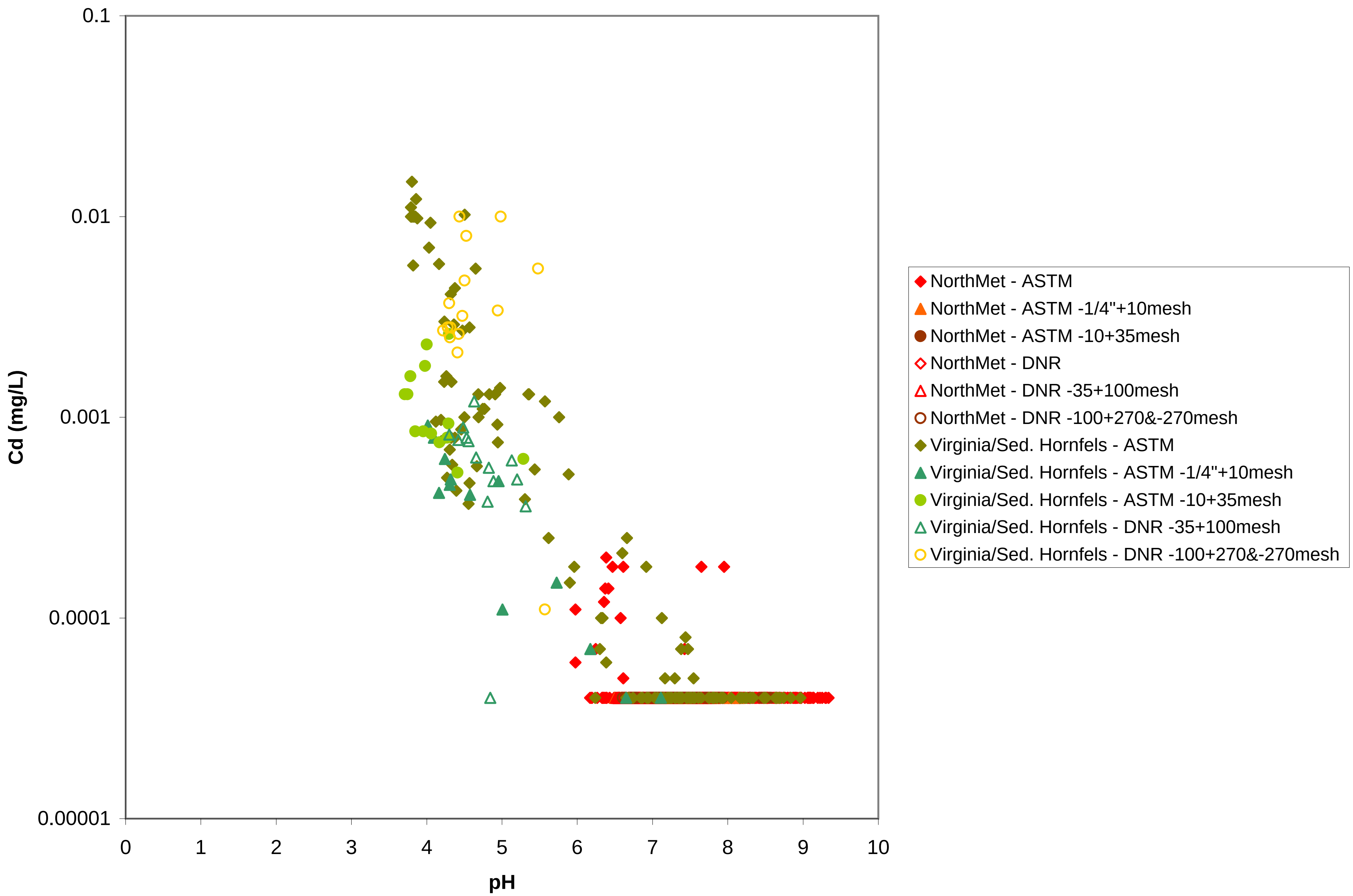

1
0.1
0.01
0.001
0.0001
As (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

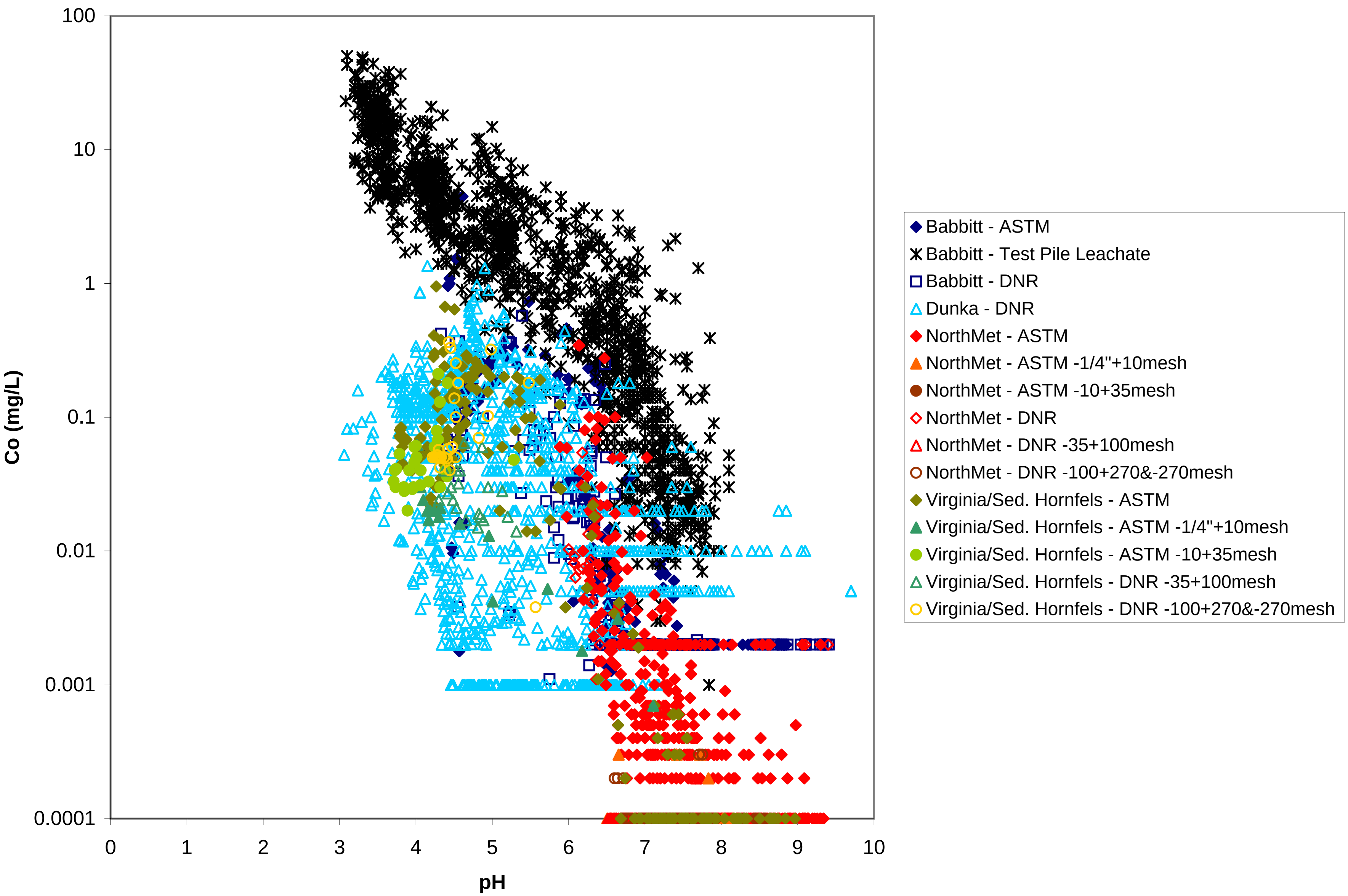

0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
B (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

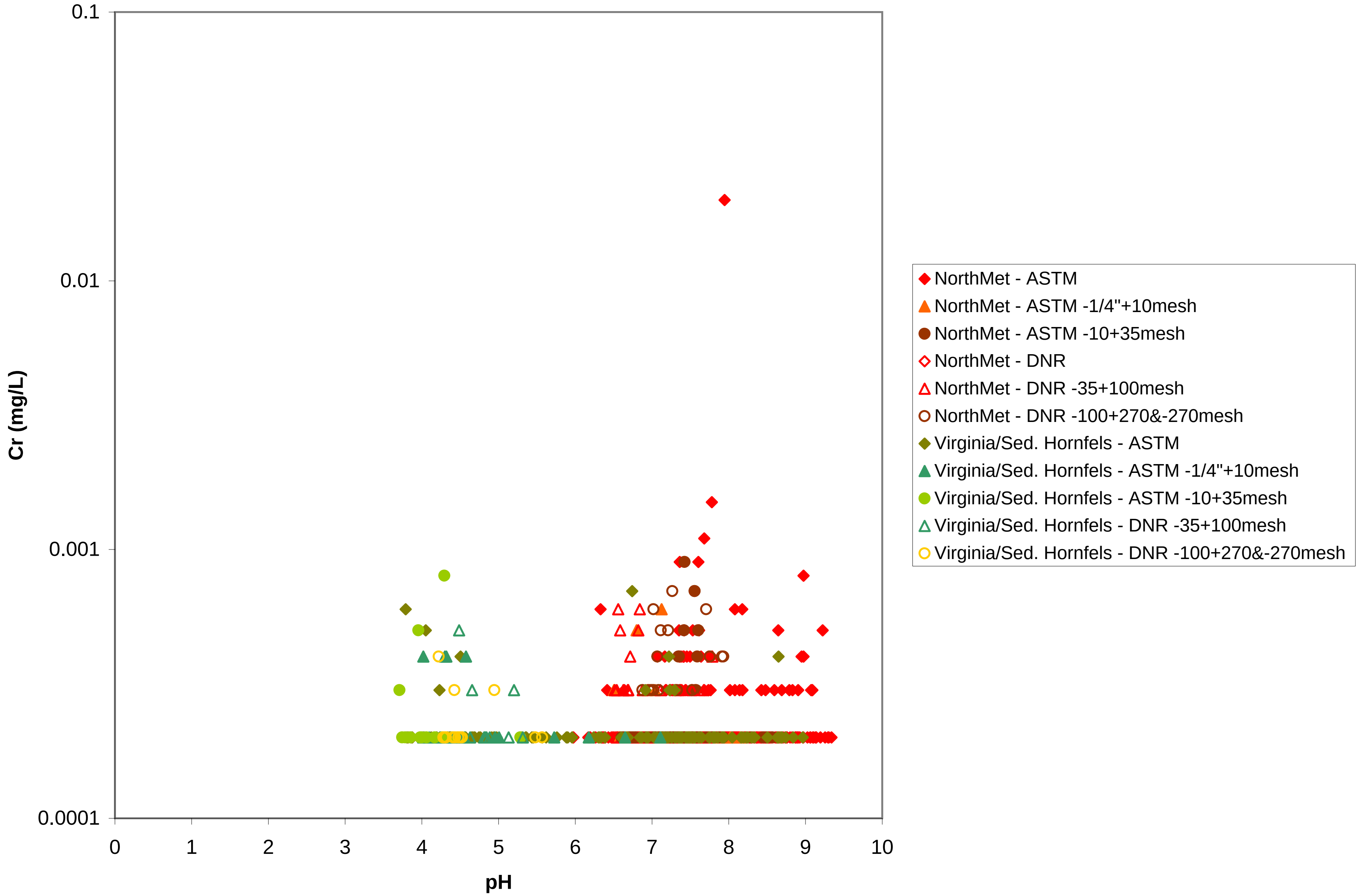

0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Ba (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

