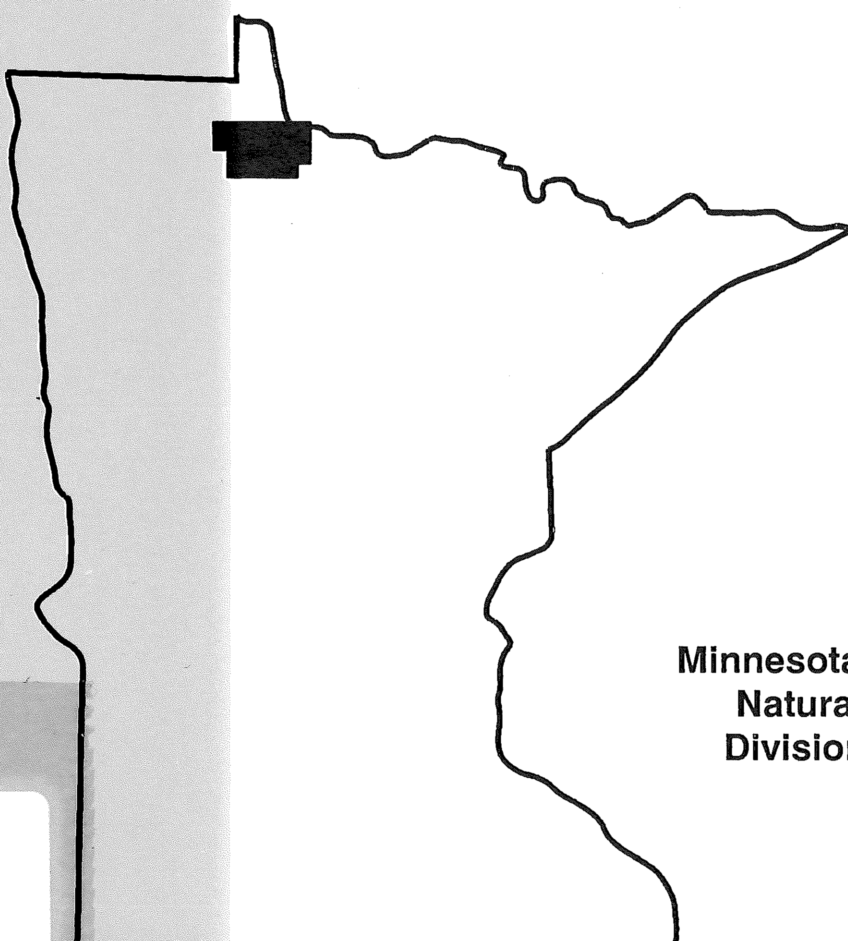
Report 278

Archean Drill Core Description and Assay in Lake of the Woods County, Minnesota



Minnesota Department of Natural Resources
Division of Minerals

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Archean Drill Core Description and Assay in Lake of the Woods County, Minnesota

By:
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A Minerals Diversification Project

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Publication Notification

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Preface

The Minnesota Department of Natural Resources (MDNR), Minerals Division, maintains a Drill Core Library at its Hibbing, Minnesota office. This facility is the repository for 5,059 drill holes totalling 1,625,888 feet of drill core or cuttings from iron, base and precious metal exploration in Minnesota. Exploration holes were drilled on evidence of inferred mineralization. But are there other clues to mineralization in these cores? By necessity, available evaluations have been limited and perhaps narrowly focused.

For a 21 township area in southern Lake of the Woods County, all 43 available drill cores (and one additional adjacent core) were logged with 205 samples analyzed. In addition, other projects conducted overburden drilling in this same area, and aeromagnetic data from a portion of this area was used to produce a pseudo-geologic map.

Executive Summary

Logging and geochemical sampling of greenstone belt rock cores maintained at the State of Minnesota Core Library in Hibbing, Minnesota, has been an ongoing project since 1988. Most of the forty-four cores examined during the current biennium are located within the Wabigoon Subprovince of the Superior Province of the Canadian Shield in Lake of the Woods County and complement the MDNR Regional Survey of Buried Glacial Drift, Saprolite, and Precambrian Bedrock project.

The cores logged and sampled for this report were drilled from 1969 through 1986 by private companies in their search for base and precious metals. Most drill holes were inclined to cross-cut the stratigraphy and the geophysical anomaly targets. True overburden thicknesses ranged from 18' to 345' (average 128') in these drill holes. Core footages (not depths) varied from 168' to 1579' (average 443') per drill hole. Most rocks of the area are greenstone belt supracrustals and intrusions, with most rocks having been metamorphosed to at least upper greenschist grade.

Drill cores were laid out and logged in a qualitative manner and then sampled in order to determine protoliths, alteration and mineralization. The previous sampling history of each drill core, gleaned from the MDNR Assessment Files, was entered into a computer database as was MDNR Thin Section Collection information. Previous sampling varied from no analytical work at all to fairly extensive whole rock, trace element, rare earth, base metal, and precious metal analyses. At least several new samples were taken from each drill core for this project, with the intention of complementing existing data. Previously sampled mineralized intervals were sampled only when trace and other element data was lacking.

Analyses for the current study were obtained for SiO_2, TiO_2, Al_2O_3, Total Fe (as Fe_2O_3), MnO, MgO, CaO, Na_2O, K_2O, P_2O_5, LOI, Li, Be, Sc, V, Cr, Co, Ni, Cu, Zn, Ga, Rb, Sr, Y, Zr, Nb, Mo, Ag, Cd, Sn, Te, Ba, La, Ce, Ta, W, Pb, Bi, B, F, As, Sb, Hg, Cr, Se, Ta, Pd, Pt, Au, and Total S.

Logging for this project has verified or expanded the knowledge of favorable greenstone lithologies in this area such as agglomerates/conglomerates, rhyolites, breccias, and magnesic ultramafics. Most drill cores contained either graphite horizons or chemical sediments with iron sulfide or oxide, some of which were zinc and/or copper bearing. Observed (metamorphosed?) alteration products varied and included carbonate, sulfides, oxides, silica, sericite, talc-serpentine, anthophyllite(?), and hornblende-garnet. Twenty two drill cores contained tourmaline, of which seven cores contain conformable tourmalinite as defined and cited by Slack and others, 1984.

The highest analytical values obtained during this project for some of the elements include the following listing in groups by drill core:

Element	Value	Unit	Drillhole	Footage
Zn	6521	ppm	YWZ-2	636.3 to 643.8
MgO	22.9	%	YWZ-2	383.0 to 393.0
Cr	3995	ppm	YWZ-2	393.0 to 403.8
Sb	4.4	ppm	YWZ-2	636.3 to 643.8
Cu	954	ppm	B31-1	318.4 to 326.5
W	31	ppm	B31-1	318.4 to 326.5
Au	115	ppb	BD-II-1	653.0 to 663.0
B	1780	ppm	B21-2	239.0 to 248.0
S	16.82	%	B58-1	306.9 to 320.0
As	444	ppm	40926	344.0 to 352.0
Ni	636	ppm	40926	334.0 to 344.0
MnO	1.59	%	BD-1	244.0 to 254.0

Pb	139	ppm	B31-3	514.0 to 525.0
SiO_2	83.3	%	B31-4	444.0 to 457.0
Na_2O	6.75	%	B31-4	465.0 to 475.0
K_2O	7.07	%	MED-1	185.0 to 194.0
F	3004	ppm	MED-1	185.0 to 194.0
V	708	ppm	MED-1	213.5 to 224.0
Ag	1.5	ppm	YWL-1	329.0 to 339.0
Hg	288	ppb	BD-N-1	515.0 to 520.5
Mo	319	ppm	BD-N-1	515.0 to 520.5
Bi	19	ppm	BD-N-1	607.0 to 610.3
Se	17	ppm	BD-N-1	474.5 to 480.3
		and	BD-N-1	607.0 to 610.3
Te	21	ppm	B54-1	213.0 to 223.0
Pd	29	ppb	B-Q-1	106.1 to 118.0
TiO_2	3.03	%	MQD-2	232.0 to 242.0
Pt	38	ppb	MQD-2	162.0 to 171.6
CaO	16.7	%	BD-P-2	342.0 to 343.3
Al_2O_3	18.05	%	B24-4	652.0 to 664.0
P_2O_5	2.87	%	MDD-1	421.0 to 432.0

Drill core YWZ-2 contained the highest analyzed zinc values from the MDNR Assessment Files (10800 ppm within 643'-646') and also this study (6521 ppm within 636.3'-643.8'). This core contained another six feet with zinc values over 5000 ppm. For this study, the highest values of magnesium oxide, chromium, and antimony also occurred in this core. Higher zinc values were associated with a 19' interval containing chert-sulfide-graphite chemical sediment and associated alteration. DDH YWZ-2 also contained approximately 96' of altered ultramafic schists which were probably komatiitic flows based on high MgO, Cr, and Ni contents and textures indicating that the protolith was fine grained.

BD-N-1 was the most sulfide rich drill core. Within the sulfide-chert chemical sediment BD-N-1 contained 25' with zinc values over 5000 ppm. For this study, the highest values of mercury, bismuth, molybdenum, and selenium also occurred in this core, the first three of which were associated with elevated gold (to 40 ppb), copper (to 742 ppm), arsenic (to 85 ppm), and zinc (to 1599 ppm) values.

Drill core BD-2 is exemplary regarding chemical sediments and footwall alteration relationships because it has been minimally disturbed by later intrusions and veining. As such, the analyses are more likely to represent the original chemical sediment and alteration compared with other intervals in other drill cores. The interval 370.0-380.0' in sulfide-chert chemical sediments contains elevated zinc (644 ppm), copper (212 ppm), lead (21 ppm), selenium (8 ppm), arsenic (110 ppm), antimony (1.5 ppm), bismuth (8 ppm), boron (61 ppm), gold (33 ppb), silver (.9 ppm), mercury (34 ppb), cadmium (5 ppm), cobalt (76 ppm), molybdenum (8 ppm), tantalum (18 ppm), manganese oxide (.33 %), sulfur (13.04 %), and iron (32.00 %).

Eight of the drill cores studied have gold values over 300 ppb in the Assessment Files. From this study, gold shows the strongest correlation with sulfur, iron, bismuth, and copper; and weaker correlations with cobalt, selenium, arsenic, molybdenum, cadmium, lead, manganese, and zinc. These elements may indicate a partial association of gold with chemical sediment and related alteration. Elevated gold values in this study may also be shear related, with a smaller number of associated anomalous elements (combinations of boron, arsenic, bismuth, selenium, mercury, and others) as in drill core's 40926, BD-II-1, B58-1, and B24-4).

This new project has demonstrated that alteration, lithologies, and trace element which may be indicative of nearby precious metal or massive sulfide deposits are present in drill cores even though they contain relatively unmineralized sulfide horizons.

Introduction

Purpose and Objectives

The purpose of this study concerning Archean Drill Core Description and Assay, Lake of the Woods County, Minnesota is to find mineralization and to seek clues to otherwise concealed mineralization using sample analyses, descriptive logging, thin section petrography, and lithochemistry of existing drill core. This information will aid in mineral potential evaluation within the project area, especially concerning mineral deposit types that are known to occur in Archean rocks, such as volcanogenic massive sulfide and gold deposits.

The large acreage of State Mineral's ownership is one reason for this project. Approximately 60% of the surface and mineral rights within the Baudette area is owned or managed by the State of Minnesota, while approximately 15% is owned by the Federal government. The remaining 25% is privately owned.

The forty-four crystalline bedrock cores examined and sampled for this study were drilled within the Wabigoon and Quetico Subprovinces of the Canadian Shield's Superior Province. This area, in southern Lake of the Woods County, has the city of Baudette located at its northeast corner, and is hereafter referred to as the Baudette area. The drill hole locations are shown in Fig. 1, with additional drill hole information tabulated in Appendix A, and chemical analyses in Appendix D. Project work included the logging and description of the drill core, drill core sampling, thin section petrographic work, and chemical analyses for fifty elements.

More detailed project and report objectives include the following:

1) To provide consistent information by generating a relatively uniform set of descriptive drill core logs, since past interpretation and description of rock types has varied with the individuals logging the core, their constraints, and their priorities.

2) To complement information that is currently available regarding the drill cores from this area including other MDNR project data and Assessment File materials.

3) To emphasize rock types, alteration, mineralization and structures that may be indicative of nearby economic mineralization.

4) To sample and analyze a wide range of lithologic situations for a large suite of elements, in an attempt to characterize lithotypes, alteration, and mineralization in a more consistent manner.

5) To use thin section petrography to try to identify otherwise unrecognized alteration, lithotypes and textures that may be indicative of mineralization.

6) To synthesize project data into the regional geologic framework in order to identify trends and relationships.

This Baudette area study complements and spatially coincides with that of a MDNR study entitled "Regional Survey of Buried Glacial Drift, Saprolite, and Precambrian Bedrock in Lake of the Woods County, Minnesota" (Martin and others 1991; Fig. 1). Twenty rotasonic holes were drilled and cored over a 21 township area for this overburden project, with recovered materials including glacial drift, saprolite, and approximately 10' of the bedrock where possible.

Design and Scope

This work was carried out within a framework imposed by the spatial scales of the materials and methods available, certain unavoidable limitations, and necessary design choices.

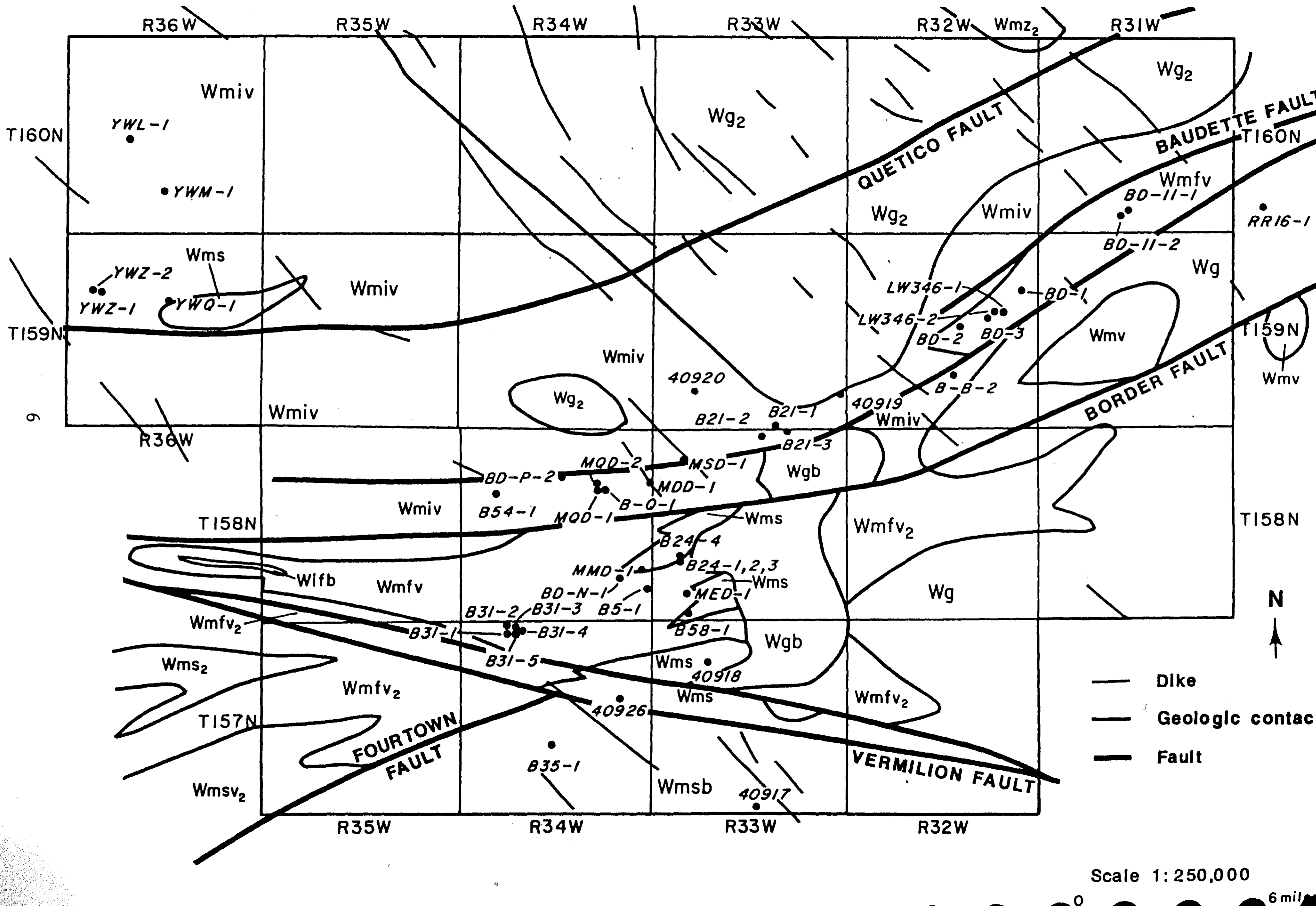

Figure 278-1. Geologic Map with Drill Hole Locations (after Day and others, 1991).

Phanerozoic Rocks

K	Cretaceous rocks, undivided

Early Proterozoic Rocks

Xd	Diabase, gabbro and diorite

Late Archean Units of the Wabigoon Subprovince

	Post-tectonic intrusive rocks (younger than about 2,700 Ma)
Wgmz	Granodiorite, quartz monzonite, and granite
Wmz	Hornblende monzonite
Wgn	Granodiorite gneiss
	Pre- and syn-tectonic intrusive rocks (about 2,700 to 2,736 Ma)
Wg	Granitoid rocks
Wgb	Mafic intrusive rocks
Wui	Ultramafic to mafic intrusive rocks
	Supracrustal rocks
Wms	Metasedimentary rocks, undivided
Wif	Iron-formation
Wifb	Chert-rich iron-formation
Wmsv	Metasedimentary and metavolcanic rocks
Wfvs	Felsic metavolcanic and volcaniclastic metasedimentary rocks
Wfv	Felsic metavolcanic rocks
Wmfv	Mafic and felsic Metavolcanic rocks
Wiv	Intermediate metavolcanic rocks
Wmiv	Mafic to intermediate metavolcanic rocks
Wmv	Mafic metavolcanic rocks
Wvs	Metavolcanic and metasedimentary rocks

Late Archean Units of the Quetico Subprovince

	Intrusive and migmatitic rocks
Whm	Hornblende monzonite
Wvsm	Schist-rich migmatite
Wmsb	Metasedimentary rocks

Late Archean Units of the Wawa-Shebandowan Subprovince

	Intrusive rocks
Wgd	Granodiorite, quartz diorite, and tonalite
	Supracrustal rocks
Wlvs	Layered volcanic-sedimentary rocks
Wmmv	Metavolcanic rocks, undivided

Spatial scales: With the different data types, the entire project is a forced interplay and assimilation of different spatial scales. The thin section petrography, X-ray diffraction (XRD) mineralogic work, and mineral grain mounts represent the smallest scale. Lithochemistry and core logging operated on larger spatial scales.

Thin section petrography was carried out on thin section sized samples (roughly 1 x 1.8 inches). This work was done without the larger scale lithologic relations which drill core examination can provide.

Other microscopic-scale information on mineralogy came from limited XRD and microscope grain mounts. These provided some microscopic information which aided the core logging at the megascopic scale.

The core logging dealt with several megascopic scales, which ranged from unique, barely visible (with a hand lens) features to the length of each respective drill core. Between these two extremes are a host of geologic features, including lithotypes and units composed of one or more lithotypes. The cores were described in terms of units which varied from less than a foot to hundreds of feet, depending on the uniqueness and commonality of the lithotypes, mineralogy, alteration, mineralization, veining, intrusions, and time. Lithotypes varied in apparent thickness from millimeter laminations to many ten's of feet, which forms a potential sampling problem with regard to lithochemistry.

The drill cores themselves are irregularly spaced and spatially biased on the chemical sediment horizons located by private exploration companies. These drill cores probably transect a small proportion of the actual stratigraphy.

The Baudette area, at the largest scale, can only be observed with the regional coverage offered by geophysics (see Fig. 2; Bracken and others, 1989; Horton and Chandler, 1988), or geologic maps (Day and others, 1991; see Spector in Lawler and Venzke, 1991) produced from this data. On such maps, drill core lithologies and stratigraphy actually represent only scattered point data.

While there is a potential problem in synthesizing this data of different scales, the core logging offers a link between these different scales. By "consistently" logging these cores, information on the smallest scales can be compared, and different drill holes (at the largest scale) can also be more readily compared with each other.

Limitations: Beside the limitations that differing spatial scales introduced, other limitations were also worked with.

All of the Drill Core Library cores from the Baudette area had to be evaluated for this project. This was the limiting factor on the amount of work done on each core. Other factors taken into account included the length of each core, the complexity of each core, and the amount and type of previous sampling. The cores and their spatial distribution were limited to what was available.

Due to funding limitations for this project, analytical and thin section work had to also be limited. For analytical work, an average of less than five samples per drill core could be taken. Similarly, only 123 thin sections could be made.

The thin section petrographer (J. Walker) worked on thin section sized samples, without the benefit of drill core lithologic relations. The sections were sampled at the senior author's (B. Frey) discretion before new chemical analyses were obtained, although the Assessment File chemistry data was scanned, with the U. S. Geological Survey data (Klein, 1988) being particularly helpful.

Design choices: The analyses of core samples that encompass more than one lithotype probably are not representative of either lithotype. On the other hand, the smaller the sample interval, the more samples that are needed to separately sample the complexity that these rocks possess. Analytical values must be reviewed in this context. For this project, a middle ground approach was necessary, since an average of less than five samples per drill core could be taken. This limitation made it important to try to complement previous analyses. The USGS core analyses (Klein, 1988) sampled relatively small intervals (<one foot), which forms an excellent, but limited, set of data on lithotypes and other features.

Thin section limitations also required a design choice. In order to provide better coverage, the 123 thin sections were limited to 25 drill cores, however it still does not constitute detailed coverage of those 25 drill cores.

Location and Access

The Baudette area, situated in north central Minnesota near the Canadian border, is located in Lake of the Woods County. The 44 cores examined fall within 10 townships, with most from a linear trend that subparallels and lies approximately 15 miles northwest of the Rainy lake-Seine River Fault.

Physiographically, the work area is equally covered by forested wetlands and upland forests. The highest percentages of wetlands are to the south. The wetlands include portions of four peatland preservation cores. Future mineral exploration work is likely to be restricted in these areas, which comprise about 15% of the Baudette area. Total surface relief in the area is about 250 feet. Access to the area is variable due to the road distribution, which in places is quite limited.

Previous Work

Considerable geologic activity has occurred in the Baudette area since the time of Winchell (1899). This has included base and precious metal exploration by industry from the late 1960's through the mid 1980's, Minnesota Geological Survey (MGS) and United States Geological Survey (USGS) CUSMAP work in the late 1980's, Minnesota Department of Natural Resources (MDNR) projects, nonferrous mineral leasing, and soil survey maps by the United States Soil Conservation Service (USSCS).

Most of the Baudette area is covered by glacial overburden, with only a few outcrops located in the eastern portion. Most of the geologic information for the area therefore is the result of variably distributed drilling and geophysics. Past regional geologic map revisions have largely resulted from refinements in geophysics, although continued drilling has created additional bedrock reference points.

This is especially true in recent years, where government agency drilling has presented bedrock information in areas away from geophysically anomalous volcanic greenstone, where drilling has been concentrated by companies for mineral exploration.

Past MDNR projects include data compilations and mineral potential studies created in 1974 (Projects 74, 75, 76, and 85), and in 1976 (Projects 123 and 130). Project materials that the MDNR Minerals Division's Hibbing office generates are made available to the public through their Open- File System.

The Baudette area drill cores that are maintained at the MDNR Hibbing Core Library were drilled from 1969 through 1986 (Ruhanen and Jiran, 1990). These private industry exploration holes, located on private and State nonferrous metallic mineral leases, were sited largely, if not completely, on magnetic and electromagnetic geophysical surveys. This information is available in the MDNR Assessment Files, along with other information, such as company lithologic logs and assay results associated with the drill holes or land parcels, any geochemical surveys, and other geophysical surveys.

Two 1:250,000 scale bedrock geologic maps of the Roseau Sheet, in which this project area falls, have been produced. The first was the Minnesota Geological Survey Sheet (Ojakangas and others, 1979), with the latest version coming from the U. S. Geological Survey (Day and others, 1991). The latter map is based on the interpretation of recently completed U. S. Geological Survey aeromagnetic and gravity survey data. The same information was used to create a 1:62,500 scaled, interpretative "pseudo-geologic" map of a portion of the Baudette area (in Lawler and Venzke, 1991).

The most recent aeromagnetic map of the 1:250,000 Roseau Sheet (Bracken and others, 1989) was produced by the U. S. Geologic Survey (USGS). The aeromagnetic data should eventually be published (by the USGS) as the Roseau Sheet of the nearly completed State of Minnesota Aeromagnetic Survey (Legislative Commission on Minnesota Resources funding), which has been published as a series of 1:250,000 scale sheets. This data has already been added to the Shaded-Relief Aeromagnetic Map of Minnesota (Chandler, 1989).

This recent aeromagnetic coverage replaces the USGS Aeromagnetic and Geology Maps (Maps GP 128 and GP 129) which were published at a scale of

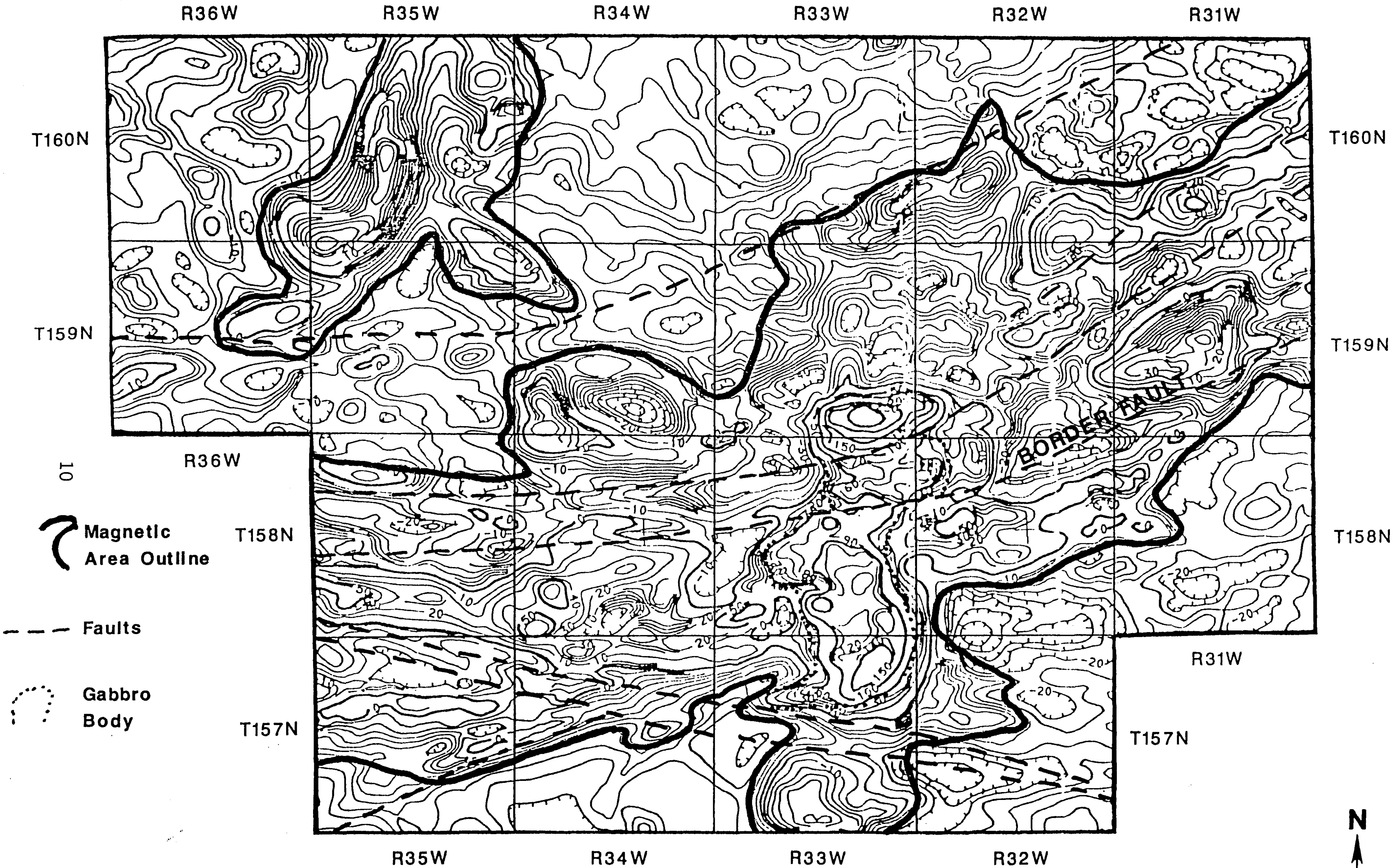

Figure 278-2 Aeromagnetic Contour Map.

(from Bracken and others, 1989)

Scale 1:250,000
0 6 miles

Contour Values (in Gammas) are ten times the contour labels.

1:63,360 (Meuschke and others, 1957a,b).

The USGS has also published a recent Bouguer Gravity Anomaly map (Horton and Chandler, 1988) for the 1:250,000 Roseau Sheet. This revises the Minnesota Geological Survey 1:250,000 scale Simple Bouguer Gravity Map of the Roseau Sheet (McGinnis and others, 1973).

Other USGS Open-File work has included tabulated bedrock sample geochemistry from exploration drilling (Klein, 1988), and a tabulated summary of lithologic logs and geological characteristics from diamond drill cores (Klein and Day, 1989). Other relevant USGS open-file materials for this area exist, but are not listed here, however.

The Minnesota MDNR Project 280, concerned with a regional survey of glacial drift, saprolite, and Precambrian bedrock, drilled 20 rotasonic drill holes (Martin and others, 1991). Within the Baudette area, the Minnesota Geological Survey (MGS) drilled 11 holes in cooperation with the U. S. Geological Survey CUSMAP work (see Mills and others, 1987). The MGS also produced a report about sulfide mineralization to the east of the Baudette area (see Ojakangas and others, 1977).

Soil studies include other USGS CUSMAP work involved with geochemistry (Clark and others, 1990) and USSCS unpublished soil survey maps.

The Ontario Geological Survey and others have carried out studies on areas of the Wabigoon Subprovince adjacent to the Baudette area in Canada where mineral exploration and development has advanced further due to greater rock exposures. This includes work on Quaternary geology (Bajc and Gray, 1987), and bedrock geology (Blackburn, 1979; Davis, 1973; Davis and others, 1982 and 1989; Davis and Edwards, 1986; and Johns, 1988).

There are eight current State nonferrous metallic mineral leases in the project area. Any data or information that is generated under these leases is confidential until the leases are terminated.

Bedrock Drilling Information Sources

Different drilling types with different objectives have occurred in the Project area. These include bedrock core drilling, overburden drilling, and water well drilling. The data or information may take the form of written records or actual physical material such as core or cuttings.

Bedrock core in the Project area was drilled between 1969 and 1987 by private companies in their search for base and precious metals. This type of drilling usually produced only limited overburden or saprolite samples. Most drill holes were drilled at an angle to cross-cut the stratigraphy and the geophysical anomaly targets. These forty-four drill cores are stored at the MDNR's Mineral Division in Hibbing, which also maintains relevant written information in the Assessment Files. Written information may include any drill logs, analytical results, geophysical or geochemical surveys, outcrop data, or other information (partially computer databased).

Overburden drilling in the Baudette area has been carried out for geologic and mineral potential information gathering by the Minnesota Geological Survey (CUSMAP drilling in cooperation with the U. S. Geological Survey, see Mills and others, 1987) and the Minnesota Department of Natural Resources for the Baudette area (see Martin and others, 1991). Beside the reports and written records, each agency may have drill cuttings, rotasonic overburden core, or rock core samples.

The Minnesota Geological Survey and the Minnesota Department of Health maintain written information about water wells (partially computer databased). The Minnesota Department of Health also maintains some written records of other drilling types.

Information Generated in Report Preparation

Beyond the results presented in this report, the Baudette area Open File materials include the following items:

1) Detailed lithologic logs. Consistently logged by the senior author (Mr. Barry Frey). One example is included in this report (Appendix C).

2) Sample Characterization Sheets. Tabular summaries that describe the samples taken for analysis by the senior author. Only those samples that were analyzed are included in this report (Appendix H).

3) Detailed thin section petrographic results. Produced by Mr. Jamie Walker, a Master's candidate at the University of Minnesota. Everything except the more detailed petrographic descriptions are included in this report as Appendix J.

4) Additional plots of reconnaissance chemistry data.

5) A computer database composed of previous geochemical-assay results from the assessment files of Lake of the Woods, Roseau, and Beltrami Counties. This is the first step in amassing the Assessment File lithochemistry data into a unified database of the Geoscience Information Services of the MDNR. This is available on disk for PC-based systems in a variety of formats.

This project will provide regional geologic information. As such, this data should not be used to move map boundaries, but should only be used to define the regional geophysical data used to make such maps, such as aeromagnetics. The observations, generalizations, and patterns noted in this report should be helpful to private industry in their search for massive sulfide or gold deposits. Hopefully this data will also stimulate additional regional variation and pattern recognition beyond those noted in this report.

Acknowledgements

Mineral Diversification funding was provided for this project. This project *could not have been completed* without the following people and their contribution. Pat Geiselman did most of the core moving, sampling, and sampling logistics. Al Dzuck and Ricco Riihiluoma also made contributions in core moving and sampling. Jay Niebuhr extracted much of the chemical data from the Assessment Files. Dorothy Cencich made all computer database entries, and was organized enough to demand little supervision. All figures containing maps of the Baudette area were drafted by Greg Walsh. Beside Ed Venzke, additional computer support was provided by Jacki Jiran and Rick Ruhanen. Diane Melchert and Helen Koslucher had the unenviable task of translating illegible scrawl with the word processor into drill logs and sample characterization sheets. Dale Cartwright helped to condense information into tables. A special thanks goes to Terry Klein of the USGS, who critically reviewed the earliest version of this manuscript and offered many constructive comments.

Regional Geologic Setting

The Baudette area is part of the Wabigoon and Quetico Subprovinces of the Superior Province of the Canadian Shield. The bedrock, composed primarily of Archean Precambrian rocks, is poorly exposed with rare outcrops reported. True overburden depths (corrected for drill hole angles) from the Baudette area drill holes vary from 18 to 345 feet.

The bedrock lithologic units have been weathered and in many places have a saprolite interval which varies from nothing on bedrock topographic highs to over 100 feet depth in zones of structural deformation, but is usually tens of feet in depth. The saprolite has very low magnetic susceptibility. Above this are deep glacial deposits usually over 100 feet in depth. The glacial deposits have a complex history. The glacial drift has variable magnetic susceptibility (Martin and others, 1991).

Based upon drill hole data, a major bedrock topographic high extends for more than 24 miles and strikes crudely parallel to the Baudette Fault. That high appears to have influenced the glacial history. East of the high, primarily late-Wisconsinan deposits are preserved, while to the west, additional older glacial deposits are also present. The glacial drift thickness is very similar on both sides of the high.

Bedrock map information is largely a synthesis of geophysics and bedrock drill cores, so improvements have usually involved a refinement in the regional geophysics (see previous section) and also the slowly but ever increasing drill hole coverage. The most recent geologic map (open-file) is the U. S. Geological Survey 1:250,000 scale Preliminary Bedrock Map for the Roseau 1° x 2° Quadrangle (Day and others, 1991). This made use of the recently completed Aeromagnetic map of the Roseau 1° x 2° quadrangle (Bracken and others, 1989), the Complete Bouguer gravity anomaly map of the Roseau 1° x 2° quadrangle (Horton and Chandler, 1988), and a tabular summary of lithologic logs by the USGS (Klein and Day, 1989). An interpretative "pseudo-geologic" map of a portion of the Baudette area has recently become available (see Spector, in Lawler and Venzke, 1991).

The regional summary of the bedrock geology presented here is based largely on this interpretation by Day and others (1991) (see Fig. 1), the regional geophysics noted above, and the lithologic logging of drill core completed for this project (Open File at the MDNR in Hibbing).

The general structural-stratigraphic fabric of the two subprovinces within the project area is northeast-southwest (see Figs. 1 and 2). Except for a narrow, flattened triangle of Quetico Subprovince rocks in the extreme south, the entire project area falls within the Wabigoon Subprovince.

Faults and Subprovince Boundaries

To the east of the study area, the two Subprovinces are conveniently separated by the Rainy Lake-Seine River Fault which trends southwest-west (see Day and others, 1991) and subparallels the general structural-stratigraphic fabric of the subprovinces. This subprovince boundary is believed to have originally been a shallow north-dipping (now vertical), reverse, dip-slip shear zone (Williams, 1990) with complementary stratigraphic and structural evidence of thrust duplication (Devaney and Williams, 1989). For additional information on subprovince boundary deformation and petrofabrics, with an emphasis on transpressive events, the papers by Borradaile and others (1988) and Hudleston and others (1988) will be helpful. Some geophysical modelling of the Quetico-Wawa subprovince boundary in Canada has also been done by Kehlenbeck and Cheadle (1990).

The Rainy Lake-Seine River Fault is crosscut and offset approximately 22 miles (Day and others, 1991) in the southern portion of the study area by another major fault system. This is the northwest-west trending, right-lateral Vermilion Fault. Approximately 100 miles to the east in the Vermilion District, Hudleston and others (1988) and Sims (1976) report a displacement of about 12 miles on this fault. To the south of the Vermilion Fault, the USGS designates the offset portion of the Rainy Lake-Seine River Fault as the Fourtown Fault.

The offset along the Vermilion Fault is primarily responsible for the small triangle of Quetico Subprovince juxtaposed in the Baudette area against the Wabigoon Subprovince on the other (north) side of the Vermilion Fault. To the north of the Vermilion Fault, the Rainy Lake-Seine River Fault (Subprovince boundary) actually lies to the east of (and out of) the Project area (see Day and others, 1991). It is only to the south of the Vermilion Fault that the Quetico Subprovince and the Fourtown Fault is present in the Project area.

Other major faults of the Baudette area interpreted by the USGS include a number of right lateral, southwest-west trending faults that are subparallel to the Rainy Lake-Seine River and Fourtown Faults (see Fig. 1). These occur to the north of the Vermilion Fault and northwest of the Rainy Lake-Seine River Fault, and include the Border Fault, Baudette Fault, and the Quetico Faults. These faults have been interpreted by Day and others (1991) to become more westerly trending as they approach the Vermilion Fault, which apparently truncates them. The net effect is that they become increasingly subparallel to the Vermilion Fault as they approach it.

Wabigoon Subprovince

The Wabigoon Subprovince is a typical granite-greenstone terrane (Windley, 1984; Devaney and Williams, 1989) made up of variably deformed and metamorphosed volcanic dominant and lesser sedimentary supracrustals intruded by mafic (perhaps ultramafic?) to felsic intrusions. Mafic to felsic cycles of bimodal volcanism and associated volcanogenic massive sulfide deposits have been recognized in other portions of the Wabigoon (Groves and others, 1988).

Other rock types described in the Wabigoon by Wilks and Nisbet (1988) include carbonates with stromatolites, komatiites and komatiitic basalts (including pyroclastics). They also recognized iron and manganese bearing units.

The rocks are metamorphosed to upper greenschist or lower amphibolite facies, with local punctuated contact metamorphism and intrusions. The supracrustals may be partially melted locally also.

All but two or possibly three Baudette area drill cores came from this subprovince (see section on Lithologic Logs), with most located within a relatively more magnetic terrane (seen on Fig. 2). This magnetic terrane may be indicative of predominantly mafic supracrustals, although other "magnetic" rock types such as gabbros, chemical sediments, and tonalites(?) could also influence the magnetic fabric of the subprovince (see Discussion). In general, the actual rocks of the Baudette area drill cores contain as much or more felsic as mafic rocks, however this may result from a bias resulting from drilling target selection within the more magnetic terrane (see Discussion).

Quetico Subprovince

Outside the project area, the Quetico Subprovince is otherwise a predominantly metasedimentary (greywacke) terrane (Percival and Williams, 1989) with gneisses, schists, migmatites, and local granitoid intrusions. The greywackes are believed to be turbidites from a mixed volcanic-plutonic source region (Ojakangas, 1985; Devaney and Williams, 1989), although they also contain syn-sedimentary debris-flow deposits, and rare beds, breccias, and pods of ultramafics (cited in Williams, 1990).

The proportion, if not the spectrum, of supracrustal protoliths in the Quetico Subprovince appears to be different from that in the Wabigoon Subprovince in general. The Quetico appears to have less mafic metavolcanics (and mafic derived sediments?) and a higher proportion of metasedimentary rocks (and/or felsic volcanogenic sediments).

The Quetico Subprovince within the study area, however, does contain other recognizable supracrustals outside of the usual metasedimentary suite. Within the study area, the Quetico Subprovince contains variably schistose, micaceous-amphibolitic-siliceous rocks, with metamorphic grades apparently similar to the Wabigoon Subprovince. These rocks include schistose volcanics and chemical sediments (see Open Filed Detailed Drill Core Logs).

In this case, based on the examination of an individual exploration company drill core, it is not necessarily possible to tell whether these particular supracrustals are from the Wabigoon or the Quetico Subprovinces (see section on Lithologic Logs). This may be expected since the two holes drilled by exploration companies in the Quetico portion of the Baudette area (DDH's 40917 and B35-1) were sited on the same type of targets that initiated the Wabigoon Subprovince drilling. Based on the higher regional magnetics, these two drill cores do not represent the dominant (metasedimentary) lithotypes of Quetico stratigraphy. Holes sited in other portions of the Quetico, such as MDNR DDH RR-2 (Sellner and others, 1985), could be differentiated from Wabigoon Subprovince rocks.

Subprovince Tectonic-Stratigraphic Relationships

With regard to the tectonic-stratigraphic history, the Canadians have done the most as far as unravelling the Superior Province and the two subprovinces of the study area. The different subprovinces of the Superior Province are believed to have formed through accretion tectonics (Williams, 1990; Langford and Morin, 1976). This includes volcanic arc (Wawa and Wabigoon Subprovinces) and fore-arc accretionary prism (Quetico Subprovince) environments. Williams (1990) also discusses other models.

A key role in such interpretations has been played by detailed radiometric dating, which often has precision as good as 2 or 3 Ma. This includes works by Davis and others (1989), Davis and Edwards (1986), Davis and others (1982), Corfu and Andrews, (1987), Corfu and Stott (1986), and Corfu and Wood (1986). Much of the strength of their work is the outcrop control on their observed geologic relationships.

The age ranges of supracrustals and batholith emplacement (between about 2.76 and 2.70 Ga) are similar for the Wabigoon and Wawa Subprovinces (Williams, 1990; Devaney and Williams, 1989). According to William's (1990) synthesis, the supracrustal rocks aggregated on a scale of five to ten's of miles, with small-scale (6-60 miles) accretion juxtaposing the varied supracrustal sequences to form greenstone belts (subprovinces). Later large-scale (60 to 600 miles) neo-Archean accretion joined the volcanic and sediment hosted subprovinces such as the Quetico. The intervening Quetico metasediments were deposited during or after the volcanic climax of these adjacent, volcanic dominated subprovinces (2.70-2.69 Ga).

Older radiometric dates (2730 to 3023 Ma) have been found to the north of the study area in the Sachigo and Uchi Subprovinces (Corfu and Wood, 1986; Corfu and Andrews, 1987). Compared with the more rapidly accumulating (more normal?) supracrustals of the Wabigoon and Wawa Subprovinces, these older sequences were particularly long lived, indicating that there were some differences in the tectonics, volcanism, and sedimentation of the different subprovinces.

Beside the Archean intrusives found within the supracrustals, there are a number of northwest trending diabase, gabbro, and diorite dikes that cut through the Archean rocks within the Project area. These belong to the Early Proterozoic Kenora-Kabetogama dike swarm that has been dated at about 2.12 Ga by Beck and Murthy (1982). This swarm has been described tectonically by Southwick and Day (1983) as a "variety of failed arm" produced along preexisting fractures as a consequence of rifting along a continental margin (presently buried beneath Early Proterozoic rocks of the Animikie Basin to the south).

Methodology

Project activities fell into three sections:

1) Core logging.
2) Thin section petrography.
3) Sampling and lithochemistry.

Each of these activities contribute to the final geologic understanding of the project area. This also suffered from the variable destruction of recognizable finer grained rock textures due to metamorphism and deformation. Nisbet (1987, p.124) states that "* * * amphibolite-grade metamorphism might rearrange the rock on a scale of the order of 1 cm, destroying all fine detail." This original texture destruction was generally not this severe, however it still is very significant when dealing with the examination of a sample the size of a thin section (40 x 24 mm), especially when the protolith is fine grained.

Core Logging

The forty-four cores examined for this project are maintained at the DNR's Drill Core Library in Hibbing, Minnesota. Drill cores were laid out (as many boxes as possible at a time), logged by the senior author (B. Frey) in a qualitative to semiquantitative manner, and sampled with an emphasis on mineralization, alteration, and the identification of different protoliths. Cores were examined with a hand lens on both outer surfaces and on fresh breaks (both wet and dry), with wet colors noted using the Rock Color Chart prepared for the Geological Society of America (Goddard and others, 1948). Grain mounts were examined with a polarizing microscope when necessary. Some X-ray diffraction (XRD) work for mineral identification purposes was done under contract with the M.A. Hanna Research Center in Nashwauk, Minnesota.

The resulting detailed logs varied in length from two to twelve pages, and are Open Filed at the DNR Minerals office in Hibbing. Brief summary logs are included as Appendix C, listed in the order in which they were logged, so that the reader may be better aware of unperceived logging changes that may have resulted due to the increasing experience base.

Thin Section Petrography

Samples for 123 thin and polished thin sections were selected by the senior author from the first 25 cores logged. Sections were chosen where petrographic work could hopefully elucidate problematic textures or mineralogy to help characterize protoliths, alteration and mineralization. Where alteration or veining was present, an attempt was made to sample some of the "unaffected" country rock also.

These sections were described under a contract with Mr. Jamie Walker, a Master's candidate at the University of Minnesota, Duluth. Emphasis here was also on alteration, protolith, and microscopic textures and mineralogy information to complement the other report data (see section on Petrographic Descriptions). All information is open filed including these descriptions, with the summary report and a tabular summary included as Appendix J.

The inventory of the MDNR Thin Section Collection information in a computer database has been initiated through this study. Polished thin sections, polished sections, and thin section heels are also included. A list of thin and polished thin sections from the Baudette area drill cores taken from this database is included as Appendix I. This appendix can be used to cross-reference the sample numbers of analyses in Appendix D with the drill cores and footages. Appendix I also includes the sections examined by Jamie Walker, and a cross reference to samples analyzed for this study.

Core Sampling and Lithochemistry

Sampling was carried out by the senior author with the intention of detecting mineralization and complementing the existing rock chemistry. Mineralization and alteration took precedence as criteria in choosing samples. To aid in this, the previous sample information from each drill core, from the MDNR Assessment Files, was entered into a computer database. The data fields contained in this database are listed in Table 278-1. Examples of the highest precious and base metal values from this database are listed in Appendix G, which does not include analytical results from the current study (Appendix D).

Some drill holes had been extensively sampled previously, while others were largely unsampled. Elements previously analyzed varied from just gold or copper and zinc, to large suites of elements including rare earths and extensive trace elements.

The sampling for this Project was reconnaissance in nature, with at least several samples taken from each drill core. Sample footages varied from 1.3 to 16 feet. Intervals varied in length due to the features being sampled, their spatial distribution, and the distribution of previous sampling. During the sampling for this project, a shorthand approach to characterizing the individual samples was adopted. Each sample is characterized using a 5 page tabular format with subdivisions of lithotype (protolith), alteration, veining, and mineralization. As with the lithologic logs, these sample descriptions are qualitative to semi-quantitative at best. The entire set of Sample Characterization Sheets, including the abbreviations and symbols used, have been Open Filed, and the data is included as Appendix H.

A total of 205 core samples for this project were prepared and analyzed under contract with Bondar-Clegg & Company, Ltd. in Ottawa, Ontario. Sample preparation consisted of primary crushing, secondary crushing to -10 mesh, and the pulverizing of a ½ pound subsample to -150 mesh. Beside the standard Bondar-Clegg Quality Control Program, two standards and a duplicate sample were submitted with every 20 samples as an extra check and a means of quantifying analytical variation (see section on Geochemistry).

Detection limits and analytical methods are shown in Table 2. A standard 52 element package analysis was done. Ten major element oxides were determined, plus loss on ignition (LOI), and with total iron reported as Fe_2O_3. Thirty-seven trace elements were analyzed, with As and Sb done by both ICP and AAS, and Cr and Ta done using ICP and XRF (Table 2). Analytical results are presented in Appendix D. The ICP values for As, Sb, and Ta were all below detection limits and are not included in Appendix D, while Cr is reported for both methods. Boron values were analyzed with a 10 ppm detection limit instead of the 1 ppm limit specified in the original contract. The samples have since been re-analyzed for boron. These new values are available in open file format but are not reported here.

Table 278-1. Assessment File Lithochemistry Database Fields.

COUNTY	SiO2 pc	Al pc	Zn ppm	Sb ppm	Hf ppm
DDH	TiO2 pc	Fe pc	Ga ppm	Te ppm	Ta ppm
UNIQUE	Al2O3 pc	Mn ppm	Ge ppm	Cs ppm	W ppm
CORE INT	Fe2O3 pc	Mg pc	As ppm	Ba ppm	Re ppm
LESSEE	FeO pc	Ca pc	Se ppm	La ppm	Os ppm
DRILLED	MnO pc	Na pc	Rb ppm	Ce ppm	Ir ppm
ORDER	MgO pc	K pc	Sr ppm	Pr ppm	Pt ppb
NUMBER	CaO pc	P pc	Y ppm	Nd ppm	Au ppb
DNR SAMP	Na2O pc	C pc	Zr ppm	Sm ppm	Hg ppb
LTR	K2O pc	Li ppm	Nb ppm	Eu ppm	Tl ppm
SAMPLE	P2O5 pc	Be ppm	Mo ppm	Gd ppm	Pb ppm
SAMPLER	LOI pc	B ppm	Ru ppm	Tb ppm	Bi ppm
SAMPLED	H2Oneg pc	F ppm	Rh ppm	Dy ppm	Th ppm
ASSAYER	Total pc	Sc ppm	Pd ppb	Ho ppm	U ppm
TOP INT	S pc	V ppm	Ag ppm	Er ppm	Cr ppm
BOT INT	CO2 pc	Co ppm	Cd ppm	Tm ppm	Cr ICP ppm
DENSITY	Si pc	Ni ppm	In ppm	Yb ppm	Cr XRF ppm
	Ti pc	Cu ppm	Sn ppm	Lu ppm	

Table 278-2. Detection Limits and Analytical Methods.

	Element	Detection Limit	Extraction	Method
SiO_2	Silica	0.01 %	Borate Fusion	Direct Current Plasma
TiO_2	Titanium	0.01 %	Borate Fusion	Direct Current Plasma
Al_2O_3	Alumina	0.01 %	Borate Fusion	Direct Current Plasma
Fe_2O_3*	Total Iron	0.01 %	Borate Fusion	Direct Current Plasma
MnO	Manganese	0.01 %	Borate Fusion	Direct Current Plasma
MgO	Magnesium	0.01 %	Borate Fusion	Direct Current Plasma
CaO	Calcium	0.01 %	Borate Fusion	Direct Current Plasma
Na_2O	Sodium	0.01 %	Borate Fusion	Direct Current Plasma
K_2O	Potassium	0.01 %	Borate Fusion	Direct Current Plasma
P_2O_5	Phosphorous	0.01 %	Borate Fusion	Direct Current Plasma
LOI	Loss on Ignition	0.05 %		Gravimetric
Total	Whole Rock Total	0.01 %		
Li	Lithium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Be	Beryllium	0.5 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Sc	Scandium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
V	Vanadium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Cr	Chromium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Co	Cobalt	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Ni	Nickel	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Cu	Copper	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Zn	Zinc	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Ga	Gallium	2 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
As	Arsenic	5 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Rb	Rubidium	20 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Sr	Strontium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Y	Yttrium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Zr	Zirconium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Nb	Niobium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Mo	Molybdenum	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Ag	Silver	0.2 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Cd	Cadmium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Sn	Tin	20 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Sb	Antimony	5 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Te	Tellurium	10 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Ba	Barium	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
La	Lanthanum	1 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Ce	Cerium	5 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Ta	Tantalum	10 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
W	Tungsten	10 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Pb	Lead	2 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
Bi	Bismuth	2 ppm	$HCl-HNO_3$, (3:1)	Inductively Coupled Plasma
B	Boron	10 ppm	NaOH Fusion	Direct Current Plasma
F	Fluoride	20 ppm	$Na_2CO_3-KNO_3$, (3:1)	Specific Ion
As	Arsenic	0.5 ppm	$HCl-HNO_3$, (3:1)	Hydride Generation Atomic Absorption Spectrometry
Sb	Antimony	0.2 ppm	$HNO_3-HCl-SnCl_2$	Hydride Generation Atomic Absorption Spectrometry
Hg	Mercury	5 ppb		Cold Vapour Atomic Absorption Spectrometry
Cr	Chromium	2 ppm		X-Ray Fluorescence
Se	Selenium	1 ppm		X-Ray Fluorescence
Ta	Tantalum	3 ppm		X-Ray Fluorescence
Pd	Palladium	1 ppb	Aqua Regia	Fire Assay/Direct Current Plasma (30 gram sample)
Pt	Platinum	5 ppb	Aqua Regia	Fire Assay/Direct Current Plasma (30 gram sample)
Au	Gold	1 ppb	Aqua Regia	Fire Assay/Direct Current Plasma (30 gram sample)
S	Total Sulphur	%		LECO Furnace

Lithologic Logging Results and Interpretations

The senior author (B. Frey) performed this descriptive and interpretive work, and he has written this section of the report. The following portions of this section will discuss and summarize those geologic observations resulting from the core logging only unless noted otherwise. The reader is referred to the Detailed Drill Core Logs (Open Filed at MDNR, Hibbing) and Sample Characterization Sheets (Appendix H) for the Baudette area drill cores. Only the Detailed Drill Core Log for DDH BD-2 is included in this report as Appendix B due to its exemplary nature (see section on Alteration and Mineralization).

All of the drill core logs are included in a summarized format in Appendix C. For most of the Summary Drill Logs, only a descriptive name and the footage interval are given for each unit. The features noted in this section are also listed in Table's 3 and 4 as a summary.

All of the rocks in these drill cores have undergone at least some deformation, alteration, metamorphism and/or recrystallization. The lithology names given to the rock units are typically interpreted protolith names with metamorphic-deformational modifiers. A "meta-" prefix is implied for all supracrustal protoliths discussed in this report. Later events have only rarely changed the protolith to the extent that the protolith could not be interpreted, even though positive identification is not certain.

Supracrustal Rocks

The probable protoliths* of the supracrustals include komatiite flows(?) (12,11), basalt (including pillow basalts, pillow breccia and finer mafic derivatives) (74,29), intermediate volcanics (tuffs and flows?) (42,1), felsic volcanics (tuffs and agglomerates) (87,21), clastic sediments (22,30), and chemical sediments (90,1). The numbers for chemical sediments in core logging includes samples where cross-cutting relationships were indistinct, which means that some footwall alteration samples are counted with this. The thin section number of chemical sediments includes only samples with distinct bedding, but leaves out chemical sediments layers interpreted as veins due to the petrographer not seeing the thin section in its larger setting.

Alteration, metamorphism, deformation, and recrystallization have locally made protolith identification difficult in drill core, primarily when these processes are superimposed. This is especially true if the original protolith grain size was smaller than the final rock grain size, or where matrix and fragments were nearly identical in fragmental volcanics or sediments. Usually minor differences in metamorphic mineral amounts in coarser fragmentals allowed for their identification, even if grain boundaries were not recognizable otherwise.

The principal criteria used to megascopically separate fine grained fragmentals from texturally similar flows or intrusives was the carbonate content of the tuffs. Tuffs tended to have a more uniform (not vein related?) carbonate distribution. Tuffs also tended to deform in a more ductile manner than intrusives or flows in the same drill cores.

Stratigraphy: Limited stratigraphic control between drill holes may be possible for most private industry drill cores logged (see Discussion). Work with the airborne EM conductors (Lawler, oral and written commun., 1990) for this area indicate that these conductors are discontinuous and appear to be found at different stratigraphic horizons. There may be more than one core from a given horizon, which forms a potential starting point for stratigraphic work (such as the B31 series of drill cores).

Ultramafic Supracrustals: Seven drill cores appeared to contain probable ultramafics (see Fig. 3 and sections on Thin Section Petrography and Lithochemistry), some of which may be intrusive and others probably extrusive. They are often schistose,

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* For a listed protolithology (x,y), the protolith name is taken from the descriptive logs, with x = # of new analytical samples, and y = # of new thin sections, classified in this category by the petrographer.

Table 278-3. Notable Lithologic and Analytical Features of Supracrustal and Intrusive Rocks.

Supracrustal Rocks	
B31-4	The largest "clast" of any certainty 194.3-197.5' (see Discussion).
MED-1	More rhyolitic than dacitic at 185-209'.
B54-1	Bedding locally disrupted; changes in bedding angles, fragmentation, apparent slumping and folding 150'-325'.
BD-N-1	The largest sulfide interval encountered was 547-716'.
B21-2	Conformable tourmalinites, thickest at 246.8-247.7' which contained 40% tourmaline, 40% pyrrhotite, and 20% quartz, hornblende and magnetite.
B5-1	Some massive "metabasalt" was noted in the logs as being grey colored instead of chlorite-hornblende green.
BD-P-2	Basaltic rocks, pillowed 123'-628'.
B31-1	Basaltic rocks, pillow breccia 326'-483'.
B5-1	Basaltic rocks, rare finer fragmental 300'-342'.
40920	Mafic volcanic dominant.
BD-P-2	Mafic volcanic dominant.
B31-4	Drill core with the most felsic volcanics (including agglomeratic units).
B54-1	Local sulfide slumping was observed within 150'-325' locally.
B31-2	Contains minor sulfide and mafic volcanic(?) fragments within 376.7'-379.7'.
B31-4	Contains minor sulfide and mafic volcanic(?) fragments within 174.9'-197.6'.
B31-1	Vitreous fragments become difficult to recognize.
B31-2	Vitreous fragments become difficult to recognize especially within 355'-364.8'.
B31 series	Matrix somewhat amphibolitic or pyrite bearing.
40919	Vitreous fragments are in a tonalitic matrix.
B31-1	Agglomerate within 178'-275' is more dacitic toward the top and rhyolitic (more siliceous) toward the base.
YW series	The most clastic sediment bearing drill cores.
YWQ-1	Graded bedding locally in 399'-434'.
MQD-2	Contained apparent soft sediment deformation (disturbed to brecciated laminations) within 288'-299'.
MQD-2	Bedding locally disrupted; changes in bedding angles, fragmentation, apparent slumping and folding 142'-176'.
B21-3	Stratiform appearing marble laminae locally within 192'-415'.
B21-3	Tonalites and nearby nearly identical metamorphic rocks.
Intrusive Rocks	
B24-3 & YWL-1	Some of these intrusives may belong to the Early Proterozoic Kenora-Kabetogama Dike Swarm.
MDD-1	Tonalitic-granodioritic intrusives occur on a very small scale in the form of numerous thin dikes.
B21-3 & B21-2	Contain tonalitic intrusives, and nearby metamorphosed plagioclase-quartz tuffs(?) which look very similar to each other, except for the rounded grains and strained blue quartz in the latter.
MQD-2	Bedding locally disrupted; changes in bedding angles, fragmentation, apparent slumping and folding 142'-176'.
MDD-1	Pyroxenitic dikes and veins.
B31-3	Basaltic-gabbroic intrusives at 355'.
B31-5	Basaltic-gabbroic intrusives at 251'.
MMD-1	Basaltic-gabbroic intrusives at 249'.
BD-II-2	Basaltic-gabbroic intrusives at +204'.
B24-3	Basaltic-gabbroic intrusives at 190'.
B21-2	Mafic intrusives cut locally by more felsic intrusives (granitic and possibly tonalite-granodiorite) within 383'-610'.
MDD-1	Tonalite-granodiorite forms the most magnetic rock type.
B21-2	Tonalite-granodiorite occasionally intrudes mafic intrusions, and is intruded itself by thin granitic veins.
BD-II-1	Andesite that has not been reworked as sediments at 472'-478'.
BD-II-2	Undeformed granite-syenite, may be cut by calcite veins locally.
B21-3	Tonalites and nearby nearly identical metamorphic rocks.

Table 278-4. Notable Metamorphism, Deformation, Alteration, and Mineralization.

Metamorphism and Deformation	
B24-4, B-B-2, LW-346-1, & RR16-1	Associated linear (L tectonite) fabric developed.
BD-N-1	Visible mineral fabric and fragment flattening in different orientations.
MMD-1	Fold closures exhibit quite variable orientations within 465-475'.
YWZ-2	Anthophyllite at 373.1'.
YWL-1	Anthophyllite at 431.5'.
LW-346-2	Cummingtonite-grunerite?
MMD-1 & B5-1	Locally actinolitic?
MDD-1	Anthophyllite? actinolite?
B21-1	Honey colored garnet within 305-306'.
B31-1	Garnet predominantly andradite in sample #20360.
B21-3	Garnet forms intergrowths with hornblende.
B24-4	Contains a 1 cm garnet-calcite-quartz-epidote vein at 803.9'.
40917	Cordierite(?)
B31-1	Local zeolites and laumontite at 463.2', sample #20361.
B24-1	Destroyed textures by re-crystallization 588-614'.
MQD-1	Iron rich biotite at 218.5'.
B-B-2	Deformation related alteration within 177-187'.
BD-II-1	Deformation related alteration within 406-473'.
YWZ-1 & 2	Locally, a second planar (here designated S_2) fabric developed.
Alteration and Mineralization	
MDD-1	Extensively intruded and complicated.
YWZ-2	Highest analyzed zinc values, 10800 ppm Zn within 643-646'.
BD-N-1	Contained 25' with zinc values over 5000 ppm.
B21-3	Highest analyzed copper value, 4200 ppm for a < one' interval at 192.8'.
B21-1	Contained copper values of 2900 ppm within 226.7-227'.
LW-346-1, B21-3 & BD-II-1	Reported gold values between 500 and 800 ppb.
B31-2	One minute gold (?) grain may have been observed in a blue quartz vein at 368.3'.
B31-3	Pyrite-pyrrhotite transitions occur but more pyritic.
B31 series	Silicification in agglomerates, especially DDH B31-4 (444-457').
MED-1	Anomalous Li and F in agglomerate (one of the more rhyolitic ones?).
B31-5	Anomalous Li and F in agglomerate.
B58-1	Anomalous Au and Bi in agglomerate (and elevated Ni? Cr? Nb?, and lower than normal Zr? Ce? La?).
B24-4	"Interpillow" chlorite, hornblende, garnet, sulfides, and carbonate "veins" 105-304'.
B31-1 & B31-2	Vitreous fragments become difficult to recognize, especially in B31-2 (355-364.8').
B31 series	Matrix somewhat amphibolitic or pyrite bearing.
40919	Vitreous fragments are in a tonalitic matrix.
YWZ-1	Biotite in variable, but usually small amounts.
B-B-2	Deformation related alteration within 177-187'.
BD-II-1	Deformation related alteration within 406-473'.
B31-1	Silicification locally increased with depth, 178-275'.
B31-2	Silicification locally increased with depth, 268-365'.
40926	Silicification locally increased with depth, 105-159'.
B5-1	Carbonatization associated with veins or shears.
MMD-1	Selvages associated with carbonate veins are skarn-like in appearance and are locally within 482-525'.
40926	Sericitization patchy and vein-shear related.
BD-2	Best example of the chlorite-hornblende-garnet alteration (chemical sediment related).
B24-2	Pyrite-pyrrhotite transitions occur locally, 621-645'.

and characterized by their high talc, tremolite-actinolite, carbonate, or mafic mineral contents. In general, their original textures have been obliterated. Of all the rock types examined, these were the least sulfide bearing.

Some massive "metabasalt" was noted in the logs as being grey colored instead of chlorite-hornblende green (such as DDH B5-1), and may be either ultramafic or perhaps a relatively "less iron rich, more aluminous or magnesic" variety of metavolcanic such as a komatiitic basalt (Nisbet, 1987, p.209).

Mafic Supracrustals: Basaltic rocks were aphanitic to fine grained, dark green to black (high color index), hornblendic or chloritic rocks. These tended to be massive, but some pillowed (DDH BD-P-2, 123-628' locally), pillow breccia (DDH B31-1, 326-483' locally), and rare finer fragmental (DDH B5-1, 300-342') intervals were recognized. Most drill cores had at least some mafic volcanics, and only rarely did they predominate (DDH 40920 and BD-P-2).

Intermediate Supracrustals: These volcanics were largely, if not entirely, tuffs. The intermediates appeared more siliceous-feldspathic and had lower color indices than the mafics. The intermediates often had recognizable feldspar phenocrysts, yet they still contained 20 to 30% mica and amphibole.

Felsic Supracrustals: These rocks were very siliceous-feldspathic with little mica and less amphibole. These were largely tuffs and other fragmental units. In the felsic volcanics, the principal recognizable features are phenocrysts and fragments.

Felsic porphyries were sometimes problematic with regard to their origin as flows, intrusives, or even tuffs, and were consequently labelled as porphyries when in doubt.

The drill core with the most felsic volcanics (including agglomeratic units) was B31-4, although this does not mean that thicker felsic piles are not associated (nearby) with other drill cores.

Agglomerates-Conglomerates: Coarser felsic fragmental rocks, including agglomerate-conglomerates (fragments > 6.4 cm) were found in 22 of the 44 cores logged (see Fig. 4). The fragments (subrounded?) are sometimes somewhat flattened (oriented?), although probably less so than finer fragmentals. The largest "clast" of any certainty was from 194.3-197.5' in DDH B31-4 (see Discussion).

These rocks are generally siliceous-feldspathic, although some units are more oligomictic, or contain accessory or accidental fragments(?) of a less siliceous-feldspathic nature. DDH B31-2 contains minor sulfide and mafic volcanic(?) fragments within 376.7-379.7', as does DDH B31-4 within 174.9-197.6'.

In drill core logging, most felsic rocks appeared to be more dacitic than rhyolitic, although some of the agglomerates may be an exception to this (DDH MED-1 at 185-209'). Unfortunately, feldspar color is not always a reliable criterion.

Some units appear to visually change composition downhole. In logging DDH B31-1, the agglomerate within 178-275' appeared to be more dacitic toward the top and rhyolitic (and more siliceous) toward the base (see Discussion).

The matrix of these rocks is commonly siliceous, and if the rock has been silicified (see Alteration and Mineralization) making the fragments vitreous also, some fragments and matrix become difficult to differentiate (DDH's B31-1; B31-2, especially within 355-364.8'). The matrix may also be somewhat amphibolitic or pyrite bearing (B31 series of drill cores). In DDH 40919, the fragments are in a tonalitic matrix.

Clastic Supracrustals: The most sediment bearing drill cores were the five YW series cores in the northwest portion of the study area. Otherwise, most clastic rocks were represented by variably reworked intermediate, felsic, and mafic volcanics.

Regarding sedimentary features, graded bedding was observed in DDH YWQ-1 within 399-434', however slumping and soft sediment deformation was noted in chemical sediment portions of other drill cores. Recrystallization and metamorphism may obscure sedimentary features such as graded beds and cross beds.

Chemical Sediment Supracrustals: Chemical sediments included various conformable mineralogic components of banded iron formations (BIF) such as cherts, sulfides, oxides, silicates, and carbonates (Goodwin, 1973), along with graphites and lesser tourmalinites and marbles. These mineralogic components appear to be intimately associated with footwall rock alteration of similar mineralogy, but the chemical sediments generally have conformable layering (see Alteration and Mineralization).

The observed mineral assemblages of chemical sediments and some of the alteration types in the drill core are shown in Table 5. Each column represents a different(?) observed assemblage. A spatial and perhaps genetic relationship between adjacent columns (assemblages) can be inferred from overlapping mineralogy, however the distance between drill cores limits the firm establishment of such a relationship.

The definite chemical sediment assemblages occupy the two left columns, while the four right columns contain assemblages of vein associated alteration. As the veinlets with alteration become more plentiful, the alteration becomes increasingly pervasive. This observed transition from vein alteration to more massive alteration typically involves the assemblages of columns two or three. In drill core, the distinction between chemical sediment and alteration cannot always be made, and this transition is typically exemplified by the second column assemblage. This assemblage can either be stratiform chemical sediments or cross-cutting veins. Due to the amount of recrystallization, it was often not possible to distinguish chemical sediment from stratiform alteration or replacement, since both would be conformable.

Sulfide, chert, graphite, and biotite(?) have the strongest tendency of the mineralogies shown in Fig. 2 to exhibit predominantly stratiform chemical sediment behavior. Other mineralogies may occur as conformable chemical sediment on a more limited or uncertain basis, however. Beside occurring as conformable layers, the other chemical sediment mineralogies (may include sulfides) can also be more spatially associated with footwall alteration-veining, with layering becoming nebulous or disappearing.

The stratiform sulfide chemical sediments are usually pyrrhotite. Sulfide-rich portions can vary from a few feet to hundreds of feet with variable sulfide amounts, including layers(?) with ten's of feet of massive sulfides. Most of the more massive layers are composed of sulfide and brecciated siliceous tuff fragments (and some chert?). This brecciation is typically only within the unit, with sulfides (often massive, >60%) as the matrix. The largest sulfide interval encountered was 547-716' in DDH BD-N-1, which was indeed the most sulfide-rich drill core.

Bedding was locally disrupted, with changes in bedding angles, fragmentation, apparent slumping and folding. This is most notable in DDH MQD-2 within 142-176' and 288-299', and locally in DDH B54-1 within 150-325'.

Chert (and iron carbonate?) chemical sediments occurred locally, and usually in relatively small amounts. Siderite-ankerite was usually intermixed with other chemical sediment-footwall alteration mineralogy. Chert, on the other hand, is most common, or at least easier to recognize, as a laminated chemical sediment, typically associated with sulfides with or without graphite or biotite. There was a general absence of fine scale (mm) laminations within the chemical sediments that were logged, perhaps due to recrystallization and metamorphism.

Graphite, which was found in 11 drill cores (see Fig. 6), is included with the chemical sediments, even though it is probably a biochemical sediment. It preferentially occurred with chert, sulfide layers, and typically very fine grained biotitic-sericitic schist.

Biotite is more commonly found in a stratiform manner (with chemical sediments) than hornblende. Biotite (as in DDH YWZ-1) is variable, usually in small amounts. XRD work indicates that the biotite is iron rich, at least in DDH MQD-1 at 218.5'.

Dark brown-black, conformable tourmalinite (as defined and cited in Slack and others, 1984) laminae and layers occur in 7 of the 22 drill cores with reported tourmaline (see Fig. 5). The thickest was at 246.8-247.7' in DDH B21-2, which contained 40% tourmaline, 40% pyrrhotite, and 20% quartz, hornblende and magnetite. Other occurrences as a chemical sediment component could have been missed in core logging, especially if the tourmaline was a minor constituent.

