LABORATORY DRAINAGE QUALITY FROM SILTITE-ARGILLITE ~~AND~~ ~~DULUTH COMPLEX~~ ROCKS

Progress Report on Contract BLM J910P~~62009~~ ~~72015~~ ✓ yes
to the
U.S. Bureau of Land Management
Salt Lake City Office

27 November 1996

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

Tailings and waste rock, as well as the mine itself, are components of metal mining operations which remain long after mining has ceased. These remnants may be, relatively speaking, chemically inert and therefore environmentally innocuous. On the other hand, mining wastes may adversely affect water quality long after mining has ceased. For example, acidic drainage was observed in 1977 at a Norwegian mine which had been abandoned in 1833 (Iversen and Johannessen, 1987). In the United States acidic drainage from mining areas has impacted thousand of miles of streams (U.S. Bureau of Mines 1985). Remediation of these problems can range from tens to hundreds of millions of dollars (Biggs 1989).

As discussed by Lapakko (1990), governmental agencies have, in recent years, developed regulations to reduce the potential for problematic mine waste drainage, and the associated financial liability. Plans for closure and post-closure care of mine wastes are an important aspect of these rules and must be submitted prior to mine development. This approach allows the costs of mine waste reclamation to be considered along with other mining costs in the assessment of mineral recovery economics.

In order to develop effective, efficient, and economical pre-development waste rock management plans it is necessary to estimate the quality of drainage generated by the lithologies excavated in order to access the ore. Mitigation techniques can then be scaled to the estimated potential for adverse impact. Existing data on a waste rock of similar composition, generated by similar mining methods, and exposed to environmental conditions for an extended time provide the best indicator of drainage quality. Since these data are rarely available, it is necessary to use other means of drainage quality prediction, such as compositional characterization and/or dissolution testing. Dissolution testing, however, can be expensive and may take several years to complete. In order to provide less expensive and time consuming method of predicting waste rock drainage quality, the U.S. Bureau of Mines Salt Lake City Research Center (USBM SLRC) initiated a program to develop a mathematical model to predict the quality of drainage from discrete rock types (individual lithologies). Such a tool will assist regulatory agencies, mining companies, and the public in assessing potential water quality impacts of waste rock drainage.

Whereas literature values can provide dissolution rates for modeling individual isolated minerals present a given lithology, empirical data are needed to provide rates describing their dissolution within the specific rock matrix. Distinct to each lithology is the grain size, surface morphology, and extent of liberation of the individual mineral. Within each rock type the interaction with other minerals and their dissolution products will also be unique. Thus, dissolution testing on individual lithologies is a necessary step in developing the mathematical model for predicting the quality of drainage from individual lithologies. This dissolution testing will also provide, on a primary level, empirical data on drainage quality and dissolution rates for the lithologies tested. As the number of lithologies subjected to dissolution testing increases the integrity of the mathematical modeling output will increase, as will the catalogue of empirical data available to assist prediction of drainage quality from similar lithologies.

2. OBJECTIVES

The objectives of the present project are as follows.

1. Describe the variation of drainage quality, particularly pH, as a function of the sulfur content of siltite-argillite rocks.
2. Determine the rates of sulfate, calcium, and magnesium release as a function of the sulfur content of siltite-argillite rocks.
3. Determine the drainage quality and rates of sulfate, calcium, and magnesium release from a sample of Duluth Complex rock subjected to dissolution testing using ASTM Standard Method 5744-96 for at least 20 weeks.

3. METHODS

3.1. Materials

Two metal-sulfide bearing waste-rock types (siltite-argillite and gabbro) have been subjected to 20 weeks of accelerated weathering (ASTM Standard Method 5744-96). The sulfur content of the siltite-argillite samples ranges from 0.12 to 5.7%, while that of the gabbro sample is 1.4 % (table 1).

3.1.1. Siltite-argillite

The siltite-argillite samples were provided by a western U.S. metal mine. Samples were initially collected by USBM SLRC during 1991 as part of its AMD predictive modelling project; these samples contained a range of sulfide values (1.5 (sample 100.4), 2.2 (99.4), 2.7 (100.5), 3.1 (99.1), 5.7 (99.6), and 13.0% (100.2)). Subsamples of all but the 13% sulfide sample were sent to the Minnesota Department of Natural Resources Division of Minerals (MN DNR). Based on USBM kinetic-testing results for those 1991 samples, additional siltite-argillite samples were provided by the mine in 1996 so that average cation/anion release rates and an AMD-producing sulfide-content cutoff value could be determined for this rock type. Sulfide content contained in the 10 siltite-argillite samples considered in this study range from 0.12 to 5.7% (table 1).

FY91 Samples. Three blast-hole drill-cuttings samples from sulfide-bearing siltite-argillite outcrops classified as waste rock contain 2.2, 3.1, and 5.7% sulfide. A bulk sample containing 1.5% sulfide was also collected and crushed to 100% passing 1/4 inch. Additional size reduction prior to blending and splitting was not necessary for the blast hole samples because the resulting cuttings from the blast-hole drilling were minus 1/4 inch. Sample preparation was initially performed during 1991 by USBM SLRC. The minus 1/4-inch samples were blended in a "V" blender and split through a Jones Splitter (comprised of 3/4-inch chutes) into 1-kg humidity-cell charges. Bagged 1-kg charges from the original USBM sample preparation were reblended and split by MDNR through a Jones Splitter (comprised of 1/2-inch chutes) into 0.25-kg aliquots. Four aliquots from the 0.25-kg aliquot population were used for the humidity-cell charge. An

additional aliquot from the 0.25-kg population was ultimately split into 50-g aliquots for mineral characterization. One 50-g aliquot was randomly selected from the population and pulverized to 90% passing 140 mesh (100 um) for chemical characterization.

FY96 Samples. Six samples estimated to contain from 0.2 to 1.5% sulfide were collected from the surface of a 600-foot-wide bench cut into a final 2 to 1 pit-wall exposure of siltite-argillite. This bench traversed an oxidation zone approximately 300-ft thick that began at the pit-wall surface and extended to a "redox" boundary situated in the wall rock. The 300-ft distance was measured perpendicular to the final 2 to 1 pit-wall surface. Sulfide content of siltite-argillite in the oxidation zone was estimated to be near zero at the pit-wall surface and about 1-2% at the "redox" boundary.

The six samples were crushed at the mine site to 100% passing 1/4 inch and shipped to MDNR in plastic 5-gal buckets. As received sample masses ranged from 12 to 18 kg. Upon receipt at MDNR, each sample was reblended by being passed three times through a Jones Splitter comprised of 3/4-inch chutes. After reblending, each of the six samples was then ultimately split into aliquots of about 0.25-kg; four of these 0.25-kg aliquots were randomly selected from each sample's aliquot population to make up the sample's 1-kg. humidity-cell charge. For each of the six samples, another 0.25-kg aliquot was selected randomly from the remaining aliquot population and further split through a Jones Splitter comprised of 1/2-inch chutes to produce 50-g aliquots for mineral characterization. A 50-g aliquot was randomly selected from the 50-g aliquot population and pulverized by ring and puck to 90% passing 140 mesh (106 um) for chemical characterization.

3.1.2. Gabbro (Duluth Complex).

The five 1-kg splits of Duluth Complex used in the "ruggedness testing" of ASTM Standard Method 5744-96 are from MDNR sample FL-6B that was collected in 1992 from one of six original 1000-ton waste-rock test piles located at MDNR's Babbitt, MN research site. Sample FL-6B was crushed to 100% passing 1/4 inch, blended in a rotary "V" blender, and split into 8 subsamples. An aliquot sample from each of the 8 sub samples was pulverized to 80% passing 150 mesh (100 micron) and analyzed for sulfur (as sulfide) and carbon (as carbonate) by infrared spectrophotometry (LECO carbon-sulfur analyzer); mean and standard deviation of the resulting values for the eight aliquot samples were recorded and used to assess the representativeness of each split. Four of the eight subsamples were randomly selected to be recombined, reblended and split into 1-kg aliquots for humidity-cell charges. Three 1-kg aliquots were randomly selected from the 1-kg sample population, recombined and used for screen-fraction analysis. The resulting eleven screen fractions were each split into two subsamples. One subsample from each of the eleven screen fractions was pulverized by ring and puck to 80% passing 150 mesh (100 um) for chemical characterization. Three screen fractions (-10/+20, -48/+65, and -200 mesh) from the non-pulverized subsample were submitted for mineral characterization by optical microscopy, scanning-electron microscopy (SEM), and X-ray diffraction (XRD).

3.2. Methods

3.2.1. Accelerated weathering "Modified Humidity Cell" (ASTM Standard Method 5744-96).

Siltite-argillite and gabbro samples have currently been subjected to 20 weeks of accelerated-weathering tests conducted according to ASTM Standard Method 5744-96. A 16-cell array identical to that illustrated by figure 1 in the standard method is being used in this study. Four 0.25-kg aliquots (each in "zip-lock bags) comprising each sample were used to load individual humidity cells; this "4-bag" loading method was used to minimize sample stratification and consequent fluid "channeling" in the cell. The final 16-cell-array composition included 13 siltite-argillite samples and three replicates of Duluth Complex sample FL-6B (designated as sample MN-6.1).

The only departure from the standard-method protocol was the volume of de-ionized water used for the initial leach (week 0); instead of a single 500-ml leach, three 500-ml rinses totaling 1.5 L were performed on each sample to flush it of residual sulfate salts produced by natural weathering prior to sample collection. The 3-rinse procedure was comprised of an initial 500-ml drip-trickle leach to wet the 1-kg sample, a 500-ml flooded leach to saturate the sample (after sample was flooded, leachant was in contact with sample for 5 minutes prior to being drained), and a final 500-ml drip-trickle leach to complete the rinse. Recovered volumes from each of the three rises were weighed, and composited. Aliquot samples (approximately 60 ml) from the composite were preserved and submitted for analyses so that selected cation/anion loads could be calculated.

Following the initial 1.5-L week 0 rinse (Monday, July 1, 1996), the subsequent weekly accelerated-weathering cycles were comprised of the following:

- Tuesday - previous week's leachant collected and weighed; each humidity cell weighed to determine amount of interstitial water present in the waste-rock sample after the leach; three-day dry-air period initiated (same time each cycle) - NOTE: start of dry-air period begins the new week (i.e., week 1).
- Friday - dry-air period ends; each humidity cell weighed to determine evaporation rate of interstitial water; three-day wet-air period initiated (same time each cycle).
- Monday - wet-air period ends; each humidity cell weighed to determine gain/loss of interstitial water; 500-mL drip-trickle leach initiated.
- Tuesday - previous week's leachant collected and weighed; each humidity cell weighed to determine amount of interstitial water present in the waste-rock sample after the leach; three-day dry-air period initiated; start of new week (i.e., week 2).

Air-flow rates (L/min) and relative-humidity readings were taken once daily for each cell during the three-day dry-air period; these readings were also taken once daily for each cell on Friday and the following Monday during the wet-air period.

3.2.2. Analyses

Water samples were analyzed for specific conductance, pH, alkalinity, acidity, and Eh at the MN DNR in Hibbing. Specific conductance was analyzed using a Myron L conductivity meter, and an Orion SA720 meter, equipped with a Ross combination pH electrode (8165), was used for pH analyses. Alkalinity (for pH $\geq$ 6.3) and acidity were determined using standard titration techniques for endpoints of 4.5 and 8.3, respectively (APHA et al., 1992). Eh readings were taken using a Beckman model 11 meter with an Orion electrode (9678BN).

Metal and sulfate determinations were conducted at the Minnesota Department of Agriculture (MN DA). Metals were determined with a Varian 400 SPECTRAA; a Zeeman GFAA furnace was attached for low concentrations. Sulfate concentrations were determined using a Technicon AA2 automated colorimeter or, for $[SO_4] < 5$ mg/L, a Dionex ion chromatograph.

4. RESULTS AND DISCUSSION

4.1. Mineral Dissolution and Drainage pH

Drainage from a mine waste will become acidic if the rate of acid production exceeds the rate of acid neutralization. Acid is produced as the result of the oxidation of iron sulfide minerals (reactions 1, 2), the rate of which is reported as proportional to the available iron sulfide surface area (e.g. Nelson 1978). Acid can be neutralized by the dissolution of calcium and magnesium carbonate minerals (reactions 3, 4). Silicate minerals such as plagioclase and olivine also dissolve to neutralize acid (reactions 5, 6 from Busenberg (1976) and Hem (1970), respectively), although much slower than carbonate minerals. Consequently, their dissolution can maintain neutral pH only if the rate of acid production is quite slow.

$$FeS_2(s) + (5/2)H_2O + (15/4)O_2(g) = FeOOH(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \quad [1]$$

$$FeS(s) + (3/2)H_2O + (9/4)O_2(g) = FeOOH(s) + 2H^+(aq) + SO_4^{2-}(aq) \quad [2]$$

$$CaCO_3(s) + 2H^+(aq) = H_2CO_3(aq) + Ca^{2+}(aq) \quad [3]$$

$$CaCO_3(s) + H^+(aq) = HCO_3^-(aq) + Ca^{2+}(aq) \quad [4]$$

$$CaAl_2Si_2O_8(s) + 2H^+ + H_2O = Ca^{2+} + Al_2Si_2O_5(OH)_4(s) \quad [5]$$

$$Mg_2SiO_4(s) + 4H^+(aq) = 2Mg^{2+}(aq) + 2H_4SiO_4(aq) \quad [6]$$

Drainage chemistry can be used to estimate rates of mineral dissolution and acid production when certain assumptions are made. Reactions 1 and 2 indicate that two moles of sulfate are released per mole of pyrite oxidized and one mole of sulfate is released per mole of pyrrhotite oxidized. In either case, two moles of acid (H^+) are released per mole of sulfate released. Thus,

by assuming all sulfate is generated by iron sulfide oxidation and that the sulfate remains in solution (i.e. is not removed by precipitation as another mineral such as anhydrite, $CaSO_4$), the rates of iron sulfide oxidation and acid production can be determined. Similarly, the neutralization of acid can be tracked by the appearance of cations such as calcium and magnesium in solution. Whether neutralization of one or two moles of H^+ is associated with the appearance of these cations must be estimated based on drainage pH.

4.2. Siltite-Argillite Samples

The objective of subjecting the 10 siltite-argillite samples to dissolution testing was to determine the variation of their drainage quality and rates of chemical release as a function of sulfur content. More precisely, pH is the drainage quality parameter of major concern. As discussed above, drainage pH is dependent upon the balance of acid-producing and acid-neutralizing reactions. In conjunction with drainage volume, drainage concentrations of sulfate will be used to calculate the rates of acid-producing reactions while concentrations of calcium and magnesium will be used to calculate the rates of acid-neutralizing reactions.

Based on the total sulfur content and typical drainage chemistry the 10 siltite-argillite samples were divided into two groups and a transitional sample. Group 1 was comprised of five samples for which $0.12 \leq$ percent total sulfur ≤ 0.30. The typical drainage pH and average rates of sulfate, calcium, and magnesium release (dSO_4/dt, dCa/dt, dMg/dt, respectively) for weeks 3 through 16 were as follows:

1) $6.35 \leq$ drainage pH ≤ 7.54,
2) 10 μmoles/week $\leq dSO_4/dt \leq$ 40 μmoles/week,
3) 20 μmoles/week $\leq dCa/dt \leq$ 35 μmoles/week,
4) 5 μmoles/week $\leq dMg/dt \leq$ 11 μmoles/week.

No relationship was apparent between sulfur content and drainage pH values or rates of release and, with one exception, the drainage from these samples would met the common pH water quality standard of 6.0. Drainage pH from the 0.19-percent sulfur sample ranged from 3.95 to 4.24 over the designated period, considerably lower than that from other samples of similar sulfur content. Rates of sulfate, calcium, and magnesium from this sample were 100, 56, and 15 μmoles/week, considerably higher than from other Group 1 samples (table 2).

The sulfide minerals, presumably pyrite, in this sample were more reactive than those in samples of similar sulfide content. Their relatively rapid oxidation generated acid which accelerated the dissolution of host rock minerals and the consequent release of calcium and magnesium. This dissolution, however, was not adequate to neutralize all of the acid and, as a result, the drainage acidified. If the reactivity of sulfide minerals commonly varies among samples, classification of drainage quality based on sulfur content will be tenuous at best. A second and relatively minor exception to the general group behavior was the elevated release of calcium and magnesium from the 0.30-percent sulfur sample.

The 0.96-percent sulfur sample is presently classified as a transition sample. It had drainage pH values in the lower fives, which did not meet the common pH standard of 6.0. Its rate of sulfate release was slightly higher than the Group 1 samples, although its calcium and magnesium release rates were within the ranges for the Group 1 samples.

The second group of samples had total sulfur contents of 1.5 to 5.7 percent. The sulfate release rates for the Group 2 samples were roughly one to two orders of magnitude higher than those for the Group 1 samples. This does not appear to be unreasonable since the Group 2 sulfur contents were 5 to 50 times those of the Group 1 samples. That is, perhaps sulfur content may indeed provide a reasonable estimate of the sample reactivity.

4.3. Duluth Complex Sample

The Duluth Complex sample was subjected to the ASTM Standard Method 5744-96 to compare the results with those generated by other laboratories to test the reproducibility of the test. For weeks 3 through 16 the drainage pH from the two Duluth Complex cells ranged from 6.21 to 6.98. The rates of sulfate, calcium, and magnesium release were approximately 290, 210, and 95 micromoles per week. At present no corresponding data have been received from the laboratories participating in the ruggedness testing. However, MN DNR data generated to date are in reasonable agreement with values generated previously at the USBM SLRC (table 3).

5. MOST RECENT ACTIVITIES AND PLANS

Six cells were terminated following the rinses at week 20 (19 November 1996). These cells were the siltite-argillite samples with sulfur contents of 0.12 (one of two), 0.26 (both cells), 1.5 (one of two), and 5.7 percent. These samples were replaced with siltite-argillite samples with sulfur contents of 0.19, 0.38, 0.42, 1.69 (two samples), and 1.89 percent. The 0.19-percent sulfur sample was the same as the 0.19-percent sample from the first sample set, and is being run to check the unusually low pH and high release rates observed initially. The remaining samples are being run to provide more detail over a range of sulfur contents for siltite-argillite samples. A summary of the samples subjected to testing is presented in table 4.

1) Obtain data from other laboratories involved in ruggedness testing.
2) Enter aluminum, iron, and manganese data which was received recently.
3) Complete sample analysis and data entry for terminated cells.
4) Increase data on solid phase characterization.
   - More chemical determinations are in progress, in particular CO_2 content.
   - Particle size distributions will be determined.
   - Samples will be selected for mineralogical analysis.
5) Obtain additional samples with sulfur contents in the range of 0.42 to 1.6 percent, with a particular focus on the range of 0.42 to 0.96 percent..

6.0. ACKNOWLEDGEMENTS

John Folman conducted laboratory dissolution tests, with assistance from Anne Jagunich and supervision from Dave Antonson. Mr. Folman was also responsible for data entry, with assistance from Gregory Walsh, calculations, as well as tabular and graphical output. Bill White of the US BLM Salt Lake City office was largely responsible for splitting rock samples received, loading humidity cells, and drafting the methods section of this report.

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Table 1. Samples and conditions for BLM humidity cells.

usbm/celldscr.tab

Cell	Rock Type	Pct. S	Cell Type	Comments	Sample No.
7	siltite-argillite	0.12	Std. USBM		1-0696a
8	siltite-argillite	0.12	Std. USBM		1-0696b
5	siltite-argillite	0.19	Std. USBM		3-0696
1	siltite-argillite	0.22	Std. USBM		6-0696
3	siltite-argillite	0.26	Std. USBM		4-0696a
4	siltite-argillite	0.26	Std. USBM		4-0696b
2	siltite-argillite	0.30	Std. USBM		5-0696
6	siltite-argillite	0.96	Std. USBM		2-0696
15	siltite-argillite	1.5	Std. USBM	These two cells were run for 31 weeks at USBM.	100.4
16	siltite-argillite	1.5	Std. USBM		100.4
9	siltite-argillite	2.2	Std. USBM		99.4
10	siltite-argillite	3.12	Std. USBM		99.1
11	siltite-argillite	5.7	Std. USBM		99.6
12	Duluth Complex	1.39	Std. USBM		MN-6.1
14	Duluth Complex	1.39	Std. USBM		MN-6.1

Table 2. Median pH and sulfate, calcium, and magnesium average release rates from week 3 through 16 for siltite-argillite samples.

S, pct.	pH			Average Release, μ mole/wk		
	Min.	Med.	Max.	SO_4	Ca	Mg
0.12	6.35	6.54	6.67	39.0	24.9	4.83
0.12	6.38	6.59	6.85	34.2	20.2[1]	5.41[1]
0.19	3.95	4.11	4.24	99.8	56.1	15.2
0.22	6.86	7.20	7.35	13.3	33.1	10.0
0.26	6.61	6.79	7.03	35.5	20.2	5.8
0.26	6.53	6.70	6.91	30.7	20.8	6.65
0.30	6.94	7.32	7.54	24.2	50.3	11.0
0.96	5.05	5.14	5.39	46.7	21.6	7.05
1.5	5.24	5.51	5.78	285	16.0[1]	266[1]
1.5	5.26	5.74	6.32	297	11.1[1]	225[1,2]
2.2	6.22	6.84	7.10	349	36.8[1]	320[1]
3.12	5.40	5.80	6.22	2530	473[1]	1856[1]
5.7	2.91	3.09	3.41	1095	7.41	10.3

[1] Through week 14.
[2] Anomalous concentration at week 3.

Table 3. Comparison of Duluth Complex drainage data with those from USBM SLRC humidity cell 6. Rates expressed as micromoles/kg week.

	pH (median)	Sulfate	Calcium	Magnesium	Ca/SO_4	Mg/SO_4
MN Cell 12, Wk 0-11	6.72	477	318	172	0.667	0.362
MN Cell 14, Wk 0-11	6.80	464	309	170	0.666	0.366
SLRC Wk 0 - 11	6.93	578.5	349.3	188.1	0.604	0.325
SLRC Wk 11 - 39	6.10	282.0	169.0	98.9	0.599	0.351
SLRC Wk 39 - 97	4.95	188.3	85.6	88.5	0.455	0.470
SLRC Wk 97 - 118	4.91	234.1	84.1	114.2	0.359	0.488
SLRC Wk 118 - 145	5.02	125.9	55.8	73.0	0.443	0.580

Table 4. Samples subjected to humidity cell tests at MN DNR. Status on 20 November 1996.