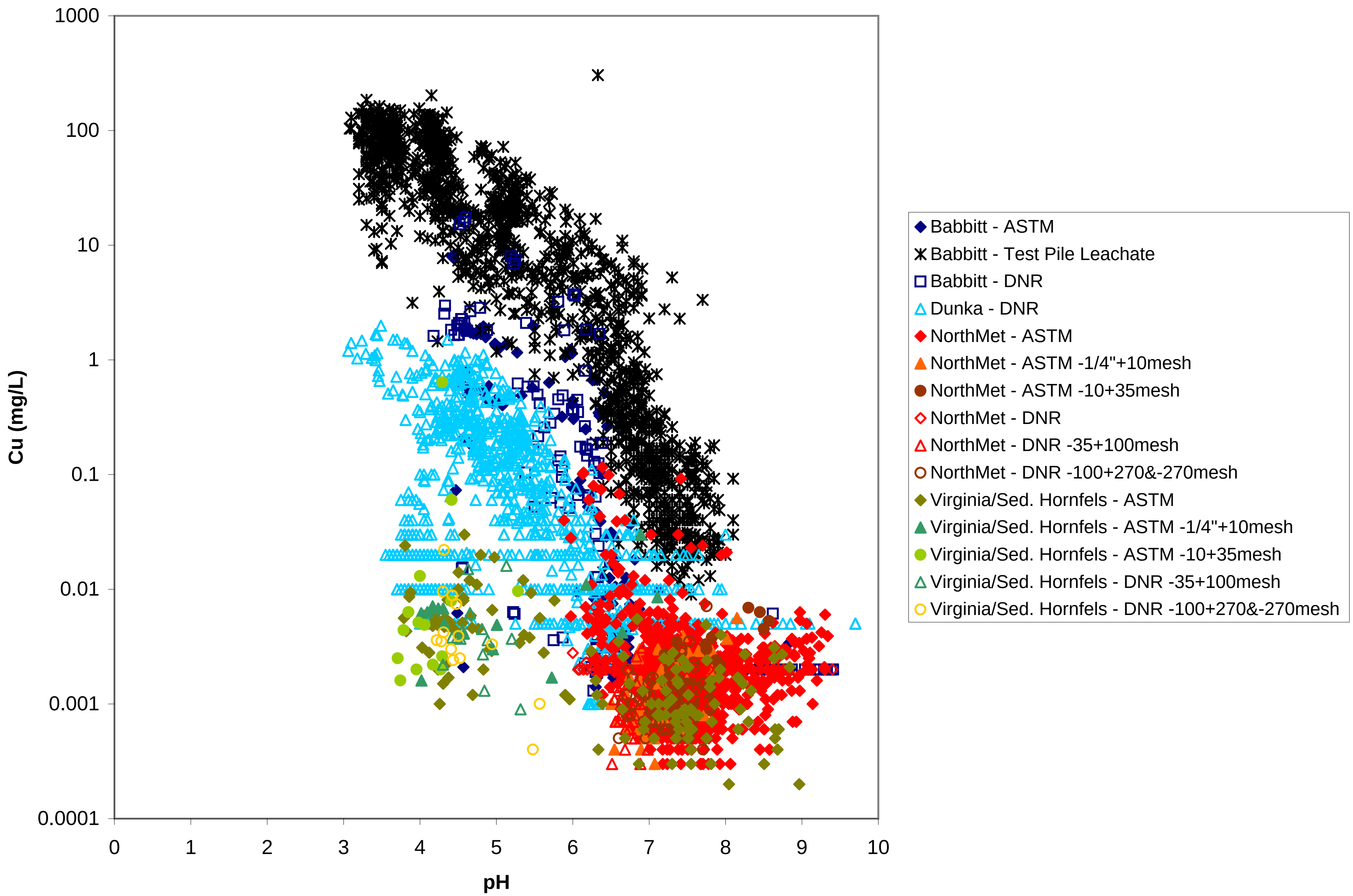

0.0025
0.002
0.0015
0.001
0.0005
0
Be (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

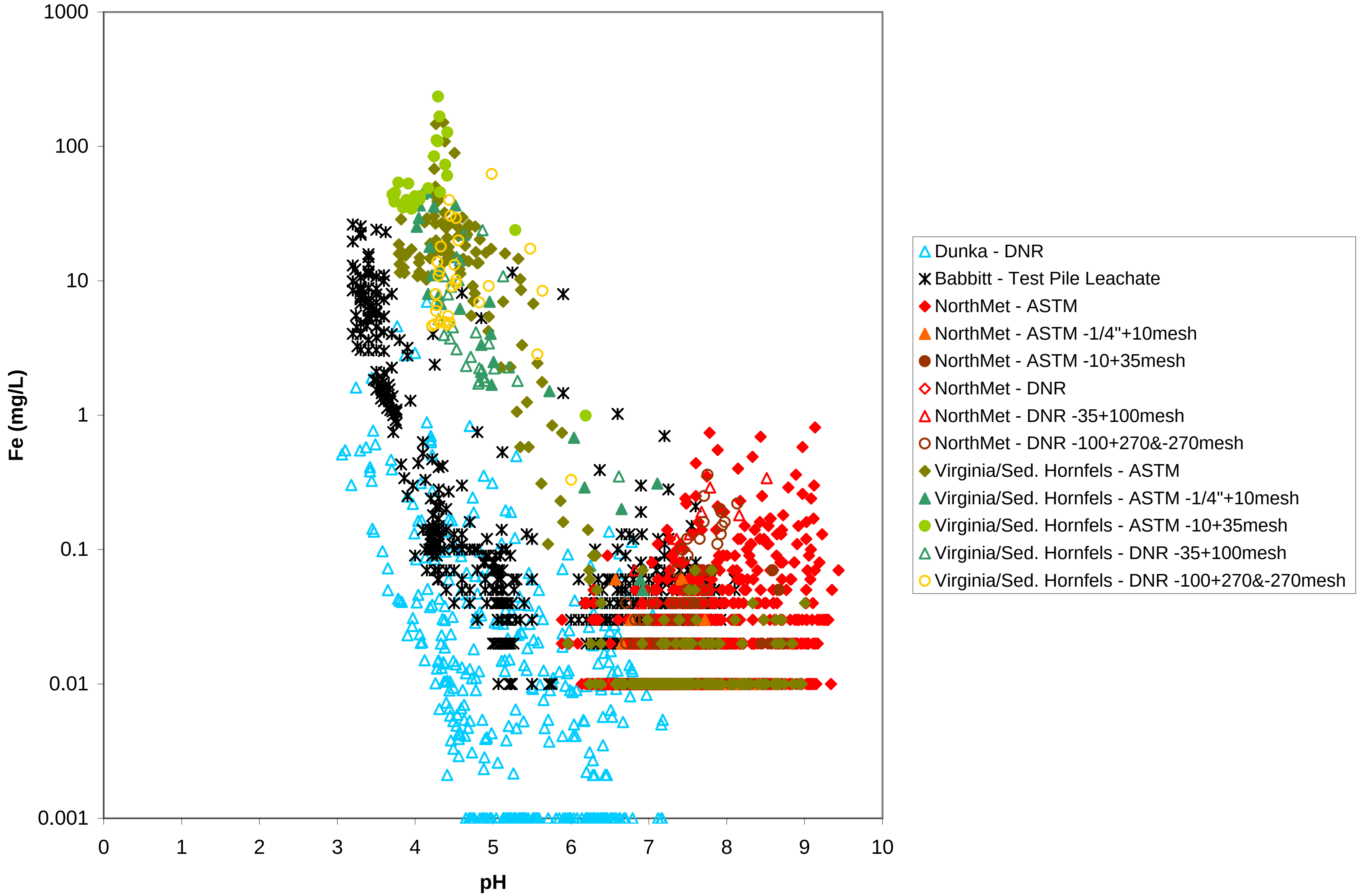

Ca (mg/L)
10000
1000
100
10
1
0.1
0
1
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

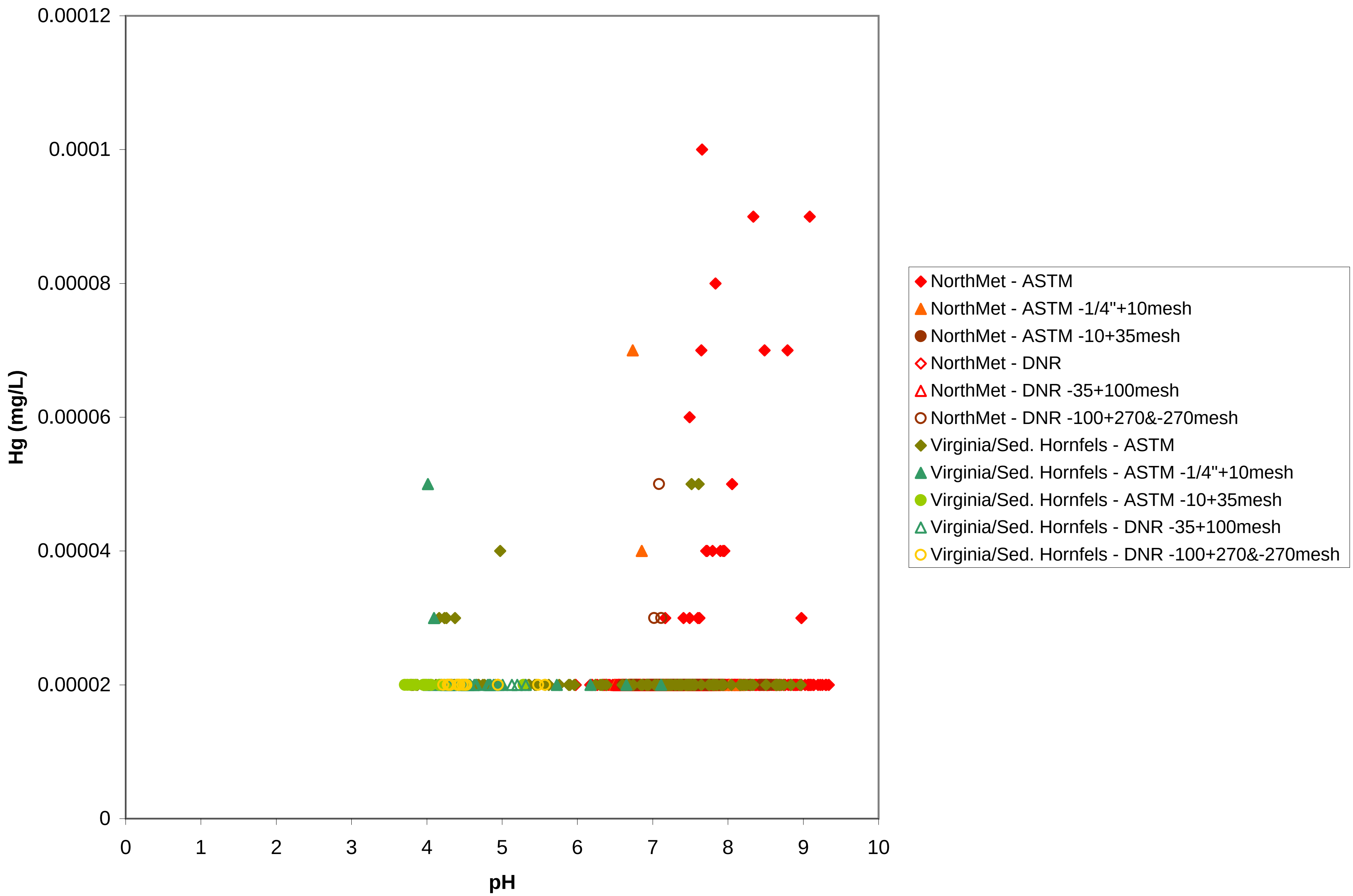

0.1
0.01
0.001
0.0001
0.00001
Cd (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