Table 278-5. Mineral Assemblages and Alteration Types.

CHEMICAL SEDIMENTS	CHEMICAL SEDIMENTS or VEIN ALTERATION	VEIN ALTERATION	VEIN ALTERATION	VEIN ALTERATION	VEIN ALTERATION
Chert	*Chert* *Silicification-Quartz*	*Silicification-Quartz*	*Silicification Quartz*	*Silicification Quartz*	**Silicification-Quartz**
Pyrrhotite *Pyrite*	**Pyrrhotite** *Pyrite* *Chalcopyrite*	*Pyrite* *Chalcopyrite* *Pyrrhotite*	**Pyrite** *Chalcopyrite* *Pyrrhotite*	*Pyrite* *Pyrrhotite*	*(Pyrite)* *(Pyrrhotite)*
Calcite	*Calcite*	*Calcite*	**Calcite**	**Calcite**	*Calcite*
Biotite	**Biotite**	*Biotite*			
(Siderite)	*Siderite*	*Siderite*	*(Siderite)*		
Graphite					
	Oxides	*Oxides*			
	Chlorite or Hornblende (w/Garnet)	**Chlorite or Hornblende (w/Garnet)**	**Chlorite or Hornblende (w/Garnet)**	*Hornblende* *Garnet*	*Hornblende* *Garnet*
	Tourmaline	*Tourmaline*			
		Epidote	**Epidote**	**Epidote**	
				K-Feldspar *(Albite?)*	**K-Feldspar** **(Albite?)**
Typical Example	DDH B21-1 239-250'	DDH B31-2 483-493'	DDH MSD-1 549-561'	DDH B24-4 1447-1464'	DDH MED-1 460-467'

Large Bold - major phase. *Small Italic* - small amounts or not present at all.
Large Italic - usually a minor phase. (Parenthesis) - may or may not be present.

Oxide chemical sediment is typically intimately intermixed with iron silicates and sulfides (in various proportions) in beds-layers usually only several feet thick. These intervals superficially resemble mafic metavolcanics. Oxides in these intervals often supersede pyrrhotite as the major magnetic phase in these units. A typical example of oxides occurs in DDH B24-1 within 136-302' locally.

Silicate chemical sediments include the amphiboles, and micas. Green chlorite and its higher grade metamorphic equivalent, hornblende, occurred more commonly as footwall alteration products rather than as conformable chemical sediments, or the distinction could not be made.

Calcium carbonate chemical sedimentation is similar to the situation with quartz, in that conformable sedimentation and alteration may look very similar. With this in mind, more stratiform appearing marble laminae did occur with other chemical sediments, such as in DDH B21-3 (within 192-415').

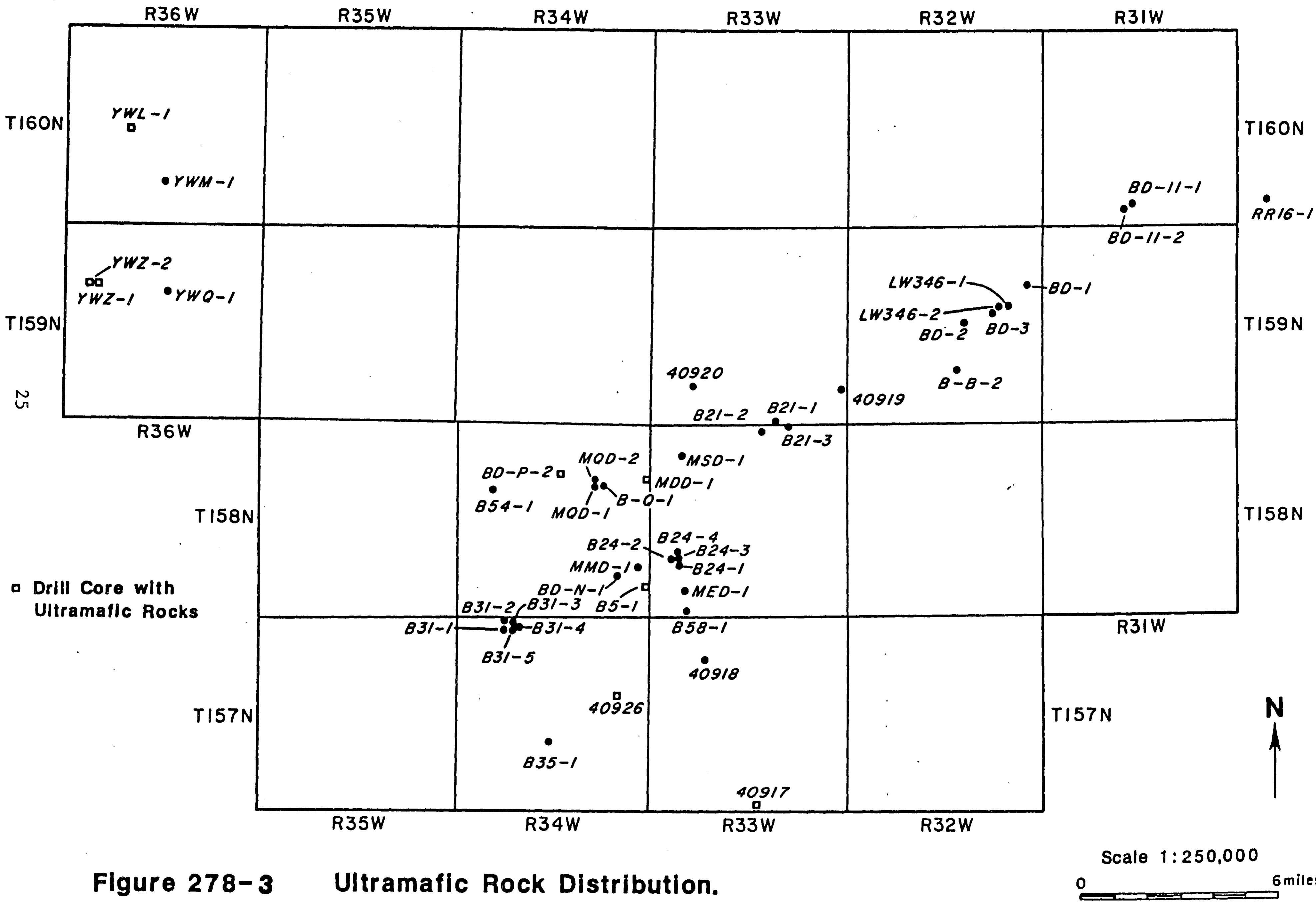
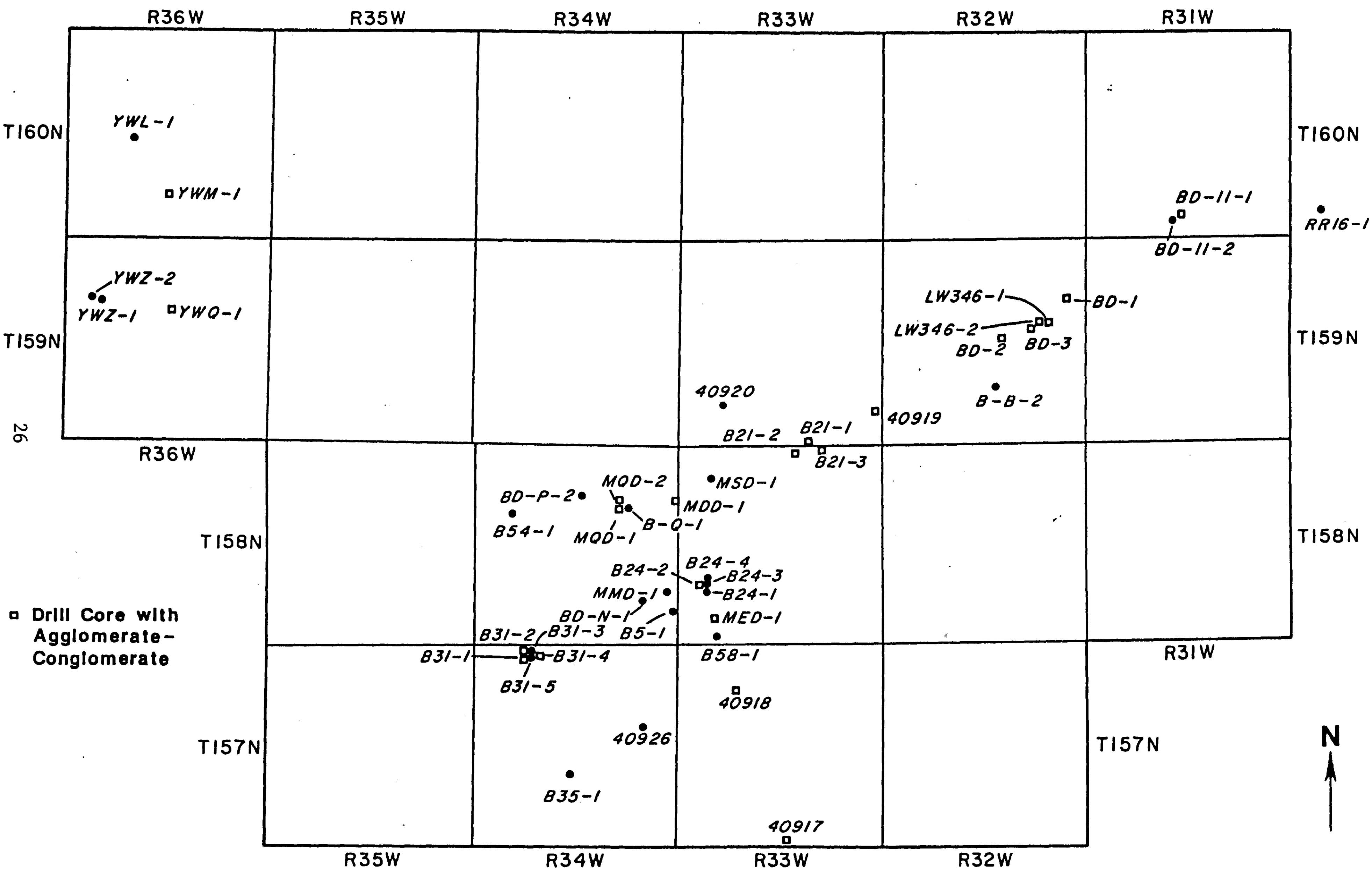


Figure 278-3 **Ultramafic Rock Distribution.**



Scale 1:250,000

0 6 miles

Figure 278-4 Agglomerate-Conglomerate Distribution.

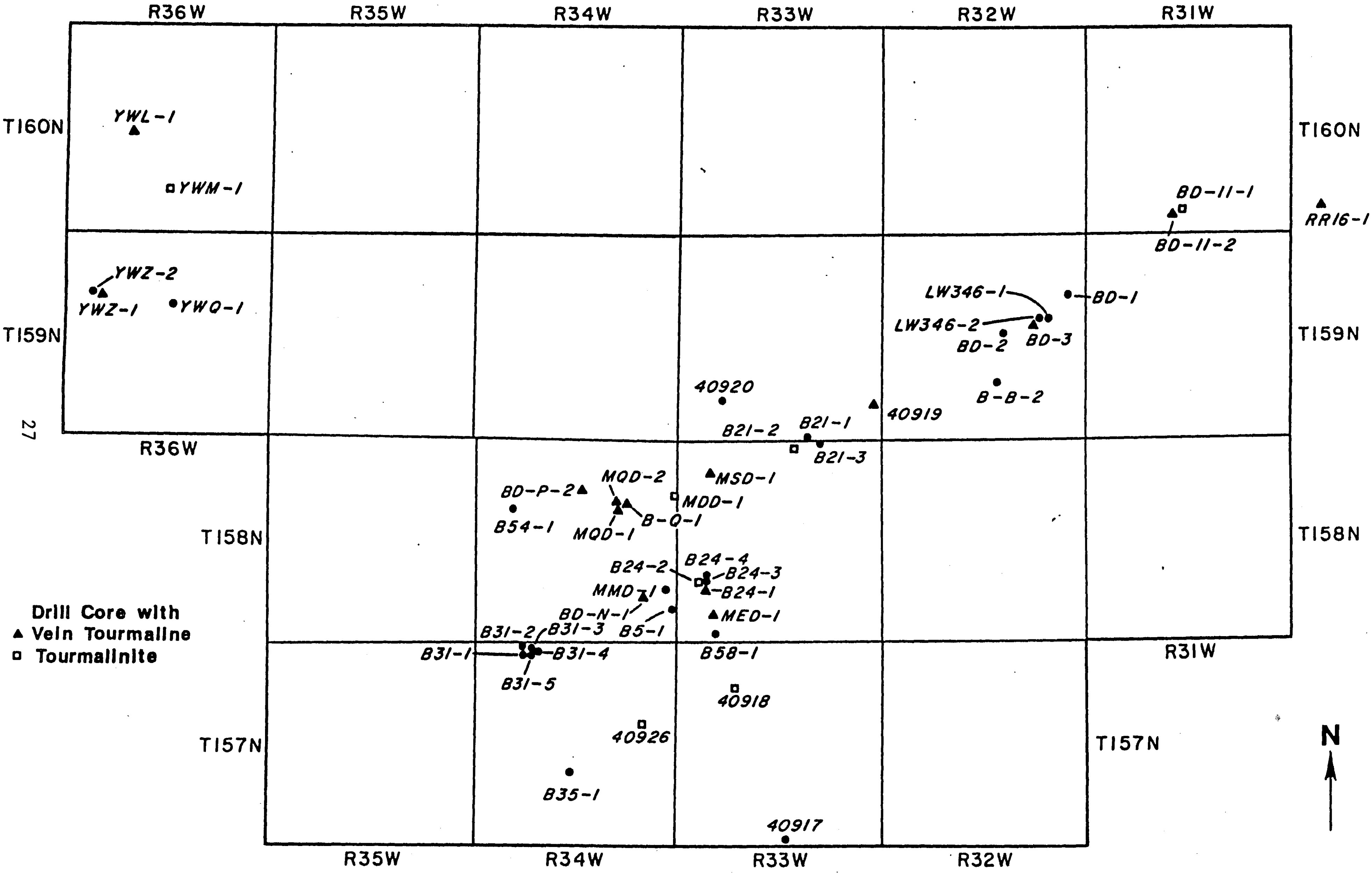


Figure 278-5 Tourmaline Distribution.

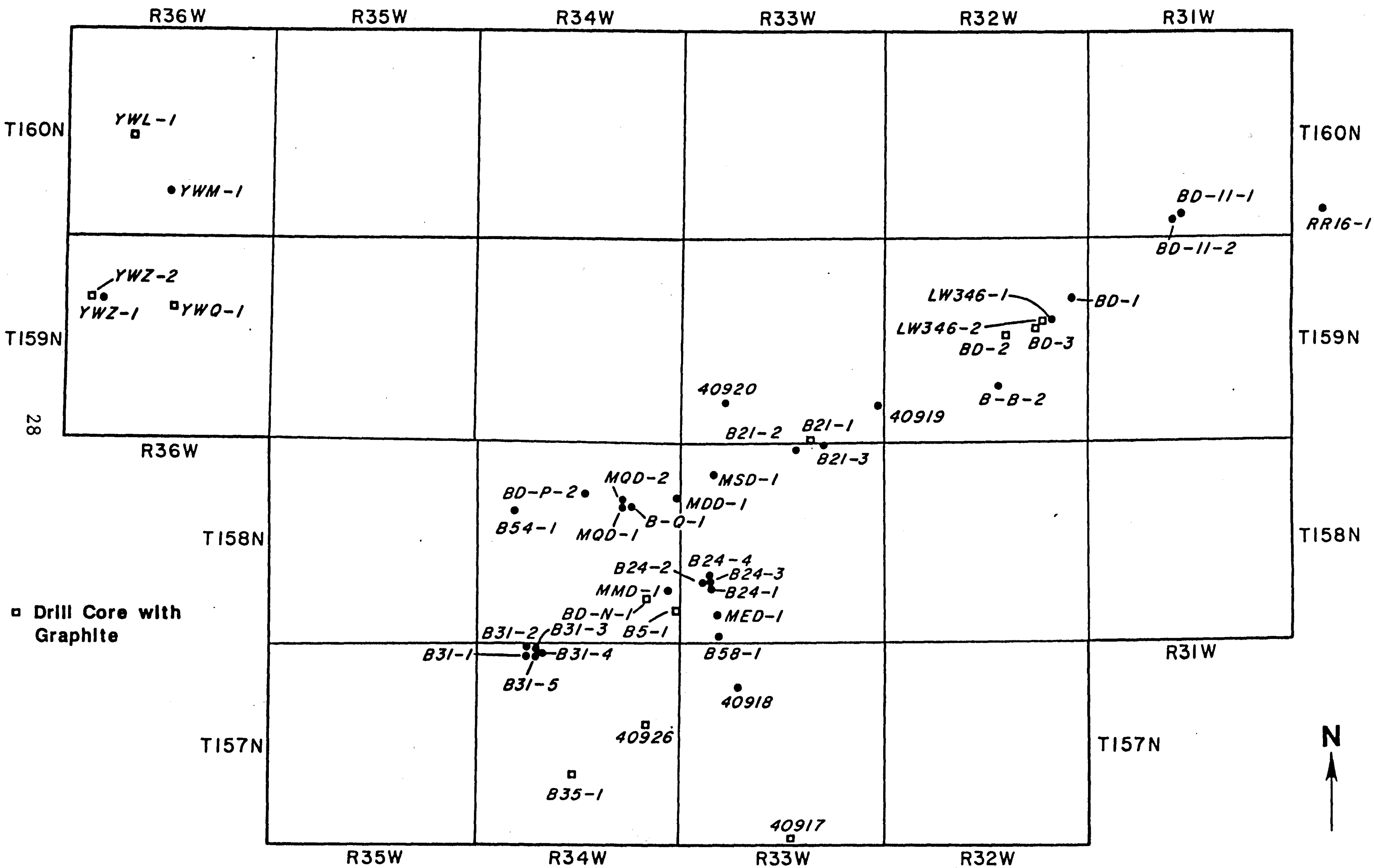


Figure 278- 6 Graphite Distribution.

Scale 1:250,000

0 6 miles

Intrusive Rocks

The amount and types of intrusive rocks within the drill core is extremely variable. They vary in scale from thin veinlets (possible metasomatic emplacement?) to gabbroic intervals of several hundred feet. Intrusives appear to fall into the following groups: ultramafic, pyroxenitic, basaltic-gabbroic, tonalitic-granodioritic, andesitic(?), felsic porphyry, and granitic-syenitic.

Ultramafic Intrusives: Some of the materials in the seven cores with ultramafic materials may indeed be intrusives (see Fig. 3 for distribution). These rocks are extensively altered in general. It was often difficult to determine if altered larger grains were porphyroblastic or porphyroclastic.

Pyroxenitic Intrusives: DDH MDD-1 contained pyroxenitic dikes and veins. These rocks do not appear as altered as other ultramafics, and are generally coarser grained. These pyroxenites are biotitic locally and may be of lamprophyric affinity.

Mafic Intrusives: The basaltic-gabbroic intrusives include the largest intrusive intersections encountered in the drill cores. At least 21 of the 44 cores had intrusives of this type. The DDH's (approximate footage in parentheses) with the largest amounts include DDH B31-3 (355'), B31-5 (251'), MMD-1 (249'), BD-II-2 (+204'), and B24-3 (190'). When cores had mafic intrusives, they were usually multiple. Some cores had deformation related alteration such as B-B-2 (177-187') and BD-II-1 (406-473'). Some alteration observed may possibly be deuteric, also. Intrusives of this composition are more likely to have recognizable chilled margins than other intrusive types. Mafic intrusives are cut locally by more felsic intrusives (granitic and possibly the tonalite-granodiorite (DDH B21-2, 383-610').

Tonalitic-Granodioritic Intrusives: The tonalitic-granodioritic intrusives (for distribution see Fig. 7) tend to be very siliceous and porphyritic. These intrusives may locally occur on a very small scale in the form of numerous thin dikes (DDH MDD-1 is the best example), even when this rock type makes up a considerable portion of the core. These intrusives may have appreciable "contamination", and may contain as much as 60% amphibole, biotite, magnetite, tourmaline, and/or pyrrhotite. In some drill cores, the tonalite-granodiorite forms the most magnetic rock type (DDH MDD-1). Some cores have tonalite-granodiorite with sharp contacts and minimal "contamination", and tonalite-granodiorite with "contamination" and nebulous contacts such as DDH's B-Q-1, MQD-1, and MQD-2.

Even if the external form of these intrusives shows no evidence of deformation, the mafic component usually has a deformational fabric developed. Tonalite-granodiorite occasionally intrudes mafic intrusions, and is intruded itself by thin granitic veins (DDH B21-2).

DDH's B21-3 and B21-2 contain tonalitic intrusives, and nearby metamorphosed plagioclase-quartz tuffs(?) which look very similar to each other, except for the rounded grains and strained blue quartz in the latter.

Andesitic Intrusives (?): Andesites that have not been reworked as sediments occur only rarely, and there is some doubt as to whether these are indeed intrusive or extrusive (DDH BD-II-1 at 472-478' for example).

Granite-Syenite Intrusives: The granite-syenite intrusives (see Fig. 8 for distribution) are generally small veins of K-feldspar with variable amounts of quartz. The thinnest dikes may only be represented by coarse K-feldspar crystals along otherwise hairline fractures. Locally, these veinlets cross-cut mafic intrusives and the tonalite-granodiorite. The granite-syenite may appear in core (but not always?) relatively undeformed, although they may be cut by calcite veins locally as in DDH BD-II-2.

Metamorphism and Deformation

The rocks vary from upper greenschist to lower amphibolite facies, and have been folded at least once. Several episodes of faulting (based on regional geophysics) have also occurred. The intent of the logging was not to produce a detailed structural study, however general fabric orientation, fold closures, shears, mylonites, and breccias were noted, since all are found locally in the drill core.

Deformation and Rock Fabric: Within the drill core a planar (S tectonite) schistosity (here designated S_1) is variably developed within and between different drill cores, and is usually subparallel to bedding (here designated S_0). There is a tendency for fragments and other features to show flattening, and only rarely is the apparent visible mineral fabric and the fragment flattening in different orientations (DDH BD-N-1). Locally, a second planar (here designated S_2) fabric may be developed (as in DDH YWZ-1 and DDH YWZ-2). Two fabrics are rarely found together, and when they are, they are not strongly developed.

Sometimes the S_0-S_1 fabric is rotated into shears locally, which is where an associated linear (L tectonite) fabric (as in DDH's B24-4, B-B-2, LW-346-1 and RR16-1) may be locally developed (indicated by mineral orientation). Some of the fold closures exhibit quite variable orientations as within 465-475' in DDH MMD-1.

Fabric development was also apparently influenced by the ductility differences of the different lithologies. Thicker, coarse-grained or siliceous intrusives developed schistosity much less readily than adjacent fine-grained or thinly bedded tuffs. The individual lithotypes appear to have behaved very differently in the same drill core. Because of this, some care must be exercised when using the rock fabrics as proximity indicators to faults.

Regarding fabric, recrystallization in many holes has created a final hornfelsic-massive texture. The rocks may locally look flattened and schistose, but they fracture irregularly when broken. This may be due to regional or local heating (associated with intrusions?), and/or alteration-silicification (see Alteration and Mineralization) which may produce, or at least promote, this texture.

Metamorphism: Regional metamorphism is at least greenschist facies, and may be as high as upper amphibolite. Except for some (early?) mafic intrusives, intrusive contacts show minimal chilling.

Metamorphic mineralogy observed in drill core worth noting includes chlorite, hornblende and other amphiboles, biotite, talc, garnet, calcite, epidote, and cordierite (see also sections on Thin Section Petrography and Discussion). In many cases, the protolith was altered and the metamorphic mineralogy may not reflect the pre-alteration mineralogy very well.

Hornblende (identified in grain mounts) was the most ubiquitous amphibole found in the core logging. It is found in the higher grade mafic volcanics, their derived materials, and also in the most common alteration-chemical sediment assemblage (see Alteration and Mineralization). Lower grade metamorphic rocks from the same starting materials were chloritic (in general green, iron rich). No chloritoid was identified, but that could easily go undetected in visual examination of the core. In many cases, it was difficult to tell whether the iron silicates were chlorite or hornblende even with a microscope, because the rock is often very fine grained or recrystallized.

Other amphiboles were less common. Tremolite and other iron deficient amphiboles were noted in some of the drill holes with metamorphosed (and altered?) ultramafics (see Fig. 3). X-ray diffraction (XRD) mineral work identified trace amounts of anthophyllite at 373.1' in DDH YWZ-2, and at 431.5' in DDH YWL-1. Other drill cores with other amphiboles include LW-346-2 (with cummingtonite-grunerite?), DDH's MMD-1 and B5-1 (locally actinolitic?), and MDD-1 (anthophyllite?, actinolite?).

Garnet was relatively ubiquitous with only 12 of the 44 drill cores lacking it (Fig. 9). Most of the garnet was red to pale pinkish, although honey colored garnet was noted in DDH B21-1 within 305-306'. One XRD mineral determination on a pink garnet at 434.7' from DDH B31-1 indicated that this garnet was andradite (predominantly), although it looks much like normal almandine. Occasionally, such as within 276-287' in DDH B35-1, garnets may have been confused with other red minerals because of their apparent softness (see Discussion).

Garnet is most pronounced and preferentially developed in the hornblende footwall alteration zones (see section on Alteration and Mineralization) associated with chemical sediments. Garnet may form 60% of rock locally and it occasionally forms intergrowths with hornblende as in DDH B21-3 within 450-480' locally.

Garnet is much less common to nonexistent in the biotite portions of drill core, even though these biotite portions are in close proximity to the garnet-hornblende-sulfide-oxide alteration assemblage. Garnet appear to preferentially replace altered portions compared with other chloritic-hornblende rich portions within the same drill core, such as metabasalt.

These alteration zones containing garnet also typically contain small amounts of calcite or other carbonate. The drill core of B24-4 contains a 1 cm garnet-calcite-quartz-epidote vein at 803.9'. In thin section, the garnet, quartz and carbonate in the vein have all been tectonized.

Cordierite(?) was only observed in DDH 40917. Drill cores in the Wabigoon Subprovince with biotite and garnet did not have any observed cordierite.

Biotite distribution was ubiquitous in variable amounts. Other sheet silicates, especially chlorite, sericite, and talc, occur with local minor retrograde metamorphism-alteration in sheared areas. Magnesium chlorites were noted in a number of thin sections (Appendix I). Mineralogic work by X-ray diffraction for sample #20361 indicated that DDH B31-1 contained local zeolites and laumontite at 463.2'.

Alteration and Mineralization

Silicification can be identified as an interstitial quartz filling in fragmental rocks (especially coarser ones). Lithotypes that become harder locally, or that appear more vitreous are also suspect.

A number of drill cores had silicification that locally increased with depth such as DDH B31-1 within 178-275', DDH B31-2 within 268-365', and DDH 40926 within 105-159'.

Carbonatization tended to be more patchy in nature than silicification. It is often associated with veins or shears, as in DDH B5-1. Selvages associated with carbonate veins often are skarn-like in appearance such as locally within 482-525' in DDH MMD-1.

Sericitization, where recognized as such, also tends to be more patchy and vein-shear related. A good example of this is DDH 40926.

Pyritization as an alteration-mineralization type may be rather deceiving because of the relatively ubiquitous nature of disseminated pyrite in most lithotypes. An exception to this uncertainty is where the pyrite occurs in veins, typically with quartz, carbonate and/or sericite or other silicates. Such veins are common in small numbers and amounts.

Again, chemical sediment mineralization appears to be intimately associated with other mineralization-alteration types. Most, if not all of the alteration observed, appears to be vein related in drill core. While all minerals may not be present for a given assemblage in a given case, the assemblages in general appear to be valid.

Of the Table 5 assemblages (with examples shown at the base of each column), the second and third columns are most likely to form a relatively massive, more pervasive alteration lithotype resulting from a high density of veins and related alteration in core. This "more pervasive" alteration occurs on the order of a few to ten's of feet at most. This assemblage can consist of various combinations of iron silicates such as chlorite and hornblende, garnets, sulfides, oxides, tourmaline, biotite, carbonate, quartz, and epidote. Typically, it is the dark green chlorite or hornblende, pink-red garnets, oxides, sulfides, and minor carbonate that typifies the alteration. Amounts of the other "VEIN ALTERATION" assemblages in core is largely dependent on density of veining, which is quite variable and often relatively minor (generally <20% of the rock).

Due to metamorphism, deformation, and intrusions, the distinction between chemical sediments and below-seawater-interface (footwall) alteration is difficult to determine and cannot always be done in drill core, if indeed a physical distinction is possible. This is especially true where the rock textures are indistinct or massive. Much of the distinction between chemical sediments and alteration is based on whether the materials appear to be grossly stratiform, cross cut the gross compositional banding, or have selvages. Stratiform alteration may be especially difficult to recognize with the scale of the sample in drill core, the scattered drill hole coverage, deformation, and recrystallization.

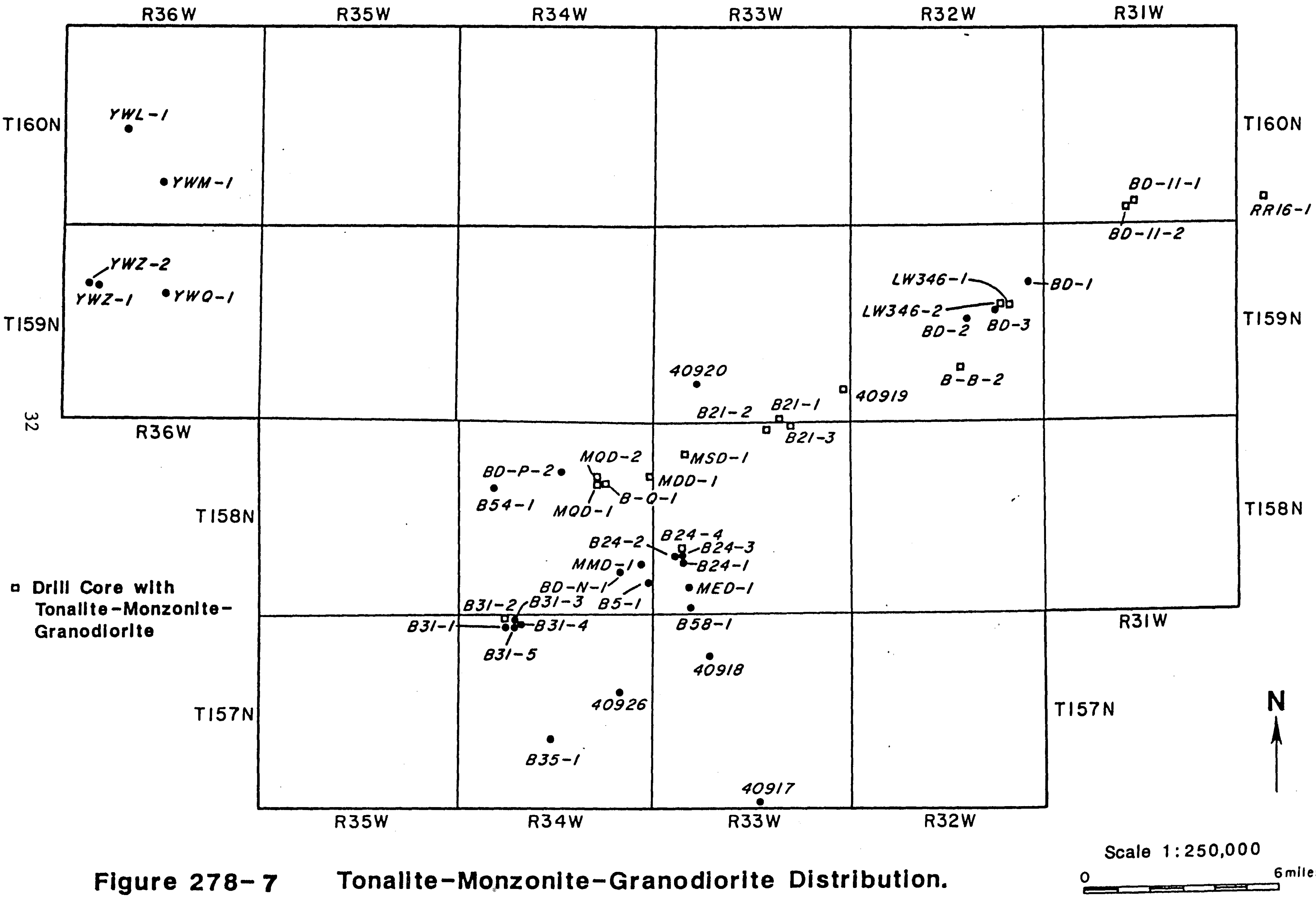


Figure 278-7 Tonalite-Monzonite-Granodiorite Distribution.

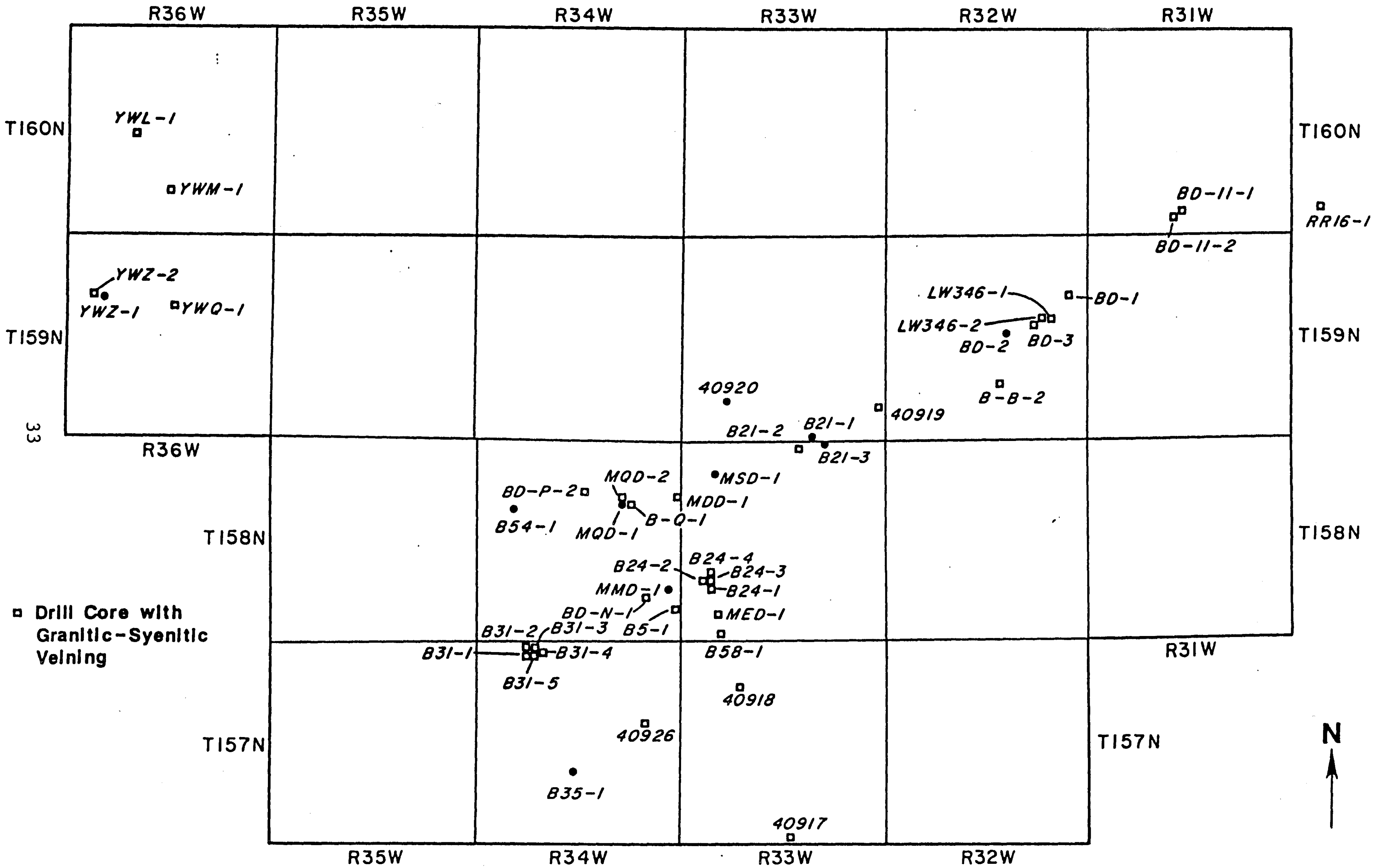


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Figure 278-8 Granitic-Syenitic Vein Distribution.

Scale 1:250,000

0 6 miles

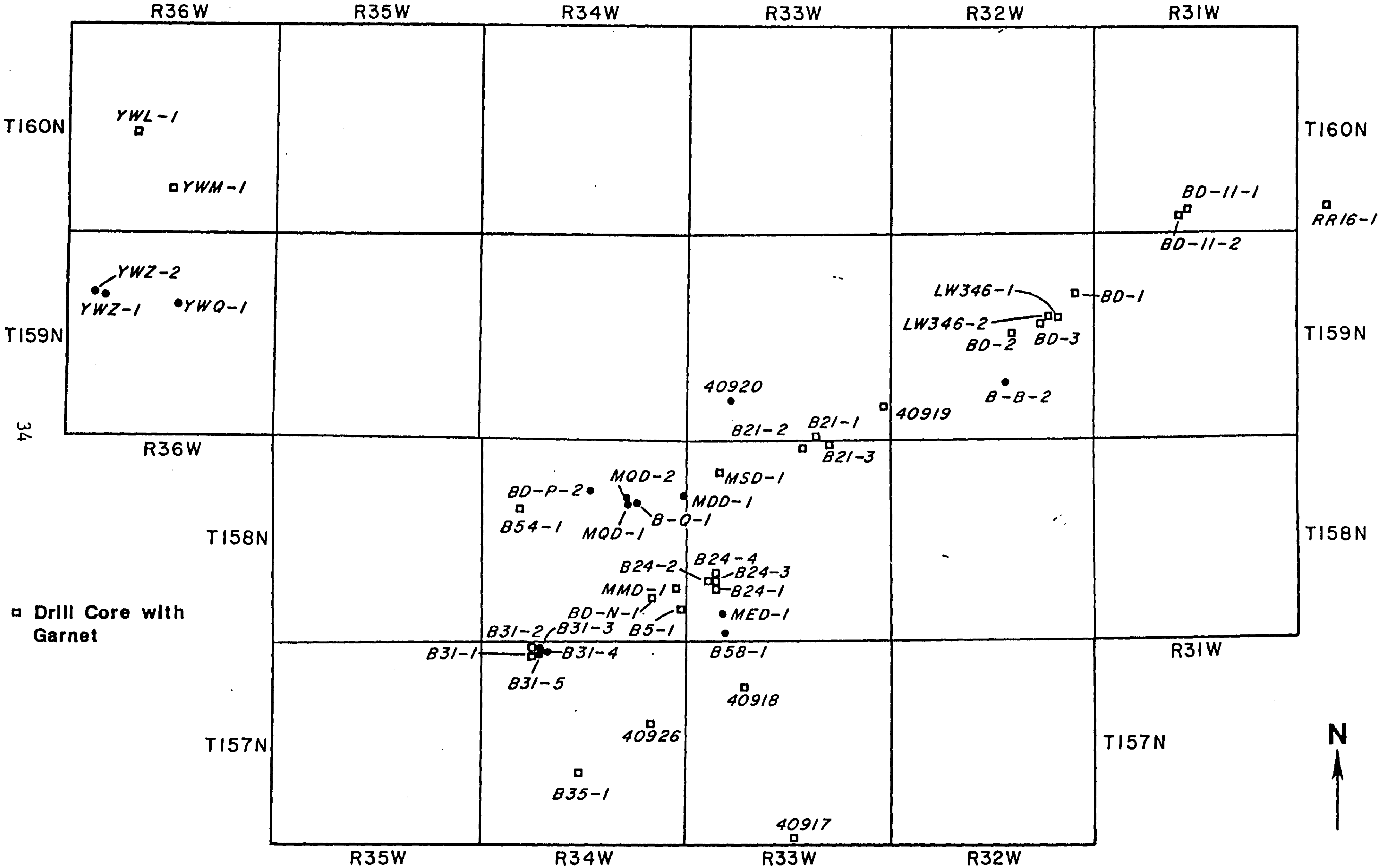

Figure 278-9 Garnet Distribution.

Scale 1:250,000

0 6 miles

The best example of the chlorite-hornblende-garnet alteration is in DDH BD-2 (see Appendix B). This core appears to be relatively free of other complicating hydrothermal systems and also later intrusions. DDH MDD-1, which is extensively intruded and complicated, is an example of the other extreme.

The highest base metal values in the Baudette area drill cores came from chemical sediment portions of the drill core. The highest analyzed zinc values for the drill core studied (as taken from the analyses in the DNR Assessment Files) was 10800 ppm Zn within the interval 643-646' in DDH YWZ-2, which contained over 15' of zinc values over 5000 ppm (please note the Jamie Walker's report in Appendix ?? quoted the wrong Zn values in his section on Economic Geology). The interval 643-646' occurred in chert-sulfide chemical sediments, directly below which the rock becomes graphitic, and above which the rock is amphibolitic, calcareous (altered?) metatuff. The entire graphitic portion 646-655' also contains high zinc values of 3400 to 7500 ppm. DDH BD-N-1 contained 25' with zinc values over 5000 ppm, all within chert-sulfide chemical sediments. The highest analyzed copper value was 4200 ppm for a <one' interval at 192.8' in DDH B21-3. This occurs in a hornfelsed chert-sulfide chemical sediment interval with nearby tonalitic intrusions. DDH B21-1 also contained copper values of 2900 ppm within 226.7'-227'. In core, the copper is typically found in small veinlets locally cross-cutting chemical sediments with chalcopyrite and rare bornite grains and coatings, but the zinc is more nebulous and may be predominantly if not entirely stratiform.

Sphalerite grains were observed in a number of thin sections. A thin section of interest from DDH BD-N-1 at 495' had 3% sphalerite. The sphalerite was vein related, along with iron sulfides, sericite, and epidote in a dacite which had sericitization. These veins were cut by hornblende veinlets that also contained sphalerite.

Three drill cores have had the highest reported gold analyses with values between 500 and 800 ppb. These are drill cores LW-346-1, B21-3, and BD-II-1. These samples are also from sulfide-rich horizons (one at a gabbro contact), however, these cores typically have other horizons that are relatively barren. One minute gold (?) grain may have been observed in a blue quartz vein at 368.3' in DDH B31-2. High gold values were not confirmed by assay, which analyzed that portion of the core without the grain. That sample was anomalous with respect to fluorine (1124 ppm, see Appendix D), however.

Pyrite-pyrrhotite transitions occur locally (DDH B24-2 within 621-645' for example), and some cores are more pyritic, such as DDH B31-3. Pyrite often appears to be replacing pyrrhotite where it occurs in the more sulfide-rich areas, or as disseminations.

Thin Section Petrography

The purpose of the thin section petrographic work was to supplement and aid the diamond drill core logging, sampling, and chemical analyses. Specific goals include identification of: primary rock textures and protoliths of metamorphic rocks, characterization of hydrothermal alteration, and rock identification in areas of intense deformation and/or metamorphism, especially when megascopic core logging left doubts.

These sections were described under a contract with Mr. Jamie Walker, a Master's candidate at the University of Minnesota, Duluth. The petrographer was completely free to describe and interpret the thin sections independent of the logs created during this project and without the benefit of visually examining the core. He did have some chemistry data, and exploration company drill logs when they were available, however. His only megascopic examination of the rock samples came from the thin section heels. The information below is based on Mr. Jamie Walker's work, unless otherwise noted.

The results of the petrographic work are divided into three sections. The first section is a summary of the major features identified in the thin sections, which includes rock groupings, metamorphism, alteration and economic considerations. The second section contains rock description for each of the 123 thin section described. The third section is a tabular summary of the rock types, protoliths, mineralogy, and textures. All of these sections have been Open-Filed at the MDNR in Hibbing. The first and third sections can be found in Appendix J.

A listing of the thin sections of the Baudette area drill cores, including those described for this project, is included in Appendix 278-H. These thin sections are available for inspection at the MDNR office in Hibbing.

Rock textures

As a rule, Jamie Walker indicated (J. Walker, oral commun., 1991) that primary textures of supracrustal rocks were gone from these rocks in thin section, and that they had generally recrystallized under stress.

Thin sections of DDH B31-1 at 583.1', DDH 40926 at 178.2' and 228.0', and DDH YWM-1 at 298.3' were especially schistose to mylonitic, although most other thin sections had a fabric developed. The thin section of DDH 40926 at 178.2' was noted as possibly being pseudotachylytic, however, it lacks an ultrafine, "glassy" matrix (senior author). Recrystallization could account for the current texture if it was a pseudotachylyte. Shearing was noted in a number of thin sections (see Appendix J), and post-metamorphic brecciation was noted by the senior author in the thin section of DDH 40917 at 405.0'.

Besides schistose and gneissic textures, there was also a number of thin sections of hornfels and granofels. Some of these contain or are indeed veins or thin dikes (DDH MDD-1 at 230.7' and DDH B-Q-1 at 371.0'), while others were from portions of the core with chemical sediments and/or related alteration (DDH B31-2 at 557.6', DDH MDD-1 at 323.0', DDH B-Q-1 at 366.3', DDH B-Q-1 at 371.0', and DDH B24-4 at 370.0').

Jamie Walker also stated that the finer-grained rocks never "coarsened up" with the metamorphism and recrystallization, which would indicate that they never reached equilibrium during metamorphism.

Protoliths

The only recognized primary supracrustal protolith textures (see Appendix J) were in felsic debris flow deposit (DDH MMD-1 at 189.5'), although phenocrysts are also generally recognizable in other thin sections. Intrusive rocks, such as the coarser gabbros, still maintain various amounts of their original textures. From their deformation, Jamie Walker inferred these to be relatively early intrusions.

Protoliths from thin section work included a wide variety of supracrustals and intrusives (see Appendix J). These included porphyritic dacite, recrystallized intrusive, porphyritic felsic flow/intrusive, deformed felsic intrusive, anorthositic intrusive, altered felsic intrusive, pegmatite, quartz-feldspar porphyry, tonalite, mafic volcanic, mudstone, mafic/ultramafic volcanic, mafic porphyry, veins, altered tonalite, gabbro, altered dacite porphyry, troctolite, greywacke, mafic/mudstone, mafic/-ultramafic, ultramafic/mafic flow, greywacke/mudstone, greywacke/lithic wacke, felsic debris flow deposits, altered mafic flows, massive sulfide vein in silicified dacite, biotite tonalite, mafic volcanic/gabbro, foliated tonalite, K-altered mafic or mudstone, pyritic chert, arkosic wacke, quartz gabbro, granophyric felsic intrusive, quartz-garnet-sulfide veins, and greywacke/mudstone/basalt. As in the core logging, there is variable uncertainty concerning the interpretative protolith name placed on these rocks.

Regarding specific rock types, Jamie Walker made several other comments (J. Walker, oral commun., 1991). He believed from the thin sections that the schistose rocks with komatiitic compositions were fine grained flows (DDH's 40926, YWZ-2) and not coarser grained intrusives.

Also, many of the rocks referred to by the senior author as intermediate tuffs in the core logging, were interpreted as clastic sediments in thin section. Since these sediments contain phenocrysts and other probable volcaniclastic material, the actual difference in the protolith interpretations may revolve only around the amount of reworking. Bedding was noted only in the thin section with pyritic chert (DDH YWZ-2 at 520.5').

Some of the thin sections identified as having a mafic protolith by Jamie Walker may contain hornblende resulting from alteration according to the senior author, although garnet contained in some of these same rocks was recognized as being alteration related (see section on Mafic Volcanic Rocks in Appendix J). It was not possible for the petrographer to determine a possible protolith in about 10% of the sections due to metamorphism and tectonism.

Alteration-mineralization-veins

The observed thin section alteration products and vein mineralogy noted by Jamie Walker in the petrographic work included hornblende, garnet, epidote, tremolite-actinolite, sheet silicates, tourmaline, sulfides, carbonate, and silica.

Hornblende alteration in thin section was observed in DDH B31-4 at 188.5' (with epidote), DDH B5-1 at 470.4', DDH YWZ-2 at 437.3', and DDH YWL-1 at 467.0'. In thin section veins, hornblende occurred in DDH 40917 at 405.0'(with epidote and plagioclase), YWZ-2 at 297.4' (with quartz), DDH B24-2 at 679.0' (with quartz, garnet, sulfide), and DDH B24-4 at 364.9' (with carbonate and epidote).

Garnet alteration was observed in a thin section of DDH B31-3 at 531.5' (with sulfides). Vein garnet occurred in thin sections of DDH 40917 at 234.7' (with quartz, feldspar, pyrite), DDH B31-1 at 350.0' (with clinopyroxene and epidote), DDH YWL-1 at 520.3' (with tremolite, biotite and pyrite), DDH B24-1 at 237.8' (with plagioclase and quartz), DDH B24-2 at 679.0' (with quartz, hornblende and sulfides), DDH B24-4 at 370.0' (with quartz), and DDH B24-4 at 982.5' (with quartz and feldspar).

Epidote alteration was noted in a number of thin sections. This was variably associated with phlogopite, carbonate, hornblende, actinolite, sericite, and silicification. In thin section veins, epidote was associated with plagioclase and hornblende; garnet and clinopyroxene; pyrite and quartz; and carbonate and hornblende.

Rocks of komatiitic composition were invariably altered to (and have veins of) talc-tremolite-chlorite-carbonate schists (thin sections of DDH 40926 at 228.0', DDH 40926 at 230.0', DDH YWZ-2 at 468.7'). If not for their chemistry (see Discussion), their extreme alteration and deformation would leave the protolith more uncertain. Actinolite alteration was observed in thin sections of DDH B31-4 at 203.5' (with epidote), and DDH B35-1 at 150.0'. Tremolite-biotite alteration was observed in DDH YWZ-2 at 347.5'.

Beside talc, other observed sheet silicates included biotite, phlogopite, sericite, Mg and Fe chlorites, and muscovite. Mg chlorite was noted in thin sections of DDH 40918 at 292.4', DDH B31-1 at 583.1', DDH B31-2 at 368.0', DDH B31-2 at 531.0', DDH 40926 at 152.9', DDH 40926 at 228.0', DDH YWZ-1 at 419.2', DDH YWZ-2 at 347.5', DDH YWZ-2 at 437.3', and DDH YWZ-2 at 468.7'.

Within thin section veins, chlorite was found with quartz and carbonate in DDH MSD-1 at 557.0', and biotite was found with garnet, tremolite, and pyrite in DDH YWL-1 at 520.3'.

Tourmaline was noted in nine thin sections. This included tourmaline-sulfide alteration in thin section DDH 40926 at 178.2' (which was also mylonitic), and sericite-tourmaline alteration in DDH B24-2 at 595.1'. It is likely that other occurrences may also be alteration related also. Thin section DDH 40918 at 292.4' caught part of a 1 cm tourmaline vein (senior author) which may be conformable. Some tourmaline in this was zoned.

Sulfide alteration in thin section was noted in DDH 40917 at 262.8' (with sericitization), DDH B31-3 at 531.5' (with garnet), and DDH 40926 at 178.2' (with tourmaline). Vein pyrite within thin sections was found in DDH 40917 at 234.7'(with quartz, feldspar, and garnet), DDH MMD-1 at 482.9' (with chalcopyrite, feldspar, and ?), DDH BD-N-1 at 609.0' (with quartz and epidote), DDH YWQ-1 at 508.3' (with quartz), DDH B24-2 at 679.0' (with quartz, garnet, and hornblende), and DDH B24-2 at 744.5' (with carbonate, talc and chlorite).

Carbonate alteration was found in a number of samples. It was either affiliated with talc and chlorite (DDH 40926 at 228.0', DDH 40926 at 230.0', DDH YWZ-2 at 385.5') or epidote (DDH B31-2 at 557.6', DDH MMD-1 at 189.5', DDH YWL-1 at 603.4'). Thin section veins with carbonate included DDH B31-4 at 479.5', DDH MED-1 at 435.5' (with clinopyroxene), DDH B-Q-1 at 373.0', DDH YWZ-1 at 419.2' (with quartz, feldspar), DDH YWZ-2 at 385.5', DDH YWZ-2 at 520.5'(with quartz, chlorite), DDH YWL-1 at 493.1 (with quartz), and DDH MSD-1 at 557.0' (with chlorite, quartz).

Silicification in thin section was noted in DDH BD-N-1 at 518.0' and DDH BD-N-1 at 609.0' (with epidotization), although other thin sections such as DDH B31-4 at 229.2' (senior author) may also be silicified. Quartz in veins occurred with other minerals (see other veins above), and also by itself in a number of thin sections (see Appendix J).

The alteration-chemical sediment assemblages described earlier from the drill core logging (shown in Table 5), were not resolvable with the limited number of thin sections made. A larger number of thin sections on a smaller number of drill cores may have been a better approach to the problem.

According to the core logging, thin sections from DDH B5-1 at 470.4', DDH YWL-1 at 524.1', DDH 40917 at 405.0', DDH B24-2 at 744.5', DDH MDD-1 at 323.0', DDH B31-3 at 531.5', DDH B24-4 at 364.9' and DDH B24-4 at 370.0' did sample altered rocks containing hornblende-garnet-epidote-sulfide alteration mineralogy (shown in Table 5). The metamorphism and deformation, however, modified textures so that alteration-replacement relationships were overprinted and obscured, often leaving a granofelsic or hornfelsic texture. Jamie Walker was not informed that the metamorphic mineral assemblages that he observed in these sections were from what the senior author considered altered intervals, and with the modified textures, he could not generally recognize these rocks as alteration products (except perhaps for DDH B5-1 at 470.4' and DDH B31-3 at 531.5'). Consequently, the reported thin section alteration was only discernible when alteration was examined in a spatial context, which thin sections allowed only adjacent to veins, or if the alteration was not too pervasive. In this context, Jamie Walker reported (J. Walker, oral commun., 1991) that most observed alteration-mineralization in thin section was vein related.

Jamie Walker's protoliths listed for the altered thin sections noted in the preceding paragraph include altered dacite porphyry, altered dacite, altered mafic, mafic volcanics, greywacke, greywacke/mudstone?, mudstone?, and ?. This indicates that protoliths in thin sections were also difficult to interpret (along with the alteration) because of the metamorphism and deformation. Better integration of the thin section petrography with the core logging would have been beneficial.

Other petrographic mineralogy

A number of other minerals were noted in the thin sections, some of which have uncertain identifications. Beside the tourmaline mentioned earlier, sphene was also noted in a number of thin sections. A trace of cassiterite and sphalerite was noted in DDH B24-4 at 982.5'. Other thin section sphalerite (typically trace amounts) occurred in DDH B31-2 at

368.0', DDH 40926 at 178.2', DDH BD-N-1 at 495.0'(3% sphalerite), DDH BD-N-1 at 518.0' (1% sphalerite), and DDH B-Q-1 at 366.3'. The high sphalerite samples are both deformed dacites, with sphalerite associated with fracture filling sulfides and quartz, sericitization and silicification. The senior author also found carbonate associated with this fracture filling. The fracture filling may be veins or possibly interfragmental material, however deformation makes this difficult to tell. The material is early enough to be deformed and cut by hairline, later hornblende veinlets which also have minor sphalerite and iron sulfides (senior author).

DDH YWZ-2 at 385.5' contained 2% red spinels. DDH YWZ-2 at 649.0' contained graphite. DDH 40926 at 228.0' contained 8% hematite, and DDH B31-4 at 148.4' contained 4% magnetite. Other thin sections with oxides include DDH YWL-1 at 680.4' and DDH B24-4 at 1564.0'.

The thin section of DDH MED-1 at 402.0' contained a blue pleochroic mineral that was probably arfvedsonite (Deer and others, 1963, p. 364-374). The senior author also found a trace amount of fluorite in this same thin section.

Green biotite occurred in DDH B31-5 at 463.0' and DDH YWZ-2 at 347.5'.

A final note concerning clinopyroxenes described in thin section veins is that some misidentification with epidote could have occurred (senior author). Some misidentification of amphiboles during the core logging may also have occurred with epidote family members. A vein at 170.6' in DDH B-Q-1 contained Fe-poor clinozoisite (XRD mineralogy, Open Filed at MDNR in Hibbing).

Specific petrographic assistance to core logging

Beside the general input to the protolithology and alteration-mineralization, petrographic work provided assistance to several specific questions encountered in core logging. These include questions regarding garnet identification, pyroxenite encountered in DDH MDD-1, and the matrix mineralogy and alteration of some of the agglomeratic rocks.

In thin section, DDH B5-1 at 470.4' contained garnets which were altered or locally enclosed large amounts of inclusions (to 70%), which explains why some garnets in drill core were soft enough to be fairly easily scratched and possibly misidentified in core (see Open Filed detailed Lithologic Logs).

In core logging, the pyroxenite of DDH MDD-1 appeared to be relatively unique with its coarse grained, porphyritic nature. Unlike most porphyritic mafic rocks that had plagioclase phenocrysts, the MDD-1 pyroxenite could be identified by pyroxene phenocrysts and 5% or less of biotite mica. The thin section from DDH B31-2 at 531.0', within a porphyritic portion (a sill?) of mafic volcanics, had these same features.

From drill core logging, a number of drill cores contained coarse fragmentals (agglomerates-conglomerates). Thin sections from DDH B31-4 at 188.5', DDH B31-4 at 203.5', and DDH B31-4 at 229.2' were made from these rocks, with an emphasis on finer fragments (maximum size about 1 cm in these sections) and matrix (senior author). Beside recrystallized quartz and feldspar, DDH B31-4 at 188.5' had hornblende and lesser epidote in the matrix. It also had pyrite scattered in the matrix and fragments. The thin section of DDH B31-4 at 203.5' was similar, but had more epidote and less pyrite and hornblende in the matrix. The thin section at DDH B31-4 at 229.2' had more textural and compositional similarity between fragments and matrix. Both fragments and matrix were more siliceous, and may have been silicified (senior author).

Thin sections work by Jamie Walker did verify the existence of clinopyroxenes, which was probably seen by the senior author in one grain mount while examining core, although identification was problematic.

Lithochemistry

Geochemical samples were selected over a wide range of lithologic situations in an attempt to characterize lithotypes, alteration, and mineralization. The rocks studied in this project have been metamorphosed from greenschist to amphibolite facies, with local alteration, tectonism, intrusion, and veining. An examination of the Sample Characterization Sheets indicates that identification of features and lithotypes was at times very problematical, and the information should be used within this context.

A total of 205 new analyses, plus eleven duplicate analyses, were completed as part of this project, with at least two taken from each core (Appendix D). Values of analyses in Appendix D marked with an * are the average of two duplicate analyses, which can be found in Appendix E. Other sampling information and detection limits are discussed in the Methods section. Reference samples were inserted with every batch. Recently acquired boron (B) values analyzed with a 1 ppm detection limit are not reported here, but are available as open file materials. A casual comparison with the values reported here with a 10 ppm detection limit did not reveal any significant differences.

Considering the objectives of characterizing lithotypes, alteration, and mineralization, the first step taken to interpret this data set of new analyses was to look at the data as a whole and observe any general trends or anomalous groups of samples that might be unique to a lithotype or alteration type. Mathematical and graphical approaches were both used to identify significant trends, sub-populations, anomalous values, and element correlations. Although a correlation and ranked correlation matrix and histograms of element abundance vs number of samples were done with the entire data set, no statistical manipulation or normalization of the analyses was done for this interpretation.

The use of any chemical variation diagram for discriminating between rock types is dependant on the assumption that the elements used for the diagram have not been affected by any alteration processes, or at least that their relative proportions have not been changed. Chemical classification diagrams, whether purely descriptive or with genetic implications, also work under this assumption. Knowing that these rocks have been metamorphosed and altered to varying degrees, variation diagrams were used in conjunction with lithologic descriptions to chemically classify these rocks. Following classification based solely on the chemical variations observed within this data set, analyses of the volcanic rocks were plotted on two standard classification diagrams, one descriptive (TAS diagram of LeBas and others, 1986), and one with genetic implications (Jensen Cation Plot of Jensen, 1976).

Assessment File Data

There are also 152 recent analyses done by the U. S. Geological Survey (Klein, 1988) on core from this area, with 135 of those from core logged for this project. Previous analytical work has been done by private industry at various times by many different laboratories. These older analyses, because they are often only base and precious metal assays, and are of unknown quality, have not been used on any of the diagrams or as a basis for any of the interpretations presented here. Earlier geochemistry done by the DNR (available as Open File) was also not used.

All of this data from the Assessment Files has, however, been entered into a database and is available on computer disk; database fields are shown on Table 1. A total of 1015 additional analyses from drillcore logged for this project are available, including 118 complete USGS analyses and 73 old DNR analyses. The database also contains analytical data for drillholes in Lake of the Woods county not included in this project area (B-3 series, B-7 series, and B57-1). Additional information available in the Assessment Files, such as analytical methods, rock type, descriptions, and other comments, is not currently available in the database, but could be added if deemed useful by private industry. The complete original analytical information is available in the Assessment Files. The database that was constructed for Lake of the Woods county does not necessarily distinguish between elements analyzed using different analytical methods or detection limits. Values have also been converted to percent, ppm, or ppb, depending on the element, although the original data may be in different units. These simplifications have created a usable database for reconnaissance investigations. The limitations of this database should be remembered and the original data consulted for any in-depth investigations which might use these analytical results. Similar databases of Assessment File analytical data for Beltrami and Roseau counties were constructed as well.

Appendix G contains tables of the highest reported values for Cu, Ni, Zn, and Au extracted from the Lake of the Woods Assessment file database. Pb, Co, As, and Ag values are also included. The tables are sorted by drillhole. Approximately the top 5% of samples analyzed for each respective element are given. New analyses discussed in this report are not included there.

Accuracy and Precision of Analyses

Two methods were used to check the validity of the analyses presented in this report. Standard samples were submitted with each batch, and duplicate analyses were done for some samples. The results of these analyses are given in Appendix E. All statistical calculations were done within a Quattro Pro 2.0 spreadsheet.

The two standards analyzed were the Canadian gold tailings standard GTS-1 and an internal MDNR greenstone standard. The average value, sample standard deviation, and sample variance have been calculated for each of the standard samples analyzed with each batch as well as for the combined analyses from both batches. Where analyses are below detection limits, statistical calculations are based on 3/5 the detection limit.

Besides the standards, some duplicate samples were analyzed for some elements. These are also presented in Appendix E. Averages, sample standard deviations, and sample variances are calculated for those elements with duplicate analyses. These average values are what is given in Appendix D and marked with an asterisk (*). In a few cases where one analysis was below detection limits and the other was not, the value above the limit is reported as the average, and the standard deviation and variance is not calculated, as indicated by a dash (--).

Considering the variable distribution and completeness of the standard and duplicate analyses, a complete detailed statistical evaluation and manipulation would probably not be useful. Therefore, the standard and duplicate analyses are presented here with some simple statistics which the reader may use to evaluate the chemical data. The analyses appear to be fairly consistent both within each analytical batch and between batches, with low standard deviations generally within 1% of the reported values.

Statistics

A combined correlation and ranked correlation matrix of all 205 analyses is given in Appendix F. The top and right half of the matrix is a standard linear correlation matrix, while the lower and left half is a ranked correlation matrix using Spearman's Rho. The matrix was calculated using the RS1 statistical computer program.

Correlation is a measure of the interdependence of two variables, which varies between -1 and +1. If the correlation coefficient (R) is closer to -1, the samples being compared exhibit a negative correlation and will plot on a line with a negative slope. A value near 0 indicates no correlation, and an R closer to +1 indicates a positive correlation, where the samples will generally plot along a line with a positive slope. If R is equal to -1 or +1, there is perfect correlation.

The rank correlation (Spearman's Rho, ρ) is a correlation measurement that uses the same formula as the linear correlation, but is able to measure associations that are non-linear. To do this, the lowest value in a set of variables is set to 1, the next lowest to 2, etc., thereby ranking the values. The ranks of the paired variables are then correlated.

For the correlation calculations, all values less than detection limits were adjusted to 3/5 (0.6) the detection limit for that element. Three elements, Sn, Be, and Te were not included in the correlation matrix, because, with the exception of one Te value (21 ppm in #23600), all values were below detection limits. If all measured values are the same, the standard deviation is 0, and the correlation formula is invalid. Although included in the matrix, it should be noted that only five values were above detection limits for W.

Descriptive Lithochemistry

This section will describe the unique geochemical characteristics for the rock types discussed previously and the drillholes and intervals in which they are found. The diagrams presented in this report show the distribution of these groups with respect to a few elements, but the interpretations and groupings are based on a variety of geochemical and lithologic characteristics. Some of the other variation diagrams used are available as open file material and with the data in a computer spreadsheet file.

Gabbroic Intrusives: Composed of gabbro, metagabbro, and gabbroic diabase dikes, the majority of this group exhibits high TiO_2 values (>1.5%) compared to the volcanics and sediments (Figs. 10 and 14). Titaniferous magnetite and/or ilmenite in these rocks is the source of these higher TiO_2 values.

The highest TiO_2 and lowest MgO values of this group are seen in amphibolitic metagabbros from DDH MQD-2. Three samples (23584, 23586, and 23587) from this drillhole comprise a sub-group (Fig. 14) with a fourth sample from MQD-2 (23587) and a sample from BD-II-2 (23849). The sample from MQD-2 (23582, 176.5-190') is logged in the same unit, but may have been partially silicified by a 3' quartz dike noted in the interval just above it (23583, 191-197').

Diabase dikes in DDH B31-4 intrude a felsic tuff. The two samples from this unit (23385 and 23386) are noted on the sample characterization sheets as being diabasic gabbro samples. However, one of these (23386) has a TiO_2 content similar to other felsic tuffs, so the sample interval may have included a significant felsic component.

Komatiites and Komatiitic Basalts: These samples generally have high MgO contents (>10%) which are obvious on MgO variation diagrams. Figure 10 shows the distribution of all of the samples analyzed on a MgO vs TiO_2 variation diagram, while Fig. 14 isolates the komatiitic, gabbroic, and pyroxenite samples. Both Cr and Ni strongly correlate with MgO in the komatiitic samples (Fig. 15). The komatiites can be distinguished from the komatiitic basalts on the basis of MgO and Cr values.

Seven analyses, one from DDH YWZ-1 (23658), four from DDH YWZ-2 (23685 to 23689), and two from DDH 40926 (23407 and 23408), are komatiites. All of these samples have >19% MgO. The samples from DDH 40926 along the Vermilion Fault zone have slightly higher TiO_2 values. These rocks have experienced a greater degree of alteration and may be mixed with some chemical sediments (see section on Lithologic Logs).

The komatiitic metabasalts have MgO values in the 11-15% range (Nisbet, 1987). The eight samples of this ultramafic basalt group are seen in DDH B5-1 (23480), DDH B-B-2 (23834), DDH YWL-1 (23730), DDH YWZ-2 (23684), DDH BD-P-2 (23594, 23597, and 23598), and DDH 40926 (23406). Metamorphism is variable between drillholes, with some being amphibolitic metabasalts. The highest TiO_2 and alteration is again the sample from DDH 40926.

Two other samples (23690, YWZ-2; 23431, B58-1) are similar to these ultramafic volcanics, with relatively high Ni, but lower Cr and MgO values compared to other samples in this group.

Pyroxenites: Both pyroxenite samples analyzed are from DDH MDD-1 (23534 and 23555). These "pyroxenite" bodies are associated with granodiorite in this drill core, but probably also occurs in DDH B31-2. See sections on Lithologic Logs and Discussion for more explanation. Chemically, these samples have MgO contents between those of the komatiites and komatiitic basalts (15-19%) (Figs. 14 and 15).

Chemical Sediments: The geochemistry of the chemical sediments is extremely variable across most elements, which is a result of the physical nature of this rock type. The chemical sediment units are heterogenous and contain brecciated and agglomeratic intervals with varying percentages of mafic and felsic materials. Alteration and mineralization in these permeable units is pervasive and variable, and can be extreme. With the exception of massive sulfide samples, the analyses from this lithology have

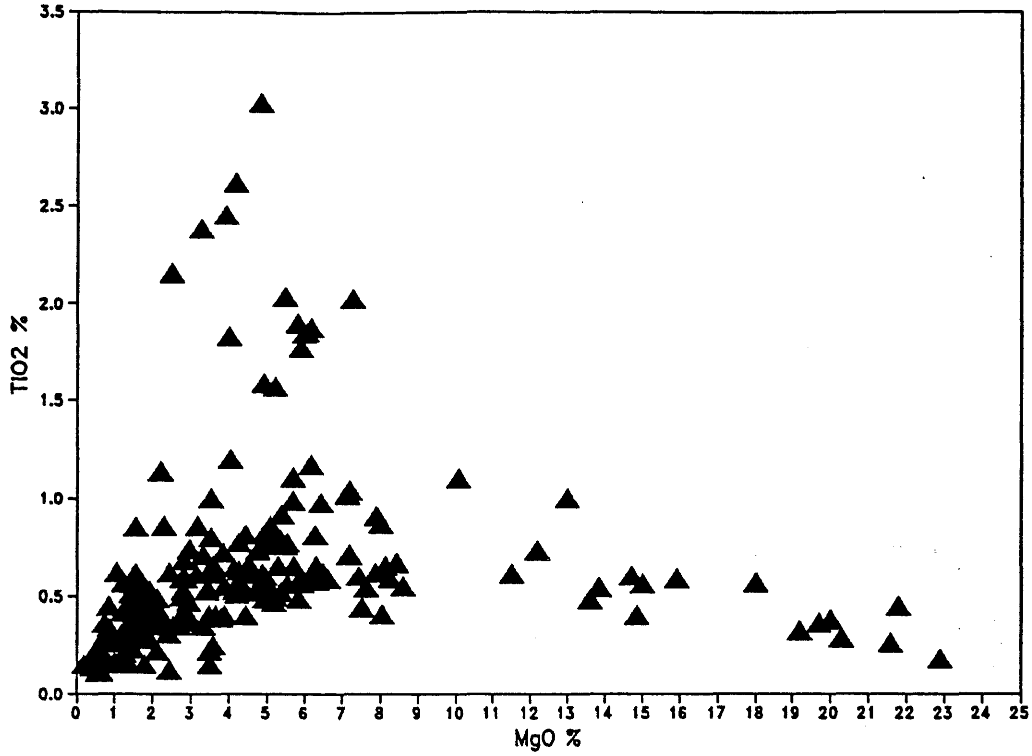

Figure 278-10. MgO vs TiO_2 variation diagram showing all samples analyzed from drillcore.

