MINERAL POTENTIAL STUDY

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
PROJECT 326

BEDROCK AND GLACIAL DRIFT MAPPING FOR VOLCANOGENIC MASSIVE SULFIDE AND LODE GOLD ALTERATION IN THE VERMILION - BIG FORK GREENSTONE BELT

PART A: DISCUSSION OF LITHOLOGY, ALTERATION, AND GEOCHEMISTRY AT THE FIVE MILE LAKE, EAGLES NEST, AND QUARTZ HILL PROSPECTS

George J. Hudak[1] and Ronald L. Morton[2]

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[1] Geology Department, University of Wisconsin Oshkosh
[2] Geology Department, University of Minnesota Duluth

MINNESOTA DEPARTMENT OF NATURAL RESOURCES
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WILLIAM C. BRICE, DIRECTOR

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Abstract and Summary

Detailed diamond drill core relogging, petrography, and lithogeochemistry have been completed at the Five Mile (Six Mile) Lake (Soudan Quadrangle, St. Louis County), Eagles Nest (Eagles Nest Quadrangle, St. Louis County), and Quartz Hill (Shagawa Lake Quadrangle, St. Louis County) prospects in northeastern Minnesota. These investigations have been performed to: a) better understand the geology (in particular, the physical volcanology) of these regions; b) identify and evaluate the metamorphosed hydrothermal alteration mineral assemblages that occur at each of these prospects; and c) evaluate the potential for volcanogenic massive sulfide (VMS) and/or lode gold mineralization in these areas.

During our investigation, a total of eight diamond drill holes from the three prospects listed above were relogged and sampled for petrographic and lithogeochemical analysis. Four diamond drill holes from the Five Mile Lake prospect (SXL-1, SXL-2, SXL-3, and SXL-4) were relogged. Two diamond drill holes from the Eagles Nest Prospect (EN-4 and EN-7) were relogged. Two diamond drill holes from the Quartz Hill prospect (QH-84-2 and QH-85-4) were relogged. All holes were relogged with an emphasis on identifying lithology, volcanic features and textures, metamorphosed hydrothermal alteration mineral assemblages, and syn-volcanic and post-volcanic fault zones. Sixty four thin sections (33 from Five Mile Lake, 18 from Eagles Nest, and 13 from Quartz Hill) were evaluated for lithology, alteration types, primary and secondary textures, mineral modal analysis, and fragment modal analysis. Thirty-eight lithogeochemical analyses (both major and trace element) were performed on samples from the three prospects (22 from Five Mile Lake, 10 from Eagles Nest, and 6 from Quartz Hill).

Based on the diamond drill holes investigated, the Five Mile Lake region is composed of massive to amygdaloidal andesite/basalt lava flows and scoria-rich volcaniclastic deposits, locally quartz-phyric dacitic to rhyolitic lavas and flow breccias, and volcaniclastic and chemical sedimentary rocks. Quartz-feldspar porphyry and diabase dikes are also present throughout the volcanic and sedimentary sequence. Volcanic textures indicate that these rocks likely were formed within a deep water (>500meters) environment. Hydrothermal alteration minerals include epidote, iron-rich chlorite, magnesium-rich chlorite, and quartz (silicification). Stringer and semi-massive sulfide mineralization at the prospect is associated with two distinct alteration

assemblages: a) an early iron-rich chlorite - sericite - quartz assemblage, and b) an epidote - iron carbonate assemblage associated with late sulfide remobilization. The Five Mile Lake prospect appears to be a "Noranda-type" VMS system based on the criteria discussed by Morton and Franklin (1987).

The two diamond drill holes investigated in the Eagles Nest region comprise massive to amygdaloidal andesite/basalt lava flows and associated flow breccias/hyaloclastite, mafic to intermediate volcaniclastic sediments, Algoma-type mixed facies (sulfide, oxide, silicate) iron formations and associated chert horizons, interbedded siltstone and debris flow deposits, semi-massive to massive sulfide deposits, and rhyodacite to rhyolite tuffs and/or tuffaceous volcaniclastic sediments. Quartz feldspar porphyry intrusions and diabase dikes are also present. Volcanic textures suggest that the rocks in the area were also formed in a deep water (>500 meters) environment. A four meter thick intersection of pyrite-rich massive sulfide is overlain by approximately 2 meters (6 feet) of sulfide (py)-chert exhalite, which is overlain in turn by approximately 22 meters (73 feet) of mixed facies Algoma-type iron formation. The host and footwall rocks to the sulfide mineralization comprise sericite-, iron-rich chlorite-, kaolinite-, carbonate- (dolomite and/or ankerite)and locally magnesium-rich chlorite-altered felsic ash tuffs or tuffaceous volcaniclastic sediments. Based on the volcanology and hydrothermal alteration present, the Eagles Nest prospect also appears to represent a "Noranda-type" VMS system.

Rocks at the Quartz Hill prospect comprise amygdaloidal to massive basalt/andesite lava flows, mixed volcaniclastic and chemical sediments (including chert, silicate-facies iron formation, oxide-facies iron formation), and felsic tuffs or tuffaceous volcaniclastic sediments. Massive to semi-massive sulfide mineralization occurs between 89 and 150 feet in exploration diamond drill hole QH-84-2, and is hosted within the felsic ash tuff/tuffaceous sedimentary deposits. The relative abundance of felsic tuffs and tuffaceous material, coupled with hydrothermal alteration assemblages comprising andalusite, chloritoid, and iron-rich chlorite suggests that the Quartz Hill mineralization may represent either a) a "Mattabi-type" VMS system (Morton and Franklin, 1987); or b) an ancient shallow subaqueous or subaerial high-sulfidation (White and Hedenquist,1990, 1995; Sillitoe,1995). Mattabi-type VMS systems are characteristic of shallow water (<500 meters water depth) hydrothermal systems, reflect extreme acid leaching of the rocks by the hydrothermal fluids, and may be analogous to "high sulfidation" epithermal systems within shallow water environments. Such hydrothermal systems may produce gold-rich massive sulfide deposits (Hannington et al., 1997).

The results of this study indicate that the Vermilion region of northeastern Minnesota contains examples of deep water, flow dominated VMS systems (Noranda-type), as well as shallow water, volcaniclastic-dominated (Mattabi-type) VMS systems. The single Mattabi-type system (Quartz Hill) may also be representative of a shallow water high sulfidation-type epithermal system. Continued re-evaluation of diamond drill core via detailed relogging, petrographic analysis, and lithogeochemical analysis should be performed to further evaluate the characteristics of these potentially ore-forming hydrothermal systems.

Introduction

The Archean Vermillion-Bigfork granite-greenstone belt of northern Minnesota represents the southern extension of the Wawa Subprovince of the Superior Province of the Canadian shield (Figure 1). In Canada, the Wawa Subprovince is the host for a variety of mineral deposits and showings, most notably lode gold and volcanogenic massive sulfides (VMS). Gold mineralization includes the world class Hemlo mining district (Williams, Golden Giant, and David Bell Mines) which contains more than 616 tons of gold at a grade of 7.7 grams/per ton, and the Renabie district (Renabie Mine, Renabie C-Zone, and Braminco No. 21 vein) which contains 34.7 tons of gold at a grade of 6.1 grams/ton (Fyon et al., 1992). VMS deposits located in the Wawa Subprovince include the Winston Lake, Willroy, Big Nama Creek, Willecho, and Geco deposits. The sizes and grades of these VMS deposits are shown in Table 1.

Presently, there are no active gold or VMS mines in the Vermillion-Bigfork area, although favorable lithological and alteration mineral associations are present. As well, mineral occurrences of copper, zinc, and gold have been identified. The lack of economic discoveries in northern Minnesota may, in part, represent the difficulty in performing accurate and efficient mineral exploration due to a paucity of outcrops and the local presence of relatively thick glacial deposits.