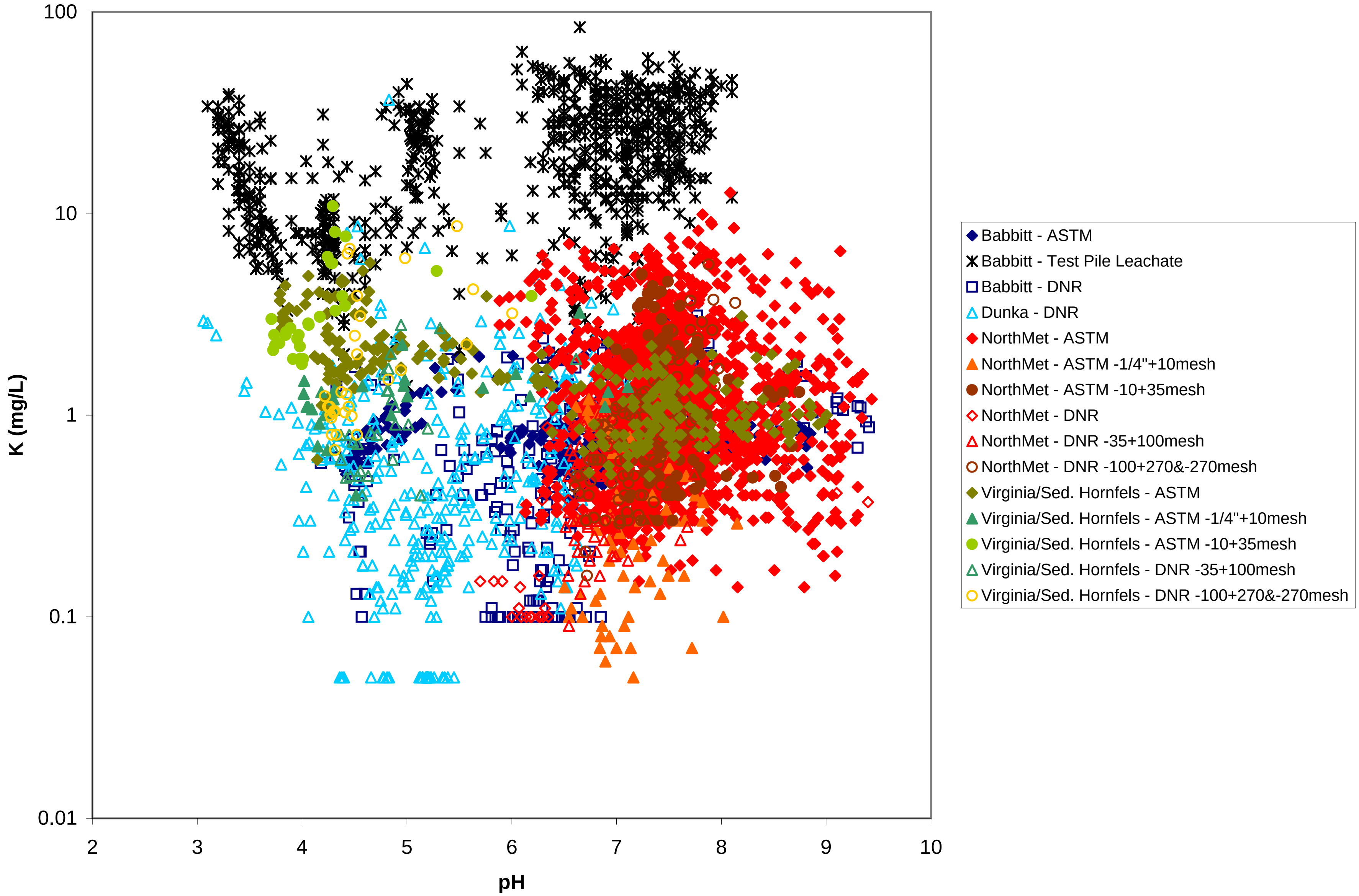

100
10
1
0.1
0.01
0.001
0.0001
Co (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

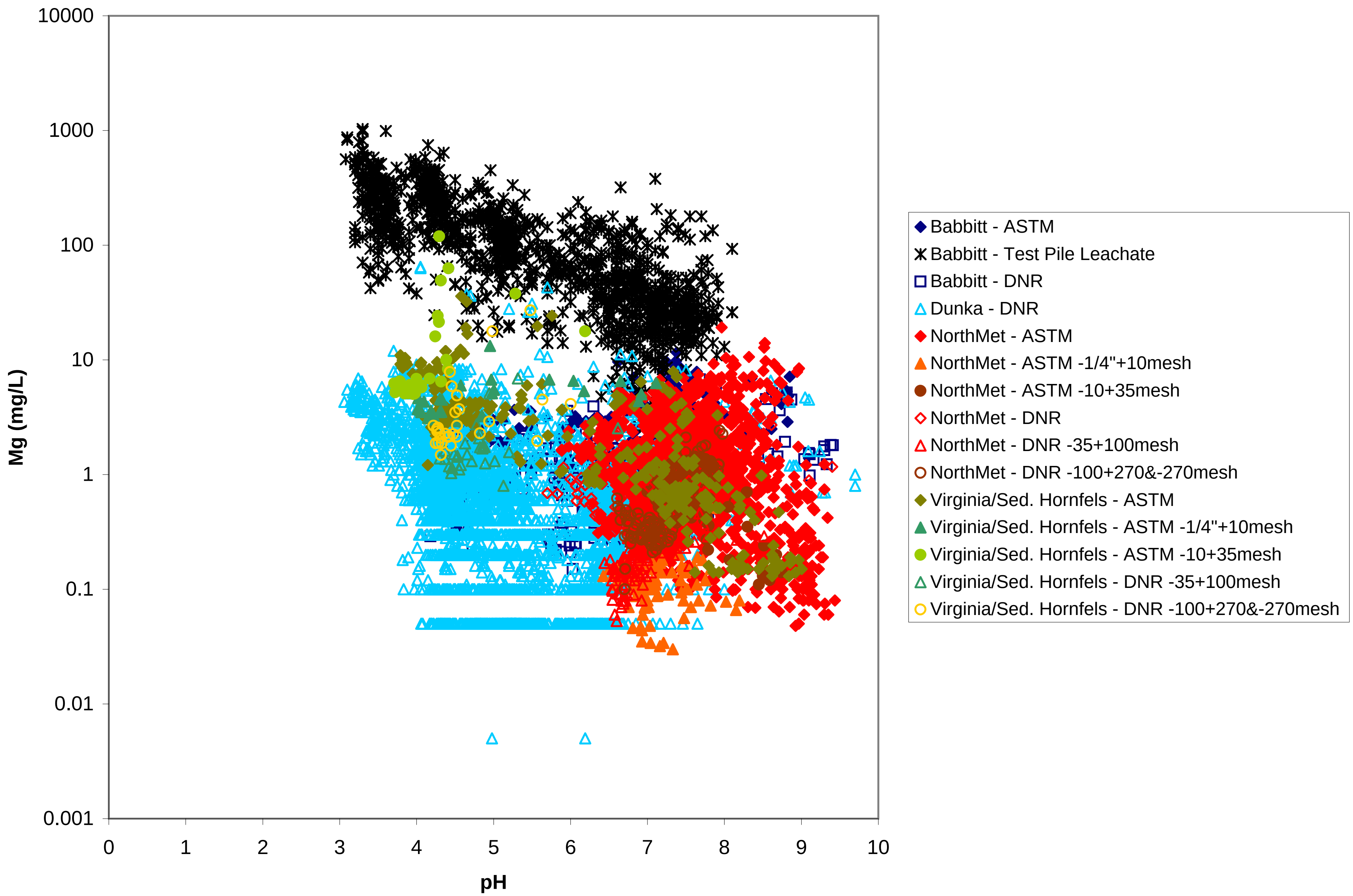

0.1
0.01
0.001
0.0001
Cr (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

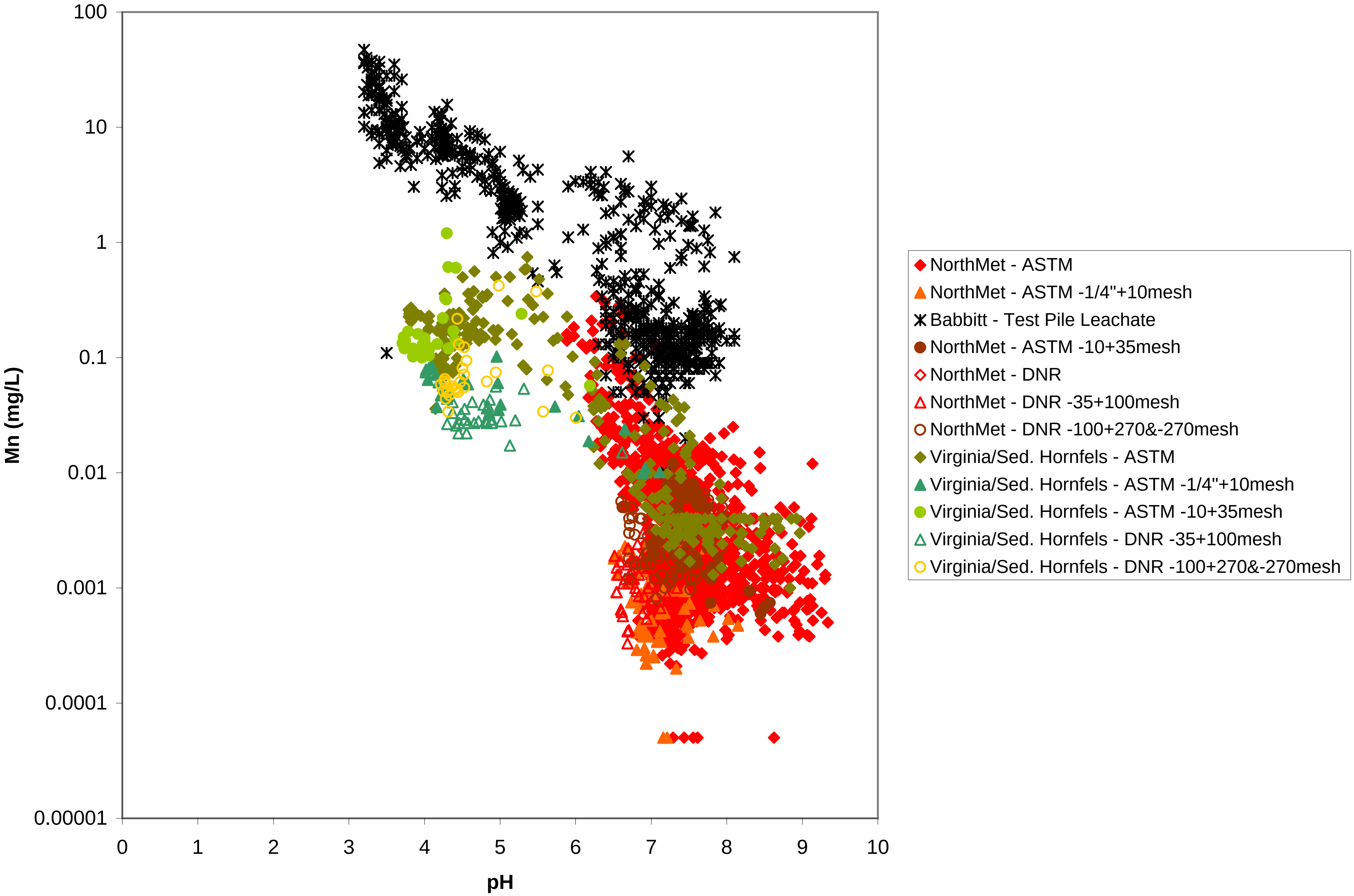

1000
100
10
1
0.1
0.01
0.001
0.0001
Cu (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