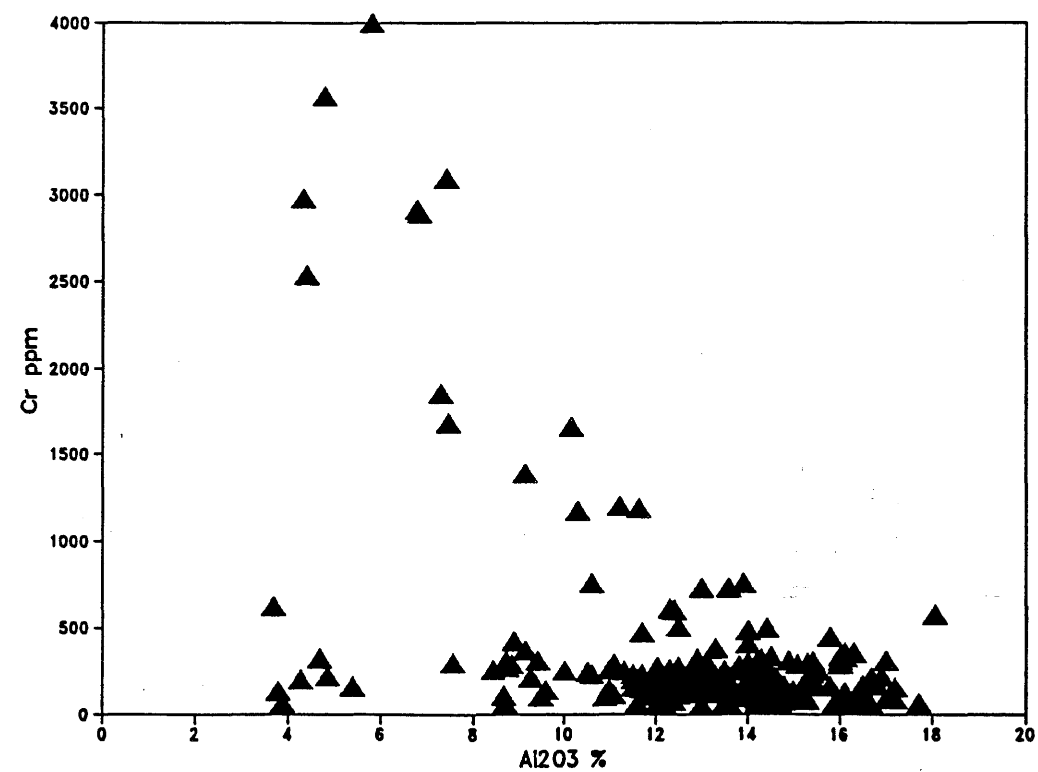

Figure 278-11. Al_2O_3 vs Cr variation diagram showing all samples analyzed from drillcore.

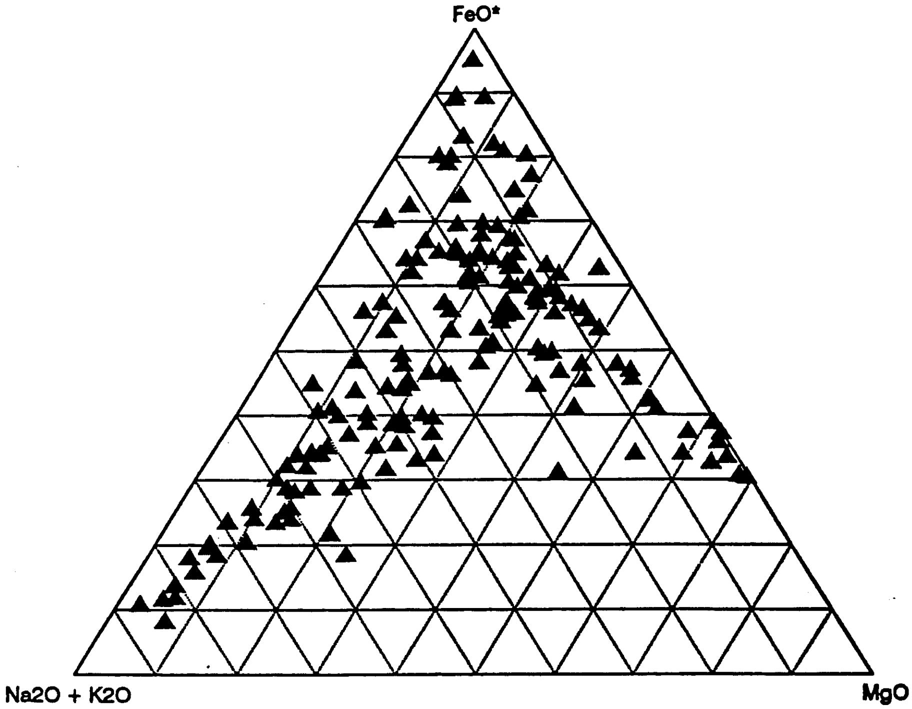

Figure 278-12. AFM Diagram of all samples analyzed.

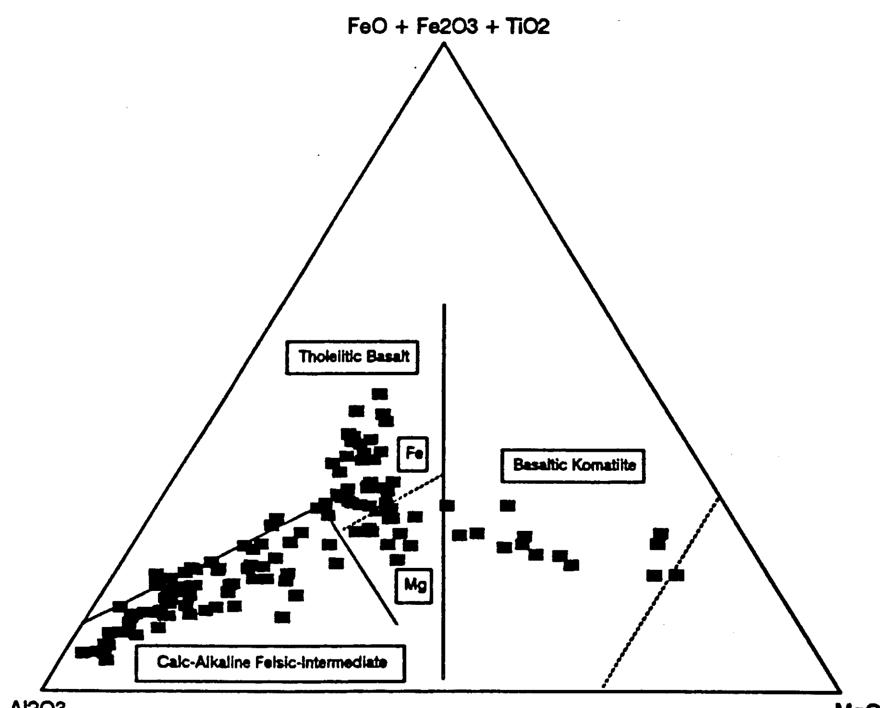

Figure 278-13. Jensen Cation Plot with analyses from komatiitic, mafic, and felsic volcanics.

not been able to be related to any particular alteration type on the basis of chemistry.

Massive sulfides are easily recognized on Al_2O_3 variation diagrams with <10% Al_2O_3 (Fig. 11). Two sub-groups can be observed within this group. The first group contains <6% Al_2O_3 and is dominantly from a cherty sulfide iron formation (BD-N-1) and magnetite-sulfide-chert-silicate chemical metasediments. The second group has between 6-10% Al_2O_3, and is primarily tuff-breccia with silicified sulfide-bearing chemical sediments. Alteration in both groups is primarily quartz-chlorite. These groups appear to be distinct, but since each unit from which the samples were taken usually contains tuff-breccia, cherty iron formation-breccia, and chemical sediments in varying amounts, the sub-groups may represent end-member sampling. Sample 23690 (YWZ-2) also falls into this group, but rather than a breccia, the unit is described as a schistose metatuff with cherty sulfide chemical sediments.

One altered chemical sediment sample from DDH BD-II-2 (23848) has a high TiO_2 content (1.59%) and contains a high percentage of oxides along with hornblende, garnet, and tourmaline.

Felsic Volcanics: Silica values for this group of rocks range from 55% to 84%. According to the SiO_2 vs Total Alkalis (K_2O + Na_2O) chemical classification for volcanic rocks of LeBas and others (1986), this range includes basaltic andesites (52-57% SiO_2), andesites (57-63% SiO_2), dacites (63-~70% SiO_2), and rhyolites (>69% SiO_2), with some trachytic varieties (> alkali content). However, the majority of felsic volcanic rocks in this area are dacitic with 62-70% SiO_2. It should be remembered that all of these rocks have been altered, so these lithologic names based on current chemical composition may not reflect the protolithology.

A group of thirteen samples are rhyolitic with >70% SiO_2. Two of these analyses are from DDH B24-1 (23747) and B24-2 (23760), while the remaining eleven are from the B31 drillholes (B31-1, 23453-23457 and 23462; B31-2, 23372; and B31-4, 23391-23394). The highest SiO_2 value is 83.3% in 23394 (B31-4). These intervals are described as silicified felsic agglomeratic tuffs and crystal metatuffs. Sample 23390 from B31-1 (68.6% SiO_2) also belongs to this group, but is sheared and contains some mafic-intermediate clasts.

Mafic Volcanics: Basalts and some basaltic andesites compose this group (names after LeBas and others, 1986). Silica contents are in the 44-55% range, with most <50% SiO_2. A group of twelve samples, although not komatiitic, are higher in MgO (> 7%) than the rest of the samples. These samples are all in the Mg-rich tholeiite field on the Jensen Cation Plot (Fig. 13).

Other Significant Observations: Some elements exhibited anomalous values in a few samples, some of these elements and sample intervals are noted below.

Fluorine >800 ppm was detected in a recrystallized felsic metatuff in DDH MED-1 (23417-23420, 174-213.5'), a rhyodacite porphyry in B31-2 (23378), a metagabbro with milky blue quartz in B31-2 (23373), and mafic tuffs and volcanics in B31-5 (23399).

Relatively elevated levels of barium (between 100-600 ppm) are present in six samples from DDH MDD-1 (23532-3, 23537, 23554-6), two from LW-346-2 (23838 and 23839), two from B35-1 (23415 and 23416), and one each from B-B-2 (23834), B-Q-1 (23568), B24-1 (23749), and B24-2 (23762). Also 3 from MQD-2, 2 from YWZ-2, 1 from YWM-1. Sample 23834 (B-B-2) has the highest Ba content with >850 ppm, more than 250 ppm greater than the others in this group.

Discussion of Results

Overall, the analyses seem to fall into two general groupings: mafic or felsic, with breccias and chemical sediments being composed of varying percentages of both. Within this mafic-felsic framework are some lithologic groups that can be fairly readily distinguished using chemical variation diagrams. The three most obvious are a group of komatiitic samples (high MgO), some gabbroic intrusives (high TiO_2), and massive sulfides (low Al_2O_3). Figs. 10, 11, and 12 show the entire set of analyses on different variation diagrams. Refer to Fig. 1 for the locations of drillholes discussed below.

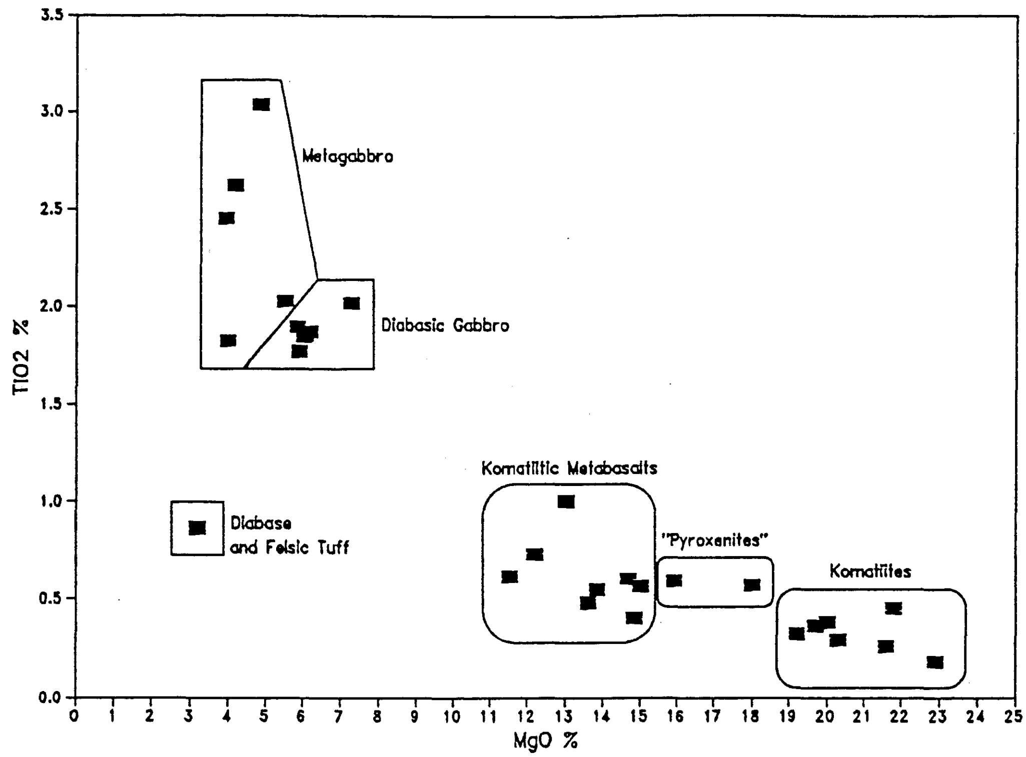

Figure 278-14. MgO vs TiO_2 variation diagram showing komatiitic, "pyroxenitic," and gabbroic rocks.

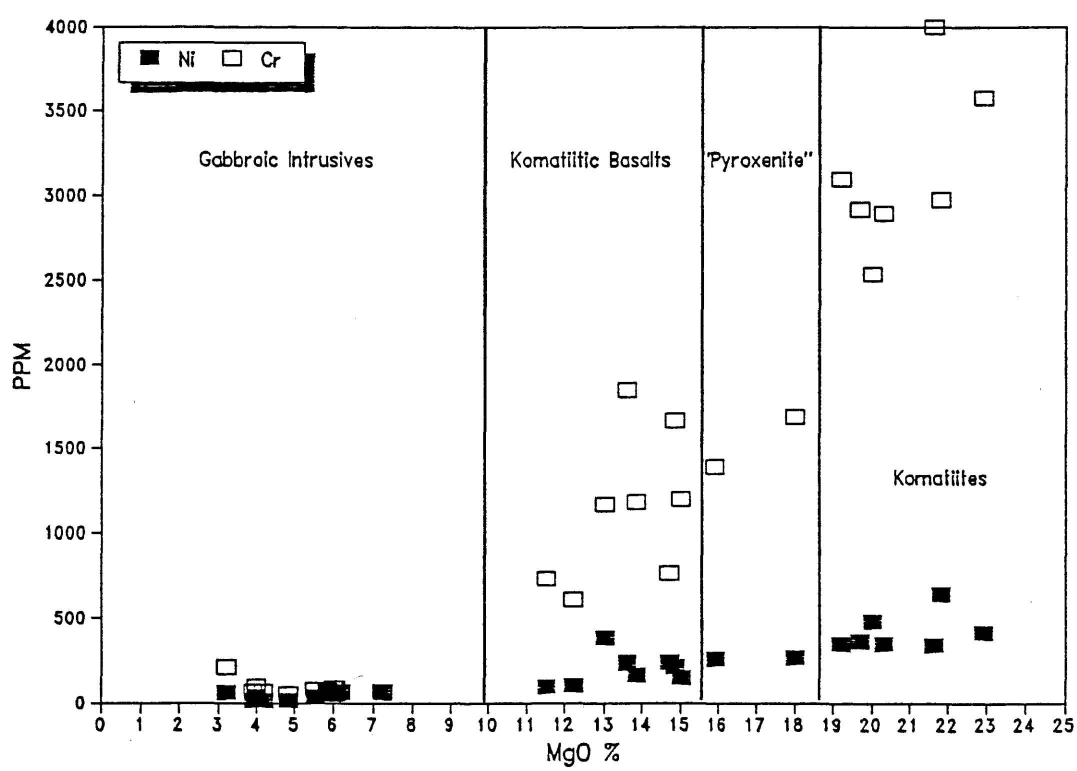

Figure 278-15. MgO vs Ni and Cr variation diagram with komatiitic, "pyroxenitic," and gabbroic rocks.

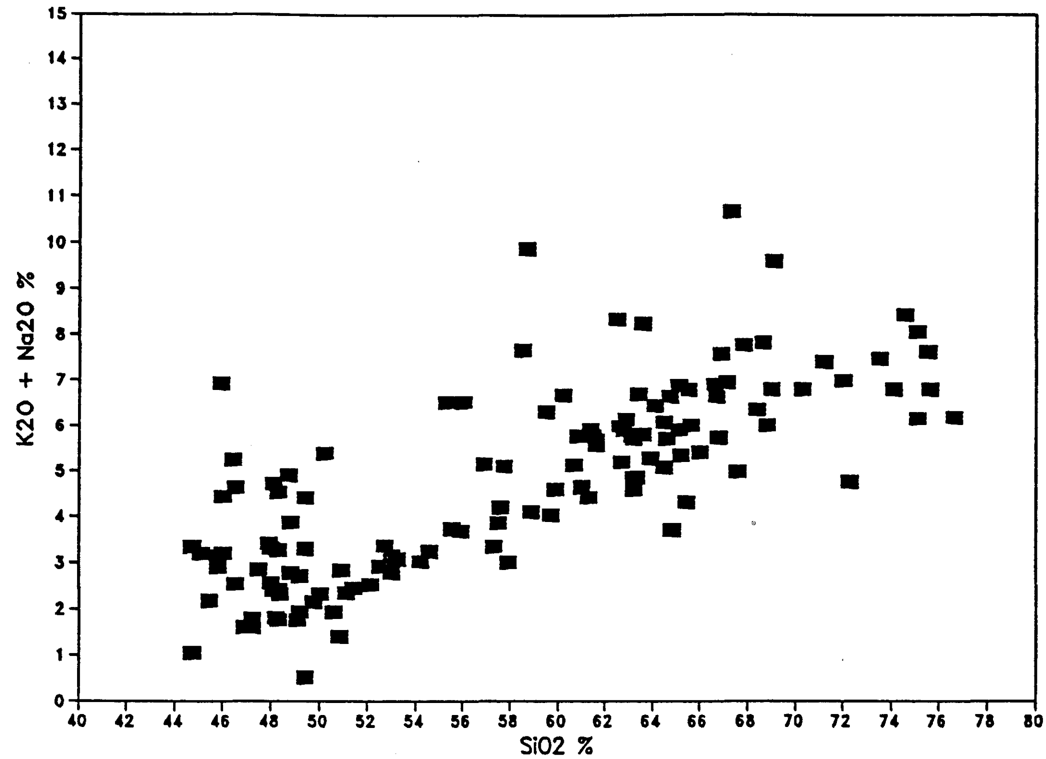

Figure 278-16. SiO_2 vs Total Alkali (K_2O + Na_2O) diagram showing mafic and felsic volcanic rocks.

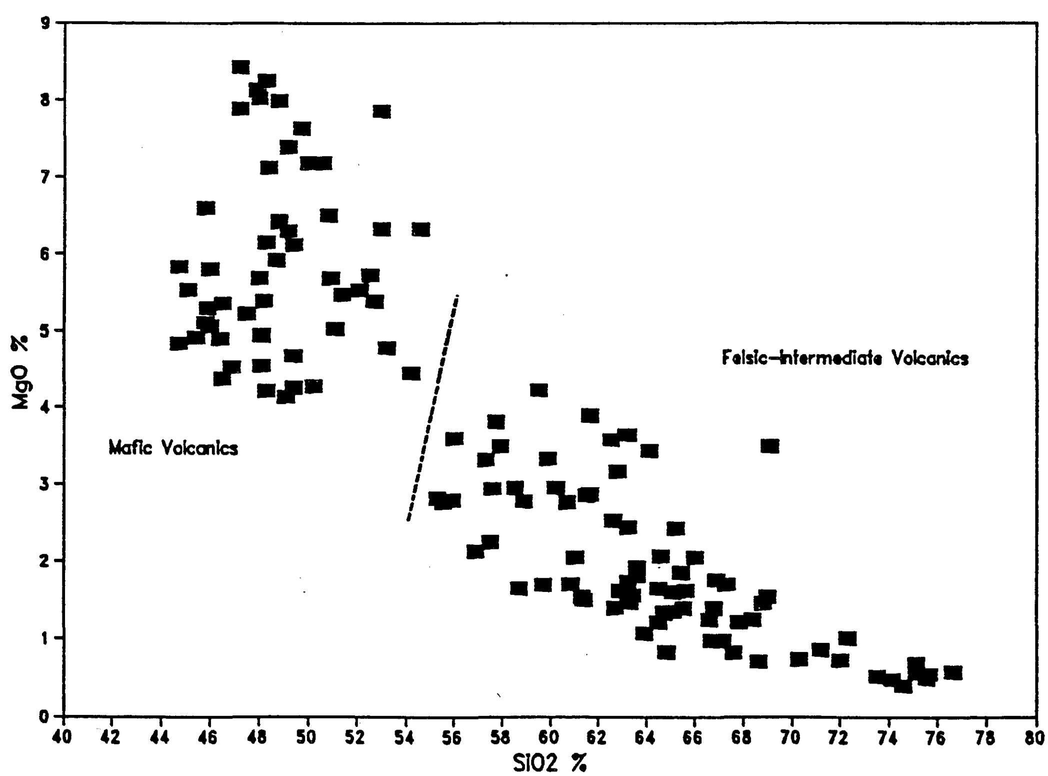

Figure 278-17. SiO_2 vs MgO diagram showing mafic and felsic volcanic rocks.

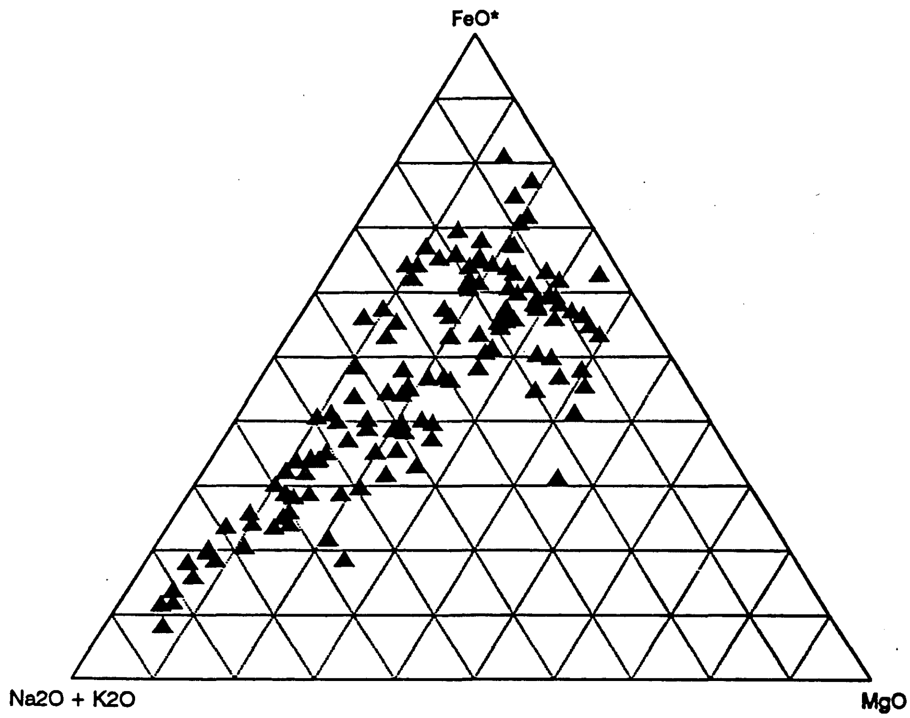

Figure 278-18. AFM diagram of Mafic and Felsic Volcanic samples.

Although many factors and processes have contributed to the chemical signature of each of the samples, an attempt has been made to assign each sample to a lithologic group. These assignments are based on the lithologic logs, sample characterization sheets, thin section descriptions, and unique geochemical characteristics. For each unit, the chemistry will be described and some features displayed using variation diagrams. Any anomalous values of particular samples or of the entire group will be discussed. The samples have been assigned to the following groups: 1) Gabbroic intrusives; 2) MgO-rich (komatiitic and amphibolitic rocks); 3) Chemical Sediments, including massive sulfides; and 4) Mafic and Felsic Volcanics. A few remaining samples, such as those sampled across a lithologic contact, did not fall into any of these general categories and are described in a final descriptive section. Following the identification of a specific group, those analyses were then removed from the working database into a separate file. This served to remove some of the "clutter" and many of the outlying samples from the larger set of analyses, allowing any clusters or trends in the mafic and felsic volcanics that remained to be observed.

Based on some key variation diagrams and lithologic log descriptions, gabbroic and komatiitic lithotypes were readily identified. Gabbros are especially noticeable on diagrams including TiO_2, while the komatiitic samples are obvious on MgO diagrams. Descriptions in the lithologic logs confirmed all of these analyses as either gabbroic or komatiitic respectively, and added only one sample to the gabbro group, which had a mixed chemical signature due to two lithologic types in the sample interval. Within the high-MgO group, two samples from a single drillhole were found to be pyroxenites.

Distinguishing the chemical sediments and brecciated units, which are very altered and mineralized compared to most of the mafic and felsic volcanics, was a more difficult task. The only chemically distinct sub-population within the chemical sediment group is composed of massive sulfides. Other samples are generally chemically confused mixtures of different volcanic types, alteration, mineralization, and deformation metamorphism. This type of mixed unit is also difficult to positively identify and describe while logging the core. In general, these rocks were enriched in iron, but other elements showed no consistent trends. To help in characterizing mafic and felsic volcanics that were positively identified, any sample intervals in which chemical sediments or significant brecciation was noted was assigned to this group.

On most variation diagrams using only analyses of volcanics, a compositional gap is apparent in which only a few samples fall. This suggests that this suite of volcanic rocks is the result of bi-modal volcanism (basalt-dacite). The few intermediate compositions may be a result of alteration processes or minor fractionation associated with either the mafic or felsic systems. Within the felsic rocks, a small group of eight samples have been silicified. This bi-modal distribution can be seen on SiO_2 and MgO variation diagrams (Fig. 16 and 17) as well as a standard AFM diagram (Fig. 18).

When plotted on a total alkali (K_2O + Na_2O) vs silica (SiO_2) diagram with the classification system of LeBas and others (1986), the majority of analyses are basalts and dacites, with a few intermediate andesitic samples and a group of silicified rocks which plot chemically as rhyolites. A few samples were slightly trachytic (alkali-rich), but the majority appeared to have standard volcanic alkali values. This may indicate that alteration processes did not greatly affect the alkali elements or that any transport was within a relatively closed system.

Another common classification technique is to use a Jensen Cation Plot (Fig. 13), which uses cation proportions of Al_2O_3, Fe_2O_3 + FeO + TiO_2, and MgO as the apices of the triangle. This diagram not only assigns rock names, but distinguishes between calc-alkaline, tholeiitic, and komatiitic suites. All of the komatiitic rocks fall into the basaltic komatiite field. The mafic volcanics are generally within the tholeiitic field, some as high-Mg tholeiites, but most as high-Fe tholeiites. The felsic volcanics are all within the calc-alkaline field. A similar division is seen if the calc-alkaline / tholeiitic dividing line of Irvine and Baragar (1971) is plotted on the AFM diagram.

Discussion

Beside the drill logs generated for this project, additional descriptive logs (primarily from the private exploration companies) can be found in the DNR Assessment Files in Hibbing. The U. S. Geological Survey also did a reconnaissance core logging (Klein and Day, 1989) of these and other drill cores from the region. The reader is encouraged to look at all these materials, for not all of the information overlaps, and the truth is probably and hopefully an admixture of all of these. The rocks are complicated, and any one person's interpretation may not be the best. **The Baudette area cores are maintained at the DNR Core Library in Hibbing, and the reader is encouraged to use these as their ultimate reference.**

There is less certainty in the protoliths and interpretative descriptions of these variably altered, metamorphosed, deformed and recrystallized rocks compared with lower grade, less deformed supracrustals.

Regional Geologic Framework

Airborne geophysics is a common thread that can allow a larger scale geologic interpretation to be made from more limited information types. Drill core data is an example of this latter information type. Since drill cores sample such a small percentage of the stratigraphy, they may or may not be representative of the larger map units in which they reside. These map units must be delineated and perhaps characterized by data that is meaningful at the same scale, such as the aeromagnetic data. The "point" data, represented by drill core information, should only be used as a supplemental information source in the creation of a geologic map at the scale of the Roseau Sheet. This is especially true of exploration company drilling, which by its nature is biased because of the dependence on airborne geophysical anomalies for siting.

The majority of drill cores studied within the Baudette area fall within a distinctive northeast to southwest trending magnetic terrain. This is outlined in Fig. 2, which is that portion of the latest aeromagnetic survey (Bracken and others, 1989) covering the Baudette area. This belt, which ranges in width from approximately 6 to 12 miles, is characterized by undulating to irregular boundaries, generally higher magnetic values, and generally higher magnetic gradients (closer contours), especially near the boundaries separating this belt from adjacent areas. USGS interpreted fault traces are shown as dashed lines.

The USGS geologic interpretation (Fig. 1) divides this area into a number of map units, as does the pseudogeologic map coverage (see Lawler and Venzke, 1991). While these interpretations are valid, the new published data should be enticing to the reader to make further evaluations. This belt does appear to be dominated with relatively iron rich rocks including mafic metavolcanics, mafic metamorphosed intrusives, chemical sediments, and relatively magnetic tonalites, granodiorites and other similar rocks. Several smaller areas with a similar magnetic fabric also exist south of the Vermilion Fault, and also to the northwest of the main belt. Note that there are also smaller magnetic lows and variable relief within these areas so that smaller scale subdivisions can be made, although 7.5' quadrangle scale magnetic maps become necessary as subdivisions become smaller.

In general, the drill holes are believed to have intersected various portions of one or more interfingered sequences (tablet or lozenge shaped?) of volcanics and sediments. While examining an enlarged northern portion of the Shaded Relief Aeromagnetic Map of Minnesota (Chandler, 1989) with Ronchi filters, the senior author discovered that the Baudette area could be subdivided into smaller "lozenge-shaped" magnetic areas. Ronchi filters are hand-held diffraction gratings that accentuate linearity and linear features in image type data (Levandowski, oral commun., 1980). Ronchi filters must be used with caution, however, since artificial linearities (such as due to data processing) may also be enhanced. Work by Hubert (1991) has described a similar fabric within the Southern Abitibi Subprovince due to coherent volcanic domains separated by narrow tectonic zones, although his methodology is not known.

Not only may the primary materials from different volcanic-sedimentary piles (distal or proximal) and/or eruptive cycles be present in a given drill core, but their associated shallow intrusives and/or systemic hydrothermal alteration may also be superimposed. Perhaps with more spatially detailed chemistry and thin section work, definite stratigraphic correlations could be made between the drill cores that are separated by greater distances.

The five most northwesterly drill cores were drilled within a slightly more subdued magnetic area. Three of these had ultramafic (komatiitic) materials, as did DDH 40926 which was also situated on a relatively subdued magnetic area. The aeromagnetics may indicate that larger areas with this kind of "low" iron rock may possibly be present within the Baudette area. The exploration company drilling based on airborne geophysical anomalies evidently found more targets within the iron rich rocks. Tectonically, perhaps the areas outside of the iron rich belt did not as readily favor the development of sulfide bodies, or perhaps their preservation was not favored. These areas may also foster mineralization that is less iron rich, and which consequently has a more subdued, less favored geophysical expression (Noranda type massive sulfides?, carbonatized ultramafic Au deposits?, komatiitic Cu-Ni deposits?).

A further note on the talc schists (komatiitic?) of DDH YWZ-2 is that this lithology in this drill core was one of the least sulfide bearing of any of the lithologies encountered (barren protolith? or sulfides remobilized?). While the komatiitic materials are highly altered, their ultramafic parentage is indicated by high chromium and nickel values.

Within the northwestern portion of the magnetic belt, most of the drill cores fall within a narrower, parallel belt (2-3 miles ? across strike). They follow this trend southward to the approximate position of the Border Fault, south of which the drill cores are more irregularly positioned, if not indeed trending differently or offset. If left-lateral offset along the Border fault was responsible for this, it probably occurred before the emplacement of a large gabbro plug in the center of the magnetic belt. The Border Fault "later" underwent right lateral motion when it offset different portions of this gabbro plug. A variation in the tectonic setting, or the emplacement of the gabbro or other intrusives could also have been responsible for the change in positioning of the geophysical targets and drill holes within the magnetic belt.

A summary of the lithostratigraphic events as interpreted from relationships observed in core logging is given in Table 6.

Stratigraphy

The majority of drill core rocks are metamorphosed supracrustals. According to the DNR Assessment Files, all of the drill holes were sited on geophysical targets, resulting in a potential bias with regard to those lithotypes drilled. The resulting drill core probably represents a relatively small proportion of the entire greenstone belt and even of the local stratigraphy, by over-representing those lithotypes spatially associated with graphite, sulfides, and oxides.

Each drill core cuts an average of approximately 400 feet of stratigraphy, and has an average nearest neighbor distance between drill holes of over 6000' (distance to the nearest neighbor varied from several hundred feet to 6 miles). Relatively few lithotypes encountered in drill core were unique enough to be considered for stratigraphic purposes without the aid of thin section petrography or chemistry. Geophysical methods therefore are an important stratigraphic tool.

An initial, quick examination of the Assessment File geophysics indicates that the sulfide conductors drilled were discontinuous lenses that occurred at multiple levels in the stratigraphy (Lawler, oral and written commun., 1990). It is unclear whether there are any horizons where the sulfides preferentially occur over others, given the stratigraphic control available.

There are, however, several spatial clusters of 3 to 5 drill cores (see Fig. 1) where common lithotypes probably represent, at least in part, the same stratigraphic units. Lithotypes with visibly more unique characteristics such as agglomerates or unique lithochemical fingerprints are necessary for such correlation.

Supracrustal Rocks

Ultramafic supracrustals: These rocks are typically talc, tremolite, chlorite, serpentine, carbonate schists, and in general, their original textures have been obliterated. These rocks have a high Mgo (>18%), Cr and Ni contents indicating that they have a komatiitic composition (Nisbet, 1987, p. 208). Of all the rock types examined, these were the least sulfide bearing. Either the parent rock did not contain much sulfides, or these have been remobilized.

Komatiitic basalt: Some massive "metabasalt" was described in the drill logs as being grey colored instead of chlorite-hornblende green, and may be either ultramafic or perhaps a "less iron rich" variety of metavolcanic such as a komatiitic basalt (Nisbet, 1987, p.209). Petrographic work established that the mineralogy was indeed tremolitic-actinolitic-chloritic instead of hornblendic-chloritic (DDH B5-1 at 383'). Analyses for DDH B5-1 at 381' to 395' verified that the rocks were komatiitic basalt with 14.7% MgO.

Mafic Supracrustals: "Pillowed" intervals often have "interpillow" chlorite, hornblende, garnet, sulfides, and carbonate "veins", such as in DDH B24-4 within 105-304'.

"Basaltic" rock descriptions must be considered with caution because the end product of the most pervasive alteration associated with chemical sediments is a massive dark green hornblende-rich rock, although the alteration hornblende typically has a slightly coarser grain size. Such alteration or chemical sediment intervals are often magnetic because of magnetite and pyrrhotite associated with the alteration (such as MED-1 within 383-433'), however they superficially look like metamorphosed mafics.

Even "pillowed" basalt intervals could be misidentified. These veins and their selvages, in an otherwise massive amphibole altered rock, could produce a pseudo-pillowed texture. These "interpillow" materials could also represent a chemical sediment contribution that was deposited with the pillows, or perhaps they are indeed veins that found the path of least resistance between the pillows. The latter interpretation is generally favored.

Intermediate Supracrustals: The thin section petrographic work (see that section) indicates that many of the rocks described in the Baudette area core logs as intermediate volcanics are probably clastic sediments (largely volcanically derived?). It is probable that many intermediate, felsic, and even mafic rocks have been reworked, since many of the "sediments" described in thin section are very amphibolitic. From the core logging, the senior author believes that many of the amphibolitic rocks are a result of alteration.

Felsic supracrustals: Due to the recrystallization of these rocks, fragments (and phenocrysts) were often difficult to recognize unless they were large enough (medium or coarse-grained lapilli) or they were sufficiently different from the matrix (accessory or accidental fragments). Recrystallization has often done a thorough job of destroying textures, such as the meta-rhyolite at 588-614' in DDH B24-1, although petrographic work suggested this was an intrusive.

Agglomerates-Conglomerates: The largest "clast" of any certainty within these rocks was from 194.3-197.5' in DDH B31-4. This porphyritic rhyolite or quartz latite interval was believed to be a fragment and not a dike because of its similarity to nearby smaller fragments whose rounded form was clearly visible. The unit that this occurred in also contained mafic and sulfide (chemical sediment?) fragments, which may be accessory and/or accidental fragments.

The matrix of this lithotype is commonly siliceous. If the rock has been silicified (see Alteration and Mineralization) making the fragments vitreous also, the fragments become difficult to differentiate from the matrix (DDH's B31-1; B31-2, especially within 355-364.8'). There is no certainty as to when this silicification occurred and it could even be syndepositional. The matrix may also be somewhat amphibolitic or pyrite bearing (B31 series of drill cores), and these may well be alteration. In

DDH 40919, the fragments are in a tonalitic matrix (see section on Intrusives).

In drill core logging, most felsic rocks appeared to be more dacitic than rhyolitic, although some of the agglomerates may be an exception to this. DDH MED-1 at 185-209' contained pink, rhyolitic (more K feldspar rich) looking fragments in agglomerate where less altered. Analyses indicated K_2O values as high as 7.07% and SiO_2 values of 69.10% for this rhyolitic rock. These were also the rocks that Jamie Walker described as having felsic debris flow textures.

Visual estimates of rock type were not always verified by analyses, however. Occasionally, units appeared to visually change composition downhole. In logging DDH B31-1, the agglomerate within 178-275' appeared to be more dacitic toward the top and rhyolitic (and more siliceous) toward the base. While analyses did indicate that this interval did become more siliceous with depth (71.20% to 75.10%), they also indicated a relative decrease in K_2O from 3.97% to 2.58%.

Despite probable limited areal extent, these "agglomerates" may be a good stratigraphic marker where drill holes exist closer together because of their more unique character. Drill cores where this is possible includes the B31 series, the MQD series, the B21 series, and the LW-346 series combined with the BD series. Their coarser grain size is also less prone to destruction by metamorphism and recrystallization. The coarse grain size may be detrimental in comparing "agglomerates" chemically, however, because of varying fragment types and proportions. If this is a problem, then perhaps detailed chemistry (and petrography) of individual fragments may be useful.

A cursory examination of the chemistry data of the agglomerates-conglomerates indicate that some elements may be useful in differentiating these units between drill cores. These include barium, chromium, vanadium, fluorine, zirconium, cobalt, lithium, rare earths, and perhaps major elements. Caution must be used since alteration will also effect the composition. Other elements, such as nickel in DDH's B31-1 and B31-4, may exhibit stratigraphic trends (both have nickel values that decrease with depth in this case).

Clastic Supracrustals: Biotite-rich portions identified in the drill logs as tuffs or part of the chemical sediment assemblages could also have been an argillitic sediment contribution.

More sedimentary features such as graded beds could probably be distinguished in the core and used to help determine younging directions, although metamorphism makes interpretation if not identification difficult.

Sulfide Chemical Sediment Supracrustals: Chemical sediments, as described in the detailed lithologic logs, are believed to be stratiform precipitates deposited onto the ocean floor from sea water. Much of the finer textures within these stratiform layers (especially the sulfides) have been removed by metamorphism and deformation. Some features do exist, that may provide evidence of their formation.

Bedding was locally disrupted, with changes in bedding angles, fragmentation, apparent slumping and folding in DDH's MQD-2 and DDH B54-1. This may be the result of local mounding of sulfides, energetic hydrothermal activity, or possibly tectonism. If mounding of the sulfides is responsible, then these may be indicating the type of sulfide discharge associated with these sulfides (see section on Ore Deposit Modelling).

Massive pyrrhotite layers often had a sulfide-siliceous breccia texture. The petrographer described a thin section of this at 245.2' in DDH B24-1 as "massive pyrrhotite in metagreywacke". Most fragments are quartz rich, with lesser hornblende and plagioclase. Some quartz grains are monomineralic, while others are composites. There is also a small hornblende pyrrhotite vein that is connected to the main sulfide mass, which may have been a feeder. Whether the siliceous fragments were deposited with or before the sulfides is uncertain, however in drill core, this texture is found within the sulfide layers but not the adjoining rock.

Tourmalinites and tourmaline: Tourmalinites are not new to Minnesota (Boerboom, 1989), but Archean tourmalinites in Minnesota have not been recognized before. Conformable tourmalinite laminae and layers occur in 7 of the 22 drill cores with reported tourmaline. The other fifteen drill cores contained tourmaline in cross cutting veins or intrusives. Whether these veins scavenged tourmaline from tourmalinites is uncertain.

Whether the tourmalinites result from stratiform replacement or actual chemical sedimentation is also unknown. The rotation of bedding and other features into the predominant schistosity may even cover up the cross-cutting relationships of tourmaline bearing veins. The association with other chemical sediment mineralogy implies that tourmalinites are a part of this package.

DDH 40918 contained tourmaline (in a 2 cm thick tourmalinite? or vein) at 292.4' that was zoned. Slack and Coad (1989) inferred that tourmaline zoning at Kidd Creek reflected episodic crystal growth during the hydrothermal mineralization associated with formation of the massive sulfide deposit. At Kidd Creek, tourmaline shows a preferential association with chalcopyrite, and is alteration-vein related and not stratiform. For this project, the chemistry indicates a stronger correlation (see Appendix F) of boron with zinc and cadmium than with copper (all these correlations are fairly weak at best).

Klein (written commun., 1991) indicates that his chemistry work clearly shows a boron enrichment in graphite zones. Perhaps tourmalinite should be included in the column one assemblage of Fig. 2.

Graphite: It is always possible that chemical sediments may be confused with conformable replacement occurring below the seawater interface. Graphite, however, if formed from an accumulation of chemosynthetic microscopic organisms, would be a good indication for seawater interface chemical sedimentation (Lydon, 1988, p. 159). Graphite may also be an indication of the proximity to a hydrothermal vent (Nisbet, 1987, p. 166).

Iron silicate chemical sediments: Instead of the very iron rich silicates (such as greenalite, stilpnomelane, chamosite, minnesotaite, and grunerite) characteristic of silicate facies banded iron formations (Klein, 1973), the occurrence of hornblende indicates the likely presence of other cations (K, Na, Mg?) beside iron. Chlorite, in chemical sediment and footwall alteration, is believed to be a lower metamorphic grade equivalent of the hornblende chemical sediment or alteration.

Biotite may be genetically related to chemical sediment, but it could also be related to felsic volcanism or argillaceous sedimentation at these breaks between volcanic cycles.

Intrusive Rocks

Ultramafic intrusives: Based on lithochemistry, these materials, whether intrusive or extrusive, are komatiitic in nature (Nisbet, 1987, p. 208) with >18% MgO, and high Ni and Cr values.

Pyroxenites: These pyroxenites are biotitic locally and may be of lamprophyric affinity. Besides DDH MDD-1 where they were recognized during the core logging, the thin section petrography indicates that DDH B31-2 at 531' also had the same lithotype. This occurrence is a porphyritic portion within mafic flows, and may represent a sill or dike. The pyroxenite in B31-2 is less altered than in MDD-1. The pyroxenites are chemically different than the komatiitic rocks.

DDH MDD-1 also contained abundant tonalitic-granodioritic rocks, the local mafic component of which looks very similar to the pyroxenite in drill core.

Mafic intrusives: Some of these intrusives (in DDH B24-3 or DDH YWL-1 perhaps) may belong to the Early Proterozoic Kenora-Kabetogama Dike Swarm (Southwick and Halls, 1987; Southwick and Day, 1983). Kenora-Kabetogama dikes can be altered and deformed, so the deformation and alteration observed in the drill core and thin sections may not indicate that these are necessarily Archean.

Tonalitic-Granodioritic Intrusives: These are the most complex and variable intrusions within the drill core.

As stated in the drill logs, these intrusives may have appreciable "contamination", and may contain as much as 60% amphibole, biotite, magnetite, tourmaline, and/or pyrrhotite. Chemical sediments may be the largest "contamination" source. These "contaminations" could also simply be melt components, and if so, then the similarity to the chemical sediment mineralogy is coincidental.

Some cores have tonalite-granodiorite with sharp contacts and minimal "contamination", and tonalite-granodiorite with "contamination" and nebulous contacts such as DDH's B-Q-1, MQD-1, and MQD-2. This may imply that there are two separate subgroups of these intrusives.

From intrusive relationships, these rocks post-date mafic intrusives, but are younger than granitic-syenitic veins. The mafic component of the tonalites-granodiorites usually has a deformational fabric developed, so it is presumed that these intrusives are pre- or syndeformational.

DDH's B21-3 and B21-2 contain tonalitic intrusives, and nearby metamorphosed plagioclase-quartz tuffs(?) which look very similar to each other. The "tuffs" are different in that they are characterized by rounded grains including strained blue quartz, and they are in general biotitic rather than amphibolitic. These "tuffs" may be extrusive equivalents of the tonalitic-porphyry intrusives, and the tonalites may occur in feeders or intrusives related to penecontemporaneous felsic volcanism.

The tonalitic-granodioritic intrusives tend to be very siliceous. They also appear to grade into at least some of the quartz veins encountered in the drill core.

In the Abitibi greenstone belt, intrusions of this type are locally altered and gold bearing (Jenkins and others, 1989; and McNeil and Kerrich, 1986).

Granite-Syenite Intrusives: These occur as thin veins or dikes, and probably represent the last magmatic event in the Baudette area, except for the Proterozoic mafic dikes. The thinnest dikes, which may only be represented by coarse K-feldspar crystals along otherwise hairline fractures, may result from metasomatic replacement along these fractures.

These dikes generally look undeformed, but may be cut by late calcite veins, which may or may not be related to the later fault zones within the Baudette area.

Metamorphism and Deformation

Deformation and Rock Fabric: It is assumed that the S_1 deformational fabric is related to a regional deformation (and folding?) that trends parallel to the regional magnetic fabric. The local development of a linear fabric appears to be shear related, as might another planar fabric (developed? in DDH's YWZ-1 and YWZ-2). Some fold closures exhibit quite variable orientations (465-475' in DDH MMD-1) associated with brecciation and shearing, however others may be related to larger scale folding.

Usually pillow basalts and sedimentary features can be used to determine the younging direction in supracrustal rocks. The use of pillow basalts in drill core is generally not practical. Metamorphism has made the use of sedimentary features difficult at best, although more work with graded beds may be possible. Another alternative is to use the observed alteration geometry as an indicator as an indicator of younging. This makes use of some assumptions concerning volcanic cyclicity, and that footwall rocks should be more altered than the hanging-wall rocks. While not all the drill cores in the Baudette area could be used for that purpose, most of them could, including DDH BD-2 which shows the chemical sediment alteration package with the least interference from later intrusives.

Metamorphism: Intrusions of various kinds and amounts occur in most drill cores (see section on Intrusive Rocks), but whether these are strictly responsible for the metamorphism, or just another response to relatively hot crustal conditions is unclear. Also, many cores have hairline or thicker veinlets with coarse K-feldspar (see Fig. 8). While this may be metasomatic, it probably indicates that the country rock was fairly hot, as does the general lack of chilled contacts.

Garnet showed a preferred association with the altered footwall rocks below chemical sediments, especially where they are hornblende rich. This could be explained in that these areas may have a more favorable composition for garnet growth after alteration. An elevated manganese content of these altered zones could explain this, since manganese lowers the formation temperature of garnets (Deere and others, 1963). Analyses for Mn in the Baudette area produced values as high as 1.59%. Another explanation is that these altered areas may in themselves have had a higher temperature and metamorphic grade due to the hydrothermal system responsible for the alteration.

Occasionally, garnets may have been confused with other red minerals (sphalerite?, siderite?) because of their apparent softness. Thin sections, such as at 470.4' in DDH B5-1, indicate that garnets may contain 60-70% inclusions (or alteration?) which could explain this apparent softness.

The occurrence of garnet in veins (with epidote, quartz and carbonate) is noted, and in thin section, the garnet, quartz and carbonate in the vein have all been tectonized. This may indicate that penecontemporaneous or post-metamorphic deformation may have occurred, even though the drill core is 1½ miles away from the larger, later shear zones. Whether the carbonate is associated with the veining, or is associated with the deformation (or both?), is unclear.

Cordierite(?) was only observed in DDH 40917. This may be expected since this is the drill hole in the Quetico Subprovince that is farthest (across strike) from the boundary with the Wabigoon Subprovince (the Fourtown Fault located southwest of the Vermilion Fault, see Fig. 1). Drill cores in the Wabigoon Subprovince with biotite and garnet did not have any observed cordierite, and whether this is a reliable criterion for differentiating the terranes is problematical.

Biotite distribution was ubiquitous in variable amounts. Alteration and chemical sedimentation may have contributed to the biotite distribution, but this is also problematical.

Retrograde metamorphism (or alteration) may have occurred as chlorite and other sheet silicates along shears. The zeolites found from XRD work probably represent retrograde metamorphism (see section on Lithologic Logging Results).

Metamorphism had one positive effect, which was the easier identification of tourmaline and tourmalinites. Instead of having a very fine-grained, black, cherty looking tourmalinite (cited in Slack and others, 1984), these tourmalinites had tourmaline grains 1/2 mm or larger, which made their grain mount identification possible.

Alteration and Mineralization

Alteration and mineralization in the Baudette area drill cores may be massive-pervasive and affect many ten's of feet of core, or it can be more localized, patchy, and vein associated. Most observed alteration and mineralization types here appear to be spatially related to the chemical sedimentation. Other observed alteration types of less certain parentage also occur, however.

A spatial and genetic link between some (if not all) adjoining assemblages may be inferred from overlapping mineralogy if nothing else. The mineral phases present are the result of metamorphism, so the present mineralogy may only have chemistry in common with the original alteration mineralogy.

On the footwall side of sulfide and other chemical sediments, structures and stratigraphy become nebulous when oxide-sulfide-tourmaline-iron silicate alteration (chlorite or hornblende, with or without garnet) is involved. The lumping together of chemical sediments and alteration in the drill logs has sometimes been done for this reason. Unfortunately, metamorphism and tectonism have made microscopic determination of these alteration textures difficult if not impossible to recognize. The petrographic work (see section on Thin Section Petrography) was done without the relationships examined in drill core, so descriptions of these altered rocks were made only within the context of that thin section sized sample. Examples of the hornblende-garnet-sulfide alteration-chemical sediment assemblage can be seen in thin sections in DDH B5-1 at 470.4', DDH YWL-1 at 524.1', and DDH B24-4 at 370'.

These alteration zones are also typically associated with small amounts of calcite or other carbonate. While not being volumetrically significant in many places, this may indicate that carbon dioxide was an important volatile in the metamorphism and the alteration, especially with regard to garnet and probably the growth of other phases.

Several (?) intrusive events may have caused (or resulting from?) the regional temperatures responsible for the variable metamorphism of the rocks. Also, with multiple intrusions in the drill cores, all of the assemblages shown in Table 5 may not be directly associated with the hydrothermal systems associated with chemical sediment formation. Nearby unrelated granites may be responsible for the veining-alteration with the K-feldspar and/or the epidote. As noted earlier, the commonality of mineralogy could also result from contamination.

Other more monomineralic (?) alteration types may be related to the chemical sediment hydrothermal systems of Table 5 even though they are not explicitly shown. Silicification, carbonatization, pyritization and sericitization may form extreme subvarieties of Table 5 assemblages. These may occur singly or together. Where cross-cutting relationships cannot be determined, these may possibly be confused with a chemical sediment contribution to clastic and volcaniclastic sedimentation.

Fault related alteration and mineralization included carbonatization, silicification (?), and sericitization. Where this occurs, the cross-cutting and fabric relationships of the shearing indicate that the associated alteration generally occurred relatively late in the sequence of events. The highest arsenic values found in the Baudette area may be fault related (DDH 40926), which also has noticeable sericitization and carbonatization. Some relevant modelling of Wabigoon gold mineralization in Canada has been done by Davis and Smith (1991), and Melling and others (1988).

If all of the assemblages shown in Table 5 are indeed related, they may also be expressing their relative depths from the seawater interface. The left one or two columns would represent deposition on the seawater interface, while columns to the right would infer increasingly greater depths below this interface. Unfortunately, drill core offers poor spatial control in substantiating these inferences.

Lithochemistry

Analytical results for the sampling must be used with some caution due to the limited number of samples and the complex small scale variations in alteration, veins, lithotypes and mineralization. The analyses carried out by the U. S. Geological Survey (Klein, 1988) typically involved smaller sampling intervals. These may therefore express the lithotype chemistry better, especially where different lithotypes are thinly interbedded or intermixed.

Some drill cores had interesting specific analytical results paired with lithologic features. These are listed in Table 3.

Many compilations of rock analyses have been made for different purposes, including "average values". Average crustal abundances have a limited value because of the wide variation in natural abundances upon which such numbers are calculated. Elemental abundances, when derived from specific rock types (median values are often used) can be useful in characterizing the lithotype of rock analyses, and may give clues to such things as parentage, formational history and contamination, although caution must be used. Abundances can also be used to indicate anomalous potential enrichments or depletions of elements, especially by using ratios. These elements may include those of economic interest or their pathfinders.

The populations for different elements for the Baudette area analyses were compared to elemental abundances for different rock types as tabulated in Koljonen (in press) and Rose and others (1979). Many Baudette area element populations fall within the spectrum of values for the varied rock types as given in these two sources (ultramafic, mafic, granitic, shale, sandstone, limestone). Table 7 shows the Baudette area analyses for elements with values greater than the tabulated abundances (anomalous?).

Most metals and trace elements in Table 7 are associated with Baudette area samples that contain chemical sediments (or footwall alteration-mineralization where difficult to separate). Of these elements of this subset, W, B, As, Bi, Sb, and Mo typically have their highest crustal abundance values associated with granitic (felsic) composition rocks. Perhaps it is coincidental that one or more of these elements are often associated with Archean gold mineralization. Perhaps they are an indication of what the hydrothermal systems may carry in places.

The elements Zn, Cu, Cd, Se, V, Pd, and Mn typically have their highest crustal abundance values associated with mafic rocks, at least some of which are affiliated with massive sulfide deposits. Fe typically occurs in its highest amounts in ultramafic rocks, although mafics run a close second.

Table 278-6. Lithostratigraphic History Summary (events in order of occurrence).

EVENT: Formation of Supracrustals. Seafloor volcanism and sedimentation in northeast trending belts. Some belts contained more evolved (iron rich) materials while others were more primitive (magnesium rich). Volcanism probably occurred in cycles.

POSSIBLE RELATED EVENTS:
A) Local intrusion of comagmatic intrusives (including diabase?).
B) Formation of hydrothermal systems and their associated chemical sedimentation and alteration.
C) Seafloor alteration and diagenesis.

EVENT: Intrusion of gabbros and diabases. (This event could have occurred before, after or during the next event listed.)

EVENT: Intrusion of pyroxenites.(?)

EVENT: Intrusion of tonalite-monzonite-granodiorite and incorporation of chemical sediments and other supracrustals.

POSSIBLE RELATED EVENTS:
A) Local quartz veining.
B) Start(?) of metamorphic heating.

EVENT: Deformation of rocks, producing the S1 fabric and metamorphism. The general bedding parallel nature may result from perhaps isoclinal folding and thrusting(?), perhaps as this slice of volcanics and sediments were accreted onto an earlier terrane(?).

POSSIBLE RELATED EVENT:
A) Formation or reactivation of stratigraphic parallel faults (growth faults?), and associated alteration.
B) Start or continuation of metamorphic heating.

EVENT: Intrusion of syenite-granite(?) veins, locally aplitic, pegmatitic, calcareous(?).

POSSIBLE RELATED EVENTS:
A) Local K-feldspar metasomatism and veining, possibly with epidote, calcite, sulfides, quartz, amphiboles, and garnet.
B) End of S1 fabric deformation.
C) Recrystallization (variable hornfelsing of S0-S1 fabric?). Local quartz, calcite, tourmaline veining.

EVENT: Late faulting (Vermilion Fault) with local sericitization and carbonatization.

POSSIBLE RELATED EVENTS:
A) Minor folding, brecciation, local L tectonite fabric developed, and/or local S2 fabric development.
B) Retrograde metamorphism.
C) Minor chlorite, calcite, quartz, limonite veinlets.

EVENT: Proterozoic mafic dikes.

Table 278-7. Comparison of elemental rock abundances and highest new analyses from southern Lake of the Woods county.

Element or Oxide	Highest Crustal Abundance		Highest Elemental Values from New Analyses			
	Rock Type *	Abundance *	DDH	Footage	Lithology	High Value
W	Shale, granitic	1.9 ppm, 1.5 ppm	B31-1	318.4-326.5	Chem sed, mafic tuff	31 ppm
Ni	Ultramafic	1400 ppm	40926	344.0-352.0	Ultramafic schist	444 ppm
SiO_2	Sandstone, granitic	78.72 %, 69.10 %	B31-4	444.0-457.0	Felsic tuff	83.30 %
Na_2O	Granitic	3.77 %	B31-4	465.0-475.0	Felsic tuff	6.75 %
K_2O	Granitic	3.73 %	MED-1	185.0-194.0	Agglomeratic felsic tuff	7.07 %
MgO	Ultramafic	33.82 % ??	YWZ-2	383.0-393.0	Ultramafic schist	22.90 %
Te	Shale, mafic	.009 ppm, .008 ppm	B54-1	213.0-223.0	Altered chem sed, tuff	21 ppm
CaO	Limestone, mafic	41.98 %, 9.38 %	BD-P-2	342.0-343.3	Felsite dike	16.70 %
Al_2O_3	Shale, mafic	15.87 %, 15.68 %	B24-4	652.0-664.0	Altered chem sed, tuff	18.05 %
La	Granitic	50 ppm	B31-2	920.8-925.4	Felsic porphyry	94 ppm
F	Granitic	800 ppm	MED-1	185.0-194.0	Felsic tuff	3004 ppm
Au	Granitic ?	2 ppb	BD-II-1	653.0-663.0	Mafic tuff	115 ppb
Ta	Granitic	2.1 ppm	BD-II-2	314.0-324.0	Mafic intrusive	30 ppm
Li	Shale, granitic	60 ppm, 25 ppm	MED-1	185.0-194.0	Felsic tuff	114 ppm
B	Shale, granitic	100 ppm, 10 ppm	B21-2	239.0-248.0	Chemical sediment, tuff	1780 ppm
As	Shale, granitic	13 ppm, 2.1 ppm	40926	344.0-352.0	Chemical sediment, tuff	444 ppm
Pb	Shale, granitic	20 ppm, 20 ppm	B31-1	514.0-525.0	Felsic tuff	139 ppm
Rb	Shale, granitic	140 ppm, 100 ppm	B31-5	465.0-475.0	Maf-int, tuff	171 ppm
Sb	Shale, granitic	1.0 ppm, 0.3 ppm	YWZ-2	636.3-643.8	Chemical sediment, tuff	4.4 ppm
Ce	Shale, granitic	90 ppm, 90 ppm	B31-2	920.8-925.4	Felsic porphyry	195 ppm
Hg	Shale, granitic	100 ppb, 40 ppb	BD-N-1	515.0-520.5	Chemical sediment	288 ppb
Bi	Shale, granitic ?	1 ppm, 0.2 ppm	BD-N-1	607.0-610.3	Chemical sediment	19 ppm
Mo	Shale, granitic	2 ppm, 1.5 ppm	BD-N-1	515.0-520.5	Chemical sediment	319 ppm
S	Shale, ultramaf ?	0.14 %, 0.09 %	B58-1	306.9-320.0	Chem sed, mafic flows	16.82 %
Zn	Shale, mafic	100 ppm, 100 ppm	YWZ-2	636.3-643.8	Chemical sediment, tuff	6521 ppm
Se	Shale, mafic ?	0.3 ppm, 0.12 ppm	BD-N-1	474.5-480.3	Chemical sediment	17 ppm
			BD-N-1	607.0-610.3	Chemical sediment	17 ppm
Cd	Shale, mafic ?	0.4 ppm, 0.2 ppm	YWZ-2	636.3-643.8	Chemical sediment	18 ppm
MnO	Mafic	0.18 %	BD-1	244.0-254.0	Chemical sediment	1.59 %
P_2O_5	Mafic	0.25 %	MDD-1	421.0-432.0	Maf-int, tuff, graywacke	2.87 %
TiO_2	Mafic	1.5 %	MQD-2	232.0-242.0	Gabbro	3.03 %
V	Mafic	250 ppm	MED-1	213.5-224.0	Chemical sediment, tuff	708 ppm
Ag	Mafic ?	0.1 ppm	YWL-1	329.0-339.0	Ultramafic schist	1.5 ppm
Cu	Mafic	90 ppm	B31-1	318.4-326.5	Chem seds, mafic tuff	954 ppm
Pd	Mafic	2 ppb	B-Q-1	106.1-118.0	Altered mafic, sediment	29 ppb
Cr	Ultramafic	1600 ppm	YWZ-2	393.0-403.8	Ultramafic schist	3995 ppm
Pt	Ultramafic	3 ppb	MQD-2	162.0-171.6	Mafic volcanics	38 ppb
Fe_2O_3	Ultramafic	13.44 %	MED-1	213.5-224.0	Chemical sediment, tuff	51.0 %

* The second and third columns are the rock type with the largest tabulated abundance value and the abundance values taken from Koljonen (in press) for each element. Where this rock type is a sediment, the igneous rock type with the highest abundance is included. A question mark is shown where the two listed references disagree as to the rock type with the highest element amounts. The fourth and fifth columns indicate the drill core and footage for the Baudette area samples with the highest analytical value for that respective element. The lithologies (from core logging) and the analytical values for these highest value samples are tabulated in the last two columns.

Elements with population abundances that may show a general depletion are Zr (limestone, ultramafic rocks typically have the lowest abundances), and perhaps Nb, Ba, and Sr (all of which typically have lowest abundances in ultramafics). Barium only had one sample that may be greater than the abundance amounts (861 ppm at 194.0-206.0' in DDH B-B-2).

Ore Deposit Modelling

Volcanogenic massive sulfides (VMS) have been a source of discussion and journal articles for several decades. Earlier descriptive papers (such as Franklin and others, 1975; Roberts, 1975; Spence, 1975; Friesen and others, 1982; Barnett and others, 1982; Casselman and Mioduszewska, 1982) are being supplanted by more modelling, classification, and genesis papers (Sawkins, 1990; Lydon, 1984; Lydon, 1988; Morton and Franklin, 1987; Hodgson and Lydon, 1977; Reed, 1983; Hutchinson, 1982). The importance of the volcanic setting in VMS formation will insure that descriptive papers will continue. More generalized papers have included Hutchinson, 1973; Franklin and others, 1981; Lydon, 1984; and Lydon, 1988.

It is becoming increasingly recognized that higher grade metamorphic rocks are favorable sites for economic mineralization. This includes gold deposits (Couture and Guha, 1990; Bernier and MacLean, 1989; and Groves and McNaughton, 1991) and massive sulfide deposits (Araujo and Scott, 1991; Ririe, 1991; Friesen and others, 1982).

Sawkins (1990): With regard to this project, the rubidium, strontium, lead, and barium populations of Baudette area chemistry data does not, in general, show any enrichment. Sawkins (1990) uses the lack of large ion lithophile elements concentration as evidence that Archean hosted massive sulfides formed in a tectonic environment that was either in an early stage of arc development, or in a back-arc setting of more tholeitic than calc-alkaline magmatic character (laterally removed from LILE enrichment which occurs below the arc system). This further implies that studies of seafloor hydrothermal mineralization associated with spreading centers (which are very numerous today), cannot be simplistically applied to the genesis of volcanogenic massive sulfides (mechanism may be very similar, though). There may be evidence, however, that similar ore forming solutions can be produced in different tectonic settings (cited in Rona, 1988).

While Sawkins hypothesis may explain the lack of Pb in the Archean Cu-Zn massive sulfides, other explanations can revolve around differences in fluid chemistry (Lydon, 1988). The Archean may well have been a time of different tectonics and distributions of chemistry, however many of these hypotheses are based on weak assumptions with poor constraints (Nisbet, 1987).

Morton and Franklin (1987): The volcanic-associated massive sulfide deposit classification of Morton and Franklin (1987) is not only concerned with mineralization and alteration, but is also concerned with the volcanogenic setting, geometries, and rock types. Of the two basic types described (Noranda vs Mattabi), we consider the Mattabi type describing most of the Baudette area sulfide features. Due to the small amount of stratigraphy intersected by the drilling, it is difficult to determine whether mafic (Noranda type) or felsic (Mattabi type) volcanics were the most abundant. Perhaps a more detailed analysis of the aeromagnetics may indicate this. The senior author thinks that mafics probably predominate.

One of the most notable features of the Baudette area drill cores is the alteration-addition of iron, sulfur, manganese and variable, but usually minor carbonate. Silicification was also locally associated with agglomeratic units (such as the B31 series), which may also be indicative of Mattabi type mineralization.

There are some differences also, however. The Baudette area cores had minimal, if any, minerals indicating an enrichment in Al (for example staurolite, kyanite), although silicates are often aluminous including tourmaline. Overburden drilling in the Baudette are (Martin and others, 1991) did find a local kyanite concentration in till, however. An enrichment in K was probably observed in intervals as biotite, but this doesn't appear to be as ubiquitous as the hornblende-garnet mineralogy. The hornblende prevalence over actinolite (and occurrence of minor calcite?) may indicate that Ca and Na depletion was not very thorough. The Baudette area cores locally had tourmalinites also. Within the supracrustals of these cores, veining with epidote occurred locally. This was typically rather distal from the chemical sediments and footwall alteration, and could have been related to later intrusions.

With regard to rock types and volcanogenic setting, metamorphism and deformation greatly impeded protolith identification, and the limited drill cores provided poor stratigraphic control. Jamie Walker was able to recognize felsic debris flow textures in DDH MED-1 (see section on Thin Section Petrography). As noted earlier, 22 of the 44 cores logged had coarse fragmental agglomerate-conglomerate (?). While there may be a number of processes that can generate coarse fragmentites, shallow water volcanism is probably responsible for some if not all of the coarser fragments within the drill cores (such as the B31 series). This is also indicative of a Mattabi type mineralization environment.

Jamie Walker, when describing thin sections, noted the local occurrence of more Mg rich amphiboles and chlorite (see section on Thin Section Petrography). Such chlorites and amphiboles can be related to alteration associated with Noranda type massive sulfides. As cited in Morton and Franklin,(1987), differences in associated chlorite composition may be due to the relative amount of cold, unreacted seawater drawn down into the discharge zone. Magnesic rocks, such as komatiites and komatiitic basalts, could also be a potential footwall Mg source for this type of alteration. As a Cu and Zn source, however, mafic footwall rocks would probably be better than ultramafics.

Lesher and others (1986): Work by Lesher and others (1986) indicate that trace element and rare earth geochemistry may be useful tools in discriminating different felsic metavolcanics, and may useful as an exploration tool for finding horizons favorable for massive sulfides. While the Baudette area drill cores have plenty of massive sulfide, there appears to be a relative lack of base metals (higher values run about 1% Zn).

Lesher and others (1986) have found that massive sulfides are associated with negative Eu anomalies, and it is hoped that this concept can be expanded to better differentiate base-precious metal rich ones from more barren ones. The USGS has done rare earth analyses on some samples (Klein, 1988). It is noted that the Baudette area analyses had relatively low Zr values, which gives most of the rocks a low Zr/Y ratio (generally less than 5). Lesher and others (1986) indicate that this ratio may be similar to that in rhyolites found in the Rouyn-Noranda area, many of which are mineralized. The low high field strength elements (heavy rare earth elements, Y, Zr, and Hf) may be more indicative of their class I, relatively barren dacitic rocks. A similar chemical classification has also been made by Barrie and others (1991). A more complete analysis of the USGS data in this light is needed.

Little can be said about the lateral spatial distribution of alteration in the Baudette area cores, since the distance between drill cores was so great. The general feeling while logging core was that alteration only became focused within a few tens of feet of the more massive sulfide, and that it was otherwise rather poorly defined.

WHERE IS THE ZINC AND COPPER? These drill cores contained more zinc than copper in general. The copper is definitely more veinlet related than stratiform in nature. The zinc is problematic, but probably more stratiform. One possibility is that there was insufficient mafic base metal source rock. Another is that the circulating hydrothermal system was lacking in some aspect, such as not destructively altering enough footwall rock. This latter is probably unlikely because the systems were definitely able to free up Fe.

Conclusions

The Baudette area drill cores are characterized by pyrrhotite-pyrite, chert, and lesser oxide, graphite, tourmalinite, silicate and carbonate chemical sediments. Footwall alteration is characterized by chlorite or hornblende-garnet along with sulfides, oxides and minor carbonate. Alteration has enriched the core in sulfur, iron, silica, manganese, copper, gold, bismuth, mercury, lead, boron, arsenic, selenium, and zinc at the expense of other cations and alumina.

Other alteration including silicification and carbonatization may also be related to chemical sediments or later shearing.

The drill cores that we suggest contain the most interesting pathfinders are YWZ-2, BD-N-1, B58-1, B21-2, MED-1, and 40926.

DDH's BD-N-1 and YWZ-2 were the drill cores with the highest zinc values (to 2808 and 6521 ppm respectively). DDH BD-N-1 was also the most sulfide bearing drill core. DDH YWZ-2 also contained komatiitic rocks and had the highest MgO (22.9 %), Cr (3995 ppm), and Sb (4.4 ppm) analyses.

DDH B58-1 contained anomalous Au (to 35 ppb) and Bi (to 8 ppm) within agglomerate.

DDH B21-2 had the thickest tourmalinite described and the highest reported B (1780 ppm) amount.

DDH MED-1 had the highest K_2O (7.07 %), V (708 ppm) and F (3004 ppm) values, and it contained rhyolitic debris flows-agglomerate.

DDH 40926 contained the highest Ni value (636 ppm) As values (444 ppm), and was sheared.

DDH BD-2 is the best core to observe the chemical sediment alteration. It has been minimally disturbed by later veining and intrusives.

Areas of Suggested Future Work

Lithologic Descriptions

Several portions of the stratigraphy cut by the drilling and the footwall alteration may deserve additional work. The sulfide and other chemical sediment layers, the footwall volcanics, and the footwall alteration could use some detailed thin section work, especially in a drill core such as BD-2 which is relatively free of later modifications. DDH B21-2 is also of interest because of the large amount of tourmalinite.

Geochemistry

Further geochemical studies to assist in understanding the geologic history of this area should include additional samples, especially intervals which are believed to be the least altered within each unit. Samples from previously unsampled units, particularly from drill cores in the eastern portion of the area, should also be taken. Analysis of rare earth elements might also be useful for interpretation and correlation of protoliths and stratigraphic relations. These might also be able to characterize the sulfide horizons and the associated felsic volcanics. Negative Eu anomalies are associated with massive sulfides (Lesher and others, 1986) and perhaps a further elucidation can be made to better separate out those relatively rich in base and precious metals from those that are poor in them.

Additional manipulation of this data set may also reveal patterns of interest, especially with respect to the trace elements. Time limitations prevented much in the way of detailed interpretation beyond gross chemical classification and identification of general features of the various lithotypes. Correlation of these new analyses with the thin section descriptions would probably be fruitful.