The Mineral Resources Division of the Minnesota Department of Natural Resources (MDNR) completed a study (Lawler and Riihilouma, 1997) to evaluate the compositions of glacial clasts from gravel pits in the Vermillion-Bigfork area of northeastern Minnesota. This report indicated the presence of mineralized and altered clasts within the glacial drift. Lawler and Riihilouma (1997) have interpreted the mineralization and alteration present in these clasts to be indicative of lode gold and massive sulfide mineralization. At the present time, however, the sources of these clasts remain problematic.

Project 326, "Bedrock and Glacial Drift Mapping for VMS and Lode Gold Alteration in the Vermillion - Big Fork Greenstone Belt" initially set out to define possible source areas for the mineralized clasts areas (MCA's) defined by Lawler and Riihilouma (1997) by means of evaluating bedrock and glacial drift samples in northeastern Minnesota. A total of twenty two diamond drill holes (Table 2, Figure 2) were relogged to: a) better understand the geology (in

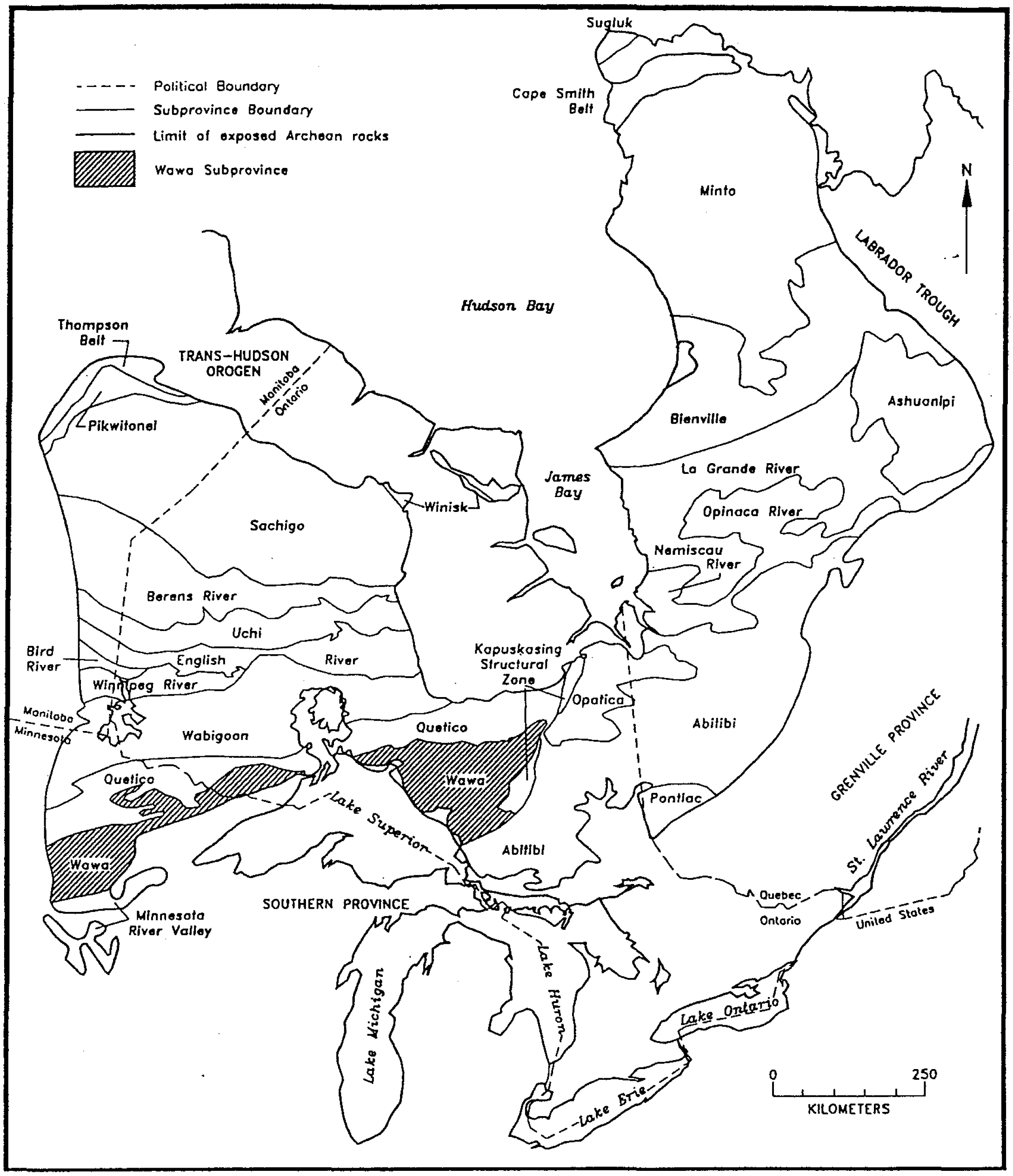

Figure 1. Location of the Wawa Subprovince of the Superior Province of the Canadian Shield (after Card and Ciesielski, 1986).

particular, the physical volcanology) of these regions; b) identify and evaluate the metamorphosed hydrothermal alteration mineral assemblages that occur at each of these prospects; and c) evaluate the potential for volcanogenic massive sulfide (VMS) and/or lode gold mineralization in these areas.

It became apparent soon after the project was initiated, however, that the tasks required to complete such a large scale, detailed study across the area studied by Lawler and Riihiluoma (1997) would require far more time and resources than initially proposed. Members of the University of Minnesota - Duluth (UMD) research team (Dr. George Hudak, Dr. Ronald Morton, and Dr. Howard Mooers, Dr. Boris Shmegin, and Phillip Larson) and MDNR representative (Henk Dahlberg, Rick Ruhanen, Tom Lawler) agreed that a more focused study should be completed to evaluate the usefulness of glacial drift prospecting in northeastern Minnesota. It was agreed that the Vermilion District would be the best location to make this evaluation because: a) there are several distinctive VMS and lode-gold mineralized prospects in the area; b) there is abundant subsurface data (diamond drill core) from these prospects; c) the detailed surficial geology of the region is well described (Peterson, in progress); d) the glacial drift in the region is relatively thin and is most likely to reflect local source areas.

The following report describes the methodology and findings of detailed investigations of selected diamond drill holes from the Five Mile Lake (Soudan Quadrangle, St. Louis County), Eagles Nest (Eagles Nest Quadrangle, St. Louis County), and Quartz Hill (Shagawa Lake Quadrangle, St. Louis County) prospects in the Vermilion district. These investigations have been performed to: a) better understand the geology (in particular, the physical volcanology) of these regions; b) identify and evaluate the metamorphosed hydrothermal alteration mineral assemblages that occur at each of these prospects; and c) evaluate the potential for volcanogenic massive sulfide (VMS) and/or lode gold mineralization in these areas.

Diamond drill core logs, petrographic data, and lithogeochemical data performed on samples from the remaining diamond drill holes investigated during this study are contained in Appendices 2, 3, and 4, but are not described in detail during the remainder of the report.

Table 1. General Characteristics of Archean VMS Deposits in the Wawa Subprovince (after Fyons et al., 1992).

DEPOSIT NAME	RESOURCES (103 TONNES)	Cu (wt. %)	Zn (wt. %)	Pb (wt. %)	Ag (oz/ton)	Au (oz/ton)
Winston Lake	3076	1.00	15.6	0	0.99	0.03
Willroy	4355	1.64	2.84	0	0.81	0
Big Nama Creek	181	0.83	4.16	0.02	1.04	0
Willecho	2163	0.5	4.43	0.18	1.98	0
Geco	50337	1.86	3.45	0.15	1.46	0

* Grade not known

Table 2

Diamond Drill Holes Investigated During Project 326

Drill Hole Number	Lessee	UTME NAD27	UTMN NAD27	UTME NAD83	UTMN NAD83
LL-1	Humble Oil	583684	5309542	583665	5309744
LL-2	Humble Oil	583846	5309967	583977	5309989
LL-3	Humble Oil	583984	5309784	583931	5310067
GL-1	Garden Lake	596552	5309534	596539	5309741
GL-14	Garden Lake	596446	5309225	596443	5309432
5406	J & L Steel	590706	5307234	590693	5307442
RZ-1	Whiteside	580707	5306183	580722	5306383
RZ-3	Whiteside	580732	5306258	580746	5306745
SP-90-1	BHP-Utah	586000	5308002	585984	5208213
23-3	Kerr-McGee	587165	5308665	587152	5308873
23-6	Kerr-McGee	587102	5308658	587089	5308866
6214-2-1	Kerr-McGee	568350	5303380	568318	5303574
SXL-1	Teck	564962	5296883	564915	5297995
SXL-2	Teck	564477	5297015	564430	5297126
SXL-3	Teck	564318	5296966	564271	5297079
SXL-4	Teck	564869	5296940	564822	5297053
EN-4	Newmont	570630	5297990	570616	5298199
EN-7	Newmont	570222	5297943	570278	5298138
SL-2	Exxon	563506	5291986	566791	5262554
TL-4	Bear Creek	582039	5300580	582095	5300790
QH-84-2	St. Joe	580246	5305954	580265	5306112
QH-85-4	St. Joe	580224	5305904	580160	5305950

Data from Peterson (personal communication, 1998, unpublished data) and Dzuck (personal communication, 1999).