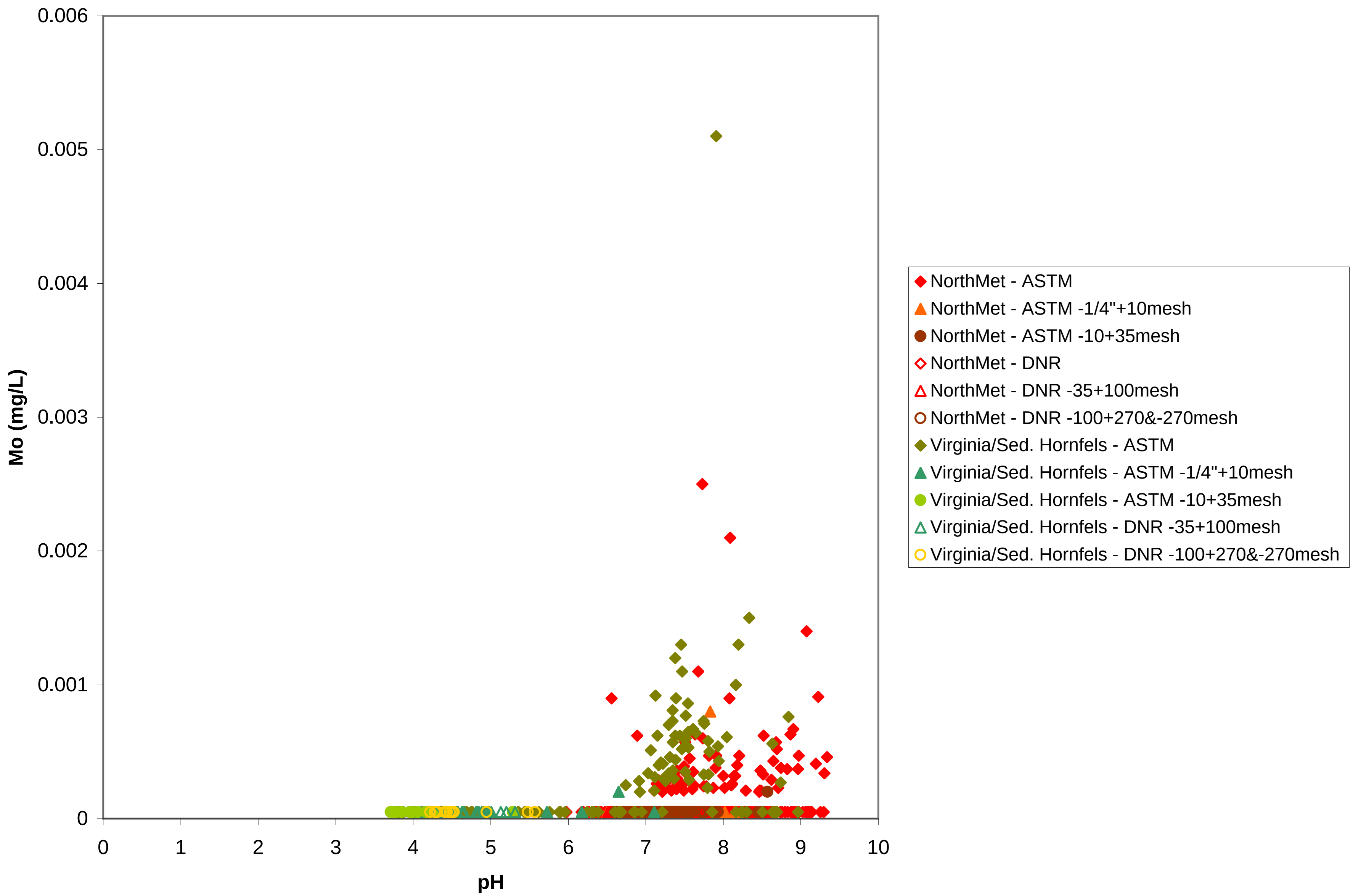

1000
100
10
1
0.1
0.01
0.001
Fe (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Dunka - DNR
Babbitt - Test Pile Leachate
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


0.00012
0.0001
0.00008
0.00006
0.00004
0.00002
0
Hg (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


100
10
1
0.1
0.01
K (mg/L)
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


10000
1000
100
10
1
0.1
0.01
0.001
Mg (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


100
10
1
0.1
0.01
0.001
0.0001
0.00001
Mn (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
Babbitt - Test Pile Leachate
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


0.006
0.005
0.004
0.003
0.002
0.001
0
Mo (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

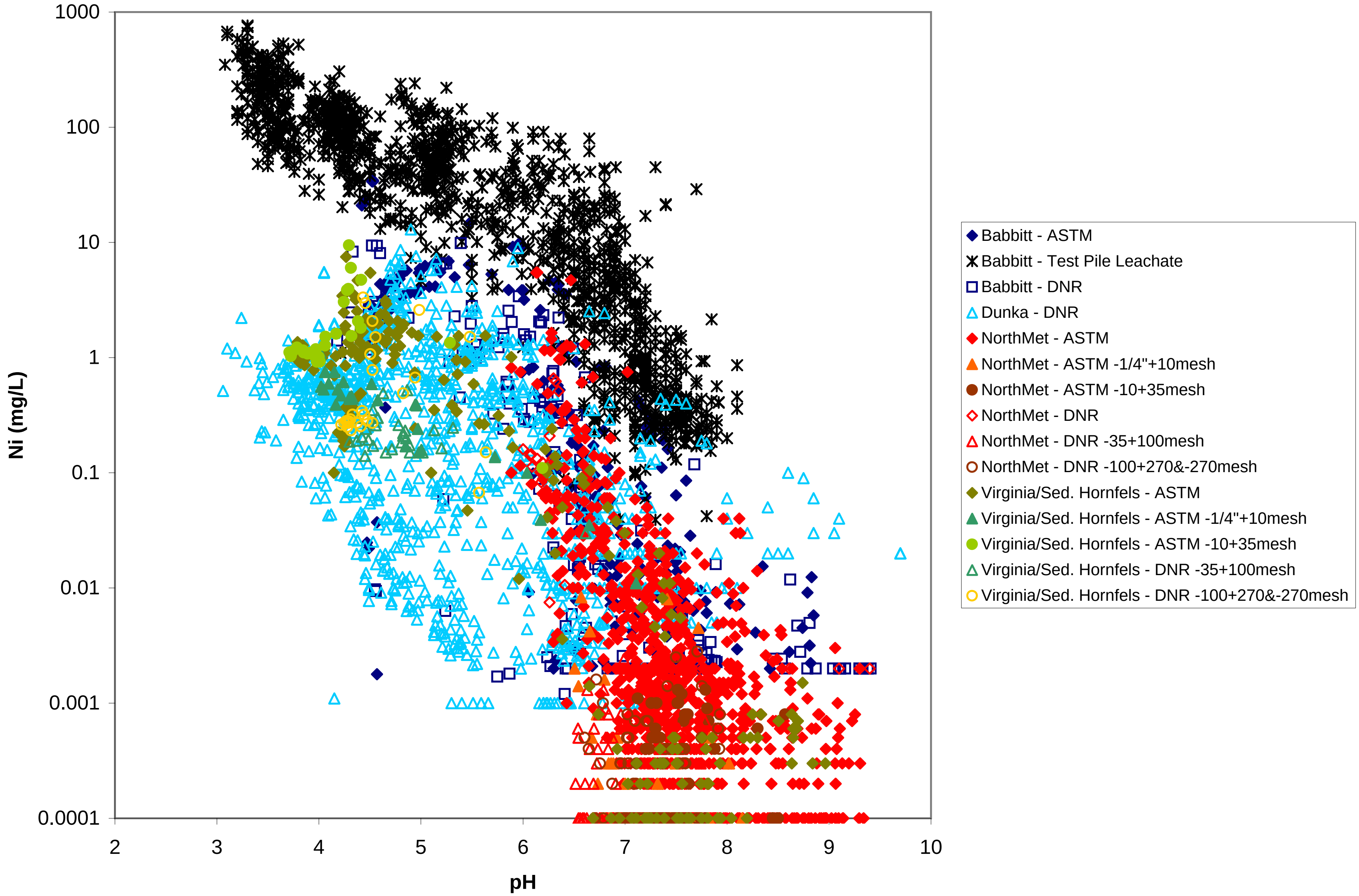
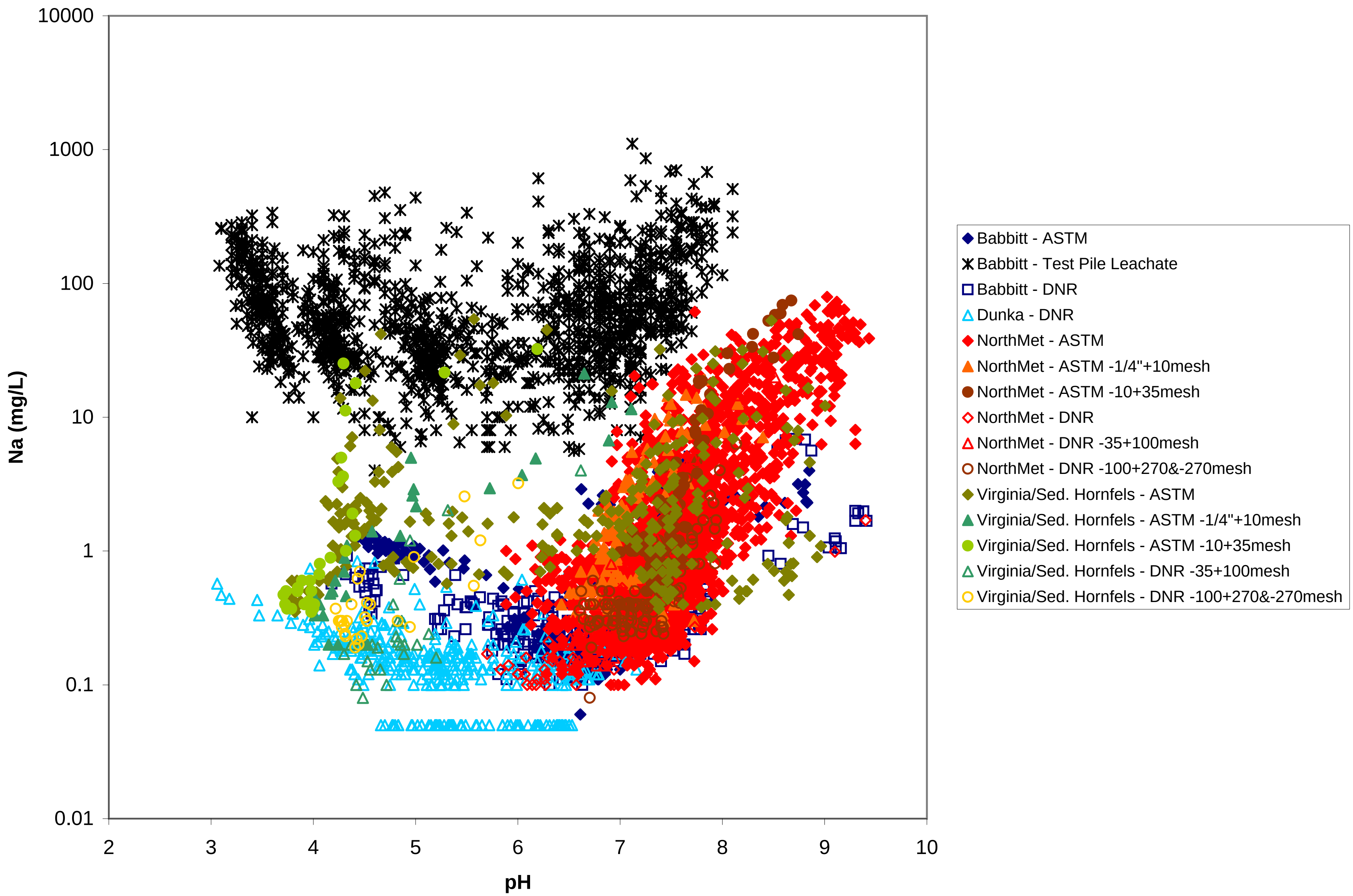

1000
100
10
1
0.1
0.01
0.001
0.0001
Ni (mg/L)
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

Chart H.2.20


10000
1000
100
10
1
0.1
0.01
Na (mg/L)
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