Further mineral chemistry work (XRD or microprobe) may also be useful. Some phases associated with the footwall alteration show some visual changes (garnet, amphibole ,chlorite), and these minerals may show trace element variations that are indicative of systems that are richer in base and precious metals. Mineralogic studies on tourmaline may give additional information as to how they did form, and whether the same tourmaline in the tourmalinites appears (scavenged) in the tonalitic-granodioritic veins.

Geophysics

The DNR Assessment Files in Hibbing have much, if not all, of the geophysics that was done in association with the exploration company drilling that produced the Baudette area drill cores. An analysis of this data may better relate the geophysics to the lithologies found in cores, and also provide insight into the lateral continuity and dimensions of the sulfide horizons. Information may also be gained about the strike of the rock units, which when combined with drill core fabric information, puts constraints on the rock fabric and structural feature orientations.

It is possible that the geophysical anomalies drilled have not been thoroughly explored. Analytical work hints that base metal mineralization contains more zinc than copper. If this is indeed so, the peripheries of geophysical anomalies along strike may need more testing.

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Appendix 278-A. List of Drillholes and Information

Appendix 278-A. Drillhole List and Information.

DDH	Unique #	Twp	Rng	Sec	Forty	Lessee	Drilled	Core Int	Core Ftg	OB Ftg	Elev	Ang	Azi	Log	Chemical Analysis Codes 1	2	3	4	5	6	7	8
40917	12341	157	33	34	NW-SW	Inco	03/23/1971	183-446	263	183		-55	0	Y	1			4				8
40918	12340	157	33	8	NW-NE	Inco	04/20/1971	239-607	368	239		-55	0	Y	1							
40919	12373	159	33	25	SE-SE	Inco	05/12/1971	130-564	434	130		-55	180	Y	1	2	3	4	5	6	7	8
40920	12374	159	33	29	SE-SW	Inco	06/10/1971	256-524	268	256		-57	180	Y	1	2	3	4	5	6	7	8
40926	12347	157	34	14	SE-NE	Inco	03/15/1972	105-493	388	105	1120.5	-50	0	Y	1	2	3	4	5	6	7	8
B-B-2	12372	159	32	27	SE-NW	W.S. Moore	11/02/1970	117-330	213	117		-50	180	Y	1	2	3	4	5	6	7	8
B-Q-1	12361	158	34	11	SW-SE	W.S. Moore	10/15/1970	88-454	366	88		-50	180	Y				4				
B21-1	12375	159	33	34	SE-SE	Humble Oil	01/08/1971	123-453	330	123		-45	180	Y	1	2	3	4	5	6	7	8
B21-2	12350	158	33	3	NE-NW	Humble Oil	02/11/1971	126-724	598	126		-45	7	Y	1			4			7	
B21-3	12349	158	33	2	NW-NW	Humble Oil	02/26/1971	128-523	395	128		-45	0	Y	1			4			7	
B24-1	12353	158	33	30	NE-NE	Humble Oil	01/15/1971	136-614	478	136		-45	0	Y	1	2	3	4	5	6	7	8
B24-2	12354	158	33	30	NE-NE	Humble Oil	02/02/1971	175-755	580	175		-45	0	Y	1	2	3	4	5	6	7	8
B24-3	12355	158	33	30	NE-NE	Humble Oil	03/24/1971	142-855	713	142		-45	180	Y	1			4			7	
B24-4	12352	158	33	19	SE-SE	Humble Oil	04/08/1971	105-1684	1579	105		-60	180	Y	1			4			7	
B31-1	12342	157	34	5	SE-NW	Humble Oil	03/30/1971	176-723	547	176		-45	150	Y	1	2	3	4	5	6	7	8
B31-2	12343	157	34	5	NE-NW	Humble Oil	03/20/1971	268-993	725	268		-50	150	Y	1			4				8
B31-3	12344	157	34	5	SW-NE	Humble Oil	12/27/1972	102-535	433	102		-55	180	Y	1	2	3	4	5	6	7	8
B31-4	12345	157	34	5	SW-NE	Humble Oil	01/12/1973	99-503	404	99		-55	0	Y	1	2	3	4	5	6	7	8
B31-5	12346	157	34	5	SW-NE	Humble Oil	02/15/1973	81-675	594	81		-90		Y	1	2	3	4	5	6	7	8
B35-1	12348	157	34	21	SE-SE	Humble Oil	02/24/1971	143-428	285	143		-45	330	Y	1	2	3	4	5	6	7	8
B5-1	12365	158	34	25	SE-SE	Exxon	04/06/1971	95-770	675	95		-45	180	Y	1			4			7	
B54-1	12363	158	34	17	NW-NW	Exxon		150-325	175	150		-55	180	Y								
B58-1	12357	158	33	32	NW-SW	Humble Oil	02/16/1971	155-444	289	155		-45	165	Y	1	2	3	4	5	6	7	8
BD-1	12367	159	32	12	SW-SE	Ridge Mining	07/02/1971	157-410	253	157		-50	315	Y	1	2	3	4	5	6	7	8
BD-2	12371	159	32	15	SE-SW	Ridge Mining	07/15/1971	185-434	249	185	1175.0	-50	135	Y	1	2	3	4	5	6	7	8
BD-3	12368	159	32	14	NE-SW	Ridge Mining	07/25/1971	256-424	168	246		-50	315	Y	1	2	3	4	5	6	7	8
BD-II-1	12387	160	31	33	SE-NE	Duval	05/30/1984	174-723	549	174	1200.0	-47	315	Y	1	2	3	4	5	6	7	
BD-II-2	12388	160	31	33	SW-NE	Duval	06/11/1984	206-502	296	206	1200.0	-60	135	Y	1			4				
BD-N-1	12366	158	34	26	SW-NE-SE	Duval	03/24/1986	71-812	741	71	1200.0	-45	0	Y	1			4				
BD-P-2	12358	158	34	10	NW-SE-NW	Duval	03/29/1986	123-638	515	123	1240.0	-45	0	Y	1			4				
LW-346-1	12369	159	32	14	SE-NE	St. Joe American	01/26/1984	202-651	449	202	1150.0	-60	340	Y	1	2	3	4	5		7	
LW-346-2	12370	159	32	14	SW-NE	St. Joe American	02/12/1984	161-641	480	161	1150.0	-60	315	Y	1	2	3	4	5		7	
MDD-1	12362	158	34	12	SE-NE-SE	Amselco	02/03/1982	216-641	425	216	1210.0	-45	340	Y	1	2	3	4	5	6	7	8
MED-1	12356	158	33	32	NW-NW	Amselco	01/25/1982	163-514	351	163	1180.0	-55	352	Y	1	2	3	4	5	6	7	8
MMD-1	12364	158	34	25	NE-SW-NE	Amselco	03/13/1982	109-559	450	109	1191.0	-55	326	Y	1	2	3	4	5	6	7	8
MQD-1	12359	158	34	11	SE-SW	Amselco	02/14/1982	121-376	255	121	1225.0	-45	137	Y	1	2	3	4	5	6	7	8
MQD-2	12360	158	34	11	SE-SW	Amselco	02/22/1982	68-422	354	68	1225.0	-45	316	Y	1	2	3	4	5	6	7	8
MSD-1	12351	158	33	6	SE-SE-SE	Amselco	03/07/1982	233-618	385	233	1232.0	-55	342	Y	1	2	3	4	5	6	7	8
OB-501	14319	158	31	17	NE-NW	MDNR	08/19/1989	0-214	214	214	1156.0	-90		Y	1							
OB-502	14320	159	31	20	SE-SE	MDNR	08/21/1989	0-187	187	179	1137.0	-90		Y	1							
OB-503	14321	160	31	14	SW-SE	MDNR	10/06/1989	0-267	267	259	1116.0	-90		Y	1							
OB-505	14322	158	32	22	SW-NW	MDNR	08/23/1989	0-267	267	261	1167.0	-90		Y	1							
OB-506	14323	159	32	22	NW-NW	MDNR	08/26/1989	0-246	246	231	1174.0	-90		Y	1							
OB-507	14324	160	32	5	SE-SE	MDNR	10/10/1989	0-247	247	247	1157.0	-90		Y	1							
OB-508	14325	157	33	15	NW-NW	MDNR	09/10/1989	0-285	285	280	1191.0	-90		Y	1							

Appendix 278-A. Drillhole List and Information.

DDH	Unique #	Twp-Rng-Sec			Forty	Lessee	Drilled	Core Int	Core Ftg	OB Ftg	Elev	Ang	Azi	Log	Chemical Analysis Codes							
															1	2	3	4	5	6	7	8
OB-509	14326	158	33	23	SE-SW	MDNR	08/24/1989	0-100	100	92	1175.0	-90		Y	1							
OB-510	14327	159	33	36	NW-SW	MDNR	09/06/1989	0-112	112	107	1226.0	-90		Y	1							
OB-511	14328	160	33	8	SW-SW	MDNR	10/04/1989	0-185	185	170	1196.0	-90		Y	1							
OB-512	14329	157	34	24	NE-SE	MDNR	09/07/1989	0-117	117	107	1185.0	-90		Y	1							
OB-513	14330	158	34	23	SE-SE	MDNR	09/11/1989	0-115	115	107	1200.0	-90		Y	1							
OB-514	14331	159	34	15	SE-SW	MDNR	09/13/1989	0-262	262	257	1305.0	-90		Y	1							
OB-515	14332	160	34	32	NE-SE	MDNR	10/02/1989	0-223	223	212	1251.0	-90		Y	1							
OB-516	14333	157	35	36	NE-SE	MDNR	09/07/1989	0-61	61	54	1211.0	-90		Y	1							
OB-517	14334	158	35	30	NW-NE	MDNR	09/27/1989	0-229	229	220	1255.0	-90		Y	1							
OB-518	14335	159	35	22	SW-NE	MDNR	09/16/1989	0-273	273	257	1280.0	-90		Y	1							
OB-519	14336	160	35	16	SE-SW	MDNR	09/29/1989	0-208	208	185	1233.0	-90		Y	1							
OB-520	14337	159	36	29	SW-NW	MDNR	09/21/1989	0-329	329	329	1249.0	-90		Y	1							
OB-521	14338	160	36	30	SE-SW	MDNR	09/25/1989	0-320	320	297	1235.0	-90		Y	1							
RR16-1	12386	160	30	31	SE-NE	Texas Gulf Sulfur	01/25/1969	26-290	264	26		-45	315	Y	1	2	3	4	5	6	7	
TB-511	14417	160	33	8	SW-SW	MDNR	09/06/1990	113-181	68	113	1196.0	-90		N								
YWL-1	12389	160	36	20	NE-SW-NE	Houston Oil	02/21/1985	282-687	405	282	1222.0	-60	250	Y	1	2	3	4	5	6	7	8
YWM-1	12390	160	36	28	NW-SE-SE	Houston Oil	02/28/1985	253-600	347	253	1235.0	-90		Y	1	2	3	4	5	6	7	8
YWQ-1	12378	159	36	15	NW-NW	Houston Oil	03/23/1984	399-844	445	399	1255.0	-60	252	Y	1	2	3	4	5	6	7	8
YWZ-1	12377	159	36	8	SW-SW-SW	Houston Oil	01/21/1984	282-814	532	282	1229.0	-60	270	Y	1	2	3	4	5	6	7	8
YWZ-2	12376	159	36	7	NW-SE-SE	Houston Oil	02/23/1985	294-790	496	294	1227.0	-60	225	Y	1			4				

Core Int = Interval of drill core stored in library.
Core Ftg = Drill core footage.
OB Ftg = Overburden footage.
Unique # = DNR-assigned unique drillhole #

Elev = Ground elevation of the drill site.
Ang = Angle that the hole was drilled.
Azi = Direction (azimuth) from north that the hole was drilled.
Log = Lithologic log in files (Y/N).

Chemical Analyses Explanation

1 = Precious metals, platinum group elements (PGE). Au, Ag, Pt, Pd, Ir, Rh, Os, Ru, Re.
2 = Whole rock - major elements. Na, Mg, K, Ca, Ti, Mn, Fe, Al, Si, P.
3 = Rare earth and associated elements. Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu.
4 = Base metals. Co, Ni, Cu, Zn, Pb.
5 = Mafic spinel oxides. Mg, Ti, V, Cr, Mn, Fe.
6 = Trace elements - minor elements. Li, Be, B, C, F, Cl, Ga, Ge, As, Se, Br, Rb, Sr, Zr, Nb, Mo, Cd, In, Sn, Sb, Te, I, Cs, Ba, Hf, Ta, W, Hg, Tl, Bi.
7 = Sulfur

Analysis codes indicate that analyses for one or more elements in each group have been analyzed for a portion of that drillhole.
Geochemical analyses are on file in the Assessment Files at the Hibbing office of the DNR Minerals Division.

Drillhole information is taken from Ruhanen and Jiran (1990), see latest Drill Core Library Index for additional information.

Appendix 278-B. Detailed Drill Core Log for DDH BD-2

Footage	Color, Name, Description
0' - 185'	**Overburden. No core.**
185' - 200'	**Overburden. Fine grained, saprolitic, clayey metatuff with quartz veins; glacial pebbles.** Color: 5GY5/2 to 10Y4/2 to 5YR8/1. Sand was encountered within 196-199'(?) with the core lost; most of unit was probably glacial. Protolith of saprolitic material was crystal tuff and amphibolitic(?) schist.
200' - 315.3'	**Fine to medium-grained, biotitic, siliceous intermediate-felsic metatuffs and metagreywacke.** Color: N4 to 5Y2/1 to 5G2/1. Most of unit is tuffaceous, including dacitic crystal tuffs. Lapilli may be very coarse locally, with poor sorting. Textural variation indicated by varying amounts of biotite, quartz, and feldspar. Flattening makes discrimination of possible boudinaged laminae and flattened coarser fragments difficult. Some variation could also result from alteration (silicification?), as in 244-254'. Minor amphibole occurs locally. Portions may be greywackes or reworked tuffs, especially below 260'. Flattened, scattered pyrrhotite grains occur below 300'. Unit otherwise contains perhaps 1% disseminated pyrite, especially along hairline veins-slip surfaces with quartz and chlorite. Rhyolitic tuff (or K feldspar-silica-pyrite metasomatism?) occurs locally, such as in 206-206.5'. Other scattered quartz veining occurs with largest at 246.7-249' (with minor K feldspar and pyrite). Some very small quartz veins are ptygmatic. Scattered separate calcite veining (later than quartz veinlets?) with minor pyrite. Local garnet and epidote associated with calcite between some volcanic fragments (?), as in 250-260'. Some calcareous (marble?) thin beds - laminae occur locally also (301.7'). Flattening oriented 40-50° to core axis. Rock is not very schistose due to siliceous nature (?).
315.3' -352'	**Interlaminated hornblende-oxide-garnet-sulfide chemical sediment and/or alteration, and siliceous-biotitic metatuff or metagreywacke.** Color: 5GY2/1 to 5G2/1 to N2. Similar to previous lithotype, but 30-60% of interval is hornblende-oxide garnet, possibly alteration and chemical sediment (or stratiform alteration?). Less associated pyrrhotite (stratiform tendency, increasing downhole) and pyrite-chalcopyrite (cross-cutting tendency). Beside being cross cutting, the hornblende-oxide-garnet alteration could be chemical sediment draped around (interstitial between) larger fragments (volcaniclasts?). Hornblendic intervals appear to have up to 20%(?) oxide, yet are only slightly to somewhat magnetic (non-mag oxides, MnO?, hematite?).

Basal 5' has less hornblende-garnet and more oxides-sulfides-calcite (marble). Also hairline calcite veins and minor related alteration (siderite?), and a trace of chalcopyrite. Thicker ones occur below 344' (with calcite, pyrite, siderite).
Layering-flattening-bedding (?) is oriented about 35° to the core axis.
Unit is semischistose.
Basal contact is gradational.

352' - 423.1' **Fine to coarse-grained, locally brecciated, locally tuffaceous, sulfide-chert-silicate-oxide chemical sediments with secondary pyrite.**

Color: 5G2/1 to 5Y4/1 to N4 to 5Y7/2.
Chert-sulfide appears brecciated (autobrecciated?) within 352-384', 389-397', and 404-423.1'.
More siliceous (chert? tuff?) portions are 357-376' and 381-383'.
More silicate rich portions include 384-389' (biotitic?, very calcareous, tuffaceous?), 397'-404' (biotitic, amphibolitic, sideritic?, tuffaceous), and 415-419' (sericitic, phyllitic, pyritic, calcareous, slightly graphitic??, possible K alteration?).
Sulfide is massive (stratiform pyrrhotite) within 354-355', 377-380', 392.5-397', and 407-413'.
Portions of unit contain oxides, with largest amount within 408'-414'.
Secondary sulfides (pyrite, some pyrrhotite, trace chalcopyrite) tend to be crosscutting(?) when in veins or veinlets. Most these are in 363.5-364.7', 375-376', 391-397', 404-415', 421-422'.
Scattered calcite-pyrite veins occur throughout.
Unit is locally semischistose. Bedding is oriented 40-80° to the core axis.
Basal contact is sharp.

423.1' -434' **Fine-grained, schistose amphibolitic mafic metavolcanic.**

Color: 5GY4/1 to 5GY6/1.
Unit is metabasalt pillow breccia and flows(?), with irregular quartz-calcite veins and fracture filling. Local portions are calcareous. Epidote alteration occurs locally also.
Unit contains <1% disseminated pyrite.

434' **End of Hole.**

NOTE: THIS DRILL CORE MORE OR LESS IDEALLY EXEMPLIFIES THE SILICATE (HORNBLENDE-GARNET)-SULFIDE-OXIDE ALTERATION TYPE ASSOCIATED WITH STRATIFORM, MASSIVE SULFIDE CHEMICAL SEDIMENT LAYERS. THIS CORE HAS MINIMAL INTERFERENCE FROM LATER INTRUSIVES OR VEINING.

Appendix 278-C. Lithologic Summary Logs

Summary Drill Log for DDH 40918

Footage	Rock Name and Description
0' - 239'	Overburden. No core.
239' - 311.7'	Variable saprolitic (altered?), schistose, lapilli-agglomeratic metatuff. Composition is probably rhyodacitic or dacitic with local potassic alteration.
311.7' - 367'	Siliceous fine-grained tuffaceous metagreywacke, felsic metatuffs, and volcaniclasts.
367.0' - 461.0'	Interlaminated to interbedded, andesitic and dacitic metatuffs with lesser chert, marble, and metagreywacke laminae. unit is moderately calcareous.
461.0' - 607.0'	Interlaminated, locally garnetiferous silicate-oxide chemical metasediment and calcareous, siliceous altered metatuff.
607'	End of Hole.

Summary Drill Log for DDH 40917

Footage	Rock Name and Description
0' - 183'	Overburden. No core.
183' - 191'	Fine to medium-grained, mica quartz schist with minor plagioclase, chlorite, and quartz-plagioclase-mica segregations(?).
191' - 226'	Fine-grained, quartz, k-feldspar, plagioclase, biotite-muscovite schist.
226' - 229'	Altered mafic dike(s); fractured, medium-grained recrystallized felsic metatuff(?); and minor metagreywacke.
229' - 233'	Fine-grained, locally laminated, quartz (silicified) k-feldspar, plagioclase gneiss with minor chlorite, biotite(?), and disseminated sulfide.
233' - 238.5'	Fine to medium-grained, locally laminated sulfide, garnet bearing, chloritic, biotitic, siliceous schist.
238.5' - 241.5'	Fine to medium-grained, garnet bearing, hornblende, chlorite, quartz, plagioclase schist with local sulfide.
241.5' - 311.1'	Interlayered-laminated, fine to medium-grained, quartz, plagioclase, k-feldspar, chlorite, biotite, schists, and gneisses with local sulfides, garnets, cordierite, and hornblende.
311.1' - 415'	Fine to medium-grained, chlorite, biotite, garnet, quartz, plagioclase schist to gneiss; interlaminated-interbedded with hornblende, quartz, garnet, plagioclase schist, with minor sulfide, graphite.
415' - 446'	Fine to medium-grained, k-feldspar, quartz, biotite, plagioclase gneiss and schist, with minor local chlorite (clinochlore?), cordierite, and garnet.
446'	End of Hole.

Summary Drill Log for DDH B31-1

Footage	Rock Name and Description
0' - 178.0'	Overburden. No core.
178.0' - 274.7'	Silicified, felsic, agglomeratic metatuff.
274.7' - 296.0'	Metachert and silicified metatuff.
296.0' - 326.5'	Very fine-grained, sulfide bearing, mafic or altered metavolcanics and sulfide-chlorite-chert-magnetite-siderite chemical metasediments.

326.5' - 483'	Locally altered, sulfide bearing, mafic metavolcanic(?) tuffaceous metagreywacke and minor chert-magnetite chemical metasediment or alteration.
483' - 524'	Locally brecciated, mafic metavolcanic, and lesser sulfide-chert chemical metasediments.
524' - 556.5'	Brecciated (autobrecciated?), laminated? Silicified metatuff and chert-sulfide chemical metasediments, with interstitial quartz, sulfides, minor limonite, and minor mafic volcanics. Silicified metatuffs are believed to be felsic, and volcaniclasts may be relatively coarse.
556.5' - 648.8'	Silicified felsic metatuff with pyrite blebs and local massive sulfide.
648.8' - 671'	Intercalated intermediate, felsic, and mafic metatuffs; and chert-sulfide chemical metasediment.
671' - 723'	Variably silicified felsic and intermediate metatuffs. Volcaniclasts range up to several cm in size. Protolith is felsic except for 709-717', which is more intermediate. A small basaltic dike may occur at 709.5'.
723'	End of Hole.

Summary Drill Log for DDH B31-2

Footage	Rock Name and Description
0' - 268'	Overburden. No core.
268' - 364.8'	Variably silicified agglomeratic metatuff, felsic metatuff, and metagreywacke.
364.8' - 376.7'	Locally brecciated, altered, fine to medium-grained, metagabbro dike(?).
376.7' - 379.7'	Variably silicified, agglomeratic(?) metatuff.
379.7' - 427'	Locally brecciated, chert-sulfide-silicate chemical metasediments and silicified and altered metavolcanics.
427' - 899'	Locally altered, mafic to intermediate metavolcanics intermixed with oxide-sulfide and lesser silicate-carbonate-chert chemical metasediments.
899' - 920.8'	Locally altered, mafic to intermediate metavolcanics.
920.8' - 925.4'	Rhyodacite(?) porphyry.
925.4' - 993'	Altered metavolcanics and chert-magnetite-sulfide-silicate chemical metasediments.
993'	End of Hole.

Summary Drill Log for DDH B31-3

Footage	Rock Name and Description
0' - 103'	Overburden. No core.
103' - 448.5'	Fine to medium-grained, porphyritic, locally altered, locally diabasic gabbro and diabase (metamorphosed).
448.5' - 475.5'	Variably sheared, flattened to brecciated, silicified felsic(?) metatuff and sulfide-chert-carbonate(?) chemical metasediment and/or alteration.
475.5' - 485'	Metadiabase dike.
485' - 514'	Variably sheared, flattened to brecciated, felsic(?) silicified metatuff and sulfide-chert-carbonate(?) chemical metasediments and/or alteration.
514' - 535'	Silicified felsic metatuff with disseminated, local stringers and massive sulfide blebs.
535'	End of Hole.

Summary Drill Log for DDH B31-4

Footage	Rock Name and Description
0' - 99'	Overburden. No core.
99' - 163.5'	Fine-grained, porphyritic, locally diabasic metagabbro with local alteration.
163.5' - 174.9'	Felsic agglomeratic metatuff-breccia and diabase dikes. Diabase is similar to chilled margin of previous unit. Dikes occur at 166.6-167.1' and 168-174.9'.
174.9' - 197.6'	Poorly sorted felsic agglomeratic metatuff-breccia, with a siliceous chloritic matrix. Largest, more angular volcaniclasts are porphyritic rhyolite or quartz latite. More mafic and intermediate fragments are common, especially in the upper part of unit (accessory or accidental fragments?) which are typically smaller in size. Some chemical sediment clasts (including sulfide) also occur.
197.6' - 208.2'	Altered, poorly sorted, felsic agglomeratic metatuff and massive sulfide.
208.2' - 289.8'	Poorly sorted, felsic agglomeratic metatuff-breccia, with a siliceous chloritic matrix.
289.8' - 305.6'	Variably sheared, felsic agglomeratic metatuff and siliceous metatuff.
305.6' - 503'	Locally agglomeratic(?), altered, sheared, siliceous felsic metatuff and crystal metatuff.
503'	End of Hole.

Summary Drill Log for DDH B31-5

Footage	Rock Name and Description
0' - 81'	Overburden. No core.
81' - 167'	Fine-grained, porphyritic diabasic gabbro grading into porphyritic diabase (metamorphosed?).
167' - 268'	Altered mafic-intermediate volcanics, or dike, and/or silicate-oxide-sulfide chemical metasediments?
268' - 432'	Porphyritic fine to medium-grained diabasic gabbro and diabase (metamorphosed?).
432' - 675'	Fractured, brecciated, altered mafic to intermediate metavolcanics, and clastic (?) and chemical metasediments.
675'	End of Hole

Summary Drill Log for DDH 40926

Footage	Rock Name and Description
0' - 105'	Overburden. No core.
105' - 159'	Locally very schistose, locally altered, interlaminated metatuffs, carbonate-sulfide-silicate chemical metasediment(?), and metagreywackes(?).
159' - 181'	Brecciated to schistose, sulfide-silicate-oxide-tourmaline(?) chemical metasediments and/or altered metatuffs.
181' - 222'	Mafic schistose to felsic lapilli (agglomeratic?) metatuff, with lesser minor chert-sulfide-carbonate-silicate-graphite chemical metasediments and/or alteration. Mafic portions could be "pyroxenite"(?).
222' - 247'	Variably schistose and altered, sulfide-carbonate-graphite?-chert?-tourmaline? chemical metasediments and metatuffs. Locally bleached, micaceous (biotitic, sericitic?, talcy?).
247' - 352'	Carbonate-tremolite?-semischist. Partially altered, metamorphosed ultramafic?, and part altered metatuff(?). Locally talcy, magnesitic, sericitic?. Siliceous fragments sit in a chloritic matrix. Biotitic toward base.
352' - 372.4'	Schistose crystalline graphite, graphitic schistose metasediment, minor pyrite laminae and metatuff.

372.4' - 493'	Very fine-grained, laminated biotite-quartz-chlorite schist-semischist, with minor veining, alteration, and local sulfide-graphite chemical metasediment.
493'	End of Hole.

Summary Drill Log for DDH B35-1

Footage	Rock Name and Description
0' - 143'	Overburden. No core.
143' - 275.4'	Schistose to brecciated, interlaminated to interbedded, schistose intermediate and mafic metatuffs (hornblende, actinolite, chlorite, quartz, plagioclase and biotite? schist).
275.4' - 275.8'	Recrystallized chert, or quartz vein.
275.8' - 289.3'	Graphite and graphite-sericite-chlorite-hornblende-garnet? schist (chemical metasediment/alteration) with minor sulfide stringers.
289.3' - 295'	Somewhat leached, sericite chlorite schist with sulfide laminae and graphite.
295' - 428'	Fine to medium-grained, interbedded-interlaminated, biotite-muscovite-quartz-feldspar schist.
428'	End of Hole.

Summary Drill Log for DDH MED-1

Footage	Rock Name and Description
0' - 163'	Overburden. No core.
163' - 209'	Locally altered, siliceous, locally agglomeratic, recrystallized felsic lapilli metatuff.
209' - 364'	Variably schistose, magnetite-sulfide-chert-silicate chemical metasediments/alteration, with local brecciation, volcaniclastics, and veins.
364' - 383'	Recrystallized siliceous-felsic lapilli metatuff, with minor veins and alteration.
383' - 456'	Intermixed sulfide-magnetite-chert chemical metasediments/alteration, mafic volcanics, and lesser intermediate-felsic metatuffs; with local veining and alteration.
456' - 459.9'	Felsic crystal metatuffs.
459.9' - 514'	Locally veined and altered, siliceous, tuffaceous, fine-grained biotite schist.
514'	End of Hole.

Summary Drill Log for DDH B58-1

Footage	Rock Name and Description
0' - 155'	Overburden. No core.
155' - 294.4'	Fine-grained, tuffaceous, siliceous, biotitic, sericitic-schist (metagreywacke); recrystallized felsic metatuffs; chert-sulfide chemical metasediments or alteration; all with local veining and alteration.
294.4' - 349.1'	Schistose, metabasalt pillow breccia, with local massive sulfide and chert.

349.1' - 444.7'	Intermixed schistose felsic to mafic, crystal and lapilli metatuffs and metagreywacke; with local sulfides, alteration and basalt dikes (metamorphosed?).
444.7'	End of Hole.

Summary Drill Log for DDH MMD-1

Footage	Rock Name and Description
0' - 109'	Overburden. No core.
109' - 175'	Locally altered, veined, fractured (sheared) metadiabase and metabasalt.
175' - 196.5'	Interlaminated-bedded, silicified and altered, felsic to mafic metatuffs, metabasalt, and chert-sulfide chemical metasediment.
196.5' - 316.3'	Metabasalt and metadiabase, with minor veining and alteration.
316.3' - 322.6'	Interbedded-interlaminated, aphanitic to coarse-grained, siliceous metatuffs and metasediments.
322.6' - 340.6'	Medium-grained metabasalt. Unit probably fine to very coarse-grained (hyaloclastic?) volcaniclastic, although rock could be pillowed or even intrusive.
340.6' - 354.8'	Interlaminated-interbedded, aphanitic to coarse-grained metatuffs, metagreywackes, and chemical metasediment.
354.8' - 390.9'	Medium to coarse-grained metabasalt with minor sulfide-chert chemical metasediments and veining.
390.9' - 430.5'	Medium-grained metabasalt, with lesser intervals of finer-grained tuffaceous chemical metasediments and metatuffs.
430.5' - 481.5'	Variably altered, deformed, and mineralized, aphanitic to fine-grained chemical metasediments, siliceous, metatuffs, and lesser chloritic-amphibolitic mafic metavolcanics(?).
481.5' - 559'	Aphanitic to coarse-grained amphibolitic mafic volcanics and metasediment with minor chemical metasediment(?).
559'	End of Hole.

Summary Drill Log for DDH B5-1

Footage	Rock Name and Description
0' - 95'	Overburden. No core.
95' - 342.3'	Altered-veined, medium-grained amphibolitic mafic metavolcanic and/or intrusives with local shears. Partially gabbroic protolith?.
342.3' - 345.6'	Aphanitic to fine-grained chert and silicified cherty metavolcanics.
345.6' - 416.3'	Aphanitic to medium-grained locally calcareous, mafic (and ultramafic) metavolcanics, locally talcy?.
416.3' - 439.6'	Interbedded-laminated, biotitic to sericitic siliceous schist. Protolith probably siliceous metagreywacke or metatuff.
439.6' - 455.6'	Intermixed cherty schist, calcareous metatuff, amphibolite mafic metavolcanics(?) brecciated chert, and sulfide chemical metasediment.
455.6' - 471.9'	Aphanitic to fine-grained, amphibolitic silicate-oxide-sulfide chemical metasediments, with local carbonate veining and alteration.
471.9' - 488'	Very fine to coarse-grained, biotitic and amphibolitic schistose metasediment and metatuff, with local alteration.
488' - 666.4'	Fine to coarse-grained, locally calcareous, variably schistose amphibolitic mafic metavolcanics and aphanitic metabasalt dikes.
666.4' - 684.6'	Fine to medium-grained, intermediate-felsic crystal metatuff.

684.6' - 770'	Fine to medium-grained, amphibolitic, locally calcareous mafic metavolcanics.
770'	End of Hole.

Summary Drill Log for DDH BD-N-1

Footage	Rock Name and Description
0' - 71'	Overburden. No core.
71' - 244.3'	Very fine to fine-grained, amphibolitic mafic to intermediate(?) metavolcanics.
244.3' - 274'	Very fine to fine-grained (mineralogic), biotitic to siliceous, somewhat schistose felsic and intermediate metatuffs and metagreywackes?.
274' - 384.1'	Very fine to fine-grained, amphibolitic and biotitic mafic to intermediate(?) metavolcanics with scattered carbonate pyrrhotite veins and alteration.
384.1' - 410.3'	Fine to medium-grained, biotitic, siliceous felsic to intermediate(?), schistose crystal metatuffs.
410.3' - 460.0'	Variably magnetic and schistose, fine to medium-grained, intermediate-mafic volcanics with oxide-sulfide chemical metasediment/alteration(?). Rock is amphibolitic-siliceous(?).
460.0' - 716.7'	Cherty sulfide iron formation (massive sulfide) with a lesser oxide-silicate-chert-graphite chemical metasediment, and felsic to mafic(?) tuff components.
716.7' - 723'	Fine to medium-grained, altered siliceous, felsic porphyry.
723' - 731.9'	Cherty sulfide iron formation (massive sulfide) with a lesser silicate-chert-graphite(?) chemical metasediment component.
731.9' - 754'	Fine to medium-grained, altered, siliceous, felsic porphyry.
754' - 812'	Cherty sulfide iron formation (massive sulfide) with a lesser chert-silicate(?)-graphitic chemical metasediment component.
812'	End of Hole.

Summary Drill Log for DDH MDD-1

Footage	Rock Name and Description
0' - 216'	Overburden. No core.
216' - 223.6'(?)	Overburden; glacial boulders. Rock type ranges from fine to medium-grained quartz-hornblende-biotite?-k-feldspar gneiss to variably saprolitic mafic metavolcanics and metagreywackes with quartz-chlorite veins, local shearing, pyrite and quartz dioritic(?) veins.
223.6' - 234'	Granite pegmatite and aplite, with tourmaline-quartz-calcite veins.
234' - 280'	Fine to medium-grained, locally plagioclase-phyric, biotitic, amphibolitic, semischistose mafic-intermediate metavolcanics, metagreywackes(?) and chemical metasediments (sulfides and chert?); with granodiorite, local "pyroxenite"; with granite and/or tourmaline veins.
280' - 285'	Fine to medium-grained, semischistose sulfide-chert chemical metasediment and mafic metavolcanics and/or silicate-oxide chemical metasediments and granodiorite hybrids.
285' - 290.5'	Fine-grained, tuffaceous, biotitic(?) semischistose siliceous chert-sulfide-oxide chemical metasediment.
290.5' - 298.8'	Fine to medium-grained amphibolitic, mafic metatuff-metagreywacke and silicate chemical metasediments, with local hybridized granodiorite.
298.8' - 359.5'	Fine to medium-grained, semischistose, locally altered siliceous biotitic metatuffs, biotitic chert-sulfide chemical metasediments, "pyroxenite" bodies, variably hybridized granodiorite bodies, and minor granite veins.
359.5' - 411.6'	Very fine-grained, variably biotitic amphibole schist and semischist, amphibolitic "pyroxenite" and "granodiorite".

411.6' - 420.8'	Very fine-grained, silicic felsic metatuff with chert-sulfide-tourmaline(?) chemical metasediment or alteration; local granodiorite and granite and tourmaline veins-dikes.
420.8' - 456.6'	Fine to medium-grained, schistose to semischistose intermediate-mafic metavolcanics, metagreywackes silicate-oxide chemical metasediments; local "granodiorite" and "pyroxenite".
456.6' - 490'	Fine to coarse-grained, amphibolitic, locally micaceous "pyroxenite" (lamprophyre?) with minor shearing, granodiorite and calcareous "granite" veins.
490' - 567.9'	Fine-grained, amphibolitic semischistose to hornfelsed mafic and intermediate metavolcanics; medium to coarse-grained "granodiorite" with mafic metavolcanic xenoliths, and local chemical metasediments.
567.9' - 628.1'	Poorly sorted, fine to coarse-grained, amphibolitic-biotitic mafic conglomeratic metagreywacke with local sulfide-chert chemical metasediment contributions, or alteration; and local fine to coarse-grained granodiorite intrusives and/or partial melting.
628.1' - 641'	Fine-grained amphibolitic mafic volcanics (flows?), minor oxide?, sulfide, silicate chemical metasediment, and "granodioritic" veins and/or partial melting.
641'	End of Hole.

Summary Drill Log for DDH B-Q-1

Footage	Rock Name and Description
0' - 88'	Overburden. No core.
88' - 106.1'	Very fine-grained, biotitic to amphibolitic metagreywackes, metatuff, sulfide-oxide-chert-silicate(?) chemical metasediments, with hybrid "granite" veins, and minor shearing.
106.1' - 186.2'	Fine-grained, predominantly amphibolitic metabasalt and metasediment.
186.2' - 254.8'	Intermixed fine-grained, amphibolitic metabasalt and medium to coarse-grained mafic contaminated tonalite.
254.8' - 357.5'	Fine-grained metabasalt, with local medium-grained mafic contaminated tonalite, quartz or tonalite veins.
357.5' - 372.1'	Tuffaceous-brecciated sulfide with lesser chert-silicate(?) chemical metasediments, with minor "granitic" veins.
372.1' - 454'	Fine-grained, biotitic hornfelsed metagreywacke and metatuff, with local granite and tonalite veins; and sulfide-silicate chemical metasediments. Unit is locally amphibolitic.
454'	End of Hole.

Summary Drill Log for DDH MQD-2

Footage	Rock Name and Description
0' - 68'	Overburden. No core.
68' - 68.3'	Overburden; glacial boulder.
68.3' - 99'	Fine to medium-grained, amphibolitic basaltic metavolcanics and intrusives, with local fine to coarse-grained mafic contaminated tonalite, and scattered tonalitic-quartz veins.
99' - 129.7'	Fine to coarse-grained, tuffaceous chert-sulfide chemical metasediments, altered metatuffs, and contaminated tonalite and granite.
129.7' - 142'	Fine to medium-grained amphibolitic metabasalt volcanics and intrusives (?), with silicified coarse-grained granodiorite veins-dikes with tourmaline.
142' - 176.5'	Locally disrupted, interlaminated fine-grained sulfide-chert chemical metasediment, altered metatuffs, and local granodiorite dikes.

176.5' - 288'	Fine to coarse-grained amphibolitic oxide-bearing metagabbro and metabasalt (?) with scattered fine to coarse-grained siliceous granodiorite-tonalite veins.
288' - 299'	Fine-grained, variably tuffaceous, sulfide-chert and lesser oxide-silicate chemical metasediments.
299' - 422'	Fine to coarse-grained, amphibolitic metatuffs with local sulfide-silicate-oxide-chert chemical metasediments.
422'	End of Hole.

Summary Drill Log for DDH MQD-1

Footage	Rock Name and Description
0' - 121'	Overburden. No core.
121' - 331'	Fine to coarse-grained, amphibolitic-micaceous intermediate metatuff with minor sulfide-silicate chemical metasediments/alteration.
331' - 376'	Fine to coarse-grained, amphibolitic intermediate metatuffs with sulfide-silicate chemical metasediments/alteration and tonalitic-granodioritic veins and dikes.
376'	End of Hole.

Summary Drill Log for DDH BD-P-2

Footage	Rock Name and Description
0' - 123'	Overburden. No core.
123' - 628'	Fine to medium-grained, variably schistose, amphibolitic metabasalt and amphibolite (ultramafic??) with minor carbonate and felsite veins. Rock is more ultramafic(?) below 450' with talc and serpentine.
628' - 639'	Fine to medium-grained biotitic, tuffaceous, chert-sulfide chemical metasediments.
639'	End of Hole

Summary Drill Log for DDH B54-1

Footage	Rock Name and Description
0' - 150'	Overburden. No core.
150' - 325'	Very fine to medium-grained, variably schistose to brecciated, intermixed amphibolitic tuffaceous silicate-oxide-sulfide-carbonate chemical metasediments/alteration, and intermediate and mafic metavolcanics and meta-intrusive(s).
325'	End of Hole.

Summary Drill Log for DDH YWQ-1

Footage	Rock Name and Description
0' - 399'	Overburden. No core.
399' - 434.3'	Very fine to fine-grained, sericitic and locally graphitic laminated tuffaceous, phyllitic-schistose argillite.
434.3' - 665.5'	Very fine to fine-grained, variably, but generally graphitic, locally tuffaceous phyllitic argillite.
665.5' - 748.6'	Fine to medium-grained, sericitic, siliceous, schistose, variably calcareous, metatuff, with minor phyllitic argillite.
748.6' - 763.5'	Fine-grained, variably graphitic, phyllitic argillite with minor felsic metatuff.
763.5' - 844'	Generally fine-grained, siliceous, variably tuffaceous and calcareous metagreywacke and distal metatuffs.
844'	End of Hole.

Summary Drill Log for DDH YWZ-1

Footage	Rock Name and Description
0' - 282'	Overburden. No core.
282' - 454.6'	Very fine to medium-grained, variably schistose to protomylonitic, metamorphosed ultramafic (and mafic?) intrusive(s) and flows.
454.6' - 588'	Fine to medium-grained, variably calcareous, amphibolitic mafic metavolcanic semischist and lesser fine to coarse-grained intermediate metatuff and minor sulfide-carbonate chemical metasediments. Amphiboles are more actinolite and/or hornblende, not tremolite.
588' - 596'	Siliceous, fine to coarse(?)-grained, felsic (to intermediate?) metatuff with a sulfide-chert-graphite-chemical metasediment component.
596' - 814'	Fine to medium-grained, variably calcareous, altered mafic to intermediate metavolcanic semischist, with minor felsic-intermediate metatuff, and sulfide-silicate-oxide-carbonate(?)-epidote alteration/chemical metasediment.
814'	End of Hole.

Summary Drill Log for DDH YWZ-2

Footage	Rock Name and Description
0' - 294'	Overburden. No core.
294' - 352.5'(?)	Medium-grained, talcy, chloritic, locally calcareous, altered amphibolite(?) schist with quartz veins. Probable mafic or ultramafic protolith.
352.5' - 403.8'	Very fine to medium-grained talc schist, with quartz carbonate veins. Probable ultramafic protolith (komatiite?).
403.8' - 461.7'	Fine to coarse-grained, calcareous, variable schistose, altered amphibolite (metabasalt?).
461.7' - 497'	Fine-grained, talc-serpentine-carbonate schist. Probable ultramafic protolith (komatiite?).
497' - 513'(?)	Fine to very coarse(?)-grained, variably calcareous, phlogopitic-biotitic, schistose, altered(?) amphibolite. Fragmental texture(?).
513'(?) - 527'(?)	Fine-grained cherty chemical sediment with lesser sulfides and tuffaceous schists laminae.
527'(?) - 636.3'	Fine to medium-grained, amphibolitic, variably schistose metabasalt.
636.3' - 643.8'	Fine-grained, micaceous, amphibolitic, calcareous, felsic(?) intermediate metatuff schist with increasing chert-sulfide chemical metasediment.

643.8' - 655'	Chert-sulfide chemical metasediments grading into schistose graphitic sulfide chemical metasediments.
655' - 790'	Fine to medium-grained, calcareous, amphibolitic, variable schistose metabasalt.
790'	End of Hole.

Summary Drill Log for DDH YWM-1

Footage	Rock Name and Description
0' - 253'	Overburden. No core.
253' - 481.5'	Fine to very coarse-grained (protolith), schistose, siliceous, biotitic to sericitic, garnetiferous, conglomeratic(?) metatuff, and pseudobrecciated(?) metagreywackes locally.
481.5' - 527'	Fine to medium-grained, garnet-hornblende alteration (?), minor sulfide chemical metasediments, and siliceous biotite schists.
527' - 537.3'	Fine to coarse-grained, siliceous metatuffs with sulfide-oxide-hornblende-garnet alteration and/or chemical metasediments.
537.3' - 551'	Fine-grained, locally brecciated, altered tuffaceous oxide-chert-sulfide-silicate schistose chemical metasediments.
551' - 599'	Fine to medium-grained, amphibolitic, variably calcareous, schistose metabasalt(?) and minor sulfide-silicate-tourmaline-carbonate(?) chemical metasediment.
599'	End of Hole.

Summary Drill Log for DDH YWL-1

Footage	Rock Name and Description
0' - 282'	Overburden. No core.
282' - 483'	Fine-grained, schistose, locally brecciated, intermediate? to ultramafic? metavolcanics.
483' - 580.5'	Variably altered, semischistose to schistose fine-grained intermediate to felsic metatuffs and metagreywackes(?).
580.5' - 598.5'	Variably deformed, sulfide bearing, very fine-grained graphitic schist-phyllite.
598.5' - 616.8'	Fine-grained, laminated chert, siliceous felsic metatuff(?), and lesser sulfide-graphite chemical metasediment.
616.8' - 684'	Fine to coarse-grained altered(?) gabbro. Proterozoic dike?
684'	End of Hole.

Summary Drill Log for DDH B24-1

Footage	Rock Name and Description
0' - 136'	Overburden. No core.
136' - 302.4'	Very fine to fine-grained, semischistose to hornfelsic, amphibolitic to biotitic metabasalt, metagreywacke(?), and sulfide-oxide-silicate chemical metasediments or alteration.
302.4' - 406'	Variably granitized, fine to medium-grained dacitic to rhyodacitic crystal metatuff(?), or tuffaceous metagreywacke.
406' - 588.3'	Fine to medium-grained (but coarse fragments), variably brecciated tuffaceous(?) chert, massive sulfide, and minor oxide-silicate chemical metasediments and metatuffs.

588.3' - 614'	Fine-grained pink granite (?) or siliceous metarhyolite(?).
614'	End of Hole.

Summary Drill Log for DDH B24-2

Footage	Rock Name and Description
0' - 175'	Overburden. No core.
175' - 440'	Fine-grained, schistose to hornfelsic, amphibolitic, biotitic, garnet bearing mafic to felsic(?) metavolcanics, metagreywackes and local oxide-silicate-sulfide chemical metasediments.
440' - 455.3'	Fine to medium-grained (coarser fragments), variably brecciated chert-sulfide chemical metasediments.
455.3' - 550.3'	Fine to very coarse-grained, biotitic, locally amphibolitic, conglomeratic (agglomeratic?)-tuffaceous metagreywacke with lesser metavolcanics and chert-sulfide-silicate-oxide chemical metasediment.
550.3' - 699.5'	Fine to very coarse-grained, variably brecciated sulfide and tuffaceous chert chemical metasediments or silicified metatuffs, with lesser silicate-magnetite chemical metasediments and volcanics.
699.5' - 755'	Fine-grained schistose to hornfelsic amphibolitic, biotitic, garnetiferous mafic to intermediate metavolcanics, metagreywacke and sulfide-silicate chemical metasediment.
755'	End of Hole.

Summary Drill Log for DDH B24-3

Footage	Rock Name and Description
0' - 142'	Overburden. No core.
142' - 428'	Fine-grained, amphibolitic pillowed metabasalt with local hornblende-sulfide-oxide chemical metasediments and/or alteration.
428' - 494'	Fine to coarse-grained, locally brecciated sulfide-silicate-oxide(?) chemical metasediments or alteration; and metatuffs(?).
494' - 583.2'	Fine-grained, semischistose to schistose, amphibolitic mafic to intermediate metavolcanics with local silicate-sulfide-oxide(?) chemical metasediments or alteration.
583.2' - 613'	Fine to medium-grained metagabbro. Unit contains minor brecciation and chilling.
613' - 677.3'	Fine-grained, semischistose to schistose, mafic to intermediate metavolcanics; oxide-silicate-sulfide chemical metasediments with sulfide-silicate-oxide(?)-garnet alteration; and minor felsic metatuff(?) or porphyritic intrusive, and metagreywacke(?).
677.3' - 846.3'	Fine to coarse-grained, somewhat altered metagabbro (metagabbro?).
846.3' - 855'	Fine-grained, semischistose to hornfelsic, amphibolitic mafic metavolcanic and dacitic metatuff with minor oxide-silicate-sulfide chemical metasediment.
855'	End of Hole.

Summary Drill Log for DDH B24-4

Footage	Rock Name and Description
0' - 105'	Overburden. No core.
105' - 303.9'	Fine-grained, amphibolitic, biotitic mafic to intermediate metavolcanics with garnet-magnetite-sulfide-silicate chemical metasediments or alteration.
303.9' - 402.5'	Fine-grained semischistose to schistose siliceous, amphibolitic, garnetiferous silicate-oxide-sulfide alteration and/or chemical metasediments, and siliceous biotitic semischist, and minor granite dike.
402.5' - 504'	Fine to medium-grained, semischistose to hornfelsic, amphibolitic, biotitic, garnetiferous altered metavolcanics and metasediments with tectonized granite dikes.
504' - 682'	Fine-grained, semischistose, variably altered siliceous biotitic, garnetiferous felsic-intermediate(?) metavolcanic or metasediments, and minor chert-sulfide chemical metasediments.
682' - 863'	Fine-grained, semischistose to schistose, amphibolitic pillowed(?) metabasalt, pillow breccia and oxide-silicate-sulfide chemical metasediment or alteration (similarly, but with garnet).
863' - 944.5'	Fine-grained, semischistose to schistose, amphibolitic and biotitic mafic to felsic (?) volcanics and oxide-silicate-chert-sulfide chemical metasediments.
944.5' - 947'	Fine to medium-grained, altered, gneissic to sheared porphyritic metagranodiorite dike.
947' - 1543'	Fine-grained amphibolitic metabasalt, intermediate metatuff, and garnetiferous silicate-oxide-sulfide-chert(?) chemical metasediment and alteration.
1543' - 1680'	Fine to medium-grained variably altered metagabbro.
1680'	End of Hole.

Summary Drill Log for DDH MSD-1

Footage	Rock Name and Description
0' - 233'	Overburden. No core.
233' - 528.7'	Fine-grained, amphibolitic, schistose to semischistose, mafic to intermediate metavolcanics with veining and minor chemical metasediment.
528.7' - 543.4'	Fine-grained tuffaceous, biotitic-amphibolitic, locally brecciated, carbonate-chert-sulfide chemical metasediment.
543.4' - 618'	Fine-grained amphibolitic, micaceous variably calcareous schistose intermediate (?) to mafic metavolcanics with veining and minor chemical metasediments(?).
618'	End of Hole.

Summary Drill Log for DDH B21-2

Footage	Rock Name and Description
0' - 126'	Overburden. No core.
126' - 150.3'	Medium-grained, amphibolitic to locally chloritic or biotitic, semischistose mafic to intermediate metavolcanics, and metagabbro.
150.3' - 383'	Variably altered, semischistose to gneissic, fine to medium-grained, amphibolitic to biotitic, intermediate to felsic tuffaceous metasediments; and sulfide-magnetite-chert-tourmaline chemical metasediments and/or alteration.
383' - 610.4'	Fine to medium-grained, locally fragmental to migmatized, schistose biotitic-amphibolite mafic-intermediate metavolcanics; metagabbro; and lesser various intrusives.

610.4' - 724'	Fine to coarse-grained, chemical metasediments; and variably altered biotitic, amphibolitic, schistose metavolcanics, with minor granite and tonalite dikes(?).
724'	End of Hole.

Summary Drill Log for DDH B21-3

Footage	Rock Name and Description
0' - 128'	Overburden. No core.
128' - 416'	Fine to coarse-grained, biotitic tonalite and fragmented (agglomeratic?) to migmatized metavolcanics; with chert-sulfide-carbonate-silicate alteration and/or chemical metasediments.
416' - 440.5'	Fine-grained, intermediate(?)-felsic metavolcanics (dacite?), with local fragments and interstitial tonalite veins; and local garnetiferous chert-sulfide chemical metasediments or alteration.
440.5' - 523'	Fine to coarse-grained, agglomeratic? intermediate to felsic metatuff-pillow breccia? with tonalitic matrix; and garnetiferous sulfide-chert-oxide alteration or chemical metasediment.
523'	End of Hole.

Summary Drill Log for DDH B21-1

Footage	Rock Name and Description
0' - 112'	Overburden. No core.
112' - 180.5'	Fine-grained, biotitic, amphibolitic intermediate-mafic metavolcanics with local magnetite chemical metasediment contributions, and fine to medium-grained amphibolitic-biotitic tonalite veins or segregations.
180.5' - 242.1'	Sulfide-chert-magnetite-silicate(?) chemical metasediments and/or altered felsic-intermediate metatuffs.
242.1' - 279.0'	Fine to medium-grained, biotitic to amphibolitic, mafic to intermediate metavolcanics.
279.0' - 453.4'	Interbedded, fine-grained, intermediate-mafic metavolcanics and metavolcanic breccia(?) with fine to medium-grained interstitial tonalite; and tuffaceous oxide-sulfide-chert chemical metasediment, and similar alteration with amphiboles and garnet.
453.4'	End of Hole.

Summary Drill Log for DDH 40920

Footage	Rock Name and Description
0' - 256'	Overburden. No core.
256' - 424'	Variably sheared, saprolitic to variably altered, fine-grained amphibolitic metabasalt.
424' - 524'	Fine-grained, amphibolitic metabasalt and metadiabase(?) with calcite veinlets and disseminated sulfides.
524'	End of Hole.

Summary Drill Log for DDH 40919

Footage	Rock Name and Description
0' - 130'	Overburden. No core.
130' - 138.5'	Fine to medium-grained, altered? gabbro (metamorphosed?).
138.5' - 279.3'	Intermixed fine to medium-grained, oxide-sulfide chemical metasediments; and medium to coarse-grained, garnet-hornblende-biotite-sulfide-quartz-tonalite-granodiorite alteration or veins.
279.3' - 391.8'	Interlaminated-bedded to irregular, fine to medium-grained, oxide-silicate-sulfide chemical metasediments; and recrystallized metachert or siliceous metasediment-metatuff(?).
391.8' - 424'	Fine to coarse-grained conglomeratic metagreywacke, lithic crystal metatuff(?) and oxide-silicate-(lesser sulfide) chemical metasediment and/or alteration.
424' - 477.2'	Fine to medium-grained, sulfide-oxide-silicate chemical metasediment/alteration with local garnet and minor siliceous metagreywacke-metatuff and tonalite.
477.2' - 546.3'	Fine to very coarse-grained, poorly sorted, amphibolitic-biotitic conglomeratic metagreywacke and/or crystal lithic agglomeratic(?) metatuff with disrupted fine-grained amphibolitic laminae-fragments.
546.3' - 594'	Fine to medium-grained altered gabbro (metamorphosed?).
594'	End of Hole.

Summary Drill Log for DDH B-B-2

Footage	Rock Name and Description
0' - 177'	Overburden. No core.
177' - 186.6'	Fine to medium-grained, variably schistose, tectonized, amphibolitic metagabbro with minor biotite, sulfide, and calcite alteration (?).
186.6' - 330'	Fine-grained, variably schistose, amphibolitic mafic to intermediate metavolcanics with minor chert-oxide-sulfide chemical metasediments. Tuff fragments to several cm.
330'	End of Hole.

Summary Drill Log for DDH BD-2

Footage	Rock Name and Description

NOTE: THIS DRILL CORE EXEMPLIFIES THE OXIDE-HORNBLENDE (SILICATE)-GARNET-SULFIDE ALTERATION / CHEMICAL METASEDIMENT ASSEMBLAGE, WITH MINIMAL INTERFERENCE FROM VEINING AND LATER INTRUSIVES.

Footage	Rock Name and Description
0' - 185'	Overburden. No core.
185' - 200'	Overburden. Fine-grained, saprolitic, clayey metatuff with quartz veins, and glacial pebbles.
200' - 315.3'	Fine to medium-grained, biotitic, siliceous, intermediate-felsic metatuffs and metagreywacke.
315.3' - 352'	Interlaminated hornblende (silicate)-oxide-garnet-sulfide chemical metasediment and/or alteration; and siliceous, biotitic metatuff or metagreywacke.
352' - 423.1'	Fine to coarse-grained, locally brecciated, locally tuffaceous, sulfide-chert-silicate-oxide chemical metasediments, with secondary pyrite.
423.1' - 434'	Fine-grained, schistose amphibolitic, mafic metavolcanic.
434'	End of Hole.

Summary Drill Log for DDH LW-346-2

Footage	Rock Name and Description
0' - 161'	Overburden. No core.
161' - 172'	Fine-grained, schistose amphibolitic mafic (?) intermediate metavolcanics and silicate-oxide-sulfide chemical metasediment/alteration(?).
172' - 318.5'	Fine-grained, variably sheared, schistose biotitic, sericitic(?)-chloritic(?) amphibolitic, intermediate metatuffs and mafic pillow breccia.
318.5' - 380.7'	Generally fine-grained, amphibolitic-micaceous schistose, mafic to intermediate metavolcanics, with minor silicate-sulfide chemical metasediments/alteration.
380.7' - 415.3'	Fine-grained, generally laminated, tuffaceous chert-sulfide-oxide-silicate chemical metasediment and local massive sulfide.
415.3' - 456'	Fine-grained(?), variably sheared, locally siliceous, micaceous, schistose intermediate(?) to felsic metavolcanics.
456' - 509'	Fine-grained, schistose, variably sheared, chloritic-amphibolitic mafic metavolcanics.
509' - 555.5'	Fine-grained, schistose, variably sheared, biotitic-sericitic, chloritic-amphibolitic felsic? to mafic metavolcanics, and local sulfide-chert chemical metasediments and/or alteration.
555.5' - 608.4'	Fine to coarse-grained, biotitic-sericitic, siliceous, feldspathic metatuffs (locally agglomeratic?), chert-sulfide-carbonate and minor oxide chemical metasediment, and local hornblende-garnet-sulfide-oxide(?) alteration.
608.4' - 641'	Fine to coarse-grained, variably schistose, siliceous amphibolitic intermediate to mafic metavolcanics and/or metagreywacke.
641'	End of Hole.

Summary Drill Log for DDH LW-346-1

Footage	Rock Name and Description
0' - 202'	Overburden. No core.
202' - 208'	Fine-grained, amphibolitic-biotitic-siliceous(?) intermediate?-mafic metavolcanics.
208' - 296'	Fine to medium-grained, interbedded-interlaminated, siliceous-biotitic felsic metatuff; hornblende-garnet-CALCITE-oxide-sulfide(?) chemical metasediment or alteration; and sulfide-chert-siderite chemical metasediment.
296' - 341'	Fine to medium-grained, schistose biotitic-amphibolitic, interbedded mafic to intermediate to felsic metavolcanics.
341' - 357'	Interlaminated, tuffaceous sulfide-oxide-silicate-chert chemical metasediments and local alteration.
357' - 494.6'	Generally fine-grained, variably schistose amphibolitic-chloritic mafic metavolcanics and minor biotitic intermediate felsic metatuffs.
494.6' - 519.2'	Fine to coarse?-grained, biotitic siliceous-sericitic(?) variably schistose intermediate-felsic metatuff and sulfide-chert chemical metasediment.
519.2' - 534.5'	Fine to coarse-grained, fairly schistose amphibolitic chloritic mafic flows and pillow breccia.
534.5' - 546'	Fine-grained, laminated schistose siliceous biotitic, locally amphibolitic, felsic-intermediate metatuff; and chert-sulfide chemical metasediment or alteration.
546' - 651'	Fine to coarse-grained, variably siliceous, biotitic to amphibolitic, chloritic metatuffs and metagreywacke, with hornblende-garnet-oxide-sulfide alteration and/or chemical metasediment.
651'	End of Hole.

Summary Drill Log for DDH BD-3

Footage	Rock Name and Description
0' - 256'	Overburden. No core.
256' - 380'	Fine to medium-grained, schistose, locally sheared, locally clayey, sericitic to biotitic felsic metatuff, and graphitic-sulfide-chert(?) calcareous chemical metasediment.
380' - 418'?	Generally fine-grained, schistose, sericitic, variably graphitic metatuff and metasediment.
418'? - 424'	Fine to medium-grained, schistose, sericitic-biotitic siliceous locally calcareous, metagreywacke.
424'	End of Hole.

Summary Drill Log for DDH BD-1

Footage	Rock Name and Description
0' - 159'	Overburden. No core.
159' - 182'	Fine to coarse-grained, schistose, siliceous, biotitic, calcareous metagreywacke or intermediate(?) metatuff, with minor sulfide-oxide chemical metasediments.
182' - 317.7'	Very fine-grained, tuffaceous, interlaminated, silicate-oxide-sulfide-chert-carbonate chemical metasediments.
317.7' - 410'	Fine to coarse-grained, variably schistose and variably altered, calcareous siliceous biotitic metagreywacke-metatuff; mafic metavolcanics, and minor sulfide-silicate chemical metasediment-alteration.
410'	End of Hole.

Summary Drill Log for DDH BD-II-1

Footage	Rock Name and Description
0' - 174'	Overburden. No core.
174' - 228'	Overburden. Fine to very coarse-grained, calcareous, locally sandy, clayey boulder till and saprolite.
228' - 243'	Fine to coarse-grained, weathered, sheared, variably schistose biotitic (?) feldspathic intermediate (?) crystal metatuff or metagreywacke?, and irregular medium-grained monzonitic-granitic (?) dikes.
243' - 406.2'	Generally fine-grained, locally biotitic, variably sheared-schistose, amphibolitic, silicate-oxide-sulfide altered metavolcanics, and silicate-oxide-sulfide chemical metasediments.
406.2' - 472.7'	Fine to medium-grained, amphibolitic, variably deformed metagabbro.
472.7' - 478.3'	Very fine-grained, plagioclase and hornblende (?) porphyritic, metadacite or meta-andesite (?).
478.3' - 496'	Fine to medium-grained, amphibolitic metagabbro, with slightly calcareous quartz and tonalitic veins locally.
496' - 549.3'	Fine-grained, variably schistose, locally hornblende-oxide-garnet(?)-sulfide, altered metavolcanics (?) and hornblende-oxide-tourmaline-garnet (?) chemical metasediments (?).
549.3' - 571.2'	Mixed fine to medium-grained, variably deformed and altered amphibolitic metagabbro-metadiabase and/or metavolcanics(?).
571.2' - 616'	Fine-grained, locally coarsely fragmental or brecciated, siliceous, micaceous, metatuff and metagreywacke; and sulfide-chert chemical metasediments.
616' - 631'	Fine to medium-grained, variably deformed, amphibolitic metagabbro; and biotitic siliceous metatuff-metagreywacke; and sulfide chemical metasediment or alteration.

631' - 723'	Fine to medium-grained, generally schistose, biotitic-siliceous metatuff, with extensive hornblende-oxide-sulfide-garnet alteration and/or chemical metasediments.
723'	End of Hole.

Summary Drill Log for DDH BD-II-2

Footage	Rock Name and Description
0' - 206'	Overburden. No core.
206' - 295.2'	Locally weathered, variably schistose, hornblende-garnet-sulfide-oxide-carbonate altered, fine to coarse-grained, siliceous biotitic felsic lapilli metatuff; mafic (?) to felsic metavolcanics; and chemical metasediment.
295.2' - 370.8'	Intermixed fine-grained metabasalt, and fine to medium-grained metagabbro.
370.8' - 496.8'	Fine to medium-grained, amphibolitic, locally contaminated metagabbro, with xenoliths.
496.8' - 498.4'	Deformed, pegmatitic syenitic dike, with chlorite, sulfide, and calcite-veinlets.
498.4' - 502'	Fine to medium-grained, amphibolitic metagabbro.
502'	End of Hole.

Summary Drill Log for DDH RR16-1

Footage	Rock Name and Description
0' - 18'	Overburden. No core.
18' - 135'	Fine-grained, schistose, amphibolitic-biotitic, locally reworked, mafic-intermediate and lesser felsic(?) metatuff; minor fine to medium-grained metagabbro or metadiabase?; and coarse-grained, deformed granite veins with tourmaline.
135' - 142.5'	Fine to coarse-grained, locally amphibolitic to siliceous altered (?) intermediate-felsic metatuffs, and sulfide-chert chemical metasediment and alteration.
142.5' - 234.5'	Generally fine-grained, locally schistose, variably hornblende-garnet-sulfide-oxide-carbonate? altered (or chemical metasediments), amphibolitic-biotitic metavolcanics.
234.5' - 282'	Generally fine-grained, amphibolitic-biotitic, locally tourmaline bearing, intermediate-mafic(?) metavolcanics and metasediment; with local deformed tourmaline-sulfide-muscovite-garnet biotite bearing, locally k-feldspar altered tonalite (?) veins.
282' - 290'	No core.
290'	End of Hole.

Appendix 278-D. Results of Chemical Analyses

Appendix 278-D. Results of Chemical Analyses.

Sample	DDH	Footage Top	Footage Bottom	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	LOI %	Total %	S %
23448	40917	229.0	233.0	66.90	15.50	4.92	0.07	1.75	1.26	5.16	2.41	0.43	0.35	1.86	100.61	0.60
23449	40917	233.0	238.5	61.30	12.30	11.90	0.27	1.54	2.62	2.92	1.50	0.61	0.34	4.10	99.40	3.53
23450	40917	252.0	257.0	67.80	15.40	3.18	0.06	1.21	2.06	4.88	2.87	0.42	0.40	1.46	99.74	0.18
23451	40917	266.0	270.5	66.00	14.30	5.62	0.15	2.05	2.39	3.27	2.15	0.40	0.30	1.88	98.51	0.36
23452	40917	353.0	361.0	52.50	14.30	12.90	0.21	5.23	6.78	3.20	0.62	1.57	0.63	0.79	98.73	0.65
23443	40918	280.5	287.0	59.90	16.90	4.54	0.05	3.33	4.03	3.17	1.40	0.35	0.21	6.69	100.57	0.07
23444	40918	287.0	305.5	61.60	17.20	4.43	0.06	2.87	3.81	4.24	1.44	0.37	0.24	4.02	100.28	<0.02
23445	40918	333.0	336.0	62.60	16.70	4.00	0.05	2.53	3.85	4.75	1.23	0.35	0.25	2.38	98.69	0.02
23446	40918	433.0	435.0	65.10	15.80	3.29	0.04	1.60	4.75	4.99	1.88	0.35	0.20	1.94	99.94	0.07
23447	40918	447.0	451.0	64.60	15.80	3.49	0.06	2.06	5.13	4.58	1.13	0.35	0.15	1.44	98.79	0.06
23833	40919	534.0	546.3	66.80	13.80	5.21	0.14	1.40	3.31	5.11	0.61	0.46	0.08	0.79	97.71	0.10
23830	40920	434.0	444.0	50.90	12.50	16.00	0.23	5.68	8.43	2.40	0.41	1.11	0.31	1.28	99.25	1.00
23831*	40920	454.0	464.0	48.35	12.40	14.55	0.18	10.05	4.61	2.29	0.12	1.11	0.23	4.83	98.70	0.62
23403	40926	166.0	175.5	53.00	13.00	15.00	0.89	2.50	3.36	2.51	0.85	2.15	0.55	7.47	101.28	4.26
23404	40926	175.5	178.5	63.10	9.14	13.20	0.23	1.78	0.34	0.23	2.14	0.47	0.39	9.94	100.96	6.29
23405	40926	178.5	192.0	47.00	16.50	15.50	0.46	3.26	5.81	3.31	0.89	2.38	0.35	4.65	100.11	1.61
23406	40926	222.0	236.0	47.30	10.30	15.70	0.32	13.00	5.42	1.59	0.72	1.00	0.52	5.98	101.85	1.19
23407	40926	334.0	344.0	36.90	4.33	15.50	0.23	21.80	6.62	0.05	0.02	0.45	0.43	12.46	98.79	0.42
23408	40926	344.0	352.0	51.20	4.41	13.30	0.13	20.00	2.56	0.01	0.03	0.38	0.25	6.03	98.30	0.91
23409	40926	372.4	384.0	61.60	16.00	6.30	0.09	3.90	2.02	3.50	2.05	0.55	0.42	3.74	100.17	1.14
23410	40926	412.0	422.0	64.10	16.00	6.09	0.09	3.43	2.09	4.65	1.78	0.54	0.30	2.53	101.60	0.75
23834	B-B-2	194.0	206.0	48.00	10.15	11.56	0.20	14.84	10.06	1.26	0.45	0.40	0.07	2.20	99.19	0.03
23835	B-B-2	306.0	314.0	49.20	12.40	13.70	0.27	6.29	13.30	1.74	0.18	0.81	0.23	0.50	98.62	0.08
23565	B-Q-1	96.1	106.1	48.30	13.50	14.20	0.44	6.15	12.20	1.35	0.39	1.17	0.31	1.56	99.57	1.08
23566	B-Q-1	106.1	118.0	54.20	13.50	11.30	0.30	4.45	9.19	2.54	0.48	0.81	0.19	0.78	97.74	0.12
23567	B-Q-1	161.0	174.0	48.20	13.90	13.80	0.51	5.39	13.70	1.55	0.25	0.77	0.19	0.19	98.45	0.19
23568	B-Q-1	224.0	234.0	52.30	17.70	11.00	0.26	2.21	6.49	4.75	1.02	1.14	0.52	0.40	97.79	0.09
23569	B-Q-1	344.0	354.0	46.50	14.90	13.90	0.55	5.36	10.90	1.99	0.54	0.79	<0.01	1.71	97.14	1.21
23570	B-Q-1	360.0	374.0	49.20	8.71	23.00	0.46	1.79	4.83	2.64	0.99	0.15	0.21	4.80	96.78	8.00
23828	B21-1	174.0	186.0	60.50	8.90	19.50	0.30	2.18	3.91	1.03	0.46	0.42	0.05	2.59	99.84	4.39
23829	B21-1	210.0	218.0	38.20	11.50	36.00	1.23	3.85	6.81	0.87	0.23	0.72	0.15	0.53	100.09	4.31
23823	B21-2	239.0	248.0	51.90	12.03	21.71	0.38	2.05	4.43	1.98	0.70	0.49	0.05	2.60	98.32	7.04
23825	B21-2	625.0	635.0	59.50	14.90	6.38	0.12	4.23	4.85	5.02	1.28	0.57	0.11	0.99	97.95	0.42
23826	B21-3	387.0	397.0	57.90	16.30	10.50	0.26	3.49	7.00	2.11	0.88	0.62	0.03	0.49	99.58	1.11
23827	B21-3	407.0	415.0	46.90	9.27	28.50	0.30	1.77	5.04	0.99	0.50	0.39	0.03	5.04	98.73	10.02
23747	B24-1	352.5	362.1	74.60	12.03	2.72	0.08	0.39	1.08	3.81	4.60	0.14	0.10	0.49	100.04	0.46
23749	B24-1	509.0	516.5	46.30	11.00	24.00	1.11	3.42	9.30	1.30	0.62	0.53	0.05	2.01	99.64	4.69
23760	B24-2	493.0	505.0	70.30	15.23	2.20	0.06	0.74	2.85	5.14	1.64	0.30	0.05	0.54	99.05	0.25
23762	B24-2	579.6	586.6	67.60	15.20	5.20	0.17	0.83	3.69	3.06	1.90	0.34	0.23	1.30	99.52	1.88
23772*	B24-3	442.0	454.0	43.00	8.75	27.80	0.95	4.45	6.38	1.35	0.38	0.40	0.13	4.87	98.46	5.23
23801	B24-4	652.0	664.0	63.40	18.05	3.56	0.06	1.56	4.03	5.72	0.96	0.85	0.14	1.06	99.39	0.48
23808	B24-4	1372.0	1384.0	38.50	10.00	33.80	0.95	5.10	9.16	1.06	0.19	0.86	0.77	0.40	100.79	2.30
23453	B31-1	215.7	223.0	71.20	14.20	2.08	0.06	0.85	1.32	3.42	3.97	0.26	0.17	0.88	98.41	0.20
23454	B31-1	223.0	233.0	73.50	12.90	1.44	0.05	0.52	1.20	3.84	3.62	0.17	0.25	0.91	98.40	0.16
23455	B31-1	253.0	265.0	75.60	12.50	1.11	0.04	0.55	0.92	3.45	3.34	0.14	0.26	0.88	98.79	0.07

Appendix 278-D. Results of Chemical Analyses.