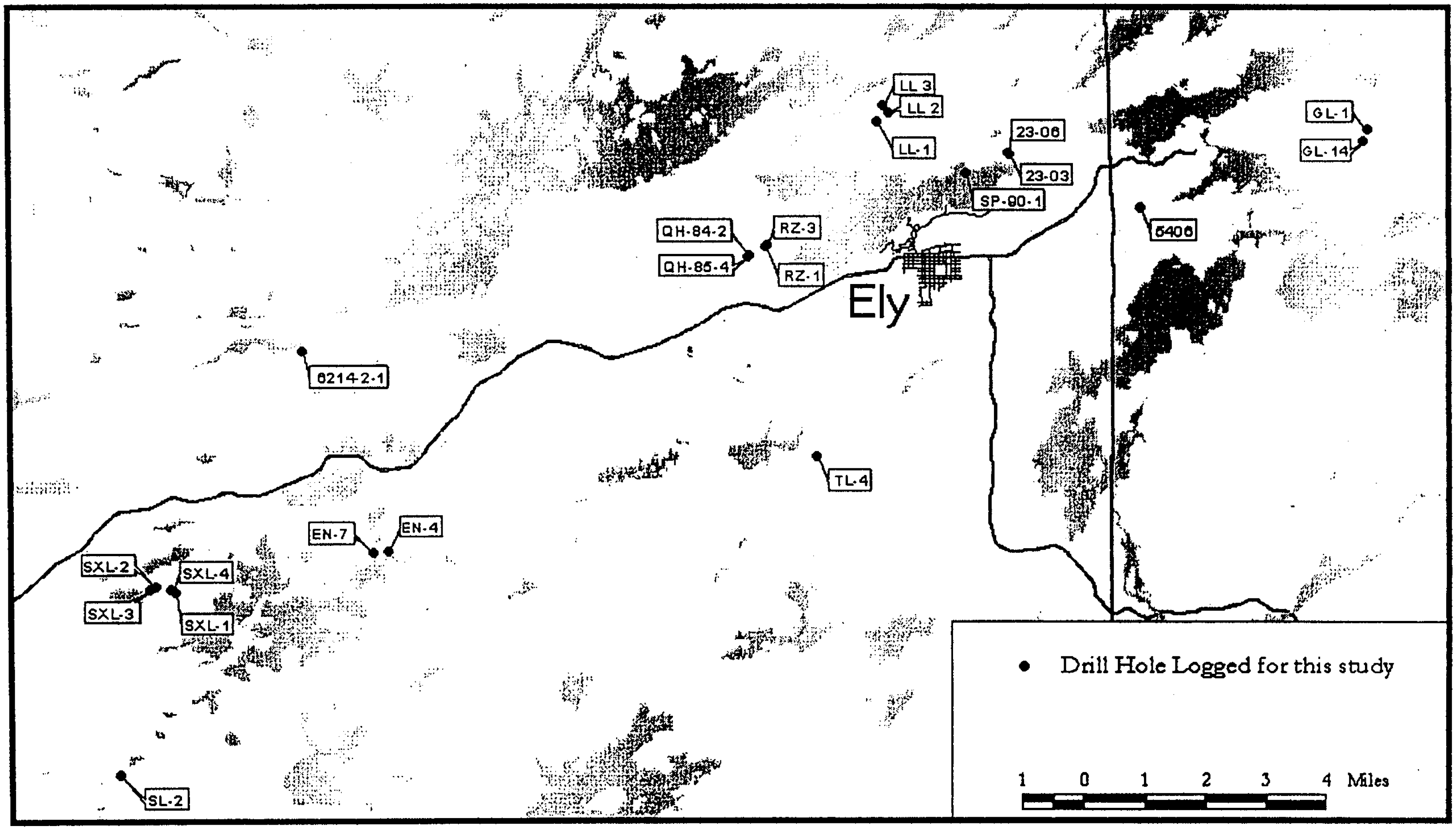

Figure 2. Location map of diamond drill holes investigated during Project 326.

Regional Geology

The Five Mile Lake, Eagles Nest, and Quartz Hill prospects lie within the Archean Vermilion District of Northern Minnesota. This district makes up the southernmost extension of the Wawa Subprovince of the Superior Province of the Canadian Shield (Card and Ciesielski, 1986). The Wawa Subprovince is composed of well-defined greenstone belts of metamorphosed komatiite, basalt, dacite, rhyolite, and sedimentary rocks, which are separated by belt-like domains of plutonic rocks (Williams et al., 1991). In Canada, the Wawa belt host a variety of ore deposits, most notably volcanogenic massive sulfide deposits and lode gold deposits.

The Vermilion District is bounded to the north-northeast by the Vermilion Granitic Complex of the Quetico Subprovince, and to the southeast by the Giants Range Batholith. The stratigraphy of the volcanic and sedimentary rocks in the Vermilion District include the Ely Greenstone, Newton Lake Formation, and the Lake Vermilion Formation (Morey et al., 1970; Sims, 1976). The Ely Greenstone comprises a sequence of metabasalts, dacitic to rhyolitic volcanic and volcaniclastic rocks, clastic sedimentary rocks, and chemical sedimentary rocks including iron formation. Whole rock Rb-Sr analyses from the Ely Greenstone yield dates of 2690± 80 ma (Jahn and Murthy, 1975). The Newton Lake Formation comprises tholeiitic volcanic rocks consisting of Mg- and Fe-basalts, komatiitic basalts, and peridotitic to gabbroic sills, with lesser amounts of dacitic to rhyolitic volcaniclastic rocks, graywackes, argillites, and breccias. Locally, thin units of laminated iron formation occur within mixed mafic-felsic volcaniclastic sequences (Morey et al., 1970; Shultz, 1974; Green and Schultz, 1977; Schultz, 1982). The Newton Lake Formation has yielded a whole rock Rb-Sr age date of 2650±110 ma (Jahn and Murthy, 1975). The Lake Vermillion Formation is composed of a thick sequence of turbiditic graywackes and associated mudstones, basalts, and minor felsic volcaniclastic rocks (Green, 1970; Ojakangas, 1972).

The supracrustal rocks of the Vermilion district are divisible into two distinct panels that differ primarily in their large scale structural styles (Jirsa and Boerboom,1990; Jirsa, 1990; Jirsa et al., 1991, 1992). The Ely Greenstone and the Lake Vermilion Formations comprise the southern panel, which is characterized by prominent folds and curvilinear structural trends. The Newton Lake Formation, which comprises the northern panel, appears to lack large scale structures, and is made up of fault-bounded, homoclinal, dominantly north-facing stratigraphic sequences (Peterson, in progress). The boundary between these two panels can be geophysically traced across the width of Minnesota, and has been named the Leech Lake structural discontinuity (Jirsa et al., 1992). In the Five Mile Lake and Eagles Nest region, the Leech Lake discontinuity coincides approximately with the Mud Creek shear zone (Hudleston et al., 1988) and segments of the Vermilion and Wolf Lake faults (Southwick, 1985).