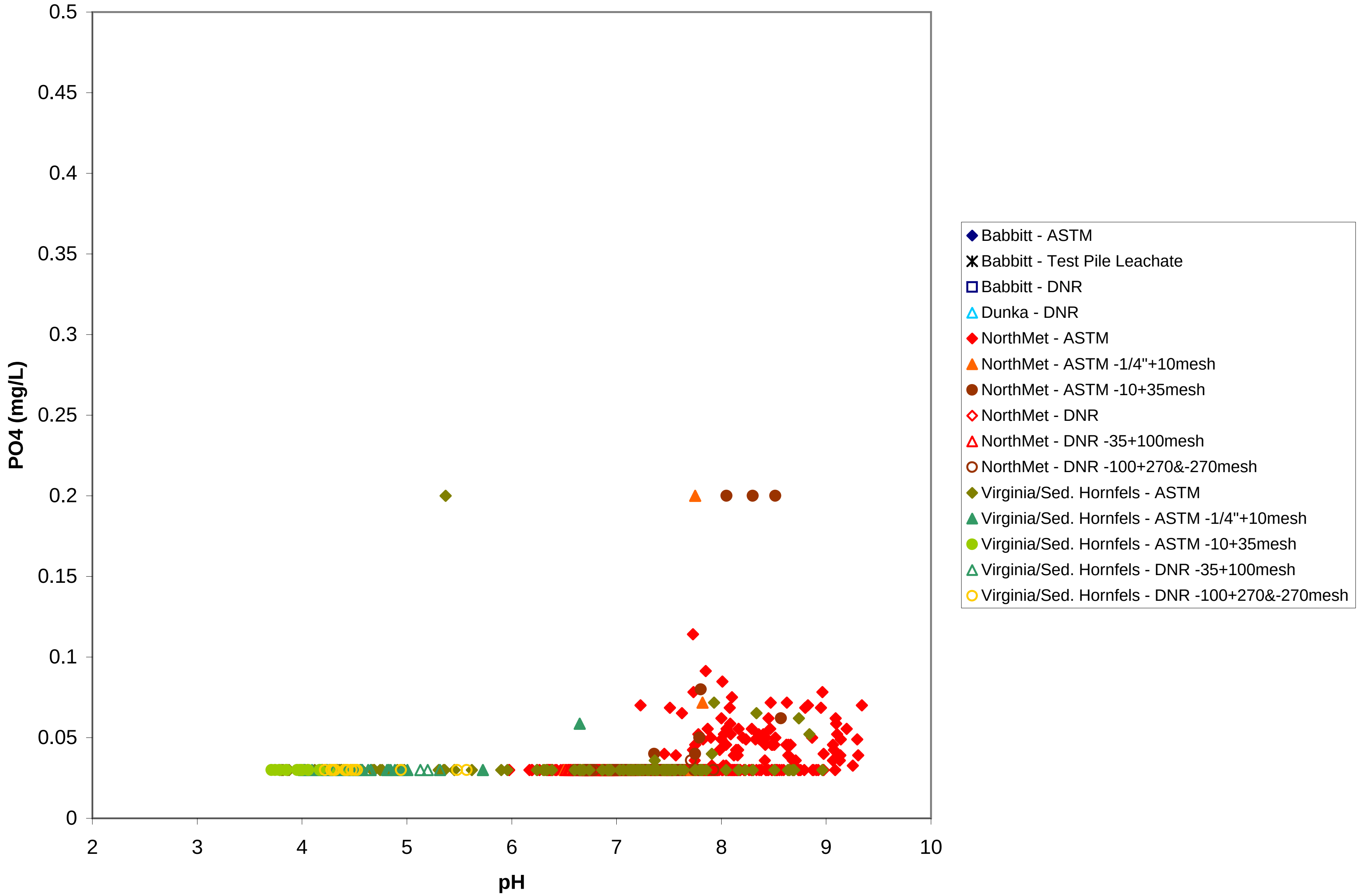
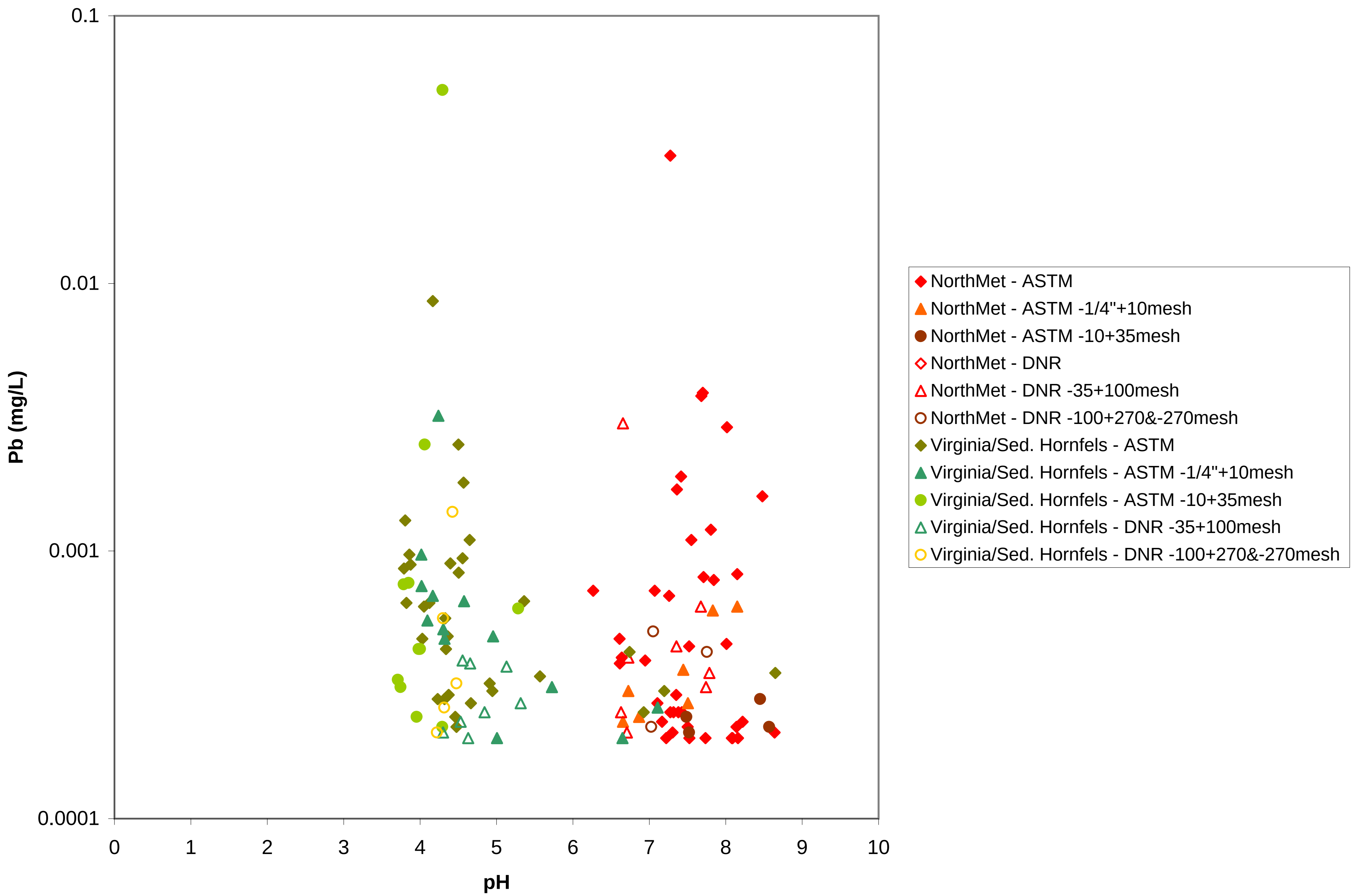
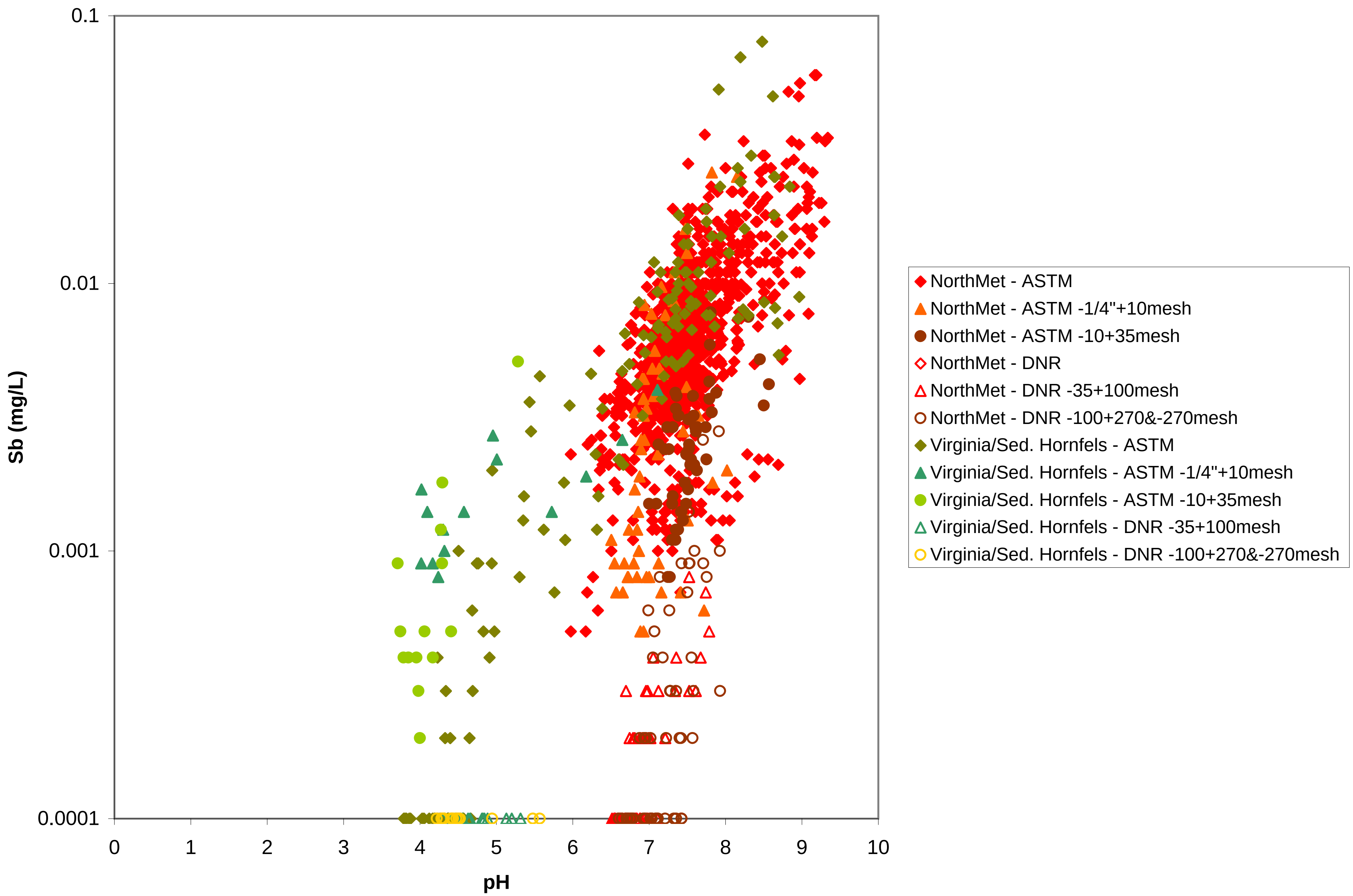
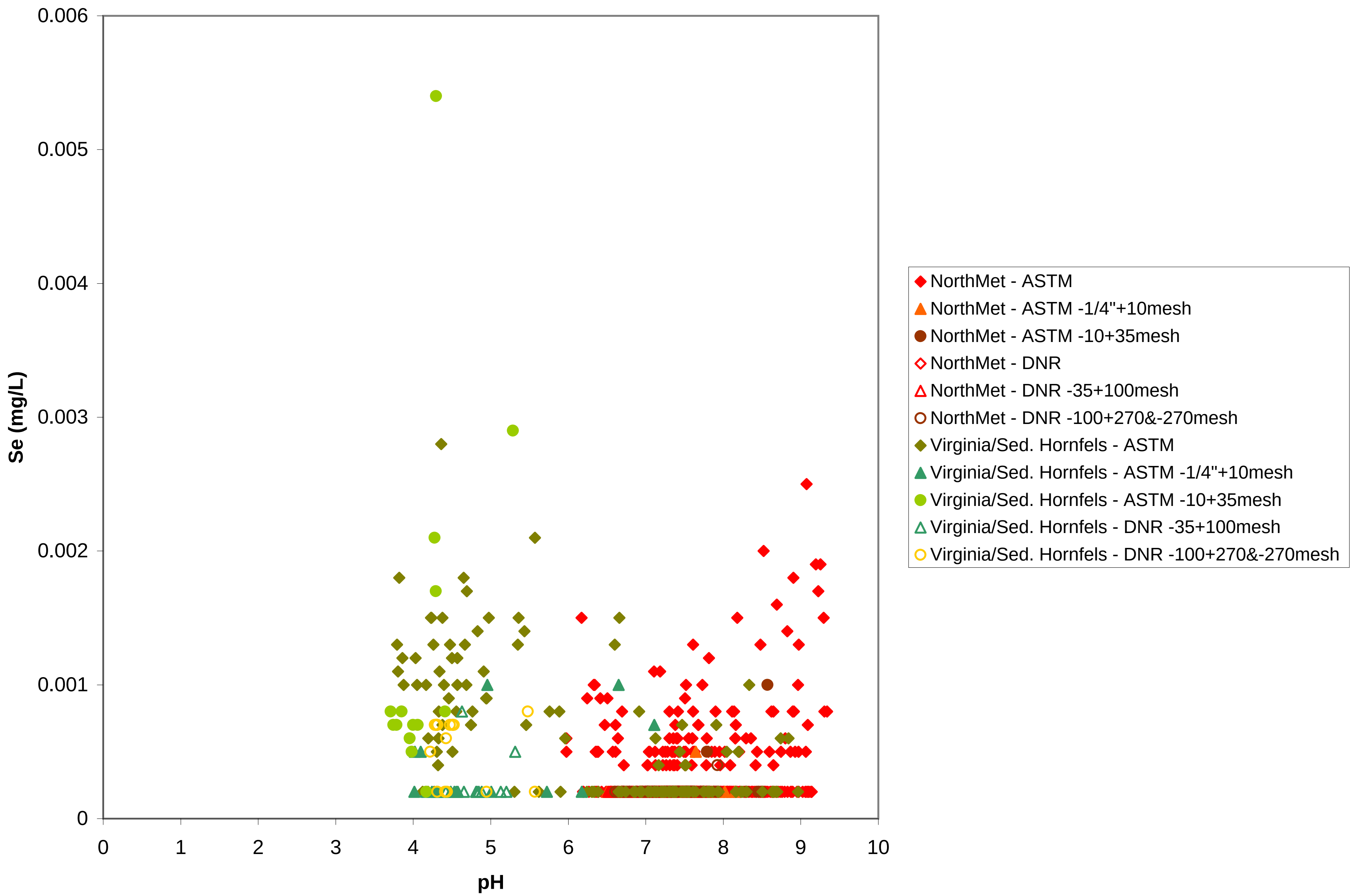