Total S pct.	Start Date	End Date	Duration Weeks	Cell	Sample	Comments
Siltite Argillite Rock						
0.12	7/1/96		20	7	1-0696	
0.12	7/1/96	11/19/96	20(T)[1]	8	1-0696	
0.19	7/1/96		20	5	3-0696	
0.19	11/25/96		0	3(2)[2]	3-0696	
0.22	7/1/96		20	1	6-0696	
0.26	7/1/96	11/19/96	20(T)	3	4-0696	
0.26	7/1/96	11/19/96	20(T)	4	4-0696	
0.30	7/1/96		20	2	5-0696	
0.38	11/25/96		0	4(2)	7-1196	
0.42	11/25/96		0	8(2)	2-1196	
0.96	7/1/96		20	6	2-0696	
1.60	7/1/96		20	15	100.4	
1.60	7/1/96	11/19/96	20(T)	16	100.4	
1.69	11/25/96		0	14(2)	1-1196	
1.69	11/25/96		0	16(2)	1-1196	
1.89	11/25/96		0	11(2)	8-1196	
2.30	7/1/96		20	9	99.4	
3.24	7/1/96		20	10	99.1	
5.82	7/1/96	11/19/96	20(T)	11	99.6	
Duluth Complex Rock						
1.39	7/1/96		20	12	MN-6.1	
1.39	7/1/96	11/19/96	20(T)	14	MN-6.1	

[1] In "Duration" column (T) indicates the cell was terminated.

[2] In "Cell" column (2) indicates the second time a cell was used.

APPENDIX 1

METHODS

Table A1.1. Temperature and relative humidity (p. 1/6).

USBM:\stataba1.1

Week	Date	Time	Ambient		Desiccant		Cell 2		Cell 10		Cell 14		Cell 16		Humidifier[1]	
			T	RH	T	RH	T	RH	T	RH	T	RH	T	RH	T	RH
2	7/12/96	08:30	21.1	54.7	22.0	13.1	22.0	90.5	22.0	91.6	22.0	91.8	22.0	92.4		
2	7/15/96	08:30	21.0	57.7			21.6	99.9	21.7	99.9	21.9	99.9	22.1	99.9	40	99.9
3	7/16/96	10:00	22.4	55.0	22.4	4.6	23	99.9	22.9	99.9	23.0	99.9	22.8	99.9		
3	7/17/96	07:20	22.1	53.5	22.1	10.3	22.6	99.9	22.5	99.9	22.6	95.0	22.7	94.5		
3	7/18/96	09:00	23.3	60.7	23.1	11.1	23.5	99.9	23.7	99.9	23.7	91.3	23.7	65		
3	7/19/96	07:15	22.6	59.7	22.5	13.5	22.7	99.9	23.0	99.3	23.0	88.9	22.6	14.3		
3	7/19/96	11:20	23.3	54.3			23.7	99.9	23.7	99.9	23.7	99.9	23.7	62.8	23.8	99.9
3	7/22/96	07:30	21.7	52.8			22.2	99.9	22.1	99.9	22.1	99.9	22.0	99.9	22.0	99.9
4	7/23/96	11:50	22.0	51.9	22.0	5.1	22.3	99.9	22.2	99.9	22.2	99.9	22.2	99.9		
4	7/24/96	07:45	20.7	55.5	20.5	9.9	21.1	99.9	21.2	99.9	21.1	81.2	21.2	89.3		
4	7/25/96	10:50	21.4	53.6	21.1	11.5	21.5	98.5	21.6	90.2	21.6	95.0	21.6	94.5		
4	7/26/96	10:40	22.1	45.8			22.6	99.9	22.7	99.9	22.6	99.9	22.6	99.9	22.7	99.9
4	7/29/96	07:15	19.0	53.1			19.7	99.9	19.7	99.9	19.8	99.9	19.8	99.9	19.8	99.9
5	7/30/96	10:30	20.9	47.5	21.6	4.6	21.5	99.9	21.5	99.9	21.5	99.9	21.5	99.9		
5	7/31/96	08:00	22.1	44.9	20.3	11.6	20.8	99.9	20.8	99.9	20.8	99.9	21.0	99.9		
5	8/1/96	07:15	22.8	46.0	22.9	9.3	23.5	99.9	23.6	99.9	23.7	99.9	23.8	99.9		
5	8/2/96	07:20	23.7	45.6	23.4	11.1	24.1	99.9	24.1	99.9	24.3	99.9	24.3	99.9	30	99.9
5	8/2/96	14:00	26.8	39.2			27.2	99.9	27.1	99.9	27.1	99.9	27.1	99.9	27.1	99.9
5	8/5/96	07:15	24.9	53.3			25.5	99.9	25.5	99.9	25.5	99.9	25.5	99.9	25.7	99.9

Table A1.1. Temperature and relative humidity (p. 2/6).

Week	Date	Time	Ambient		Desiccant		Cell 2		Cell 10		Cell 14		Cell 16		Humidifier[1]	
			T	RH	T	RH	T	RH	T	RH	T	RH	T	RH	T	RH
6	8/6/96	09:15	25.8	54.7	26.1	3.5	26.5	99.9	26.6	99.9	26.7	99.9	26.6	99.9		
6	8/7/96	07:15	24.8	49.2	24.9	5.2	25.3	99.9	24.9	99.9	24.6	99.9	24.0	99.9		
6	8/8/96	07:15	22.5	45.5	22.6	10.0	23.1	99.9	23.1	99.9	23.1	99.9	23.1	97.0		
6	8/9/96	07:20	21.0	44.8	21.4	11.2	21.7	99.9	21.7	99.9	21.7	99.9	21.6	99.9		
6	8/12/96	07:15	21.8	50.7			23.1	99.9	22.8	99.9	22.7	99.9	22.6	99.9	24.1	99.9
7	8/13/96	11:35	23.7	42.8	23.9	3.8	24.5	99.9	24.4	99.9	24.5	99.9	24.5	97.1		
7	8/14/96	07:15	21.8	50	21.9	7.3	22.1	99.9	22.0	97.2	22.2	96.3	22.1	95.5		
7	8/15/96	07:05	22.2	44.7	22.5	8.8	22.9	99.9	23.0	97.1	23.0	95.3	23.0	94.9		
7	8/16/96	07:20	24.1	40.4	24.1	7.3	24.6	99.9	24.6	96.7	24.6	96.7	24.4	58.0		
7	8/16/96	13:30	25.7	36.7			26.3	99.9	26.2	99.9	26.2	99.9	26.1	99.9	26.2	99.9
7	8/19/96	07:20	23.8	52.2			29.2	99.9	30.2	99.9	30.5	99.9	30.9	99.9	27.8	99.9
8	8/20/96	09:00	25.0	44.6	34.6	3.4	36.8	99.9	37.1	99.9	37.5	99.9	38.4	99.9		
8	8/21/96	07:10	25.3	39.6	28.1	3.9	35.2	99.9	36.6	99.9	37.8	99.9	38.6	99.9		
8	8/22/96	08:30	22.9	44.1	22.8	7.3	23.2	99.9	23.3	94.9	23.7	95.1	23.7	92.4		
8	8/22/96	10:45	23.2	39.1												
8	8/23/96	07:30	24.0	38.5	23.7	6.6	24.3	97.1	24.3	95.0	24.3	95.1	24.0	29.8		
8	8/23/96	15:10	25.1	30.1			25.5	99.9	25.6	99.9	25.6	99.9	25.5	94.8	25.6	99.9
8	8/26/96	07:25	21.8	40.7			22.5	99.9	22.5	99.9	22.5	99.9	22.5	99.9	22.6	99.9
9	8/27/96	09:10	21.8	36.3	21.7	4.6	22.1	99.9	22.1	99.9	22.1	99.9	22.1	99.9		

Table A1.1. Temperature and relative humidity (p. 3/6).

Week	Date	Time	Ambient		Desiccant		Cell 2		Cell 10		Cell 14		Cell 16		Humidifier[1]	
			T	RH	T	RH	T	RH	T	RH	T	RH	T	RH	T	RH
9	8/28/96	07:40	21.1	39.8	21.3	6.6	21.3	92.4	21.3	92.9	21.3	92.5	21.4	92.4		
9	8/29/96	07:30	21.9	46.5	21.8	7.7	22.2	97.2	22.3	95.1	22.3	92.8	22.3	94.7		
9	8/30/96	07:35	23.7	37.1	23.8	6.4	24.1	97.4	24.0	95.7	23.9	96.2	23.9	95.1		
9	8/30/96	11:00	24.5	38.1			25.0	99.3	25.0	99.4	24.9	99.2	24.9	99.3	25.0	99.9
9	9/2/96	07:30	22.6	53.0			23.0	99.9	23.1	99.9	23.2	99.9	23.3	99.9	24.0	99.9
10	9/3/96	09:05	22.3	56.4	23.0	3.8	23.3	99.9	23.2	99.9	23.2	99.9	23.1	99.9		
10	9/4/96	07:20	22.0	43.6	22.2	5.0	22.7	95.5	22.5	92.5	22.6	93.6	22.6	96.2		
10	9/5/96	07:15	22.2	47.8	22.5	7.0	22.7	96.2	22.6	95.3	22.6	93.5	22.8	95.7		
10	9/6/96	07:45	22.7	53.5	22.7	6.5	23.3	93.3	23.4	93.2	23.2	95.3	23.3	94.1		
10	9/6/96	12:35	25.0	45.8			25.2	99.9	25.3	99.9	25.3	99.9	25.3		25.3	99.9
10	9/9/96	07:15	20.2	48.1			20.8	99.9	20.9	99.9	21.0	99.9	21.0	99.9	21.1	99.9
11	9/10/96	09:15	21.0	51.9	21.3	4.6	21.6	99.9	21.8	99.9	21.8	99.9	21.7	99.9		
11	9/11/96	07:15	19.7	42.1	19.7	5.7										
11	9/16/96	07:45	19.6	39.5			20.1	99.9	19.8	99.9	19.9	99.9	19.9	99.9	20.1	99.9
12	9/17/96	09:05	20.0	39.0	20.7	4.9	21.3	99.9	21.3	99.9	21.2	99.9	21.2	99.9		
12	9/18/96	07:50	19.8	37.1	20.7	5.2	20.7	93.0	20.6	93.5	20.6	92.6	20.6	92.2		
12	9/19/96	07:25	20.3	30.5	20.6	7.1	20.8	92.5	20.9	91.7	20.9	90.9	20.9	88.4		
12	9/20/96	07:25	19.7	32.4	19.7	7.2	20.1	91.8	20.1	92.4	20.2	91.7	19.8	49.1		
12	9/20/96	11:30	20.9	34.7			22.0	99.9	21.8	99.9	21.8	99.9	21.6	99.9	21.9	99.9

Table A1.1. Temperature and relative humidity (p. 4/6).

Week	Date	Time	Ambient		Desiccant		Cell 2		Cell 10		Cell 14		Cell 16		Humidifier[1]	
			T	RH	T	RH	T	RH	T	RH	T	RH	T	RH	T	RH
12	9/23/96	07:25	18.1	41.9			19.7	99.9	19.5	99.9	19.3	99.9	19.1	99.9	20.3	99.9
13	9/24/96				20.7	6.5	19.7	92.3	19.6	94.2	19.6	95.0	19.6	94.6		
13	9/25/96				18.1	7.8	18.1	95.3	18.2	95.2	18.2	96.2	18.1	74.5		
13	9/26/96	07:45	18.7	37.6	18.7	7.3	19.0	98.0	19.0	94.2	19.0	93.6	18.7	67.6		
13	9/27/96	07:15	18.5	40.8	18.5	7.4	18.8	93.5	18.8	90.8	18.7	84.5	18.2	14.0		
13	9/27/96	10:30	19.7	37.0			20.3	92.0	20.1	93.4	20.0	93.8	19.8	44.9		
13	9/30/96	07:30	19.1	26.3			20.5	99.9	20.3	99.9	20.1	99.9	19.8	99.9	21.1	99.9
14	10/1/96	09:20	19.8	34.7	20.3	5.1	20.3	95.5	20.3	97.8	20.3	96.2	20.3	96.9		
14	10/2/96	07:50	19.1	31.5	19.6	5.3	19.6	88.3	19.5	88.2	19.4	88.8	19.4	89.7		
14	10/3/96	07:10	17.1	26.9	17.7	6.5	17.7	84.6	17.7	87.0	17.7	86.7	17.7	86.0		
14	10/4/96	07:20	18.0	24.0	18.5	7.7	18.1	88.1	18.1	86.0	18.2	86.1	18.1	86.1		
14	10/4/96	10:45	19.7	22.8			21.2	99.9	20.8	99.9	20.7	99.9	20.7	99.9	21.7	99.9
14	10/7/96	07:30	19.1	26.9			20.6	99.9	20.5	99.9	20.3	99.9	20.2	99.9	20.5	99.9
15	10/8/96	09:12	23.2	20.1	23.6	3.8	23.5	94.3	23.2	93.2	23.1	96.1	23.1	96.6		
15	10/10/96	07:25	22.2	19.4	22.4	5.9	22.4	95.3	22.3	95.1	22.1	94.8		95.8		
15	10/11/96	07:50	22.8	15.9	22.9	5.7	23.1	87.0	22.8	90.4	22.7	89.8	22.5	55.6		
15	10/11/96	11:40	24.6	11.2			24.5	99.9	24.6	99.9	24.6	99.9	24.7	99.9	25.0	99.9
15	10/14/96	07:30	25.5	18.5			26.0	96.5	25.8	97.2	25.7	99.9	25.8	99.9	26.0	99.9
16	10/15/96	09:15	25.3	19.9	25.6	3.2	25.7	95.7	25.3	96.1	25.2	96.4	25.1	96.1		

Table A1.1. Temperature and relative humidity (p. 5/6).

Week	Date	Time	Ambient		Desiccant		Cell 2		Cell 10		Cell 14		Cell 16		Humidifier[1]	
			T	RH	T	RH	T	RH	T	RH	T	RH	T	RH	T	RH
16	10/16/96	07:30	25.0	17.9	25.3	3.4	25.6	87.5	25.3	88.5	25.2	89.3	25.2	89.3		
16	10/17/96	07:15	25.5	18.7	25.7	4.4	26.0	84.4	25.8	84.7	25.8	85.2	25.8	86.4		
16	10/18/96	07:10	21.9	18.9	22.0	5.7	22.2	84.1	22.1	83.3	22.1	84.9	22.1	85.1		
16	10/18/96	10:30	23.1	18.7			23.3	94.2	23.3	95.1	23.2	96.2	23.2	96.9	23.0	99.9
16	10/21/96	07:15	23.5	18.9			24.5	99.9	24.1	99.9	24.0	99.9	24.1	99.9	24.4	99.9
17	10/22/96	09:10	23.8	17.5	24.1	3.8	24.1	92.5	24.0	92.8	23.9	91.9	23.8	93.1		
17	10/24/96	07:30	22.1	20.1	22.2	5.0	22.3	85.4	22.1	85.7	22.1	90.1	22.0	90.9		
17	10/25/96	07:25	22.3	19.5	22.3	5.7	22.3	88.0	22.3	84.3	22.3	84.5	22.3	85.9		
17	10/25/96	14:40	24.4	20.1			24.8	95.7	25.0	96.1	24.7	95.3	24.7	96.1	24.5	99.9
17	10/28/96	07:25	22.6	17.9			23.8	99.9	23.8	99.9	23.7	99.9	23.5	99.9	24.6	99.9
18	10/29/96	09:10	24.1	17.3	23.8	3.8	23.7	92.1	23.5	93.2	23.4	93.4	23.3	91.8		
18	10/31/96	07:50	17.7	12.8	18.7	6.0	17.8	88.1	17.7	88.9	17.6	88.4	17.6	87.3		
18	11/1/96	07:30	18.3	12.2	18.6	6.6										
18	11/1/96	11:50	20.0	15.8			21.3	99.9	19.8	99.9	19.8	99.9	19.8	99.9	21.0	99.9
18	11/4/96	07:30	20.8	18.5			22.2	99.9	21.8	99.9	21.6	99.9	21.5	99.9	22.8	99.9
19	11/5/96	09:05	21.8	22.9	22.3	4.4	22.2	99.9	21.7	99.9	21.7	99.9	21.7	99.9		
19	11/6/96	08:20	21.9	25.3	22.8	4.5	22.3	86.2	22.2	88.1	22.2	87.3	22.2	87.2		
19	11/8/96	07:35	21.8	19.0	21.6	5.7	21.5	88.7	21.5	89.6	21.4	88.6	21.3	93.1		
19	11/8/96	11:45	22.7	17.4			23.7	99.9	23.6	99.9	23.6	99.9	23.7	99.9	23.7	99.9

Table A1.1. Temperature and relative humidity (p. 6/6).

Week	Date	Time	Ambient		Desiccant		Cell 2		Cell 10		Cell 14		Cell 16		Humidifier[1]	
			T	RH	T	RH	T	RH	T	RH	T	RH	T	RH	T	RH
19	11/11/96	07:40	19.4	11.3			20.7	99.9	20.6	99.9	20.3	99.9	20.3	99.9	20.9	99.9
20	11/12/96	09:15	19.7	9.1	19.7	5.3	19.8	99.9	19.8	99.9	18.7	99.9	18.8	99.9		
20	11/13/96	07:50	21.2	7.8	21.5	4.9	21.6	96.5	21.5	93.9	21.6	95.5	21.5	96.8		
20	11/14/96	07:15	21.3	7.4	21.3	5.8	21.3	86.0	21.1	85.3	21.1	87.3	21.1	89.9		
20	11/15/96	07:40	19.8	11.0	20.2	6.6	19.8	83.8	19.7	82.4	19.5	84.2	19.4	86.2		
20	11/18/96	07:30	21.2	8.5			21.7	99.9	21.6	99.9	21.7	99.9	21.7	99.9	22.1	99.9

Table A1.2. Air flow rates in liters per minute (p. 1/3).

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Week	4	4	8	9	9	9	9	10	10	10	10	11	12	12	12
Cell	7/24/96	7/26/96	8/26/96	8/28/96	8/29/96	8/30/96	9/2/96	9/4/96	9/5/96	9/6/96	9/9/96	9/11/96	9/18/96	9/19/96	9/20/96
1	1	1		1.75	1.25	1	.75	1.75	1	1	1	1.5	1.75	1.5	1
2	1	1	1.25	2	1.25	1	1	1.5	1	1	1	1.5	1.75	1.25	1
3	1	.75	1	2.25	1.25	1	1	2	1	1	1	2	2.5	1.25	1
4	1	.75	1	2	1.25	1	.75	2	1	1	1	1.25	2	1.25	1
5	1	1	2	1.75	1.5	1	1	1.5	1	1	1.25	1.5	2	1.25	1
6	1	1	1	2.25	1.25	1	1	1.5	1	1	1	1.5	2.25	1	1
7	1	1	1.5	1.75	1.5	1	1	1.5	1	1	1	1.5	1.5	1	1
8	1	1	1.5	2	1.25	1	1	1.75	1	1	1	1.5	1.25	1	1
9	1	1	1.25	2	1.5	1	1	1.75	1	1	1	1.5	2	1.25	1
10	1	1	1	1.75	1	1	1	1.75	1	1	.75	1.25	1.5	1	1
11	1	1	1	1.75	1.5	1	1	1.5	1	1	1	1.5	2	1	1
12	1	1	1.25	1.25	1	1	1	2.5	1	1	1	2.5	1.5	1	1
13	1	1	1.25	3	2	.75	1	1.75	1	1	1	1.25	1.5	1	1
14	1	1	1	1.25	1.5	1	1	1	1	1	.75	1.5	1.5	1	1
15	1	1	1	2	1.5	1	1	2	1	1	1.25	1.5	1.5	1.25	1.5
16	1	1	1	1.25	1	.75	1	1	1	1	1	1.5	1	1	1

Table A1.2. Air flow rates in liters per minute (p. 2/3).

Week	12	13	13	13	14	14	14	14	15	15	15	16	16	16	16
Cell	9/23/96	9/25/96	9/27/96	9/30/96	10/2/96	10/3/96	10/4/96	10/7/96	10/10/96	10/11/96	10/14/96	10/16/96	10/17/96	10/18/96	10/21/96
1	1.5	2.5	1.5	1.5	1	1	1	1.25	1.25	1.25	1	1	1	1.25	1
2	1	1	1.5	1.25	1	1	1	1	1	1	1	1.25	1	1	1
3	1	1.75	2.5	1.25	1.25	1	1	1.5	1.25	1	1.5	1.25	1	1	1
4	1	1.25	2	1.25	1	1	1	1	1	1	1	1.5	1	1	.75
5	1	1.25	1	1	1.25	1	1	1	1	1	1	1.25	1	1	1
6	1	1	1.5	1	1	1.25	1.25	1	1.25	1	1	1	1.25	1.5	1
7	1	1.25	1.5	1.25	1.25	1	1	1.5	1	1	1.25	1.25	1	1	1
8	1	2.5	2	1.25	1	1	1.25	1	1	1	1	1	1	1	1
9	1	2	1.5	1.25	1	1	1	1	2	1	1.25	1.25	1	1	1
10	1	1	2	1.25	1.25	1	1	1	1	1	1	1	1	1	1
11	1	1	1.75	1	1	1	1	1	1	1	1.25	1.25	1	1	1
12	1	2.5	2.5	1	1	1	1	1.25	1	1	1	1	1	1	1
13	1	2	3.5	2	1.25	1	1	1.25	1.25	1	1	1	1	1	1
14	1	1.75	3.75	1	1	1.25	1	1.25	1	1	1	1	1	1	1
15	1.25	2.5	2	1.5	1.25	1	1.25	1	1	1.25	1	1.5	1	1	1
16	1	3.5	2	1.25	1	1.5	1	1.25	1	1	1	1	1	1	1

Table A1.2. Air flow rates in liters per minute (p. 3/3).