Methods

A total of eight diamond drill holes from the Five Mile Lake, Eagles Nest, and Quartz Hill prospects were relogged during this investigation. These include: SXL-1, SXL-2, SXL-3, and SXL-4 from the Five Mile Lake prospect; EN-4 and EN-7 from the Eagles Nest Prospect; and QH-84-2 and QH-85-4 from the Quartz Hill Prospect. All diamond drill holes were relogged at the Minnesota Department of Natural Resources Core Repository in Hibbing, Minnesota. Geology and alteration legends modified from Peterson (in progress) and Hudak (1996) were used to characterize the samples. These legends can be found in Appendix 1. Universal Transverse Mercator (UTM) coordinates (in both NAD27 and NAD83), re-interpreted drill logs, and drill core sampling logs for the diamond drill holes investigated during Project 326 can be found in Appendix 2.

A total of 193 diamond drill core samples were obtained from the eight previously mentioned diamond drill holes. The samples were split at the Hibbing core repository to ensure that complete sections of the diamond drill holes were preserved. A total of sixty four thin sections (33 from Five Mile Lake, 18 from Eagles Nest, and 13 from Quartz Hill) were prepared. Petrographic analyses were performed to evaluate the lithology, mineral modes, fragment modes, alteration mineral assemblages, and primary and secondary textures within the samples. The results of the petrographic analyses are included in Appendix 3.

Thirty-eight of the samples chosen for petrographic analysis (22 from Five Mile Lake, 10 from Eagles Nest, and 6 from Quartz Hill) were also chosen for lithogeochemical analysis. The results of these analyses are presented in Appendix 4. The samples were analyzed by Activation Laboratories Limited (ACTLABS) of Ancaster, Ontario, Canada for the following analyses: a) whole rock research quality fusion ICP (major oxides, LOI, Ba, Sr, Y, Zr, Sc, Be, and V); and b) trace elements by fusion ICP/MS (Ag, As, Ba, Bi, Co, Cr, Cs, Cu, Ga, Ge, Hf, In, Mo, Nb, Ni, Pb, Rb, Sb, Sn, Sr, Ta, Th, Tl, U, V, W, Y, Zn, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Zr). The detection limits for the various techniques and elements analyzed are also included in Appendix 4.

<u>The Five Mile Lake Investigation</u>

The Five Mile (Six Mile) Lake region (Soudan Quadrangle, St. Louis County) was the subject of detailed exploration since the late 1800's. The most recent exploration program was carried out in 1994 under the direction of Teck Exploration Ltd (North Bay, Ontario). This program included line cutting, geological mapping, geochemical surveys, geophysical surveys, and diamond drilling of four surface exploration drillholes (SXL-1, SXL-2, SXL-3, AND SXL-4).

For the present investigation, all four diamond drill holes completed during the 1994 Teck exploration program were re-logged and sampled for petrographic and lithogeochemical analyses. Logs for diamond drill holes SXL-1, SXL-2, SXL-3, and SXL-4 are included in Appendix 2. The results of petrographic and lithogeochemical analyses are included in Appendix 3 and Appendix 4, respectively.

Five Mile Lake Lithology

The Five Mile (Six Mile) Lake region is composed of massive to amygdaloidal andesite/basalt lava flows and associated scoria-rich volcaniclastic deposits, locally quartz-phyric dacitic to rhyolitic lavas and associated flow breccias, and volcaniclastic and chemical sedimentary rocks. Quartz-feldspar porphyry and diabase dikes are also present and occur throughout the volcanic and sedimentary sequence.

Andesite/basalt lava flows occur in all drill holed examined. These flows vary from massive to amygdaloidal, and pillow lavas and possible flow lobes have been identified. The flows are locally plagioclase feldspar-phyric (<2mm in diameter, typically <5%, locally up to 15%). Amygdules commonly occur with 2-4 feet of individual flow contacts, are round to lens-shaped, and vary in composition from quartz - carbonate, quartz-chlorite, and locally pyrrhotite-rich. Generally, amygdules are <5mm in diameter and comprise less than 5% of the rock, but locally, amygdule-rich flow margins contain up to 15% amygdules up to 1cm in diameter. Petrographic examination of the andesite to basalt lava flows (Table 3a, Appendix 3) indicates that the fine grained groundmass is composed of quartz and feldspar (up to 70%). Up to 15% plagioclase phenocrysts and up to 15% amygdules may be present. Mineral phases which also occur in these flows include sericite (up to 30%), iron-rich chlorite (up to 52%), magnesium-rich chlorite (up to 5%), iron carbonate (up to 10%), actinolite (up to 38%), epidote (up to 55%), and opaques (up to 3%).

Interflow hyaloclastites are common in the basalt/andesite succession. The hyaloclastite horizons vary from green (fresh) to yellow- green (epidote-rich) in color. Hyaloclastite horizons are commonly less than 3 feet thick, but locally are up to 14 feet in thickness (SXL-2, 90'-104'). Petrographic observations indicate the presence of up to 15% plagioclase phenocrysts in a fine grained matrix composed of quartz-feldspar (22-67%), sericite (10-28%), magnesium-rich chlorite (up to 25%), carbonate (up to 2%), epidote (up to 35%), and opaques (up to 1%).

Andesite to basalt flow breccias commonly occur at the margins of individual lava flows. These breccias have also been identified in the four diamond drill holes that were re-logged. The flow breccias are commonly less than 15 feet thick, but may be up to 38 feet in thickness (SXL-4, 182-220'). The breccias contain 5-15% subangular to angular massive to amygdaloidal (up to 4% amygdules) basalt/andesite fragments in a fine-grained greenish-tan to grey-green matrix. Petrographic investigation (Table 3a, Appendix 3) indicates that the flow breccia matrix is composed of fine grained quartz-feldspar (40%), sericite (36%), iron-rich chlorite (3%), carbonate (10%), epidote (20%), and opaque minerals (1%). Scoria-rich volcaniclastic deposits are similar in appearance to flow breccias within the diamond drill core. In thin section, these scoria-rich deposits are characterized by up to 55% scoria clasts and up to 2% mafic lava clasts within in fine-grained matrix composed of quartz-feldspar (up to 33%), sericite (up to 40%), iron-rich chlorite (up to 36%), magnesium-rich chlorite (up to 24%), carbonate (up to 20%), actinolite (up to 5%), epidote (up to 58%), and opaque minerals (up to 9%).

Dacite to rhyolite lava flows occur in diamond drill holes SXL-2 and SXL-3. In drill core, these lavas are characterized by a fine-grained tan to pale green grey groundmass which contains up to 4% <1-2mm quartz phenocryst, up to 5% <1-2mm cream colored tabular feldspar phenocrysts, and 1-5% (1-3% most common) rounded to oval quartz amygdules up to 5mm in diameter. In thin section, the groundmass is composed of a fine-grained mixture of quartz and feldspar (30-65%). Petrographic investigations indicate that up to 20% quartz phenocrysts and up to 15% plagioclase phenocrysts may be present. Sericite (13-34%), iron-rich chlorite (up to 5%), epidote (up to 25%), and opaque minerals (up to 1%) also occur within these lavas.

Interflow volcaniclastic sediments typically comprise green to green-grey mafic tuffaceous siltstone deposits. These deposits, which occur in all diamond drill holes investigated, are commonly <2 feet in thickness, but locally are up to 55 feet thick (SXL-4, 222'-267'). The deposits vary from massive to poorly bedded. Petrographic investigation of these sediments indicates that they are composed of quartz-feldspar (65-68%), sericite (15-20%), iron-rich chlorite (up to 20%), and magnesium-rich chlorite (up to 10%) with up to 1% carbonate and opaque minerals, respectively. Quartz grains (up to 3%), plagioclase grains (up to 5%), and scoria (up to 5%) occur locally. The interflow sediments are locally interbedded with chert horizons that are up to 4 feet thick in diamond drill hole SXL-1.