PO4 (mg/L)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

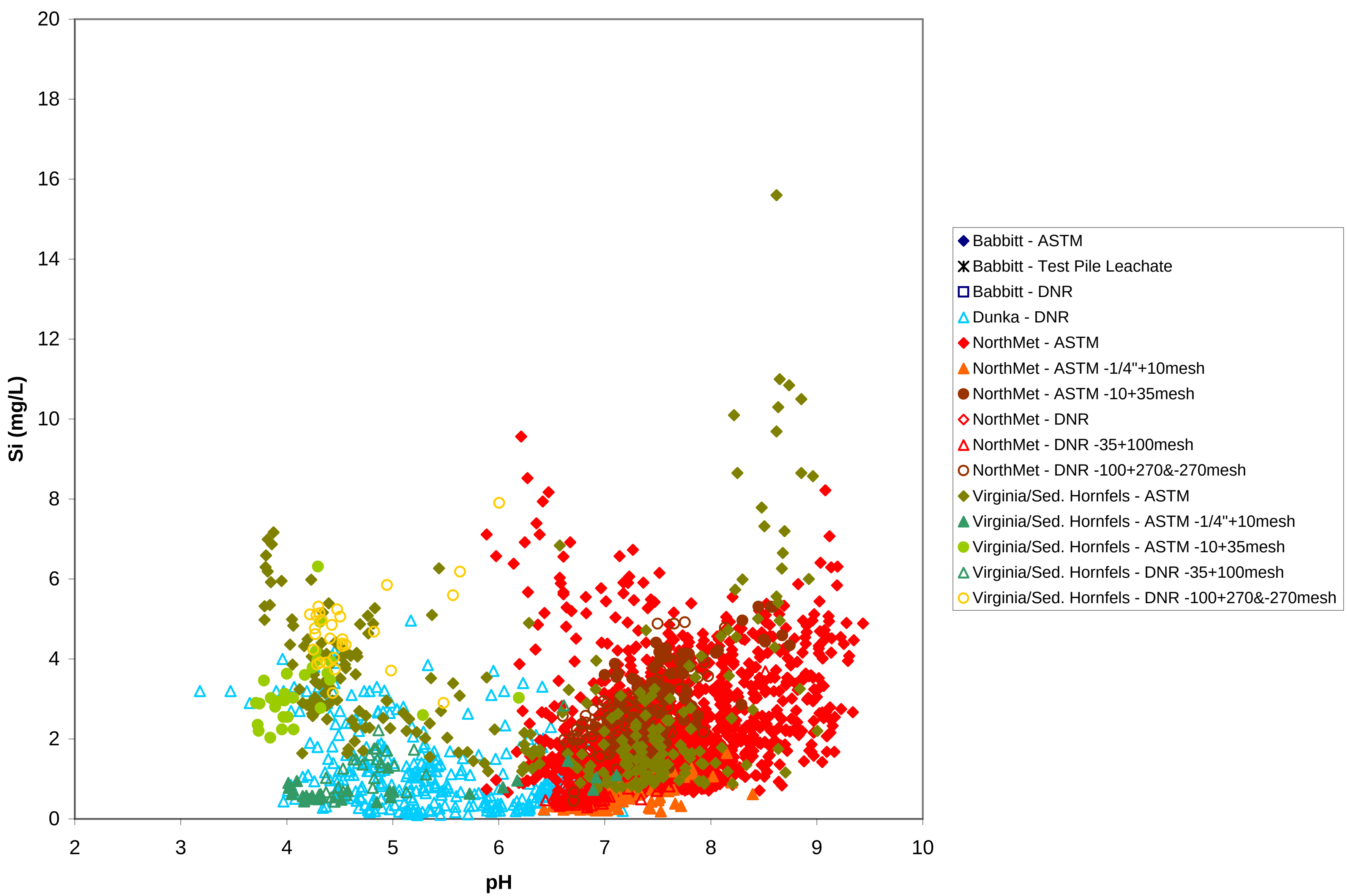
Chart H.2.22

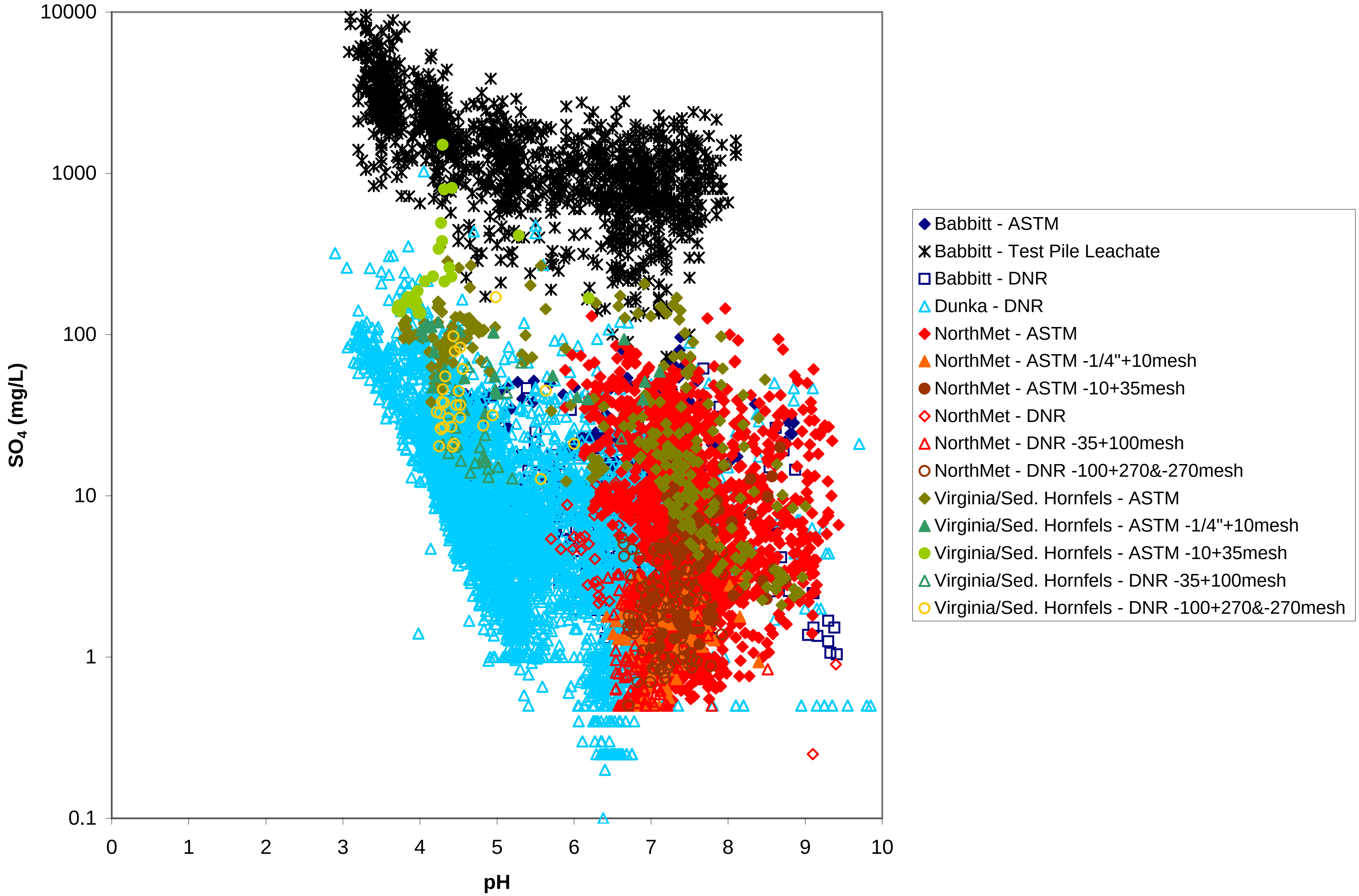

0.1
0.01
0.001
0.0001
Pb (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

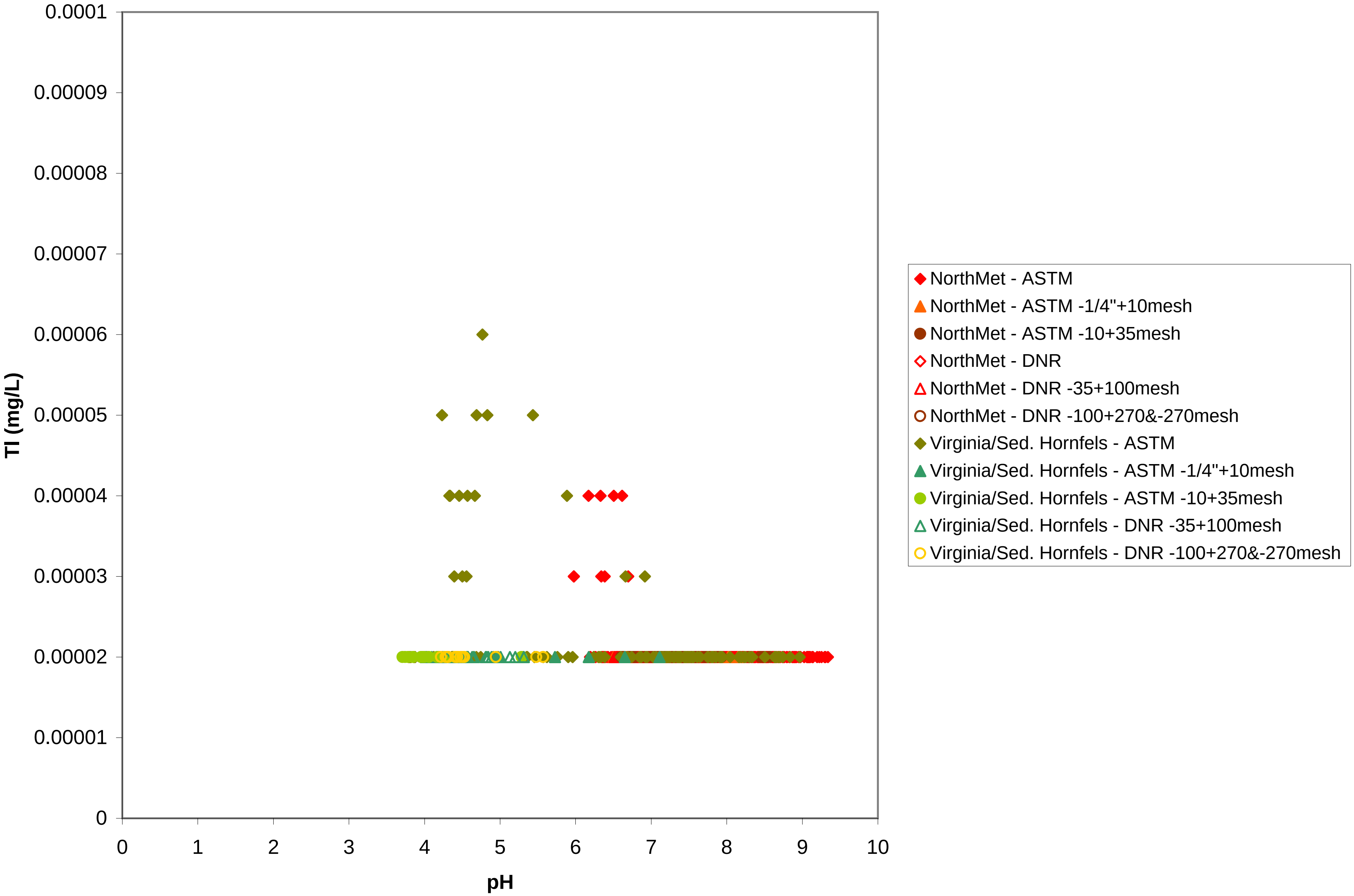

0.1
0.01
0.001
0.0001
Sb (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

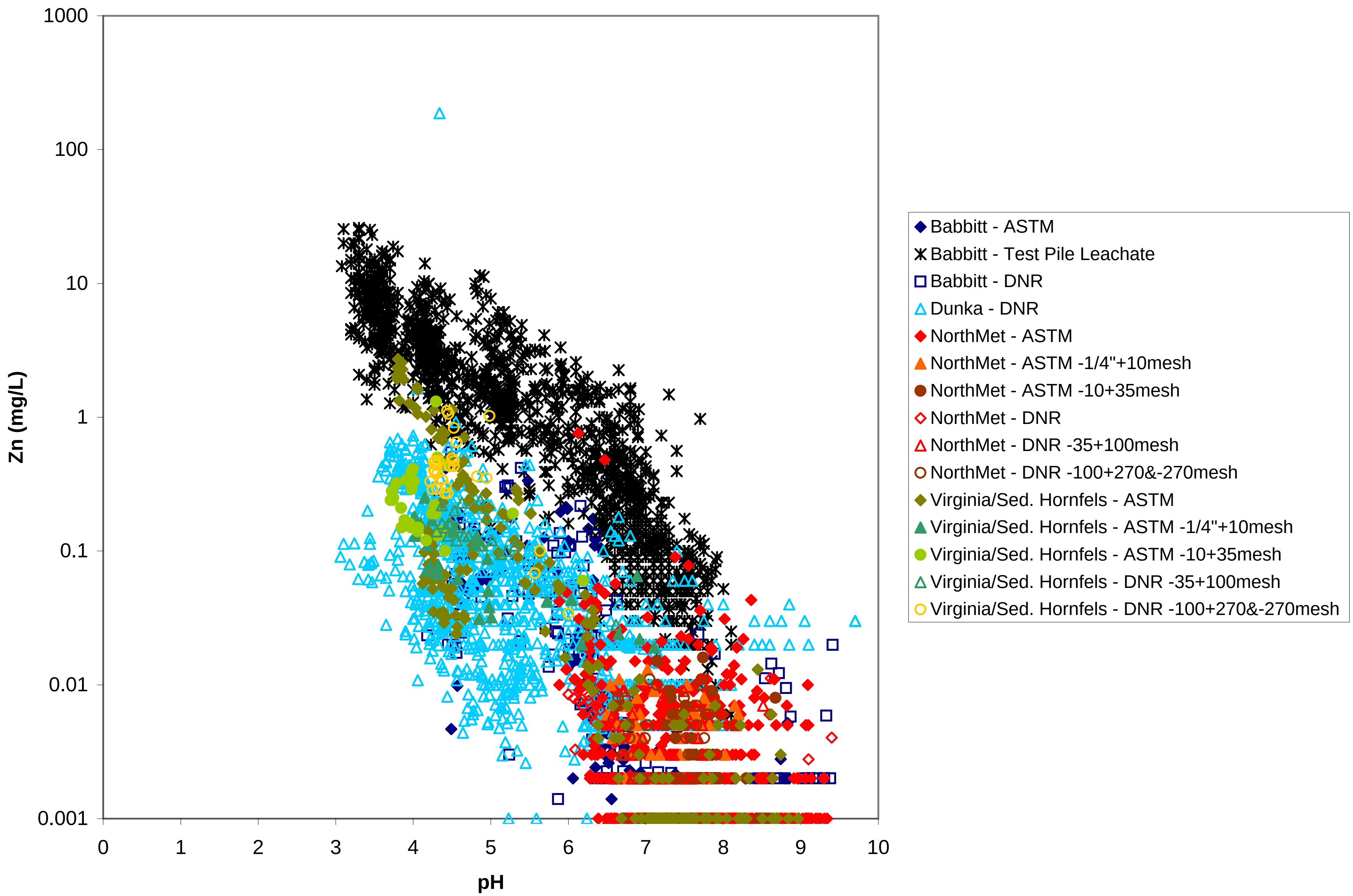


0.006
0.005
0.004
0.003
0.002
0.001
0
Se (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


20
18
16
14
12
10
8
6
4
2
0
Si (mg/L)
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


10000
1000
100
10
1
0.1
SO4 (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


0.0001
0.00009
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
0
Tl (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh


1000
100
10
1
0.1
0.01
0.001
Zn (mg/L)
0
1
2
3
4
5
6
7
8
9
10
pH
Babbitt - ASTM
Babbitt - Test Pile Leachate
Babbitt - DNR
Dunka - DNR
NorthMet - ASTM
NorthMet - ASTM -1/4"+10mesh
NorthMet - ASTM -10+35mesh
NorthMet - DNR
NorthMet - DNR -35+100mesh
NorthMet - DNR -100+270&-270mesh
Virginia/Sed. Hornfels - ASTM
Virginia/Sed. Hornfels - ASTM -1/4"+10mesh
Virginia/Sed. Hornfels - ASTM -10+35mesh
Virginia/Sed. Hornfels - DNR -35+100mesh
Virginia/Sed. Hornfels - DNR -100+270&-270mesh

Appendix I

Modelling Results

SRK Consulting
Project Name NorthMet
Project Number 1UP005.001
Author SD
Date 3/6/2007 16:50

Summary of Waste Rock Stockpile Leachate Chemistry Predictions
All concentrations are dissolved
All concentrations are average annual

Stockpile	Year	Flow Scenario	Flow	Acidic	Acidity (pH=8.3)	Alkalinity	Hardness	F	Cl	SO4	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	PO4	K	Se	SiO2	Ag	Na	Tl	Zn	NO3	NH4
			m3/year		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg-N/L	mg-N/L
2	1	low	170705	FALSE	8.00E-02	6.68E-01	4.79E-01	4.03E-03	5.79E-02	3.49E-01	1.32E-02	6.72E-04	1.33E-03	1.50E-05	5.88E-04	3.00E-06	1.49E-01	1.64E-05	7.99E-06	1.29E-04	2.29E-03	9.47E-06	2.62E-02	1.46E-04	4.12E-06	3.70E-05	2.96E-03	1.08E-01	1.61E-05	1.56E-01	3.80E-06	2.25E-01	1.51E-06	2.00E-04	7.51E-04	7.51E-04
2	2	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	3	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	4	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	5	low	198148	FALSE	1.18E+01	7.25E+01	1.16E+03	9.73E+00	4.01E+01	8.45E+02	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	3.59E+02	1.50E-03	1.93E-02	9.20E-02	8.10E-01	2.29E-02	6.34E+01	3.52E-01	5.10E-03	8.93E-02	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	5.43E+02	2.00E-05	9.00E-02	5.20E-01	5.20E-01