Week	17	17	17	18	18	18	19	19	19	19	20	20	20	20
Cell	10/24/96	10/25/96	10/28/96	10/31/96	11/1/96	11/4/96	11/6/96	11/7/96	11/8/96	11/11/96	11/13/96	11/14/96	11/15/96	11/18/96
1	1.25	1	1	1.5	1	1.5	1.25	1	1	1.25	1	1	1	1
2	1	1	1	1	1	1	1.25	1	1	1.5	1	1	1	1
3	1	1	1	1.25	1	1.25	1.25	1	1	1.5	1	1	1	1.25
4	1	1	.75	1	1	1	2	1	1	1.5	1	1	1	1
5	1	1	1	1.25	1	1.25	1.5	1	1	1.5	1	1	1	1
6	1	1	.5	1.5	1	1	1.25	1.25	1	1.5	1	2.5	1	1.25
7	1	1	1.5	1	1	1.25	1.25	1	1	1.5	1	1	1	1.5
8	1	1	.75	1.25	1	1.5	1.25	1	1	1.75	1	1	1	1.25
9	1	1	1	1.25	1	1	1.25	1	1	1.5	1	1	1	1.25
10	1	1	1	1.5	1	1	1.5	1	1	1.5	2	1	1	1
11	1	1	1	1.5	1	1	1	1	1	1.5	1	1	1	1.25
12	1	1	1	1.25	1	1	1.25	1	1	1.5	1	1	1	1.25
13	1	1	1	1.25	1	1	2	1.25	1	1.5	1	1	1	1
14	1	1	1	1.25	1	1.5	1.25	1	1	1.5	1.5	1	1	1.25
15	1.25	1	.75	1.25	1	1.25	1	1	1	1.75	1	1	1	1.25
16	1	1	1	1	1	1	1.25	1	1	1.5	1	1.25	1	1

Table A1.3. Chemical composition of siltite-argillite samples. usbm:/chemcomp.tab

	1-0696R	3-0696R	6-0696R	4-0696R	4-0696R DUP	5-0696R	2-0696R
S_T %	0.12	0.16	0.22	0.26	0.26	0.30	0.96
SO_4 %							
S^{2-} %							
Ag ppm	1.0	<0.2	0.6	0.8	0.8	0.6	0.4
Al %	6.56	6.14	6.55	6.13	6.00	6.30	5.12
Ba ppm	1650	1010	950	2790	3140	1540	1570
Be ppm	<0.5	0.5	1.0	<0.5	<0.5	0.5	<0.5
Bi ppm	<2	<2	<2	<2	<2	<2	<2
Ca %	0.07	0.04	0.09	0.05	0.05	0.10	0.06
Cd ppm	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Co ppm	5	1	1	1	1	9	1
Cr ppm	23	52	69	59	96	58	40
Cu ppm	116	40	91	53	54	86	45
Fe %	1.32	0.91	2.58	1.42	1.45	3.81	3.14
K %	5.19	4.64	5.22	6.64	6.81	4.52	4.95
Mg %	0.39	0.27	0.48	0.23	0.22	0.44	0.27
Mn ppm	20	5	5	5	5	20	5
Mo ppm	26	5	5	30	31	7	33
Na %	0.64	0.83	0.20	0.28	0.29	0.22	0.28
Ni ppm	15	6	6	4	3	17	3
P ppm	220	340	610	400	390	520	500
Pb ppm	10	44	5	28	14	10	18
Sr ppm	152	310	631	358	363	582	509
Ti %	0.13	0.18	0.23	0.15	0.13	0.21	0.10
V ppm	30	53	71	42	40	66	37
W ppm	10	10	10	10	<10	10	10
Zn ppm	16	8	18	8	6	108	8

Table A1.4. Chemical composition of USBM SLRC siltite-argillite samples. Sulfur determinations by LECO furnace, metals by ICP.

Concentrations in ppm unless otherwise noted.

	Sample No. 100.4	Sample No. 99.4	Sample No. 99.1	Sample No. 99.6
Total S, pct	1.60	2.30	3.24	5.82
S^2, pct	1.53	2.21	3.12	5.70
SO_4, pct	0.20	0.27	0.36	0.37
Al	6.52	6.33		
As	<0.307	<0.301		
B	<0.051	<0.50		
Ba	<0.010	<0.010		
Ca	0.442	0.472		
Cd	0.046	<0.020		
Ce	<0.408	<0.401		
Co	<0.042	<0.042		
Cr	<0.035	<0.034		
Cu	<0.050	<0.049		
Fe	4.62	4.75		
Ga	<0.101	<0.099		
La	<0.030	<0.029		
Mg	0.776	0.931		
Mn	<0.023	<0.022		
Mo	<0.060	<0.059		
Ni	<0.240	<0.235		
P	<0.766	<0.753		
Pb	<0.250	<0.246		
Th	<0.091	<0.089		
Ti	0.277	0.283		
V	<0.040	<0.040		
Y	<0.020	0.025		
Zn	<0.033	<0.032		

Table A1.5. Siltite-argillite sample mineralogy and neutralization potential. USBM:/sltargmn.tab

	100.2[1]	100.4	99.4
XRD Mineralogy:			
Qtz	30	40	
K-spar	12	18	
Plag.	8	20	
Olivine	4	5	
Illite	5	2	
Pyrite	31[2]	5[2]	
Carbonate:			
Siderite	1-2	1-2	
Kutnohorite	1-2	1-2	
Dolomite (ferroan)	tr.	tr.	
Magnesite (ferroan)	tr.	tr.	
Ankerite	tr.	tr.	
Total (XRD)	94%	94%	
NP (by method)			
C-S	59	40	
ABA, Std.	4.4	6.9	15.2
ABA, Mod.	3.9	2.9	
NP (pHG), Mod.	1.9	2.3	

[1] Sample subjected to 216 wks of accelerated weathering by USBM; included to demonstrate similarity in mineralogy and NP to sample 100.4.

[2] Stoichiometric pyrite values based on sulfide content were 24% and 3%, respectively.

Table A1.6. Particle size distribution of Duluth Complex sample MN6.1. Distribution determined by USBM SLRC.

Mesh	Diameter mm	Wt.(g)	Pct
-.25+4	4.75 - 6.35	415.9	20.65
-4+10	2.00 - 4.75	950.8	47.21
-10+20	0.850 - 2.00	220.8	10.96
-20+28	- 0.850	46.2	2.29
-28+35		23.9	1.19
-35+48		44.2	2.19
-48+65		43.8	2.17
-65+100		71.4	3.55
-100+150		85.4	4.24
-150+200		21.2	1.05
-200		90.4	4.49
Total		2014	100

Table A1.7. Chemical composition of Duluth Complex sample MN6.1. Analysis by ICP unless otherwise noted. Analyses by USBM SLRC. XRF analysis was also conducted to estimate contents of Si, K, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Sr, Zr, Ba.

Sample	S_T[1] pct	SO_4[1] pct	S^{2-} pct	NP kg/t	CO_3 pct	Ca ppm	Mg ppm	Na ppm	K ppm	Cu ppm	Ni ppm	Co ppm	Zn ppm	Fe ppm	Mn ppm	Al ppm
MN6.1 #1	1.5	0.026	1.5													
MN6.1 #2	1.3	0.073	1.2													
MN6.1 #3	1.4	0.067	1.3													
MN6.1 #4	1.4	0.086	1.3													
MN6.1 #5	1.5	0.087	1.4													
MN6.1 #6	1.4	0.116	1.3													
MN6.1 #7	1.8	0.086	1.7													
MN6.1 #8	1.9	0.094	1.8													
MN6.1					<0.1[2]			1.42[3]	0.51[3]	0.38[3]	0.096[3]	0.0079[3]	0.22[3]			
MN6.1					0.3											
-1/4+4	1.0	0.020				4.93	5.14			0.382	0.139	<0.89	<0.016	10.8	0.127	7.26
-4+10	1.2	0.019				4.79	5.12			0.337	<0.119	<0.90	0.020	11.2	0.129	7.63
-10+20	1.7	0.023				4.59	5.32			0.570	0.152	<0.89	0.018	11.8	0.129	7.28
-20+28	2.1	0.023				4.58	5.32			0.644	0.167	<0.90	0.025	12.3	0.127	7.15
-28+35	2.1	0.021				4.61	5.29			0.624	0.172	<0.88	0.018	12.2	0.127	7.04
-35+48	2.1	0.027				4.44	5.09			0.609	0.188	<0.88	0.018	11.8	0.128	6.70
-48+65	2.0	0.023				4.46	5.08			0.568	0.165	<0.82	0.019	11.6	0.123	6.98
-65+100	1.6	0.026				4.42	5.07			0.450	0.152	<0.89	0.017	11.0	0.120	7.36
-100+150	1.6	0.023				4.20	5.08			0.495	0.144	<0.89	0.019	11.1	0.121	7.26
-150+200	1.6	0.024				4.29	5.08			0.801	0.195	<0.87	0.032	11.9	0.121	7.08
-200	2.0	0.036				4.25	5.26			0.572	0.165	<0.84	0.027	11.5	0.122	7.37

[1] By LECO furnace
[2] By wet distillation
[3] Analysis by atomic absorption Spectrophotometer
[4] By infrared spectrophotometry (1996 SEG paper)
Note: As, Ba, Ca, Cr, Mo, P, Pb, Ti, and V were also determined by ICP.

Table A1.8. Mineral composition of Duluth Complex sample MN6.1, 48x65 mesh fraction, and degree of sulfide mineral liberation. Values determined by point count and SEM analysis of thin sections at USBM SLRC.

Mineral	Percent
plagioclase (An51)	62
pyroxene & amphibole	13.5
olivine	5.5
biotite	5.5
sericite	3.5
chlorite	1
apatite	<1
epidote	<1
opaques* cubanite/ccp 2.8% pyrrhotite 2.3% pentlandite .2% ilmenite 1.5% magnetite 1.0% FeCuNiS .3%	8
quartz, orthoclase, zircon, monazite, chromite, calcite, & barite	<1

Sulfide mineral liberation in three size fractions.

<u>10x20 mesh</u>

Large - 50-1500 micrometers
Medium - 15-50 micrometers
Small - 1-15 micrometers
Liberation - 1-5%, included in plagioclase, pyroxene and sericite

<u>48x65 mesh</u>

Large - 100-280 micrometers
Medium - 20-100 micrometers
Small - 1-20 micrometers
Liberation - 40-50%, included in plagioclase, pyroxene and sericite

<u>-200 mesh</u>

Large - 20-75 micrometers
Medium - 5-20 micrometers
Small - <1-5 micrometers
Liberation - 99-100%

Table A1.9. Release rates for sulfate, calcium, and magnesium from MN6.1 in USBM SLRC humidity cells. Rates expressed as micromoles/kg week (Cell 6).

	pH (median)	Sulfate	Calcium	Magnesium	Ca/SO_4	Mg/SO_4
Wk 0 - 11	6.93	578.5	349.3	188.1	0.604	0.325
Wk 11 - 39	6.10	282.0	169.0	98.9	0.599	0.351
Wk 39 - 97	4.95	188.3	85.6	88.5	0.455	0.470
Wk 97 - 118	4.91	234.1	84.1	114.2	0.359	0.488
Wk 118 - 145	5.02	125.9	55.8	73.0	0.443	0.580

APPENDIX 2

DRAINAGE QUALITY TABLES

Table A2.1 Drainage quality from 0.12% S siltite-argillite (sample number 1-0696R, cell 7).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	5.91	-5.0	112	31.1	10.4	2.4	4.2	3.7	0.07	7.2	0.014	0.009	0.006	0.003	0.001	0.019
1	xxx	6.64	12.5	70	22.1	6.1	1	2.7	2.7	0.022	10.8	0.001	0.005	0.006	0.001	0.001	0.012
2	xxx	6.66	10.0	50	14.8	4.2	1	1.9	2	0.03	10.9	0.002	0.003	0.007	<0.001	0.005	0.032
3	xxx	6.41	10.0	38.5	9.6	2.6	0.7	1.7	2.2	0.1	12.5	<0.001	<0.001	0.009	<0.001	0.001	0.036
4	xxx	6.35	15.0	33.5	8.6	2	<0.1	1.6	1.9	0.2	9.5	0.033	<0.001	0.008	0.001	0.003	0.008
*5	187	6.63	10.0	32.5													
6	192.7	6.45	10.0	27.5	7.4	1.9	0.4	1.2	1.8	0.1	8.9	<0.001	<0.001	0.011	0.001	0.01	0.013
*7	190.7	6.49	10.0	29.5													
8	178.7	6.51	12.5	26.5	8.9	1.9	0.7	1	1.9								
*9	162.4	6.50	10.0	22.5													
10	190.9	6.62	7.5	25.5	5.9	1.8	<0.1	0.8	1.8								
*11	199.2	6.80	7.5	25													
12	199.9	6.67	5.0	19	7.28	1.6	0.1	0.6	2.5	0.008	10.1	0.031	0.006	0.005	0.001	0.003	0.012
*13	216.2	6.58	5.0	46													
14	190.5	6.57	7.5	39	14.75	4.6	0.3	0.5	1.7	0.005	9.1	0.001	0.003	0.003	<0.001	0.034	0.056
*15	218.5	6.56	7.5	21													
16	171.5	6.43	5.0	27	8.98	2.6	0.2	0.4	1.8	0.012	7.8	0.001	0.003	0.004	0.002	0.009	0.037

Table A2.2 Drainage quality from 0.12% S siltite-argillitite (sample number 1-0696R, cell 8).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	6.02	<-5	109	30.6	9.8	1.3	3.9	3.4	0.023	7	0.01	0.006	0.006	0.002	0.001	0.015
1	xxx	6.29	7.5	75	23.6	6.3	1	3	2.7	0.022	11.4	0.006	0.005	0.006	0.001	0.001	0.011
2	xxx	6.42	7.5	45	13.2	3.7	0.7	1.7	1.7	0.027	8.8	0.004	0.003	0.01	<0.001	0.003	0.039
3	xxx	6.45	10	46.5	12.8	3.1	0.6	2.2	2	0.007	10.1	<0.001	<0.001	0.005	0.026	0.001	0.034
4	xxx	6.38	15	39	10.5	2.6	0.6	1.6	1.7		<1	<0.001	0.003	0.005	0.001	0.002	0.091
5	186.7	6.59	5	34													
6	196.5	6.51	10	30	8.1	2.1	0.1	1.5	1.9	0.02	7.2	<0.001	<0.001	0.007	0.001	0.01	0.012
7	190.8	6.55	10	27													
8	178.6	6.56	5	23	6.5	1.5	0.5	0.8	1.8		5.8			0.008	0.001	0.011	0.04
9	163.7	6.53	7.5	23.5													
10	192.6	6.65	7.5	22	6.47	1.7	0.2	0.7	1.7		2.2			0.006	0.001	0.004	0.036
11	200	6.85	5	24.5													
12	202.1	6.74	7.5	19	6.72	1.6	0.1	0.5	1.7	0.006	8.3	0.056	0.002	0.005	0.001	0.003	0.013
13	218.6	6.71	5	19													
14	185.5	6.60	7.5	17.5	7.67	1.5	0.3	0.4	1.6	0.021	7	0.008	0.002	0.004	0.001	0.007	0.063
15	218.6	6.59	10	20.5													
16	171.1	6.53	12.5	19.5	6.63												

Table A2.3 Drainage quality from 0.19% S siltite-argillite (sample number 3-0696R, cell 5).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Net Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	3.83	-25	298	114.4	26.3	4.5	2	11.5	1.4	2.3	0.8	0.051	0.124	0.025	0.009	0.2
1	xxx	3.91	-25	325	17	33.5	5.3	1.2	7	0.085	8.6	0.097	0.075	0.1	0.03	0.012	0.2
2	xxx	4.00	-25	185	66.3	17.6	3	0.6	4.6	0.8	4.9	0.015	0.036	0.078	0.013	0.009	0.1
3	xxx	4.15	-20	115	30.3	8.4	1.7	0.6	3.7	0.2	<1	0.042	0.013	0.028	0.005	0.003	0.065
4	xxx	4.11	-15	135	41.4	10	1.9	0.4	3.4	0.3	2.9	0.07	0.03	0.049	0.015	0.009	0.064
5	218	4.02	-10	100													
6	237.5	4.04	-12.5	100	30.6	7.3	1.5	0.3	2.5	0.2	2.8	<0.001	0.014	0.027	0.009	0.005	0.035
7	245.3	3.96	-10	100													
8	226.9	3.95	-10	95	27.8	6.4	1.4	0.2	2.4								
9	194.6	3.96	-10	80													
10	220.9	4.12	-10	80	22.43	5.3	0.1	0.2	1.9								
11	237.5	4.11	-12.5	75													
12	234.5	4.18	-5	56	17.18	4.3	0.6	0.1	1.7	0.064	4.8	0.051	0.011	0.022	0.008	0.005	0.05
13	241.5	4.19	-7.5	55													
14	212.9	4.24	-5	55	16.39	3.5	0.7	0.1	1.5	0.044	2.2	0.01	0.012	0.018	0.005	0.016	0.058
15	239.0	4.10	-7.5	60													
16	190.2	4.17	-7.5	65	16.1	3.5	0.5	0.1	1.6	0.193	1.4	0.009	0.011	0.018	0.005	0.029	0.045

Table A2.4 Drainage quality from 0.22% S siltite-argillite (sample number 1-0696R, cell 1).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	7.21	12.5	178	34.7	22	3	4.1	1.7	0.032	11	0.002	0.003	0.003	0.001	0.001	0.007
1	xxx	7.44	22.5	60	97.8	8.4	1.3	2.4	0.8	0.01	12.9	0.002	0.001	0.002	0.001	0.001	0.002
2	xxx	7.10	20	44.5	6.8	5.6	1.2	1.6	0.6	0.019	11.2	0.003	0.001	0.005		0.005	0.02
3	xxx	7.07	15	32.5	2.5	3.2	0.4	1.6	0.7	0.042	15.4	0.006	<0.001	0.003	0.001	0.002	0.32
4	xxx	6.86	15	38	3.3	4	0.5	1.6	0.6	0.004	13.1	<0.001	<0.001	0.002	0.001	0.002	0.006
5	156.5	7.30	15	34													
6	168.3	7.12	17.5	33	5.4	3.6	0.7	1.2	0.6	0.004	8.9	<0.001	<0.001	0.002	<0.001	0.001	0.01
7	154.3	7.08	15	31													
8	152.9	7.22	15	29	3.4	3.4	0.2	1.1	0.6								
9	131.1	7.26	10	25													
10	155.8	7.24	10	25	2.5	3.1	0.9	0.9	0.5								
11	187.4	7.35	10	29.5													
12	186.5	7.25	10	26	2.2	2.9	0.9	0.8	30.6								
13	193.6	7.24	12.5	25													
14	158.5	7.01	12.5	20.5	2.2	2.6	0.4	0.5	0.4	0.011	6.1	0.008	0.001	0.001	0.001	0.005	0.067
15	206.2	7.17	10	22													
16	152.8	6.89	7.5	22	2.6	2.6	0.4	0.5	0.5	0.008	6.9	0.002	0.001	0.001	<0.001	0.007	0.023

Table A2.5 Drainage quality from 0.26% S siltite-argillite (sample number 4-0696R cell 3).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	6.85	5	78	22.2	5.1	0.9	2.4	5.3	0.06	3.1	0.009	0.004	0.001	0.001	0.001	0.015
1	xxx	6.45	5	55	16	4.7	0.7	2.2	3	0.029	6	0.005	0.002	0.002	0.001	0.005	0.025
2	xxx	6.46	12.5	50	13.1	3.6	0.7	1.9	2.7	0.018	6.9	0.047	0.002	0.002	<0.001	0.003	0.021
3	xxx	6.90	15	42.5	10.8	2.6	0.7	1.7	2.2	0.024	8.1	0.006	<0.001	0.002	<0.001	0.041	0.03
4	xxx	6.84	12.5	35.5	8.7	2.3	0.6	1.4	1.8	0.1	5.3	0.008	<0.001	0.002	<0.001	0.002	0.01
5	199	6.98	10	38.5													
6	177.4	6.98	12.5	31	8.8	2.3	0.5	1.2	1.6	0.1	2.3	<0.001	<0.001	0.003	<0.001	0.002	0.01
7	178.8	6.99	12.5	26													
8	170.5	6.69	10	24.5	8.1	1.9	0.3	0.8	1.4								
9	146.9	6.85	5	23													
10	172.2	6.63	5	21	7.3	1.9	<0.1	0.6	1.1								
11	185.6	7.03	10	21													
12	195.6	6.70	7.5	19	7.59	1.6	0.2	0.5	1.2	0.008	4.9	0.012	0.001	0.044	0.002	0.002	0.056
13	169.5	6.74	5	19													
14	171.4	6.61	7.5	16	7.86	1.5	0.3	0.4	0.9	0.011	2.6	0.003	0.001	0.001	0.001	0.005	0.071
15	210.8	6.64	5	19.5													
16	162.7	6.62	5	19.5	6.62	1.6	0.3	0.4	1	0.017	2.5	0.005	0.002	0.001	<0.001	0.003	0.004

Table A2.6 Drainage quality from 0.26% S siltite-argillite (sample number 4-0696R, cell 4).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	6.89	N.S.	78	21.8	5.3	0.7	2.3	5.2	0.05	2.8	<0.001	0.004	0.003	0.01	0.002	0.018
1	xxx	6.69	7.5	60	17	4.8	0.8	2.3	3.2	0.014	7.6	0.003	0.003	0.003	0.018	0.009	0.031
2	xxx	6.49	10	39	13.1	2.9	0.3	1.4	2.1	0.016	6	0.002	0.001	0.003	<0.001	0.032	0.03
3	xxx	6.79	10	39	9.9	2.5	0.9	1.5	2.1	0.016	7.2	<0.001	<0.001	0.001	<0.001	0.002	0.036
4	xxx	6.74	10	31	7.5	2.1	0.5	1.1	1.7	0.1	3.9	0.021	<0.001	0.002	0.001	0.004	0.01
5	183	6.91	7.5	32													
6	180.9	6.84	7.5	30	8.5	2.4	0.4	0.9	1.6	0.005	4.2	<0.001	<0.001	0.002	<0.001	0.002	0.008
7	180.4	6.88	7.5	30													
8	169.6	6.67	7.5	24	7.2	2	0.4	0.6	1.4								
9	152.7	6.73	5	22													
10	177.1	6.66	7.5	22	5.28	1.8	0.2	0.5	1.2								
11	188	6.88	7.5	20.5													
12	196.9	6.66	5	17	4.6	1.6	0.2	0.4	1.3	0.01	5.4	0.063	0.001	0.002	0.002	0.002	0.035
13	197.9	6.66	5	18.5													
14	173.7	6.56	5	16.5	6.06	1.6	0.4	0.3	1	0.01	2.4	0.003	0.001	0.002	0.002	0.007	0.058
15	213.8	6.63	5	19													
16	164.4	6.53	2.5	17.5	6.62	1.5	0.2	0.3	1	0.034	2.2	0.003	0.001	0.02	0.001	0.006	0.027