Two types of intrusive rocks occur within the volcanic and sedimentary sequence at the Five Mile (Six Mile) Lake prospect. A 12 foot thick diabase dike occurs in diamond drill hole SXL-1 (216'-228'). This dike is dark green, fined grained, and contains 5-7% tabular feldspar phenocrysts up to 1mm in diameter, and up to 10% <1-2mm chlorite pseudomorphs after pyroxene. The contacts between the dike and the adjacent country rock are sharp and fine grained. In thin section, the diabase dike comprises a fine-grained quartz-feldspar groundmass (60%) with actinolite (33%), carbonate (3%), and opaque minerals (4%).

Quartz-feldspar porphyry dikes occur in all diamond drill holes investigated. These dikes vary from 1 to 19 feet in thickness, and are characterized by a gray to green-gray fine grained groundmass which contains up to 15% <1-6mm gray quartz phenocrysts and up to 30% cream colored, commonly zoned tabular plagioclase phenocrysts.

Quartz-sericite-carbonate schists occur within a shear zones that are present in diamond drill hole SXL-2 (219-221', 224-226', 263-265', and 274-284'). Locally, bluish-green fuchsite (tr-5%) and remobilized sphalerite (up to 5%) are also present within these shear zones.

Five Mile Lake Alteration

Several alteration mineral assemblages have resulted from hydrothermal activity followed by subsequent greenschist facies metamorphism in the Five Mile (Six Mile) Lake region. Hydrothermal alteration assemblages identified during diamond drill core re-logging and petrographic investigations include: a) silicification; b) epidote + quartz ± chlorite ± actinolite; c) iron-rich chlorite ± iron carbonate; d) sericite ± pyrophyllite ± chlorite; and e) carbonate ± sericite ± quartz ± fuchsite. Based on the four diamond drill holes logged for this study, it is not possible to fully evaluate the geometry of these alteration zones within the Five Mile (Six Mile) Lake region. However, Peterson (personal communication, 1998) and Mooers et al. (1999) have indicated the presence of a regionally extensive (at least 8 km in strike length) epidote + quartz alteration zone within mafic lava flows between Five Mile and Eagle's Nest Lakes based on outcrop exposures. Peterson (personal communication, 1998) has also illustrated the occurrence of patchy to stringer silicified zones, and locally pipe-like zones of chlorite alteration in volcanic and volcaniclastic rocks in the Five Mile (Six Mile) Lake region.

Silicified rocks occur in all diamond drill holes investigated, and are characterized by their light grey to green-grey color. Patchy to vein-like silicification is commonly accompanied by minor to moderate amounts (up to 25%) of chlorite, sericite, and or epidote. Silicification occurs within mafic to intermediate lava flows and flow breccias, felsic lava flows, and volcaniclastic sediments in the diamond drill holes investigated.

The most common alteration assemblage encountered in drill core from the Five Mile (Six Mile) Lake prospect contains an alteration assemblage comprising epidote + quartz ± chlorite ± actinolite. This assemblage commonly occurs within basalt to andesite lava flows, but is also present within mafic to intermediate flow breccias and associated hyaloclastite, as well as felsic lava flows and associated volcaniclastic sediments. This alteration assemblage most commonly occurs as mottled patches up to several feet in width, and as thin veins up to several centimeters in width. Amygdaloidal and flow brecciated flow margins are commonly affected by this alteration. Petrographic investigations of epidote + quartz ± chlorite ± actinolite altered mafic lavas, flow breccias and associated hyaloclastite deposits indicates the presence of epidote (10-58%), quartz (up to 53%), iron-rich chlorite (up to 5%), magnesium-rich chlorite (up to 25%), and actinolite (up to 30%). Carbonate (up to 20%) post dates the epidote + quartz ± chlorite ± actinolite alteration; it also occurs locally in epidote-carbonate ± sphalerite veins that cross-cut chlorite-sphalerite veins (described below). Felsic lavas affected by this alteration assemblage contain 15-25% epidote, up to 65% quartz, 13-34% sericite, up to 5% iron-rich chlorite, and 1-2% opaque minerals.

The iron-rich chlorite ± iron carbonate assemblage occurs within mafic to intermediate lava flows and associated scoriaceous flow breccias and volcaniclastic sediments. Iron-rich chlorite (9-52%) occurs as patchy to massive replacement of the groundmass/matrix of these deposits, and locally occurs as thin (generally <1cm) wide veins. These iron-chlorite-rich veins locally contain fine (<<1mm) inclusions of reddish brown to honey-colored sphalerite when observed with a petrographic microscope. Patches, lenses, and veins of sericite (10-40%) are commonly present. Iron carbonate (up to 2%) is locally present. Other phases which occur within this alteration assemblage include quartz (up to 67%), epidote (up to 20%), and opaque minerals (up to 9%).

The sericite ± pyrophyllite ± chlorite assemblage occurs with mafic to intermediate lava flows and associated flow breccias, felsic lava flows, and interflow volcaniclastic sediments. In diamond drill core, this alteration assemblage is characterized by patches to veins of greenish tan to tan sericite ± pyrophyllite (up to 40%). Locally, disseminated to vein-like chlorite (up to 30%) is also present. This assemblage was not directly observed petrographically.

An alteration assemblage comprising carbonate ± sericite ± quartz ± fuchsite occurs within several shear zones that occur within diamond drill hole SXL-2. Carbonate and sericite are tan in color, and combined, make up 10-60% of the rock. Pale grey to white quartz (up to 80%) and disseminated greenish-blue fuchsite (trace-5%) are also present. Minor amounts of sphalerite (up to 3%) locally are present within these shear zones as thin veins and patches, and appears to have been remobilized from the adjacent country rock. Up to 5% tan to orange-brown carbonate porphyroblasts are disseminated within the groundmass of the feldspar porphyry intrusions. Minor amounts of carbonate also occur within all rock units observed in diamond drill core. These carbonate-bearing alteration assemblages are similar to carbonate-bearing alteration assemblages that are associated with shear zones in other diamond drill holes investigated during this investigation (e.g. SP-90-1) and are similar to alteration assemblages characteristic of shear zone hosted lode gold deposits.

Five Mile Lake Geochemistry .

Major and trace element geochemical analyses were performed on 19 samples from the four diamond drill holes investigated. The results of these analyses, as well as the detection limits and analytical methods are included in Table 4a (Appendix 4).

Due to the hydrothermal alteration present in the region, immoble elements (Winchester and Floyd, 1977) have been used to classify the compositions of the rock types in the region (Figure 3). Using these plots of Nb/Y versus Zr/TiO_2, rocks in the Five Mile (Six Mile) Lake region vary from subalkaline basalt to rhyodacite/dacite in composition.

A discrimination diagram utilizing an immobile low field strength element (Th) and high field elements (Hf, Ta) developed by Wood et al. (1979, 1980) has been used to evaluate the tectonic regime for mafic to felsic volcanic rocks at the Five Mile Lake prospect (Figure 4). This diagram indicates that volcanic rocks at the Five Mile (Six Mile) Lake prospect were derived from arc-associated magmas.

A rare earth element plot (after Lesher et al., 1986) of felsic lava flows from the Five Mile Lake prospect is shown in Figure 5. Chondrite-normalized values (Leedy chondrite (Masuda et al., 1973) divided by 1.20) for La/Yb range from 1.55-7.92. Chondrite-normalized values of Zr/Y range from 7.2 to 10 for these rocks. Negative Eu anomalies occur in five samples; a positive Eu anomaly occurs in one sample.