2	6	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	7	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	8	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	9	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	10	low	99754	FALSE	1.19E+01	7.25E+01	1.73E+03	5.51E+01	8.43E+01	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	5.06E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	1.09E+00	1.09E+00
2	11	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	12	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	13	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	14	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	15	low	239852	FALSE	1.19E+01	7.25E+01	1.73E+03	2.76E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	2.54E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	16	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	17	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	18	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	19	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	20	low	239852	FALSE	1.19E+01	7.25E+01	1.73E+03	2.76E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	2.54E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	21	low	210618	FALSE	1.19E+01	7.25E+01	1.73E+03	3.15E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	2.89E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	22	low	181384	FALSE	1.19E+01	7.25E+01	1.73E+03	3.66E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	3.36E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	23	low	152150	FALSE	1.19E+01	7.25E+01	1.73E+03	4.36E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	4.00E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	24	low	122916	FALSE	1.19E+01	7.25E+01	1.73E+03	5.39E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	4.95E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	25	low	93682	FALSE	1.19E+01	7.25E+01	1.73E+03	7.08E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	6.50E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	26	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	27	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	28	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	29	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2	30	low	93682	FALSE	1.19E+01	7.25E+01	1.73E+03	7.08E+01	0.00E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	5.28E-02	9.30E+01	7.50E-01	5.10E-03	6.50E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	0.00E+00	0.00E+00
2	31	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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Summary of Waste Rock Stockpile Leachate Chemistry Predictions
All concentrations are dissolved
All concentrations are average annual