Table A2.7 Drainage quality from 0.30% S siltite-argillite (sample number 5-0696R, cell 2).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	7.77	15.0	58	7.7	7	0.9	1.5	1.6	0.031	5.4	0.011	0.001	0.002	0.014	0.001	0.006
1	xxx	7.49	25.0	55	9.2	7.5	0.8	1.2	1.2	0.015	6	0.002	<0.001	0.001	0.009	0.002	0.015
2	xxx	7.19	20.0	50	6.8	7	0.9	1	1.1	0.022	8	0.003	0.001	0.004	<0.001	0.006	0.038
3	xxx	7.23	20.0	55	9.8	7.6	1.2	1.1	1.1	0.023	8.1	0.003	<0.001	0.001	0.001	<0.001	0.029
4	xxx	6.94	20.0	50	8	6.3	0.8	0.8	0.9	0.014	6.9	<0.001	<0.001	0.002	0.01	0.008	0.007
5	171	7.48	15.0	50													
6	174.9	7.18	12.5	45	7.7	5.7	0.6	0.6	0.8	0.1	4.1	<0.001	<0.001	0.004	0.014	0.002	0.009
7	167	7.24	12.5	41.5													
8	161.4	7.37	17.5	34	5.3	1.6	0.4	0.4	0.8							0.014	
9	137.5	7.30	15.0	31													
10	162.8	7.33	12.5	30.5	3.4	4.1	0.6	0.4	0.7							0.006	
11	180	7.53	20.0	42.5													
12	194.5	7.54	15.0	33	5	4.9	0.4	0.3	1	0.008	7	0.013	<0.001	0.001	0.008	0.003	0.025
13	191.9	7.45	15.0	36													
14	164.6	7.29	17.5	30	2.8	4.6	0.7	0.3	0.7	0.011	3.6	0.003	0.001	0.001	0.006	0.012	0.058
15	207.8	7.42	12.5	29													
16	157.0	7.08	12.5	29	2.9	3.8	0.5	0.2	0.7	0.026	3.8	0.006	0.001	0.001	0.007	0.01	0.028

Table A2.8 Drainage quality from 0.96% S siltite-argillite (sample number 2-0696R, cell 6).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Net Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	5.51	<-5.0	72	21.5	4.7	0.5	1.1	7.3	0.112	20.3	0.017	0.005	0.004	0.003	0.001	0.023
1	xxx	5.43	<-5.0	85	29	5.7	0.8	1.1	7.6	0.074	9.6	0.002	0.004	0.008	0.002	0.001	0.019
2	xxx	6.16	<-5.0	65	21	4.4	0.9	0.8	6	0.042	7.7	0.003	0.003	0.005	0.002	0.003	0.033
3	xxx	5.39	<-5.0	55	17.1	3.2	1	0.8	5	0.1	7.7	<0.001	<0.001	0.002	0.001	0.002	0.064
4	xxx	5.23	<-5.0	45	13.5	2.8	0.6	0.6	4.2	0.2	2.8	0.067	<0.001	0.003	0.002	0.004	0.011
5	203	5.06	<-5.0	50													
6	206.4	5.54	<-5.0	43	13.9	2.6	0.4	0.4	3.9	0.2	4.1	<0.001	<0.001	0.003	<0.001	0.001	0.011
7	219.7	5.07	-5.0	40													
8	196.9	5.08	-5.0	33	10.1	2	0.7	0.3	3.3								
9	177.7	5.08	-5.0	33.5													
10	208.2	5.19	-5.0	32	9.05	1.8	<0.1	0.2	3.1								
11	214.5	5.38	-5.0	26													
12	215.8	5.28	-5.0	24	8.01	1.4	0.2	0.1	2.8	0.032	5.9	0.065	0.002	0.002	0.001	0.002	<0.001
13	228.2	5.10	-2.5	33													
14	202.4	5.22	<-5.0	24	7.54	1.5	0.4	0.5	2.7	0.02	2.9	0.009	0.002	0.001	0.001	0.068	0.072
15	229.4	5.05	<-5.0	26.5													
16	182.2	5.06	-2.5	27.5	7.87	1.5	0.2	0.1	2.8	0.039	1.9	0.006	0.002	0.002	0.004	0.035	0.029

Table A2.9 Drainage qualinity from 1.5% S siltite-argillitite (sample number MT-100.4, cell 15).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Net Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	5.70	-5	623	590	11.8	144	0.3	2.1	0.036	0.7	0.01	1	0.002	0.313	0.015	0.044
1	xxx	5.68	-5	230	94.8	2.3	23	0.2	1.5	0.023	1	0.022	0.2	0.003	0.036	0.011	0.039
2	xxx	5.81	-5	225	95.6	2.1	22.4	0.3	1.2	0.1	0.2	0.004	0.2	0.006	0.038	0.029	0.024
3	xxx	5.60	<-5	145	54.5	1.2	13.2	0.2	1.4	0.1	1	0.041	0.1	0.003	0.022	0.005	0.048
4	xxx	5.51	<-5	165	61.7	1.3	14.2	0.3	1.3	0.1	<1	0.003	0.1	0.005	0.03	0.005	0.017
5	240.5	5.29	<-5	165													
6	246.6	5.51	<-5	165	72.1	1.6	16.6	0.2	1.5								
7	260	5.24	-5	165													
8	254.6	5.29	-5	180	74.1	1.5	17.2	0.3	1.5								
9	210.5	5.26	-5	170													
10	250.7	5.53	<-5	175	70.47	1.3	16.8	0.2	1.3								
11	281.9	5.84	<-5	145													
12	272.5	5.48	<-5	123	54.52	1.4	13.6	0.1	1.3	0.017	1	0.089	0.109	0.005	0.035	0.016	0.026
13	259.8	5.78	-2.5	135													
14	262.3	5.77	<-5	130	57.57	2.2	12.7	0.1	1.1	0.017	0.4	0.042	0.098	0.001	0.022	0.401	0.086
15	290.7	5.49	<-5	140													
16	280.9	5.54	-2.5	155	65.66												

Table A2.10 Drainage qualinity from 1.5% S siltite-argillitite (sample number MT-100.4, cell 16).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Net Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	5.66	<-5	580	560.8	9.6	131	0.3	2.2	0.031	0.6	<0.001	0.9	0.002	0.137	0.012	0.039
1	xxx	6.15	<-5	310	138	2.6	32.7	0.3	1.6	0.016	0.8	0.035	0.2	0.002	0.041	0.005	0.071
2	xxx	6.43	7.5	215	87.3	1.7	21.9	0.3	1.4	0.112	<1	0.053	0.2	0.006	0.024	0.005	0.021
3	xxx	5.67	15.0	140	54	1	1	0.2	1.4	0.1	<1	0.031	0.1	0.002	0.013	0.003	0.044
4	xxx	5.74	10.0	190	71.3	1.3	17.4	0.2	1.1	0.1	0.6	<0.001	0.1	0.002	0.021	0.004	0.017
5	235	5.98	<-5	210													
6	240.9	5.88	<-5	190	81.2	1.5	19.4	0.2	1.3								
7	234	5.58	<-5	165													
8	243.6	5.26	<-5	160	66.6	1	15.3	0.2	1.4								
9	211.1	5.37	<-5	175													
10	247.5	5.91	<-5	190	79.35	1.3	19.9	0.2	1.2								
11	276.6	6.32	5.0	175													
12	264.2	6.07	2.5	120	53.89	0.8	12.5	0.1	1.3	0.014	0.7	0.033	0.074	0.003	0.016	0.003	0.01
13	250.8	5.75	-2.5	135													
14	258.5	5.94	<-5	135	58.85	1	13.8	0.1	1	0.017	<0.1	0.013	0.076	0.001	0.016	0.153	0.078
15	284.5	5.61	<-5	140													
16	276.6	5.72	<-5	175	73.6												

Table A2.11 Drainage quality from 2.2% S siltite-argillitite (sample number MT-99.4, cell 9).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	6.00	-17.50	527	254.3	22.3	37.1	7.9	21.6	0.082	0.9	4.8	0.9	0.051	0.5	0.2	0.9
1	xxx	4.47	-7.50	550	231.8	11.3	38.9	5.5	12.5	0.144	2.8	0.9	0.8	0.008	0.285	0.055	0.1
2	xxx	5.38	-7.50	380	155.6	8.5	33	2.7	8.7	0.093	2.7	0.3	0.6	0.011	1.1	0.034	0.092
3	xxx	6.22	<-5	335	130.8	6.4	26.6	1.8	6.6	0.016	1.2	0.01	0.3	0.001	0.1	0.019	0.065
4	xxx	6.33	<-5	305	119.9	5.6	24.5	1.3	5.1	0.3	1.1	0.061	0.3	0.002	0.062	0.017	0.039
5	196	6.77	7.50	260													
6	209	6.68	5.00	230	97.9	4.4	21.7	0.7	4.2		1.4						
7	205.3	6.71	7.50	205													
8	187.9	6.86	7.5	200	79.7	3.3	18	0.5	3.4		0.3						
9	170.6	6.74	10	155													
10	192.2	7.07	7.5	160	62.25	2.8	15.4	0.4	2.8		<1						
11	206.2	7.10	12.5	145													
12	204.6	7.09	10	120	51.77	2	11.9	0.2	2.4	0.006	2.5	0.044	0.46	0.001	0.014	0.003	0.01
13	219.4	7.05	10	135													
14	189.0	6.98	10	125	50.66	2.1	12.7	22	2.2	0.006	1.1	0.004	0.045	0.001	0.012	0.009	0.07
15	213.0	6.99	12.5	105													
16	171.5	6.83	10	155	62.57												

Table A2.12 Drainage quality from 3.12% S siltite-argillitite (sample number MT-99.1, cell 10).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Net Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	3.74	-375	1944	1509	113.3	172	5.8	15.1	5	2.7	149.3	17.3	3	1.7	0.8	3.1
1	xxx	4.83	-45	2350	1228.2	74.1	145	5.3	13.3	37	1.5	9.5	7.6	0.014	0.417	0.2	0.1
2	xxx	6.06	-5	1650	883.9	75.9	132	3.4	12.3	0.026	2.7	0.6	3.1	0.004	1.1	0.026	0.044
3	xxx	5.70	-5	1450	649.6	59.5	91	1.8	8.8	0.005	<1	<0.001	1.6	0.003	0.1	0.015	0.047
4	xxx	5.94	<-5.0	1250	644.2	58.2	118.7	1.6	8.1	0.2	<1	0.048	2.1	0.003	0.142	0.022	0.027
5	199.5	5.74	<-5.0	1050													
6	226.2	6.08	<-5.0	1250	715	48.6	113.7	1	7.3		0.8			0.005	0.101	0.012	0.022
7	224.9	5.79	-5	950													
8	211.3	5.40	-5	1100	604.4	42.5	108.1	0.7	5.9		<1			0.007	0.055	0.011	0.075
9	187.6	5.49	-5	900													
10	206.8	5.68	-5	1050	548.4	39	102.1	0.6	5		<1			0.006	0.042	0.009	0.059
11	222.9	5.74	-5	750													
12	219.7	5.70	-7.5	610	467.7	35.5	101.2	0.5	4.9	0.022	0.7	0.112	1.3	0.006	0.049	0.007	0.034
13	231.5	5.65	-7.5	650													
14	199.4	5.81	-5	650	382.3	27.6	76.9	0.4	4.3	0.008	<0.1	0.041	0.999	0.002	0.038	0.022	0.066
15	221.2	5.86	-5	700													
16	179.0	6.22	-7.5	850	459.3												

Table A2.13 Drainage quality from 5.7% S siltite-argillitite (sample number MT-99.6, cell 11).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Net Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	3.97	-335	699	421.8	3.2	2.4	10	17.1	23.2	3.8	112.3	1.8	1.5	2.1	3.4	0.7
1	xxx	3.78	-90	365	127	1.6	1	4.8	8.8	4.4	9.2	22.6	2.9	2.9	0.9	0.9	0.3
2	xxx	3.63	-85	280	98.2	1.6	1.2	1.8	6.1	6.3	4.6	9.1	3	6.4	1.2		0.4
3	xxx	3.41	-140	445	153.5	1.7	0.8	1.5	4.9	4.9	5.8	14.5	3.3	7.8	1.6	1.1	0.5
4	xxx	3.36	-215	500	196.6	1.7	1	1.3	4.2	6.5	7.3	18.6	3.2	8.4	1.5	1	0.5
5	314.5	3.19	-240	500													
6	323.5	3.10	-265	550	279.5	0.9	1	0.5	1.9		9.8			5.284	0.743	0.48	0.267
7	357.2	3.02	-280	600													
8	334.7	2.94	-295	550	279.5	0.4	1	0.5	0.8		5.8			3.299	0.418	0.276	0.171
9	338.8	2.91	-252.5	650													
10	345	3.11	-255	650	283.9	0.2	<0.1	0.5	0.6		2.5			2.285	0.27	0.175	0.126
11	373.7	3.10	-220	500													
12	355.3	3.05	-255	500	232.3	0.3	0.2	0.4	0.6	16.1	11	42.1	0.115	1.5	0.265	0.114	0.08
13	365.9	3.08	-205	500													
14	339.0	3.16	-200	500	208.8	0.3	0.2	0.4	0.5	13.2	10.4	43.1	0.074	1.1	0.158	0.091	0.095
15	360.0	3.03	-235	600													
16	337.4	3.04	-282.5	650	262.4												

Table A2.14 Drainage quality from 1.39% S Duluth Complex (sample number Mn-6.1, cell 12).

Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	7.61	32.5	264	106.6	27	11.9	5.1	2.8	0.027	2.5	0.083	0.073	0.005	0.4	0.005	0.014
1	xxx	6.66	7.5	440	161.5	44.8	15.1	5.4	2.2	0.031	2	0.018	0.078	0.02	0.247	0.008	0.046
2	xxx	7.00	10	260	98.2	30.7	9.3	1.6	0.6	0.023	3	0.075		0.006		0.007	0.028
3	xxx	6.79	12.5	295	107.4	32.9	8.9	2.6	1.8	0.2	1.6	0.019	0.037	0.002	0.2	0.004	0.035
4	xxx	6.62	12.5	255	92.4	28.3	7.5	2.1	1.7	0.2	0.1	0.1	0.051	0.002	0.1	0.004	0.008
5	240	6.94	7.5	215													
6	254.6	6.66	5	170	69.6	18.8	5.3	1.5	2.6		1.8			0.006	0.126	0.01	0.009
7	257	6.71	10	175													
8	255	6.69	10	155	62.5	16.7	4.8	1.2	2.9		0.3			0.003	0.165	0.013	0.043
9	238.9	6.61	7.5	170													
10	267.8	6.73	7.5	150	55.61	15.7	4.5	1	2.7		<1			0.003	0.12	0.008	0.039
11	307.2	6.81	5	125													
12	281.8	6.76	7.5	125	51.2	14	4.3	0.8	2.9	0.012	4.1	0.02	0.094	0.006	0.8	0.011	<0.001
13	304.9	6.58	7.5	135													
14	282.6	6.54	10	120	51.73	13.8	4.1	0.7	2.7	0.013	2.4	0.005	0.112	0.004	0.238	0.016	0.059
15	322.5	6.50	5	145													
16	295.6	6.21	5	145	59.04												

Table A2.15 Drainage quality from 1.39% S siltite-argillitite (sample number Mn-6.1, cell 14).

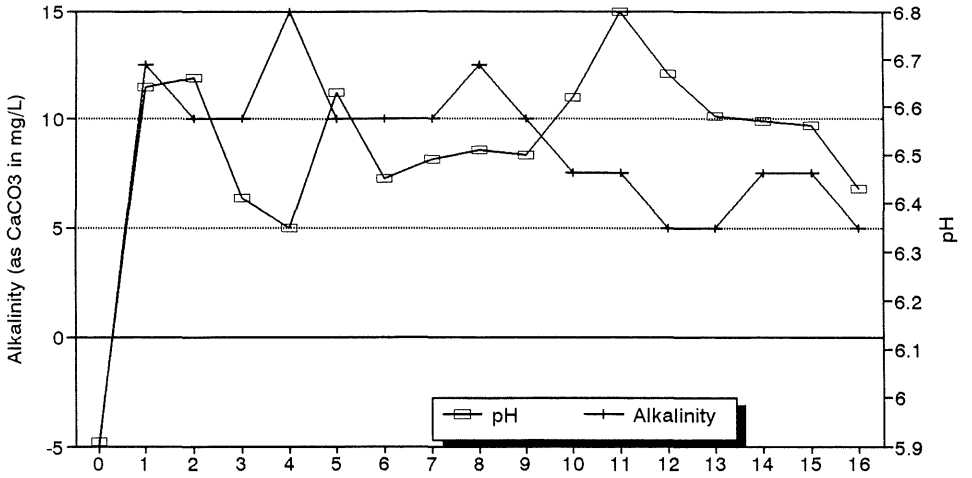
Concentrations are in mg/L unless otherwise noted. pH is in standard units, alkalinity in mg/L as CaCO3.

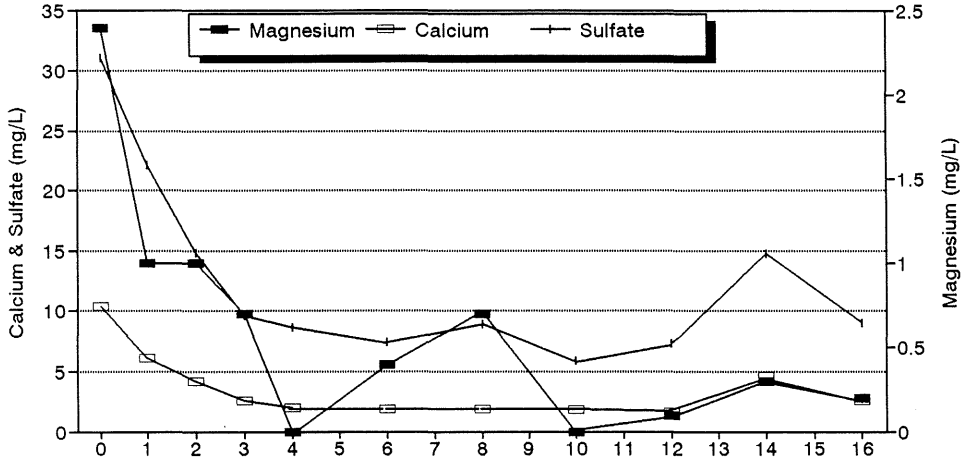
week	Eh(mv)	pH	Alkalinity	Cond(uS)	SO4	Ca	Mg	Na	K	Al	Si	Fe	Mn	Cu	Ni	Co	Zn
0	xxx	7.82	37.5	258	99.5	25	11.6	4.9	2.7	0.028	1.5	0.051	0.071	0.003	0.403	0.004	0.007
1	xxx	7.05	12.5	375	147.8	42.7	14	5.3	2	0.028	3	0.001	0.067	0.003	0.0475	0.004	0.006
2	xxx	7.18	15.0	280	108.4	32.7	10	32	1.7		0.2	0.013	0.042	0.003	0.069	0.004	0.016
3	xxx	6.82	15.0	230	81.3	24.9	6.3	1.7	1.4	0.2	<1	0.015	0.027	0.002	0.2	0.004	0.03
4	xxx	6.62	10.0	235	83.8	23.8	8	1.9	1.8	0.2	<1	<0.001	0.045	0.002	0.2	0.005	0.013
5	233.5	6.98	15.0	240													
6	243.5	6.72	5.0	200	82.5	22.9	6	1.6	2.4	.	1.6			0.003	0.087	0.041	0.015
7	251.6	6.77	5.0	180													
8	245.1	6.69	5.0	155	61.2	16.5	4.5	1.2	2.4		0.1			0.006	0.079	0.009	0.046
9	198	6.66	7.5	155													
10	254	6.79	7.5	165	61.58	18.1	5.2	1.1	2		<1			0.005	0.052	0.007	0.044
11	287	6.82	5.0	145													
12	275.3	6.72	12.5	128	51.64	14	4.2	0.9	2.5	0.009	3.1	0.006	0.09	0.008	0.175	0.009	0.029
13	288.0	6.61	10.0	125													
14	273.1	6.57	5.0	120	50.21	14	3.8	0.7	2.5	0.01	1.5	0.016	0.103	0.006	0.185	0.019	0.089
15	309.2	6.54	5.0	135													
16	285.9	6.36	12.5	135	52.26												

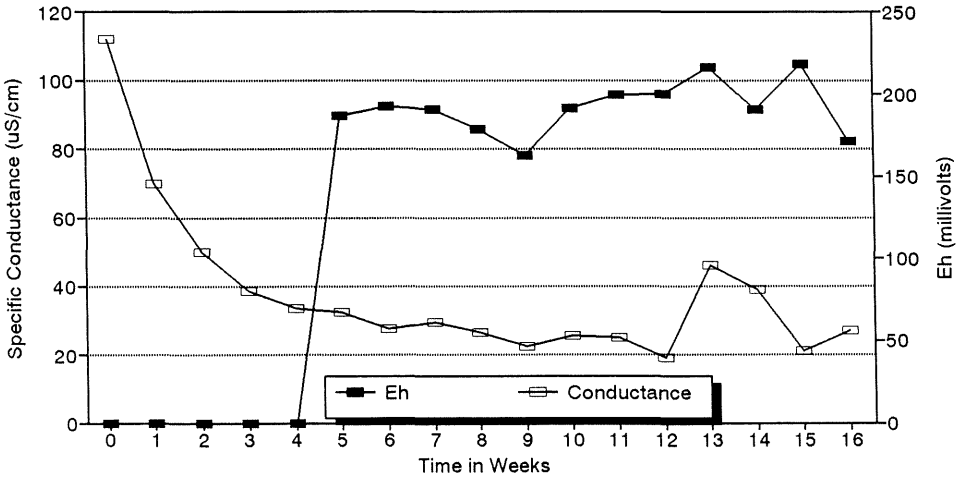
APPENDIX 3

DRAINAGE QUALITY FIGURES

Figure A3.1 Drainage quality vs. time for 0.12% S siltite-argillite (sample number 1-0696R, cell 7).