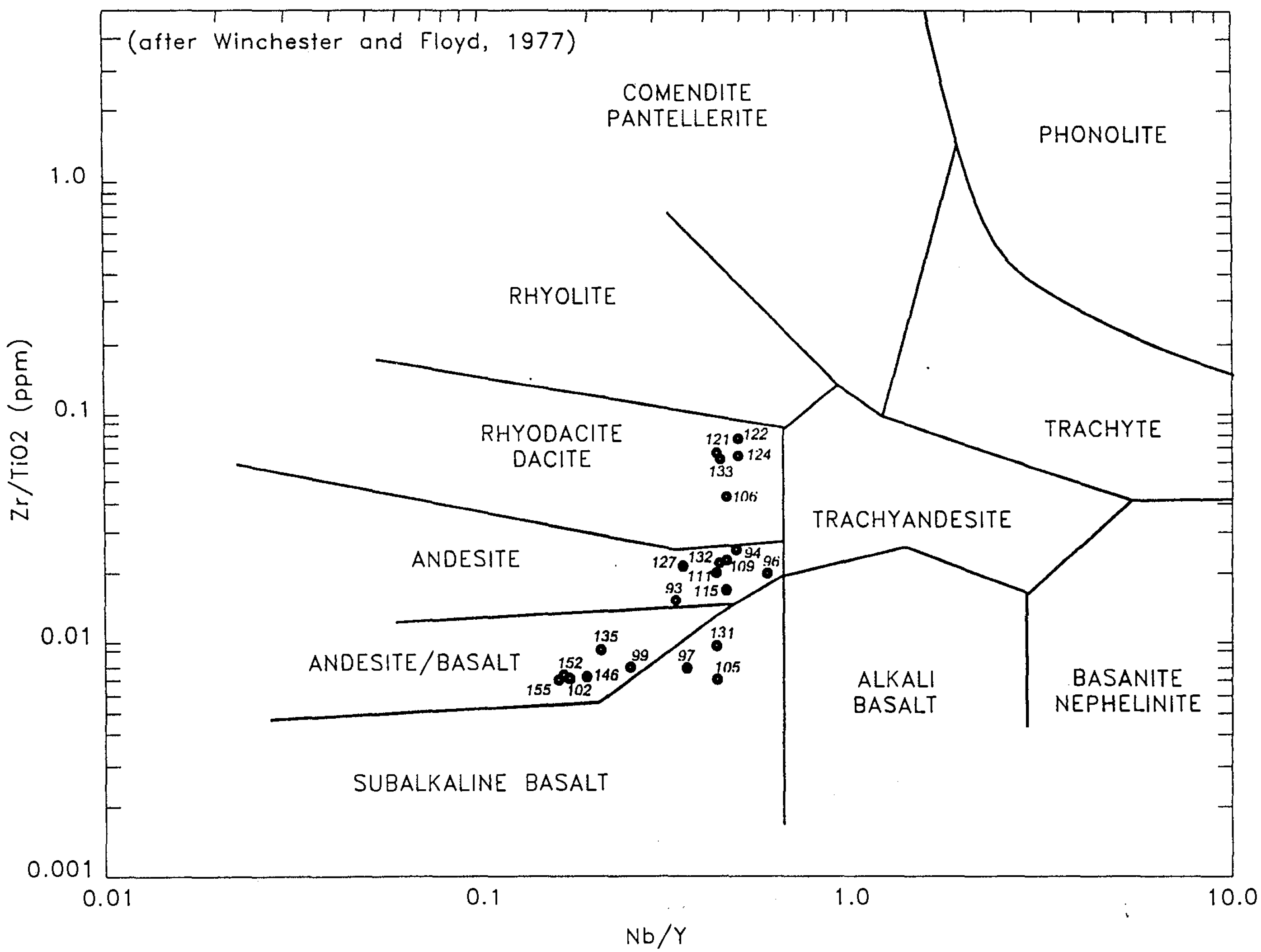

Figure 3. Immobile element classification of samples from the Five Mile Lake Prospect.

Five Mile Lake Tectonic Discrimination Diagram

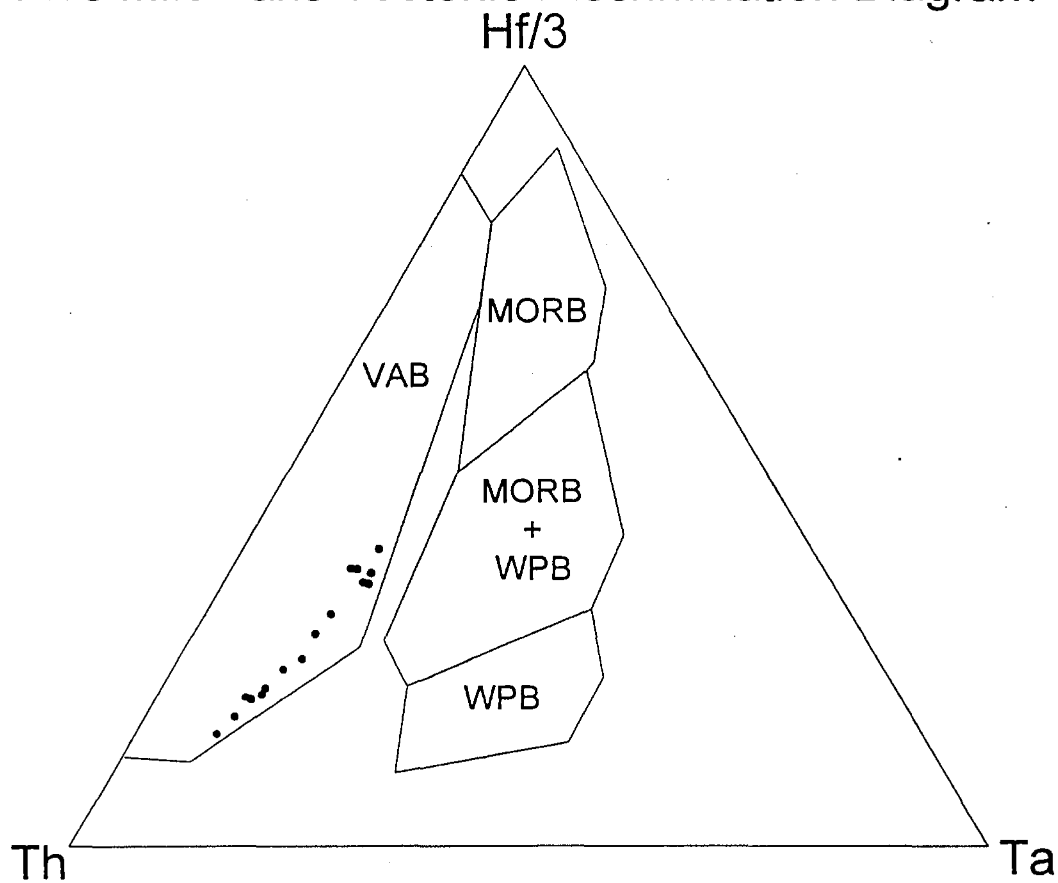

Figure 4. Tectonic discrimination diagram (after Wood et al., 1979, 1980). VAB = volcanic arc basalt, MORB= mid ocean ridge basalt, WPB = within plate basalt. MORB + WPB field is transitional between mid ocean ridge basalt and within plate basalt.