Sample	DDH	Footage		SiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	TiO_2	P_2O_5	LOI	Total	S
		Top	Bottom	%	%	%	%	%	%	%	%	%	%	%	%	%
23456	B31-1	265.0	274.7	75.10	12.50	1.41	0.07	0.56	1.59	3.56	2.58	0.11	0.12	0.87	98.47	0.09
23457	B31-1	274.7	284.5	72.00	12.70	2.67	0.09	0.72	1.45	3.73	3.25	0.15	0.35	1.51	98.62	0.31
23458	B31-1	318.4	326.5	45.60	4.86	28.70	0.69	3.51	6.42	1.52	0.52	0.22	0.19	6.86	99.09	0.35
23459	B31-1	429.7	439.2	48.30	12.00	17.30	0.46	4.21	10.00	3.65	0.88	0.51	0.18	2.55	100.04	4.20
23460	B31-1	453.0	463.0	49.40	13.30	15.20	0.56	4.26	11.50	2.62	0.66	0.63	0.18	2.14	100.45	3.03
23461	B31-1	510.0	524.0	46.50	11.70	16.20	0.63	4.37	11.80	3.49	1.14	0.55	0.22	4.18	100.78	4.67
23462	B31-1	698.0	708.5	76.60	10.60	1.85	0.06	0.57	1.81	3.96	2.22	0.21	0.37	1.37	99.62	0.71
23371	B31-2	335.0	345.0	65.60	16.10	4.60	0.09	1.62	1.40	3.42	2.58	0.48	0.20	2.25	98.34	0.50
23372	B31-2	353.0	364.8	72.30	14.00	1.97	0.06	1.00	1.69	2.82	1.94	0.26	0.23	1.69	97.96	0.12
23373	B31-2	364.8	376.7	56.10	14.50	5.84	0.13	7.49	6.97	2.17	1.80	0.44	0.19	3.07	98.70	0.43
23374	B31-2	376.7	379.7	68.80	15.30	2.63	0.04	1.46	2.54	3.60	2.39	0.23	0.15	1.46	98.60	0.46
23375	B31-2	483.0	493.0	46.00	12.10	16.20	0.69	5.06	13.00	2.20	0.98	0.49	0.14	1.29	98.15	0.69
23376	B31-2	673.0	683.0	44.70	12.20	17.30	0.60	5.84	11.70	2.57	0.76	0.49	0.15	2.21	98.52	1.26
23377	B31-2	805.0	815.0	49.40	13.00	16.20	0.61	4.67	10.10	3.62	0.78	0.52	0.20	0.94	100.04	0.82
23378	B31-2	920.8	925.4	58.70	17.70	5.55	0.15	1.64	4.08	5.45	4.40	0.34	0.35	0.93	99.29	0.20
23379	B31-2	925.4	938.0	46.40	12.30	17.30	0.63	4.89	9.49	3.75	1.49	0.53	0.12	2.16	99.06	2.37
23380	B31-2	948.0	963.0	43.40	11.70	21.20	0.83	5.20	8.67	3.78	1.06	0.47	0.15	2.90	99.36	3.62
23434*	B31-3	215.0	226.0	47.70	14.20	13.10	0.40	6.04	7.15	3.55	1.87	1.85	0.27	2.31	98.42	0.15
23437	B31-3	445.0	448.5	40.00	15.90	19.00	0.25	7.25	9.06	3.08	1.08	2.02	0.70	2.70	101.04	0.18
23381	B31-3	475.5	485.0	47.20	14.40	14.30	0.22	5.89	7.87	3.29	0.99	1.77	0.28	2.38	98.59	0.45
23382	B31-3	505.0	514.0	62.60	8.87	15.20	0.08	0.65	1.20	4.05	0.93	0.11	0.29	5.96	99.94	8.56
23383	B31-3	514.0	525.0	66.70	11.90	6.94	0.09	0.98	3.21	4.35	2.29	0.16	0.23	3.74	100.59	3.33
23384	B31-3	525.0	535.0	58.50	14.40	7.55	0.18	2.96	4.29	5.93	1.71	0.74	0.26	1.43	97.95	0.71
23435*	B31-4	135.0	145.0	48.10	14.35	13.95	0.23	5.98	8.08	3.14	1.32	1.85	0.51	2.01	99.49	0.15
23385	B31-4	163.5	168.0	48.30	14.70	14.50	0.29	6.17	8.22	3.19	1.08	1.87	0.33	1.72	100.37	0.05
23386	B31-4	168.0	174.9	54.00	14.00	11.00	0.29	3.18	6.05	6.10	0.79	0.86	0.21	1.91	98.39	1.74
23387	B31-4	174.9	185.0	43.00	9.49	24.90	0.14	1.50	4.60	3.37	0.64	0.35	0.23	10.74	98.96	13.71
23388	B31-4	197.6	208.2	64.50	15.10	5.75	0.14	1.64	3.92	4.60	1.47	0.43	0.20	1.54	99.29	0.72
23389	B31-4	208.2	215.0	62.90	8.44	14.00	0.08	0.60	1.14	3.83	0.87	0.12	0.27	5.57	97.82	6.86
23390	B31-4	289.5	305.6	68.60	13.20	2.41	0.08	0.71	3.29	6.46	1.35	0.36	0.17	1.66	98.29	0.76
23391	B31-4	305.6	315.0	74.10	12.60	1.79	0.06	0.47	1.79	5.17	1.60	0.21	0.13	0.78	98.70	0.57
23392	B31-4	393.0	405.0	75.50	13.40	1.19	0.02	0.48	1.55	5.61	1.99	0.20	0.12	1.01	101.07	0.25
23393	B31-4	444.0	457.0	83.30	9.41	0.79	<0.01	0.19	0.56	5.39	0.27	0.15	0.04	0.45	100.55	0.31
23394	B31-4	465.0	475.0	75.10	13.40	0.88	0.02	0.68	2.34	6.75	1.30	0.20	0.07	0.09	100.83	0.19
23436*	B31-5	163.0	167.0	49.00	14.65	11.90	0.34	5.81	6.88	4.35	1.27	1.90	0.36	2.42	98.85	0.47
23395	B31-5	167.0	179.0	45.10	11.50	20.10	0.59	5.54	11.40	2.71	0.47	0.56	0.23	2.66	100.86	2.49
23396	B31-5	190.0	205.0	45.80	12.30	15.60	0.56	5.11	13.80	2.86	0.28	0.53	0.04	2.37	99.25	2.10
23397	B31-5	235.0	251.0	48.10	13.20	12.30	0.39	4.94	11.80	3.75	0.96	0.60	0.12	2.71	98.87	2.96
23398	B31-5	432.0	445.0	46.00	12.60	14.10	0.41	5.81	11.50	3.70	0.73	0.57	0.42	2.41	98.25	1.30
23399	B31-5	455.3	465.0	43.30	10.90	16.50	0.59	4.94	9.17	5.13	1.42	0.49	0.35	3.75	96.54	4.42
23400	B31-5	465.0	475.0	45.90	11.80	15.40	0.51	5.29	6.74	5.14	1.78	0.65	0.44	4.98	98.63	3.48
23401	B31-5	538.0	552.0	43.40	11.50	20.10	0.74	5.35	9.41	4.06	1.85	0.52	0.26	2.85	100.04	1.42
23402	B31-5	665.0	675.0	48.70	13.60	12.70	0.44	5.93	9.75	4.01	0.89	0.57	0.45	1.18	98.22	0.58
23411	B35-1	259.4	268.0	54.60	14.40	10.80	0.34	6.32	7.29	2.52	0.71	0.65	0.36	2.41	100.40	0.17
23412	B35-1	268.0	275.3	49.20	14.00	14.30	0.45	7.39	6.45	1.79	0.90	0.60	0.27	3.74	99.09	0.29

Appendix 278-D. Results of Chemical Analyses.

Sample	DDH	Footage Top	Footage Bottom	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	LOI %	Total %	S %
23413	B35-1	275.3	289.3	64.80	13.10	6.48	0.03	0.83	0.19	0.08	3.63	0.45	0.30	8.50	98.39	3.19
23414	B35-1	289.3	295.0	63.20	17.00	6.51	0.08	2.43	0.22	0.28	4.31	0.62	0.39	5.44	100.48	1.72
23415	B35-1	295.0	308.0	63.10	16.10	7.05	0.11	3.65	2.21	3.13	2.63	0.61	0.30	2.00	100.89	0.29
23416	B35-1	385.0	393.0	62.80	16.00	6.66	0.10	3.16	2.56	3.35	2.54	0.61	0.30	1.38	99.46	0.37
23474	B5-1	155.0	167.0	48.30	13.90	9.03	0.16	8.23	11.90	2.98	0.29	0.59	0.33	1.39	97.10	0.14
23478	B5-1	268.2	279.0	47.90	13.60	11.30	0.21	8.11	12.90	3.27	0.14	0.65	0.30	1.58	99.96	0.18
23480	B5-1	381.0	395.0	45.30	10.60	13.60	0.25	14.70	7.33	1.35	0.49	0.60	0.32	2.99	97.53	0.06
23483	B5-1	430.5	440.2	60.20	16.50	5.84	0.06	2.96	1.92	2.21	4.45	0.39	0.49	2.24	97.26	0.50
23489	B5-1	471.7	481.0	50.60	14.50	13.50	0.32	7.18	11.10	0.63	1.29	0.71	0.36	1.79	101.98	0.11
23490	B5-1	675.0	685.0	67.10	14.60	3.06	0.05	0.97	3.07	5.08	1.87	0.30	0.60	0.58	97.28	0.13
23600	B54-1	213.0	223.0	49.10	11.70	19.60	0.57	4.14	5.34	1.57	0.18	0.53	0.60	5.68	99.01	0.41
23601	B54-1	268.0	274.0	44.70	11.10	22.30	0.93	4.84	11.00	0.75	0.30	0.52	0.74	1.47	98.65	1.21
23602	B54-1	320.0	325.0	44.80	8.69	26.80	0.98	4.90	8.05	0.73	0.20	0.61	0.18	2.04	97.98	2.08
23427	B58-1	165.0	174.5	66.60	14.80	4.31	0.09	1.24	3.25	4.80	2.10	0.32	0.29	2.24	100.04	1.69
23428	B58-1	210.0	221.4	63.20	13.00	8.26	0.16	1.74	4.21	3.43	1.40	0.32	0.23	2.66	98.61	2.17
23429	B58-1	225.0	231.0	64.70	15.40	3.58	0.08	1.34	4.11	4.22	2.41	0.31	0.30	2.29	98.74	0.33
23430	B58-1	285.0	295.0	50.70	12.40	16.30	0.12	2.23	3.29	3.29	1.66	0.38	0.17	7.03	97.57	9.09
23431	B58-1	306.9	320.0	35.60	10.90	28.40	0.26	4.14	6.99	1.47	0.34	0.64	1.55	9.73	100.02	16.82
23432	B58-1	320.0	328.0	45.40	13.50	19.10	0.45	4.91	10.10	1.76	0.40	0.81	0.58	2.37	99.38	3.69
23433	B58-1	401.0	410.0	65.50	14.80	3.68	0.09	1.39	3.35	5.00	1.78	0.35	0.84	1.11	97.89	0.44
23844	BD-1	244.0	254.0	37.40	9.59	37.60	1.59	3.48	6.08	2.34	0.60	0.40	0.07	<0.05	99.15	2.67
23845	BD-1	355.0	370.0	65.20	13.80	4.80	0.10	2.42	4.82	3.93	1.40	0.31	0.11	1.01	97.90	0.67
23836	BD-2	304.0	316.0	57.30	15.00	10.10	0.29	3.31	7.75	2.45	0.88	0.71	0.08	0.30	98.17	0.33
23837	BD-2	370.0	380.0	49.20	4.29	32.00	0.33	2.11	3.93	0.23	0.58	0.22	0.21	4.67	97.77	13.04
23842	BD-3	362.0	370.0	65.40	14.50	6.20	0.12	1.85	3.49	2.98	1.32	0.30	0.14	3.29	99.59	1.65
23843	BD-3	404.0	412.0	61.00	14.30	5.75	0.04	2.05	1.95	1.78	2.85	0.39	0.12	9.30	99.53	2.25
23846*	BD-II-1	592.0	602.0	67.00	13.75	4.80	0.20	1.65	5.33	2.30	2.28	0.54	0.12	0.40	98.36	0.54
23847	BD-II-1	653.0	663.0	48.00	13.20	19.10	0.60	5.68	6.98	2.49	0.82	0.99	0.18	1.61	99.65	2.93
23848	BD-II-2	314.0	324.0	52.03	14.57	13.72	0.19	4.91	7.85	3.73	0.50	1.59	0.17	0.54	99.80	0.96
23849*	BD-II-2	486.0	495.0	53.67	14.52	13.62	0.20	3.99	6.09	3.75	0.41	1.83	0.15	0.81	99.01	2.03
23510	BD-N-1	474.5	480.3	60.40	4.69	22.60	0.08	0.62	0.40	0.70	0.96	0.20	0.49	5.99	97.13	11.62
23511	BD-N-1	515.0	520.5	60.00	5.40	16.20	0.16	1.25	4.13	2.04	0.29	0.21	0.39	7.52	97.59	12.41
23512	BD-N-1	607.0	610.3	26.50	3.88	37.80	0.08	0.69	1.74	0.40	0.53	0.15	0.29	25.13	97.19	14.87
23513	BD-N-1	716.7	723.0	57.70	13.30	8.73	0.10	3.80	5.00	4.28	0.82	0.39	0.50	2.63	97.25	3.77
23514	BD-N-1	742.0	752.0	63.20	12.90	5.17	0.08	3.65	4.81	4.44	1.26	0.40	0.19	1.75	97.85	2.18
23594	BD-P-2	156.0	163.0	47.00	12.30	13.20	0.25	12.20	11.70	1.53	0.32	0.73	0.50	2.03	101.76	0.05
23595	BD-P-2	342.0	343.3	45.80	13.50	10.50	0.32	6.59	16.70	1.49	1.40	0.59	0.68	2.28	99.85	0.13
23596	BD-P-2	414.0	422.0	47.20	12.90	12.80	0.25	8.41	15.30	1.36	0.23	0.67	0.73	2.13	101.98	0.08
23597	BD-P-2	548.0	552.0	47.30	11.20	13.10	0.23	15.00	9.96	1.65	0.15	0.56	0.47	2.09	101.71	0.21
23598	BD-P-2	622.0	628.0	48.00	13.00	13.00	0.24	11.50	11.10	1.46	0.21	0.61	0.57	1.62	101.31	0.17
23599	BD-P-2	628.0	632.0	64.00	14.60	7.35	0.06	2.81	4.08	4.23	1.31	0.42	0.54	1.68	101.08	2.35
23840	LW-346-1	280.0	287.3	44.50	10.50	33.00	1.31	2.68	3.55	2.16	1.17	0.35	0.14	0.34	99.70	6.78
23841*	LW-346-1	535.0	546.0	58.90	12.80	9.95	0.25	2.78	5.41	3.23	0.87	0.39	0.12	5.26	49.98	1.99
23838*	LW-346-2	247.7	259.6	52.50	15.50	9.67	0.24	5.73	10.70	2.29	0.62	0.65	0.13	1.59	49.81	0.08
23839	LW-346-2	425.0	436.0	53.00	15.80	8.52	0.20	6.32	10.40	2.39	0.74	0.58	0.09	1.79	99.83	0.42

Appendix 278-D. Results of Chemical Analyses.

Sample	DDH	Footage Top	Footage Bottom	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	LOI %	Total %	S %
23532	MDD-1	229.0	240.5	69.00	13.00	3.67	0.05	1.54	1.32	4.80	1.99	0.29	0.04	1.32	97.02	0.21
23533	MDD-1	252.0	262.0	55.30	16.40	8.33	0.14	2.83	5.73	4.51	1.99	0.68	0.11	1.11	97.13	1.20
23534	MDD-1	303.5	308.4	46.50	7.46	12.90	0.26	18.00	10.00	0.59	0.69	0.57	<0.01	2.68	99.65	<0.01
23535	MDD-1	316.0	326.0	61.40	16.20	4.25	0.09	1.50	7.18	4.33	1.58	0.44	<0.01	0.57	97.54	0.02
23536	MDD-1	372.0	382.0	56.00	14.60	7.04	0.13	3.60	7.17	4.71	1.81	0.66	1.02	0.42	97.16	0.08
23537	MDD-1	412.8	421.0	61.50	14.20	6.08	0.12	2.86	4.96	4.13	1.62	0.59	0.69	0.77	97.52	0.11
23554	MDD-1	421.0	432.0	50.20	16.10	9.29	0.17	4.27	7.50	3.88	1.50	0.77	2.87	1.19	97.74	0.69
23555	MDD-1	463.0	474.0	48.20	9.14	11.40	0.21	15.90	8.64	1.66	2.07	0.59	1.87	1.84	101.52	0.06
23556	MDD-1	538.0	552.0	53.00	16.10	12.90	0.32	3.52	8.11	3.99	1.08	1.00	0.66	0.61	101.29	0.07
23417	MED-1	174.0	185.0	62.50	12.00	3.05	0.24	3.59	6.04	4.19	4.12	0.25	0.24	1.81	98.03	0.02
23418	MED-1	185.0	194.0	69.10	11.10	4.06	0.21	3.49	1.85	2.51	7.07	0.15	0.16	0.79	100.49	<0.02
23419	MED-1	204.0	209.0	67.30	14.30	3.56	0.15	1.71	1.55	5.45	5.22	0.29	0.16	0.68	100.37	0.05
23420	MED-1	209.0	213.5	50.70	8.77	27.50	0.24	1.84	0.91	3.21	4.26	0.28	0.18	0.15	98.04	0.74
23421	MED-1	213.5	224.0	36.60	3.69	51.00	0.35	1.38	1.15	2.62	1.47	0.15	0.19	<0.05	98.60	0.44
23422	MED-1	424.0	436.1	45.20	11.90	19.80	0.49	5.06	8.56	3.21	1.39	0.54	0.20	4.17	100.52	4.90
23423	MED-1	441.0	451.0	42.30	3.80	37.50	0.73	2.44	3.92	1.15	0.37	0.12	0.33	7.40	100.06	14.75
23424	MED-1	451.0	456.0	60.80	12.80	11.20	0.15	1.70	4.05	3.62	2.13	0.32	0.21	3.23	100.21	9.38
23425	MED-1	456.0	459.9	63.60	15.30	3.76	0.06	1.81	4.09	6.12	2.10	0.38	0.28	1.04	98.54	0.55
23426	MED-1	459.9	469.0	62.90	17.00	3.48	0.10	1.62	5.38	4.08	2.04	0.43	0.36	0.83	98.22	0.31
23438	MMD-1	175.0	188.0	60.70	14.30	7.17	0.13	2.76	5.88	3.81	1.32	0.59	0.38	1.29	98.33	0.98
23439	MMD-1	188.0	196.5	56.90	14.00	13.30	0.09	2.12	4.12	3.87	1.28	0.49	0.58	3.90	100.65	5.87
23440	MMD-1	379.0	390.9	50.00	13.50	14.70	0.19	7.18	9.31	2.08	0.23	1.04	0.18	0.72	99.13	0.35
23441	MMD-1	415.3	430.5	48.80	14.20	14.90	0.23	6.42	8.72	2.57	0.20	0.98	0.09	0.67	97.78	0.15
23442	MMD-1	481.5	493.0	48.40	13.00	15.30	0.20	7.12	9.97	2.06	0.25	1.02	0.21	0.33	97.86	<0.01
23589	MQD-1	152.0	162.0	48.70	14.00	14.10	0.35	4.03	11.90	1.68	0.46	1.20	0.33	0.79	97.54	0.62
23590	MQD-1	277.0	288.0	50.10	15.00	11.40	0.34	5.10	11.70	1.44	0.41	0.82	0.48	0.93	97.72	0.41
23593	MQD-1	298.0	308.0	55.30	17.20	8.84	0.21	3.54	8.84	3.98	1.53	0.80	0.39	0.71	101.34	0.20
23591	MQD-1	322.0	332.0	51.10	14.50	11.40	0.31	5.03	11.50	1.88	0.46	0.76	0.52	0.49	97.95	0.25
23592	MQD-1	346.0	356.0	46.90	12.40	17.20	0.61	4.52	12.80	1.12	0.47	0.61	0.55	0.80	97.98	1.26
23580	MQD-2	132.0	142.0	52.70	13.50	12.30	0.19	5.38	7.58	2.69	0.67	0.92	1.16	0.59	97.68	0.35
23581	MQD-2	162.0	171.6	59.70	13.40	11.40	0.12	1.69	4.29	2.89	1.12	0.47	0.39	2.20	97.67	4.49
23582	MQD-2	176.5	190.0	47.80	14.60	15.50	0.21	5.49	7.58	2.79	0.71	2.03	0.32	0.99	98.02	0.22
23583	MQD-2	191.0	197.0	66.00	11.60	7.18	0.11	2.29	3.96	3.82	0.89	0.86	0.05	0.45	97.21	0.12
23584	MQD-2	202.0	212.0	49.00	11.60	18.90	0.25	3.91	7.20	2.75	0.66	2.45	0.68	0.38	97.78	0.28
23585	MQD-2	212.0	224.0	48.10	12.10	18.90	0.28	4.18	7.37	2.95	0.83	2.62	0.15	0.57	98.05	0.39
23586	MQD-2	232.0	242.0	45.90	12.20	20.50	0.31	4.83	9.17	2.65	0.65	3.03	0.72	0.54	100.50	0.33
23587	MQD-2	252.0	262.0	48.80	14.60	13.00	0.23	7.98	9.97	2.49	1.37	0.87	0.40	0.83	100.54	0.10
23588	MQD-2	344.0	356.0	48.10	13.00	14.30	0.48	4.53	11.00	1.92	0.48	0.66	0.62	2.29	97.38	0.75
23814*	MSD-1	345.0	357.0	49.75	13.58	12.69	0.33	7.62	11.19	1.81	0.33	0.55	0.11	1.22	99.15	0.12
23850	RR-16-1	52.0	62.0	53.00	14.20	10.30	0.19	7.84	10.20	2.33	0.44	0.62	0.07	0.83	100.02	0.24
23851	RR-16-1	136.0	146.0	47.50	11.30	20.40	0.41	5.23	8.05	1.94	0.90	0.50	0.14	3.19	99.56	5.35
23730*	YWL-1	329.0	339.0	48.10	11.63	12.37	0.20	13.84	8.16	1.78	0.30	0.55	0.20	2.41	99.51	<0.02
23733	YWL-1	506.0	516.0	53.20	15.42	12.50	0.34	4.78	9.11	2.35	0.71	0.73	0.03	1.07	100.24	0.20
23704	YWM-1	290.0	300.0	63.30	15.50	5.50	0.18	1.47	5.43	3.28	1.56	0.56	0.05	1.37	98.20	0.09
23705	YWM-1	323.0	333.0	63.20	16.50	4.23	0.13	1.50	4.31	4.24	1.57	0.60	0.24	1.33	97.85	0.10

Appendix 278-D. Results of Chemical Analyses.

Sample	DDH	Footage Top	Footage Bottom	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	TiO_2 %	P_2O_5 %	LOI %	Total %	S %
23706	YWM-1	365.0	375.0	64.50	15.50	4.96	0.18	1.22	4.76	3.69	1.39	0.57	0.20	1.17	98.14	0.09
23707	YWM-1	408.0	419.0	62.70	14.30	6.91	0.24	1.40	5.06	3.79	1.39	0.51	0.25	1.33	97.88	0.13
23708	YWM-1	465.0	475.0	57.50	12.90	12.80	0.60	2.25	7.22	2.85	1.00	0.38	0.08	1.18	98.76	0.28
23709	YWM-1	484.2	491.0	55.50	13.00	14.00	0.62	2.76	6.34	3.26	0.46	0.50	0.17	1.58	98.19	0.87
23710	YWM-1	527.0	537.3	55.90	12.80	13.90	0.65	2.79	6.63	3.21	0.46	0.53	0.12	1.99	98.98	0.80
23711	YWM-1	537.3	551.0	52.10	13.60	12.10	0.23	5.53	10.30	2.08	0.43	0.77	0.05	1.54	98.73	0.23
23712	YWM-1	577.0	587.0	51.40	13.40	12.20	0.25	5.47	10.20	2.03	0.41	0.76	0.21	1.68	98.01	0.13
23603	YWQ-1	480.0	501.0	63.60	16.10	5.07	0.08	1.91	0.48	3.59	2.20	0.53	0.03	3.63	97.22	0.88
23604	YWQ-1	673.0	683.0	57.60	16.70	5.24	0.26	2.95	5.68	1.34	2.85	0.47	0.39	4.75	98.23	0.96
23605	YWQ-1	739.5	748.6	68.40	15.00	4.32	0.08	1.25	2.64	5.13	1.21	0.42	0.24	1.53	100.22	0.68
23606	YWQ-1	816.0	826.0	65.10	15.90	4.23	0.09	1.35	5.76	4.69	1.20	0.35	0.80	2.09	101.56	0.19
23607	YWZ-1	295.0	306.0	49.00	14.00	11.60	0.17	8.59	8.47	2.40	0.27	0.55	0.14	3.05	98.24	0.01
23658	YWZ-1	417.5	428.0	46.90	7.40	12.20	0.21	19.20	6.13	0.22	0.09	0.32	0.22	5.60	98.49	<0.01
23608	YWZ-1	553.0	560.0	47.20	14.30	13.90	0.20	7.88	10.70	1.67	0.10	0.91	0.42	2.48	99.76	0.26
23609	YWZ-1	725.5	730.2	61.60	11.00	5.51	0.16	3.89	12.60	1.78	0.41	0.40	0.10	10.71	108.16	0.32
23610	YWZ-1	778.0	785.5	50.80	13.50	10.70	0.25	6.50	10.50	1.28	0.11	0.62	0.25	3.44	97.95	1.49
23611	YWZ-1	799.0	806.5	49.40	13.00	12.40	0.29	6.11	10.00	0.36	0.14	0.59	0.17	4.97	97.43	1.58
23684	YWZ-2	311.0	321.0	57.00	7.28	8.74	0.14	13.60	5.92	0.71	0.80	0.48	0.19	3.52	98.38	0.15
23685	YWZ-2	369.0	375.0	45.20	6.77	11.30	0.19	19.70	4.69	0.01	1.15	0.36	0.30	8.79	98.46	0.29
23686	YWZ-2	383.0	393.0	40.50	4.78	11.30	0.20	22.90	5.09	<0.01	0.12	0.18	0.21	12.74	98.02	<0.01
23687	YWZ-2	393.0	403.8	48.80	5.77	10.90	0.17	21.60	3.55	<0.01	0.35	0.26	0.20	6.50	98.10	<0.01
23688	YWZ-2	443.0	453.0	48.00	12.50	9.80	0.17	8.01	8.59	2.34	0.21	0.41	0.12	8.97	99.12	0.01
23689	YWZ-2	463.0	473.0	40.30	6.83	11.70	0.19	20.30	6.25	0.16	0.23	0.29	0.20	11.80	98.25	0.31
23690	YWZ-2	636.3	643.8	49.80	7.55	25.70	0.18	1.92	2.76	1.16	1.54	0.36	0.16	6.79	97.92	11.59
23691	YWZ-2	643.8	655.0	63.90	16.80	4.85	0.15	1.06	3.08	2.76	2.51	0.62	0.18	2.16	98.07	0.16

* = Average of two duplicate analyses.

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
23448	40917	229.0	233.0	304	<1	<10	<1	0.5	<5	6	33	<5	<1	<1	<0.5	<5	<1	44	2	25	32	13
23449	40917	233.0	238.5	242	<1	<10	<1	0.4	<5	6	30	<5	<1	1	<0.5	<5	<1	90	3	71	48	25
23450	40917	252.0	257.0	204	<1	<10	<1	0.4	<5	8	42	<5	<1	<1	<0.5	<5	<1	48	4	21	15	7
23451	40917	266.0	270.5	312	8	<10	<1	0.2	<5	10	45	<5	<1	<1	0.6	<5	<1	113	3	55	15	9
23452	40917	353.0	361.0	296	<1	<10	<1	<0.2	<5	8	15	<5	<1	<1	0.7	<5	<1	64	4	74	19	16
23443	40918	280.5	287.0	184	<1	<10	<1	<0.2	<5	7	49	<5	<1	<1	<0.5	<5	<1	67	<2	21	31	10
23444	40918	287.0	305.5	210	<1	<10	<1	0.2	<5	6	353	<5	2	1	<0.5	<5	<1	63	<2	27	39	14
23445	40918	333.0	336.0	215	<1	<10	<1	0.4	<5	7	25	<5	1	<1	<0.5	<5	<1	53	<2	22	35	11
23446	40918	433.0	435.0	151	<1	<10	1	0.8	<5	8	100	<5	<1	<1	0.6	<5	<1	44	3	28	23	7
23447	40918	447.0	451.0	156	<1	<10	<1	0.5	<5	7	71	<5	<1	<1	<0.5	<5	<1	45	3	39	26	9
23833	40919	534.0	546.3	139	2	<10	1	<0.2	<5	13	30	<5	<1	2	<0.5	<5	<1	34	4	20	11	7
23830	40920	434.0	444.0	190	2	<10	3	0.2	<5	13	20	<5	<1	21	<0.5	9	<1	48	8	324	31	34
23831*	40920	454.0	464.0	280.5	<1	<10	2	<0.2	6	22	18.5	<5	<1	8	<0.5	9	<1	62	11	138	37	42
23403	40926	166.0	175.5	291	3	<10	11	0.2	<5	9	150	<5	2	2	<0.5	<5	2	956	6	62	36	45
23404	40926	175.5	178.5	151	13	<10	150	0.5	<5	8	1390	<5	<1	28	<0.5	27	13	2637	24	80	67	75
23405	40926	178.5	192.0	354	2	<10	4	<0.2	<5	10	56	<5	<1	<1	<0.5	<5	<1	156	<2	50	16	26
23406	40926	222.0	236.0	279	<1	<10	150	0.3	<5	6	92	7	5	2	<0.5	<5	<1	235	<2	91	379	60
23407	40926	334.0	344.0	85	<1	<10	336	0.3	<5	<2	30	<5	2	6	<0.5	<5	<1	50	<2	34	636	90
23408	40926	344.0	352.0	418	2	<10	444	0.3	<5	3	11	<5	3	2	<0.5	<5	<1	81	<2	23	474	71
23409	40926	372.4	384.0	499	2	<10	78	0.3	<5	8	193	<5	2	<1	<0.5	<5	<1	115	5	56	94	23
23410	40926	412.0	422.0	451	<1	<10	112	0.3	<5	11	142	<5	1	<1	<0.5	<5	<1	66	6	48	75	18
23834	B-B-2	194.0	206.0	105	2	<10	1	<0.2	<5	12	103	10	10	3	<0.5	<5	<1	38	5	46	213	32
23835	B-B-2	306.0	314.0	103	2	<10	1	<0.2	<5	9	33	13	15	1	<0.5	6	<1	19	<2	16	45	13
23565	B-Q-1	96.1	106.1	156	<1	<10	3	<0.2	<5	7	24	13	16	14	<0.5	<5	<1	211	3	145	33	17
23566	B-Q-1	106.1	118.0	187	<1	<10	5	<0.2	<5	6	16	22	29	6	<0.5	<5	<1	45	4	96	40	19
23567	B-Q-1	161.0	174.0	106	<1	<10	2.5	<0.2	<5	5	13	13	16	3	<0.5	<5	<1	21	3	68	22	9
23568	B-Q-1	224.0	234.0	358	<1	<10	<0.5	<0.2	<5	8	30	<5	2	<1	<0.5	<5	<1	98	5	17	8	10
23569	B-Q-1	344.0	354.0	153	<1	<10	110	<0.2	<5	6	56	11	16	3	<0.5	<5	<1	66	5	65	64	22
23570	B-Q-1	360.0	374.0	99	<1	<10	2	<0.2	12	<2	65	<5	5	15	<0.5	<5	2	414	14	209	65	27
23828	B21-1	174.0	186.0	168	7	<10	13	<0.2	7	10	194	<5	4	7	<0.5	25	1	709	22	417	87	59
23829	B21-1	210.0	218.0	65	7	<10	10	<0.2	11	10	47	<5	2	7	1.1	22	1	382	13	392	95	55
23823	B21-2	239.0	248.0	146	4	<10	7	<0.2	14	9	1780	6	8	6	0.6	9	3	528	12	333	95	51
23825	B21-2	625.0	635.0	356	<1	<10	6	0.2	<5	10	77	<5	2	2	0.6	13	<1	58	8	46	65	17
23826	B21-3	387.0	397.0	319	<1	<10	20	0.2	<5	16	58	9	8	4	0.7	13	<1	128	10	162	52	26
23827	B21-3	407.0	415.0	119	8	<10	14	<0.2	16	7	48	6	6	95	0.6	16	8	2304	20	648	149	125
23747	B24-1	352.5	362.1	210	<1	<10	10	<0.2	<5	3	11	<5	<1	15	<0.5	9	<1	68	11	22	5	2
23749	B24-1	509.0	516.5	219	<1	<10	3	0.2	8	9	12	10	10	6	<0.5	19	2	112	12	45	49	17
23760	B24-2	493.0	505.0	339	<1	<10	5	0.2	<5	7	44	<5	1	1	<0.5	9	<1	36	3	16	12	5
23762	B24-2	579.6	586.6	391	<1	<10	40	0.8	<5	5	165	<5	<1	3	<0.5	28	1	63	6	19	21	6
23772*	B24-3	442.0	454.0	182	<1	<10	7	0.2	9	6	52	9.5	9.5	13	<0.5	9	1	101	15	85	39	26
23801	B24-4	652.0	664.0	907	5	<10	7	<0.2	<5	11	77	18	20	20	<0.5	9	<1	31	6	141	117	57
23808	B24-4	1372.0	1384.0	180	2	<10	5	<0.2	<5	8	7	8	9	70	<0.5	9	<1	54	7	126	57	24
23453	B31-1	215.7	223.0	313	3	<10	3	0.3	<5	4	108	<5	<1	2	<0.5	<5	<1	39	4	19	15	5
23454	B31-1	223.0	233.0	220	2	<10	5	0.3	<5	4	51	<5	1	8	<0.5	6	<1	52	7	14	10	4
23455	B31-1	253.0	265.0	288	<1	<10	3	0.2	<5	2	23	<5	<1	1	<0.5	6	<1	44	6	7	6	2

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage		F	Se	Te	As	Sb	Bi	Ga	B	Pt	Pd	Au	Ag	Hg	Cd	Zn	Pb	Cu	Ni	Co
		Top	Bottom	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppb	ppb	ppb	ppm	ppb	ppm	ppm	ppm	ppm	ppm	ppm
23456	B31-1	265.0	274.7	245	<1	<10	2	0.2	<5	3	25	<5	<1	<1	<0.5	<5	<1	44	5	10	6	2
23457	B31-1	274.7	284.5	268	5	<10	3	0.3	<5	2	22	<5	4	22	<0.5	9	<1	36	8	16	8	3
23458	B31-1	318.4	326.5	196	5	<10	2	0.2	8	<2	15	7	4	24	0.6	6	<1	67	<2	954	79	84
23459	B31-1	429.7	439.2	281	<1	<10	<1	<0.2	<5	4	15	16	12	9	<0.5	6	<1	48	<2	129	78	95
23460	B31-1	453.0	463.0	191	<1	<10	1	<0.2	<5	3	19	17	12	9	<0.5	<5	1	52	<2	106	65	28
23461	B31-1	510.0	524.0	261	2	<10	3	0.2	<5	4	12	14	11	18	<0.5	<5	<1	191	<2	82	52	35
23462	B31-1	698.0	708.5	224	1	<10	1	0.2	<5	3	17	<5	2	15	<0.5	<5	<1	21	<2	18	8	4
23371	B31-2	335.0	345.0	363	7	<10	3	0.2	<5	5	27	<5	7	22	<0.5	12	<1	57	3	44	47	19
23372	B31-2	353.0	364.8	163	7	<10	3	<0.2	<5	4	29	<5	2	3	<0.5	6	<1	50	7	20	15	7
23373	B31-2	364.8	376.7	1124	3	<10	4	0.4	<5	6	30	<5	3	5	<0.5	<5	<1	42	4	43	153	23
23374	B31-2	376.7	379.7	324	<1	<10	11	0.4	<5	5	21	<5	<1	4	<0.5	24	<1	83	5	42	50	14
23375	B31-2	483.0	493.0	264	2	<10	2	<0.2	<5	5	17	12	13	3	0.6	<5	<1	43	<2	124	48	23
23376	B31-2	673.0	683.0	279	3	<10	<1	<0.2	<5	5	12	13	14	3	<0.5	<5	<1	80	<2	117	50	32
23377	B31-2	805.0	815.0	236	2	<10	1	0.2	<5	5	12	14	14	2	<0.5	<5	<1	69	<2	61	55	27
23378	B31-2	920.8	925.4	925	<1	<10	2	0.2	<5	8	16	<5	<1	1	0.7	<5	1	69	6	20	8	9
23379	B31-2	925.4	938.0	589	2	<10	1	<0.2	<5	4	12	12	13	5	<0.5	<5	1	88	<2	126	63	33
23380	B31-2	948.0	963.0	445	<1	<10	1	<0.2	<5	4	11	11	12	3	<0.5	6	<1	113	<2	162	62	38
23434*	B31-3	215.0	226.0	541	2	<10	1	<0.2	<5	11.5	27.5	<5	<1	2	0.5	<5	<1	88	2	27	48	30.5
23437	B31-3	445.0	448.5	410	1	<10	5.5	<0.2	<5	11	47	<5	2	<1	<0.5	<5	<1	88	11	47	57	33
23381	B31-3	475.5	485.0	616	1	<10	3	<0.2	<5	13	24	<5	<1	3	0.6	<5	<1	74	2	43	53	34
23382	B31-3	505.0	514.0	118	2	<10	10	0.4	6	<2	11	<5	<1	24	<0.5	<5	<1	39	10	100	20	14
23383	B31-3	514.0	525.0	198	3	<10	4	0.4	<5	2	11	<5	1	7	<0.5	18	2	493	139	24	11	9
23384	B31-3	525.0	535.0	288	<1	<10	1	0.3	<5	7	15	<5	5	1	<0.5	<5	<1	41	4	58	43	26
23435*	B31-4	135.0	145.0	466	<1	<10	1	<0.2	<5	11.5	28	<5	<1	3	0.7	<5	<1	80.5	<2	41	45	30
23385	B31-4	163.5	168.0	543	<1	<10	<1	0.2	<5	14	21	<5	<1	1	0.6	<5	<1	84	3	30	52	27
23386	B31-4	168.0	174.9	332	<1	<10	3	0.2	<5	9	11	<5	6	1	0.6	<5	<1	39	3	59	57	31
23387	B31-4	174.9	185.0	190	3	<10	7	<0.2	5	<2	10	<5	<1	14	<0.5	<5	<1	27	<2	195	53	35
23388	B31-4	197.6	208.2	248	<1	<10	1	<0.2	<5	7	16	<5	5	2	<0.5	<5	<1	45	3	40	32	14
23389	B31-4	208.2	215.0	107	1	<10	9	0.2	<5	<2	12	<5	<1	28	<0.5	<5	<1	39	12	95	18	14
23390	B31-4	289.5	305.6	244	<1	<10	2	0.2	<5	4	12	<5	1	3	0.5	<5	<1	16	<2	25	20	10
23391	B31-4	305.6	315.0	156	<1	<10	5	<0.2	<5	<2	29	<5	<1	4	<0.5	<5	<1	50	13	16	11	4
23392	B31-4	393.0	405.0	260	1	<10	1	<0.2	<5	2	16	<5	<1	1	<0.5	<5	<1	17	2	13	8	4
23393	B31-4	444.0	457.0	75	<1	<10	<1	<0.2	<5	<2	12	<5	<1	1	<0.5	<5	<1	6	2	7	6	2
23394	B31-4	465.0	475.0	144	<1	<10	<1	<0.2	<5	2	12	<5	<1	<1	<0.5	<5	<1	14	<2	6	5	<1
23436*	B31-5	163.0	167.0	582.5	3	<10	1	<0.2	<5	12	21.5	<5	3	2	<0.5	<5	<1	120.5	9.5	45.5	64.5	32
23395	B31-5	167.0	179.0	340	<1	<10	1	<0.2	<5	4	14	10	12	3	<0.5	<5	<1	33	<2	65	33	42
23396	B31-5	190.0	205.0	354	2	<10	2	0.2	<5	3	14	12	14	3	0.5	<5	<1	33	<2	80	34	28
23397	B31-5	235.0	251.0	658	<1	<10	1	0.2	<5	5	16	16	16	3	0.5	<5	<1	57	3	132	45	37
23398	B31-5	432.0	445.0	663	<1	<10	1	<0.2	<5	4	15	15	15	1	<0.5	<5	<1	60	<2	104	50	31
23399	B31-5	455.3	465.0	1691	3	<10	2	0.2	7	<2	10	12	13	3	<0.5	<5	2	111	5	179	53	32
23400	B31-5	465.0	475.0	1625	<1	<10	2	<0.2	<5	6	10	13	10	2	0.5	<5	1	124	6	105	55	35
23401	B31-5	538.0	552.0	443	<1	<10	1	<0.2	<5	4	10	13	13	1	<0.5	<5	<1	138	2	131	52	32
23402	B31-5	665.0	675.0	248	<1	<10	2	0.2	<5	5	11	17	15	<1	0.6	<5	<1	41	<2	90	55	29
23411	B35-1	259.4	268.0	184	1	<10	4	<0.2	<5	5	38	8	8	2	<0.5	<5	<1	65	3	46	46	23
23412	B35-1	268.0	275.3	189	<1	<10	5	<0.2	<5	5	37	8	7	2	<0.5	<5	<1	246	3	48	56	24

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
23413	B35-1	275.3	289.3	312	5	<10	1	<0.2	<5	<2	63	<5	1	1	<0.5	<5	<1	60	4	107	56	26
23414	B35-1	289.3	295.0	505	<1	<10	<1	<0.2	<5	3	116	<5	2	<1	<0.5	<5	<1	177	9	69	77	26
23415	B35-1	295.0	308.0	486	<1	<10	<1	<0.2	<5	10	29	<5	2	1	<0.5	<5	<1	117	6	56	83	22
23416	B35-1	385.0	393.0	481	<1	<10	3	<0.2	<5	12	26	<5	2	<1	<0.5	<5	1	96	5	57	70	23
23474	B5-1	155.0	167.0	78	<1	<10	0.5	<0.2	<5	3	38	<5	4	4	<0.5	<5	<1	15	<2	31	33	10
23478	B5-1	268.2	279.0	77	<1	<10	1	<0.2	<5	<2	31	5	5	1	<0.5	<5	<1	14	3	39	28	12
23480	B5-1	381.0	395.0	108	2	<10	1	<0.2	<5	4	36	5	7	3	<0.5	<5	<1	42	<2	96	232	37
23483	B5-1	430.5	440.2	197	<1	<10	1	<0.2	<5	6	59	<5	1	2	<0.5	<5	<1	138	2	72	32	13
23489	B5-1	471.7	481.0	173	<1	<10	3	<0.2	<5	4	40	13	14	6	<0.5	<5	<1	50	5	172	45	23
23490	B5-1	675.0	685.0	232	1	<10	<0.5	<0.2	<5	7	37	<5	2	2	<0.5	<5	<1	46	4	14	10	6
23600	B54-1	213.0	223.0	88	<1	21	3	<0.2	<5	4	21	13	13	3	<0.5	<5	2	132	6	155	74	42
23601	B54-1	268.0	274.0	92	1	<10	1	<0.2	5	3	20	14	13	2	<0.5	<5	<1	99	9	138	53	26
23602	B54-1	320.0	325.0	106	1	<10	1.5	<0.2	<5	4	22	17	19	11	<0.5	<5	<1	58	5	570	32	34
23427	B58-1	165.0	174.5	297	<1	<10	3	<0.2	<5	7	23	<5	<1	36	0.6	<5	<1	63	<2	21	15	7
23428	B58-1	210.0	221.4	269	<1	<10	1	0.2	<5	6	20	<5	2	27	0.5	<5	<1	72	3	64	36	23
23429	B58-1	225.0	231.0	318	<1	<10	2	<0.2	<5	8	21	<5	<1	11	0.6	<5	<1	68	2	26	18	7
23430	B58-1	285.0	295.0	363	<1	<10	12	0.3	<5	4	19	<5	1	16	<0.5	<5	<1	106	<2	102	51	31
23431	B58-1	306.9	320.0	114	1	<10	11	<0.2	8	<2	46	<5	<1	18	<0.5	<5	<1	40	6	178	142	73
23432	B58-1	320.0	328.0	175	<1	<10	1	<0.2	6	3	37	<5	<1	35	<0.5	<5	<1	69	8	88	86	27
23433	B58-1	401.0	410.0	303	<1	<10	1.5	<0.2	<5	7	46	<5	<1	5	<0.5	<5	<1	46	5	15	18	7
23844	BD-1	244.0	254.0	130	<1	<10	1	0.2	12	8	11	<5	<1	19	<0.5	9	1	34	12	56	75	34
23845	BD-1	355.0	370.0	239	<1	<10	1	0.2	<5	15	33	<5	1	<1	<0.5	9	<1	69	6	29	34	12
23836	BD-2	304.0	316.0	154	<1	<10	1	0.2	<5	15	30	<5	<1	<1	<0.5	<5	<1	49	<2	60	54	24
23837	BD-2	370.0	380.0	215	8	<10	110	1.5	8	5	61	<5	2	33	0.9	34	5	644	21	212	72	76
23842	BD-3	362.0	370.0	102	2	<10	6	0.2	<5	13	26	5	1	2	0.7	9	<1	117	6	86	26	16
23843	BD-3	404.0	412.0	247	7	<10	5	0.3	<5	7	29	<5	<1	4	<0.5	16	2	649	16	150	106	40
23846*	BD-II-1	592.0	602.0	219.5	2	<10	2	0.2	<5	10	25	<5	<1	3	<0.5	7.5	<1	101	4	46	25	13
23847	BD-II-1	653.0	663.0	250	5	<10	1	0.3	7	13	9	16	7	115	<0.5	6	1	122	7	102	55	38
23848	BD-II-2	314.0	324.0	250	1	<10	19	0.4	<5	13	95	<5	<1	7	<0.5	<5	<1	68	7	100	56	38
23849*	BD-II-2	486.0	495.0	264.5	1	<10	1.5	<0.2	<5	11	60.5	<5	<1	12	<0.5	7.5	1	46	6	144	32	34.5
23510	BD-N-1	474.5	480.3	123	17	<10	5.5	<0.2	8	<2	41	<5	2	10	<0.5	135	6	2808	31	463	144	40
23511	BD-N-1	515.0	520.5	128	3	<10	25	0.3	8	<2	30	<5	1	40	<0.5	288	5	1599	29	59	98	63
23512	BD-N-1	607.0	610.3	289	17	<10	85	0.4	19	<2	16	<5	3	24	<0.5	285	5	1581	69	742	113	114
23513	BD-N-1	716.7	723.0	507	5	<10	13	<0.2	<5	5	36	5	3	5	0.7	27	<1	317	16	222	82	20
23514	BD-N-1	742.0	752.0	603	3	<10	7	<0.2	<5	4	36	<5	1	2	<0.5	26	<1	94	10	58	66	18
23594	BD-P-2	156.0	163.0	140	1	<10	4	<0.2	<5	4	28	11	10	2	<0.5	<5	<1	39	4	88	96	24
23595	BD-P-2	342.0	343.3	100	<1	<10	6.5	<0.2	<5	<2	287	10	9	11	<0.5	<5	<1	169	4	131	58	12
23596	BD-P-2	414.0	422.0	87	<1	<10	1	<0.2	<5	<2	30	12	11	5	<0.5	<5	<1	26	<2	103	54	12
23597	BD-P-2	548.0	552.0	61	<1	<10	1	<0.2	<5	4	28	7	9	1	<0.5	<5	<1	35	4	61	144	26
23598	BD-P-2	622.0	628.0	88	<1	<10	0.5	<0.2	<5	4	21	9	8	7	<0.5	<5	<1	32	5	89	95	20
23599	BD-P-2	628.0	632.0	164	2	<10	3	<0.2	<5	5	36	<5	2	7	<0.5	12	<1	304	8	65	39	25
23840	LW-346-1	280.0	287.3	235	<1	<10	2	<0.2	17	3	37	<5	<1	13	<0.5	9	1	50	10	55	65	42
23841*	LW-346-1	535.0	546.0	146	3	<10	2	0.2	<5	12	18	2	3.5	7	<0.5	9	2	137	7	69	29	20
23838*	LW-346-2	247.7	259.6	218	<1	<10	3	0.2	<5	13	16	15	11	4	<0.5	<5	<1	39	6	56	44	21
23839	LW-346-2	425.0	436.0	309	1	<10	5	<0.2	<5	15	21	14	10	3	<0.5	<5	<1	34	4	80	125	39

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
23532	MDD-1	229.0	240.5	251	1	<10	1	<0.2	<5	4	791	<5	2	<1	<0.5	5	<1	43	7	17	9	9
23533	MDD-1	252.0	262.0	480	<1	<10	1.5	<0.2	<5	8	476	<5	2	3	<0.5	<5	<1	77	9	44	12	18
23534	MDD-1	303.5	308.4	510	<1	<10	1	<0.2	<5	5	<10	14	10	5	<0.5	<5	<1	58	3	51	265	29
23535	MDD-1	316.0	326.0	281	<1	<10	2	<0.2	<5	5	20	<5	1	1	<0.5	<5	<1	35	4	17	14	5
23536	MDD-1	372.0	382.0	719	<1	<10	5.5	<0.2	<5	7	35	<5	4	4	0.6	<5	<1	40	6	40	17	10
23537	MDD-1	412.8	421.0	433	1	<10	2	<0.2	<5	7	778	<5	4	3	0.6	<5	<1	60	5	37	41	13
23554	MDD-1	421.0	432.0	494	<1	<10	1	<0.2	<5	7	32	<5	2	4	<0.5	<5	<1	51	6	39	11	15
23555	MDD-1	463.0	474.0	538	<1	<10	3	<0.2	<5	5	27	12	10	4	<0.5	<5	<1	50	7	41	256	33
23556	MDD-1	538.0	552.0	385	2	<10	4	<0.2	<5	6	35	7	8	4	<0.5	<5	<1	69	6	115	34	18
23417	MED-1	174.0	185.0	1471	2	<10	1	0.2	<5	4	11	<5	<1	<1	0.7	<5	<1	25	35	8	7	2
23418	MED-1	185.0	194.0	3004	<1	<10	<1	<0.2	<5	4	12	<5	<1	2	<0.5	<5	<1	38	19	9	6	4
23419	MED-1	204.0	209.0	1248	<1	<10	<1	<0.2	<5	4	11	6	1	1	<0.5	<5	<1	22	20	31	9	3
23420	MED-1	209.0	213.5	1558	<1	<10	<1	<0.2	6	<2	11	<5	2	6	<0.5	<5	2	109	23	390	30	27
23421	MED-1	213.5	224.0	627	<1	<10	<1	<0.2	13	<2	24	<5	2	5	<0.5	<5	2	146	<2	612	25	39
23422	MED-1	424.0	436.1	615	<1	<10	<1	<0.2	<5	5	11	7	7	7	<0.5	<5	2	87	9	105	44	31
23423	MED-1	441.0	451.0	167	3	<10	1	<0.2	12	<2	10	<5	3	14	<0.5	<5	<1	57	<2	391	43	29
23424	MED-1	451.0	456.0	337	<1	<10	2	<0.2	<5	2	15	<5	2	5	0.5	<5	1	46	10	184	24	25
23425	MED-1	456.0	459.9	519	<1	<10	1	<0.2	<5	5	13	<5	<1	1	0.6	<5	<1	31	4	26	17	8
23426	MED-1	459.9	469.0	276	<1	<10	<1	<0.2	<5	8	21	<5	<1	<1	0.5	<5	<1	45	3	19	16	9
23438	MMD-1	175.0	188.0	220	2	<10	2	<0.2	<5	8	33	<5	2	3	<0.5	<5	<1	175	5	72	47	22
23439	MMD-1	188.0	196.5	182	2	<10	8	<0.2	<5	4	35	<5	2	5	<0.5	21	1	572	15	243	59	22
23440	MMD-1	379.0	390.9	132	<1	<10	0.5	<0.2	<5	6	35	11	11	3	<0.5	<5	<1	21	3	139	18	15
23441	MMD-1	415.3	430.5	131	<1	<10	<0.5	<0.2	<5	6	33	12	11	4	0.5	<5	<1	23	<2	133	13	13
23442	MMD-1	481.5	493.0	118	<1	<10	1	<0.2	<5	5	36	12	11	5	<0.5	<5	<1	30	<2	132	20	17
23589	MQD-1	152.0	162.0	94	<1	<10	1.5	<0.2	<5	6	31	11	10	7	<0.5	<5	<1	38	3	160	63	22
23590	MQD-1	277.0	288.0	154	1	<10	<0.5	<0.2	<5	6	27	15	18	5	<0.5	<5	<1	97	6	141	50	18
23593	MQD-1	298.0	308.0	314	<1	<10	0.5	<0.2	<5	7	36	10	10	9	<0.5	<5	<1	43	5	87	24	13
23591	MQD-1	322.0	332.0	183	2	<10	2	<0.2	<5	5	24	14	16	5	<0.5	<5	<1	29	4	137	29	14
23592	MQD-1	346.0	356.0	103	<1	<10	1	<0.2	<5	4	60	13	13	4	<0.5	<5	<1	63	5	248	37	21
23580	MQD-2	132.0	142.0	185	4	<10	1	<0.2	<5	6	216	11	11	3	<0.5	<5	<1	84	6	78	25	23
23581	MQD-2	162.0	171.6	232	2	<10	40	<0.2	9	4	26	38	6	11	0.5	12	4	1521	20	454	61	51
23582	MQD-2	176.5	190.0	340	<1	<10	<0.5	<0.2	<5	10	20	<5	2	4	<0.5	<5	<1	72	6	93	34	25
23583	MQD-2	191.0	197.0	223	<1	<10	17.5	<0.2	<5	7	28	<5	2	<1	<0.5	<5	<1	56	11	21	19	13
23584	MQD-2	202.0	212.0	404	1	<10	<0.5	<0.2	<5	11	23	<5	3	2	<0.5	<5	<1	71	7	89	9	23
23585	MQD-2	212.0	224.0	441	1	<10	2	<0.2	<5	10	19	<5	2	1	<0.5	<5	1	65	4	80	8	23
23586	MQD-2	232.0	242.0	469	<1	<10	<0.5	<0.2	<5	11	24	<5	<1	<1	<0.5	<5	<1	72	7	83	11	25
23587	MQD-2	252.0	262.0	167	1	<10	3.5	<0.2	<5	6	31	9	10	3	<0.5	<5	<1	55	3	98	33	22
23588	MQD-2	344.0	356.0	121	<1	<10	3	<0.2	<5	<2	31	11	16	6	<0.5	<5	<1	46	2	130	48	30
23814*	MSD-1	345.0	357.0	106	1.5	<10	2	<0.2	<5	12	30.5	16	16	5	<0.5	0.5	<1	24	4	86	125	20
23850	RR-16-1	52.0	62.0	141	<1	<10	1	0.2	<5	11	15	7	9	<1	<0.5	6	<1	25	9	73	41	17
23851	RR-16-1	136.0	146.0	149	2	<10	2	<0.2	<5	9	22	10	10	5	<0.5	<5	<1	61	8	143	83	52
23730*	YWL-1	329.0	339.0	67.5	<1	<10	1	<0.2	<5	11	21	14	11	1	1.5	<5	<1	41	6	82	156	28
23733	YWL-1	506.0	516.0	116	<1	<10	3	<0.2	<5	11	17	16	11	5	1	<5	1	38	5	91	46	23
23704	YWM-1	290.0	300.0	369	<1	<10	1	0.3	<5	6	40	<5	1	2	<0.5	10	<1	67	<2	41	12	7
23705	YWM-1	323.0	333.0	622	<1	<10	1	0.3	<5	8	67	<5	1	2	<0.5	10	<1	64	3	41	27	16

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
23706	YWM-1	365.0	375.0	488	<1	<10	<1	0.3	<5	6	60	<5	<1	<1	<0.5	10	<1	49	<2	41	18	10
23707	YWM-1	408.0	419.0	262	<1	<10	<1	0.3	<5	8	25	<5	1	1	<0.5	10	<1	52	3	35	17	10
23708	YWM-1	465.0	475.0	688	<1	<10	<1	0.7	<5	4	10	<5	<1	2	0.6	10	<1	27	3	23	18	10
23709	YWM-1	484.2	491.0	187	<1	<10	<1	0.3	<5	5	60	<5	4	4	<0.5	10	<1	55	5	83	27	18
23710	YWM-1	527.0	537.3	168	<1	<10	1	0.4	<5	6	86	6	5	5	<0.5	14	<1	55	5	88	28	18
23711	YWM-1	537.3	551.0	187	<1	<10	1	0.2	<5	4	30	11	10	6	<0.5	10	<1	32	<2	97	25	16
23712	YWM-1	577.0	587.0	194	<1	<10	1	0.3	<5	3	24	12	10	4	<0.5	14	<1	31	<2	106	25	16
23603	YWQ-1	480.0	501.0	495	<1	<10	2	<0.2	<5	5	130	<5	2	1	<0.5	<5	<1	82	5	46	40	17
23604	YWQ-1	673.0	683.0	458	<1	<10	1	<0.2	<5	<2	64	<5	1	21	1.1	<5	<1	332	27	59	22	14
23605	YWQ-1	739.5	748.6	286	1	<10	1	<0.2	5	7	60	<5	2	3	<0.5	<5	<1	56	6	19	26	12
23606	YWQ-1	816.0	826.0	267	1	<10	2	<0.2	<5	6	28	<5	1	1	<0.5	<5	<1	64	4	26	24	10
23607	YWZ-1	295.0	306.0	71	<1	<10	1	<0.2	<5	5	23	6	3	2	<0.5	5	<1	47	5	62	52	27
23658	YWZ-1	417.5	428.0	64	<1	<10	4	0.5	<5	3	18	7	4	1	<0.5	10	2	70	2	188	342	49
23608	YWZ-1	553.0	560.0	127	2	<10	8	0.2	<5	5	87	9	10	3	<0.5	5	<1	69	6	145	47	30
23609	YWZ-1	725.5	730.2	50	<1	<10	7	0.7	<5	<2	770	8	10	2	<0.5	13	<1	53	<2	38	63	28
23610	YWZ-1	778.0	785.5	91	3	<10	3	0.4	<5	2	47	11	15	3	<0.5	14	2	237	<2	186	83	41
23611	YWZ-1	799.0	806.5	64	<1	<10	2	0.4	6	<2	35	11	14	1	<0.5	7	<1	148	6	232	70	42
23684	YWZ-2	311.0	321.0	457	<1	<10	2	0.4	<5	5	24	<5	1	<1	<0.5	7	<1	48	<2	28	229	30
23685	YWZ-2	369.0	375.0	358	<1	<10	3	0.4	<5	3	22	<5	3	<1	<0.5	10	<1	47	3	37	357	42
23686	YWZ-2	383.0	393.0	116	1	<10	4	0.4	<5	<2	18	<5	<1	<1	<0.5	17	<1	29	<2	18	406	46
23687	YWZ-2	393.0	403.8	219	<1	<10	7	0.4	5	5	16	<5	<1	<1	<0.5	7	<1	33	<2	27	336	39
23688	YWZ-2	443.0	453.0	56	<1	<10	1	0.2	<5	<2	11	6	9	5	<0.5	10	<1	47	4	128	76	33
23689	YWZ-2	463.0	473.0	71	<1	<10	10	0.5	<5	<2	<10	<5	3	<1	<0.5	10	<1	46	<2	32	340	53
23690	YWZ-2	636.3	643.8	97	11	<10	1	4.4	12	<2	50	<5	1	1	0.9	257	18	6521	101	922	182	118
23691	YWZ-2	643.8	655.0	479	<1	<10	<1	0.3	<5	6	77	<5	<1	<1	<0.5	17	<1	133	3	50	23	13

* = Average of two duplicate analyses.

Sample	DDH	Footage Top	Footage Bottom	Sn ppm	W ppm	Mo ppm	Cr (XRF) ppm	Cr (ICP) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
23448	40917	229.0		<20	<10	<1	254	130	47	<1	9	15	33	6	5	9	34	16	<0.5	43	14
23449	40917	233.0		<20	<10	<1	267	119	49	2	<3	12	25	5	5	8	93	18	<0.5	59	14
23450	40917	252.0		<20	<10	<1	241	162	46	1	<3	13	29	7	5	10	33	21	<0.5	63	15
23451	40917	266.0		<20	<10	<1	322	186	38	2	<3	16	33	5	6	11	59	12	<0.5	<20	30
23452	40917	353.0		<20	<10	<1	186	100	89	2	<3	8	18	4	9	8	28	6	<0.5	24	11
23443	40918	280.5		<20	<10	<1	218	65	30	1	5	10	15	5	2	2	74	93	<0.5	<20	11
23444	40918	287.0		<20	<10	<1	156	74	31	1	<3	10	21	8	2	2	57	61	<0.5	<20	11
23445	40918	333.0		<20	<10	<1	211	108	35	<1	6	11	28	8	2	3	72	45	<0.5	<20	11
23446	40918	433.0		<20	<10	2	158	134	29	2	12	11	21	9	2	4	23	42	<0.5	<20	11
23447	40918	447.0		<20	<10	<1	168	110	35	1	<3	13	25	10	2	3	67	31	<0.5	<20	10
23833	40919	534.0		<20	<10	2	252	141	27	1	7	20	48	3	5	12	24	25	<0.5	99	8
23830	40920	434.0		<20	<10	<1	114	86	131	<1	18	9	16	3	12	8	6	20	<0.5	102	14
23831*	40920	454.0		<20	<10	3	153	68	263	2	<3	15	18	5	27	18	<5	13	<0.5	54	45
23403	40926	166.0		<20	<10	<1	138	59	92	2	8	16	30	10	16	12	35	49	<0.5	<20	21
23404	40926	175.5		<20	<10	2	370	179	46	2	14	16	30	14	6	7	22	32	<0.5	<20	19
23405	40926	178.5		<20	<10	<1	56	37	82	1	<3	18	33	9	15	18	32	28	<0.5	<20	19
23406	40926	222.0		<20	<10	<1	1173	562	110	5	<3	13	16	6	15	8	115	21	<0.5	31	21
23407	40926	334.0		<20	<10	<1	2981	1248	60	8	9	11	<5	4	11	5	<5	34	<0.5	<20	1
23408	40926	344.0		<20	<10	<1	2538	1108	56	3	<3	6	6	5	6	3	<5	7	<0.5	30	7
23409	40926	372.4		<20	<10	<1	334	234	76	1	3	27	50	16	8	6	89	16	<0.5	44	22
23410	40926	412.0		<20	<10	<1	312	201	83	1	<3	25	48	16	9	7	48	10	<0.5	27	19
23834	B-B-2	194.0		<20	<10	<1	1665	482	36	2	<3	5	11	<1	4	2	861	18	<0.5	<20	25
23835	B-B-2	306.0		<20	<10	<1	603	157	45	<1	<3	5	16	3	6	6	15	24	<0.5	<20	5
23565	B-Q-1	96.1		<20	<10	3	157	76	48	1	10	4	<5	3	4	4	19	38	<0.5	79	8
23566	B-Q-1	106.1		<20	<10	2	208	124	87	<1	<3	3	<5	3	10	5	53	10	<0.5	95	15
23567	B-Q-1	161.0		<20	<10	<1	93	79	49	2	9	4	<5	2	4	4	10	34	<0.5	<20	5
23568	B-Q-1	224.0		<20	<10	2	60	58	33	<1	6	26	53	4	6	9	421	33	<0.5	22	25
23569	B-Q-1	344.0		<20	<10	<1	126	125	103	2	<3	5	<5	4	8	6	18	24	<0.5	38	18
23570	B-Q-1	360.0		<20	<10	5	61	68	16	5	4	21	23	16	3	6	7	10	<0.5	54	6
23828	B21-1	174.0		<20	<10	2	423	193	83	<1	3	11	15	3	10	6	100	41	<0.5	<20	15
23829	B21-1	210.0		<20	<10	2	234	129	111	<1	7	13	12	4	7	7	57	58	<0.5	72	6
23823	B21-2	239.0		<20	<10	3	274	180	87	<1	4	16	21	5	12	8	95	18	<0.5	116	14
23825	B21-2	625.0		<20	<10	1	309	173	55	<1	26	25	53	4	4	5	121	44	<0.5	61	16
23826	B21-3	387.0		<20	<10	<1	355	201	91	<1	23	13	26	2	10	8	307	68	<0.5	124	15
23827	B21-3	407.0		<20	<10	6	212	154	79	<1	16	14	11	5	8	5	101	43	<0.5	31	11
23747	B24-1	352.5		<20	<10	1	220	135	8	1	<3	24	56	25	1	8	18	4	<0.5	23	8
23749	B24-1	509.0		<20	<10	2	260	237	136	<1	<3	12	9	5	7	6	240	65	<0.5	<20	17
23760	B24-2	493.0		<20	<10	<1	116	147	32	<1	4	17	37	5	3	3	107	20	<0.5	67	16
23762	B24-2	579.6		<20	<10	<1	163	129	22	<1	<3	14	28	5	3	3	491	23	<0.5	80	34
23772*	B24-3	442.0		<20	<10	2	308	136	81	<1	<3	17	12	5	8	6	110	23	<0.5	90	14
23801	B24-4	652.0		<20	<10	<1	577	359	239	<1	7	5	10	<1	26	4	52	9	<0.5	48	35
23808	B24-4	1372.0		<20	<10	2	248	133	107	<1	<3	13	10	4	8	5	23	20	<0.5	60	5
23453	B31-1	215.7		<20	<10	11	243	182	20	<1	14	15	32	7	2	4	51	14	<0.5	<20	14
23454	B31-1	223.0		<20	<10	4	219	152	12	<1	3	19	43	8	1	3	75	13	<0.5	24	8
23455	B31-1	253.0		<20	<10	5	187	128	6	<1	<3	17	39	8	<1	3	95	8	<0.5	<20	11

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	Sn ppm	W ppm	Mo ppm	Cr (XRF) ppm	Cr (ICP) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
23456	B31-1	265.0		<20	<10	2	276	198	5	<1	<3	14	30	9	<1	3	103	12	<0.5	28	10
23457	B31-1	274.7		<20	<10	32	193	132	9	<1	<3	14	30	10	1	3	83	21	<0.5	53	9
23458	B31-1	318.4		<20	31	<1	219	151	81	4	<3	14	19	9	5	6	12	14	<0.5	43	6
23459	B31-1	429.7		<20	<10	<1	109	121	71	3	<3	8	8	6	5	5	13	10	<0.5	<20	27
23460	B31-1	453.0		<20	<10	8	181	119	61	2	26	7	8	5	7	6	<5	12	<0.5	59	15
23461	B31-1	510.0		<20	<10	<1	144	179	90	3	<3	10	7	10	7	7	40	33	<0.5	31	36
23462	B31-1	698.0		<20	<10	16	231	146	11	<1	3	12	24	9	<1	2	14	15	<0.5	52	7
23371	B31-2	335.0		<20	<10	2	329	187	47	<1	<3	11	22	7	3	3	37	10	<0.5	38	30
23372	B31-2	353.0		<20	<10	2	302	199	12	<1	<3	15	32	6	<1	2	75	13	<0.5	<20	20
23373	B31-2	364.8		<20	<10	<1	335	170	34	3	<3	20	34	9	2	3	51	113	<0.5	64	33
23374	B31-2	376.7		<20	<10	14	296	215	32	<1	6	20	40	8	2	2	88	25	<0.5	22	18
23375	B31-2	483.0		<20	18	4	157	156	109	2	<3	7	6	5	7	6	18	19	<0.5	<20	16
23376	B31-2	673.0		<20	<10	<1	171	216	120	4	<3	13	14	7	9	9	48	59	<0.5	<20	68
23377	B31-2	805.0		<20	<10	10	195	211	156	2	<3	9	10	5	7	7	23	10	<0.5	32	25
23378	B31-2	920.8		<20	<10	1	52	89	49	5	6	94	195	82	2	17	66	150	<0.5	57	46
23379	B31-2	925.4		<20	<10	1	166	191	128	3	<3	11	11	8	8	7	42	26	<0.5	77	56
23380	B31-2	948.0		<20	<10	<1	233	215	138	4	<3	16	15	9	9	7	52	26	<0.5	119	50
23434*	B31-3	215.0		<20	<10	<1	85	69	164	5.5	<3	19.5	35.5	23.5	6	13.5	29	20.5	<0.5	74	58.5
23437	B31-3	445.0		<20	<10	3	61	68	154	1	<3	22	33	30	8	14	71	43	<0.5	46	38
23381	B31-3	475.5		<20	<10	<1	63	50	138	4	<3	23	38	36	6	13	61	45	<0.5	<20	41
23382	B31-3	505.0		<20	<10	93	287	185	10	2	<3	16	28	13	2	3	42	21	<0.5	<20	2
23383	B31-3	514.0		<20	<10	<1	116	127	17	3	<3	16	32	17	2	4	29	41	<0.5	44	1
23384	B31-3	525.0		<20	<10	3	221	190	84	<1	<3	11	21	19	7	6	31	20	<0.5	<20	13
23435*	B31-4	135.0		<20	<10	<1	88	57	134	4	<3	20.5	36	21	3.5	12	32	33	<0.5	87	27
23385	B31-4	163.5		<20	<10	<1	63	61	127	4	<3	20	36	26	4	11	57	40	<0.5	65	45
23386	B31-4	168.0		<20	<10	<1	208	177	113	<1	<3	9	14	11	7	8	17	15	<0.5	<20	10
23387	B31-4	174.9		<20	<10	<1	100	128	31	3	7	16	23	12	3	4	8	43	<0.5	38	3
23388	B31-4	197.6		<20	<10	<1	292	200	70	<1	<3	14	26	13	6	5	37	24	<0.5	58	14
23389	B31-4	208.2		<20	<10	92	255	150	10	2	14	16	25	13	2	3	38	22	<0.5	<20	1
23390	B31-4	289.5		<20	<10	7	239	198	32	1	<3	13	25	14	3	4	34	32	<0.5	27	5
23391	B31-4	305.6		<20	<10	2	196	140	14	<1	3	14	29	13	1	2	29	14	<0.5	<20	3
23392	B31-4	393.0		<20	<10	2	174	113	10	<1	<3	13	26	13	<1	2	40	20	<0.5	<20	5
23393	B31-4	444.0		<20	<10	37	309	143	7	<1	<3	8	18	8	<1	1	41	8	<0.5	26	2
23394	B31-4	465.0		<20	<10	4	134	107	10	1	<3	15	30	10	<1	2	20	18	<0.5	22	<1
23436*	B31-5	163.0		<20	<10	2	81	90	175	<1	8	16	24	40	8.5	11.5	35.5	27	<0.5	34	75.5
23395	B31-5	167.0		<20	<10	<1	196	147	77	3	<3	9	10	5	6	6	<5	68	<0.5	26	10
23396	B31-5	190.0		<20	<10	<1	125	137	66	2	7	7	6	5	5	6	<5	71	<0.5	<20	7
23397	B31-5	235.0		<20	<10	8	131	154	86	2	8	7	<5	7	7	7	21	57	<0.5	22	32
23398	B31-5	432.0		<20	<10	<1	158	168	117	3	3	10	5	7	9	7	13	72	<0.5	<20	25
23399	B31-5	455.3		<20	<10	<1	101	170	107	5	5	19	10	13	10	10	52	25	<0.5	121	79
23400	B31-5	465.0		<20	<10	<1	163	182	121	3	<3	14	12	16	9	8	53	21	<0.5	171	90
23401	B31-5	538.0		<20	<10	<1	153	172	135	4	<3	12	7	10	10	8	42	15	<0.5	130	56
23402	B31-5	665.0		<20	<10	6	185	168	112	3	9	6	5	6	11	6	37	15	<0.5	<20	30
23411	B35-1	259.4		<20	<10	<1	501	245	82	3	<3	8	11	4	10	8	8	8	<0.5	<20	18
23412	B35-1	268.0		<20	<10	<1	486	197	79	3	<3	9	13	4	12	8	10	18	<0.5	<20	18