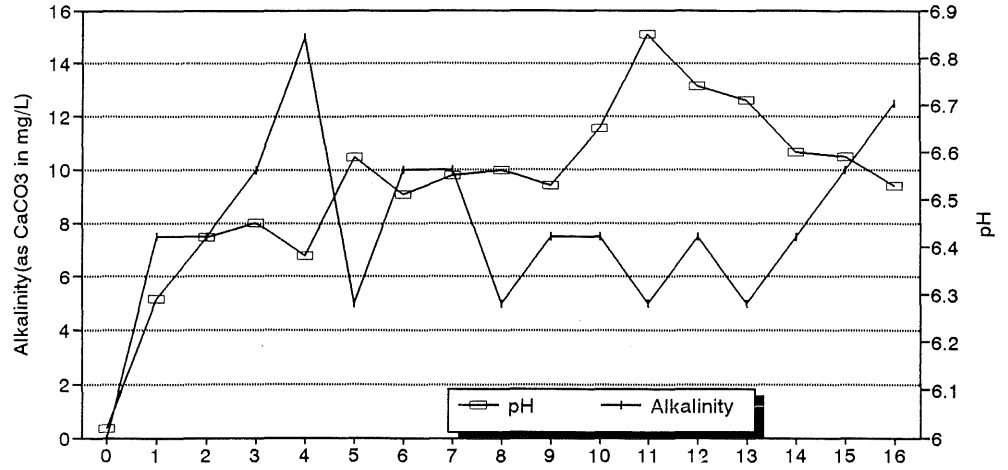


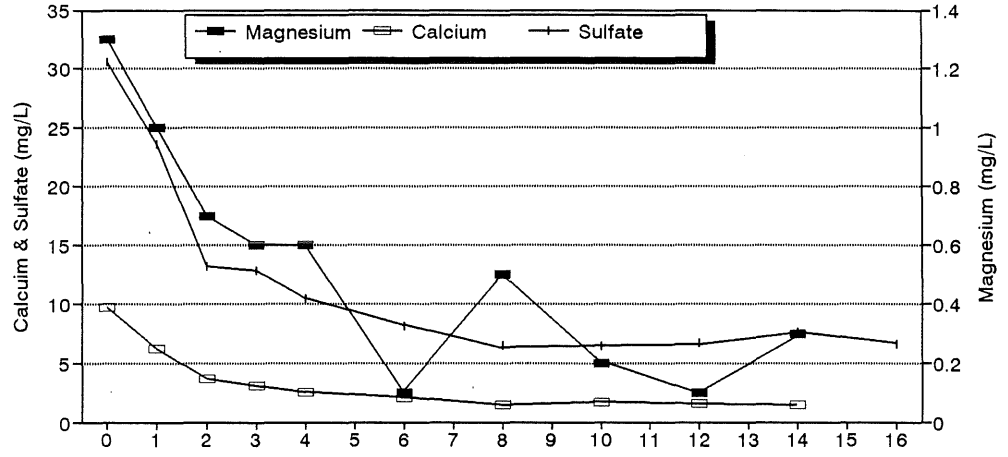


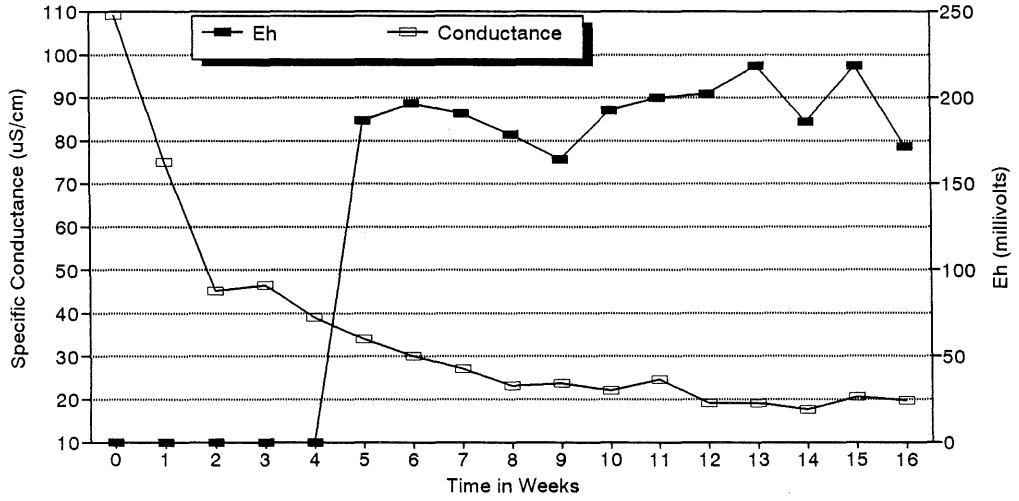


Note: Eh readings were taken thru week 4.

Figure A3.2 Drainage quality vs. time for 0.12% S siltite-argillitite (sample number 1-0696Rb, cell 8).

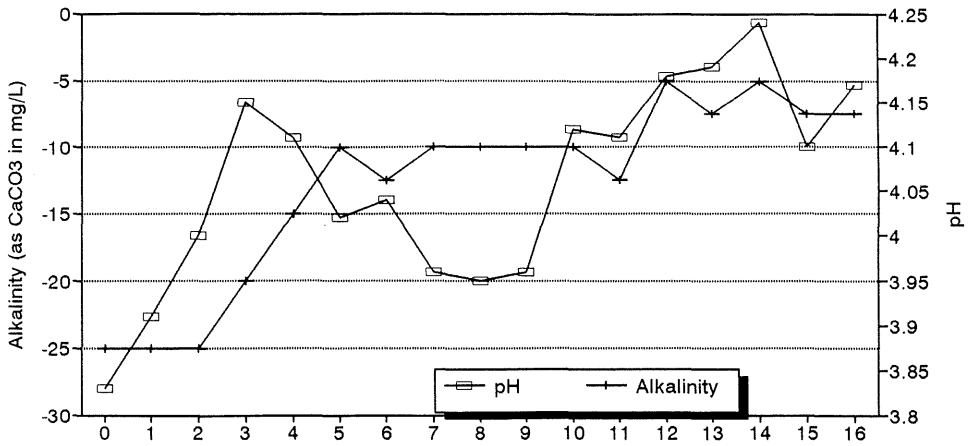


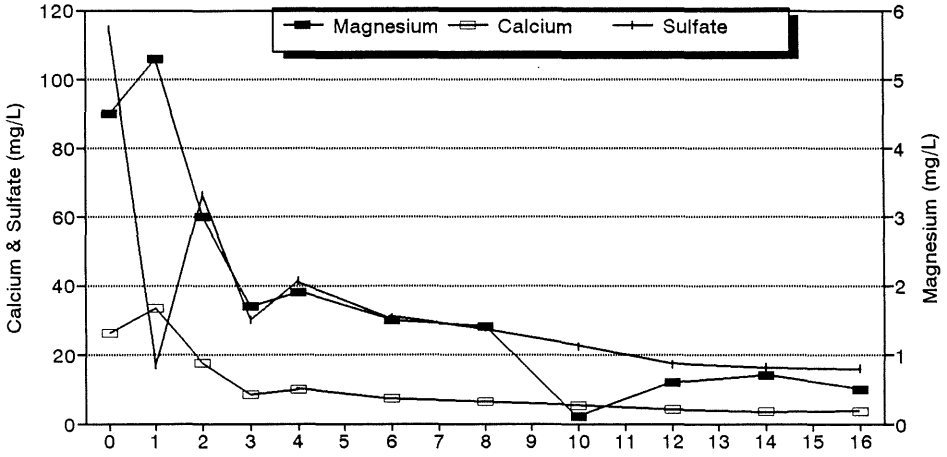


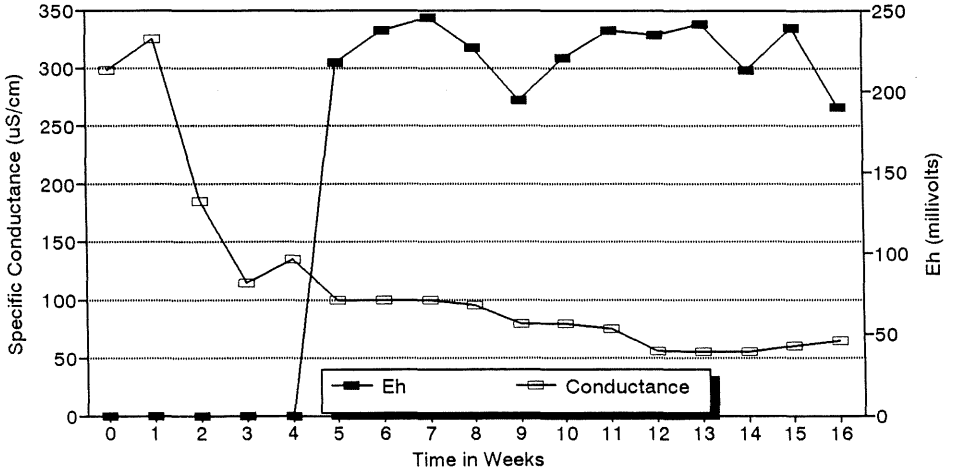


Note: Eh readings were taken thru week 4.

Figure A3.3 Drainage quality vs. time for 0.19% S siltite-argillite (sample number 3-0696R, cell 5).

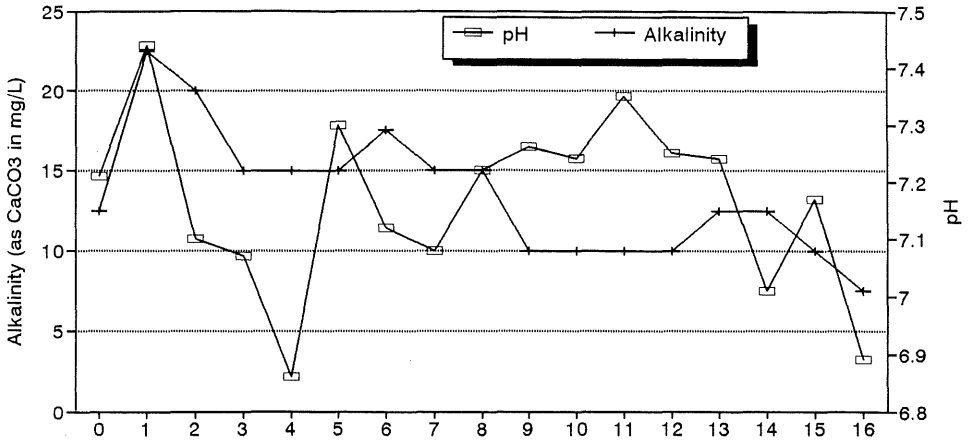


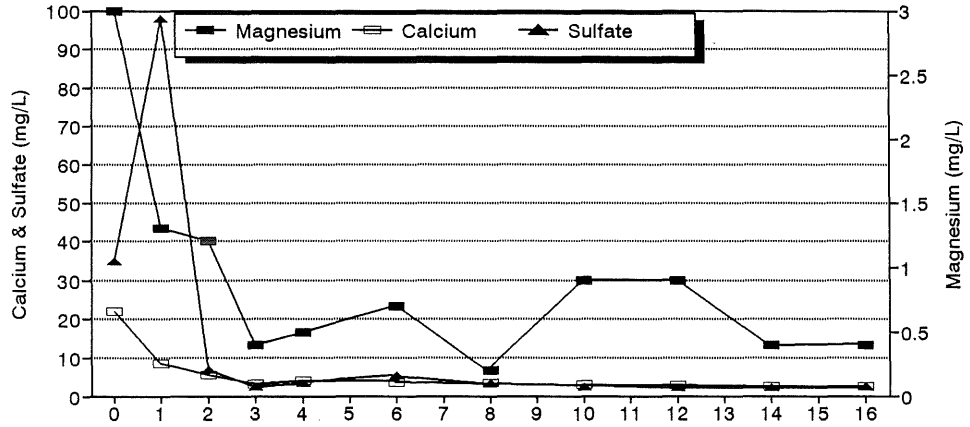


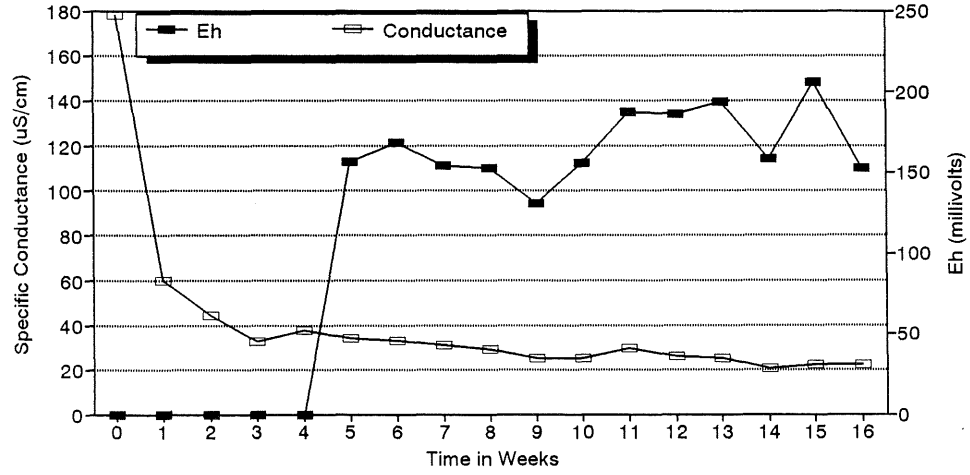


Note: Eh readings were taken thru week 4.

Figure A3.4. Drainage quality vs. time for 0.22% S siltite-argillite (sample number 6-0696R, cell1).

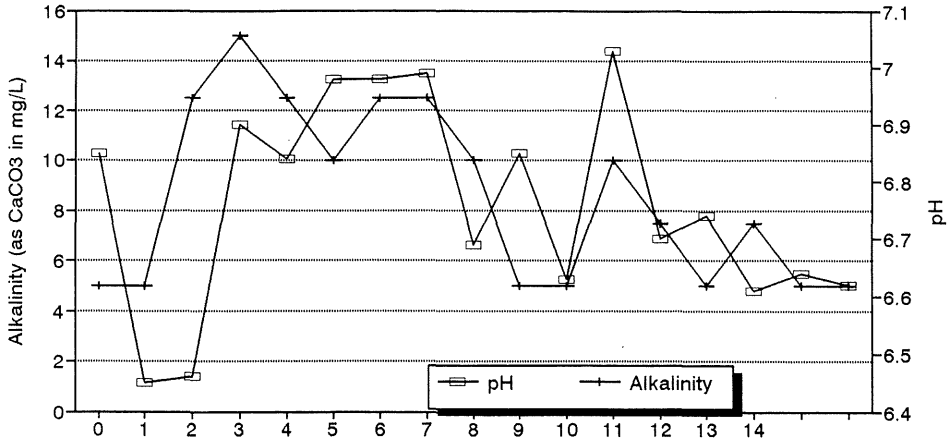


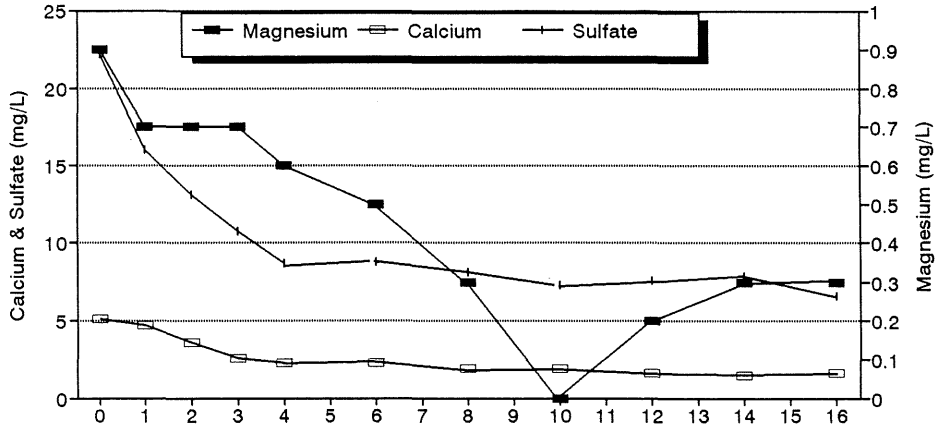


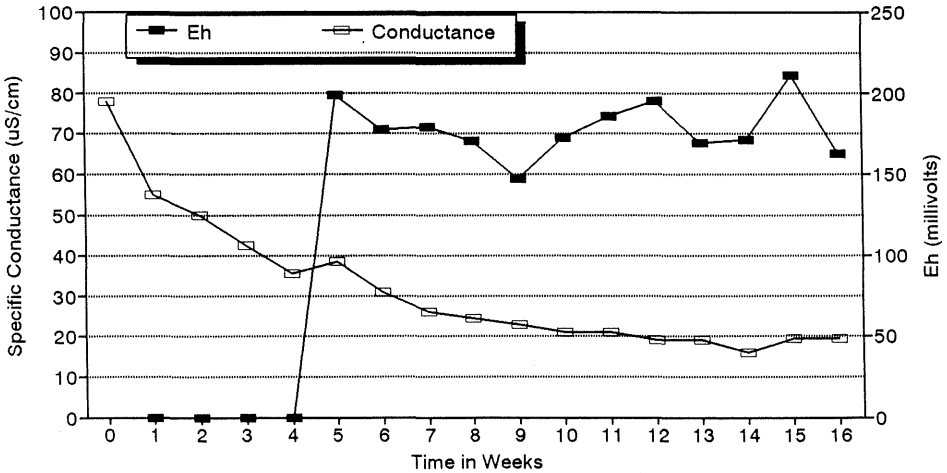


Note: Eh readings were not taken thru week 4

Figure A3.5 Drainage quality vs. time for 0.26% S siltite-argillite (sample number 4-0696R, cell 3).

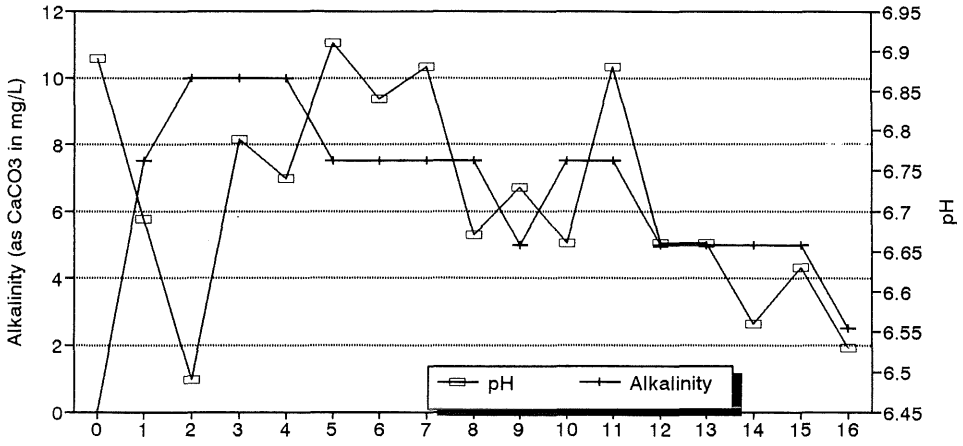


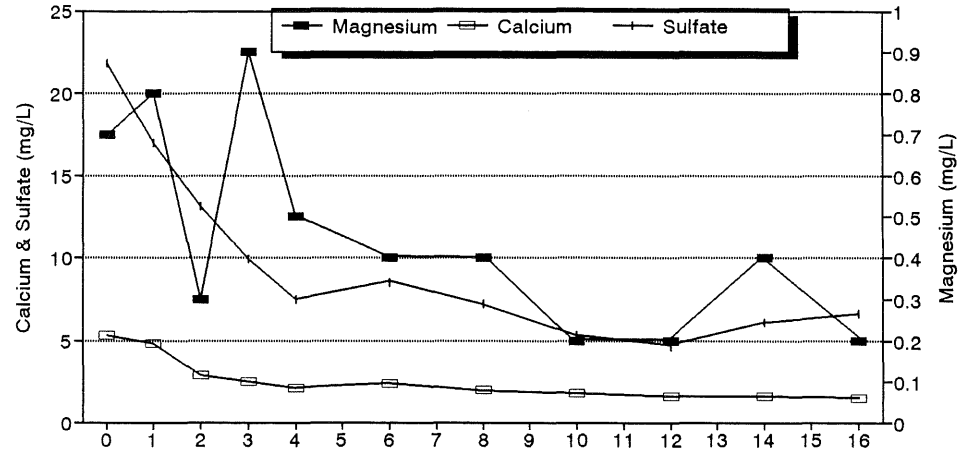


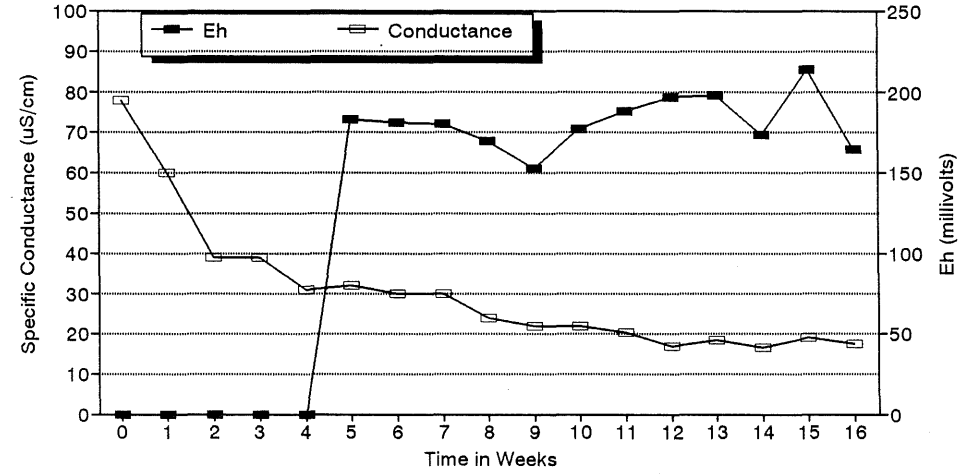


Note: Eh readings were taken thru week 4.

Figure A3.6 Drainage quality vs. time for 0.26% S siltite-argillite (sample number 4-0696R, cell 4).