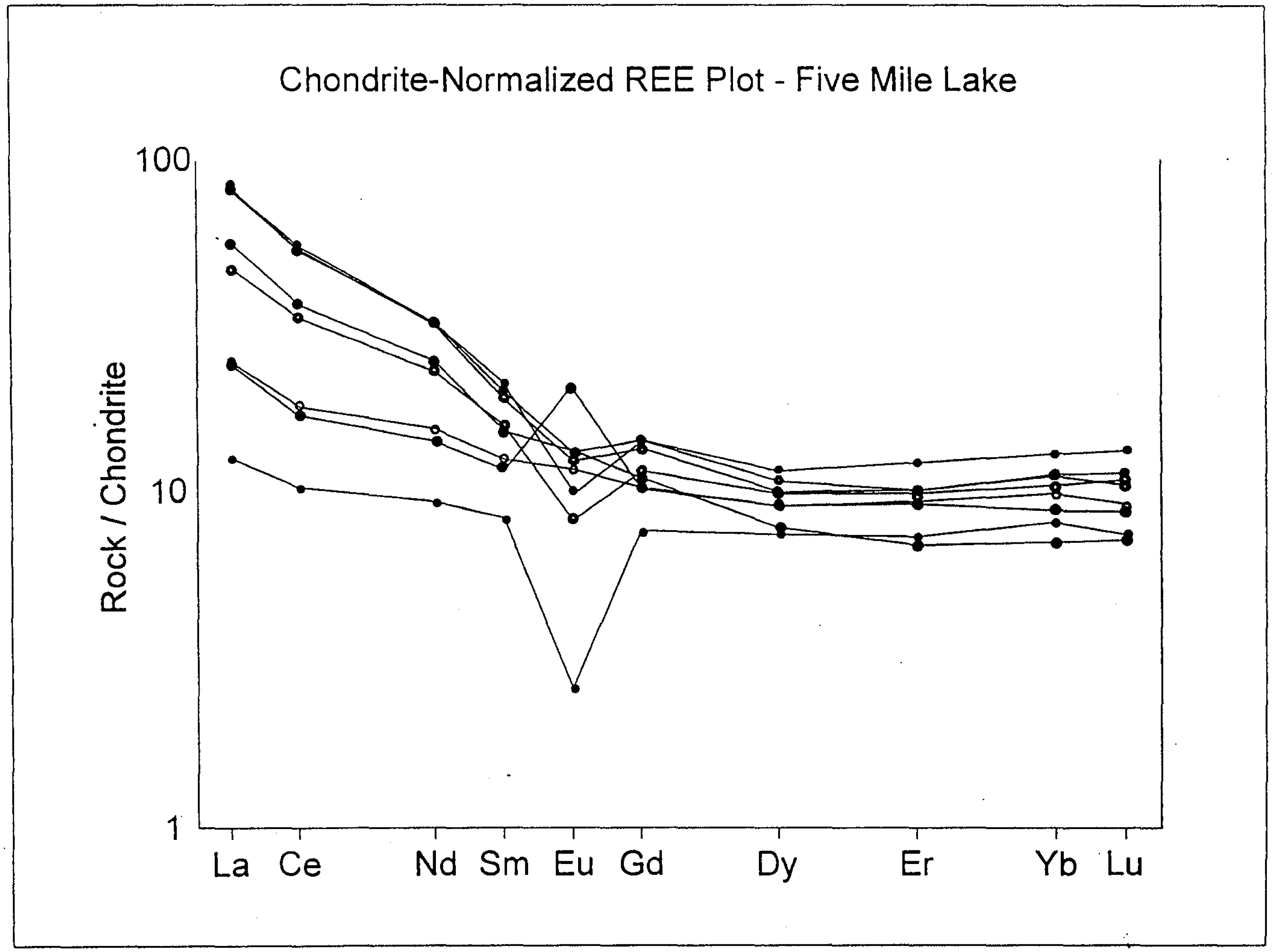

Figure 5. Chondrite normalized REE plot for felsic volcanic rocks (after Lesher et al., 1986). Chondrite normalizing values are those of the

The Eagles Nest Investigation

The Eagles Nest Prospect (Eagles Nest Quadrangle, St. Louis County) was the subject of mineral exploration by Newmont Exploration Limited in 1988 and 1989. Two diamond drill holes from this exploration program, EN-4 and EN-7, were relogged and resampled during the present investigation. Logs for these drill holes are included in Appendix 2. The results of petrographic and lithogeochemical analyses on samples from these cores are included in Appendix 3 and Appendix 4, respectively.

Eagles Nest Lithology

The diamond drill holes investigated from the Eagles Nest prospect contain the following lithological units: a) andesitic to basalt lava flows with associated flow breccias and hyaloclastite; b) mafic to intermediate interflow sedimentary rocks; c) oxide, silicate, and carbonate facies Algoma-type iron formation; d) bedded volcaniclastic deposits including non-graded to normally graded siltstones interbedded with thin debris flow deposits; e) massive and semi-massive sulfide deposits and associated cherty exhalite deposits; and f) felsic tuffs and/or tuffaceous siltstone deposits. Quartz feldspar porphyry and diabase intrusions were also observed within the diamond drill core.

A sequence of pale to dark green, massive to amygdaloidal, commonly pillowed andesite to basalt lava flows up to 100 meters in thickness was observed at the top of both diamond drill holes investigated. These flows are locally feldspar-phyric, containing up to 15% 1-5mm tabular tan to ivory colored plagioclase phenocrysts. In diamond drill hole EN-4, locally glomero-porphyritic flows contain irregularly shaped glomerocrysts of plagioclase feldspar up to 1cm in diameter. Amygdules (<1-15%) are typically present in abundances less than 5%, and average 2-4mm in diameter, and are generally oval to round in shape. Locally, amygdules increase in size toward the centers of individual flows, and may be up to 1cm in diameter. Pillow breccias and hyaloclastite deposits vary from 0.5-2 feet in thickness. Pillow rinds are typically chlorite and epidote-rich, and range in thickness from 5-10mm. In diamond drill hole EN-7, interflow hyaloclastites locally contain minor amounts of sulfide mineralization.

In thin section, the andesite to basalt lava flows contain a fine-grained groundmass composed of quartz and feldspar (27-32%), iron-rich chlorite (17-18%), epidote (13-18%), actinolite (30-35%),with minor amounts of magnetite (up to 2%) and pyrite (up to 1%). Plagioclase phenocrysts (2-5%) are euhedral tabular to subhedral and vary from <1-2mm in diameter. Glomeroporphyritic sections of these flows were not observed petrographically.

Interbedded with the lava flows are a series of fine grained mafic tuffaceous siltstone deposits. These deposits vary in thickness from 1-30 feet and are typically massive and chlorite-rich. Minor abundances (trace-5%) of <1mm quartz grains, <1mm feldspar grains (up to 10%), and scoria lapilli (up to 5%) have been observed locally. Petrographically, these deposits contain a matrix composed of quartz-feldspar (24-34%), sericite (up to 17%), iron-rich chlorite (25-30%), carbonate(20%), epidote (3-12%%), magnetite (up to 1%) and pyrite (tr). Plagioclase grains (up to 1mm, up to 10%) and quartz grains (up to 3%, up to 1mm in diameter) are also locally present.

A series of Algoma-type iron formations (oxide, silicate, and carbonate facies) occurs interbedded with, and stratigraphically below, the basalt to andesite lava flows in both EN-4 and EN-7. Banded oxide facies iron formation is typically <5 feet thick (up to 18 feet maximum thickness), and is composed of 1mm-cm thick interbedded magnetite and chert bands. Silicate facies iron formations are up to 8 feet in thickness, and are chlorite-rich. Carbonate facies iron formations are up to 4 feet thick, and occur between 661and 679 feet in diamond drill hole EN-4. These iron formations are typically interbedded with black chert, grey siltstone, or graywackes deposits up to 3 feet in thickness.

Petrographically, the mixed facies iron formations contain 22-24% iron-rich chlorite, 19-59% iron carbonate, 10-14% magnetite, 7-10% pyrrhotite, up to 12 % quartz, and minor amounts of sericite (trace-1%) and epidote (up to 10%). A single sample of silicate facies iron formation contains 78% grunerite, 15% iron carbonate, 3% quartz, 3% pyrrhotite, and 1% iron oxide (alteration on the pyrrhotite). A single sample of carbonate facies iron formation contains 77% iron carbonate, 15% iron-rich chlorite, 5% quartz, and 3% pyrrhotite.

A sequence of bedded to massive volcaniclastic deposits immediately underlies the iron formations in both diamond drill holes investigated. These deposits vary from 13 to at least 30 feet in thickness, and comprise interbedded non-graded to normally graded light grey to green banded/bedded siltstones (up to 13 feet thick), and underlying debris flow deposits (up to 3 feet thick) which contain up to 12% 3mm-20mm diameter normally graded cherty siliceous clasts. These deposits were not observed petrographically.

Semi-massive to massive sulfide deposits occur between 425 and 443 feet in diamond drill hole EN-7. The semi-massive sulfide is a sulfide-chert exhalite (6 feet thick) which contains 5-15% stringer py . This horizon grades down into massive sulfide (up to 12 feet thick) containing 10-80% stringer to massive pyrite, and up to 30% very fine grained brown sphalerite. It is important to note that only 42 inches of core was recovered from this massive sulfide intersection. Chert-pyrite exhalite is also present between 650 and 653 feet in diamond drill hole EN-4. Petrographic observations of a single sample of semi-massive sulfide (EN-7-442.5') indicate the presence of quartz matrix (17%), iron-rich chlorite (35%), iron carbonate (26%), pyrrhotite (20%), and sphalerite (intermixed with pyrrhotite, 1%).