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	Sn ppm	W ppm	Mo ppm	Cr (XRF) ppm	Cr (ICP) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
23413	B35-1	275.3		<20	<10	3	308	105	10	<1	<3	10	23	9	2	4	18	22	<0.5	28	3
23414	B35-1	289.3		<20	<10	1	312	124	38	<1	<3	24	49	12	3	8	68	35	<0.5	64	15
23415	B35-1	295.0		<20	<10	<1	356	258	98	1	4	31	56	19	12	9	368	14	<0.5	23	29
23416	B35-1	385.0		<20	<10	<1	292	215	95	2	<3	31	59	15	12	10	283	10	<0.5	67	27
23474	B5-1	155.0		<20	<10	<1	759	197	51	2	<3	3	<5	4	6	5	8	15	<0.5	<20	16
23478	B5-1	268.2		<20	<10	<1	56	45	52	3	7	4	<5	3	6	5	<5	7	<0.5	87	10
23480	B5-1	381.0		<20	<10	<1	761	298	75	3	<3	5	<5	3	5	3	17	9	<0.5	<20	32
23483	B5-1	430.5		<20	<10	1	113	87	34	<1	6	11	20	7	3	3	15	5	<0.5	<20	35
23489	B5-1	471.7		<20	<10	2	239	163	88	2	4	5	<5	3	8	5	14	13	<0.5	34	35
23490	B5-1	675.0		<20	<10	3	156	113	26	<1	<3	15	29	17	2	4	47	15	<0.5	<20	18
23600	B54-1	213.0		<20	<10	3	470	199	158	5	<3	13	<5	5	26	7	6	10	<0.5	42	19
23601	B54-1	268.0		<20	<10	2	289	118	59	3	21	8	<5	7	8	4	21	11	<0.5	<20	8
23602	B54-1	320.0		<20	<10	1	106	53	70	3	10	8	5	7	8	5	7	3	<0.5	95	9
23427	B58-1	165.0		<20	<10	2	167	130	31	1	7	16	32	10	2	3	45	29	<0.5	43	10
23428	B58-1	210.0		<20	<10	<1	220	182	48	2	<3	16	29	8	3	3	68	26	<0.5	23	12
23429	B58-1	225.0		<20	<10	<1	166	144	31	2	<3	17	33	12	2	3	51	34	<0.5	<20	14
23430	B58-1	285.0		<20	<10	<1	223	161	39	2	<3	18	32	11	3	4	19	26	<0.5	<20	13
23431	B58-1	306.9		<20	<10	1	98	80	59	5	<3	12	<5	7	7	5	<5	14	<0.5	<20	14
23432	B58-1	320.0		<20	<10	2	132	168	108	4	14	8	<5	5	12	7	6	10	<0.5	51	15
23433	B58-1	401.0		<20	<10	2	73	79	35	1	<3	18	35	10	2	4	94	20	<0.5	74	13
23844	BD-1	244.0		<20	<10	5	137	62	79	<1	<3	23	32	16	7	10	80	55	<0.5	62	12
23845	BD-1	355.0		<20	<10	<1	283	173	33	<1	<3	13	30	7	3	3	97	25	<0.5	102	19
23836	BD-2	304.0		<20	<10	1	139	130	69	<1	<3	16	38	7	6	7	87	40	<0.5	59	13
23837	BD-2	370.0		<20	<10	8	196	180	23	<1	18	11	16	12	5	6	28	13	<0.5	41	8
23842	BD-3	362.0		<20	<10	<1	144	103	34	<1	15	10	23	8	4	2	104	39	<0.5	<20	18
23843	BD-3	404.0		<20	<10	4	173	126	11	<1	<3	17	43	19	2	6	44	28	<0.5	116	10
23846*	BD-II-1	592.0		<20	<10	1	112	149	29	<1	<3	14	30	10	2	3	184	18	<0.5	107	13
23847	BD-II-1	653.0		<20	<10	2	174	124	98	<1	<3	16	33	5	11	7	151	26	<0.5	23	18
23848	BD-II-2	314.0		<20	<10	9	122	100	69	<1	30	6	15	4	7	6	32	12	<0.5	53	12
23849*	BD-II-2	486.0		<20	<10	<1	93	91	79	<1	5.5	8	16	3.5	7.5	7.5	31	8.5	<0.5	50	10.5
23510	BD-N-1	474.5		<20	17	14	320	164	13	3	<3	8	12	16	3	3	29	5	<0.5	42	11
23511	BD-N-1	515.0		<20	<10	319	162	140	16	4	<3	7	8	11	6	5	<5	6	<0.5	38	3
23512	BD-N-1	607.0		<20	<10	17	62	125	8	6	<3	16	11	22	4	4	6	9	<0.5	66	4
23513	BD-N-1	716.7		<20	<10	7	381	219	30	2	<3	16	33	18	2	5	33	20	<0.5	54	10
23514	BD-N-1	742.0		<20	<10	4	275	174	26	<1	<3	15	29	17	1	4	19	19	<0.5	30	6
23594	BD-P-2	156.0		<20	<10	1	608	157	55	1	17	5	<5	4	4	4	5	18	<0.5	83	23
23595	BD-P-2	342.0		<20	<10	2	161	102	33	2	<3	3	<5	4	2	6	<5	<1	<0.5	59	6
23596	BD-P-2	414.0		<20	<10	2	325	121	31	2	11	4	<5	3	3	6	<5	21	<0.5	<20	8
23597	BD-P-2	548.0		<20	<10	3	1202	346	53	2	<3	4	<5	3	4	4	<5	6	<0.5	51	17
23598	BD-P-2	622.0		<20	<10	<1	731	172	33	2	3	3	<5	2	3	3	18	47	<0.5	<20	10
23599	BD-P-2	628.0		<20	<10	2	221	130	34	1	5	13	20	11	3	4	46	12	<0.5	82	9
23840	LW-346-1	280.0		<20	<10	6	244	106	47	<1	<3	25	43	18	5	7	182	21	<0.5	<20	18
23841*	LW-346-1	535.0		<20	<10	3	246	196	50	<1	<3	11	23	4	6	4	100	17	<0.5	63	15
23838*	LW-346-2	247.7		<20	<10	<1	266.5	227	82	<1	3.5	6	15	2	11	6	565	27	<0.5	<20	16
23839	LW-346-2	425.0		<20	<10	2	448	299	75	<1	12	6	15	2	8	5	470	34	<0.5	72	25

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	Sn ppm	W ppm	Mo ppm	Cr (XRF) ppm	Cr (ICP) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
23532	MDD-1	229.0		<20	<10	<1	259	137	50	<1	<3	12	22	11	5	5	214	18	<0.5	82	17
23533	MDD-1	252.0		<20	<10	2	69	113	109	<1	<3	27	51	7	8	12	380	51	<0.5	90	29
23534	MDD-1	303.5		<20	<10	2	1685	845	76	3	<3	11	15	8	4	4	51	60	<0.5	38	27
23535	MDD-1	316.0		<20	<10	<1	53	121	33	<1	<3	11	22	7	2	4	30	44	<0.5	<20	6
23536	MDD-1	372.0		<20	<10	2	63	90	68	<1	<3	51	115	11	4	10	105	80	<0.5	78	12
23537	MDD-1	412.8		<20	<10	1	181	159	69	2	<3	22	43	6	7	7	518	52	<0.5	66	21
23554	MDD-1	421.0		<20	<10	<1	57	56	98	<1	8	18	31	5	7	8	289	41	<0.5	<20	18
23555	MDD-1	463.0		<20	<10	<1	1392	710	73	2	3	13	21	6	4	4	419	88	<0.5	95	30
23556	MDD-1	538.0		<20	<10	<1	104	86	84	<1	<3	17	30	6	9	10	240	20	<0.5	<20	10
23417	MED-1	174.0		<20	<10	3	55	106	29	2	13	7	10	16	1	3	25	33	<0.5	35	33
23418	MED-1	185.0		<20	<10	<1	111	142	48	<1	<3	3	6	18	<1	1	25	14	<0.5	44	114
23419	MED-1	204.0		<20	<10	<1	77	89	36	<1	<3	6	12	15	<1	2	20	14	<0.5	<20	39
23420	MED-1	209.0		<20	<10	72	272	77	409	4	5	14	23	19	1	3	11	9	<0.5	40	28
23421	MED-1	213.5		<20	<10	<1	625	48	708	7	10	25	28	12	2	2	48	15	<0.5	26	20
23422	MED-1	424.0		<20	<10	8	202	125	94	3	15	14	15	8	6	6	34	29	<0.5	52	29
23423	MED-1	441.0		<20	<10	<1	131	86	78	5	<3	22	24	9	2	3	<5	6	<0.5	23	3
23424	MED-1	451.0		<20	<10	<1	130	117	33	1	<3	13	21	8	2	3	24	14	<0.5	<20	22
23425	MED-1	456.0		<20	<10	<1	82	104	31	<1	<3	20	41	13	1	4	29	61	<0.5	23	18
23426	MED-1	459.9		<20	<10	7	89	130	36	<1	<3	15	29	7	2	4	27	24	<0.5	48	27
23438	MMD-1	175.0		<20	<10	2	100	102	68	2	3	13	23	8	6	6	47	10	<0.5	46	23
23439	MMD-1	188.0		<20	<10	3	130	138	43	2	19	12	21	11	3	5	15	9	<0.5	50	16
23440	MMD-1	379.0		<20	<10	2	59	41	58	1	4	4	<5	3	7	5	<5	19	<0.5	<20	9
23441	MMD-1	415.3		<20	<10	2	60	43	66	2	4	4	<5	2	8	6	<5	33	<0.5	<20	8
23442	MMD-1	481.5		<20	<10	1	55	39	68	1	18	4	6	2	7	6	<5	15	<0.5	34	9
23589	MQD-1	152.0		<20	<10	1	193	132	108	1	<3	5	<5	4	8	7	47	18	<0.5	<20	14
23590	MQD-1	277.0		<20	<10	3	132	96	52	2	<3	4	<5	2	5	4	24	43	<0.5	46	12
23593	MQD-1	298.0		<20	<10	3	88	83	57	<1	<3	34	66	13	8	11	131	15	<0.5	50	20
23591	MQD-1	322.0		<20	<10	2	115	82	56	1	<3	6	6	3	6	4	60	24	<0.5	<20	11
23592	MQD-1	346.0		<20	<10	2	77	94	70	2	<3	7	<5	5	9	7	9	15	<0.5	<20	12
23580	MQD-2	132.0		<20	<10	2	62	57	123	<1	<3	6	8	4	7	6	52	12	<0.5	54	17
23581	MQD-2	162.0		<20	<10	3	121	137	62	2	4	13	19	8	6	6	46	17	<0.5	86	8
23582	MQD-2	176.5		<20	<10	2	77	64	122	2	16	13	18	5	6	7	52	23	<0.5	58	20
23583	MQD-2	191.0		<20	<10	1	204	121	70	<1	<3	8	15	17	4	6	153	10	<0.5	78	18
23584	MQD-2	202.0		<20	<10	2	63	46	131	<1	<3	24	45	12	6	15	90	21	<0.5	78	13
23585	MQD-2	212.0		<20	<10	4	61	50	112	1	8	18	32	9	5	13	81	18	<0.5	50	13
23586	MQD-2	232.0		<20	<10	2	50	34	181	<1	<3	16	27	10	7	13	19	27	<0.5	<20	8
23587	MQD-2	252.0		<20	<10	<1	59	68	119	1	<3	6	<5	8	12	7	132	31	<0.5	79	22
23588	MQD-2	344.0		<20	<10	2	120	106	104	4	7	7	<5	4	10	5	34	10	<0.5	26	21
23814*	MSD-1	345.0		<20	<10	<1	733	211	42	<1	2.5	5	11	<1	6	3	29	27	<0.5	111	13
23850	RR-16-1	52.0		<20	<10	<1	305	118	52	<1	10	7	18	2	7	4	33	19	<0.5	26	14
23851	RR-16-1	136.0		<20	<10	1	252	173	65	<1	14	12	25	5	9	5	25	18	<0.5	<20	16
23730*	YWL-1	329.0		<20	<10	<1	1186	433	61	<1	<3	6	8	2	5	3	10	9	<0.5	103	29
23733	YWL-1	506.0		<20	<10	<1	304	153	91	<1	8	7	11	2	14	7	39	21	<0.5	92	13
23704	YWM-1	290.0		<20	<10	1	160	116	43	2	10	18	39	8	5	12	72	27	<0.5	27	22
23705	YWM-1	323.0		<20	<10	2	168	124	56	2	<3	18	42	14	6	10	93	20	<0.5	24	31

Appendix 278-D. Results of Chemical Analyses

Sample	DDH	Footage Top	Footage Bottom	Sn ppm	W ppm	Mo ppm	Cr (XRF) ppm	Cr (ICP) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
23706	YWM-1	365.0		<20	<10	1	161	102	43	2	3	17	38	8	5	10	69	20	<0.5	57	23
23707	YWM-1	408.0		<20	<10	2	155	107	58	2	5	19	41	8	6	13	185	13	<0.5	51	45
23708	YWM-1	465.0		<20	<10	2	152	80	24	3	<3	13	24	4	3	8	27	21	<0.5	32	14
23709	YWM-1	484.2		<20	11	2	171	125	91	3	13	8	13	4	10	7	9	24	<0.5	80	24
23710	YWM-1	527.0		<20	11	2	164	117	93	4	<3	8	13	5	10	7	8	24	<0.5	27	24
23711	YWM-1	537.3		<20	<10	2	151	96	79	3	9	5	<5	3	11	6	42	23	<0.5	83	16
23712	YWM-1	577.0		<20	<10	3	148	96	77	3	13	5	<5	2	10	6	36	24	<0.5	77	16
23603	YWQ-1	480.0		<20	<10	1	127	61	22	1	<3	14	29	10	2	3	15	12	<0.5	74	23
23604	YWQ-1	673.0		<20	<10	2	53	48	19	4	<3	13	13	10	2	6	20	33	<0.5	66	26
23605	YWQ-1	739.5		<20	<10	2	95	82	32	2	8	15	28	9	3	5	28	16	<0.5	38	17
23606	YWQ-1	816.0		<20	<10	2	55	107	33	2	<3	14	21	9	3	4	60	29	<0.5	50	12
23607	YWZ-1	295.0		<20	<10	<1	407	222	68	<1	<3	4	<5	5	7	3	7	24	<0.5	54	14
23658	YWZ-1	417.5		<20	<10	<1	3098	1817	101	5	<3	5	8	2	3	2	7	7	<0.5	<20	6
23608	YWZ-1	553.0		<20	<10	2	92	89	77	2	<3	6	<5	3	5	5	<5	10	<0.5	71	13
23609	YWZ-1	725.5		<20	<10	2	144	265	115	6	11	2	<5	<1	13	6	7	5	<0.5	47	19
23610	YWZ-1	778.0		<20	<10	<1	258	197	66	4	18	4	<5	<1	5	4	<5	6	<0.5	58	15
23611	YWZ-1	799.0		<20	<10	<1	266	229	88	6	<3	4	<5	2	6	4	14	3	<0.5	37	19
23684	YWZ-2	311.0		<20	<10	1	1851	947	70	3	6	29	64	12	4	5	177	20	<0.5	47	25
23685	YWZ-2	369.0		<20	<10	2	2916	1674	100	7	14	21	40	3	12	6	177	59	<0.5	21	18
23686	YWZ-2	383.0		<20	<10	2	3572	1686	71	7	9	6	<5	<1	16	3	9	120	<0.5	27	3
23687	YWZ-2	393.0		<20	<10	2	3995	2132	87	5	<3	12	26	3	11	2	56	24	<0.5	84	7
23688	YWZ-2	443.0		<20	<10	1	503	374	172	7	<3	6	<5	1	29	7	18	41	<0.5	28	22
23689	YWZ-2	463.0		<20	<10	2	2899	1384	107	8	16	5	<5	<1	20	4	11	45	<0.5	46	7
23690	YWZ-2	636.3		<20	<10	11	294	185	21	6	3	14	38	20	5	6	34	7	<0.5	<20	4
23691	YWZ-2	643.8		<20	<10	<1	168	118	43	1	7	16	38	13	4	7	45	22	<0.5	<20	17

* = Average of two duplicate analyses.

Appendix 278-E. Duplicate Samples and Statistics

Appendix E. CANMET GTS-1 Gold Tailings Standard and DNR Greenstone standard

DDH	Sample	SiO_2 %	TiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	P_2O_5 %	LOI %	Total %	S %
First Batch of Analyses														
GTS-1	21839	53.10	0.74	12.30	8.41	0.16	4.28	5.03	1.88	4.07	0.33	7.50	97.80	1.15
GTS-1	21841						4.39							
GTS-1	21843	52.70	0.69	12.60	8.49	0.17	4.35	5.11	1.92	3.96	0.64	7.45	98.07	1.42
GTS-1	21845						4.42							
GTS-1	21847	55.50	0.69	12.20	9.73	0.16	4.24	5.33	1.77	3.88	0.07	3.81	97.38	1.15
GTS-1	21849						4.46							
GTS-1	23473	50.30	0.82	12.80	10.20	0.18	5.02	6.14	2.27	4.94	0.36	6.66	99.70	1.15
Average		52.90	0.74	12.48	9.21	0.17	4.45	5.40	1.96	4.21	0.35	6.36	98.24	1.22
Standard Deviation		2.13	0.06	0.28	0.90	0.01	0.26	0.51	0.22	0.49	0.23	1.74	1.02	0.14
Variance		4.53	0.00	0.08	0.80	0.00	0.07	0.26	0.05	0.24	0.05	3.03	1.03	0.02
Second Batch of Analyses														
GTS-1	23852	53.00	0.71	12.60	8.92	0.15	4.59	5.31	1.82	4.21	0.22	6.40	97.93	1.06
GTS-1	23853	52.80	0.72	13.10	8.80	0.16	4.41	5.19	1.94	4.20	0.25	6.84	98.41	1.05
Average		52.90	0.72	12.85	8.86	0.16	4.50	5.25	1.88	4.21	0.24	6.62	98.17	1.06
Standard Deviation		0.14	0.01	0.35	0.08	0.01	0.13	0.08	0.08	0.01	0.02	0.31	0.34	0.01
Variance		0.02	0.00	0.13	0.01	0.00	0.02	0.01	0.01	0.00	0.00	0.10	0.12	0.00
Combined														
Average		52.90	0.73	12.60	9.09	0.16	4.46	5.35	1.93	4.21	0.31	6.44	98.22	1.16
Standard Deviation		1.65	0.05	0.33	0.72	0.01	0.23	0.40	0.18	0.38	0.19	1.36	0.80	0.13
Variance		2.72	0.00	0.11	0.52	0.00	0.05	0.16	0.03	0.14	0.04	1.85	0.64	0.02
First Batch of Analyses														
DNR Gst	21838	51.00	1.38	13.60	13.90	0.23	6.70	6.10	2.54	1.92	0.30	2.79	100.46	0.16
DNR Gst	21840						6.74							
DNR Gst	21842	51.30	1.49	13.80	14.00	0.22	6.75	6.02	2.67	1.85	0.63	2.90	101.63	0.24
DNR Gst	21844						6.90							
DNR Gst	21846	48.60	1.45	13.10	14.30	0.23	6.76	5.85	2.57	1.84	<0.01	2.89	97.59	0.05
DNR Gst	21848						6.76							
DNR Gst	21850	49.60	1.43	13.50	13.30	0.21	6.36	5.66	2.46	1.81	0.22	2.76	97.31	0.05
Average		50.13	1.44	13.50	13.88	0.22	6.71	5.91	2.56	1.86	0.29	2.84	99.25	0.13
Standard Deviation		1.26	0.05	0.29	0.42	0.01	0.17	0.20	0.09	0.05	0.26	0.07	2.13	0.09
Variance		1.58	0.00	0.09	0.18	0.00	0.03	0.04	0.01	0.00	0.07	0.00	4.55	0.01
Second Batch of Analyses														
DNR Gst	23854	50.20	1.48	14.10	13.60	0.21	6.55	5.83	2.54	1.79	0.14	2.53	98.97	0.07
DNR Gst	23855	50.30	1.41	13.70	13.50	0.20	6.42	5.74	2.45	1.82	0.18	2.83	98.55	0.07
Average		50.25	1.45	13.90	13.55	0.21	6.49	5.79	2.50	1.81	0.16	2.68	98.76	0.07
Standard Deviation		0.07	0.05	0.28	0.07	0.01	0.09	0.06	0.06	0.02	0.03	0.21	0.30	0.00
Variance		0.01	0.00	0.08	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.09	0.00
Combined														
Average		50.17	1.44	13.63	13.77	0.22	6.66	5.87	2.54	1.84	0.25	2.78	99.09	0.11
Standard Deviation		0.98	0.04	0.33	0.37	0.01	0.18	0.17	0.08	0.05	0.21	0.14	1.68	0.08
Variance		0.95	0.00	0.11	0.13	0.00	0.03	0.03	0.01	0.00	0.05	0.02	2.81	0.01

Appendix E. CANMET GTS-1 Gold Tailings Standard and DNR Greenstone standard

DDH	Sample	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
First Batch of Analyses																				
GTS-1	21839	597	1	<10	45	1.2	<5	<2	168	9	3	324	0.5	231	<1	133	31	84	79	25
GTS-1	21841			<10	41	<5	5					300	<0.5		<1	138	30	88	79	25
GTS-1	21843	580	3	<10	37	0.8	<5	<2	175	<5	3	323	0.6	264	<1	134	28	86	81	24
GTS-1	21845			<10	43	<5	6					320	<0.5		<1	151	32	87	80	26
GTS-1	21847	677	3	<10	30	0.4	<5	<2	166	<5	2	253	0.7	285	<1	148	42	93	89	30
GTS-1	21849			<10	58	<5	<5					310	0.8		<1	140	35	97	81	24
GTS-1	23473	622	<1	24	4	0.3	<5	<2	176	7	4	278	0.6	300	<1	146	38	92	84	26
Average		619.0	1.9	8.6	36.9	1.7	3.7	1.2	171.3	5.5	3.0	301.1	0.5	270.0	0.6	141.4	33.7	89.6	81.9	25.7
Standard Deviation		42.3	1.3	6.8	16.8	1.3	1.3	0.0	5.0	3.0	0.8	26.7	0.2	29.9	0.0	7.0	4.9	4.6	3.6	2.1
Variance		1792.7	1.6	46.3	282.5	1.6	1.6	0.0	24.9	9.0	0.7	714.8	0.0	894.0	0.0	49.3	24.2	21.0	12.8	4.2
Second Batch of Analyses																				
GTS-1	23852	527	4	<10	40	1.2	7	13	160	5	2	305	0.7	331	<1	150	39	97	82	27
GTS-1	23853	473	2	18	40	1.7	<5	14	161	<5	3	359	<0.5	306	1	147	36	96	83	27
Average		500.0	3.0	12.0	40.0	1.5	5.0	13.5	160.5	4.0	2.5	332.0	0.5	318.5	0.8	148.5	37.5	96.5	82.5	27.0
Standard Deviation		38.2	1.4	8.5	0.0	0.4	2.8	0.7	0.7	1.4	0.7	38.2	0.3	17.7	0.3	2.1	2.1	0.7	0.7	0.0
Variance		1458.0	2.0	72.0	0.0	0.1	8.0	0.5	0.5	2.0	0.5	1458.0	0.1	312.5	0.1	4.5	4.5	0.5	0.5	0.0
Combined																				
Average		579.3	2.3	9.3	37.6	1.6	4.0	5.3	167.7	5.0	2.8	308.0	0.5	286.2	0.6	143.0	34.6	91.1	82.0	26.0
Standard Deviation		71.7	1.3	6.8	14.6	1.1	1.6	6.4	6.8	2.5	0.8	30.1	0.2	35.0	0.1	6.9	4.6	5.0	3.1	1.9
Variance		5143.5	1.7	46.0	213.8	1.2	2.5	40.4	45.9	6.4	0.6	903.5	0.0	1226.2	0.0	47.3	21.5	25.1	9.8	3.5
First Batch of Analyses																				
DNR Gst	21838	308	<1	<10	<1	0.2	<5	14	18	9	3	<1	0.5	9	<1	85	2	83	18	24
DNR Gst	21840			<10	<5	<5	<5					1	<0.5		<1	136	4	92	18	26
DNR Gst	21842	292	<1	<10	<1	<0.2	<5	15	18	12	7	<1	<0.5	<5	2	83	<2	76	17	22
DNR Gst	21844			<10	<5	<5	<5					1	<0.5		<1	123	<2	91	17	25
DNR Gst	21846	305	<1	<10	0.5	<0.2	<5	15	24	8	7	1	<0.5	5	<1	91	8	90	20	26
DNR Gst	21848			<10	12	<5	<5					1	<0.5		<1	113	6	81	19	25
DNR Gst	21850	300	<1	12	2	<0.2	<5	15	28	10	8	1	<0.5	9	<1	109	8	94	23	28
Average		301.3	0.6	6.9	3.1	1.4	3.0	14.8	22.0	9.8	6.3	0.9	0.3	6.5	0.8	105.7	4.3	86.7	18.9	25.1
Standard Deviation		7.0	0.0	2.3	4.1	1.5	0.0	0.5	4.9	1.7	2.2	0.2	0.1	3.0	0.5	20.2	3.0	6.7	2.1	1.9
Variance		48.9	0.0	5.1	16.6	2.3	0.0	0.3	24.0	2.9	4.9	0.0	0.0	9.0	0.3	406.9	9.1	45.2	4.5	3.5
Second Batch of Analyses																				
DNR Gst	23854	246	3	<10	1	0.5	<5	19	24	10	7	1	<0.5	19	<1	104	8	91	21	27
DNR Gst	23855	248	<1	<10	1	0.2	<5	18	17	8	7	1	<0.5	19	<1	84	10	85	19	26
Average		247.0	1.8	6.0	1.0	0.4	3.0	18.5	20.5	9.0	7.0	1.0	0.3	19.0	0.6	94.0	9.0	88.0	20.0	26.5
Standard Deviation		1.4	1.7	0.0	0.0	0.2	0.0	0.7	4.9	1.4	0.0	0.0	0.0	0.0	0.0	14.1	1.4	4.2	1.4	0.7
Variance		2.0	2.9	0.0	0.0	0.0	0.0	0.5	24.5	2.0	0.0	0.0	0.0	0.0	0.0	200.0	2.0	18.0	2.0	0.5
Combined																				
Average		283.2	1.0	6.7	2.6	1.1	3.0	16.0	21.5	9.5	6.5	0.9	0.3	10.7	0.8	103.1	5.4	87.0	19.1	25.4
Standard Deviation		28.5	1.0	2.0	3.6	1.4	0.0	2.0	4.5	1.5	1.8	0.2	0.1	6.9	0.5	18.9	3.4	6.0	2.0	1.7
Variance		814.6	1.0	4.0	13.3	2.0	0.0	4.0	19.9	2.3	3.1	0.0	0.0	47.1	0.2	356.9	11.3	36.5	3.9	3.0

Appendix E. CANMET GTS-1 Gold Tailings Standard and DNR Greenstone standard

DDH	Sample	Sn ppm	W ppm	Mo ppm	Cr (ICP) ppm	Cr (XRF) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
First Batch of Analyses																			
GTS-1	21839	<20	<10	27	114	121	60	6	<3	31	49	25	9	9	223	373	<0.5	57	19
GTS-1	21841	<20	<10	29	112	140	60			28	54			8	233	380			
GTS-1	21843	<20	<10	28	106	95	56	5	9	30	47	22	8	8	212	362	<0.5	35	18
GTS-1	21845	<20	<10	28	114	149	61			28	52			9	237	391			
GTS-1	21847	<20	<10	34	135	123	70	6	9	34	49	29	10	10	248	415	<0.5	86	21
GTS-1	21849	<20	<10	28	110	108	59			29	42			8	221	362			
GTS-1	23473	<20	<10	31	120	113	62	5	17	33	45	28	9	9	222	382	<0.5	74	19
Average		12.0	6.0	29.3	115.9	121.3	61.1	5.5	9.2	30.4	48.3	26.0	9.0	8.7	228.0	380.7	0.3	63.0	19.3
Standard Deviation		0.0	0.0	2.4	9.5	18.5	4.3	0.6	6.2	2.4	4.1	3.2	0.8	0.8	12.1	18.5	0.0	22.1	1.3
Variance		0.0	0.0	5.9	89.5	342.9	18.8	0.3	38.6	5.6	16.6	10.0	0.7	0.6	145.3	340.6	0.0	490.0	1.6
Second Batch of Analyses																			
GTS-1	23852	<20	<10	30	126	152	65	<1	<3	35	69	18	10	9	242	412	<0.5	111	20
GTS-1	23853	<20	<10	29	120	91	64	<1	<3	32	65	25	10	9	243	409	<0.5	66	20
Average		12.0	12.0	29.5	123.0	121.5	64.5	0.6	1.8	33.5	67.0	21.5	10.0	9.0	242.5	410.5	0.3	88.5	20.0
Standard Deviation		0.0	0.0	0.7	4.2	43.1	0.7	0.0	0.0	2.1	2.8	4.9	0.0	0.0	0.7	2.1	0.0	31.8	0.0
Variance		0.0	0.0	0.5	18.0	1860.5	0.5	0.0	0.0	4.5	8.0	24.5	0.0	0.0	0.5	4.5	0.0	1012.5	0.0
Combined																			
Average		12.0	6.0	29.3	117.4	121.3	61.9	3.9	6.7	31.1	52.4	24.5	9.3	8.8	231.2	387.3	0.3	71.5	19.5
Standard Deviation		0.0	2.6	2.1	8.9	22.1	4.0	2.6	6.1	2.6	9.0	4.0	0.8	0.7	12.2	20.7	0.0	25.9	1.0
Variance		0.0	7.0	4.5	79.3	489.8	16.4	6.6	37.7	6.6	81.5	16.3	0.7	0.4	149.9	428.5	0.0	669.9	1.1
First Batch of Analyses																			
DNR Gst	21838	<20	<10	5	88	100	134	4	19	14	23	19	7	23	14	47	<0.5	<20	11
DNR Gst	21840	<20	<10	5	92	110	135			11	24			23	21	46			
DNR Gst	21842	<20	<10	3	87	91	133	4	<3	14	22	19	7	23	12	47	<0.5	28	11
DNR Gst	21844	<20	<10	5	92	112	136			12	23			23	20	46			
DNR Gst	21846	<20	<10	8	96	111	154	<1	16	14	20	20	9	27	17	60	<0.5	<20	13
DNR Gst	21848	<20	<10	7	88	103	137			12	18			24	20	52			
DNR Gst	21850	<20	<10	9	99	75	152	<1	<3	15	20	19	8	26	13	54	<0.5	<20	13
Average		12.0	6.0	6.0	91.7	100.3	140.1	2.3	9.7	13.1	21.4	19.3	7.8	24.1	16.7	50.3	0.3	16.0	12.0
Standard Deviation		0.0	0.0	2.1	4.5	13.4	8.9	2.0	9.1	1.5	2.1	0.5	1.0	1.7	3.7	5.3	0.0	8.0	1.2
Variance		0.0	0.0	4.3	20.2	179.9	79.1	3.9	83.7	2.1	4.6	0.3	0.9	2.8	13.9	28.2	0.0	64.0	1.3
Second Batch of Analyses																			
DNR Gst	23854	<20	<10	7	92	111	147	2	<3	15	30	21	9	26	18	63	<0.5	77	12
DNR Gst	23855	<20	<10	6	88	122	137	2	13	12	26	21	8	24	18	53	<0.5	<20	12
Average		12.0	6.0	6.5	90.0	116.5	142.0	2.0	7.4	13.5	28.0	21.0	8.5	25.0	18.0	58.0	0.3	44.5	12.0
Standard Deviation		0.0	0.0	0.7	2.8	7.8	7.1	0.0	7.9	2.1	2.8	0.0	0.7	1.4	0.0	7.1	0.0	46.0	0.0
Variance		0.0	0.0	0.5	8.0	60.5	50.0	0.0	62.7	4.5	8.0	0.0	0.5	2.0	0.0	50.0	0.0	2112.5	0.0
Combined																			
Average		12.0	6.0	6.1	91.3	103.9	140.6	2.2	8.9	13.2	22.9	19.8	8.0	24.3	17.0	52.0	0.3	25.5	12.0
Standard Deviation		0.0	0.0	1.8	4.1	13.9	8.1	1.5	8.0	1.5	3.6	1.0	0.9	1.6	3.3	6.2	0.0	26.0	0.9
Variance		0.0	0.0	3.4	16.8	193.6	66.3	2.3	64.1	2.2	12.9	1.0	0.8	2.5	10.8	39.0	0.0	677.5	0.8

Appendix E. Duplicate Sample Analyses

DDH	Sample	SiO_2 %	TiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	P_2O_5 %	LOI %	Total %	S %
First Batch of Analyses														
B31-3	23434A	48.40	1.83	14.10	12.80	0.39	5.90	7.01	3.45	1.87	0.22	2.17	98.70	0.15
B31-3	23434B	47.00	1.87	14.30	13.40	0.40	6.17	7.29	3.64	1.87	0.31	2.45	98.14	0.15
Average	23434	47.70	1.85	14.20	13.10	0.40	6.04	7.15	3.55	1.87	0.27	2.31	98.42	0.15
Standard Deviation		0.70	0.02	0.10	0.30	0.01	0.14	0.14	0.10	0.00	0.05	0.14	0.28	0.00
Variance		0.49	0.00	0.01	0.09	0.00	0.02	0.02	0.01	0.00	0.00	0.02	0.08	0.00
B31-4	23435A	49.30	1.88	14.30	14.00	0.23	6.01	8.00	3.20	1.29	0.58	2.08	98.11	0.12
B31-4	23435B	46.90	1.81	14.40	13.90	0.22	5.95	8.15	3.07	1.34	0.44	1.94	100.87	0.18
Average	23435	48.10	1.85	14.35	13.95	0.23	5.98	8.08	3.14	1.32	0.51	2.01	99.49	0.15
Standard Deviation		1.20	0.04	0.05	0.05	0.01	0.03	0.08	0.07	0.03	0.07	0.07	1.38	0.03
Variance		1.44	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	1.90	0.00
B31-5	23436A	49.20	1.93	14.80	12.20	0.34	5.95	7.01	4.46	1.30	0.15	2.49	97.86	0.48
B31-5	23436B	48.80	1.86	14.50	11.60	0.33	5.67	6.74	4.23	1.24	0.56	2.34	99.83	0.46
Average	23436	49.00	1.90	14.65	11.90	0.34	5.81	6.88	4.35	1.27	0.36	2.42	98.85	0.47
Standard Deviation		0.20	0.04	0.15	0.30	0.01	0.14	0.14	0.12	0.03	0.21	0.08	0.99	0.01
Variance		0.04	0.00	0.02	0.09	0.00	0.02	0.02	0.01	0.00	0.04	0.01	0.97	0.00
Second Batch of Analyses														
YWL-1	23730A	48.00	0.53	11.70	12.60	0.20	13.70	8.15	1.78	0.30	0.26	2.38	99.60	<0.02
YWL-1	23730B	48.20	0.56	11.56	12.13	0.20	13.97	8.16	1.78	0.29	0.14	2.43	99.42	<0.02
Average	23730	48.10	0.55	11.63	12.37	0.20	13.84	8.16	1.78	0.30	0.20	2.41	99.51	<0.02
Standard Deviation		0.10	0.02	0.07	0.24	0.00	0.14	0.01	0.00	0.01	0.06	0.03	0.09	0.00
Variance		0.01	0.00	0.00	0.06	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00
B24-3	23772A	43.00	0.40	8.75	27.80	0.95	4.45	6.38	1.35	0.38	0.13	4.87	98.46	5.23
B24-3	23772B													
Average	23772	43.00	0.40	8.75	27.80	0.95	4.45	6.38	1.35	0.38	0.13	4.87	98.46	5.23
Standard Deviation														
Variance														
MSD-1	23814A	49.90	0.54	13.72	12.50	0.33	7.51	11.09	1.80	0.32	0.08	1.19	98.98	0.12
MSD-1	23814B	49.60	0.55	13.44	12.88	0.33	7.72	11.28	1.82	0.33	0.13	1.24	99.32	0.11
Average	23814	49.75	0.55	13.58	12.69	0.33	7.62	11.19	1.81	0.33	0.11	1.22	99.15	0.12
Standard Deviation		0.15	0.01	0.14	0.19	0.00	0.11	0.10	0.01	0.01	0.03	0.03	0.17	0.01
Variance		0.02	0.00	0.02	0.04	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.00
40920	23831A	48.60	1.11	12.50	14.60	0.18	10.10	4.65	2.30	0.11	0.26	4.87	99.28	0.63
40920	23831B	48.10	1.10	12.30	14.50	0.18	10.00	4.56	2.27	0.12	0.20	4.78	98.11	0.61
Average	23831	48.35	1.11	12.40	14.55	0.18	10.05	4.61	2.29	0.12	0.23	4.83	98.70	0.62
Standard Deviation		0.25	0.01	0.10	0.05	0.00	0.05	0.05	0.02	0.01	0.03	0.05	0.59	0.01
Variance		0.06	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00

Appendix E. Duplicate Sample Analyses

DDH	Sample	SiO_2 %	TiO_2 %	Al_2O_3 %	Fe_2O_3 %	MnO %	MgO %	CaO %	Na_2O %	K_2O %	P_2O_5 %	LOI %	Total %	S %
LW-346-2	23838A	52.50	0.65	15.50	9.67	0.24	5.73	10.70	2.29	0.62	0.13	1.59	99.62	0.08
LW-346-2	23838B													
Average	23838	52.50	0.65	15.50	9.67	0.24	5.73	10.70	2.29	0.62	0.13	1.59	99.62	0.08
Standard Deviation														
Variance														
LW-346-1	23841A	58.90	0.39	12.80	9.95	0.25	2.78	5.41	3.23	0.87	0.12	5.26	99.96	1.99
LW-346-1	23841B													
Average	23841	58.90	0.39	12.80	9.95	0.25	2.78	5.41	3.23	0.87	0.12	5.26	99.96	1.99
Standard Deviation														
Variance														
BD-II-1	23846A	66.90	0.54	13.70	4.73	0.20	1.64	5.28	2.28	2.25	0.09	0.40	98.01	0.52
BD-II-1	23846B	67.10	0.54	13.80	4.86	0.20	1.65	5.38	2.32	2.31	0.14	0.40	98.70	0.55
Average	23846	67.00	0.54	13.75	4.80	0.20	1.65	5.33	2.30	2.28	0.12	0.40	98.36	0.54
Standard Deviation		0.10	0.00	0.05	0.07	0.00	0.01	0.05	0.02	0.03	0.03	0.00	0.35	0.02
Variance		0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00
BD-II-2	23849A	53.10	1.82	15.50	13.60	0.19	4.00	6.02	3.72	0.40	0.15	0.64	99.14	2.08
BD-II-2	23849B	54.24	1.83	13.54	13.63	0.20	3.98	6.16	3.78	0.41	0.14	0.97	98.88	1.97
Average	23849	53.67	1.83	14.52	13.62	0.20	3.99	6.09	3.75	0.41	0.15	0.81	99.01	2.03
Standard Deviation		0.57	0.01	0.98	0.02	0.01	0.01	0.07	0.03	0.01	0.01	0.17	0.13	0.06
Variance		0.32	0.00	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00

If only one analysis for a sample is above detection limits, that value is reported as the average and no standard deviation or variance is calculated (indicated by --).

Appendix E. Duplicate Sample Analyses

DDH	Sample	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
First Batch of Analyses																				
B31-3	23434A	536	<1	<10	1	<0.2	<5	12	27	<5	<1	<1	<0.5	<5	<1	87	2	25	49	31
B31-3	23434B	546	2	<10	1	<0.2	<5	11	28	<5	<1	2	0.5	<5	<1	89	2	29	47	30
Average	23434	541.0	2	<10	1.00	<0.2	<5	11.50	27.50	<5	<1	2	0.5	<5	<1	88.00	2.00	27.00	48.00	30.50
Standard Deviation		5.00	--	0.00	0.00	0.00	0.00	0.50	0.50	0.00	0.00	--	--	0.00	0.00	1.00	0.00	2.00	1.00	0.50
Variance		25.00	--	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.00	--	--	0.00	0.00	1.00	0.00	4.00	1.00	0.25
B31-4	23435A	447	<1	<10	1	<0.2	<5	12	28	<5	<1	<1	0.7	<5	<1	83	<2	42	45	30
B31-4	23435B	485	<1	<10	<1	<0.2	<5	11	28	<5	<1	3	<0.5	<5	<1	78	<2	40	45	30
Average	23435	466.0	<1	<10	1	0.00	0.00	11.50	28.00	0.00	0.00	3	0.7	<5	<1	80.50	<2	41.00	45.00	30.00
Standard Deviation		19.00	0.00	0.00	--	0.00	0.00	0.50	0.00	0.00	0.00	--	--	0.00	0.00	2.50	0.00	1.00	0.00	0.00
Variance		361.0	0.00	0.00	--	0.00	0.00	0.25	0.00	0.00	0.00	--	--	0.00	0.00	6.25	0.00	1.00	0.00	0.00
B31-5	23436A	576	3	<10	1	<0.2	<5	12	25	<5	4	2	<0.5	<5	<1	125	9	44	62	30
B31-5	23436B	589	<1	<10	1	<0.2	<5	12	18	<5	2	2	<0.5	<5	<1	116	10	47	67	34
Average	23436	582.5	3	<10	1.00	<0.2	<5	12.00	21.50	<5	3.00	2.00	<0.5	<5	<1	120.5	9.50	45.50	64.50	32.00
Standard Deviation		6.50	--	0.00	0.00	0.00	0.00	0.00	3.50	0.00	1.00	0.00	0.00	0.00	0.00	4.50	0.50	1.50	2.50	2.00
Variance		42.25	--	0.00	0.00	0.00	0.00	0.00	12.25	0.00	1.00	0.00	0.00	0.00	0.00	20.25	0.25	2.25	6.25	4.00
Second Batch of Analyses																				
YWL-1	23730A	72	<1	<10	1	<0.2	<5	11	21	14	11	1	1.5	<5	<1	41	6	82	156	28
YWL-1	23730B	63			1	<0.2			21					<5						
Average	23730	67.5	<1	<10	1	<0.2	<5	11	21	14	11	1	1.5	<5	<1	41	6	82	156	28
Standard Deviation		4.50			0.00	0.00			0.00					0.00						
Variance		20.25			0.00	0.00			0.00					0.00						
B24-3	23772A	182	<1	<10	7	0.2	9	6	52	7	9	12	<0.5	9	1	101	15	85	39	26
B24-3	23772B									12	10	14								
Average	23772	182	<1	<10	7	0.2	9	6	52	9.5	9.5	13	<0.5	9	1	101	15	85	39	26
Standard Deviation										2.50	0.50	1.00								
Variance										6.25	0.25	1.00								
MSD-1	23814A	101	1	<10	2	<0.2	<5	12	28	16	16	5	<0.5	6	<1	24	4	86	125	20
MSD-1	23814B	111	2		2	<0.2			33					<5						
Average	23814	106	1.5	<10	2	<0.2	<5	12	30.5	16	16	5	<0.5	6	<1	24	4	86	125	20
Standard Deviation		5.00	0.50		0.00	0.00			2.50					--						
Variance		25.00	0.25		0.00	0.00			6.25					--						
40920	23831A	289	<1	<10	2	<0.2	6	22	17	<5	<1	8	<0.5	9	<1	62	11	138	37	42
40920	23831B	272			2	<0.2			20					9						
Average	23831	280.5	<1	<10	2	<0.2	6	22	18.5	<5	<1	8	<0.5	9	<1	62	11	138	37	42
Standard Deviation		8.50			0.00	0.00			1.50					0.00						
Variance		72.25			0.00	0.00			2.25					0.00						

Appendix E. Duplicate Sample Analyses

DDH	Sample	F ppm	Se ppm	Te ppm	As ppm	Sb ppm	Bi ppm	Ga ppm	B ppm	Pt ppb	Pd ppb	Au ppb	Ag ppm	Hg ppb	Cd ppm	Zn ppm	Pb ppm	Cu ppm	Ni ppm	Co ppm
LW-346-2	23838A	218	<1	<10	3	0.2	<5	13	16	15	11	4	<0.5	<5	<1	39	6	56	44	21
LW-346-2	23838B		<1																	
Average	23838	218	<1	<10	3	0.2	<5	13	16	15	11	4	<0.5	<5	<1	39	6	56	44	21
Standard Deviation			0.00																	
Variance			0.00																	
LW-346-1	23841A	146	3	<10	2	0.2	<5	12	18	9	4	8	<0.5	9	2	137	7	69	29	20
LW-346-1	23841B									<5	3	6								
Average	23841	146	3	<10	2	0.2	<5	12	18	9	3.5	7	<0.5	9	2	137	7	69	29	20
Standard Deviation										--	0.50	1.00								
Variance										--	0.25	1.00								
BD-II-1	23846A	203	2	<10	2	0.2	<5	10	25	<5	<1	3	<0.5	6	<1	101	4	46	25	13
BD-II-1	23846B	236			2	0.2			25					9						
Average	23846	219.5	2	<10	2	0.2	<5	10	25	<5	<1	3	<0.5	7.5	<1	101	4	46	25	13
Standard Deviation		16.50			0.00	0.00			0.00					1.50						
Variance		272.2			0.00	0.00			0.00					2.25						
BD-II-2	23849A	262	1	<10	2	<0.2	<5	11	58	<5	<1	13	<0.5	6	<1	44	7	142	32	34
BD-II-2	23849B	267	<1	<10	1	<0.2	<5	11	63	<5	<1	11	<0.5	9	1	48	5	146	32	35
Average	23849	264.5	1	<10	1.5	<0.2	<5	11	60.5	<5	<1	12	<0.5	7.5	1	46	6	144	32	34.5
Standard Deviation		2.50	--	0.00	0.50	0.00	0.00	0.00	2.50	0.00	0.00	1.00	0.00	1.50	--	2.00	1.00	2.00	0.00	0.50
Variance		6.25	--	0.00	0.25	0.00	0.00	0.00	6.25	0.00	0.00	1.00	0.00	2.25	--	4.00	1.00	4.00	0.00	0.25

If only one analysis for a sample is above detection limits, that value is reported as the average and no standard deviation or variance is calculated (indicated by --).

Appendix E. Duplicate Sample Analyses

DDH	Sample	Sn ppm	W ppm	Mo ppm	Cr (ICP) ppm	Cr (XRF) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
First Batch of Analyses																			
B31-3	23434A	<20	<10	<1	65	80	165	5	<3	20	36	24	6	14	28	20	<0.5	<20	59
B31-3	23434B	<20	<10	<1	73	90	163	6	<3	19	35	23	6	13	30	21	<0.5	74	58
Average	23434	<20	<10	<1	69.00	85.00	164.0	5.50	<3	19.50	35.50	23.50	6.00	13.50	29.00	20.50	<0.5	74	58.50
Standard Deviation		0.00	0.00	0.00	4.00	5.00	1.00	0.50	0.00	0.50	0.50	0.50	0.00	0.50	1.00	0.50	0.00	--	0.50
Variance		0.00	0.00	0.00	16.00	25.00	1.00	0.25	0.00	0.25	0.25	0.25	0.00	0.25	1.00	0.25	0.00	--	0.25
B31-4	23435A	<20	<10	<1	54	97	133	4	<3	20	37	20	3	12	30	31	<0.5	87	27
B31-4	23435B	<20	<10	<1	60	79	135	4	<3	21	35	22	4	12	34	35	<0.5	<20	27
Average	23435	<20	<10	<1	57.00	88.00	134.0	4.00	<3	20.50	36.00	21.00	3.50	12.00	32.00	33.00	<0.5	87	27.00
Standard Deviation		0.00	0.00	0.00	3.00	9.00	1.00	0.00	0.00	0.50	1.00	1.00	0.50	0.00	2.00	2.00	0.00	--	0.00
Variance		0.00	0.00	0.00	9.00	81.00	1.00	0.00	0.00	0.25	1.00	1.00	0.25	0.00	4.00	4.00	0.00	--	0.00
B31-5	23436A	<20	<10	<1	83	78	168	<1	8	16	22	37	8	11	35	25	<0.5	26	74
B31-5	23436B	<20	<10	2	97	84	182	<1	<3	16	26	43	9	12	36	29	<0.5	42	77
Average	23436	<20	<10	2	90.00	81.00	175.0	<1	8	16.00	24.00	40.00	8.50	11.50	35.50	27.00	<0.5	34.00	75.50
Standard Deviation		0.00	0.00	--	7.00	3.00	7.00	0.00	--	0.00	2.00	3.00	0.50	0.50	0.50	2.00	0.00	8.00	1.50
Variance		0.00	0.00	--	49.00	9.00	49.00	0.00	--	0.00	4.00	9.00	0.25	0.25	0.25	4.00	0.00	64.00	2.25
Second Batch of Analyses																			
YWL-1	23730A	<20	<10	<1	433	1186	61	<1	<3	6	8	2	5	3	10	9	<0.5	103	29
YWL-1	23730B																		
Average	23730	<20	<10	<1	433	1186	61	<1	<3	6	8	2	5	3	10	9	<0.5	103	29
Standard Deviation																			
Variance																			
B24-3	23772A	<20	<10	2	136	308	81	<1	<3	17	12	5	8	6	110	23	<0.5	90	14
B24-3	23772B																		
Average	23772	<20	<10	2	136	308	81	<1	<3	17	12	5	8	6	110	23	<0.5	90	14
Standard Deviation																			
Variance																			
MSD-1	23814A	<20	<10	<1	211	767	42	<1	8	5	11	<1	6	3	29	27	<0.5	111	13
MSD-1	23814B					699			<3										
Average	23814	<20	<10	<1	211	733	42	<1	8	5	11	<1	6	3	29	27	<0.5	111	13
Standard Deviation						34.00			--										
Variance						1156.00													
40920	23831A	<20	<10	3	68	153	263	2	<3	15	18	5	27	18	<5	13	<0.5	54	45
40920	23831B																		
Average	23831	<20	<10	3	68	153	263	2	<3	15	18	5	27	18	<5	13	<0.5	54	45
Standard Deviation																			
Variance																			

Appendix E. Duplicate Sample Analyses

DDH	Sample	Sn ppm	W ppm	Mo ppm	Cr (ICP) ppm	Cr (XRF) ppm	V ppm	Nb ppm	Ta ppm	La ppm	Ce ppm	Zr ppm	Sc ppm	Y ppm	Ba ppm	Sr ppm	Be ppm	Rb ppm	Li ppm
LW-346-2	23838A	<20	<10	<1	227	290	82	<1	<3	6	15	2	11	6	565	27	<0.5	<20	16
LW-346-2	23838B					243			10										
Average	23838	<20	<10	<1	227	266.5	82	<1	10	6	15	2	11	6	565	27	<0.5	<20	16
Standard Deviation						23.50			--										
Variance						552.25			--										
LW-346-1	23841A	<20	<10	3	196	246	50	<1	<3	11	23	4	6	4	100	17	<0.5	63	15
LW-346-1	23841B																		
Average	23841	<20	<10	3	196	246	50	<1	<3	11	23	4	6	4	100	17	<0.5	63	15
Standard Deviation																			
Variance																			
BD-II-1	23846A	<20	<10	1	149	112	29	<1	<3	14	30	10	2	3	184	18	<0.5	107	13
BD-II-1	23846B																		
Average	23846	<20	<10	1	149	112	29	<1	<3	14	30	10	2	3	184	18	<0.5	107	13
Standard Deviation																			
Variance																			
BD-II-2	23849A	<20	<10	<1	101	103	83	<1	14	9	16	3	8	8	31	9	<0.5	74	11
BD-II-2	23849B	<20	<10	<1	81	83	75	<1	<3	7	16	4	7	7	31	8	<0.5	26	10
Average	23849	<20	<10	<1	91	93	79	<1	14	8	16	3.5	7.5	7.5	31	8.5	<0.5	50	10.5
Standard Deviation		0.00	0.00	0.00	10.00	10.00	4.00	0.00	--	1.00	0.00	0.50	0.50	0.50	0.00	0.50	0.00	24.00	0.50
Variance		0.00	0.00	0.00	100.00	100.00	16.00	0.00	--	1.00	0.00	0.25	0.25	0.25	0.00	0.25	0.00	576.0	0.25

If only one analysis for a sample is above detection limits, that value is reported as the average and no standard deviation or variance is calculated (indicated by --).

Appendix 278-F. Correlation/Ranked Correlation Matrix

	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	LOI	S	Li	B	F	Sc
SiO_2	***	-0.34	0.39	-0.79	-0.60	-0.54	-0.63	0.56	0.58	-0.17	-0.32	-0.26	-0.10	0.10	0.09	-0.42
TiO_2	-0.40	***	0.25	0.16	0.14	0.11	0.34	-0.04	-0.26	0.19	-0.19	-0.19	0.15	-0.04	0.02	0.28
Al_2O_3	0.45	0.30	***	-0.60	-0.27	-0.39	0.06	0.53	0.28	0.05	-0.52	-0.48	0.17	0.01	0.07	-0.05
Fe_2O_3	-0.84	0.34	-0.55	***	0.69	0.13	0.26	-0.50	-0.44	0.05	0.27	0.55	-0.05	-0.03	-0.10	0.23
MnO	-0.76	0.45	-0.35	0.77	***	0.08	0.42	-0.32	-0.34	-0.04	-0.06	0.18	0.13	-0.06	-0.04	0.28
MgO	-0.71	0.56	-0.18	0.44	0.52	***	0.40	-0.55	-0.41	0.10	0.26	-0.23	0.04	-0.10	-0.10	0.34
CaO	-0.66	0.62	-0.04	0.45	0.67	0.75	***	-0.32	-0.57	0.12	-0.17	-0.19	0.08	-0.11	-0.17	0.28
Na_2O	0.56	-0.16	0.47	-0.54	-0.45	-0.53	-0.34	***	0.35	-0.03	-0.43	-0.21	0.17	-0.06	0.27	-0.25
K_2O	0.62	-0.36	0.40	-0.57	-0.49	-0.61	-0.61	0.55	***	-0.01	-0.15	-0.14	0.34	0.03	0.58	-0.42
P_2O_5	-0.14	0.24	0.09	0.09	0.01	0.14	0.07	-0.03	0.04	***	0.01	0.04	0.00	-0.02	0.02	0.02
LOI	-0.27	-0.22	-0.33	0.25	0.05	0.17	-0.09	-0.34	-0.12	0.12	***	0.53	-0.12	0.11	-0.12	0.22
S	-0.19	-0.10	-0.31	0.48	0.25	-0.23	-0.13	-0.08	-0.03	0.00	0.36	***	-0.15	0.09	-0.10	-0.06
Li	-0.06	0.26	0.26	-0.02	0.20	0.20	0.13	0.14	0.29	0.04	0.03	-0.11	***	-0.02	0.69	0.15
B	0.23	0.16	0.36	-0.17	-0.20	-0.12	-0.13	-0.08	0.09	0.11	0.00	-0.05	0.05	***	-0.07	0.08
F	0.18	0.06	0.30	-0.19	-0.11	-0.18	-0.24	0.45	0.60	0.06	-0.11	0.02	0.49	-0.12	***	-0.11
Sc	-0.52	0.58	-0.06	0.50	0.57	0.54	0.48	-0.31	-0.49	0.05	0.14	0.13	0.25	0.05	-0.12	***
V	-0.61	0.61	-0.09	0.54	0.62	0.58	0.50	-0.20	-0.36	0.07	0.01	0.04	0.44	-0.14	0.13	0.76
Co	-0.68	0.23	-0.48	0.73	0.50	0.47	0.25	-0.54	-0.46	0.03	0.54	0.46	0.10	-0.07	-0.09	0.54
Ni	-0.54	0.13	-0.34	0.47	0.32	0.53	0.26	-0.57	-0.40	0.05	0.54	0.25	0.07	0.05	-0.20	0.40
Cu	-0.56	0.29	-0.31	0.72	0.51	0.29	0.36	-0.47	-0.43	0.07	0.26	0.50	-0.04	-0.01	-0.24	0.39
Zn	-0.12	0.05	-0.04	0.30	0.17	-0.09	-0.16	-0.17	0.16	0.18	0.38	0.49	0.17	0.24	0.15	0.12
Ga	0.11	0.47	0.49	-0.08	0.03	0.08	0.07	0.19	0.06	-0.09	-0.31	-0.14	0.29	0.19	0.21	0.26
As	-0.04	-0.11	-0.20	0.11	-0.05	-0.01	-0.12	-0.20	-0.10	-0.02	0.32	0.32	-0.19	0.15	-0.12	0.13
Se	-0.02	-0.10	-0.22	0.18	0.00	-0.12	-0.14	-0.13	-0.04	0.07	0.22	0.33	-0.14	0.10	-0.07	-0.02
Rb	-0.03	0.14	0.02	0.03	0.06	0.08	0.06	0.00	0.00	-0.05	-0.05	0.05	0.16	0.05	0.12	0.12
Sr	-0.13	0.08	0.18	-0.02	0.08	0.11	0.15	0.07	0.08	-0.11	0.03	-0.08	0.05	-0.11	0.25	0.05
Y	-0.28	0.60	0.18	0.34	0.43	0.19	0.27	0.04	-0.05	0.16	-0.07	0.12	0.32	0.12	0.27	0.58
Zr	0.28	-0.30	0.03	-0.13	-0.28	-0.51	-0.54	0.45	0.64	0.13	0.06	0.23	0.09	-0.10	0.50	-0.42
Nb	-0.46	-0.04	-0.38	0.38	0.32	0.33	0.23	-0.30	-0.26	0.21	0.51	0.09	0.13	-0.16	-0.06	0.20
Mo	0.09	-0.20	-0.21	0.05	-0.07	-0.26	-0.15	-0.04	0.00	0.02	-0.08	0.19	-0.22	-0.01	-0.12	-0.14
Pd	-0.48	0.37	-0.16	0.40	0.54	0.53	0.67	-0.34	-0.46	0.01	0.04	0.05	0.13	-0.09	-0.23	0.46
Ag	0.01	-0.03	0.09	0.00	0.05	-0.05	0.01	0.11	0.12	-0.03	0.01	0.07	0.03	-0.06	0.17	-0.07
Cd	-0.16	-0.16	-0.32	0.38	0.20	-0.17	-0.17	-0.19	-0.02	-0.10	0.22	0.47	-0.04	-0.01	-0.06	0.06
Sb	0.19	-0.30	-0.09	-0.16	-0.16	-0.14	-0.24	-0.04	0.07	-0.18	0.27	0.03	-0.09	0.03	-0.01	-0.02
Ba	0.31	-0.02	0.30	-0.29	-0.19	-0.26	-0.25	0.27	0.44	-0.12	-0.26	-0.11	0.28	0.16	0.38	-0.01
La	0.22	-0.19	0.16	-0.12	-0.22	-0.46	-0.52	0.38	0.55	0.09	-0.02	0.18	0.14	0.05	0.54	-0.20
Ce	0.50	-0.21	0.33	-0.40	-0.45	-0.53	-0.61	0.47	0.66	-0.02	-0.17	-0.01	0.08	0.14	0.52	-0.34
Ta	-0.08	0.08	-0.01	0.09	0.06	0.08	0.11	-0.10	-0.16	-0.07	0.01	0.06	-0.05	0.10	-0.13	0.16
W	-0.05	-0.10	-0.14	0.17	0.15	-0.06	0.01	-0.09	-0.08	-0.06	0.06	0.08	0.00	0.04	-0.07	0.06
Pt	-0.46	0.36	-0.14	0.37	0.55	0.53	0.71	-0.32	-0.45	-0.05	-0.01	-0.02	0.14	-0.18	-0.25	0.42
Au	-0.23	-0.04	-0.31	0.41	0.26	-0.05	0.11	-0.24	-0.19	0.02	0.12	0.47	-0.18	-0.07	-0.20	0.04
Hg	0.09	-0.25	-0.21	0.03	-0.07	-0.17	-0.20	-0.21	-0.09	-0.27	0.17	0.22	-0.12	0.13	-0.13	0.05
Pb	0.14	-0.08	-0.07	0.07	-0.07	-0.24	-0.27	-0.03	0.16	0.03	-0.04	0.31	-0.01	0.16	0.03	-0.08
Bi	-0.31	-0.24	-0.45	0.50	0.23	-0.14	-0.15	-0.30	-0.21	-0.07	0.22	0.46	-0.20	-0.02	-0.18	0.07
Cr (ICP)	0.02	-0.30	-0.29	-0.09	-0.07	0.16	-0.05	-0.17	-0.08	-0.19	0.35	0.03	0.05	-0.12	-0.13	0.16
Cr (XRF)	0.02	-0.25	-0.31	-0.05	-0.09	0.16	-0.16	-0.31	-0.14	-0.16	0.27	-0.06	-0.07	0.00	-0.23	0.08

Values to the top and right are linear correlation coefficients.

Values below and left are ranked correlation coefficients (Spearman's Rho).

	V	Co	Ni	Cu	Zn	Ga	As	Se	Rb	Sr	Y	Zr	Nb	Mo	Pd	Ag
SiO_2	-0.44	-0.56	-0.38	-0.39	-0.05	0.02	-0.11	-0.04	-0.09	-0.14	-0.25	0.13	-0.48	0.09	-0.44	-0.05
TiO_2	0.29	0.04	-0.11	-0.08	-0.08	0.49	-0.06	-0.13	0.06	0.00	0.63	0.07	-0.10	-0.13	0.06	0.00
Al_2O_3	-0.17	-0.57	-0.55	-0.46	-0.29	0.42	-0.32	-0.34	0.03	0.09	0.24	0.07	-0.52	-0.26	-0.01	0.03
Fe_2O_3	0.48	0.61	0.17	0.64	0.25	-0.10	0.08	0.27	0.05	-0.04	0.15	-0.03	0.35	0.07	0.23	0.07
MnO	0.25	0.25	0.00	0.23	-0.03	-0.01	-0.05	-0.03	0.09	0.07	0.23	-0.09	0.15	-0.07	0.39	0.05
MgO	0.15	0.29	0.81	-0.09	-0.14	-0.03	0.31	-0.19	0.03	0.18	-0.06	-0.27	0.44	-0.12	0.24	-0.04
CaO	0.15	0.05	0.04	0.00	-0.20	0.05	-0.12	-0.27	0.07	0.10	0.15	-0.33	0.15	-0.15	0.71	0.00
Na_2O	-0.08	-0.51	-0.53	-0.36	-0.23	0.15	-0.25	-0.26	0.01	0.02	0.09	0.32	-0.37	0.00	-0.28	0.01
K_2O	-0.14	-0.36	-0.28	-0.21	-0.01	-0.09	-0.11	0.00	-0.02	0.03	-0.07	0.45	-0.24	-0.02	-0.41	0.03
P_2O_5	0.03	0.00	0.04	-0.05	-0.02	-0.07	0.01	-0.03	-0.03	0.06	0.13	0.02	0.03	0.00	-0.01	-0.06
LOI	-0.08	0.60	0.49	0.31	0.32	-0.32	0.33	0.44	-0.04	0.07	-0.09	0.02	0.57	0.14	-0.13	-0.05
S	-0.13	0.55	0.06	0.49	0.50	-0.27	0.10	0.51	-0.04	-0.11	-0.08	0.12	0.19	0.31	-0.10	0.08
Li	0.28	-0.03	-0.08	-0.13	-0.11	0.19	-0.11	-0.09	0.25	0.07	0.30	0.30	0.11	-0.13	0.11	0.03
B	-0.01	0.11	-0.01	0.03	0.18	0.05	0.11	0.20	0.12	-0.01	0.06	-0.04	-0.05	-0.03	-0.03	0.04
F	0.21	-0.11	-0.10	-0.08	-0.10	0.01	-0.03	-0.07	0.16	0.16	0.10	0.37	0.02	-0.02	-0.11	0.05
Sc	0.41	0.35	0.26	0.07	-0.01	0.24	0.08	-0.05	0.10	0.01	0.40	-0.26	0.31	-0.08	0.35	-0.07
V	***	0.21	0.05	0.27	-0.09	0.15	-0.04	-0.13	0.08	-0.02	0.26	0.02	0.32	-0.05	0.18	-0.04
Co	0.55	***	0.55	0.64	0.55	-0.07	0.38	0.50	0.01	-0.03	0.07	-0.02	0.44	0.10	0.12	0.13
Ni	0.33	0.79	***	0.09	0.13	-0.14	0.57	0.09	-0.02	0.14	-0.16	-0.15	0.51	-0.01	0.03	-0.02
Cu	0.39	0.64	0.46	***	0.57	-0.18	0.00	0.53	0.07	-0.17	-0.05	0.00	0.29	0.03	0.14	0.19
Zn	0.17	0.39	0.28	0.36	***	-0.12	0.10	0.65	-0.04	-0.08	0.00	0.14	0.17	0.18	-0.10	0.20
Ga	0.28	-0.04	-0.06	-0.12	0.11	***	-0.08	-0.07	0.20	0.13	0.45	0.05	-0.42	-0.18	-0.09	0.17
As	-0.02	0.31	0.37	0.15	0.26	-0.06	***	0.15	-0.07	-0.06	-0.05	-0.01	0.19	0.01	-0.07	-0.02
Se	-0.11	0.28	0.20	0.25	0.28	0.01	0.34	***	-0.02	-0.09	-0.06	0.12	0.05	0.08	-0.08	0.13
Rb	0.15	0.10	0.11	0.10	0.16	0.16	0.11	0.01	***	-0.01	0.15	0.01	-0.02	-0.06	0.12	0.13
Sr	0.08	-0.03	-0.03	-0.19	-0.07	0.28	-0.06	-0.10	-0.03	***	0.14	0.24	0.09	-0.10	-0.04	0.15
Y	0.54	0.23	0.03	0.17	0.28	0.38	-0.10	-0.05	0.17	0.14	***	0.33	0.05	-0.10	-0.06	0.08
Zr	-0.23	-0.12	-0.20	-0.21	0.29	-0.05	-0.01	0.11	-0.01	0.02	0.08	***	0.07	0.07	-0.37	0.14
Nb	0.25	0.40	0.34	0.26	0.18	-0.46	0.00	-0.06	-0.02	-0.06	0.11	-0.02	***	0.08	0.08	0.00
Mo	-0.22	-0.03	-0.05	0.09	0.05	-0.20	0.09	0.18	0.05	-0.15	-0.07	0.13	-0.09	***	-0.10	-0.05
Pd	0.42	0.32	0.35	0.50	-0.02	-0.11	0.03	0.04	0.07	-0.06	0.06	-0.48	0.16	-0.06	***	-0.07
Ag	0.00	0.01	-0.02	0.05	0.08	0.19	0.04	0.04	0.04	0.20	0.13	0.12	0.04	-0.01	-0.10	***
Cd	0.05	0.39	0.23	0.37	0.47	-0.07	0.25	0.26	0.14	-0.09	0.09	0.17	0.09	0.22	0.02	0.09
Sb	-0.15	0.04	0.08	-0.17	0.05	-0.06	0.20	0.03	-0.04	0.07	-0.05	0.01	0.14	0.04	-0.25	0.00
Ba	0.02	-0.20	-0.15	-0.29	0.14	0.46	0.04	0.00	0.15	0.32	0.14	0.21	-0.40	-0.04	-0.19	0.04
La	-0.09	-0.10	-0.19	-0.24	0.31	0.22	0.04	0.05	0.09	0.21	0.31	0.65	-0.10	0.06	-0.52	0.12
Ce	-0.27	-0.31	-0.31	-0.44	0.17	0.35	-0.03	0.03	0.03	0.18	0.19	0.58	-0.31	0.02	-0.63	0.12
Ta	0.04	0.10	0.06	0.17	-0.02	0.01	0.09	0.02	0.02	0.08	0.01	-0.26	0.05	0.13	0.07	0.04
W	0.06	0.07	0.05	0.16	0.03	-0.10	-0.02	0.10	0.00	-0.06	0.02	0.00	0.16	0.09	0.07	0.08
Pt	0.38	0.27	0.30	0.48	-0.10	-0.07	-0.01	-0.03	0.04	-0.03	0.06	-0.50	0.16	-0.09	0.85	-0.02
Au	0.00	0.28	0.16	0.48	0.15	-0.18	0.31	0.28	0.09	-0.06	-0.07	-0.06	0.06	0.25	0.22	-0.01
Hg	-0.10	0.20	0.19	0.13	0.27	-0.07	0.33	0.24	0.15	-0.06	-0.03	-0.06	-0.01	0.22	-0.11	0.01
Pb	-0.13	0.05	0.02	0.17	0.35	0.12	0.28	0.26	0.18	-0.10	0.03	0.25	-0.32	0.32	-0.13	0.05
Bi	0.05	0.42	0.29	0.40	0.29	-0.21	0.19	0.26	0.03	-0.13	-0.01	0.14	0.16	0.26	-0.04	0.06
Cr (ICP)	0.04	0.25	0.52	-0.03	0.00	-0.12	0.33	0.10	-0.02	-0.05	-0.21	-0.19	0.10	-0.08	0.20	-0.01
Cr (XRF)	-0.03	0.22	0.50	0.00	-0.03	-0.11	0.21	0.03	-0.07	-0.09	-0.27	-0.25	0.03	-0.07	0.12	-0.11

Values to the top and right are linear correlation coefficients.

Values below and left are ranked correlation coefficients (Spearman's Rho).