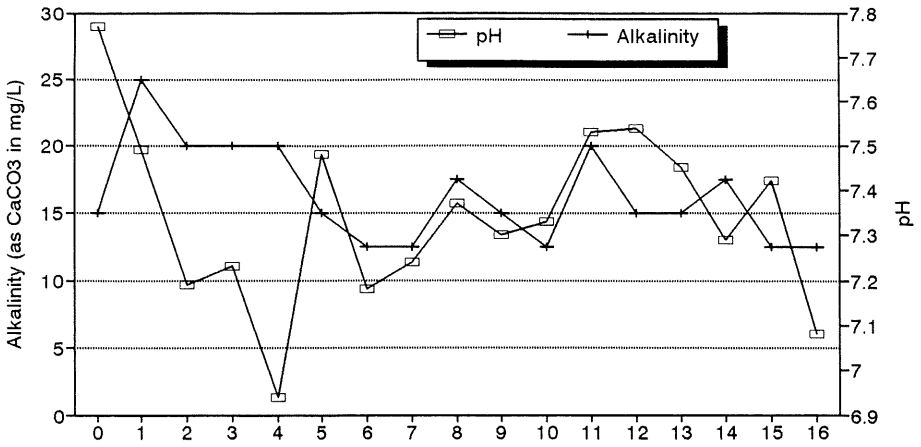


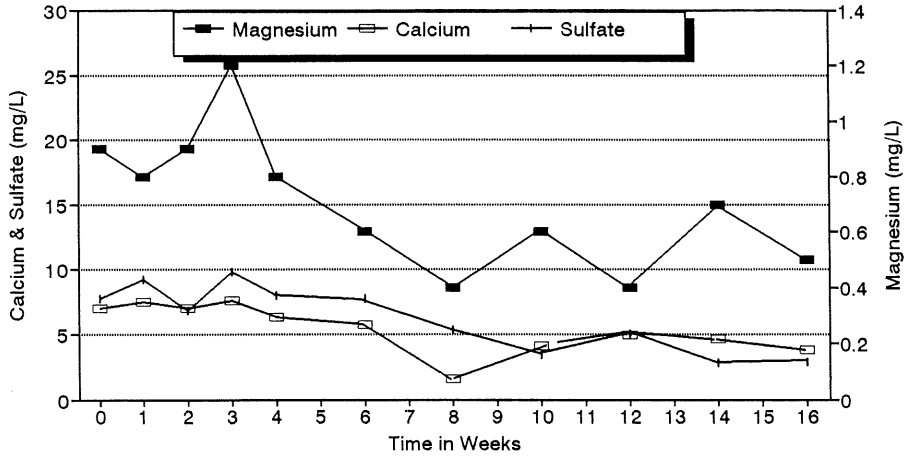


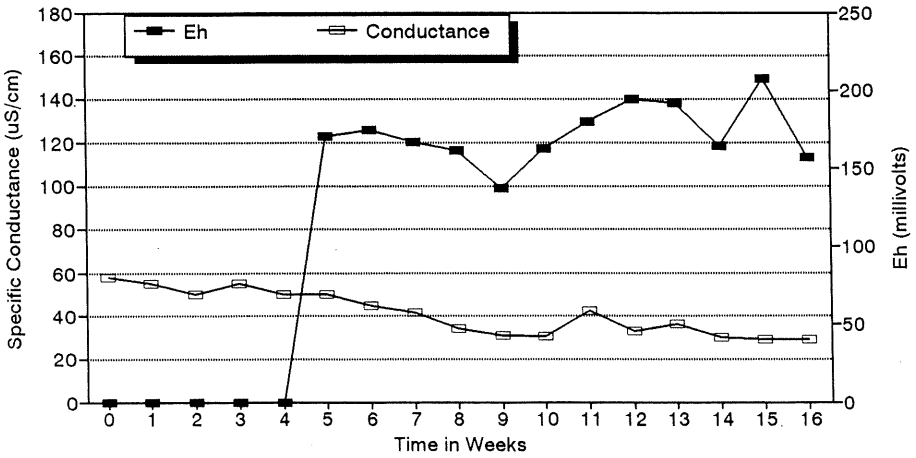


Note: Eh readings were taken thru week 4.

Figure A3.7 Drainage quality vs. time for 0.30% S siltite-argillite (sample number 5-0696R, cell2).

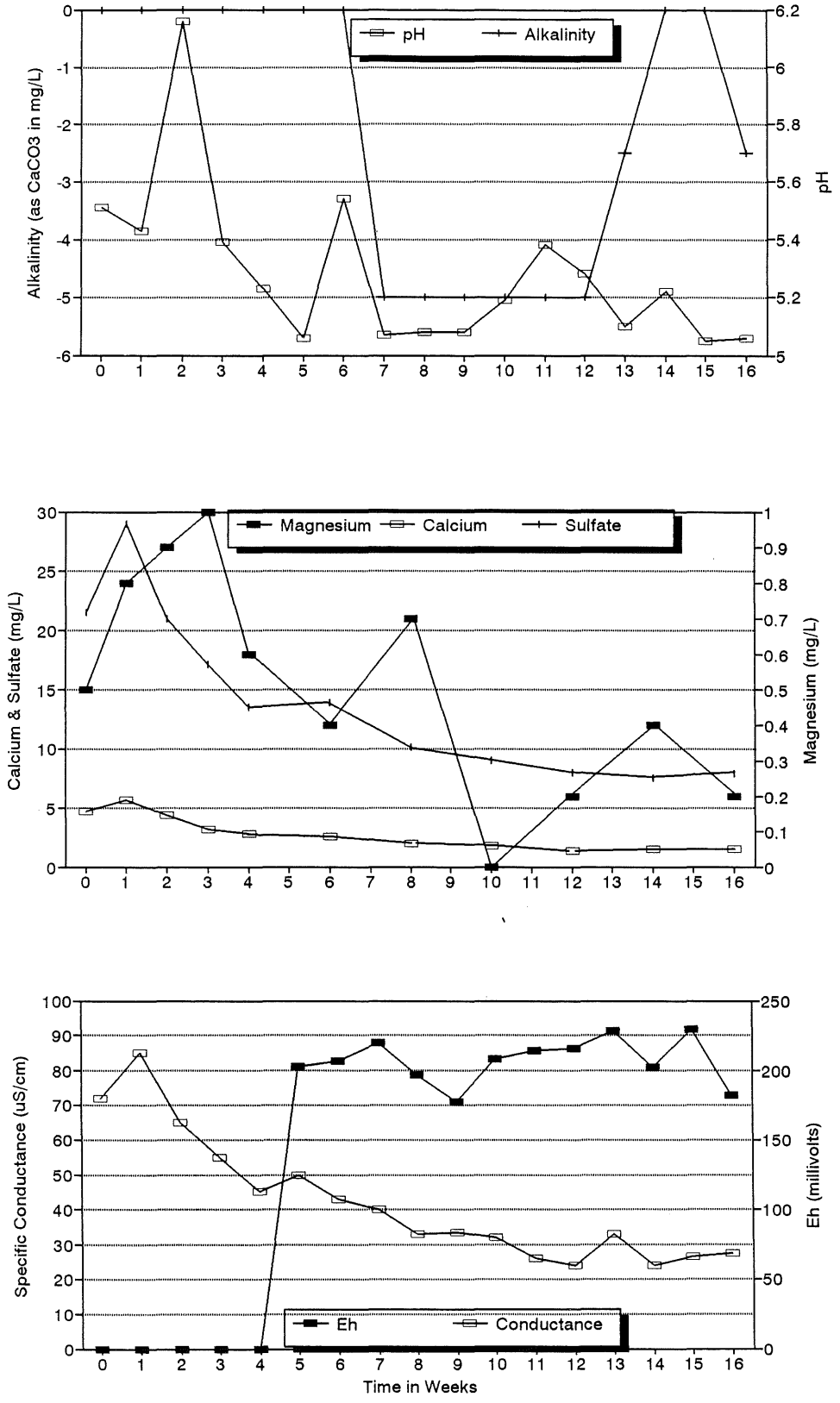






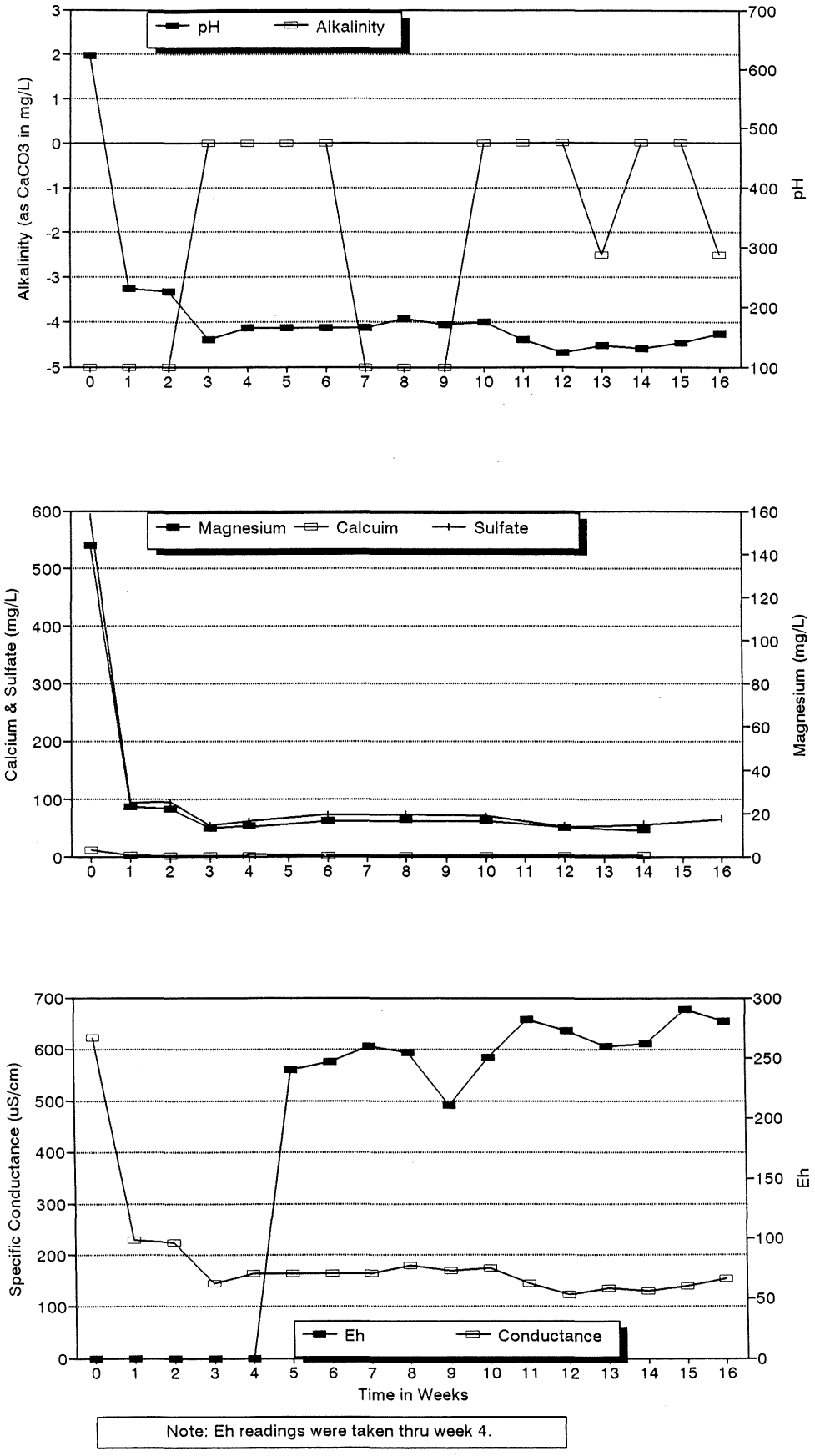
Note: Eh readings were taken thru week 4.

Figure A3.8 Drainage quality vs. time for 0.96% S siltite-argillite (sample number 2-0696R, cell 6).



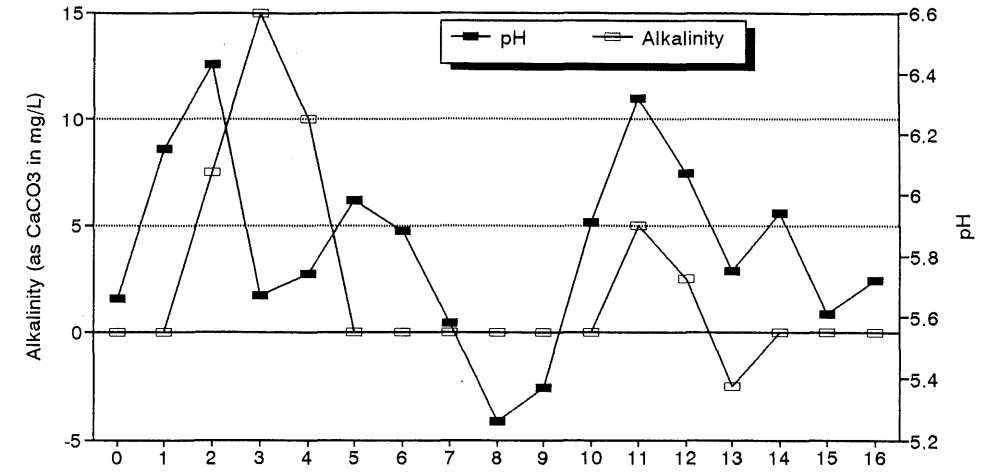
Note: Eh readings were taken thru week 4.

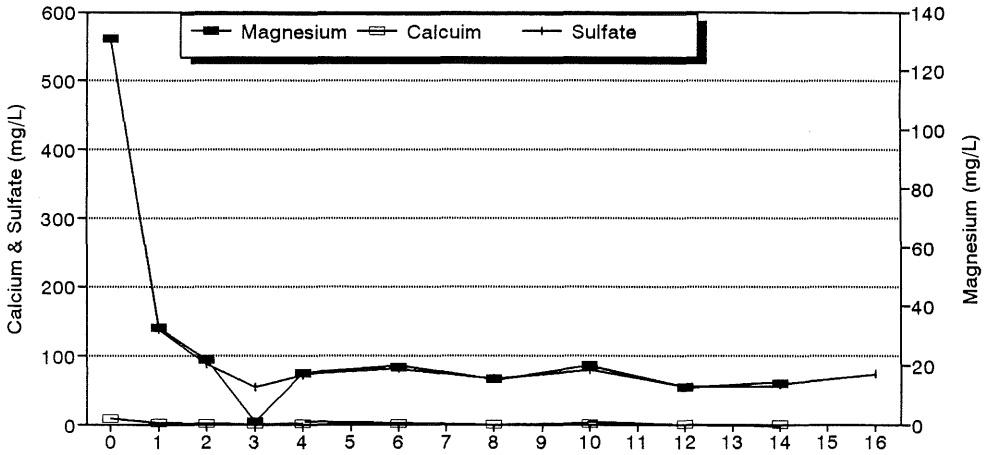
Figure A3.9 Drainage quality vs. time for 1.60% S siltite-argilltie (sample number MT-100.4, cell 15).

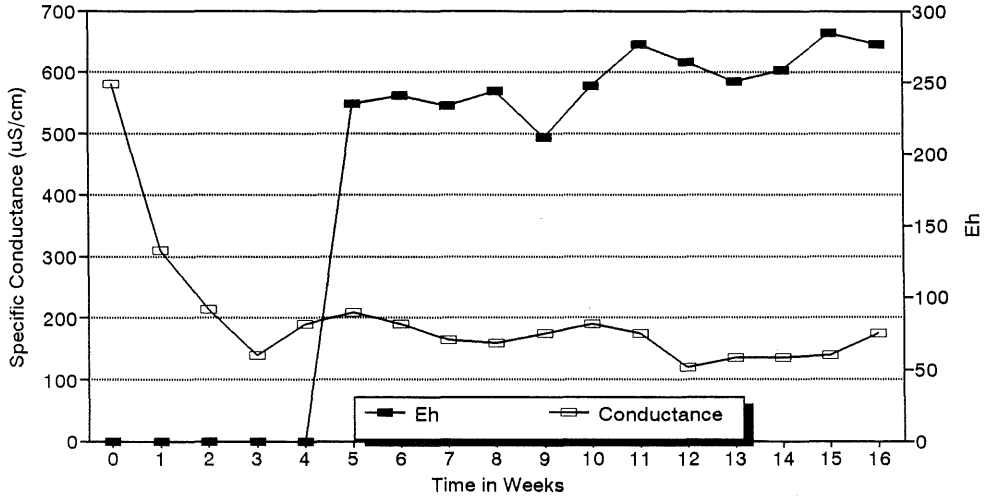


Note: Eh readings were taken thru week 4.

Figure A3.10 Drainage quality vs. time for 1.60% S siltite-argilltie (sample number MT-100.4, cell 16)

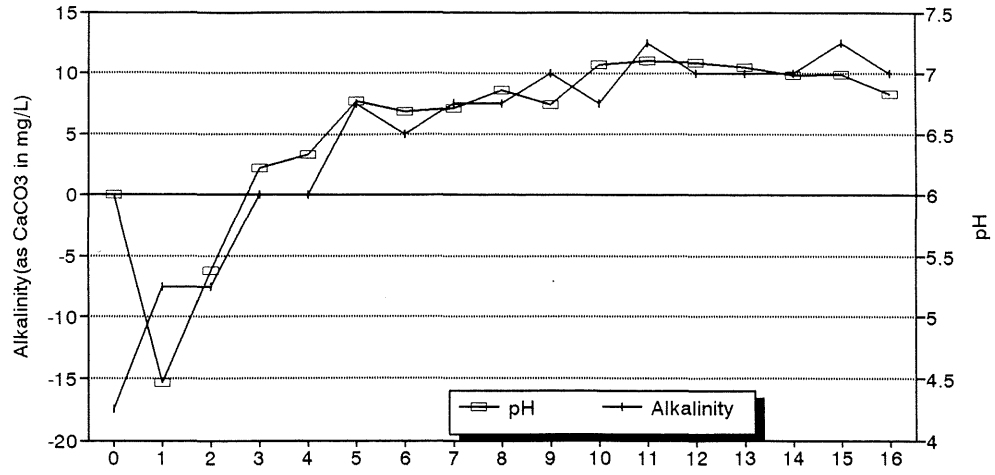


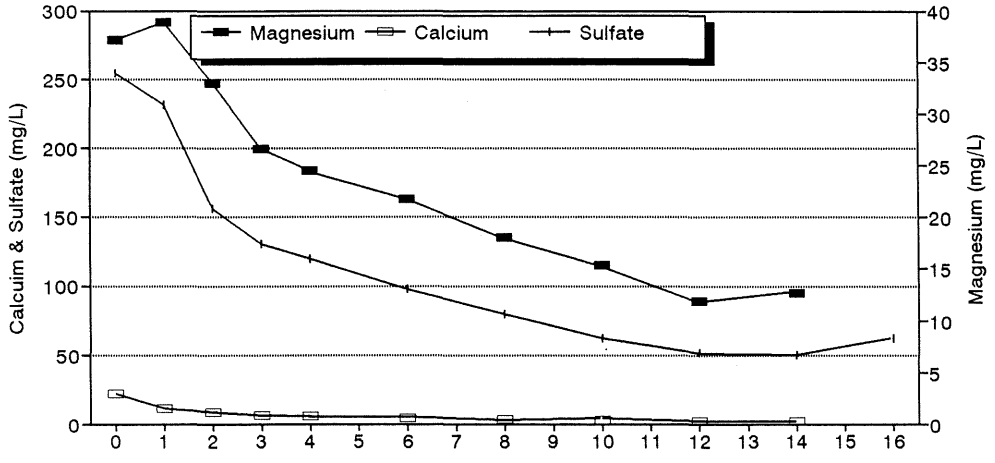


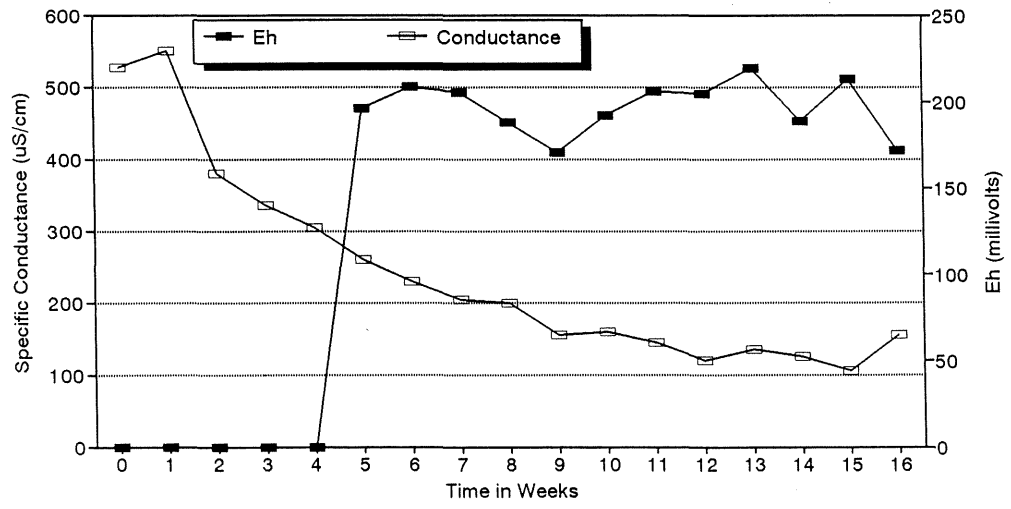


Note: Eh readings were taken thru week 4.

Figure A3.11 Drainage quality vs. time for 2.30% S siltite-argillitite (sample number MT-99.4, cell 9).