Stockpile	Year	Flow Scenario	Flow	Acidic	Acidity (pH=8.3)	Alkalinity	Hardness	F	Cl	SO4	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	PO4	K	Se	SiO2	Ag	Na	Tl	Zn	NO3	NH4
			m3/year		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg-N/L	mg-N/L
3	1	low	7546	FALSE	1.19E+01	7.25E+01	1.14E+03	3.29E+00	1.91E+01	1.54E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.27E-01	1.80E-04	3.71E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	9.25E-03	5.31E+01	7.50E-01	5.10E-03	8.60E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	2.67E+02	2.00E-05	9.00E-02	2.00E-01	2.00E-01
3	2	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	3	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	4	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	5	low	29211	FALSE	1.19E+01	7.25E+01	1.73E+03	9.70E+00	1.29E+01	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	2.73E-02	9.30E+01	7.50E-01	5.10E-03	8.60E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	1.35E-01	1.35E-01
3	6	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	7	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	8	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	9	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	10	low	50313	TRUE	6.15E+02	7.25E+01	5.42E+03	1.22E+01	5.74E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	1.54E+01	2.18E+01	2.87E+01	5.28E-02	1.03E+03	4.70E+01	5.10E-03	1.82E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	1.05E+01	6.04E-02	6.04E-02
3	11	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	12	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	13	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	14	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	15	low	68482	TRUE	7.01E+02	7.25E+01	5.44E+03	1.70E+01	8.41E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	2.40E+01	3.39E+01	4.47E+01	5.28E-02	1.03E+03	4.70E+01	5.10E-03	2.84E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	1.64E+01	8.85E-02	8.85E-02
3	16	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	17	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	18	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	19	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3	20	low	19939	TRUE	1.53E+03	7.25E+01	5.44E+03	8.55E+01	5.35E+01	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	5.62E-01	5.62E-01
3	21	low	18005	TRUE	1.53E+03	7.25E+01	5.44E+03	9.47E+01	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	22	low	16071	TRUE	1.53E+03	7.25E+01	5.44E+03	1.06E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	23	low	14137	TRUE	1.53E+03	7.25E+01	5.44E+03	1.21E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	24	low	12203	TRUE	1.53E+03	7.25E+01	5.44E+03	1.40E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	25	low	10269	TRUE	1.53E+03	0.00E+00	5.44E+03	1.66E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	26	low	8335	TRUE	1.53E+03	0.00E+00	5.44E+03	2.04E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	27	low	6401	TRUE	1.53E+03	0.00E+00	5.44E+03	2.66E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	28	low	4467	TRUE	1.53E+03	0.00E+00	5.44E+03	3.82E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	29	low	2533	TRUE	1.53E+03	0.00E+00	5.44E+03	6.73E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	30	low	599	TRUE	1.53E+03	0.00E+00	5.44E+03	2.85E+03	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3	31	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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Summary of Waste Rock Stockpile Leachate Chemistry Predictions
All concentrations are dissolved
All concentrations are average annual

Stockpile	Year	Flow Scenario	Flow	Acidic	Acidity (pH=8.3)	Alkalinity	Hardness	F	Cl	SO4	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	PO4	K	Se	SiO2	Ag	Na	Tl	Zn	NO3	NH4
			m3/year		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg-N/L	mg-N/L
3LO	1	low	45113	FALSE	1.19E+01	7.25E+01	1.43E+03	4.11E+00	2.38E+01	1.92E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	4.65E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	1.16E-02	6.64E+01	7.50E-01	5.10E-03	8.60E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	3.34E+02	2.00E-05	9.00E-02	2.51E-01	2.51E-01
3LO	2	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	3	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	4	low	#N/A	FALSE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	5	low	73001	FALSE	1.19E+01	7.25E+01	1.73E+03	1.31E+01	9.82E+00	2.34E+03	1.68E+00	7.10E-01	1.90E-01	2.00E-04	7.60E-01	1.80E-04	5.40E+02	1.50E-03	5.20E-02	9.20E-02	8.10E-01	3.70E-02	9.30E+01	7.50E-01	5.10E-03	8.60E-01	2.00E-01	4.90E+01	2.90E-03	8.65E+00	7.00E-04	6.81E+02	2.00E-05	9.00E-02	1.03E-01	1.03E-01
3LO	6	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	7	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	8	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	9	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	10	low	66971	TRUE	8.45E+02	7.25E+01	5.44E+03	2.81E+01	1.77E+01	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	3.85E+01	5.43E+01	7.17E+01	5.28E-02	1.03E+03	4.70E+01	5.10E-03	4.55E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	1.86E-01	1.86E-01
3LO	11	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	12	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	13	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	14	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	15	low	52059	TRUE	1.27E+03	7.25E+01	5.44E+03	6.82E+01	6.14E+01	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	1.36E+02	1.80E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	6.46E-01	6.46E-01
3LO	16	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	17	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	18	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	19	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
3LO	20	low	44740	TRUE	1.53E+03	7.25E+01	5.44E+03	1.07E+02	3.15E+01	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	3.31E-01	3.31E-01
3LO	21	low	40386	TRUE	1.53E+03	7.25E+01	5.44E+03	1.19E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	22	low	36032	TRUE	1.53E+03	7.25E+01	5.44E+03	1.33E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	23	low	31677	TRUE	1.53E+03	7.25E+01	5.44E+03	1.51E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	24	low	27323	TRUE	1.53E+03	7.25E+01	5.44E+03	1.75E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	25	low	22968	TRUE	1.53E+03	0.00E+00	5.44E+03	2.09E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	26	low	18614	TRUE	1.53E+03	0.00E+00	5.44E+03	2.57E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	27	low	14259	TRUE	1.53E+03	0.00E+00	5.44E+03	3.36E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	28	low	9905	TRUE	1.53E+03	0.00E+00	5.44E+03	4.84E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	29	low	5550	TRUE	1.53E+03	0.00E+00	5.44E+03	8.63E+02	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	30	low	1196	TRUE	1.53E+03	0.00E+00	5.44E+03	4.01E+03	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
3LO	31	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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Summary of Waste Rock Stockpile Leachate Chemistry Predictions
All concentrations are dissolved
All concentrations are average annual

Stockpile	Year	Flow Scenario	Flow	Acidic	Acidity (pH=8.3)	Alkalinity	Hardness	F	Cl	SO4	Al	As	Ba	Be	B	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	PO4	K	Se	SiO2	Ag	Na	Tl	Zn	NO3	NH4
			m3/year		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg-N/L	mg-N/L
4	1	low	5703	TRUE	8.02E+02	4.61E+00	6.02E+02	2.00E-01	6.51E+00	3.11E+03	2.27E+01	4.42E-02	1.90E-01	2.30E-03	7.60E-01	1.49E-02	9.73E+01	1.50E-03	2.39E+00	2.95E-01	2.35E+02	5.28E-02	8.74E+01	7.67E+00	1.59E-03	3.49E+01	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	4.54E+01	6.00E-05	2.60E+01	9.21E-02	9.21E-02
4	2	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	3	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	4	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	5	low	45573	TRUE	1.15E+03	2.03E+01	2.64E+03	2.00E-01	1.12E+01	9.60E+03	8.30E+01	1.94E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.27E+02	1.50E-03	1.05E+01	1.29E+00	2.35E+02	5.28E-02	3.84E+02	3.37E+01	5.10E-03	1.53E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	1.99E+02	6.00E-05	2.60E+01	1.58E-01	1.58E-01
4	6	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	7	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	8	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	9	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	10	low	51430	TRUE	1.18E+03	4.74E+01	4.89E+03	2.00E-01	5.63E+00	9.60E+03	8.30E+01	4.54E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	2.46E+01	3.03E+00	2.35E+02	5.28E-02	8.98E+02	4.70E+01	5.10E-03	3.58E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	7.96E-02	7.96E-02
4	11	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	12	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	13	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	14	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	15	low	46343	TRUE	1.20E+03	6.35E+01	5.44E+03	2.00E-01	2.82E-01	9.60E+03	8.30E+01	6.08E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	3.29E+01	4.06E+00	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	4.80E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	3.99E-03	3.99E-03
4	16	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	17	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	18	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	19	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4	20	low	1836	TRUE	1.38E+03	7.25E+01	5.44E+03	2.00E-01	1.61E+01	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	1.07E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	2.27E-01	2.27E-01
4	21	low	1224	TRUE	1.47E+03	7.25E+01	5.44E+03	2.00E-01	7.81E+01	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	1.64E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	1.10E+00	1.10E+00
4	22	low	612	TRUE	1.53E+03	7.25E+01	5.44E+03	2.00E-01	0.00E+00	9.60E+03	8.30E+01	7.10E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02	4.80E+02	1.50E-03	4.40E+01	2.02E+02	2.35E+02	5.28E-02	1.03E+03	4.70E+01	5.10E-03	7.62E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	3.38E+02	6.00E-05	2.60E+01	0.00E+00	0.00E+00
4	23	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	24	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	25	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	26	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	27	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	28	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	29	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	30	low	0	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#DIV/0!	#DIV/0!
4	31	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

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Project Number 1UP005.001
Author SD
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Summary of Waste Rock Stockpile Leachate Chemistry Predictions
All concentrations are dissolved
All concentrations are average annual

Stockpile	Year	Flow Scenario	Flow	Acidic	Acidity (pH=8.3)	Alkalinity	Hardness	F	Cl	SO4	Al	As	Ba	Be	B	Cd
			m3/year		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
4LO	1	low	69552	TRUE	1.52E+02	3.97E-01	5.19E+01	1.79E-01	6.19E-01	2.68E+02	1.96E+00	3.81E-03	2.77E-02	2.30E-03	1.11E-01	1.49E-02
4LO	2	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	3	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	4	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	5	low	69552	TRUE	8.61E+02	6.68E+00	8.72E+02	2.00E-01	5.63E-01	4.50E+03	3.29E+01	6.40E-02	1.90E-01	2.30E-03	7.60E-01	1.49E-02
4LO	6	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	7	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	8	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	9	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	10	low	69552	TRUE	9.44E+02	9.62E+00	1.26E+03	2.00E-01	1.41E+00	6.47E+03	4.73E+01	9.21E-02	1.90E-01	2.30E-03	7.60E-01	1.49E-02
4LO	11	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	12	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	13	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	14	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	15	low	69552	TRUE	1.16E+03	2.58E+01	3.21E+03	2.00E-01	2.74E-01	9.60E+03	8.30E+01	2.47E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02
4LO	16	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	17	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	18	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	19	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	20	low	69552	TRUE	1.15E+03	2.07E+01	2.70E+03	2.00E-01	1.75E+00	9.60E+03	8.30E+01	1.98E-01	1.90E-01	2.30E-03	7.60E-01	1.49E-02
4LO	21	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	22	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	23	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	24	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	25	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	26	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	27	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	28	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	29	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	30	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	31	low	#N/A	TRUE	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Stockpile	Year	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	PO4	K	Se	SiO2	Ag	Na	Tl	Zn	NO3	NH4
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg-N/L	mg-N/L
4LO	1	8.38E+00	6.61E-04	2.06E-01	2.54E-02	5.06E+01	6.06E-03	7.53E+00	6.61E-01	1.37E-04	3.00E+00	9.67E-02	8.22E+00	2.90E-03	3.88E+00	1.54E-04	3.91E+00	6.00E-05	3.19E+00	7.93E-03	7.93E-03
4LO	2	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	3	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	4	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	5	1.41E+02	1.50E-03	3.47E+00	4.27E-01	2.35E+02	5.28E-02	1.27E+02	1.11E+01	2.30E-03	5.05E+01	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	6.58E+01	6.00E-05	2.60E+01	7.22E-03	7.22E-03
4LO	6	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	7	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	8	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	9	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	10	2.03E+02	1.50E-03	4.99E+00	6.15E-01	2.35E+02	5.28E-02	1.82E+02	1.60E+01	3.31E-03	7.27E+01	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	9.46E+01	6.00E-05	2.60E+01	1.81E-02	1.81E-02
4LO	11	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	12	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	13	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	14	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	15	4.80E+02	1.50E-03	1.34E+01	1.65E+00	2.35E+02	5.28E-02	4.88E+02	4.28E+01	5.10E-03	1.95E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	2.54E+02	6.00E-05	2.60E+01	3.52E-03	3.52E-03
4LO	16	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	17	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	18	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	19	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	20	4.36E+02	1.50E-03	1.07E+01	1.32E+00	2.35E+02	5.28E-02	3.92E+02	3.44E+01	5.10E-03	1.56E+02	2.00E-01	3.80E+01	2.90E-03	3.88E+00	7.00E-04	2.04E+02	6.00E-05	2.60E+01	2.24E-02	2.24E-02
4LO	21	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	22	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	23	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	24	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	25	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	26	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	27	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	28	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	29	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	30	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
4LO	31	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A