	Cd	Sb	Ba	La	Ce	Ta	W	Pt	Au	Hg	Pb	Bi	Cr (ICP)	Cr (XRF)
SiO_2	-0.07	0.02	0.09	0.16	0.36	-0.12	-0.07	-0.36	-0.14	-0.09	0.02	-0.34	-0.19	-0.22
TiO_2	-0.11	-0.13	-0.01	0.01	0.00	0.06	-0.08	0.04	-0.07	-0.14	-0.14	-0.18	-0.19	-0.18
Al_2O_3	-0.34	-0.21	0.15	0.15	0.27	-0.05	-0.23	0.01	-0.24	-0.36	-0.23	-0.49	-0.48	-0.51
Fe_2O_3	0.29	0.09	-0.12	-0.04	-0.26	0.11	0.17	0.19	0.34	0.24	0.16	0.68	-0.03	0.01
MnO	0.00	-0.07	-0.06	-0.07	-0.25	0.03	0.15	0.34	0.19	-0.07	-0.06	0.36	-0.09	-0.09
MgO	-0.13	-0.02	0.03	-0.25	-0.29	0.08	-0.05	0.21	-0.12	-0.12	-0.19	-0.15	0.78	0.83
CaO	-0.20	-0.15	-0.03	-0.38	-0.44	0.14	0.01	0.61	-0.04	-0.17	-0.23	-0.17	-0.04	-0.03
Na_2O	-0.24	-0.13	0.04	0.31	0.38	-0.13	-0.10	-0.23	-0.17	-0.19	-0.08	-0.28	-0.40	-0.45
K_2O	-0.01	0.01	0.07	0.37	0.45	-0.15	-0.07	-0.34	-0.10	-0.07	0.15	-0.15	-0.18	-0.21
P_2O_5	-0.04	-0.10	0.11	0.10	0.04	-0.05	-0.03	-0.01	0.01	-0.02	-0.02	-0.07	-0.04	-0.03
LOI	0.33	0.22	-0.17	-0.05	-0.15	0.03	0.09	-0.14	0.14	0.46	0.26	0.33	0.39	0.37
S	0.50	0.26	-0.13	0.04	-0.08	0.05	0.04	-0.07	0.40	0.52	0.39	0.64	-0.11	-0.14
Li	-0.10	-0.11	0.11	0.14	0.06	-0.10	-0.06	0.10	-0.15	-0.14	-0.09	-0.14	-0.09	-0.12
B	0.29	0.04	0.14	0.03	0.04	0.04	-0.03	-0.08	0.01	0.01	0.05	0.14	-0.04	-0.04
F	-0.07	-0.07	0.04	0.24	0.20	-0.09	-0.05	-0.08	-0.11	-0.08	0.06	-0.07	-0.07	-0.11
Sc	-0.01	-0.02	0.03	-0.15	-0.24	0.11	-0.01	0.29	0.05	-0.04	-0.11	0.01	0.23	0.21
V	-0.03	-0.11	-0.02	0.04	-0.10	0.05	0.01	0.14	-0.01	-0.13	-0.11	0.17	0.03	0.06
Co	0.57	0.35	-0.09	-0.09	-0.22	0.13	0.17	0.14	0.34	0.46	0.29	0.55	0.28	0.28
Ni	0.12	0.17	0.05	-0.12	-0.17	0.06	0.02	0.03	0.01	0.12	0.00	0.09	0.83	0.87
Cu	0.53	0.34	-0.14	-0.06	-0.17	0.10	0.41	0.18	0.27	0.45	0.37	0.64	-0.08	-0.08
Zn	0.94	0.71	-0.06	0.01	0.02	0.04	0.09	-0.03	0.21	0.71	0.62	0.45	-0.04	-0.04
Ga	-0.11	-0.13	0.32	0.17	0.24	0.06	-0.12	-0.04	-0.01	-0.18	-0.13	-0.15	-0.16	-0.15
As	0.15	0.10	-0.05	-0.03	-0.07	0.03	-0.03	-0.07	0.04	0.09	0.04	0.04	0.31	0.36
Se	0.64	0.31	-0.08	-0.01	-0.02	0.00	0.23	-0.10	0.32	0.59	0.47	0.45	-0.05	-0.06
Rb	-0.04	-0.09	0.09	0.09	0.04	0.05	-0.02	0.15	-0.03	0.00	0.02	0.03	-0.03	-0.04
Sr	-0.07	-0.05	0.16	0.38	0.34	0.04	-0.07	-0.04	-0.05	-0.12	-0.05	-0.07	0.16	0.15
Y	-0.01	-0.04	0.06	0.44	0.38	-0.04	-0.02	-0.05	-0.07	-0.06	-0.07	-0.02	-0.21	-0.23
Zr	0.14	0.07	-0.06	0.71	0.66	-0.16	0.00	-0.32	-0.04	0.14	0.22	0.11	-0.18	-0.21
Nb	0.17	0.22	-0.21	0.01	-0.14	0.05	0.10	0.04	-0.04	0.23	0.10	0.20	0.45	0.44
Mo	0.18	0.05	-0.07	-0.03	-0.04	-0.01	-0.01	-0.09	0.23	0.55	0.16	0.15	-0.03	-0.04
Pd	-0.09	-0.15	-0.04	-0.41	-0.48	0.05	0.01	0.84	0.01	-0.11	-0.16	-0.09	-0.03	-0.03
Ag	0.19	0.22	-0.04	0.12	0.12	0.07	0.09	0.01	0.05	0.09	0.16	0.13	-0.06	-0.06
Cd	***	0.69	-0.06	0.02	0.01	0.09	0.05	-0.03	0.26	0.64	0.58	0.46	-0.01	-0.02
Sb	0.09	***	-0.02	0.00	0.07	0.07	-0.01	-0.14	0.01	0.51	0.48	0.21	0.12	0.09
Ba	0.04	0.10	***	0.19	0.23	-0.05	-0.07	-0.01	-0.05	-0.06	-0.03	-0.03	0.06	0.07
La	0.15	0.08	0.51	***	0.94	-0.11	-0.04	-0.36	0.00	-0.02	0.04	0.12	-0.08	-0.11
Ce	0.01	0.17	0.58	0.88	***	-0.10	-0.06	-0.41	-0.07	-0.03	0.04	-0.04	-0.08	-0.11
Ta	0.11	0.13	-0.09	-0.13	-0.13	***	-0.06	0.07	0.08	-0.04	-0.02	-0.01	0.04	0.04
W	0.02	0.06	-0.14	-0.08	-0.08	-0.06	***	0.01	0.07	0.08	0.00	0.11	-0.02	-0.03
Pt	-0.02	-0.24	-0.20	-0.56	-0.64	0.08	0.03	***	0.07	-0.11	-0.12	-0.04	-0.03	-0.03
Au	0.31	-0.13	-0.16	-0.06	-0.22	0.09	0.11	0.20	***	0.17	0.13	0.39	-0.09	-0.10
Hg	0.37	0.44	0.09	0.06	0.08	0.11	0.16	-0.14	0.19	***	0.57	0.46	0.00	-0.02
Pb	0.41	-0.08	0.18	0.20	0.16	0.02	-0.02	-0.17	0.27	0.29	***	0.36	-0.09	-0.10
Bi	0.51	0.03	-0.04	0.16	-0.05	0.03	0.11	-0.06	0.38	0.29	0.35	***	-0.06	-0.05
Cr (ICP)	0.04	0.28	0.06	-0.14	-0.12	-0.05	0.02	0.16	-0.04	0.21	-0.07	-0.02	***	0.97
Cr (XRF)	0.04	0.22	0.05	-0.14	-0.06	0.01	0.02	0.08	-0.05	0.21	-0.05	0.04	0.78	***

Values to the top and right are linear correlation coefficients.

Values below and left are ranked correlation coefficients (Spearman's Rho).

Appendix 278-G. Highest Cu, Ni, Zn, and Au Values from Assessment File Data

Table 278-G-1. Highest Cu Values Reported in Assessment File Data.

DDH	Sample	Top Interval	Bottom Interval	Cu ppm	Ni ppm	Zn ppm	Pb ppm	Co ppm	As ppm	Ag ppm	Au ppb
40919	FX003049	161.5	162.5	620	150			160			
40919	FX003060	215.0	218.2	610	110			160			
40919	FX003062	219.5	225.8	600	110			150			
40919	FX003087	442.0	454.0	700	200			190			
40919	FX003089	456.0	457.0	800	200			210			
B21-1	B21-1-04	185.0	194.0	675	160	3400	60	145	5	1	
B21-1	3302	190.9		1180	253	6666		156		1	
B21-1	B21-1-05	194.0	199.4	740	160	5600	60	145	<5	1	
B21-1	B21-1-06	199.4	201.4	2300	90	975	70	85	5	1	
B21-1	B21-1-07	201.4	206.5	710	160	1400	30	140	15	2	
B21-1	B21-1-09	226.7	227.0	2900	115	65	20	80	<5	1	
B21-1	3305	337.0		1917	203	343		140		1.5	
B21-2	B21-2-01	165.0	166.0	890	315	4500	40	200	10	1	
B21-2	B21-2-08	295.0	297.0	1400	65	485	10	75	15	1	
B21-3	3309	192.8		4200	267	106		230		0.02	343
B21-3	B21-3-09	408.4	415.0	630	180	3000	20	155	20	2	
B21-3	B21-3-11	450.8	456.0	900	125	550	10	80	10	2	
B24-4	3410	981.5		687	150	313		63		1.8	
B31-1	B31-1-09	323.0	328.0	1100	120	45		145	<5	1	
BD-II-1	BDII-1-315	315.0		800	320	84	55	69	<100	1.7	2
BD-II-2	30271	283.5	287.0	700		70	<5			0.4	200
BD-N-1	30360	550.0	555.0	960		3990			1.2		50
BD-N-1	30366	610.0	615.0	630		3290			1		7
BD-N-1	30374	690.0	695.0	720		4650			1.1		10
BD-N-1	30375	700.0	705.0	640		3860			1.2		7
BD-N-1	30376	710.0	715.0	740		3050			0.9		10
BD-N-1	30379	755.0	760.0	670		4650			1.3		6
BD-N-1	30382	780.0	785.0	650		3500			1.6		11
BD-N-1	30383	790.0	795.0	1150		5380			1.5		9
BD-N-1	30385	810.0	812.0	690		3330			0.6		5
B-Q-1	BQ1-365	365.0		2020	260						
B-Q-1	BQ1-366	366.0		2020	260						
MDD-1	MDD1-01	299.3	300.0	1775	185	200	10			1.5	20
MED-1	MED1-03	231.5	236.0	1400	300	33	148			2.5	20
MED-1	MED1-04	238.5	246.0	1925	93	55	178			2.5	40
MED-1	MED-1-295	295.0		2600	89	163		38	<100	2.4	18
MMD-1	MMD-1-446	446.0		704		2120		28	<100	1.9	15
MQD-2	MQD-2-107	107.0		900	37	500		39	<100	1.8	<10
MSD-1	MSD1-02	534.8	536.3	1000	175	2500	33	120		2	<20
MSD-1	MSD1-04	538.3	540.7	700	78	38	10	115		1.8	60
MSD-1	MSD1-05	540.7	541.7	1500	153	1200	18			1.8	20
YWZ-1	104227	626.0	629.0	1090		810			18		<10
YWZ-1	YWZ-1-802	802.0		600	99	224		32	<100	0.68	<10
YWZ-2	211959	513.0	518.0	660		91	15			<0.2	<20
YWZ-2	211960	518.0	523.0	1100		33	11			<0.2	<20
YWZ-2	211964	643.0	646.0	730		10800	41			0.8	<20
YWZ-2	211965	646.0	649.0	1030		7500	106			1.5	<20
YWZ-2	211966	649.0	652.0	750		3400	124			1	<20
YWZ-2	211967	652.0	655.0	820		5100	138			1.2	<20

Total Cu analyses: 934
High Value: 4200 ppm
Range of table: > 600 ppm

Table 278-G-2. Highest Ni Values Reported in Assessment File Data.

DDH	Sample	Top Interval	Bottom Interval	Cu ppm	Ni ppm	Zn ppm	Pb ppm	Co ppm	As ppm	Ag ppm	Au ppb
40917	FX003016	292.0	302.0		300			20			
40926	40926-227	227.0		11	808	62	34	77	350	0.62	<100
40926	40926-346	346.0		<10	570	118	25	74	690	0.22	<6800
B21-1	3301	180.7		250	240	133		153		2	
B21-1	3302	190.9		1180	253	6666		156		1	
B21-1	3303	202.4		457	393	237		269		6	7
B21-1	3305	337.0		1917	203	343		140		1.5	
B21-1	3306	409.5		290	300	763		150		6.4	
B21-2	B21-2-01	165.0	166.0	890	315	4500	40	200	10	1	
B21-3	3309	192.8		4200	267	106		230		0.02	343
B24-2	3400	221.0		341	250	206		93		1.2	
B24-4	3409	532.0		293	267	263		127		1.3	
B24-4	3418	1540.0		340	387	90		113		1.1	
B31-1	2618	600.5		130	230	200	<20	110		0.3	69
B58-1	3433	302.0		190	203	100		63		1.8	
B58-1	B58-1-07	327.5	332.0	235	205	95	10	170	<5	1	
BD-II-1	BDII-1-315	315.0		800	320	84	55	69	<100	1.7	2
BD-II-1	BDII-1-580	580.0		<10	270	<10	<22	110	<100	5.1	<6800
B-B-2	BB2-332	332.0		<10	204	78					
B-Q-1	BQ1-199	199.0		100	600						
B-Q-1	BQ1-282	282.0		200	400						
B-Q-1	BQ1-308	308.0		200	400						
B-Q-1	BQ1-314	314.0		200	400						
B-Q-1	BQ1-365	365.0		2020	260						
B-Q-1	BQ1-366	366.0		2020	260						
MED-1	MED1-03	231.5	236.0	1400	300	33	148			2.5	20
MMD-1	MMD1-04	444.2	447.3	565	300	650	28			2	50
MSD-1	MSD-1-341	341.0		72	272	68		68	<100	0.6	<6800
MSD-1	MSD-1-469	469.0		194	368	75		50	<100	0.47	<6800
RR16-1	RR16-1-177	177.0		<10	236	44		43	<100	1.5	10
YWZ-1	YWZ-1-425	425.0		<10	661	87		89	<100	0.47	<10
YWZ-1	YWZ-1-446	446.0		<10	590	85		53	<100	0.31	<6800
YWZ-1	YWZ-1-767	767.0		<10	236	244		33	<100	0.27	<6800

Total Ni analyses: 657
High value: 808 ppm
Range of table: > 200 ppm

DDH 40919: 21 "FX" samples with 200 ppm Ni
DDH 40926: 6 "FX" samples with 200 ppm Ni
Also 200 ppm Ni intervals in DDH's B21-1, B21-2, B21-3, and LW-346-2.

Table 278-G-3. Highest Zn Values Reported in Assessment File Data.

DDH	Sample	Top Interval	Bottom Interval	Cu ppm	Ni ppm	Zn ppm	Pb ppm	Co ppm	As ppm	Ag ppm	Au ppb
40926	FX003208	175.0	179.5	200	200	3000					
B21-1	B21-1-04	185.0	194.0	675	160	3400	60	145	5	1	
B21-1	3302	190.9		1180	253	6666		156		1	
B21-1	B21-1-05	194.0	199.4	740	160	5600	60	145	<5	1	
B21-1	B21-1-197	197.0		132	62	3000	130	60	<100	0.63	<10
B21-2	B21-2-01	165.0	166.0	890	315	4500	40	200	10	1	
B21-2	B21-2-09	300.0	308.0	235	90	2600	30	85	15	<1	
B21-3	B21-3-09	408.4	415.0	630	180	3000	20	155	20	2	
B21-3	3317	481.4		450	160	2600		163		0.01	
B5-1	B5-1-6	448.0	452.0	565	110	2900	60	105	<5	1	
BD-2	407	357.0	362.3	150	50	5000	20	20	<500	<1	
BD-2	409	367.8	373.7	100	70	5000	30	50	<500	<1	
BD-2	417	411.1	416.6	100	150	3000	15	50	<500	1	
BD-2	418	416.6	421.4	150	100	5000	15	20	<500	<1	
BD-2	419	421.4	423.0	150	150	5000	10	<5	<500	1	
BD-N-1	30390	490.0	495.0	185		3910			0.6		20
BD-N-1	30394	530.0	535.0	260		3180			1		10
BD-N-1	30359	540.0	545.0	410		3180			0.8		45
BD-N-1	30360	550.0	555.0	960		3990			1.2		50
BD-N-1	30361	560.0	565.0	490		5610			0.9		11
BD-N-1	30362	570.0	575.0	540		4320			1.5		20
BD-N-1	30363	580.0	585.0	235		2750			0.8		7
BD-N-1	30364	590.0	595.0	580		3580			0.9		7
BD-N-1	30365	600.0	605.0	590		3770			1		7
BD-N-1	30366	610.0	615.0	630		3290			1		7
BD-N-1	30367	620.0	625.0	580		4790			1		7
BD-N-1	30368	630.0	635.0	510		4370			1		7
BD-N-1	30369	640.0	645.0	310		5240			1		7
BD-N-1	30370	650.0	655.0	570		4710			1.1		7
BD-N-1	30371	660.0	665.0	165		3430			1.2		6
BD-N-1	30372	670.0	675.0	245		4260			1.1		7
BD-N-1	30374	690.0	695.0	720		4650			1.1		10
BD-N-1	30375	700.0	705.0	640		3860			1.2		7
BD-N-1	30376	710.0	715.0	740		3050			0.9		10
BD-N-1	30378	730.0	735.0	420		2710			0.4		13
BD-N-1	30379	755.0	760.0	670		4650			1.3		6
BD-N-1	30380	760.0	765.0	590		7260			1.6		9
BD-N-1	30381	770.0	775.0	480		6730			1.3		7
BD-N-1	30382	780.0	785.0	650		3500			1.6		11
BD-N-1	30383	790.0	795.0	1150		5380			1.5		9
BD-N-1	30384	800.0	805.0	435		3980			1.2		2
BD-N-1	30385	810.0	812.0	690		3330			0.6		5
MQD-2	MQD-2-07	289.0	292.0	305	68	4500	28			2	130
MSD-1	MSD1-01	530.0	534.8	300	113	2550	15			1	<20
MSD-1	MSD1-02	534.8	536.3	1000	175	2500	33	120		2	<20
YWL-1	YWL-1-584	584.0		236	156	4000		150	170	1.2	<10
YWQ-1	104332	665.5	670.0	127	8	4615	33	8	6	1.2	40
YWQ-1	YWQ-1-669	669.0		67	12	7000		9.3	180	1	33
YWZ-2	211964	643.0	646.0	730		10800	41			0.8	<20
YWZ-2	211965	646.0	649.0	1030		7500	106			1.5	<20
YWZ-2	211966	649.0	652.0	750		3400	124			1	<20
YWZ-2	211967	652.0	655.0	820		5100	138			1.2	<20

Total Zn analyses: 874
High value: 10,800 ppm
Range of table: > 2,500 ppm

Table 278-G-4. Highest Au Values Reported in Assessment File Data.

DDH	Sample	Top Interval	Bottom Interval	Cu ppm	Ni ppm	Zn ppm	Pb ppm	Co ppm	As ppm	Ag ppm	Au ppb
40918	5271	451.0	453.0							<0.34	309
40918	5275	469.0	471.0							<0.34	170
40918	5276	473.0	475.0							<0.34	170
B21-2	3347	652.0		187	113	223		100		0.02	343
B21-3	3309	192.8		4200	267	106		230		0.02	343
B21-3	3316	456.0		253	183	473		133		0.02	686
B31-1	2617	531.0		170	110	1670	<20	80		1	137
B31-1	B31-1-15	534.0	536.0	270	135	330		125	20	2	100
B31-1	TBDNR-82-1	534.0	538.0	153	63	360	10	45	25	0.7	140
B31-1	TBDNR-82-1	538.0	542.0	78	39	715	12	32	14	0.4	130
B31-1	TBDNR-82-1	542.0	543.8	71	33	252	16	42	32	1.1	220
B31-1	B31-1-36	542.0	545.8	75	55	215		65	20	1	100
B31-1	TBDNR-82-1	543.8	548.0	44	28	115	7	22	23	0.7	140
B31-1	2616	548.0		590	120	570	<20	60		1.2	309
B31-1	TBDNR-82-1	548.0	552.0	86	63	225	12	29	55	1.2	105
B31-3	B31-3-461	461.0		120	74	83	83	27	360	1.5	100
B31-3	B31-3-10	469.8	472.0	140	45	40		110			100
B58-1	B58-1-03	291.0	298.0	175	160	175	20	100	20	1	200
BD-3	BD3-1-02	272.0	276.0	237		123			10	1.9	160
BD-3	BD3-1-07	380.0	382.0	109		1370			119	0.8	445
BD-II-1	30257	615.0	620.0	130		40	<5			<0.2	580
BD-II-2	30267	240.0	245.0	320		120	<5			<0.2	160
BD-II-2	30270	275.0	280.0	180		130	<5			<0.2	300
BD-II-2	30271	283.5	287.0	700		70	<5			0.4	200
BD-II-2	30272	287.0	291.0	470		190	<5			0.2	190
BD-II-2	30274	295.0	300.0	110		155	<5			<0.2	100
BD-II-2	30275	390.0	395.0	115		50	<5			<0.2	340
BD-II-2	30280	420.0	425.0	160		35	<5			<0.2	140
LW-346-1	LW12769-R	205.4	206.8	70	100	<200	20	50	<200	<0.2	200
LW-346-1	LW12770-R	207.6	209.6	70	50	<200	20	20	<200	<0.2	180
LW-346-1	LW16714-R	212.0	214.0	20	50	<200	<10	20	<200	<0.2	180
LW-346-1	LW16713-R	216.0	220.0	30	50	<200	30	15	<200	<0.2	140
LW-346-1	LW16712-R	221.0	226.0	20	50	<200	50	10	<200	0.4	300
LW-346-1	LW16715-R	226.0	231.0	50	30	<200	10	15	<200	<0.2	180
LW-346-1	LW16716-R	231.0	235.0	30	30	<200	50	10	<200	<0.2	220
LW-346-1	LW16721-R	285.9	286.3	70	50	<200	10	200	<200	<0.2	790
LW-346-1	LW16734-R	513.0	517.0	300	70	2000	20	50	<200	0.4	620
MQD-2	MQD-2-02	104.0	109.0	510	73	450	15			1.3	130
MQD-2	MQD-2-07	289.0	292.0	305	68	4500	28			2	130
MQD-2	MQD-2-08	292.0	295.5	50	55	550	15			1	190

Total Au analyses: 554
High value: 790 ppb
Range of table: > 100 ppb

Appendix 278-H. Sample Characterizations

Abbreviations of Sample Characterization Categories

Lithologic Descriptions		Minerals	
Med	Medium	Cal	Calcite
Crs	Coarse	Carb	Carbonate
Lith Contact	Lithology Contact	Tour	Tourmaline
UM	Ultramafic	Sulf	Sulfides
Maf	Mafic	Graph	Graphite
Int	Intermediate	Gar	Garnet
Fel	Felsic	Ep	Epidote
Porph	Porphyritic	Serp	Serpentine
Agg/VBx	Agglomerate/Volcanic Breccia	Ser	Sericite
Gwcke/Arenite	Greywacke/Arenite	Chl	Chlorite
Cgl	Conglomerate	Musc	Muscovite
Phyl	Phyllite	Biot	Biotite
Rxtl Hfls	Recrystallized Hornfels	Alb	Albite
Bx	Breccia	Kfs	K-Feldspar
		Plag	Plagioclase
		Qtz	Quartz
		Amph	Amphibole

Abbreviations used for Sample Characterizations

X - feature or characterization present.

XX - amount present is relatively greater than either a similar characteristic for the same sample, or the same column for adjacent samples, both where marked by one "X".

? - identification or amount in doubt.

XM	mafic intrusive	CP	chalcopyrite	MAG	magnetite (in "OXIDES")
XI	intermediate intrusive	BN	bornite		
XF	felsic intrusive	APY	arsenopyrite	LIM	limonite
XUM	ultramafic intrusive	TOUR	tourmaline	HEM	hematite
P	pillows	AZUR	azurite	CAL	calcite
PB	pillow breccia	MN	manganese	DOL	dolomite
RHY	rhyolite	AU	gold fleck?	BAR	barite
SLICKS	slickensides	GR	graphite	SID	siderite
SERP	serpentine	KAO	kaolin	ANK	ankerite
PHLOG	phlogopite	RHO	rhodochrosite	MAG	magnesite (in "OTHER CARBONATE)

OXIDES - magnetite unless otherwise noted. Mn oxides were problematical regarding their identification due to fine grain size of rock and similarity to magnetite.

H-CH - hornblende-chlorite; dark green "iron" silicates found separately (or together) with oxides, sulfides, garnet, calcite, siderite, and occasionally tourmaline chemical sediments and/or alteration. Used in the "OTHER" column to represent what is believed to be the major alteration type associated with sulfide mineralization and chemical sedimentation. The relationship of the association may vary from crosscutting to stratiform, with replacement and tectonism making the distinction between chemical sediment and alteration at times very difficult.

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Grain Size			Lithology											
		Top	Bottom	Fine	Med	Crs	Lith Contact	UM	Maf	Int	Fel	Porph	Intrusive	Extrusive	Flows	Tuffs	Agg/ VBx	Gwcke/ Arenite
23448	40917	229.0	233.0	X			X				X?	X		X		X		
23449	40917	233.0	238.5	X	X		X				X			X		X		
23450	40917	252.0	257.0	X	X	X					RHY X	X?		X		X	X	
23451	40917	266.0	270.5	X	X						X	X?		X		X		
23452	40917	353.0	361.0	X	X				X?	X?	X?			X		X		
23443	40918	280.5	287.0	X	X	X				X	X	X		X		X	X	
23444	40918	287.0	305.5	X	X	X				X	X	X		X		X	X	
23445	40918	333.0	336.0	X	X					X	RHY X	X		X		X		X?
23446	40918	433.0	435.0	X						X	X?	X		X		X		
23447	40918	447.0	451.0	X						X	X?	X		X		X		
23833	40919	534.0	546.3	X	X	X?	X			X?	X?	X		X		X?		X?
23830	40920	434.0	444.0	X					X					X	X?			
23831	40920	454.0	464.0	X					X					X	X?			
23403	40926	166.0	175.5	X					X?					X		X		X
23404	40926	175.5	178.5	X			X		X?					X		X		X
23405	40926	178.5	192.0	X			X		X?					X		X		X?
23406	40926	222.0	236.0	X			X				X?			X		X?		
23407	40926	334.0	344.0	X	X		X			X	X			X		X		
23408	40926	344.0	352.0	X			X			X	X			X		X		
23409	40926	372.4	384.0	X			X			X?				X?		X?		X?
23410	40926	412.0	422.0	X						X?				X?		X?		X?
23834	B-B-2	194.0	206.0	X	X				X	X?				X	X?	X?		
23835	B-B-2	306.0	314.0	X	X				X	X	X?			X		X		
23565	B-Q-1	96.1	106.1	X	X		X		X	X?	X?			X		X		X
23566	B-Q-1	106.1	118.0	X			X	X??	X					X	X?	X?		
23567	B-Q-1	161.0	174.0	X	X			X??	X					X	X	X?		
23568	B-Q-1	224.0	234.0		X	X				X		X?	XI					
23569	B-Q-1	344.0	354.0	X					X	X?				X	X	X		
23570	B-Q-1	360.0	374.0	X			X		X	X?	X?			X		X?		
23828	B21-1	174.0	186.0	X	X						X?	X		X?		X?		
23829	B21-1	210.0	218.0	X	X	X					X?			X?		X?		
23823	B21-2	239.0	248.0	X	X		X			X?	X			X?		X?		
23825	B21-2	625.0	635.0	X	X	X?				X?	X?	X	XI?	X		X		
23826	B21-3	387.0	397.0	X	X	X	X			X	X			X		X	X?	
23827	B21-3	407.0	415.0	X	X						X?			X		X		
23747	B24-1	352.5	362.1	X	X						X			X		X		X?
23749	B24-1	509.0	516.5	X	X		X		X?	X?						X?		
23760	B24-2	493.0	505.0	X	X	X?				X?	X?			X?		X?	X??	X
23762	B24-2	579.6	586.6	X	X?						X			X		X		
23772	B24-3	442.0	454.0	X			X		X	X?	X?			X?	X	X?		
23801	B24-4	652.0	664.0	X		X?				X?	X			X		X		X?
23808	B24-4	1372.0	1384.0	X			X?		X?	X?				X		X		
23453	B31-1	215.7	223.0	X	X	X	X			X	X	X?	XF	X		X	X	X?
23454	B31-1	223.0	233.0	X	X	X					X	X?		X		X	X	X?
23455	B31-1	253.0	265.0	X	X	X					X	X?		X		X	X	X?

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Grain Size			Lithology											
		Top	Bottom	Fine	Med	Crs	Lith Contact	UM	Maf	Int	Fel	Porph	Intrusive	Extrusive	Flows	Tuffs	Agg/ VBx	Gwcke/ Arenite
23456	B31-1	265.0	274.7	X	X	X	X				X	X?		X		X	X	X?
23457	B31-1	274.7	284.5	X			X				X			X?		X?		
23458	B31-1	318.4	326.5	X			X		X?					X?		X?		
23459	B31-1	429.7	439.2	X					X					X		X		X
23460	B31-1	453.0	463.0	X		X?			X					X	X		PB?	X
23461	B31-1	510.0	524.0	X	X	X?	X		X					X	X?	X?	PB?	
23462	B31-1	698.0	708.5	X							X			X		X		
23371	B31-2	335.0	345.0	X	X	X				X	X	X?	XF	X		X	X	X?
23372	B31-2	353.0	364.8	X	X	X	X			X	X	X?		X		X	X	X?
23373	B31-2	364.8	376.7	X	X		X		X				XM	X?	X?	X?		
23374	B31-2	376.7	379.7	X	X	X	X			X	X	X?		X		X	X	X?
23375	B31-2	483.0	493.0	X					X		X		X	X		X?		
23376	B31-2	673.0	683.0	X					X					X		X?		
23377	B31-2	805.0	815.0	X	X				X		X		XF	X		X?	X?	
23378	B31-2	920.8	925.4	X	X		X				X	X	XF?	?				
23379	B31-2	925.4	938.0	X	X		X		X	X				X		X		
23380	B31-2	948.0	963.0	X														
23434	B31-3	215.0	226.0	X	X				X			X	XM					
23437	B31-3	445.0	448.5	X			X		X				XM					
23381	B31-3	475.5	485.0	X			X		X			X	XM					
23382	B31-3	505.0	514.0	X	X		X				X			X		X		
23383	B31-3	514.0	525.0	X	X		X				X			X		X		
23384	B31-3	525.0	535.0	X	X						X			X		X		
23435	B31-4	135.0	145.0	X								X	XM					
23385	B31-4	163.5	168.0	X	X	X	X				X	X	XM	X		X	X	
23386	B31-4	168.0	174.9	X			X					X	XM					
23387	B31-4	174.9	185.0	X	X	X	X				X	X		X		X	X	
23388	B31-4	197.6	208.2	X	X	X	X				X	X		X		X	X	
23389	B31-4	208.2	215.0	X	X	X	X				X	X		X		X	X	
23390	B31-4	289.5	305.6	X	X	X	X				X	X		X		X	X	
23391	B31-4	305.6	315.0	X	X	X	X				X	X		X		X	X?	
23392	B31-4	393.0	405.0	X	X	X					X	X		X		X	X?	
23393	B31-4	444.0	457.0	X	X?						X			X		X		
23394	B31-4	465.0	475.0	X							X			X		X		
23436	B31-5	163.0	167.0	X			X		X			X	XM					
23395	B31-5	167.0	179.0	X			X		X				XM?	X?	X?	X?		
23396	B31-5	190.0	205.0	X					X				XM?	X?	X?	X?		
23397	B31-5	235.0	251.0	X					X				XM?	X?	X?	X?		
23398	B31-5	432.0	445.0	X	X		X		X	X?			X?	X?	X?	X?		X?
23399	B31-5	455.3	465.0	X	X					X				X		X		
23400	B31-5	465.0	475.0	X	X				X	X			X	X		X		
23401	B31-5	538.0	552.0	X	X					X				X		X		
23402	B31-5	665.0	675.0	X	X				X					X		X?		
23411	B35-1	259.4	268.0	X					X	X				X		X		
23412	B35-1	268.0	275.3	X			X		X	X				X		X		

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Grain Size			Lithology											
		Top	Bottom	Fine	Med	Crs	Lith Contact	UM	Maf	Int	Fel	Porph	Intrusive	Extrusive	Flows	Tuffs	Agg/ VBx	Gwcke/ Arenite
23413	B35-1	275.3	289.3	X			X				X?			X		X?		
23414	B35-1	289.3	295.0	X			X				X?			X		X?		
23415	B35-1	295.0	308.0	X			X				X?			X		X?		
23416	B35-1	385.0	393.0	X							X?			X		X?		
23474	B5-1	155.0	167.0	X	X				X				XM	X?				
23478	B5-1	268.2	279.0	X	X				X				XM?	X		X?		
23480	B5-1	381.0	395.0	X				X?	X				XM?	X?				
23483	B5-1	430.5	440.2	X			X				X?			X?		X?		X
23489	B5-1	471.7	481.0	X	X	X?	X			X?	X?			X		X		X
23490	B5-1	675.0	685.0	X	X					X?	X			X		X		
23600	B54-1	213.0	223.0	X					X?	X?				X	X	X?		
23601	B54-1	268.0	274.0	X					X	X				X	X	X	XPB	X?
23602	B54-1	320.0	325.0	X					X					X	X?	X?		
23427	B58-1	165.0	174.5	X						X	X			X?		X?		X
23428	B58-1	210.0	221.4	X							X			X?		X?		X
23429	B58-1	225.0	231.0	X						X	X			X?		X		X?
23430	B58-1	285.0	295.0	X	X		X				X			X?		X		X?
23431	B58-1	306.9	320.0	X?	X	X									X?		X	
23432	B58-1	320.0	328.0	X	X	X									X?		X	
23433	B58-1	401.0	410.0	X	X				X	X	X	X		X		X		X
23844	BD-1	244.0	254.0	X	X?	X?					X?			X		X	X?	
23845	BD-1	355.0	370.0	X	X?						X			X		X		
23836	BD-2	304.0	316.0	X	X	X	X			X?	X			X		X	X?	
23837	BD-2	370.0	380.0	X	X						X			X?		X?		
23842	BD-3	362.0	370.0	X	X	X	X				X	X?		X		X	X?	
23843	BD-3	404.0	412.0	X	X						X	X?		X		X		
23846	BD-II-1	592.0	602.0	X	X					X?	X			X		X		
23847	BD-II-1	653.0	663.0	X	X				X					X	X?	X		
23848	BD-II-2	314.0	324.0	X	X				X	X			X,IM?	X	X	X?		
23849	BD-II-2	486.0	495.0		X				X				XM					
23510	BD-N-1	474.5	480.3	X	X?					X?	X?			X		X		X?
23511	BD-N-1	515.0	520.5	X	X	X?				X?	X?			X		X		
23512	BD-N-1	607.0	610.3	X	X					X?	X?			X?		X?		
23513	BD-N-1	716.7	723.0	X	X						X	X	XF?	X?		X?		
23514	BD-N-1	742.0	752.0	X	X						X	X	XF?	X?		X?		
23594	BD-P-2	156.0	163.0	X					X					X	X			
23595	BD-P-2	342.0	343.3	X			X		X		X		XMF	X	X?	X?		
23596	BD-P-2	414.0	422.0	X					X					X	X	X?		
23597	BD-P-2	548.0	552.0	X	X			X?	X				XM?	X	X	X?		
23598	BD-P-2	622.0	628.0	X				X?	X					X?	X?			
23599	BD-P-2	628.0	632.0	X							X?							
23840	LW-346-1	280.0	287.3	X	X	X?	X				X	X		X		X	X?	
23841	LW-346-1	535.0	546.0	X	X	X?					X			X		X		
23838	LW-346-2	247.7	259.6	X	X?	X?				X?	X?			X	X?	X	X?	
23839	LW-346-2	425.0	436.0	X	X?	X?				X?	X?			X	X?	X	X?	

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Grain Size			Lithology											
		Top	Bottom	Fine	Med	Crs	Lith Contact	UM	Maf	Int	Fel	Porph	Intrusive	Extrusive	Flows	Tuffs	Agg/ VBx	Gwcke/ Arenite
23532	MDD-1	229.0	231.0	X	X						X		XF					
23533	MDD-1	252.0	262.0	X	X				X?	X				X		X		X
23534	MDD-1	303.5	308.4	X	X	X	X	X?	X?			X	XUM?	X?				
23535	MDD-1	316.0	326.0	X							X?			X		X		
23536	MDD-1	372.0	382.0	X				X?	X					X	X?	X?		
23537	MDD-1	412.8	421.0	X	X	X	X				X	X		X		X		
23554	MDD-1	421.0	432.0	X	X		X		X	X?		X		X		X		X
23555	MDD-1	463.0	474.0	X	X	X		X?	X?		X	X	XM,UM,F	X?				
23556	MDD-1	538.0	552.0	X	X	X			X	X	X	X?	XI,F	X	X	X	X?	
23417	MED-1	174.0	185.0	X	X	X					X	X		X		X	X	
23418	MED-1	185.0	194.0	X	X	X					X	X		X		X	X	
23419	MED-1	204.0	209.0	X	X	X	X				X	X		X		X	X	
23420	MED-1	209.0	213.5	X			X				X?			X		X		
23421	MED-1	213.5	224.0	X												X?		
23422	MED-1	424.0	436.1	X					X					X		XX		
23423	MED-1	441.0	451.0	X					X					X		XX		
23424	MED-1	451.0	456.0	X			X		X?	X	X			X		XX	X	
23425	MED-1	456.0	459.9	X	X		X				X	X		X		X		
23426	MED-1	459.9	469.0	X						X?	X?	X		X		X?		X?
23438	MMD-1	175.0	188.0	X			X				X	X		X		X		
23439	MMD-1	188.0	196.5	X			X				X	X		X		X		
23440	MMD-1	379.0	390.9	X?	X	X?	X		X					X		X		
23441	MMD-1	415.3	430.5	?	X	X?	X		X					X		X		
23442	MMD-1	481.5	493.0	X	X		X		X					X		X?		X?
23589	MQD-1	152.0	162.0	X	X				X?	X				X		X		
23590	MQD-1	277.0	288.0	X	X				X?	X				X		X		X?
23593	MQD-1	298.0	308.0	X	X	X				X	X?			X		X	X?	X?
23591	MQD-1	322.0	332.0	X	X	X				X				X		X	X?	X?
23592	MQD-1	346.0	356.0	X	X					X				X		X		X?
23580	MQD-2	132.0	142.0	X	X	X			X		X		XF?	X?	X?	X		
23581	MQD-2	162.0	171.6	X							X?			X		X	X??	
23582	MQD-2	176.5	190.0	X	X		X		X				XM	X?		X?		
23583	MQD-2	191.0	197.0	X	X	X	X		X		XX		XMF	X?		X?		
23584	MQD-2	202.0	212.0		X	X			XX		X		XMF					
23585	MQD-2	212.0	224.0		X	X			XX		X		XMF					
23586	MQD-2	232.0	242.0		X	X			XX		X		XMF					
23587	MQD-2	252.0	262.0	X	X				X				XM?	X	X?	X	X?	
23588	MQD-2	344.0	356.0	X	X?				X				XM?	X	X?	X?		
23814	MSD-1	345.0	357.0	X					X	X?				X	X?	X?		
23850	RR-16-1	52.0	62.0	X	X				X	X?				X	X?	X		
23851	RR-16-1	136.0	146.0	X	X	X				X?	X			X		X		
23730	YWL-1	329.0	339.0	X				X	X					X	X?			
23733	YWL-1	506.0	516.0	X					X	X	X?		XM	X		X?		X?
23704	YWM-1	290.0	300.0	X	X	X				X?	X?			X		X	X	
23705	YWM-1	323.0	333.0	X	X	X?				X?	X?			X?		X	X?	X

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Grain Size			Lithology											
		Top	Bottom	Fine	Med	Crs	Lith Contact	UM	Maf	Int	Fel	Porph	Intrusive	Extrusive	Flows	Tuffs	Agg/ VBx	Gwcke/ Arenite
23706	YWM-1	365.0	375.0	X	X?	X?				X?	X?			X?		X?	X?	X
23707	YWM-1	408.0	419.0	X	X?	X??				X?	X?			X?		X?	X?	X
23708	YWM-1	465.0	475.0	X	X	X				X?	X?			X		X	X?	X?
23709	YWM-1	484.2	491.0	X	X					X?	X?			X		X?		X
23710	YWM-1	527.0	537.3	X	X	X				X	X			X		X		X?
23711	YWM-1	537.3	551.0	X						X?	X?			X?		X?		X?
23712	YWM-1	577.0	587.0	X	X?				X					X	X?	X		
23603	YWQ-1	480.0	501.0	X						X?	X?			X?		X?		
23604	YWQ-1	673.0	683.0	X							X	X		X		X		
23605	YWQ-1	739.5	748.6	X			X				X	X		X		X		
23606	YWQ-1	816.0	826.0	X	X?	X?	X				X			X		X	X?	X
23607	YWZ-1	295.0	306.0	X	X		X	X	X?				XUM?	X	X			
23658	YWZ-1	417.5	428.0	X	X			X				X?	XUM					
23608	YWZ-1	553.0	560.0	X					X				XM?	X	X?	X?		
23609	YWZ-1	725.5	730.2	X					X				XM?	X	X?	X?		
23610	YWZ-1	778.0	785.5	X					X				XM?	X	X?	X?		
23611	YWZ-1	799.0	806.5	X					X				XM?	X	X?	X?		
23684	YWZ-2	311.0	321.0	X	X			X	X?				X?	X?				
23685	YWZ-2	369.0	375.0	X	X		X	X					X?	X		X?		
23686	YWZ-2	383.0	393.0	X				X					X?	X				
23687	YWZ-2	393.0	403.8	X	X		X	X					X?	X				
23688	YWZ-2	443.0	453.0	X	X			X?	X					X	X	X?		
23689	YWZ-2	463.0	473.0	X	X			X						X	X			
23690	YWZ-2	636.3	643.8	X	X		X			X	X?			X		X		
23691	YWZ-2	643.8	655.0	X	X		X			X?	X?			X		X		

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Lithology								Chemical Sediments						
		Top	Bottom	Cgl	Mudstone/ Slate/Phyl	Gneissic	Schistose	Rxtl Hfls	Bx	Fold Closures	Other	Carb	Tour	Oxide	Chert	Silicate	Sulf	Graph
23448	40917	229.0	233.0			X	X?	X										
23449	40917	233.0	238.5				X					X		LIM	X	X	X	
23450	40917	252.0	257.0			X	X	X										
23451	40917	266.0	270.5			X	X	X								X?	X?	
23452	40917	353.0	361.0				X										X	
23443	40918	280.5	287.0				X											
23444	40918	287.0	305.5				X						?					
23445	40918	333.0	336.0				X											
23446	40918	433.0	435.0				X?					X	X	X	X?		X	
23447	40918	447.0	451.0				X					X		X	X?		X	
23833	40919	534.0	546.3					X		X								
23830	40920	434.0	444.0				X?	X	X									
23831	40920	454.0	464.0				X?	X	X									
23403	40926	166.0	175.5				X		X								X	
23404	40926	175.5	178.5				X							HEM?			X	X
23405	40926	178.5	192.0				X					X	X?	HEM?	X?	X?	X	
23406	40926	222.0	236.0		X		X						X?		X		X	X
23407	40926	334.0	344.0				X											
23408	40926	344.0	352.0				X		X	X								X
23409	40926	372.4	384.0				XX									X		X
23410	40926	412.0	422.0				X											
23834	B-B-2	194.0	206.0				X					X?						
23835	B-B-2	306.0	314.0				X											
23565	B-Q-1	96.1	106.1				X?	X?	X			X?		X?	X	X	X	
23566	B-Q-1	106.1	118.0				X?	X?	X?									
23567	B-Q-1	161.0	174.0				X?	X?										
23568	B-Q-1	224.0	234.0				X?	X?										
23569	B-Q-1	344.0	354.0				X?	X				X?			X	X?	X	
23570	B-Q-1	360.0	374.0				X	X	X	X					X	X	XX	
23828	B21-1	174.0	186.0					X	X?					X	XX?		X	
23829	B21-1	210.0	218.0					X	X?					XX	X?		X	X?
23823	B21-2	239.0	248.0				X	X	X?				XX	X?	XX	XX	XX	
23825	B21-2	625.0	635.0			X?		X	X?									
23826	B21-3	387.0	397.0			X	X?	X	X?			X?			X?		X?	
23827	B21-3	407.0	415.0			X?	X	X	X					X	X	X?	X	
23747	B24-1	352.5	362.1					X								X?	X?	
23749	B24-1	509.0	516.5					X						X	X	X	X	
23760	B24-2	493.0	505.0	X			X?	X?										
23762	B24-2	579.6	586.6					X							XX		X	
23772	B24-3	442.0	454.0				X	X	X					XX		XX	XX	
23801	B24-4	652.0	664.0				X?	X	X?						X?		X?	
23808	B24-4	1372.0	1384.0				X		X					X	X?	X	X	
23453	B31-1	215.7	223.0	X?				X							X?		X?	
23454	B31-1	223.0	233.0	X?				X							XX?		X?	
23455	B31-1	253.0	265.0	X?				X							XX?		X?	

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Lithology								Chemical Sediments						
		Top	Bottom	Cgl	Mudstone/ Slate/Phyl	Gneissic	Schistose	Rxtl Hfls	Bx	Fold Closures	Other	Carb	Tour	Oxide	Chert	Silicate	Sulf	Graph
23456	B31-1	265.0	274.7	X?				X							X?		X?	
23457	B31-1	274.7	284.5				X	X							XX		X	
23458	B31-1	318.4	326.5				X	X?	X			X		X	X	X?	X	
23459	B31-1	429.7	439.2				X	X?						X?	X?		X?	
23460	B31-1	453.0	463.0				X	X?	X?									
23461	B31-1	510.0	524.0					X	X						X		X	
23462	B31-1	698.0	708.5				X			X					X?			
23371	B31-2	335.0	345.0	X?				X										
23372	B31-2	353.0	364.8	X?				X										
23373	B31-2	364.8	376.7					X	X									
23374	B31-2	376.7	379.7	X?				X										
23375	B31-2	483.0	493.0				X?	X?				X?		XX	X?	X?	X	
23376	B31-2	673.0	683.0				X?	X	X			X?		XX		X?	X	
23377	B31-2	805.0	815.0				X?	X	X			X?		XX	XX	X?	X	
23378	B31-2	920.8	925.4					X										
23379	B31-2	925.4	938.0				X?	X						X	X	X?	XX	
23380	B31-2	948.0	963.0				X?	X						X	X	X?	XX	
23434	B31-3	215.0	226.0					X?										
23437	B31-3	445.0	448.5					X?										
23381	B31-3	475.5	485.0					X?										
23382	B31-3	505.0	514.0				X		X			X		X?	XX	X	XX	
23383	B31-3	514.0	525.0				X		X								XX	
23384	B31-3	525.0	535.0				X		X								XX	
23435	B31-4	135.0	145.0					X										
23385	B31-4	163.5	168.0	X?				X							X??	X??		
23386	B31-4	168.0	174.9					X										
23387	B31-4	174.9	185.0	X?				X							X??	X??	X??	
23388	B31-4	197.6	208.2	X?			X		X						X??	X??	X??	
23389	B31-4	208.2	215.0	X?				X							X??	X??	X??	
23390	B31-4	289.5	305.6	X?			X		X						X??	X??	X??	
23391	B31-4	305.6	315.0	X?			X								X??			
23392	B31-4	393.0	405.0	X?			X											
23393	B31-4	444.0	457.0				X											
23394	B31-4	465.0	475.0				X											
23436	B31-5	163.0	167.0					X?										
23395	B31-5	167.0	179.0					X?				X?		X?		X?	X?	
23396	B31-5	190.0	205.0					X?				XX		X?		X?	X?	
23397	B31-5	235.0	251.0					X?				XX		X?		X?	X?	
23398	B31-5	432.0	445.0				X		X						X?	X?	X?	
23399	B31-5	455.3	465.0				X		X						X?	X?	X?	
23400	B31-5	465.0	475.0				X		X						X?	X?	X?	
23401	B31-5	538.0	552.0				X		X			X		X	X?	X?	X?	
23402	B31-5	665.0	675.0					X?								X?	X?	
23411	B35-1	259.4	268.0				X			X								
23412	B35-1	268.0	275.3				X											

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Lithology								Chemical Sediments						
		Top	Bottom	Cgl	Mudstone/ Slate/Phyl	Gneissic	Schistose	Rxtl Hfls	Bx	Fold Closures	Other	Carb	Tour	Oxide	Chert	Silicate	Sulf	Graph
23413	B35-1	275.3	289.3				X								X		X	XX
23414	B35-1	289.3	295.0				X										XX	X
23415	B35-1	295.0	308.0				X											
23416	B35-1	385.0	393.0		X?		X											
23474	B5-1	155.0	167.0				X		X?		XX							
23478	B5-1	268.2	279.0				X		X?		X							
23480	B5-1	381.0	395.0				X				X?							
23483	B5-1	430.5	440.2				X										X	
23489	B5-1	471.7	481.0				X			X?							X?	
23490	B5-1	675.0	685.0				X											
23600	B54-1	213.0	223.0				X	X?	X?			X??			X?		X??	
23601	B54-1	268.0	274.0				X	X?	X?			X?		X		X	X?	
23602	B54-1	320.0	325.0				X	X?	X?			X?		X		X	X	
23427	B58-1	165.0	174.5				X											
23428	B58-1	210.0	221.4				X		X						X?		X?	
23429	B58-1	225.0	231.0				X											
23430	B58-1	285.0	295.0					X?	X						X?		X	
23431	B58-1	306.9	320.0				X								X		X	
23432	B58-1	320.0	328.0				X										X	
23433	B58-1	401.0	410.0				X											
23844	BD-1	244.0	254.0				X		X			X		X	X?	X	X	
23845	BD-1	355.0	370.0				X		X?								X?	
23836	BD-2	304.0	316.0				X	X?	X?									
23837	BD-2	370.0	380.0				X?	X	X						XX		XX	
23842	BD-3	362.0	370.0				X		X						X?		X?	
23843	BD-3	404.0	412.0				X		X			X			X?		X?	XX
23846	BD-II-1	592.0	602.0					X	X						XX		X?	
23847	BD-II-1	653.0	663.0				X	X?	X			X				XX	XX	
23848	BD-II-2	314.0	324.0				X?	X	X								X?	
23849	BD-II-2	486.0	495.0					X	X?									
23510	BD-N-1	474.5	480.3				X?							X?	XX	X?	X	
23511	BD-N-1	515.0	520.5				X?		X						X		X	
23512	BD-N-1	607.0	610.3				X?		X						X?	X?	XX	X?
23513	BD-N-1	716.7	723.0				X?	X?										
23514	BD-N-1	742.0	752.0				X?	X										
23594	BD-P-2	156.0	163.0					X										
23595	BD-P-2	342.0	343.3				X	X										
23596	BD-P-2	414.0	422.0				X	X?										
23597	BD-P-2	548.0	552.0				X	X?										
23598	BD-P-2	622.0	628.0				X?	X?							X?	X	X	
23599	BD-P-2	628.0	632.0					X							X	X?	X	
23840	LW-346-1	280.0	287.3				X		X					X	X	X?	XX	
23841	LW-346-1	535.0	546.0				X					X?		X	X		X	
23838	LW-346-2	247.7	259.6				X		X?									
23839	LW-346-2	425.0	436.0				X		X						X?			

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Lithology								Chemical Sediments						
		Top	Bottom	Cgl	Mudstone/ Slate/Phyl	Gneissic	Schistose	Rxtl Hfls	Bx	Fold Closures	Other	Carb	Tour	Oxide	Chert	Silicate	Sulf	Graph
23532	MDD-1	229.0	231.0					X?										
23533	MDD-1	252.0	262.0				X	X?					X??					
23534	MDD-1	303.5	308.4				X?	X?										
23535	MDD-1	316.0	326.0				X?	X							X?		X?	
23536	MDD-1	372.0	382.0				X?	X										
23537	MDD-1	412.8	421.0				X?	X					X?		X?		X?	
23554	MDD-1	421.0	432.0				X?	X?										
23555	MDD-1	463.0	474.0				X	X?	X?									
23556	MDD-1	538.0	552.0			X?	X?	X	X?						X	X?	X	
23417	MED-1	174.0	185.0					X?										
23418	MED-1	185.0	194.0					X?										
23419	MED-1	204.0	209.0					X?						X				
23420	MED-1	209.0	213.5				X		X					XXX		X?	XX	
23421	MED-1	213.5	224.0				X		X					XX	XX	XX	XX	
23422	MED-1	424.0	436.1					X?						X		X?	X	
23423	MED-1	441.0	451.0					X?									X	
23424	MED-1	451.0	456.0					X?										
23425	MED-1	456.0	459.9					X?								X?		
23426	MED-1	459.9	469.0				X	X?										
23438	MMD-1	175.0	188.0					X	X						X		X	
23439	MMD-1	188.0	196.5					X	X						X		X	
23440	MMD-1	379.0	390.9		X?		X	X?							X?		X?	
23441	MMD-1	415.3	430.5					X?										
23442	MMD-1	481.5	493.0				X?	X?										
23589	MQD-1	152.0	162.0				X?	X	X	X?		X?		X?	X?	X	X	
23590	MQD-1	277.0	288.0				X?	X	X?				X?	X	X?	X	X	
23593	MQD-1	298.0	308.0				X?	X								X?	X?	
23591	MQD-1	322.0	332.0				X?	X	X?						X?		X	
23592	MQD-1	346.0	356.0				X?	X	X?						X?	X	X	
23580	MQD-2	132.0	142.0				X?	X										
23581	MQD-2	162.0	171.6				X?	X							XX		X	
23582	MQD-2	176.5	190.0				X?	X										
23583	MQD-2	191.0	197.0				X?	X										
23584	MQD-2	202.0	212.0				X?	X										
23585	MQD-2	212.0	224.0				X?	X										
23586	MQD-2	232.0	242.0				X?	X										
23587	MQD-2	252.0	262.0				X?	X										
23588	MQD-2	344.0	356.0				X?	X	X?			X?				X?	X?	
23814	MSD-1	345.0	357.0				X	X?	X									
23850	RR-16-1	52.0	62.0				X											
23851	RR-16-1	136.0	146.0				X?	X	X						XX		XX	
23730	YWL-1	329.0	339.0				X		X?									
23733	YWL-1	506.0	516.0				X		X?			X?				X?		
23704	YWM-1	290.0	300.0	X?			X		X??						X?	X?		
23705	YWM-1	323.0	333.0	X?			X								X?	X?		

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Lithology								Chemical Sediments						
		Top	Bottom	Cgl	Mudstone/ Slate/Phyl	Gneissic	Schistose	Rxtl Hfls	Bx	Fold Closures	Other	Carb	Tour	Oxide	Chert	Silicate	Sulf	Graph
23706	YWM-1	365.0	375.0	X?			X								X?	X?		
23707	YWM-1	408.0	419.0	X??			X								X?	X?		
23708	YWM-1	465.0	475.0	X?			X		X?						X?	X?		
23709	YWM-1	484.2	491.0				X							X		X	X?	
23710	YWM-1	527.0	537.3				X?	X?						X?	X	X	X	
23711	YWM-1	537.3	551.0				X?	X?	X?					X	X	X	X	
23712	YWM-1	577.0	587.0				X						X			X?	X	
23603	YWQ-1	480.0	501.0		X		X		X									X
23604	YWQ-1	673.0	683.0				X					X?					X??	
23605	YWQ-1	739.5	748.6		X		X		X?	X?		X?					X?	X
23606	YWQ-1	816.0	826.0				X?	?							X??			
23607	YWZ-1	295.0	306.0				X	X?										
23658	YWZ-1	417.5	428.0				X	X?										
23608	YWZ-1	553.0	560.0				X	X?										
23609	YWZ-1	725.5	730.2				X	X?										
23610	YWZ-1	778.0	785.5				X	X?				X?				X?	X	
23611	YWZ-1	799.0	806.5				X	X?				X?				X?	X?	
23684	YWZ-2	311.0	321.0				X	X?										
23685	YWZ-2	369.0	375.0				X	X?										
23686	YWZ-2	383.0	393.0				X	X?										
23687	YWZ-2	393.0	403.8				X	X?		X								
23688	YWZ-2	443.0	453.0				X	X?										
23689	YWZ-2	463.0	473.0				X	X?										
23690	YWZ-2	636.3	643.8				X	X?										
23691	YWZ-2	643.8	655.0				X	X?				X?			XX		XX	XX

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Alteration															
		Top	Bottom	Cal	Other Carb	Ep	Serp	Talc	Ser	Chl	Biot	Gar	Alb	Kfs	Oxides	Silica	Clays	Sulf	Other
23448	40917	229.0	233.0	X?		X				X				X	LIM HEM	X			
23449	40917	233.0	238.5	X?	X?					X?		X?			LIM			X?	H-CH?
23450	40917	252.0	257.0									X						X?	H-CH?
23451	40917	266.0	270.5												LIM HEM	X		X?	H-CH?
23452	40917	353.0	361.0	X												X		X	H-CH?
23443	40918	280.5	287.0	X?					X		X?				HEM?	X?	X?		
23444	40918	287.0	305.5	X?					X		X?				HEM?	X?	X?		
23445	40918	333.0	336.0	X					X						HEM?				
23446	40918	433.0	435.0	X		X								X		X?			H-CH?
23447	40918	447.0	451.0	X		X								X		X?			H-CH?
23833	40919	534.0	546.3	X?	X?	X							X?	X?		X?		X	H-CH
23830	40920	434.0	444.0	X		X				X?								X	H-CH?
23831	40920	454.0	464.0	X	X?					X?								X	H-CH?
23403	40926	166.0	175.5						X	X								X	
23404	40926	175.5	178.5																
23405	40926	178.5	192.0							X					LIM HEM	X		X	H-CH
23406	40926	222.0	236.0						XX		XX	X							
23407	40926	334.0	344.0						X	X					LIM	X			
23408	40926	344.0	352.0						X	X					LIM	X	KAO		
23409	40926	372.4	384.0							X?	X?					X?			H-CH?
23410	40926	412.0	422.0						X									X	
23834	B-B-2	194.0	206.0	XX					X?	X	X						X		H-CH?
23835	B-B-2	306.0	314.0	X	X?				X?	X?								X	H-CH?
23565	B-Q-1	96.1	106.1	X?	X?											X?			H-CH?
23566	B-Q-1	106.1	118.0	X	X?					X						X?			
23567	B-Q-1	161.0	174.0	X	X?					X						X?		X??	
23568	B-Q-1	224.0	234.0	X						X?	X?								
23569	B-Q-1	344.0	354.0	X	X?	X				X						X		X	H-CH?
23570	B-Q-1	360.0	374.0	X?		X?										X?		X?	H-CH
23828	B21-1	174.0	186.0						X?		X?	X?			X?	XX		X	
23829	B21-1	210.0	218.0								X	X				X		X	H-CH
23823	B21-2	239.0	248.0	X		X?					X?	X			X	X		X	TOUR? H-CH
23825	B21-2	625.0	635.0	X		X			X		X?		X?	X		X		X	TOUR
23826	B21-3	387.0	397.0	X	X?						X?	X	X?			X			H-CH?
23827	B21-3	407.0	415.0		X?						X?	X?			X?	X?		X	H-CH?
23747	B24-1	352.5	362.1										X?	X		X		X?	H-CH?
23749	B24-1	509.0	516.5								X?				X??	X?		X?	H-CH
23760	B24-2	493.0	505.0	X?					X				X			X		X?	
23762	B24-2	579.6	586.6	X?					X?							XX		X	TOUR
23772	B24-3	442.0	454.0	X						X					LIM			X?	H-CH
23801	B24-4	652.0	664.0	X					X?		X		X	X?		X		X	TOUR
23808	B24-4	1372.0	1384.0	X		X				X		X			X	X		X	H-CH
23453	B31-1	215.7	223.0	X?										X	X HEM	X		X?	
23454	B31-1	223.0	233.0	X?										X	X HEM	XX		X?	
23455	B31-1	253.0	265.0	X?										X	X HEM	XX		X?	

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Alteration															
		Top	Bottom	Cal	Other Carb	Ep	Serp	Talc	Ser	Chl	Biot	Gar	Alb	Kfs	Oxides	Silica	Clays	Sulf	Other
23456	B31-1	265.0	274.7	X?										X	X HEM	X		X?	BAR?
23457	B31-1	274.7	284.5								X?				X HEM	XX		X	
23458	B31-1	318.4	326.5	X	SID	X						X						X	H-CH
23459	B31-1	429.7	439.2		SID?	X									MAG?	X?		X?	H-CH?
23460	B31-1	453.0	463.0	X	SID?	X									LIM			X?	H-CH?
23461	B31-1	510.0	524.0	X	SID?	XX						X				X		X	H-CH
23462	B31-1	698.0	708.5	X										X?	HEM	X		X	
23371	B31-2	335.0	345.0	XX	SID	XX						X		X		XX		X?	
23372	B31-2	353.0	364.8	X	SID	X						X				XX		X?	
23373	B31-2	364.8	376.7	X	ANK	X						X				XX		X	
23374	B31-2	376.7	379.7	X	SID	X						X				X		X?	
23375	B31-2	483.0	493.0	X	SID	X				X?		X		X				X	H-CH?
23376	B31-2	673.0	683.0	X		X				X?								X?	H-CH?
23377	B31-2	805.0	815.0	X						?				X?	X??			X?	H-CH?
23378	B31-2	920.8	925.4													X?			
23379	B31-2	925.4	938.0		ANK					?		X				X?		X?	H-CH?
23380	B31-2	948.0	963.0	X	ANK					?				X?				X	H-CH?
23434	B31-3	215.0	226.0																
23437	B31-3	445.0	448.5																
23381	B31-3	475.5	485.0																
23382	B31-3	505.0	514.0							?						XX		X?	H-CH
23383	B31-3	514.0	525.0		SID?					X			X?			XX			
23384	B31-3	525.0	535.0		SID?					X			X?			XX			
23435	B31-4	135.0	145.0	X?		X?													
23385	B31-4	163.5	168.0							X?						X?		X?	H-CH?
23386	B31-4	168.0	174.9																
23387	B31-4	174.9	185.0							X?						X?		X?	H-CH?
23388	B31-4	197.6	208.2			X				X?						X?		X	H-CH?
23389	B31-4	208.2	215.0			X				X?		X				X?		X?	H-CH?
23390	B31-4	289.5	305.6	X?		X				X				X	HEM?	XX		X?	H-CH?
23391	B31-4	305.6	315.0													X			
23392	B31-4	393.0	405.0	X									X	X		X			
23393	B31-4	444.0	457.0										X	X	X	XX			
23394	B31-4	465.0	475.0			X							XX	X	HEM XX	XX			
23436	B31-5	163.0	167.0	X		X												X	
23395	B31-5	167.0	179.0	X		X				X?		X			HEM			X	H-CH?
23396	B31-5	190.0	205.0	XX	DOL	X				X?		X			HEM			X	H-CH?
23397	B31-5	235.0	251.0	XX	DOL	XX				X?			X					X	H-CH?
23398	B31-5	432.0	445.0	XX		X				X?					HEM	X		XX	H-CH?
23399	B31-5	455.3	465.0	XX		XX				X?					HEM	X		XX	H-CH?
23400	B31-5	465.0	475.0	X		X				X?						X?		X	H-CH?
23401	B31-5	538.0	552.0	X		X				X?						X?		X	H-CH?
23402	B31-5	665.0	675.0	X						X?								X?	H-CH?
23411	B35-1	259.4	268.0												HEM	X			
23412	B35-1	268.0	275.3												HEM		X		

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Alteration															
		Top	Bottom	Cal	Other Carb	Ep	Serp	Talc	Ser	Chl	Biot	Gar	Alb	Kfs	Oxides	Silica	Clays	Sulf	Other
23413	B35-1	275.3	289.3		SID?				XX	X									
23414	B35-1	289.3	295.0						XX	X									
23415	B35-1	295.0	308.0												HEM				
23416	B35-1	385.0	393.0												HEM				
23474	B5-1	155.0	167.0	X			?			X?			X?	X?					
23478	B5-1	268.2	279.0	X						X?			X?			X?			
23480	B5-1	381.0	395.0	X?				X?		X									
23483	B5-1	430.5	440.2						X?		X?					X?			
23489	B5-1	471.7	481.0	X					X		X?								
23490	B5-1	675.0	685.0	X		X			X					X		X?			
23600	B54-1	213.0	223.0	X	X					X							X	X?	
23601	B54-1	268.0	274.0	X	X?					X?		X					X??	X	H-CH
23602	B54-1	320.0	325.0	X	X?					X?								X	H-CH
23427	B58-1	165.0	174.5	X					X				X?					X	
23428	B58-1	210.0	221.4		DOL?	X			X				X		LIM			X	
23429	B58-1	225.0	231.0	X		X			X										
23430	B58-1	285.0	295.0		DOL	XX			XX	X			X?		LIM	XX			
23431	B58-1	306.9	320.0	X		X												X	
23432	B58-1	320.0	328.0	X		X												X	
23433	B58-1	401.0	410.0	X					X							X?			
23844	BD-1	244.0	254.0	X?						X		X			X?	X?		X	H-CH
23845	BD-1	355.0	370.0						XX					XX		X		X	
23836	BD-2	304.0	316.0	X?	X?				XX		X?				MAG?	X		X	H-CH
23837	BD-2	370.0	380.0	X?	X?											X		XX	
23842	BD-3	362.0	370.0						XX						X LIM	X?		X	
23843	BD-3	404.0	412.0	X?					X						X LIM	X?		X?	
23846	BD-II-1	592.0	602.0	X					X?				X?	X		X		X	
23847	BD-II-1	653.0	663.0	X							X?	X						X	H-CH
23848	BD-II-2	314.0	324.0										X			X		X	H-CH?
23849	BD-II-2	486.0	495.0								X?		X			X		X	H-CH
23510	BD-N-1	474.5	480.3	X?												X?		X?	H-CH?
23511	BD-N-1	515.0	520.5	X?	X?				X?							X		X	
23512	BD-N-1	607.0	610.3															X?	H-CH
23513	BD-N-1	716.7	723.0	X					X?							X		X	
23514	BD-N-1	742.0	752.0	X					X?							X		X	
23594	BD-P-2	156.0	163.0	X?															
23595	BD-P-2	342.0	343.3	X										X?		X?			
23596	BD-P-2	414.0	422.0	X						X?									
23597	BD-P-2	548.0	552.0	X			X??	X??		X?									
23598	BD-P-2	622.0	628.0							X?						X?		X?	H-CH
23599	BD-P-2	628.0	632.0								X?					X		X?	H-CH?
23840	LW-346-1	280.0	287.3								X	X						X	H-CH
23841	LW-346-1	535.0	546.0	X					X				X?			X		X	
23838	LW-346-2	247.7	259.6	X	X?			X?	X?	X	X?					X?			H-CH?
23839	LW-346-2	425.0	436.0	X	X?				X		X		X?			X		X	H-CH?

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Alteration															
		Top	Bottom	Cal	Other Carb	Ep	Serp	Talc	Ser	Chl	Biot	Gar	Alb	Kfs	Oxides	Silica	Clays	Sulf	Other
23532	MDD-1	229.0	231.0		X														
23533	MDD-1	252.0	262.0	X?							X?							X?	
23534	MDD-1	303.5	308.4					X?		X?									H-CH? X
23535	MDD-1	316.0	326.0						X				X	X				X?	
23536	MDD-1	372.0	382.0	X?	X?														
23537	MDD-1	412.8	421.0	X?	X?								X?	X		X		X?	
23554	MDD-1	421.0	432.0	X	X?														
23555	MDD-1	463.0	474.0	X?	X?			X?		X?	X?								
23556	MDD-1	538.0	552.0	X?					X				X			X?		X?	H-CH?
23417	MED-1	174.0	185.0	X		X					X?		X			X		X	
23418	MED-1	185.0	194.0								X?					X			
23419	MED-1	204.0	209.0	X		X					X?		X			X		X	
23420	MED-1	209.0	213.5							X?					?				
23421	MED-1	213.5	224.0							X?			X?		HEM	X		X	H-CH?
23422	MED-1	424.0	436.1												X?				H-CH
23423	MED-1	441.0	451.0																
23424	MED-1	451.0	456.0																
23425	MED-1	456.0	459.9							X?	X?					X			H-CH?
23426	MED-1	459.9	469.0	X?		X					X?		X	X		X			
23438	MMD-1	175.0	188.0	XX					XX							XX			
23439	MMD-1	188.0	196.5	XX					X							X			
23440	MMD-1	379.0	390.9	?															
23441	MMD-1	415.3	430.5	?															
23442	MMD-1	481.5	493.0	X	X	X				X		X?				X		X	H-CH?
23589	MQD-1	152.0	162.0	X	X							X??				X?		X?	H-CH
23590	MQD-1	277.0	288.0	X?	X?											X?		X?	H-CH
23593	MQD-1	298.0	308.0	X	X??				X?							X			H-CH?
23591	MQD-1	322.0	332.0	X?	X?											X?			
23592	MQD-1	346.0	356.0	X?		X?							X?			X		X	H-CH
23580	MQD-2	132.0	142.0											X?		X			
23581	MQD-2	162.0	171.6	X?					X?		X?		X	X		X?		X?	
23582	MQD-2	176.5	190.0	X?									X?					X?	
23583	MQD-2	191.0	197.0	X?							X?		X	X?		X			
23584	MQD-2	202.0	212.0	X?							X		X	X?		X			
23585	MQD-2	212.0	224.0	X							X		X	X?		X			
23586	MQD-2	232.0	242.0	X?							X		X	X		X			
23587	MQD-2	252.0	262.0	X?							X?					X			
23588	MQD-2	344.0	356.0	X	X	X										X		X	
23814	MSD-1	345.0	357.0	X	X?					X	X?					X?		X?	H-CH
23850	RR-16-1	52.0	62.0	X?														X?	H-CH
23851	RR-16-1	136.0	146.0			X?			X?		X?		X?			X		X	H-CH
23730	YWL-1	329.0	339.0	X	X?			X?		X?							X?		
23733	YWL-1	506.0	516.0	X					X		X					X?			H-CH?
23704	YWM-1	290.0	300.0	X?		X			XX	X?		X			HEM	XX	X?		H-CH TOUR?
23705	YWM-1	323.0	333.0	X?		X			XX	X?		X			HEM?	XX	X?		H-CII TOUR?