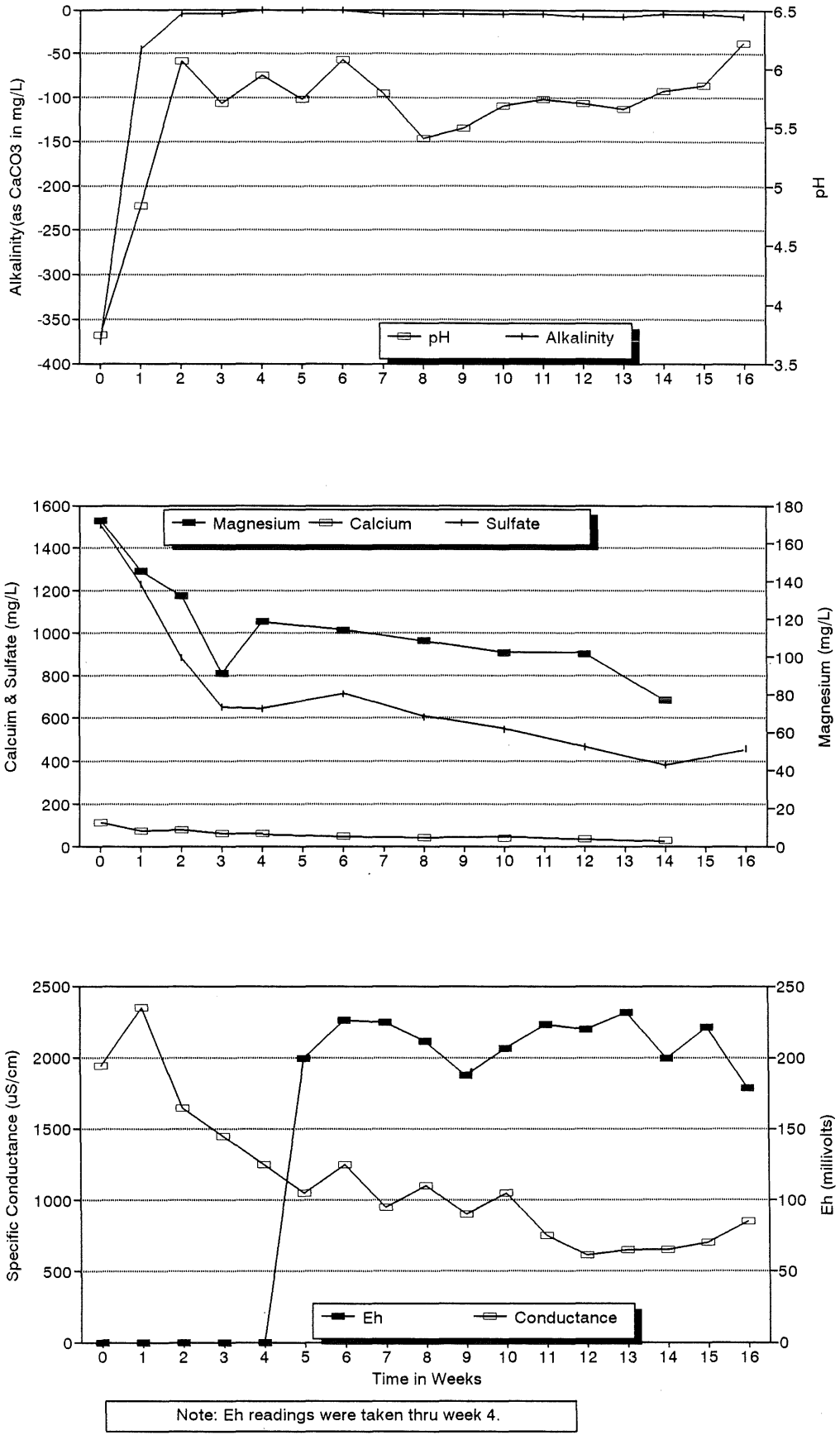






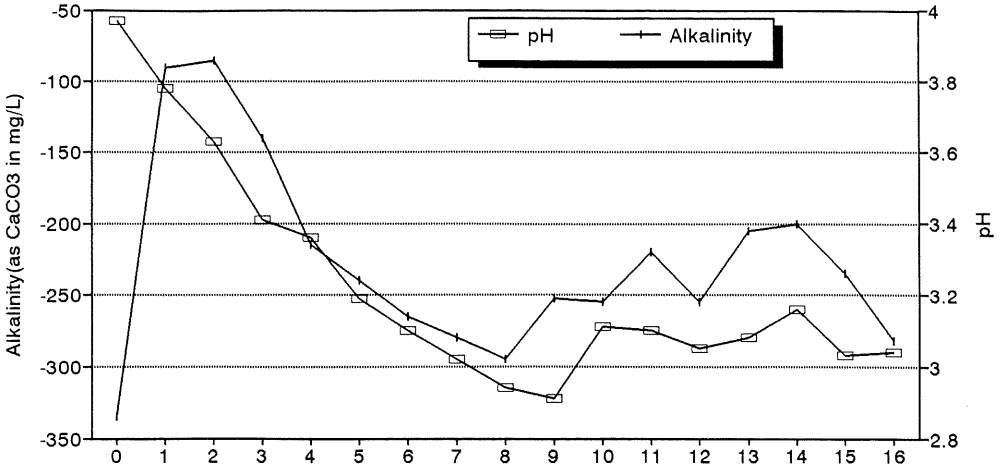
Note: Eh readings were taken thru week 4.

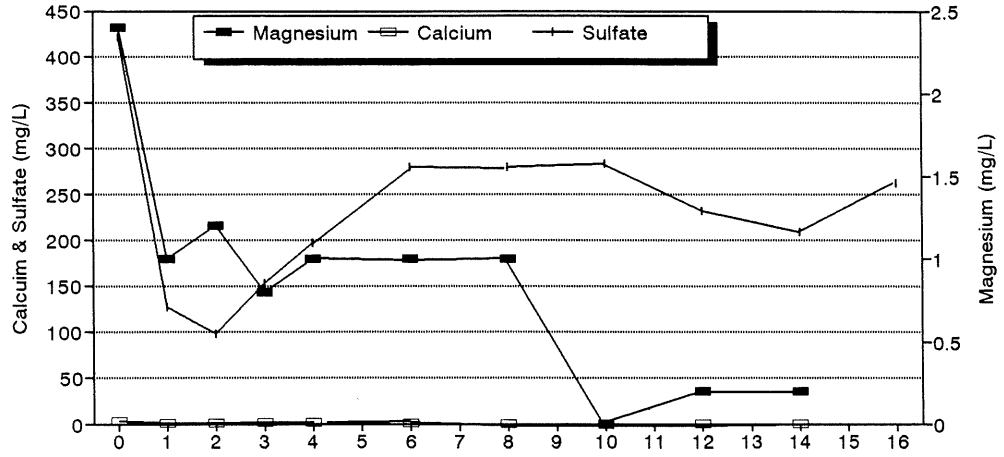
Figure A3.12 Drainage quality vs. time for 3.24% S siltite-argillitite (sample number MT-99.1, cell 10).

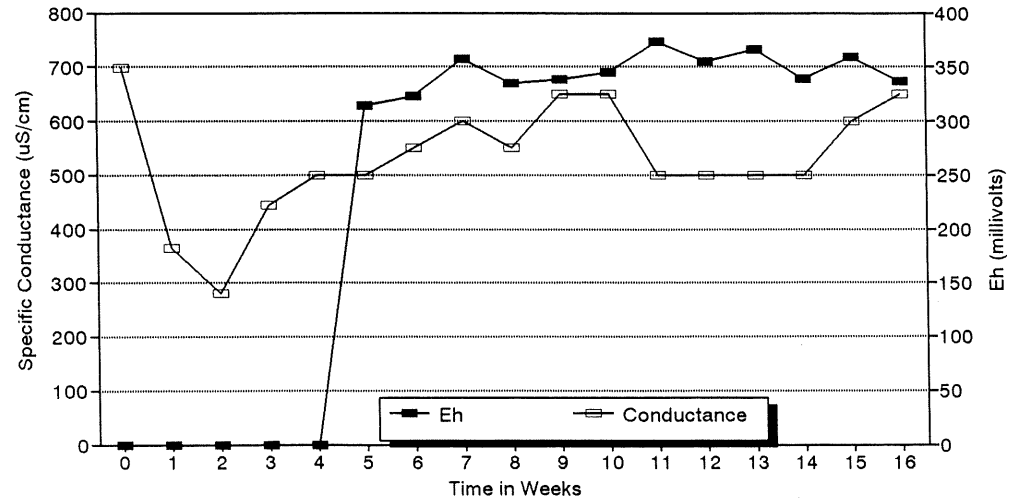


Note: Eh readings were taken thru week 4.

Figure A3.13 Drainage quality vs. time for 5.82% S siltite-argillitite (sample number MT-99.6, cell 11).

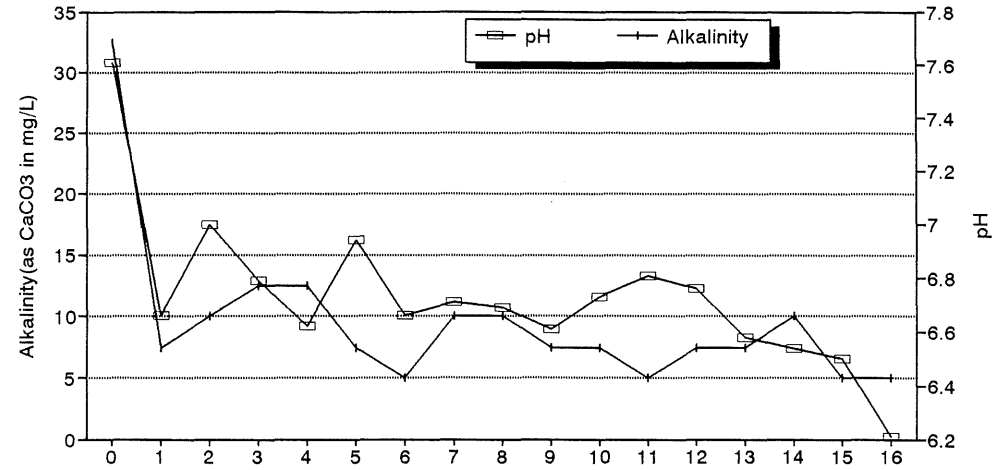


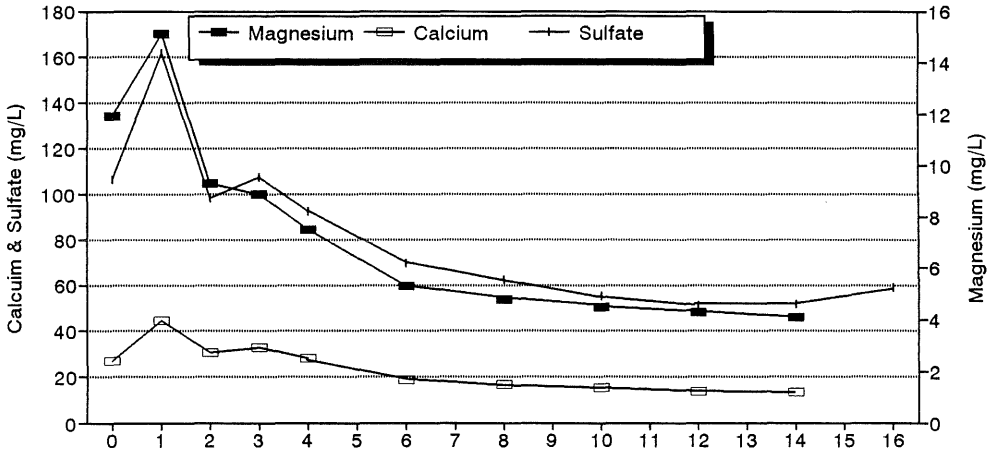


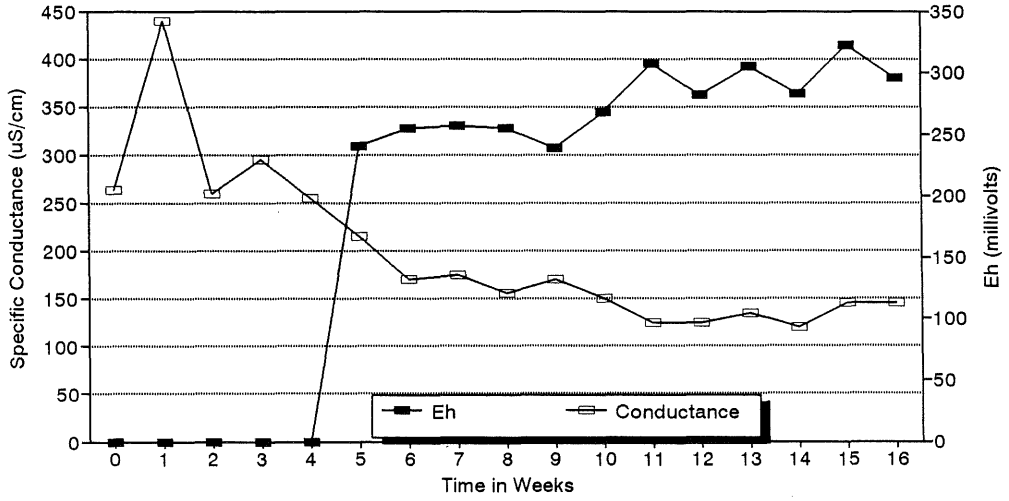


Note: Eh readings were taken thru week 4.

Figure A3.14 Drainage quality vs. time for 1.39% S siltite-argillitite (sample number Mn-6.1, cell 12).

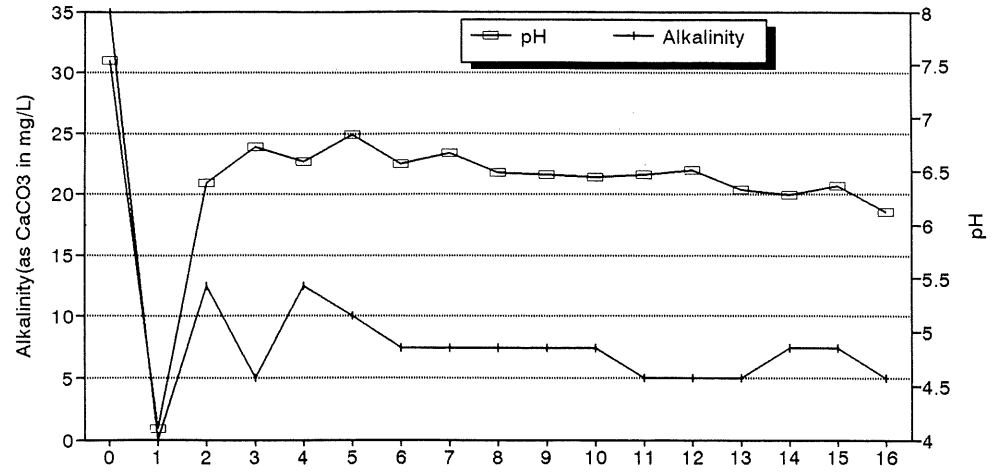


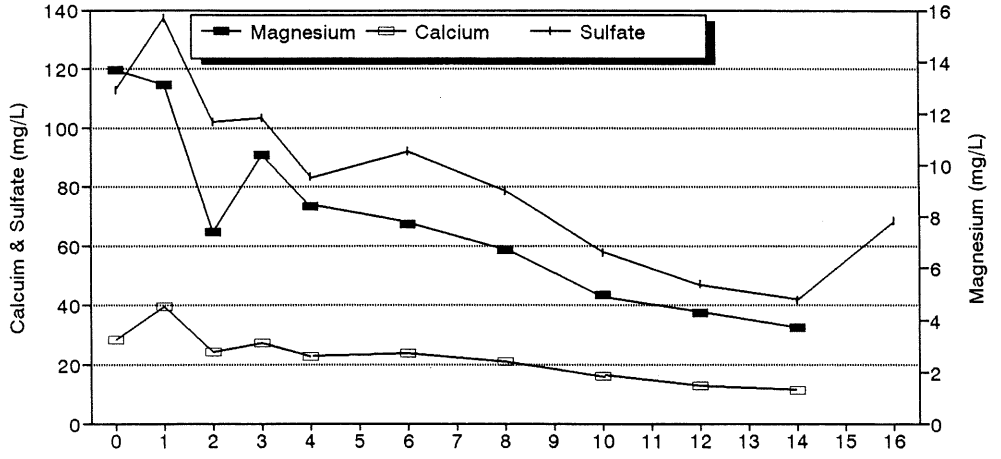


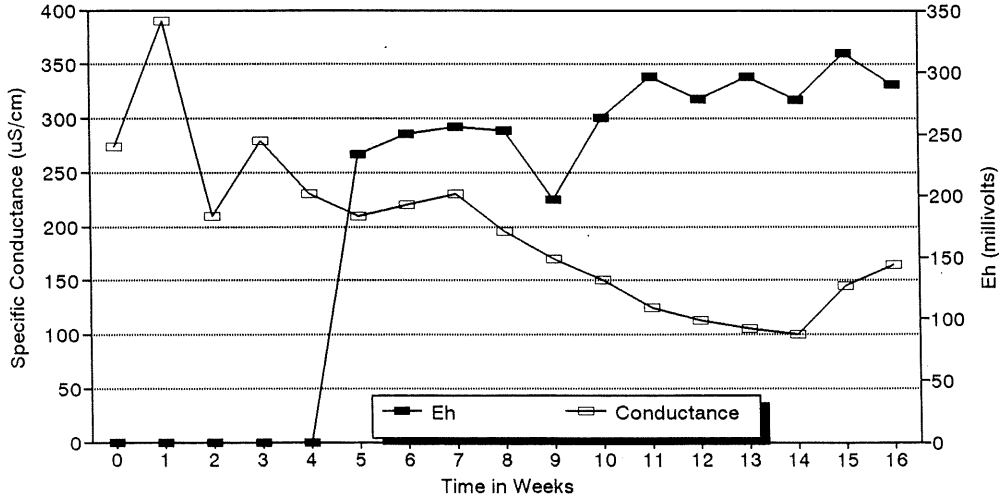


Note: Eh readings were taken thru week 4.

Figure A3.15 Drainage quality vs. time for 1.39% S siltite-argillitite (sample number Mn-6.1, cell 14).







Note: Eh readings were taken thru week 4.

APPENDIX 4

SULFATE, CALCIUM, AND MAGNESIUM

MASS RELEASE TABLES

Table A4.1 Mass release from 0.12% S siltite-argillite (sample number 1-0696R, cell 7).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1340	31.10	433.8	433.8	10.4	347.7	347.7	2.4	132.3	132.3
1	435	22.10	100.1	533.9	6.1	66.2	413.9	1	17.9	150.2
2	549	14.80	84.6	618.5	4.2	57.5	471.4	1	22.6	172.8
3	369	9.60	36.9	655.4	2.6	23.9	495.4	0.7	10.6	183.4
4	436	8.60	39.0	694.4	2	21.8	517.1	<0.1	0.0	183.4
5	414	8.00	34.5	728.9	1.95	20.1	537.3	0.2	3.4	186.8
6	398	7.40	30.7	759.5	1.9	18.9	556.1	0.4	6.5	193.3
7	408	8.15	34.6	794.2	1.9	19.3	575.5	0.55	9.2	202.6
8	423	8.90	39.2	833.4	1.9	20.1	595.5	0.7	12.2	214.8
9	420	7.40	32.4	865.7	1.85	19.4	614.9	0.35	6.0	220.8
10	416	5.90	25.6	891.3	1.8	18.7	633.6	<0.1	0.0	220.8
11	445	6.59	30.5	921.8	1.7	18.9	652.5	0.05	0.9	221.7
12	451	7.28	34.2	956.0	1.6	18.0	670.5	0.1	1.9	223.6
13	417	11.02	47.8	1003.8	3.1	32.3	702.7	0.2	3.4	227.0
14	448	14.75	68.8	1072.6	4.6	51.4	754.2	0.3	5.5	232.5
15	419	11.87	51.8	1124.3	3.6	37.6	791.8	0.25	4.3	236.8
16	428	8.98	40.0	1164.3	2.6	27.8	819.6	0.2	3.5	240.4

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.2 Mass release from 0.12% S siltite-argillitite (sample number 1-0696R, cell 8)

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1334	30.6	424.9	424.9	9.8	326.2	326.2	1.3	71.3	71.3
1	453	23.6	111.3	536.2	6.3	71.2	397.4	1	18.6	90.0
2	546	13.2	75.0	611.3	3.7	50.4	447.8	0.7	15.7	105.7
3	432	12.8	57.6	668.8	3.1	33.4	481.2	0.6	10.7	116.4
4	438	10.5	47.9	716.7	2.6	28.4	509.6	0.6	10.8	127.2
*5	377	9.3	36.5	753.2	2.35	22.1	531.7	0.35	5.4	132.6
6	412	8.1	34.7	787.9	2.1	21.6	553.3	0.1	1.7	134.3
*7	422	7.3	32.1	820.0	1.8	19.0	572.3	0.3	5.2	139.5
8	404	6.5	27.3	847.4	1.5	15.1	587.4	0.5	8.3	147.8
*9	417	6.485	28.2	875.5	1.6	16.6	604.0	0.35	6.0	153.8
10	422	6.47	28.4	903.9	1.7	17.9	621.9	0.2	3.5	157.3
*11	436	6.595	29.9	933.9	1.65	17.9	639.9	0.15	2.7	160.0
12	435	6.72	30.4	964.3	1.6	17.4	657.2	0.1	1.8	161.8
*13	430	7.195	32.2	996.5	1.55	16.6	673.9	0.2	3.5	165.3
14	432	7.67	34.5	1031.0	1.5	16.2	690.0	0.3	5.3	170.6
*15	415	7.15	30.9	1061.9						
16	419	6.63	28.9	1090.8						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.3 Mass release from 0.19% S siltite-argillite (sample number 3-0696R, Cell 5).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1333	114.40	1587.5	1587.5	26.3	874.7	874.7	4.5	246.8	246.8
1	462	17.00	81.8	1669.3	33.5	386.2	1260.9	5.3	100.7	347.5
2	458	66.30	316.1	1985.4	17.6	201.1	1462.0	3	56.5	404.0
3	380	30.30	119.9	2105.2	8.4	79.6	1541.6	1.7	26.6	430.6
4	442	41.40	190.5	2295.7	10	110.3	1651.9	1.9	34.5	465.1
*5	409	36.00	153.3	2449.0	8.65	88.3	1740.2	1.7	28.6	493.7
6	422	30.60	134.4	2583.4	7.3	76.9	1817.0	1.5	26.0	519.8
*7	417	29.20	126.8	2710.2	6.85	71.3	1888.3	1.45	24.9	544.6
8	418	27.80	121.0	2831.2	6.4	66.7	1955.0	1.4	24.1	568.7
*9	423	25.12	110.6	2941.8	5.85	61.7	2016.8	0.75	13.1	581.7
10	429	22.43	100.2	3041.9	5.3	56.7	2073.5	0.1	1.8	583.5
*11	451	19.81	93.0	3134.9	4.8	54.0	2127.5	0.35	6.5	590.0
12	436	17.18	78.0	3212.9	4.3	46.8	2174.3	0.6	10.8	600.8
*13	400	16.79	69.9	3282.8	3.9	38.9	2213.2	0.65	10.7	611.5
14	445	16.39	75.9	3358.7	3.5	38.9	2252.1	0.7	12.8	624.3
*15	433	16.25	73.2	3431.9	3.5	37.8	2289.9	0.6	10.7	635.0
16	424	16.10	71.1	3503.0	3.5	37.0	2326.9	0.5	8.7	643.7

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimatted as the average of the previous and subsequent week's concentrations.

Table A4.4 Mass release from 0.22% S siltite-argillite (sample number 1-0696R, cell 1).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1308	34.7	472.5	472.5	22.0	718.0	718.0	3.0	161.4	161.4
1	437	97.8	444.9	917.4	8.4	91.6	809.6	1.3	23.4	184.8
2	615	6.8	43.5	960.9	5.6	85.9	895.5	1.2	30.4	215.1
3	354	2.5	9.2	970.2	3.2	28.3	923.7	0.4	5.8	221.0
4	441	3.3	15.1	985.3	4.0	44.0	967.8	0.5	9.1	230.0
*5	408	4.4	18.5	1003.8	3.8	38.7	1006.4	0.6	10.1	240.1
6	430	5.4	24.2	1028.0	3.6	38.6	1045.1	0.7	12.4	252.5
*7	403	4.4	18.5	1046.4	3.5	35.2	1080.3	0.5	7.5	259.9
8	421	3.4	14.9	1061.3	3.4	35.7	1116.0	0.2	3.5	263.4
*9	412	3.0	12.7	1074.0	3.3	33.4	1149.4	0.6	9.3	272.7
10	413	2.5	10.7	1084.7	3.1	31.9	1181.3	0.9	15.3	288.0
*11	422	2.4	10.3	1095.0	3.0	31.6	1212.9	0.9	15.6	303.6
12	414	2.2	9.5	1104.5	2.9	30.0	1242.9	0.9	15.3	319.0
*13	460	2.2	10.5	1115.1	2.8	31.6	1274.4	0.7	12.3	331.3
14	456	2.2	10.4	1125.5	2.6	29.6	1304.0	0.4	7.5	338.8
*15	421	2.4	10.5	1136.0	2.6	27.3	1331.3	0.4	6.9	345.7
16	408	2.6	11.0	1147.1	2.6	26.5	1357.8	0.4	6.7	352.4

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.5 Mass release from 0.26% S siltite-argillite (sample number 4-0696R Cell 3).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1339	22.2	309.5	309.5	5.1	170.4	170.4	0.9	49.6	49.6
1	436	16.0	72.6	382.1	4.7	51.1	221.5	0.7	12.6	62.1
2	451	13.1	61.5	443.6	3.6	40.5	262.0	0.7	13.0	75.1
3	447	10.8	50.3	493.8	2.6	29.0	291.0	0.7	12.9	88.0
4	423	8.7	38.3	532.1	2.3	24.3	315.3	0.6	10.4	98.4
*5	425	8.8	38.7	570.9	2.3	24.4	339.7	0.6	9.6	108.0
6	430	8.8	39.4	610.2	2.3	24.7	364.4	0.5	8.8	116.9
*7	383	8.5	33.7	643.9	2.1	20.1	384.4	0.4	6.3	123.2
8	421	8.1	35.5	679.4	1.9	20.0	404.4	0.3	5.2	128.4
*9	417	7.7	33.4	712.9	1.9	19.8	424.1	0.2	2.6	131.0
10	421	7.3	32.0	744.9	1.9	20.0	444.1	<0.1	0.0	131.0
*11	419	7.4	32.5	777.3	1.8	18.3	462.4	0.1	1.7	132.7
12	419	7.6	33.1	810.4	1.6	16.7	479.1	0.2	3.4	136.1
*13	418	7.7	33.6	844.1	1.6	16.2	495.3	0.3	4.3	140.4
14	445	7.9	36.4	880.5	1.5	16.7	511.9	0.3	5.5	145.9
*15	419	7.2	31.6	912.0	1.6	16.2	528.1	0.3	5.2	151.1
16	423	6.6	29.2	941.2	1.6	16.9	545.0	0.3	5.2	156.3

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.6 Mass release from 0.26% S siltite-argillite (sample number 4-0696R, Cell 4).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1336	21.80	303.2	303.2	5.3	176.7	176.7	0.7	38.5	38.5
1	469	17.00	83.0	386.2	4.8	56.2	232.8	0.8	15.4	53.9
2	546	13.10	74.5	460.7	2.9	39.5	272.3	0.3	6.7	60.6
3	451	9.90	46.5	507.1	2.5	28.1	300.5	0.9	16.7	77.3
4	454	7.50	35.4	542.6	2.1	23.8	324.3	0.5	9.3	86.7
*5	408	8.00	34.0	576.6	2.25	22.9	347.2	0.45	7.6	94.2
6	444	8.50	39.3	615.8	2.4	26.6	373.8	0.4	7.3	101.5
*7	428	7.85	35.0	650.8	2.2	23.5	397.2	0.4	7.0	108.6
8	438	7.20	32.8	683.7	2	21.9	419.1	0.4	7.2	115.8
*9	431	6.24	28.0	711.7	1.9	20.4	439.5	0.3	5.3	121.1
10	432	5.28	23.7	735.4	1.8	19.4	458.9	0.2	3.6	124.7
*11	401	4.94	20.6	756.0	1.7	17.0	475.9	0.2	3.3	128.0
12	429	4.60	20.5	776.6	1.6	17.1	493.1	0.2	3.5	131.5
*13	462	5.33	25.6	802.2	1.6	18.4	511.5	0.3	5.7	137.2
14	457	6.06	28.8	831.0	1.6	18.2	529.8	0.4	7.5	144.7
*15	443	6.34	29.2	860.3	1.55	17.1	546.9	0.3	5.5	150.2
16	430	6.62	29.6	889.9	1.5	16.1	563.0	0.2	3.5	153.7

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.7 Mass release from 0.30% S siltite-argillite (sample number 5-0696R, Cell 2).

week	Vol.(ml)	Sulfate Conc(mg/L)	Sulfate Mass(um)	Sulfate Sum Mass	Calcium Conc(mg/L)	Calcium Mass(um)	Calcium Sum Mass	Magnesium Conc(mg/L)	Magnesium Mass(um)	Magnesium Sum Mass
0	1344	7.7	107.7	107.7	7.0	234.7	234.7	0.9	49.8	49.8
1	456	9.2	43.7	151.4	7.5	85.3	320.1	0.8	15.0	64.8
2	503	6.8	35.6	187.0	7.0	87.8	407.9	0.9	18.6	83.4
3	462	9.8	47.1	234.1	7.6	87.6	495.5	1.2	22.8	106.2
4	443	8.0	36.9	271.0	6.3	69.6	565.1	0.8	14.6	120.8
*5	420	7.9	34.3	305.4	6.0	62.9	628.0	0.7	12.1	132.9
6	432	7.7	34.6	340.0	5.7	61.4	689.5	0.6	10.7	143.5
*7	426	6.5	28.8	368.8	3.7	38.8	728.3	0.5	8.8	152.3
8	429	5.3	23.7	392.5	1.6	17.1	745.4	0.4	7.1	159.3
*9	425	4.4	19.2	411.7	2.9	30.2	775.6	0.5	8.7	168.1
10	426	3.4	15.1	426.8	4.1	43.6	819.2	0.6	10.5	178.6
*11	424	4.2	18.6	445.4	4.5	47.6	866.8	0.5	8.7	187.3
12	432	5.0	22.6	468.0	4.9	52.8	919.6	0.4	7.1	194.4
*13	459	3.9	18.7	486.7	4.8	54.4	974.0	0.55	10.4	204.8
14	460	2.8	13.4	500.1	4.6	52.8	1026.8	0.7	13.2	218.1
*15	433	2.9	12.8	513.0	4.2	45.4	1072.2	0.6	10.7	228.7
16	422	2.9	12.7	525.7	3.8	40.0	1112.2	0.5	8.7	237.4

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimatted as the average of the previous and subsequent week's concentrations.

Table A4.8 Mass release from 0.96% S siltite-argillite (sample number 2-0696R, Cell 6).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1319	21.50	295.2	295.2	4.7	154.7	154.7	0.5	27.1	27.1
1	459	29.00	138.6	433.8	5.7	65.3	220.0	0.8	15.1	42.2
2	478	21.00	104.5	538.3	4.4	52.5	272.4	0.9	17.7	59.9
3	445	17.10	79.2	617.5	3.2	35.5	308.0	1	18.3	78.2
4	393	13.50	55.2	672.7	2.8	27.5	335.4	0.6	9.7	87.9
*5	408	13.70	58.2	730.9	2.7	27.5	362.9	0.5	8.4	96.3
6	458	13.90	66.3	797.2	2.6	29.7	392.6	0.4	7.5	103.9
*7	450	12.00	56.2	853.4	2.3	25.8	418.4	0.55	10.2	114.0
8	417	10.10	43.8	897.3	2	20.8	439.2	0.7	12.0	126.1
*9	436	9.58	43.5	940.7	1.9	20.7	459.9	0.35	6.3	132.3
10	434	9.05	40.9	981.6	1.8	19.5	479.4	<0.1	0.0	132.3
*11	430	8.53	38.2	1019.8	1.6	17.2	496.6	0.1	1.8	134.1
12	440	8.01	36.7	1056.5	1.4	15.4	511.9	0.2	3.6	137.7
*13	401	7.78	32.5	1088.9	1.45	14.5	526.4	0.3	4.9	142.7
14	441	7.54	34.6	1123.5	1.5	16.5	542.9	0.4	7.3	149.9
*15	429	7.71	34.4	1158.0	1.5	16.1	559.0	0.3	5.3	155.2
16	417	7.87	34.2	1192.1	1.5	15.6	574.6	0.2	3.4	158.6

NOTE: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimatted as the average of the previous and subsequent week's concentrations.

Table A4.9 Mass release from 1.5% S siltite-argillitite (sample number MT-100.4, cell 15).

		Sulfate			Calcium			Magnesium		
Week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1427	590.0	8764.6	8764.6	11.8	420.1	420.1	144.0	8452.8	8452.8
1	412	94.8	406.6	9171.2	2.3	23.6	443.8	23.0	389.8	8842.6
2	614	95.6	611.1	9782.3	2.1	32.2	475.9	22.4	565.8	9408.4
3	424	54.5	240.6	10022.8	1.2	12.7	488.6	13.2	230.2	9638.6
4	436	61.7	280.0	10302.9	1.3	14.1	502.8	14.2	254.7	9893.3
*5	415	66.9	289.0	10591.9	1.5	15.0	517.8	15.4	262.9	10156.2
6	421	72.1	316.0	10907.9	1.6	16.8	534.6	16.6	287.5	10443.7
*7	417	73.1	317.3	11225.2	1.6	16.1	550.7	16.9	289.9	10733.5
8	425	74.1	327.8	11553.1	1.5	15.9	566.6	17.2	300.7	11034.2
*9	423	72.3	318.3	11871.4	1.4	14.8	581.4	17.0	295.8	11330.0
10	427	70.5	313.2	12184.6	1.3	13.8	595.3	16.8	295.1	11625.1
*11	437	62.5	284.3	12468.9	1.4	14.7	610.0	15.2	273.2	11898.4
12	431	54.5	244.6	12713.6	1.4	15.1	625.0	13.6	241.1	12139.5
*13	439	56.0	256.1	12969.7	1.8	19.7	644.7	13.2	237.5	12377.0
14	421	57.6	252.3	13222.0	2.2	23.1	667.9	12.7	219.9	12596.9
*15	415	61.6	266.2	13488.2						
16	417	65.7	285.0	13773.2						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concetrations.

Table A4.10 Mass release from 1.5% S siltite-argillitite (sample number MT-100.4, cell 16).

		Sulfate			Calcium			Magnesium		
Week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1453	560.8	8482.6	8482.6	9.6	348.0	377.7	131.0	7829.8	7829.8
1	457	138.0	656.5	9139.2	2.6	29.6	397.9	32.7	614.7	8444.5
2	476	87.3	432.6	9571.8	1.7	20.2	407.9	21.9	428.8	8873.4
3	403	54.0	226.5	9798.3	1.0	10.1	421.7	1.0	16.6	8889.9
4	425	71.3	315.5	10113.8	1.3	13.8	436.7	17.4	304.2	9194.1
*5	429	76.3	340.5	10454.3	1.4	15.0	452.2	18.4	324.7	9518.8
6	415	81.2	350.8	10805.1	1.5	15.5	464.9	19.4	331.2	9850.0
*7	407	73.9	313.1	11118.2	1.3	12.7	475.1	17.4	290.5	10140.5
8	408	66.6	282.9	11401.1	1.0	10.2	487.2	15.3	256.8	10397.3
*9	421	73.0	319.8	11720.9	1.2	12.1	501.0	17.6	304.8	10702.1
10	426	79.4	351.9	12072.8	1.3	13.8	512.6	19.9	348.7	11050.8
*11	444	66.6	307.9	12380.7	1.1	11.6	520.9	16.2	295.9	11346.7
12	415	53.9	232.8	12613.5	0.8	8.3	530.4	12.5	213.4	11560.1
*13	421	56.4	247.1	12860.6	0.9	9.5	541.0	13.2	227.7	11787.8
14	427	58.9	261.6	13122.2	1.0	10.7	541.0	13.8	242.4	12030.2
*15	411	66.2	283.3	13405.5						
16	425	73.6	325.6	13731.2						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concetrations.

Table A4.11 Mass release from 2.2% S siltite-argillitite (sample number MT-99.4, cell 9)

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1354	254.3	3584.4	3584.4	22.3	753.3	753.3	37.1	2066.4	2066.4
1	545	231.8	1315.1	4899.6	11.3	153.7	907.0	38.9	872.1	2938.5
2	503	155.6	814.8	5714.3	8.5	106.7	1013.7	33	682.8	3621.3
3	425	130.8	578.7	6293.0	6.4	67.9	1081.5	26.6	465.0	4086.3
4	450	119.9	561.7	6854.7	5.6	62.9	1144.4	24.5	453.5	4539.8
*5	423	108.9	479.5	7334.3	5	52.8	1197.2	23.1	401.9	4941.8
6	429	97.9	437.2	7771.5	4.4	47.1	1244.3	21.7	382.9	5324.7
*7	422	88.8	390.1	8161.6	3.85	40.5	1284.8	19.85	344.6	5669.3
8	437	79.7	362.6	8524.2	3.3	36.0	1320.8	18	323.6	5992.9
*9	433	70.975	319.9	8844.1	3.05	33.0	1353.7	16.7	297.5	6290.3
10	424	62.25	274.8	9118.9	2.8	29.6	1383.4	15.4	268.6	6558.9
*11	439	57.01	260.5	9379.4	2.4	26.3	1409.7	13.65	246.5	6805.4
12	431	51.77	232.3	9611.7	2	21.5	1431.2	11.9	211.0	7016.4
*13	428	51.215	228.2	9839.9	2.05	21.9	1453.1	12.3	216.6	7232.9
14	445	50.66	234.7	10074.6	2.1	23.3	1476.4	12.7	232.5	7465.4
*15	427	56.615	251.7	10326.2						
16	416	62.57	271.0	10597.2						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.12 Mass release from 3.12% S siltite-argillitite (sample number MT-99.1, cell 10).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1351	1509	21222.8	21222.8	113.3	3819.1	3819.1	172	9558.7	9558.7
1	463	1228.2	5919.8	27142.6	74.1	856.0	4675.1	145	2761.6	12320.3
2	482	883.9	4435.1	31577.7	75.9	912.8	5587.8	132	2617.2	14937.5
3	443	649.6	2995.8	34573.5	59.5	657.6	6245.5	91	1658.3	16595.8
4	429	644.2	2877.0	37450.4	58.2	622.9	6868.4	118.7	2094.7	18690.5
*5	435	679.6	3077.5	40528.0	53.4	579.6	7448.0	116.2	2079.3	20769.8
6	444	715	3304.8	43832.8	48.6	538.4	7986.4	113.7	2076.6	22846.4
*7	436	659.7	2994.3	46827.0	45.55	495.5	8481.9	110.9	1989.0	24835.4
8	425	604.4	2674.1	49501.1	42.5	450.7	8932.5	108.1	1889.9	26725.3
*9	436	576.4	2616.2	52117.3	40.75	443.3	9375.8	105.1	1885.0	28610.2
10	432	548.4	2466.3	54583.5	39	420.4	9796.2	102.1	1814.4	30424.6
*11	447	508.05	2364.1	56947.7	37.25	415.4	10211.6	101.65	1869.1	32293.7
12	446	467.7	2171.5	59119.2	35.5	395.0	10606.7	101.2	1856.7	34150.3
*13	448	425	1982.1	61101.3	31.55	352.7	10959.3	89.05	1641.1	35791.4
14	448	382.3	1783.0	62884.2	27.6	308.5	11267.8	76.9	1417.2	37208.6
*15	451	420.8	1975.6	64859.9						
16	446	459.3	2132.5	66992.4						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.13 Mass release from 5.7% S siltite-argillitite (sample number MT-99.6, cell 11).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1341	421.8	5888.3	5888.3	3.2	107.1	107.1	2.4	132.4	132.4
1	447	127.0	591.0	6479.3	1.6	17.8	124.9	1	18.4	150.8
2	471	98.2	481.5	6960.8	1.6	18.8	143.7	1.2	23.2	174.0
3	402	153.5	642.4	7603.2	1.7	17.1	160.8	0.8	13.2	187.3
4	452	196.6	925.1	8528.3	1.7	19.2	179.9	1	18.6	205.8
*5	419	238.1	1038.3	9566.6	1.3	13.6	193.5	1	17.2	223.1
6	436	279.5	1268.6	10835.2	0.9	9.8	203.3	1	17.9	241.0
*7	424	279.5	1233.7	12068.9	0.65	6.9	210.2	1	17.4	258.5
8	423	279.5	1230.8	13299.7	0.4	4.2	214.4	1	17.4	275.9
*9	423	281.7	1240.5	14540.1	0.3	3.2	217.6	0.5	8.7	284.6
10	445	283.9	1315.2	15855.3	0.2	2.2	219.8	<0.1	0.0	284.6
*11	427	258.1	1147.3	17002.6	0.25	2.7	222.5	0.1	1.8	286.3
12	443	232.3	1071.3	18073.9	0.3	3.3	225.8	0.2	3.6	290.0
*13	460	220.6	1056.1	19130.0	0.3	3.4	229.2	0.2	3.8	293.7
14	448	208.8	973.8	20103.8	0.3	3.4	232.6	0.2	3.7	297.4
*15	425	235.6	1042.4	21146.2						
16	420	262.4	1147.3	22293.5						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.14 Mass release from 1.39% S Duluth Complex (sample number Mn-6.1, cell 12).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1365	106.6	1514.8	1514.8	27.0	919.5	919.5	11.9	668.2	668.2
1	465	161.5	781.8	2296.5	44.8	519.8	1439.3	15.1	288.8	957.0
2	500	98.2	511.1	2807.7	30.7	383.0	1822.3	9.3	191.3	1148.3
3	445	107.4	497.5	3305.2	32.9	365.3	2187.6	8.9	162.9	1311.2
4	449	92.4	431.9	3737.1	28.3	317.0	2504.6	7.5	138.5	1449.7
*5	431	81.0	363.4	4100.5	23.6	253.2	2757.8	6.4	113.5	1563.2
6	429	69.6	310.8	4411.4	18.8	201.2	2959.1	5.3	93.5	1656.7
*7	430	66.1	295.7	4707.0	17.8	190.4	3149.5	5.1	89.3	1746.1
8	424	62.5	275.9	4982.9	16.7	176.7	3326.2	4.8	83.7	1829.8
*9	402	59.1	247.1	5230.0	16.2	162.5	3488.7	4.7	76.9	1906.7
10	426	55.6	246.6	5476.7	15.7	166.9	3655.5	4.5	78.9	1985.5
*11	446	53.4	248.0	5724.6	14.9	165.2	3820.8	4.4	80.7	2066.2
12	440	51.2	234.5	5959.1	14.0	153.7	3974.5	4.3	77.8	2144.1
*13	458	51.5	245.4	6204.5	13.9	158.7	4133.1	4.2	79.1	2223.2
14	455	51.7	245.0	6449.5	13.8	156.3	4289.4	4.1	76.7	2299.9
*15	442	55.4	254.8	6704.4						
16	438	59.0	269.2	6973.6						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.

Table A4.15 Mass release from 1.39% S Duluth Complex (sample number Mn-6.1, cell 14).

		Sulfate			Calcium			Magnesium		
week	Vol.(ml)	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass	Conc(mg/L)	Mass(um)	Sum Mass
0	1377	99.5	1426.3	1426.3	25.0	858.9	858.9	11.6	657.1	657.1
1	459	147.8	706.2	2132.5	42.7	489.0	1347.9	14.0	264.3	921.4
2	496	108.4	559.7	2692.3	32.7	404.7	1752.6	10.0	204.0	1125.4
3	412	81.3	348.7	3041.0	24.9	256.0	2008.5	6.3	106.8	1232.2
4	414	83.8	361.2	3402.1	23.8	245.8	2254.4	8.0	136.2	1368.4
*5	423	83.2	366.2	3768.3	23.4	246.4	2500.8	7.0	121.8	1490.2
6	446	82.5	383.0	4151.3	22.9	254.8	2755.6	6.0	110.1	1600.3
*7	438	71.9	327.6	4478.9	19.7	215.3	2970.9	5.3	94.6	1694.9
8	420	61.2	267.6	4746.5	16.5	172.9	3143.8	4.5	77.7	1772.7
*9	430	61.4	274.8	5021.3	17.3	185.6	3329.4	4.9	85.8	1858.4
10	442	61.6	283.3	5304.7	18.1	199.6	3529.0	5.2	94.5	1953.0
*11	447	56.6	263.4	5568.1	16.1	179.0	3708.0	4.7	86.4	2039.4
12	447	51.6	240.3	5808.4	14.0	156.1	3864.2	4.2	77.2	2116.6
*13	457	50.9	242.3	6050.6	14.0	159.6	4023.8	4.0	75.2	2191.8
14	450	50.2	235.2	6285.9	14.0	157.2	4181.0	3.8	70.3	2262.2
*15	449	51.2	239.5	6525.3						
16	440	52.3	239.4	6764.7						

Note: Starred(*) weeks concentration, for SO4, Ca, and Mg were estimated as the average of the previous and subsequent week's concentrations.