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Alteration															
		Top	Bottom	Cal	Other Carb	Ep	Serp	Talc	Ser	Chl	Biot	Gar	Alb	Kfs	Oxides	Silica	Clays	Sulf	Other
23706	YWM-1	365.0	375.0	X		X			XX	X?	X?	X		X?	HEM?	XX	X?	X	H-CH TOUR?
23707	YWM-1	408.0	419.0	X		X			X	X?	X?	X		X		XX	X?	X	H-CH TOUR?
23708	YWM-1	465.0	475.0	X		X?				X?	X?	X				X		X	H-CH TOUR?
23709	YWM-1	484.2	491.0	X	X?	X?				X?		XX						X?	H-CH XX
23710	YWM-1	527.0	537.3	X	X?							X				X		X?	H-CH?
23711	YWM-1	537.3	551.0	X						X		X				XX		X?	
23712	YWM-1	577.0	587.0	X												X		X?	TOUR?
23603	YWQ-1	480.0	501.0											X?		X		X?	
23604	YWQ-1	673.0	683.0	XX					X							X	X?	X	
23605	YWQ-1	739.5	748.6	X	X				X							X	X?	X?	
23606	YWQ-1	816.0	826.0	X	X?				X?							X			
23607	YWZ-1	295.0	306.0	X	X		X	X							X HEM	X?	X		
23658	YWZ-1	417.5	428.0	X	X?		X	X							HEM				
23608	YWZ-1	553.0	560.0	X	X					X						X?			
23609	YWZ-1	725.5	730.2	XX		X				X?						X?			
23610	YWZ-1	778.0	785.5	X		X				X?	X?								H-CH
23611	YWZ-1	799.0	806.5	X		X				X?	X?					X?			H-CH
23684	YWZ-2	311.0	321.0	X?	X?		X?	X		X?							X?		
23685	YWZ-2	369.0	375.0	X	X		X?	XX		X?							X?		
23686	YWZ-2	383.0	393.0	X	X		X?	XX											
23687	YWZ-2	393.0	403.8	X?	X?		X	X		X?	PHL						X?		
23688	YWZ-2	443.0	453.0	XX	X?		X	X?		X								X?	
23689	YWZ-2	463.0	473.0	X?	MAG		X	XX											
23690	YWZ-2	636.3	643.8	XX	X?				X?		X?					X		X	
23691	YWZ-2	643.8	655.0	X											LIM	X		X	

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Vein Minerals														
		Top	Bottom	Qtz	Cal	Other Carb	Chl	Ser/ Musc	Biot	Tour	Gar	Sulf	Oxides	Kfs	Plag	Ep	Amph	Other
23448	40917	229.0	233.0				X					X						
23449	40917	233.0	238.5	X?			X					X						
23450	40917	252.0	257.0									X						
23451	40917	266.0	270.5				X					X						
23452	40917	353.0	361.0	X	X	X?	X					X						
23443	40918	280.5	287.0	X	X					X								
23444	40918	287.0	305.5	X	X					X								
23445	40918	333.0	336.0		X													
23446	40918	433.0	435.0		X							X				X		
23447	40918	447.0	451.0		X					X		X				X		
23833	40919	534.0	546.3	X						X?		X		X		X		
23830	40920	434.0	444.0	X	XX						X	X	RED HEM			X		
23831	40920	454.0	464.0	X	XX	X						X	RED HEM					
23403	40926	166.0	175.5															
23404	40926	175.5	178.5															
23405	40926	178.5	192.0							X?			LIM					
23406	40926	222.0	236.0	X									LIM					
23407	40926	334.0	344.0															
23408	40926	344.0	352.0	X				X				X						
23409	40926	372.4	384.0	X								X						
23410	40926	412.0	422.0					X				X		X				
23834	B-B-2	194.0	206.0	X	X		X											
23835	B-B-2	306.0	314.0	X	X		X	X?	X?			X						
23565	B-Q-1	96.1	106.1	X	X?	X?			X									
23566	B-Q-1	106.1	118.0	X	X	X	X?					X?					X?	
23567	B-Q-1	161.0	174.0	X	X	X	X?		X						X		X	
23568	B-Q-1	224.0	234.0	X?	X?		X?											
23569	B-Q-1	344.0	354.0	X	X							X			X		X	
23570	B-Q-1	360.0	374.0	X?	X?													
23828	B21-1	174.0	186.0	X				X?				X						
23829	B21-1	210.0	218.0								X	X	X?				X	
23823	B21-2	239.0	248.0		X					X?	X	X				X?	X	
23825	B21-2	625.0	635.0	XX	X?			X?		X					X?			
23826	B21-3	387.0	397.0	X	X		X											
23827	B21-3	407.0	415.0	X					X?			X						
23747	B24-1	352.5	362.1	X								X		X	X?			
23749	B24-1	509.0	516.5	X			X					X						
23760	B24-2	493.0	505.0	X	X		X	X				X			X			
23762	B24-2	579.6	586.6	XX	X			X		X		X						
23772	B24-3	442.0	454.0	X								X	LIM				X?	
23801	B24-4	652.0	664.0	X	X			X?		X		X		X	XX			
23808	B24-4	1372.0	1384.0	X	X		X					X					X	
23453	B31-1	215.7	223.0	X	X?					X		X	X HEM	X				
23454	B31-1	223.0	233.0	X	X?							X						
23455	B31-1	253.0	265.0	X	X?							X						

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Vein Minerals														
		Top	Bottom	Qtz	Cal	Other Carb	Chl	Ser/ Musc	Biot	Tour	Gar	Sulf	Oxides	Kfs	Plag	Ep	Amph	Other
23456	B31-1	265.0	274.7		X?													
23457	B31-1	274.7	284.5	X			X					X						
23458	B31-1	318.4	326.5	X	X	SID?	X				X	X						
23459	B31-1	429.7	439.2		X	SID?	X									X		
23460	B31-1	453.0	463.0		X	SID?	X									X		
23461	B31-1	510.0	524.0	X	X		X				X	X						
23462	B31-1	698.0	708.5	X	X		X						HEM	X				CLAYS
23371	B31-2	335.0	345.0	X	X	X?					X	X				X	X	
23372	B31-2	353.0	364.8	X	X	X?					X	X				X	X	
23373	B31-2	364.8	376.7	X	X	SID?					X	X	HEM		X			Au?
23374	B31-2	376.7	379.7	X	X	X?	X				X	X				X	X	
23375	B31-2	483.0	493.0		X	SID					X	X		X		X		
23376	B31-2	673.0	683.0		X							X				X		
23377	B31-2	805.0	815.0		X							X		X				
23378	B31-2	920.8	925.4															
23379	B31-2	925.4	938.0			ANK					X	X						
23380	B31-2	948.0	963.0		X	ANK						X						
23434	B31-3	215.0	226.0		X	DOL	X									X?		
23437	B31-3	445.0	448.5															
23381	B31-3	475.5	485.0				X											
23382	B31-3	505.0	514.0															
23383	B31-3	514.0	525.0			SID?	X					X			X?			
23384	B31-3	525.0	535.0			SID?	X					X			X?			
23435	B31-4	135.0	145.0		X		X											
23385	B31-4	163.5	168.0				X											
23386	B31-4	168.0	174.9				X											
23387	B31-4	174.9	185.0				X					X						
23388	B31-4	197.6	208.2				X					X				X		
23389	B31-4	208.2	215.0				X					X						
23390	B31-4	289.5	305.6	XX														
23391	B31-4	305.6	315.0	X			X					X						
23392	B31-4	393.0	405.0		X		X									X		
23393	B31-4	444.0	457.0	X														
23394	B31-4	465.0	475.0	X														
23436	B31-5	163.0	167.0		X		X									X		
23395	B31-5	167.0	179.0		X		X				X					X		
23396	B31-5	190.0	205.0		X		X				X					X		
23397	B31-5	235.0	251.0		X											X		
23398	B31-5	432.0	445.0	X	X							X				X		
23399	B31-5	455.3	465.0	X?	X							X				X		
23400	B31-5	465.0	475.0		X							X				X		
23401	B31-5	538.0	552.0		X							X				X		
23402	B31-5	665.0	675.0		X							X						
23411	B35-1	259.4	268.0		X		X						HEM					
23412	B35-1	268.0	275.3		X		X						HEM					

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Vein Minerals														
		Top	Bottom	Qtz	Cal	Other Carb	Chl	Ser/ Musc	Biot	Tour	Gar	Sulf	Oxides	Kfs	Plag	Ep	Amph	Other
23413	B35-1	275.3	289.3			SID?												
23414	B35-1	289.3	295.0	X									LIM					
23415	B35-1	295.0	308.0	X	X	SID?						CP?	HEM					
23416	B35-1	385.0	393.0	X	X							X						
23474	B5-1	155.0	167.0	X?	X		X						HEM	X	X			
23478	B5-1	268.2	279.0	X	X		X					X	HEM					
23480	B5-1	381.0	395.0		X		X					X						
23483	B5-1	430.5	440.2	X	X		X					X						
23489	B5-1	471.7	481.0	X	X			X										
23490	B5-1	675.0	685.0	X	X?									X?		X?		
23600	B54-1	213.0	223.0	X?	X	X	X?						LIM					
23601	B54-1	268.0	274.0		X	X	X?					X						
23602	B54-1	320.0	325.0		X	X	X?					X					X?	
23427	B58-1	165.0	174.5	X			X											
23428	B58-1	210.0	221.4		X		X					X						
23429	B58-1	225.0	231.0	X	X		X	X				X			X			
23430	B58-1	285.0	295.0		X		X	X						X		X		
23431	B58-1	306.9	320.0		X							X				X		
23432	B58-1	320.0	328.0		X							X				X		
23433	B58-1	401.0	410.0															
23844	BD-1	244.0	254.0	X?	X							X	X?					
23845	BD-1	355.0	370.0	XX								X						
23836	BD-2	304.0	316.0	X?	X		X	X										
23837	BD-2	370.0	380.0	X	X?	X?						XX						
23842	BD-3	362.0	370.0	X				X		X?		XX						
23843	BD-3	404.0	412.0		X													
23846	BD-II-1	592.0	602.0	X?	X			X?				X		X	X		X?	
23847	BD-II-1	653.0	663.0	X	X							XX					X	
23848	BD-II-2	314.0	324.0	X								X			X		X	
23849	BD-II-2	486.0	495.0	X					X?			X			X			
23510	BD-N-1	474.5	480.3	XX	X?							X						
23511	BD-N-1	515.0	520.5	X	X			X?				X						
23512	BD-N-1	607.0	610.3				X?					X						
23513	BD-N-1	716.7	723.0	X	X?							X?						
23514	BD-N-1	742.0	752.0	X	X							X?						
23594	BD-P-2	156.0	163.0		X		X?										X?	
23595	BD-P-2	342.0	343.3	X	X				X?	X??		X		X	X		X?	
23596	BD-P-2	414.0	422.0	X	X							X						
23597	BD-P-2	548.0	552.0	X?	X										X?			
23598	BD-P-2	622.0	628.0	X	X	X						X?						
23599	BD-P-2	628.0	632.0	X	X	X												
23840	LW-346-1	280.0	287.3	X								X						
23841	LW-346-1	535.0	546.0	X	X							X			X?			
23838	LW-346-2	247.7	259.6	X	X	X?		X	X?									
23839	LW-346-2	425.0	436.0	X	X			X	X			X			X?			

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Vein Minerals														
		Top	Bottom	Qtz	Cal	Other Carb	Chl	Ser/ Musc	Biot	Tour	Gar	Sulf	Oxides	Kfs	Plag	Ep	Amph	Other
23532	MDD-1	229.0	231.0	X	X					X								
23533	MDD-1	252.0	262.0	X	X					XX								
23534	MDD-1	303.5	308.4		X		X											
23535	MDD-1	316.0	326.0	X?	X		X							X	X?			
23536	MDD-1	372.0	382.0	X?	X	X	X											
23537	MDD-1	412.8	421.0	X	X?					XX				X	X?			
23554	MDD-1	421.0	432.0	X	X	X				X?								
23555	MDD-1	463.0	474.0	X	X			X	X			X		X	X		X?	
23556	MDD-1	538.0	552.0	X	X?			X						X?	X			
23417	MED-1	174.0	185.0	X									LIM					
23418	MED-1	185.0	194.0	X														
23419	MED-1	204.0	209.0															
23420	MED-1	209.0	213.5									X	LIM					
23421	MED-1	213.5	224.0	X						X?			HEM		X			
23422	MED-1	424.0	436.1			SID?						X						
23423	MED-1	441.0	451.0															
23424	MED-1	451.0	456.0															
23425	MED-1	456.0	459.9	X								X						
23426	MED-1	459.9	469.0	X	X							X		X				
23438	MMD-1	175.0	188.0															
23439	MMD-1	188.0	196.5		X		X											
23440	MMD-1	379.0	390.9	X?	X		X					X	LIM					
23441	MMD-1	415.3	430.5		X		X					X						
23442	MMD-1	481.5	493.0	X	X?	X	X					X				X		
23589	MQD-1	152.0	162.0	X	X	X			X	X?		X	X?		X		X	
23590	MQD-1	277.0	288.0	X	X	X			X	X?		X						
23593	MQD-1	298.0	308.0	X	X	X?			X			X					X	
23591	MQD-1	322.0	332.0	X	X	X?				X?		X			X		X	
23592	MQD-1	346.0	356.0	XX	X				X?			X			X		X	
23580	MQD-2	132.0	142.0	X					X?	X	X			X	X			
23581	MQD-2	162.0	171.6	X	X							X						
23582	MQD-2	176.5	190.0	X	X?	X?						X		X	X			
23583	MQD-2	191.0	197.0	XX	X?				X					X	X		X	
23584	MQD-2	202.0	212.0	XX					X					X	XX		X	
23585	MQD-2	212.0	224.0	XX	X				X	X?				X	XX		XX	
23586	MQD-2	232.0	242.0	XX					X					X	XX		X	
23587	MQD-2	252.0	262.0	X					X					X	X			
23588	MQD-2	344.0	356.0	XX	X	X				X?		X			X	X?		
23814	MSD-1	345.0	357.0	X	X	X?	X?		X?			X	LIM				X	
23850	RR-16-1	52.0	62.0	X	X							X						
23851	RR-16-1	136.0	146.0	X	X?							X			X?	X		
23730	YWL-1	329.0	339.0	XX	X		X?			X		X?			X?			APY?
23733	YWL-1	506.0	516.0		XX		X											
23704	YWM-1	290.0	300.0	X	X	X?	X	X		X			HEM			X		FUCHSITE?
23705	YWM-1	323.0	333.0	X	XX	X?	X?	X		X			HEM?			X		

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Vein Minerals														
		Top	Bottom	Qtz	Cal	Other Carb	Chl	Ser/ Musc	Biot	Tour	Gar	Sulf	Oxides	Kfs	Plag	Ep	Amph	Other
23706	YWM-1	365.0	375.0	X	X	X?		X		X		X	HEM?	X?		X		
23707	YWM-1	408.0	419.0	X	X	X?		X		X	X?	X		X		X	X?	
23708	YWM-1	465.0	475.0	X	X	X?					X						X	
23709	YWM-1	484.2	491.0		X	X?					XX					X	X	
23710	YWM-1	527.0	537.3	X	X			X?		X?	X	X?		X			X	
23711	YWM-1	537.3	551.0	X	X		X				X	X?						
23712	YWM-1	577.0	587.0	X?	X					X?								
23603	YWQ-1	480.0	501.0	XX	X	X						X?		X?				
23604	YWQ-1	673.0	683.0	X	X			X				X						
23605	YWQ-1	739.5	748.6	X	X	X		X				X	HEM?					
23606	YWQ-1	816.0	826.0	X	X	X		X?				X					X	
23607	YWZ-1	295.0	306.0	X	X	X	X?				X?		HEM?					TALC?
23658	YWZ-1	417.5	428.0		X	X?							X HEM					TALC
23608	YWZ-1	553.0	560.0	X	X	X				X		X					X?	
23609	YWZ-1	725.5	730.2	X	X					X?		X			X	X?		
23610	YWZ-1	778.0	785.5	X	X							X						
23611	YWZ-1	799.0	806.5	X	X		X					X			X?	X?		
23684	YWZ-2	311.0	321.0	XX	X	X?	X?							X	X			
23685	YWZ-2	369.0	375.0	X	X	X												SERP TALC
23686	YWZ-2	383.0	393.0	X	X	X												SERP TALC
23687	YWZ-2	393.0	403.8	X?	X?	X?												SERP? TALC
23688	YWZ-2	443.0	453.0	XX	X							X?						
23689	YWZ-2	463.0	473.0		X?	MAG						X?						
23690	YWZ-2	636.3	643.8	X	X	X?		X?	X?			X						
23691	YWZ-2	643.8	655.0	X?	X?	X?						X?						

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Sulfide Mineralization									
		Top	Bottom	Disseminated	Blebs	Stringers	Massive	Veins	Pyrite	Pyrrhotite	Chalcopyrite	Sphalerite	Other Sulfides
23448	40917	229.0	233.0	X	X				X	X	X		
23449	40917	233.0	238.5	X		X?		X	X	X	X		
23450	40917	252.0	257.0	X				X	X	X	X		
23451	40917	266.0	270.5	X				X	X	X	X		
23452	40917	353.0	361.0	X				X	X	X?			
23443	40918	280.5	287.0										
23444	40918	287.0	305.5										
23445	40918	333.0	336.0										
23446	40918	433.0	435.0	X				X	X		?		BN?
23447	40918	447.0	451.0	X				X	X		?		
23833	40919	534.0	546.3	X				X?	X				
23830	40920	434.0	444.0	X	X			X	X				
23831	40920	454.0	464.0	X				X	X				
23403	40926	166.0	175.5	X		X			X				
23404	40926	175.5	178.5	X		X			X				
23405	40926	178.5	192.0	X		X			X				
23406	40926	222.0	236.0	X		X			X				
23407	40926	334.0	344.0	X					X				
23408	40926	344.0	352.0	X					X				
23409	40926	372.4	384.0	X		X			X				
23410	40926	412.0	422.0	X					X				
23834	B-B-2	194.0	206.0	X					X	X?			
23835	B-B-2	306.0	314.0	X				X	X?	X			
23565	B-Q-1	96.1	106.1	X		X	X	X?	X	X	X?		
23566	B-Q-1	106.1	118.0	X									
23567	B-Q-1	161.0	174.0	X					X?	X?			
23568	B-Q-1	224.0	234.0	X						X			
23569	B-Q-1	344.0	354.0	X		X		X	X	X	X		
23570	B-Q-1	360.0	374.0	X		X	X		X	XX	X		
23828	B21-1	174.0	186.0	X		X			X?	X			
23829	B21-1	210.0	218.0	XX	XX	X		X	X	X	X?		
23823	B21-2	239.0	248.0	XX	X?	X	X?	X	X	XX	XX	X?	BN?
23825	B21-2	625.0	635.0					X	X				
23826	B21-3	387.0	397.0	X					X	X			
23827	B21-3	407.0	415.0	X	X	X	X	X	X	X	X	X?	
23747	B24-1	352.5	362.1	X				X	X?	X?			APY?
23749	B24-1	509.0	516.5	X		X	X	X	X	XX	X?		
23760	B24-2	493.0	505.0	X				X	X		X?		
23762	B24-2	579.6	586.6	X				X?	X	X?	X?		
23772	B24-3	442.0	454.0	X	X	X	X	X	X	X?	X?	X?	
23801	B24-4	652.0	664.0	X				X	X		X?		
23808	B24-4	1372.0	1384.0	X		X	X	X	X	X	X		
23453	B31-1	215.7	223.0	X	X			X	X	X			
23454	B31-1	223.0	233.0	X				X	X	X			
23455	B31-1	253.0	265.0	X				X	X	X			

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Sulfide Mineralization									
		Top	Bottom	Disseminated	Blebs	Stringers	Massive	Veins	Pyrite	Pyrrhotite	Chalcopyrite	Sphalerite	Other Sulfides
23456	B31-1	265.0	274.7	X					X	X			
23457	B31-1	274.7	284.5	X				X	X	X			
23458	B31-1	318.4	326.5	X	X	X	X	X	X	X	X	X	
23459	B31-1	429.7	439.2	X	X		X	X	X?	X	X	X?	
23460	B31-1	453.0	463.0	X	X			X	X	X	X	X?	
23461	B31-1	510.0	524.0	X	X		X	X	X	X	X		
23462	B31-1	698.0	708.5	X				X	X				
23371	B31-2	335.0	345.0	X				X		X	X		
23372	B31-2	353.0	364.8	X				X		X	X		
23373	B31-2	364.8	376.7	X				X	X				
23374	B31-2	376.7	379.7	X	X		X	X	X	X	X		
23375	B31-2	483.0	493.0	XX				X	X	X	X		
23376	B31-2	673.0	683.0	XX				X	X	X	X		
23377	B31-2	805.0	815.0	X				X	X	X	X		
23378	B31-2	920.8	925.4	X									
23379	B31-2	925.4	938.0	X			X	X					
23380	B31-2	948.0	963.0	X				X					
23434	B31-3	215.0	226.0	X					X		X		
23437	B31-3	445.0	448.5	X					X		X		
23381	B31-3	475.5	485.0	X					X				
23382	B31-3	505.0	514.0	X	X	X	X		X		X		
23383	B31-3	514.0	525.0	X	X	X		X	XX		X		
23384	B31-3	525.0	535.0	X	X	X		X	XX		X		
23435	B31-4	135.0	145.0	X					X		X		
23385	B31-4	163.5	168.0	X					X		X		
23386	B31-4	168.0	174.9	X					X		X		
23387	B31-4	174.9	185.0	X				X	X				
23388	B31-4	197.6	208.2	X	X	X	X	X	XX	X	X		
23389	B31-4	208.2	215.0	X				X	X				
23390	B31-4	289.5	305.6	X					X				
23391	B31-4	305.6	315.0	X	X			X	X				
23392	B31-4	393.0	405.0	X					X				
23393	B31-4	444.0	457.0	X					X				
23394	B31-4	465.0	475.0	X					X				
23436	B31-5	163.0	167.0	X					X		X		
23395	B31-5	167.0	179.0	X			X		X	X	X		
23396	B31-5	190.0	205.0	X			X		X	X	X		
23397	B31-5	235.0	251.0	X					X	X	X		
23398	B31-5	432.0	445.0	X	X	X	X?	X	XX	XX	X		
23399	B31-5	455.3	465.0	X	X	X	X?	X	XX	XX	X		
23400	B31-5	465.0	475.0	X	X	X		X	XX	X	X?		
23401	B31-5	538.0	552.0	X	X	X		X	XX	X	X?		
23402	B31-5	665.0	675.0	X					X				
23411	B35-1	259.4	268.0	X					X				
23412	B35-1	268.0	275.3	X					X				

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Sulfide Mineralization									
		Top	Bottom	Disseminated	Blebs	Stringers	Massive	Veins	Pyrite	Pyrrhotite	Chalcopyrite	Sphalerite	Other Sulfides
23413	B35-1	275.3	289.3	X		X			XX		X	X?	
23414	B35-1	289.3	295.0	X					X				
23415	B35-1	295.0	308.0	X				X	X		X		BN?
23416	B35-1	385.0	393.0					X					
23474	B5-1	155.0	167.0	X							X		
23478	B5-1	268.2	279.0	X				X	X		X		
23480	B5-1	381.0	395.0	X					X		X?		
23483	B5-1	430.5	440.2	X		X		X	X				
23489	B5-1	471.7	481.0	X?		X			X		X?		
23490	B5-1	675.0	685.0	X					X?	X?			
23600	B54-1	213.0	223.0	X?					X?				
23601	B54-1	268.0	274.0	X		X			X		X?	X?	
23602	B54-1	320.0	325.0	X		X	X?	X	X	X?	X		BN
23427	B58-1	165.0	174.5	X					X				
23428	B58-1	210.0	221.4	X	X			X	X				
23429	B58-1	225.0	231.0	X				X	X				
23430	B58-1	285.0	295.0	X			X		X	X	X		
23431	B58-1	306.9	320.0			X	X	X	XX	XX	X		
23432	B58-1	320.0	328.0		X			X	XX	XX	X		
23433	B58-1	401.0	410.0	X					X				
23844	BD-1	244.0	254.0	X		X		X	X	X?			
23845	BD-1	355.0	370.0	X				X	X				
23836	BD-2	304.0	316.0	X				X	X				
23837	BD-2	370.0	380.0	X	X	X	X	X	XX	XX	X	X?	
23842	BD-3	362.0	370.0	X		X		XX	X		X		BN
23843	BD-3	404.0	412.0	X		X		X	X				
23846	BD-II-1	592.0	602.0	X				X	X				
23847	BD-II-1	653.0	663.0	X		XX		XX	X	X	?		
23848	BD-II-2	314.0	324.0	X		X?		X	X		X		
23849	BD-II-2	486.0	495.0	X		X		X	X	X	X		
23510	BD-N-1	474.5	480.3	X		X		X	X	X	X		
23511	BD-N-1	515.0	520.5	X	X	X		X?	X	X	X		
23512	BD-N-1	607.0	610.3				XX		X	X	X		?
23513	BD-N-1	716.7	723.0	X		X		X?	X	X	X		?
23514	BD-N-1	742.0	752.0	X					X	X	X		
23594	BD-P-2	156.0	163.0	X					X				
23595	BD-P-2	342.0	343.3	X				X	X	X		X?	
23596	BD-P-2	414.0	422.0	X					X				
23597	BD-P-2	548.0	552.0										
23598	BD-P-2	622.0	628.0	X				X	X		X		
23599	BD-P-2	628.0	632.0	X		X		X	X	X	X		BN
23840	LW-346-1	280.0	287.3	X		X	X	X	XX	XX	X		BN?
23841	LW-346-1	535.0	546.0	X		X		X	X	X			
23838	LW-346-2	247.7	259.6	X?					X?				
23839	LW-346-2	425.0	436.0	X				X	X		X		

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage		Sulfide Mineralization									
		Top	Bottom	Disseminated	Blebs	Stringers	Massive	Veins	Pyrite	Pyrrhotite	Chalcopyrite	Sphalerite	Other Sulfides
23532	MDD-1	229.0	231.0										
23533	MDD-1	252.0	262.0	X					X?	X?			
23534	MDD-1	303.5	308.4										
23535	MDD-1	316.0	326.0	X					X?	XX			
23536	MDD-1	372.0	382.0	X?					X?	X?			
23537	MDD-1	412.8	421.0	X					X?	X			
23554	MDD-1	421.0	432.0	X?					X?	X			
23555	MDD-1	463.0	474.0	X	X				X	X	X		
23556	MDD-1	538.0	552.0	X				X?	X?	X	X?		
23417	MED-1	174.0	185.0	X					X				
23418	MED-1	185.0	194.0	X					X				
23419	MED-1	204.0	209.0	X					X				
23420	MED-1	209.0	213.5	X	X	X		X	X		X		
23421	MED-1	213.5	224.0	X	X	X			XX		X		
23422	MED-1	424.0	436.1	X	X	X			XX	XX	X		
23423	MED-1	441.0	451.0	X	X	X	X		XX	XX	X		
23424	MED-1	451.0	456.0	X	X	X			X	XX	X		
23425	MED-1	456.0	459.9	X				X	X				
23426	MED-1	459.9	469.0	X				X	X				
23438	MMD-1	175.0	188.0	X					X				
23439	MMD-1	188.0	196.5		X	X	X		X	X	X		
23440	MMD-1	379.0	390.9	X				X?	X?	X	X		
23441	MMD-1	415.3	430.5	X					X?	X	X		
23442	MMD-1	481.5	493.0	X		X		X	X	X	X?		
23589	MQD-1	152.0	162.0	X		X		X	X	X	X?		
23590	MQD-1	277.0	288.0	XX			X?	X	X	X	X?		
23593	MQD-1	298.0	308.0	X				X	X	X			
23591	MQD-1	322.0	332.0	X		X		X	X	X			
23592	MQD-1	346.0	356.0	X		X		X	X	X	X?		
23580	MQD-2	132.0	142.0	X					X?	X?			
23581	MQD-2	162.0	171.6	X		X	X	X	X	XX	X		
23582	MQD-2	176.5	190.0	X					X	X			
23583	MQD-2	191.0	197.0	X				X	X?	X			
23584	MQD-2	202.0	212.0	X				X	X	X			
23585	MQD-2	212.0	224.0	X					X	X			
23586	MQD-2	232.0	242.0	X					X	X			
23587	MQD-2	252.0	262.0	X?					X	X			
23588	MQD-2	344.0	356.0	X		X		X	X	X	X?		
23814	MSD-1	345.0	357.0	X				X	X	X	X?		
23850	RR-16-1	52.0	62.0	X				X	X	X			
23851	RR-16-1	136.0	146.0	X	X	X	X	X	X	X	X		
23730	YWL-1	329.0	339.0					X					APY?
23733	YWL-1	506.0	516.0	X					X	X?	X		
23704	YWM-1	290.0	300.0	X?					X?				
23705	YWM-1	323.0	333.0	X					X				

Appendix 278-H. Sample Characterizations

Sample	DDH	Footage Top	Footage Bottom	Sulfide Mineralization: Disseminated	Blebs	Stringers	Massive	Veins	Pyrite	Pyrrhotite	Chalcopyrite	Sphalerite	Other Sulfides
23706	YWM-1	365.0	375.0	X					X				
23707	YWM-1	408.0	419.0	X					X				
23708	YWM-1	465.0	475.0	X					X				
23709	YWM-1	484.2	491.0	X	X	X		X	X	X	X		
23710	YWM-1	527.0	537.3	X	X	X?		X	X				
23711	YWM-1	537.3	551.0	X	X	X?		X	X				
23712	YWM-1	577.0	587.0	X	X			X?		X			
23603	YWQ-1	480.0	501.0	X		X			X				
23604	YWQ-1	673.0	683.0	X				X	X				
23605	YWQ-1	739.5	748.6	X		X		X	X				
23606	YWQ-1	816.0	826.0	X				X	X		X		BN?
23607	YWZ-1	295.0	306.0	X?					X??				
23658	YWZ-1	417.5	428.0	X??					X??	X??			
23608	YWZ-1	553.0	560.0	X				X	X				
23609	YWZ-1	725.5	730.2	X				X	X				
23610	YWZ-1	778.0	785.5	X		X		X	X	X			
23611	YWZ-1	799.0	806.5	X				X	X				
23684	YWZ-2	311.0	321.0										
23685	YWZ-2	369.0	375.0										
23686	YWZ-2	383.0	393.0										
23687	YWZ-2	393.0	403.8	X?					X	X?	X	X?	
23688	YWZ-2	443.0	453.0	X					X	X?	X		
23689	YWZ-2	463.0	473.0	X					X	X?	X		
23690	YWZ-2	636.3	643.8	X		X		X?	X	X			
23691	YWZ-2	643.8	655.0	X	X	X	X?	X	X	X	X	X(?)	BN?

Appendix 278-I. Thin Sections

Appendix 278-I. Thin Sections

DDH	Section Sample #	Footage	PTS	TS	Analysis Number
40918	20331	292.4		X	23444
40918	20332B	295.1		X	
40918	20334B	363.1		X	
40918	20335	473.3	X		
40917	20340	234.7	X		23449
40917	20341A	253.5		X	23450
40917	20342	262.8	X		
40917	20347	405.0		X	
B31-1	2613*	196.0		X	
B31-1	20351A	219.1		X	23453
B31-1	20352	230.5	X		23454
B31-1	2614*	260.5		X	23455
B31-1	20356	350.0	X		
B31-1	2615*	374.5		X	
B31-1	2617*	531.0		X	
B31-1	20362	556.7	X		
B31-1	20363B	583.1	X		
B31-1	2618*	600.5		X	
B31-2	20366A	368.0		X	23373
B31-2	20366B	368.0	X		
B31-2	20366C	368.0		X	
B31-2	20369	531		X	
B31-2	20370	557.6	X		
B31-2	20372A	757.3		X	
B31-2	20376	921.7		X	23378
B31-3	20379	300.5		X	
B31-3	20381B	531.5	X		
B31-4	20382	148.4	X		
B31-4	20383	168.0	X		23385
B31-4	20384	188.5	X		
B31-4	20385	203.5		X	23388
B31-4	20387	229.2	X		
B31-4	20389A	364.4		X	
B31-4	20391B	479.5		X	
B31-5	20393	463	X		23399
40926	20397	152.9	X		
40926	20398	178.2	X		23404
40926	2506*	211.0		X	
40926	21789	223.3	X		23406
40926	20399	224.5	X		
40926	20400	228		X	
40926	21788	230		X	
40926	2507*	249.0		X	
40926	2508*	308.5		X	
40926	2509*	338.5		X	23407

DDH	Section Sample #	Footage	PTS	TS	Analysis Number
40926	2510*	387.0		X	
40926	2511*	447.0		X	
B35-1	20396	150		X	
MED-1	21791	168		X	23417
MED-1	21793A	200		X	
MED-1	21793B	200		X	
MED-1	21797	402		X	
MED-1	21798	435.5	X		23422
MED-1	21799	458.9		X	23425
MED-1	21800	466	X		23426
B58-1	3428*	189.5		X	
B58-1	3430*	258.0		X	
B58-1	3435*	361.0		X	
B58-1	3436*	408.0		X	23433
MMD-1	21811A	189.5	X		23439
MMD-1	21811B	189.5	X		
MMD-1	21833	482.9	X		23442
B5-1	23476	157.6	X		23474
B5-1	23481	383	X		23480
B5-1	23487	470.4		X	
BD-N-1	23502	480.2	X		23510
BD-N-1	23503	495	X		
BD-N-1	23504	518	X		23511
BD-N-1	23505	609	X		23512
BD-N-1	23507	750.5	X		23514
MDD-1	23516A	230.7		X	23523A
MDD-1	23527A	323		X	23535
MDD-1	23528A	345		X	
MDD-1	23529	348.9		X	
MDD-1	23544A	464	X		23555
MDD-1	23547	541.7		X	23556
B-Q-1	23571	366.3	X		23570A
B-Q-1	23572	367	X		
B-Q-1	23573A	371	X		23570B
B-Q-1	23573B	371	X		
B-Q-1	23574A	373		X	
B-Q-1	23574B	373	X		
B-Q-1	23575	391		X	
YWQ-1	23634	491		X	23603
YWQ-1	23635A	508.3	X		
YWZ-1	23656	419.2	X		23658
YWZ-1	23657	421.3	X		
YWM-1	23696B	293.8		X	
YWM-1	23699	390		X	
YWZ-2	23671	297.4		X	

Appendix 278-I. Thin Sections

DDH	Section Sample #	Footage	PTS	TS	Analysis Number
YWZ-2	23672	312.5	X		23684
YWZ-2	23673A	320.7		X	
YWZ-2	23673B	320.7		X	
YWZ-2	23674A	347.5		X	
YWZ-2	23674B	347.5	X		
YWZ-2	23675	359.3	X		
YWZ-2	23676	373.1	X		23685
YWZ-2	23677	385.5	X		23686
YWZ-2	23678	409		X	
YWZ-2	23679A	437.3		X	
YWZ-2	23679B	437.3		X	
YWZ-2	23680	468.7		X	23689
YWZ-2	23681	520.5	X		
YWZ-2	23682	643.1	X		23690
YWZ-2	23683	649	X		23691
YWL-1	23722	467		X	23708
YWL-1	23723	493.1		X	
YWL-1	23724	520.3	X		
YWL-1	23725	524.1	X		
YWL-1	23727	603.4	X		
YWL-1	23729	680.4	X		
B24-1	23738	237.8	X		
B24-1	23739	245.2	X		
B24-1	23740	309.5		X	
B24-1	23742*	376	X		
B24-1	23744	599.4	X		
B24-1	3427*	607.0			
B24-2	23751	228	X		
B24-2	23752	485.1	X		
B24-2	23753	595.1	X		
B24-2	23754	619.4	X		
B24-2	23755	679	X		
B24-2	23756	744.5	X		
B24-3	23764	589	X		
B24-3	3475*	599.0		X	
B24-3	23766	657		X	
B24-3	23768	683	X		
B24-3	3477*	720.0		X	
B24-3	23769	729.2	X		
B24-3	23770	828.1		X	
B24-3	3478*	840.0		X	
B24-4	23780	294.2		X	
B24-4	23782	364.9		X	
B24-4	23783	370	X		
B24-4	23789	579.9		X	
B24-4	23790	594.8	X		
B24-4	23791	803.9		X	
B24-4	23797	944.5		X	
B24-4	23798	982.5	X		
B24-4	3419*	1552.0		X	
B24-4	23805	1564	X		
B24-4	3420*	1588.0		X	
MSD-1	23817	557		X	
MSD-1	23818	601.5		X	
BD-1	1271**	159.0			
BD-1	1272*	172.0		X	
BD-1	1273*	231.0		X	
BD-1	1274*	321.0		X	
BD-1	1275*	340.0	X		
B-B-2	1283*	281.0	X		

* Sections not described by Mr. Jamie Walker.

** Section broken or missing.

Appendix 278-J Report on Petrographic Analysis for Project #278

March 1, 1991

For the Minnesota Department of Natural Resources

By

Jamieson S. Walker

University of Minnesota-Duluth

Table of Contents

EDITORIAL NOTES:

Part II. Thin section descriptions are not published as part of this report, but are available on an open file basis at the DNR Minerals Division office in Hibbing, Minnesota.

Part III. Tabular summaries have been condensed from the submitted spreadsheet into two tables while retaining all of the information.

Appendices have been renamed as tables to avoid appendices within appendices.

Introduction

This report supplements the geological investigations of Project #278 of the Minnesota Department of Natural Resources - Hibbing. The purpose of the petrographic work was to augment the extensive diamond drill hole core relogging program. Specific goals include identification of: primary rock textures and lithologies, protoliths of metamorphic rocks, characterization of hydrothermal alteration and rock identification in areas of intense deformation and/or metamorphism.

This report is divided into three sections. The first section contains a summary of the major features identified in the thin sections, which includes: rock groupings, metamorphism, alteration and economic considerations. The second section contains rock description for each of the 123 thin section described, and the third section contains tabular summaries of rock types, protoliths, mineralogy and textures.

I. Summary of Results

Lithologies

The rocks described in the petrographic work can be divided into three broad groupings:

a) Felsic volcanic and intrusive rocks and derived schists.
b) Mafic and ultramafic volcanic and intrusive rocks and derived schists.
c) Sedimentary rocks and derived schists.

Felsic Volcanic Rocks:

Felsic volcanic rocks are represented by feldspar and quartz porphyritic dacitic lava flows and shallow intrusives. These rocks are characterized by their very fine grained "cherty" quartzo-feldspathic matrix and presence of very similar rocks containing fragments of the dacites, indicating a reworking of these units. In the summaries these rocks are called dacite or felsic flows. As with many of the other rock units, primary textures beyond phenocrysts could not be identified due to the metamorphism and strong deformation.

Felsic Intrusive Rocks:

Felsic intrusive rocks can be further subdivided into: fine grained porphyritic dacitic intrusives and medium to coarse grained tonalites and pegmatites.

Porphyritic dacitic intrusives are characterized by a fine grained matrix of interlocking quartz, K-feldspar (microcline, orthoclase and lesser perthite) and albitic plagioclase. This matrix is petrographically distinct from the dacitic flow units described above. Contact relationships could not be established as this investigator did not examine the diamond drill core. In the summaries these units are called dacite porphyry, dacite intrusive or felsic intrusive.

Tonalitic and pegmatitic intrusive rocks were identified in several of the thin sections. These rocks are characterized by their medium to coarse grained nature and mineralogy. Most of the units probably represent early dikes or sills and show evidence of the deformation common to the volcanic units.

"Felsic" schists:

Several schists of dominantly "felsic" mineralogy (quartz and feldspar) are considered derivatives of felsic intrusives or flows. These rocks commonly have a fine grained recrystallized matrix of quartz and feldspar, and may contain relics of feldspar phenocrysts. Due to the deformation and recrystallization, identification of the rocks' protoliths are speculative. Several of these "schists" may have been altered felsic volcanics which were subsequently more vulnerable to strain and metamorphic recrystallization.

Mafic Volcanic Rocks:

Unlike the felsic volcanic rocks, the mafic volcanic units appear to have undergone a more complete metamorphic recrystallization and development of metamorphic textures. Most of these rocks were classified as schists due to the lack of any primary textures and strong foliation observed. The mineralogy and fine grained nature of these units were the key factors in interpretation of the schists' protolith. These rocks usually have a fine grained plagioclase-rich (± quartz) matrix and contain significant amounts of fine to medium grained foliated hornblende porphyroblasts. Other minerals common to these rocks are biotite, epidote, carbonate, and in altered rocks, garnet.

Mafic to Ultramafic Rocks:

Many of the thin sections examined consist of schists derived from a mafic to ultramafic protolith. These schists consist of fine grained intergrowths of tremolite, chlorite, talc, carbonate and epidote with lesser amounts of plagioclase. They contain no identifiable primary textures and are commonly comprised of only metamorphic minerals. These rocks are consistently fine grained and contain no relics of coarser grained material and were therefore most likely flows or shallow sills and not coarse grained intrusives. Other evidence for these rocks being volcanic or shallow intrusive in origin are: a) development of many cross-cutting fabrics indicating that these rocks were emplaced early in the geological evolution of the area and b) apparent association of these rocks with sedimentary rocks (i.e. DDH# YWZ-2), however, the contact relationships cannot be verified by this investigator. It should be noted that due to the complex nature of the deformation and metamorphism, the origin of these rocks is still unclear.

Mafic Intrusive Rocks:

Gabbroic rocks are the most commonly identified mafic intrusive rocks in this study. Other mafic intrusive rocks include: anorthosite and minor mafic porphyry. Gabbros and anorthosites were perhaps the most easily identified rocks in the study due to their relatively coarse grained nature and lack of metamorphic recrystallization. These rocks consist dominantly of medium to coarse grained plagioclase and pyroxene (± hornblende) and have obvious igneous textures. In most cases these rocks show evidence of stain and minor recrystallization, and therefore appear to be early intrusives into the dominantly volcanic strata.

Sedimentary Rocks:

Sedimentary rocks and derived schists were identified in many of the thin sections examined. Most of these rocks are greywackes, arkosic wackes and mudstones (and their metamorphic equivalents). These rocks are most likely of volcaniclastic origin. Most of these rocks have undergone moderate to strong metamorphic recrystallization and are therefore classified as schists. In the lesser deformed rocks, a clearly sedimentary matrix can be identified. Greywackes are usually recrystallized to hornblende biotite schists; mudstones to hornblende schists and the arkosic rocks to quartz feldspar mica schists.

Miscellaneous Rock Units:

Approximately 10% of the rocks examined have no clear protolith. These rocks are usually strongly deformed or contain anomalous mineralogy. The strongly deformed rocks are most likely in and around fault zones and have been hydrothermally altered. Rocks with a weak foliation (hornfels and granofels) and anomalous mineralogy are most likely samples obtained from veins and identified as such in the comments field of the tables.

Metamorphism

All the rocks in the study group have undergone some degree of metamorphism and deformation. Most of the rocks show evidence of recrystallization in lower amphibolite facies conditions (epidote-amphibolite facies). The most common mineral assemblages include: hornblende, epidote, chlorite and biotite. There is some limited evidence that some of these rocks have recrystallized earlier at a higher metamorphic grade. Sample 23529 contains relics of coarse grained pyroxenes and many of the pelitic rocks contain corroded garnet porphyroblasts. These textures suggest that the rocks have undergone retrograde recrystallization from middle amphibolite to lower amphibolite.

Deformation is evident in most of the study group samples. The deformation ranges from development of a weak foliation in some of the dacitic volcanic rocks to well foliated schistose textures and intensely deformed (mylonitic?) textures (i.e. 23696B, 20398).

The most common textures are fine grained recrystallized matrix, and is moderately- to well- foliated, probably as a result of retrograde recrystallization under strain. The highly deformed rocks are probably associated with shear zones.

Deformation has overprinted most of the primary features in the rocks of the study group. Feldspar and quartz phenocrysts are the most persistent primary feature observed. Bedding is recognized only in one sample of chert (23681).

Alteration

Rock alteration in the rocks of the study group has been identified where possible (Table 1). Attempting to identify alteration in a rock requires a knowledge of the primary rock textures and mineralogy. Since most the rock samples are deformed and variably recrystallized, positive identification was difficult. The fine grained nature of these rocks will also create difficulties in identifying alteration in drill core. In samples that the primary rock (protolith) was identifiable, an alteration assemblage was identified.

In the felsic rocks, the most common alteration assemblage distinguished was sericite and/or biotite. In most cases, this potassic alteration had sulfides and/or tourmaline associated with it. This alteration type appears to be associated with fluids most commonly attributed to gold mineralizing systems. Several of the potassic altered rocks had corresponding elevated geochemical values for gold (See Table 3), mercury, arsenic and boron.

The mafic to ultramafic rocks contain abundant carbonate, talc, tremolite and chlorite. Although it is always difficult to distinguish alteration in ultramafic rocks, this mineral assemblage can be attributable to water and CO_2 mobility during metamorphism. There appears to be no elevated geochemical values of Zn, Cu or Au within these rocks.

Economic Geology

In many respects the rocks of the study group are typical of lithologies from an Archean granite-greenstone terrain. These rocks should never be overlooked for the potential to host gold and base metal deposits. Within the Superior Province in Canada (of which these rocks are an extension), rocks of similar lithologies and structural styles host some world-class deposits (eg. Hemlo and Kidd Creek).

The rocks of this study group represent sampling from a large area with a low sampling density, and it is therefore difficult to draw any specific conclusions about the economic potential of the area. A comparison of these rocks with rocks from areas which host Archean lode gold deposits, may be the only way to examine the potential of this area to host these types of deposits. It is not the intention of this report to examine these aspects of the economic geology however there are some rough comparisons that can be made. The area has many large scale long-lived faults and/or deformation zones which are common to areas hosting Archean gold deposits (See Archean Lode Gold Deposits in Ontario, OGS Misc. Paper 139, 1988). It also has a variability of lithologies that provides a ductility contrast during deformation, and possibly the compositional variation (i.e. iron formations), which may be important in the concentration and deposition of gold. Finally, the area has some indication of geochemically elevated gold values (Sample 20398, see Table 3), possibly indicating the mobility of gold in hydrothermal fluids.

Indications of volcanogenic massive sulfide deposits (VMS) are scant. This may be a function of sampling density and/or sample location. Many of the holes sampled where drilled on geophysical anomalies and not necessarily on any geological evidence. Drill hole YWZ-2 has some "interesting" geology from a VMS viewpoint. The drill hole intersects a thick package of possibly altered mafic to ultramafic rocks, a pyritic chert unit (23681), a possible greywacke unit and sampling ends in a pyritic mudstone unit. The mudstone unit is 12 ft. thick has a cherty cap? and contains up to 3.1% Zn over 3 ft. Further sampling and geochemistry should be conducted to examine these rocks for VMS potential.

Recommendation

In general, this study has provided some basic information about the lithologies, protoliths, alteration and economic geology of the study area. It by no means provides any comprehensive information about any of the above subjects. In the short term to complete this study, further geochemical sampling should be conducted around sample # 20398to extend the information on this area of intense deformation and alteration; more complete sampling of drill hole # YWZ-2 to examine the VMS potential is necessary.

Further work is necessary to extend any knowledge gained from this study. Generally, work should be conducted toward: the knowledge of the stratigraphy of the area, identification and characterization of any alteration trends observed, and the geochemical correlation and characterization of stratigraphy and alteration. This would require an extension of the current studies with more emphasis on petrographic study and a strong effort to compile this information into a complete and comprehensive package. This work would become an excellent starting point for exploration of mineral deposits in the area.

III. Tabular Summaries

Explanation of Abbreviations

Grain Size

1	Very Fine	< 0.2mm
2	Fine	0.2- 1.0mm
3	Medium	1.0- 5.0mm
4	Coarse	> 5.0mm

Primary Textures

1	Porphyritic
2	Myrmekitic
3	Bedded
4	Amygdaloidal
5	Fragmental

Foliation

0	None
1	Weak
2	Moderate
3	Strong
4	Extreme

Mineralogy

Q	Quartz	Act	Actinolite	Gn	Garnet
Or	Orthoclase	Tc	Talc	Tour	Tourmaline
Pl	Plagioclase	Cpx	Clinopyroxene	Op	Opaque
Pr	Perthite	Opx	Orthopyroxene	Il	Ilmenite
Chl	Chlorite	Ol	Olivine	Py	Pyrite
Bio	Biotite	Cb	Carbonate	Po	Pyrrhotite
Ser	Sericite	Hb	Hornblende	Phl	Phlogopite
Tr	Tremolite	Ep	Epidote		

Table 1. Rock Type, Protolith, Alteration, Primary Texture, Grain Size, and Veins.

Sample #	Rock Type	Protolith	Alteration	Prim Text	Grain Size	Fol'n	Comments	Veins %	Veins Type
20331	Porphyritic Dacite	N/A	Bio-Chl	1	1	2		30	
20332B	Recrystallized Intrusive	N/A		1	2	2		20	
20334B	Porphyritic Felsic Flow/Int	N/A		1	1	2			
20335	Hornblende Biotite Garnet Gneiss	?			2	3	Possibly all vein	?	Poss. all vein
20340	Feldspar Quartz Schist	Deformed Felsic Intrusive			2	2	75% Fsp, 10% Quartz	30	
20341	Anorthositic Intrusive	N/A	Ser		3	1	Vein controlled alteration	15	
20342	Altered Felsic intrusive	N/A	Ser/Sulf		2	2			
20347	Hornblende Plagioclase Garnet Schist	Mafic Volcanic?			2/3	3	Cloudy plag	10	
20351	Pegmatite	N/A		2	3/4	0	Perthite, strained tr myrmekite		
20352	Quartz Feldspar Porphyry	N/A	Fresh	1	1/2	1		20	
20356	Hornblende Schist	? Mudstone	?		1/2	1		30	
20362	Dacite Porphyry	N/A	Ep/Phl	1	1/2	1	cross cutting alt'n patterns		
20363B	Sheared Dacite	poss. wacke		1	1	3	Sheared, mylonite? banded		
20366	Tonalite in Hornblende Schist	Mafic/ultramafic Volcanic			2	2	Hb may be Trem.	60	
20366B	Hornblende Muscovite Chlorite Schist	Mafic/Mudstone?			2	2	70% Tonalite intrusion	70	
20366C	Tonalite in Hornblende Schist	N/A			2/3	1	2-microcline		
20369	Mafic porphyry	N/A		1	2	1	Grungy matrix		
20370	Epidote Cpx Carbonate Granofels	Vein?	?Ep/Cb		2/3	0	Possibly all vein	?	Poss. all vein
20372	Altered Tonalite	N/A	Ep		2	1		60	
20376	Porp. Felsic Flow	N/A		1	1	1	Hb xtals alt'd to chl-bio, pl to ser		
20379	Gabbro	N/A		1	3	0	?Chl alt'd?		
20381B	Altered Dacite Porphyry	N/A	Gn/Sulfides	1	1	1	Fracture controlled alt'n		
20382	Troctolite	N/A	Ser/Chl	1	3	1	sl. alt'd, 1pheno		
20383	Mafic Porphyry	N/A		1	1	0	glassy matrix		
20384	Alt'd Dacite Porphyry	N/A	Hb/Ep	1	1/2	1	local alt'n?	10	
20385	Porphyritic felsic flow (Dacite)	N/A	Act-Ep	1	1	1	Vein alt'n		
20387	Alt'd Dacite Porphyry	N/A	Ep/Ser	1	1	1	microporphyritic		
20389	Porphyritic Dacite	N/A	Fresh	1	1	1	poss Plag & K-spar phenos		
20391B	Quartz Feldspar Porphyry	N/A		1	1	1		5	Cb
20393	Metagreywacke	Greywacke			2	2	green Biotite		
20396	Actinolite Schist	Dacite?/Greywacke	?Act		1/2	3			
20397	Tremolite Chlorite Schist	Mafic/Ultramafic			2	2			
20398	Mylonitic Quartz Tourmaline Garnet	?	Tour/Sulfides		1/2	4	Pseudotachylite ?Chl-rich mtx	10	
20399	Actinolite Chlorite Schist	Mafic/Ultramafic			2	2			
20400	Talc Carbonate Chlorite Schist	Mafic/ultra Volcanic	Tc-Cb-Chl		1/2	4	Banded/veined	?	
21788	Talc Chlorite Carbonate Schist	Ultramafic/mafic flow	Tc-Chl-Cb	4?	3	3	Poss. 5mm rextallized amyg.	?	
21789	Biotite Hornblende Schist	Greywacke/Mudstone			2	3		10	
21791	Quartz Hornblende Biotite Schist	Greywacke/Lithic wacke			1/2	3	10% rextallized RF, up to 6mm		
21793	Felsic Debris Flow Deposit	N/A		5	1/2	2	15% R.F (Porp.) Ep poss. diopside		
21793B	Felsic Debris Flow Deposit	N/A		5	1/2	2	20% R.F> EP poss. diopside		
21797	Quartz Pyroxene Schist	Alt'd Dacite?	Fe/Mg	?5	2/3	3	Similar to 21793, Poss. R.F.		
21798	Hornblende Pyroxene Schist	Greywacke/Mudstone			1/2	3		5	Cpx, Cb
21799	Feldspar Porphyry	N/A		1	2	2		20	
21800	Felsic Intrusive	N/A			1	1	Rextallized mtx, late silicification		
21811A	Epidote Carbonate Actinolite Schist	Alt'd mafic flow?	Ep/Cb		2	1		15	

Table 1. Rock Type, Protolith, Alteration, Primary Texture, Grain Size, and Veins.

Sample #	Rock Type	Protolith	Alteration	Prim Text	Grain Size	Fol'n	Comments	Veins	
								%	Type
21811B	Epidote Carbonate Actinolite Schist	Alt'd Mafic Flow?					As 21811A		
21833	Hornblende Schist	Mafic Volcanic			2	2		30	
23476	Hornblende Schist	Greywacke/Mudstone			2	3			
23481	Chlorite Tremolite Schist	Mafic to Ultramafic			2	3			
23487	Hornblende Garnet Amphibolite	Altered Mafic	Hb		1/2	0			
23502	Sheared Porphyritic Dacite	N/A			1	3	Sheared, rxtl, tr sphene		
23503	Fractured Dacite	N/A	Ser		1	0	Fracture filling sulfides	5	Q
23504	Sheared Recrystallized Dacite	N/A	Silic.	1?	1/2	2	Sheared pheno's.	30	
23505	M.S. Vein in Silicified Dacite	N/A	Silic/Ep		1	0		60	
23507	Quartz Feldspar Porphyry	N/A		1	1/2	0	Wormy unknown,low rel,hi bir,hi 2V		
23516	Felsic Granofels	Dacite?			2	0	40-Q, 25-Mc, 25-Pl	5	Q-Tour
23527	Epidote Granofels (Epidosite)	Alt'd Dacite	Ep		2	0	Ep=clinozoisite,alt'd k-spar,10% R.F.		
23528	Hornblende Biotite Schist	?			1/2	2			
23528B	Biotite Tonalite	N/A			3/4	0			
23529	Tremolite Talc Schist	Mafic/Ultra Volcanic/Int.			2/3	1	Cpx porphyroblasts, ?Phlogopite		
23544	Hornblende Feldspar Schist	Mafic Volc/Gabbro?			2/3	2			
23547	Foliated Tonalite	N/A	Minor Ser		3	2	60-Plag, 29-Quartz		
23571	Granofels	Sediment?	?		2	0	Hornfels?		
23572	Quartz Gabbro	N/A			2	0	intrudes Hornblende Schist?		
23573	Pegmatite	N/A			3/4	0	25Q, 25% Pr, 25% Or, 22Alb		
23573B	Epidote Hornblende Hornfels	Greywacke			2	0		70	
23574	Foliated Tonalite	N/A	Biotite		3/4	1	Sheared, 70% Pl, 11% Quartz		
23574B	Pegmatitic Intrusive	N/A			3	0	20% Q, 35% Alb, 40% Or	2	Cb
23575	Hornblende Biotite Feldspar Schist	Greywacke or Alt'd Felsic			2/3	2	30% Mc, 30% Pr, 18% Q		
23634	Brecciated Argillite	N/A		3	1			60	
23635	Sericite Schist	?			1	3/4	Chl in matrix?	15	
23656	Tremolite Chlorite Schist	Mafic Volcanic/Intrusive			2	2	Mostly vein	70	
23657	Tremolite Chlorite Schist	Mafic volcanic/Intrusive			2/3	3	poss. relict amph. and plag.		
23671	Talc Chlorite Tremolite Schist	Mafic/Ultra Volcanic			3	3		10	
23672	Biotite Tremolite Schist	Mafic volcanic/intrusive	Bio		2/3	3			
23673	Tremolitic Anorthosite	N/A	Tr		4	0/1		50	
23673B	Tremolite Feldspar Schist	Mafic Volcanic	Tr		2	2		60	
23674	Tremolite Chlorite Biotite Schist	Mafic Volcanic?	Tr/Bio		2	3	Green biotite		
23674B	Tremolite Chlorite Biotite Schist	Mafic Volcanic?					As 23674A		
23675	Talc Chlorite Carbonate Schist	Mafic Volcanic/Intrusive	Tc		2/3	3			
23676	Biotite Epidote Schist	K-alt'd mafic or Mudstone	Bio		1/2	3	poss. phlogopite 5% 2mm fragments?		
23677	Talc Chlorite Carbonate Schist	Mafic/Ultramafic volc/int	Cb		1/2	2		10	
23678	Biotite Schist	Greywacke			2	3	Perthite in mtx		
23679	Amphibolite	Mafic Volcanic?	Hb		1/3	1	Vfg mtx, poss relict plag		
23679B	Amphibolite	Mafic Volcanic					same as 23679A		
23680	Talc Chlorite Carbonate Schist	Ultramafic	Tc/Chl		2	1			
23681	Pyritic Chert	N/A		3	1	1		5	Q-Cb-Chl
23682	Pyritic Chlorite Carbonate Schist	Greywacke?			1/2	3			
23683	Mudstone	N/A		3?	1	3	20% mica	30	

Table 1. Rock Type, Protolith, Alteration, Primary Texture, Grain Size, and Veins.

Sample #	Rock Type	Protolith	Alteration	Prim Text	Grain Size	Fol'n	Comments	Veins %	Veins Type
23696B	Muscovite Schist	Greywacke			1	3	Mylonite?		
23699	Quartz Feldspar Mica Schist	Arkosic Wacke?			1	1		35	
23722	Hornblende Schist	Mafic Flow?	Hb		2	3	relict Cpx		
23723	Hornblende Chlorite Schist	Mafic Flow?			2	2	Similar to 23722	50	
23724	Hornblende Schist	Greywacke			1/2	2/3	equigranular	10	
23725	Hornblende Garnet Schist	Greywacke			3/4	1/2	vein alt'n of 23724		poss. all vein
23727	Altered Felsic Intrusive	N/A	Cb/Ep		1	0		5	Feldspar
23729	Quartz Gabbro	N/A			3/4	0	50% Pl, 7% Qtz		
23738	Hornblende Schist	Mudstone			2	2/3		10	
23739	Massive Pyrrhotite in Metagreywacke	Greywacke			1/2	1	poss. all vein		
23740	Felsic Intrusive	N/A		1	2	0	40% Q, 40% k-spar, 11-Pl		
23744	Felsic Intrusive	N/A					As 23740		
23751	Granophyric Felsic Intrusive	N/A		2	2	1	similar to 23740except Med. gr.		
23752	Foliated Felsic Intrusive	N/A		1	2	2	same as 23740		
23753	Alt'd Felsic Intrusive	N/A	Ser-Tour	1	2	1	selective Ser alt'n of Fsp	4	Q-Op
23754	Epidote Biotite Schist	Greywacke	Epidote		1/2	1	cpx in veins		
23755	Quartz Vein with Garnet and Sulfides	N/A			3/4		all vein	10	Q-Gn-Sul-Hb
23756	Garnet Pyroxene Hornfels w/ Cb veins	?			3/4	1	?vein	30	
23764	Gabbro	N/A			2	0	45% Pl, 44% cpx		
23766	Meta-arkosic wacke	N/A			2/3	1	60% Feldspar grains		
23768	Gabbro	N/A			3		45% Pl, 47% Cpx		
23769	Gabbro	N/A			3/4		3% Q, 50% Alt'd Pl, 25% Cpx		
23770	Gabbro	N/A			2/3	1		40	
23780	Meta-arkose	N/A	Ser		1/2	1			
23782	Amphibolite	Mudstone?	?		1/2	1	Grungy	35	
23783	Pyroxene Garnet Hornfels	Greywacke/Mudstone?	?		1/2	0/1		10	
23789	Meta-arkose	N/A			1/2	1	Pegmatite cuts T.S.	60	
23790	Felsic Intrusive	N/A	Ser		1/2		K-Spar phenos=musc		
23791	Epidote Hornfels	Greywacke/Mudstone?	?		1/2	0/1	mostly alt'n along vein	10	
23797	Alt'd Felsic Intrusive	N/A	Muscovite		2/3	0			
23798	Quartz Feldspar Garnet Vein	N/A			2	0	tr cassiterite, sph	10	Q-Fsp-Gn
23805	Gabbro	N/A			2	0	2% Q, K-Spar?		
23817	Hornblende Schist	Mudstone/Greywacke			1/2	3		40	
23818	Hornblende Biotite Schist	Greywacke/Mudstone/Basalt			1/2	3			

Table 2. Matrix, Phenocrysts, and Mineralogy.

Sample	Matrix		Phenocrysts			Mineralogy																	
#	%	Type	Pl	Q	Kf	Bio	Mus	Ser	Chlorite %	Chlorite Type	Tr	Act	Hb	Cpx	Ol	Ep	Tc	Gn	Cb	Tour	Opaque %	Opaque Type	Other
20331	62	Pl/Q		1	3	8	3	5	12	Mg								tr		3	1		
20332B	83	Q/Pl			3	5										2					0.5		
20334B	71	Q/Pl	6		6			2	1				12			2					tr		
20335	12	Q/Pl				25							30	8		8		6	8		3		
20340	85	Fsp/Q							5				5								5		
20341A	82	Pl						15	2												1		
20342	56	Q/Fsp				8		15					7						tr				
20347	39	Pl							3	Fe			55					1			2		
20351A	98	Pr/Q											2								tr		
20352	79	Q/Fsp		10	5			2					3			tr					1		
20356	30	Q/Fsp?							4				45			20					1		
20362	46	Q/Fsp	2		12			4								15			4		2		15 Phlog
20363B	64	Q/Fsp	1		2				3	Mg			12	15							3	?Py	
20366A	18	Pl							20	Mg			35			10	5				2	?Sph	
20366B	9	Q/Fsp				4	20		25				40								2		
20366C	84	Q/P					6	2	4												2		
20369	19	Pl	5			15			20	Mg				15	1	3					2		20 Cpx phenos
20370	5	Q											3	40			30			10	12	Py	
20372A	76	Q/Pl											3			20					1	Py	
20376	54	Q/F	5(			4		3	8	Fe			10			5					3		8 Hb phenos
20379	47	Pl	2					5	8	Fe				35							3		
20381B	51	Q/Fsp			20			5										15			8	Py	1 Sphene
20382	60	Pl	2					5	5					20	4	tr					4	Mt	
20383	60	Glassy	35																				5 Ol phenos
20384	35	Q/Fsp	10		15				5					20		12					2	Py	1 Sphene
20385	54	Q/Fsp	20	2					4			12				8					1		
20387	32	Q/Fsp	35			tr		10	3				tr			15					5		
20389A	87	Q/Fsp	8					2											2		1		
20391B	85	Q/Fsp	4	1	8																1		1 Sphene
20393	51	Fsp?Q				20	tr		5				tr			5			6		12	Sulfides	
20396	44	Q/Fsp				tr		5				50									1		
20397	10	Q/Fsp							35	Mg	40					4					7	Sulfides	4 Phlog
20398	75	Q/Chl?																4		6	15	Sulfides, Sph	
20399	5	Q							45			45				3					2		
20400	0								25	Mg	5						27		35		8	Hem	
21788	0								25		2						40		30		2		1 br. grunge
21789	29	Q/Fsp				35			4				30								2		
21791	78	Q/Pl				6							12			3			1		tr		
21793A	72	Q/Fsp	3		4	6		3	4				2			5			1		tr		
21793B	73	Q/Fsp				5			3				5			4					tr		
21797	60	Q/K-spar	3			2								35							2		1 blue pleo.
21798	27	Q/Fsp											45	25							3	Py	
21799	67	Q/Pl	4		10	14										3					2	Py	
21800	92	Q/Mc/Fs				4										3					1		
21811A	27	Fsp/Q				5						25				30			10		3	Sulfides	

Table 2. Matrix, Phenocrysts, and Mineralogy.

Sample #	Matrix %	Matrix Type	Phenocrysts Pl	Phenocrysts Q	Phenocrysts Kf	Mineralogy Bio	Mus	Ser	Chlorite %	Chlorite Type	Tr	Act	Hb	Cpx	Ol	Ep	Tc	Gn	Cb	Tour	Opaque %	Opaque Type	Other
21811B																							
21833	32	Q/Fsp											60			4					4		
23476	14	Q/Fsp						4	10				60	5					3		2		
23481	5	Q							54		30					10		tr	tr		1		
23487	0								15				65					15	2		3		
23502	76	Q/Fsp			2	10															12	Dom sulfides	
23503	68	Q/Fsp						15								2					15	Sulf; 3%	
23504	83	Q>Fsp	10					3								6			tr		8	Py, 1% Sph	
23505	82	Q/Fsp?														15			tr		3		
23507	38	Q/Fsp	20	3	8						12										4		15 unknown
23516A	90	Q/Pl/K-S					5		2										3		tr		
23527A	22	Q-K-Spa						8								70					tr		
23528A	20	Q/Pl				25							55								tr		
23528B	88	Pl/Q				12															tr		
23529	0					5					45			5			40				5		
23544A	42	Pl					2						55								1		
23547	89	Pl/Q				tr		3						5							3		tr Sphene
23571	45	Q/Pl/K-S											10	3							40	Py, Po, Sph	2 Sphene
23572	68	Pl/Q							tr				15	5							10	Sulfides	2 Sphene
23573A	97	Q/Pr/Or/				1													tr	1	1		
23573B	47	Fsp/Q											20			30					1		2 Sphene
23574A	81	Pl/Q				6			3	Fe	4					3			2		1		tr Sphene
23574B	95	Alb/Q/Or				2													2		1		
23575	68	K-spar/Q				12							20								tr		
23634	50	Q						15	30												5		
23635A	70	Fsp/Q/C				3		25	?												2		
23656	35	Fsp							20	Mg	40										5		
23657	5	Pl							20		60		3				11				1		
23671	6	Pl				4			30		25						35				tr		
23672	32	Pl				35			tr		30					tr					2		
23673A	71	Pl				tr		3	4		20								1				1 Sphene
23673B	34	Pl/Q				5			5		55										1		
23674A	5	Q/Pl				30			30	Mg	32												2 Sphene, 1 fine cls
23674B																							
23675	3	Pl							20								55		20		2		Cb after plag
23676	18	Pl/Q				45			5							30					1		1 Sphene
23677	0								40								40		15		3		2 Spinel? (red)
23678	47	Pl/Q				40					8								5		tr		
23679A	38	Q/Pl							10	Mg			50						3		tr		1 Sphene
23679B																							
23680	0								37	Mg							40		20		3		
23681	91	Q					1						6								4	Dom. Py	
23682	45	Fsp/Q							20							10			15		10	Dom. Py	
23683	40	Q/?					20														40	graph? & sul.	

Table 2. Matrix, Phenocrysts, and Mineralogy.

Sample #	Matrix		Phenocrysts			Mineralogy																	
	%	Type	Pl	Q	Kf	Bio	Mus	Ser	Chlorite %	Chlorite Type	Tr	Act	Hb	Cpx	Ol	Ep	Tc	Gn	Cb	Tour	Opaque %	Opaque Type	Other
23696B	49	Q/Fsp				1	45		tr	Fe			3							1	1		tr Sphene
23699	85	Q/Fsp				2	5		5							tr			tr		2		
23722	10	Q/Fsp							8				65	1		15					1		
23723	10	Q/Fsp							20	Fe			50			19							1 unknown
23724	61	Q/K-spar											35			3					1		
23725	15	Q/Pl				4							70					8			3	Py	
23727	74	Q/K-spar							3							8			10		5	Some Sph	
23729	57	Pl/Q				3							35								5	4 ox, 1 sul	
23738	6	Q/Pl				3			1				85						2		3		
23739	13	Q/Fsp						4	5				10			3			tr		65	Po	
23740	89	Q/K-spar			4		3		4												tr		tr Sphene
23744																							
23751	86	Q/K-spar					4	5	4												1		
23752	84	Q/K-spar		3	4	6		2													1		
23753	77	Q/K-spar			5	tr	3	10	tr							1				2	2		
23754	49	Q-Pl				12						3		3		25				tr	6	Sulfides	tr Sphene
23755	41	Q											4					20		tr	35	Po, Py	
23756	0					5							25	30				35	5		tr		
23764	89	Pl/Cpx				7															3		1 Sphene
23766	28	Q						tr	6					2		3			tr		tr		
23768	92	Pl/Cpx											5			1					2		
23769	78	Pl/Cpx/Q						3	4				6			5					4		
23770	52	Pl							3	Fe			40	tr		tr			2		2		1 Sphene
23780	84	Q/Pl/Or				8		6										1			1		
23782	15	Q/tr Fsp											65			25		4			1		
23783	6	Q											20	35		10		25			4		
23789	82	Q/Pl/Or				8	2	2	4												2		
23790	78	Q/K-Spa			4	4	4	10												1	3		
23791	25	Q/Fsp				tr	5									35		15	20		tr		tr Sphene
23797	46	Q/Pl					50		3												1		
23798	63	Q						2										10					tr cass, sph
23805	50	Pl				3							4	35		5					1	Oxides	
23817	42	Q/K-Spa											65			2					1		
23818	46	Q/Fsp				20							30			3					1		

Table 3. Elevated Au Geochemistry vs. Alteration Type

Chem. Anal. #	Au-value	T.S.#	DDH#	Alt'n Type	Rock Type
23371	22	-	B-31-2	-	-
23382	24	-	B-31-3	-	-
23389	28	-	B-31-4	-	-
-	-	20385	"	Act/ep	Dacite Flow
23404	28	20398	40926	Tour/sul	Schist?
23423	14	-	MED-1	-	-
23427	36	-	B-58-1	-	-
23428	27	-	"	-	-
23429	11	-	"	-	-
23430	16	-	"	-	-
23431	18	-	"	-	-
23432	35	-	"	-	-
23457	22	-	B-31-1	-	-
23458	24	-	"	-	-
23510	10	23502	BD-N-1	Bio/sul	Dacite Flow
-	-	23503	"	Ser	"
23511	40	23504	"	Silic.	"
23512	24	23505	"	Silic/ep	"

Table 4. Elevated Zn-Cu Geochemistry vs. Alteration Type

Chem. Anal. #	Zn	Cu	Au	T.S.#	DDH#	Alt'n Type	Rock type
23458	67	954	24	-	B-31-1	-	-
23383	493	24	7	-	B-31-3	-	-
23403	956	62	2	-	40926	-	-
23404	2637	80	28	20398	"	Tour/sul	Schist?
23406	235	91	2	20399	"	-	Act Chl Schist
23420	109	390	6	-	MED-1	-	-
23421	146	612	5	-	"	-	-
23423	57	391	14	-	"	-	-
23439	572	243	5	21811A	MMD-1	Ep/Act	Alt'd Mafic?/Vein
23510	2808	463	10	23502	BD-N-1	Bio/sul	Dacite Flow
23511	1599	59	40	23504	"	Silic	"
23512	1581	472	24	23505	"	Silic/Ep	"
23513	317	222	5	-	"	-	"
23565	211	145	14	-	B-Q-1	-	-
23570	414	209	15	23571	"	?	SMS in Granofels
23581	1521	454	11	-	MQD-2	-	-
23592	63	248	4	-	MQD-1	-	-
23599	304	65	7	-	BD-P-1	-	-
23602	58	570	11	-	B-54-1	-	-
23604	332	59	21	-	YWQ-1	-	-
23611	148	232	1	-	YWZ-1	-	-
23690	6521	922	1	23682	YWZ-2	?	Mudstone