In diamond drill hole EN-7, the semi-massive and massive sulfide are underlain by up to 205 feet of variably altered, pale green to tan rhyolite ash tuff or tuffaceous siltstone. These deposits are typically massive, and contain <1-2% <1mm angular quartz phenocrysts or grains which are locally normally graded. Faint banding present in the rock may reflect original bedding.

Several possible synvolcanic or reactivated synvolcanic fault zones occur within this unit between depths of 454 and 648 feet in diamond drill hole EN-7. The characteristics of synvolcanic fault zones are described by Gibson et al (1977). In EN-7, these zones are characterized by broken core, rapidly changing hydrothermal alteration mineral assemblages (described below), and local abundances of secondary clay minerals. These clay-rich zones may represent reactivated synvolcanic structures which have been further modified by recent weathering processes such as groundwater movement.

Petrographically, these deposits comprise a fine-grained quartz-feldspar matrix (15-51%), sericite (up to 51%), pyrophyllite/kaolinite (up to 10%), iron-rich chlorite (up to 84%), magnesium-rich chlorite (up to 45%), iron carbonate (up to 30%), pyrite (up to 8%), pyrrhotite (up to 6%), sphalerite (disseminated in iron-rich chlorite, up to 2%), and ilmenite (up to 1%). Traces of <1mm angular quartz phenocrysts/grains and secondary feldspar are also present.

Two types of intrusive rocks have been identified during this study. Quartz-feldspar porphyry dikes are composed of 5-15% <1-6mm clear to gray quartz phenocrysts and 5-15% 1-6mm cloudy euhedral tabular to subhedral, locally zoned plagioclase phenocryst in a fine grained light gray to medium gray quartzofeldspathic groundmass. These dikes are up to 9 feet in thickness. Diabase comprises a pale green to dark green fine-grained to medium grained groundmass which contains 10-25% <1-1mm tabular plagioclase phenocrysts which locally have been stained pale orange by iron carbonate alteration. Intersections of the diabase are up to 62 feet thick, but most intersections are less than 10 feet in thickness. Neither of these intrusive units was observed petrographically.

Eagles Nest Alteration

Several alteration mineral assemblages have resulted from hydrothermal activity followed by regional greenschist facies metamorphism in the Eagles Nest region. Hydrothermal alteration assemblages identified during diamond drill core re-logging and petrographic investigations include: a) least altered basalt and andesite lava flows; b) epidote + chlorite ± actinolite; c) silicification; d) sericite + iron carbonate ± fuchsite; d) patchy to disseminated iron carbonate; e) iron chlorite ± iron carbonate; and f) sericite ± chlorite ± iron carbonate ± pyrophyllite/kaolinite. Based on the limited number of drill holes investigated at the Eagles Nest prospect, it is not possible to fully evaluate the geometry of the various alteration zones present.

Least altered basalt to andesite lava flows have been described above. These rocks were not observed petrographically.

Epidote + chlorite alteration zones vary from <1-87 feet in thickness, and are confined to the basalt/andesite lava flows and associated flow breccias and hyaloclastites. Epidote-rich pillow rinds and flow breccias are generally less than 2 feet in thickness. Fine-grained epidote (up to 20%) locally replaces the groundmass of the lava flows, and commonly occurs in areas where feldspar phenocrysts have been chloritized. Epidote also occurs as apple green irregular patches and lenses up to several feet in width, and is locally associated with patchy silicification.

Epidote veins ranging from 1-5mm in width are locally present. Petrographic observation of this assemblage indicates the presence of epidote (13-18%), iron-rich chlorite (17-18%), actinolite (30-35%), quartz (27-32%), with minor amounts of magnetite (up to 2%) and pyrite (up to 1%).

Local zones of silicification up to 14 feet in thickness occur within both diamond drill holes investigated. Patchy silicification associated with epidote + chlorite alteration locally occurs within basalt to andesite lava flows in drill hole EN-4. Veins and bands of silicification occur within silicate facies iron formation and mafic volcaniclastic sediments. These veins locally contain up to 5% sulfide mineralization. Volcaniclastic sediments have locally been silicified in drill hole EN-7. Silicified rocks were not observed petrographically.

Local zones ranging from 2-4 feet thick containing and alteration assemblage of sericite + iron carbonate ± fuchsite occur at the margins of diabase dikes and within clastic sediments in drill hole EN-4. Up to 5% disseminated aqua-green fuchsite occurs within tan to light-brown sericite and carbonate-rich altered rocks. These rocks are locally strongly sheared. This alteration assemblage was not evaluated petrographically.

Patchy carbonate alteration occurs locally within mafic sediments, volcaniclastic sediments, iron formation, and diabase dikes within diamond drill hole EN-4. These rocks contain 3-10% 1-5mm tan to brown disseminated ankerite porphyroblasts. This alteration appears to post-date the other alteration assemblages in the core. Patchy carbonate alteration was not evaluated petrographically.

Semi-massive and massive sulfide mineralization present in the two drill holes investigated at the Eagles Nest prospect appear to be spatially associated with alteration assemblages comprising a) iron-rich chlorite ± iron carbonate; and b) sericite ± pyrophyllite/ kaolinite ± chlorite ± iron carbonate. These assemblages are closely associated with one another below a depth of 431 feet in diamond drill hole EN-7.

Semi-massive and massive sulfide mineralization is associated with iron-chlorite-rich host rocks in both diamond drill holes investigated. Cherty exhalite semi-massive sulfide (EN-4, 689-691 feet)contains 1-5% 1-2mm dark green chlorite veins. Cherty exhalite which overlies massive sulfide in drill core EN-7 (425-431 feet) contains veins of chlorite and assocaited grunerite (identified petrographically). Massive sulfides in EN-7 (431-433 feet) contain 10-30%

dark green chlorite veins and stringers mixed with banded and brecciated sulfides. Several chlorite-altered zones occur beneath the massive sulfide mineralization in this drill hole as well. A single petrographic analysis of iron chlorite-altered rhyolite ash tuff or tuffaceous siltstone contains 20% iron-rich chlorite, 30% iron carbonate, 42% quartz, 6% pyrrhotite and 2% sphalerite. The sphalerite occurs as very fine grained anhedral disseminations within the iron-rich chlorite in this sample.

Sericite ± chlorite ± iron carbonate ± kaolinite/pyrophyllite alteration occurs in a zone extending between 443 feet and 613 feet in drill hole EN-7. This alteration varies from dominantly sericite-rich (up to 80%) to dominantly chlorite-rich (with up to 10% sericite). Petrographic investigation of this alteration assemblage indicates the presence of sericite (37-64%), iron-rich chlorite (up to 20%), magnesium-rich chlorite (up to 4%), carbonate (up to 3%), quartz (35-48%) and pyrite (trace to 8%). Locally, tan to pale white kaolinite/pyrophyllite (varying from <20%-100%) may be intermixed with chlorite and/or sericite, or may be massive within this alteration zone. These kaolinite/pyrophyllite-rich zones are generally highly fractured, and may represent synvolcanic fault zones which have been subsequently reactivated. These clay-rich zones may represent reactivated synvolcanic structures which have been further modified by groundwater weathering processes.

Eagles Nest Geochemistry

Major and trace element lithogeochemical analyses were performed on 10 samples from the two diamond drill holes investigated. The results of these analyses, as well as the detection limits and analytical methods, are included in Table 4a (Appendix 4).

Due to locally intense hydrothermal alteration, immobile elements (Winchester and Floyd, 1977) have been used to classify the compositions of the volcanic rocks at this prospect (Figure 6). Based on this analysis, rocks at the Eagles Nest prospect vary from subalkaline basalt to rhyodacite/dacite in composition.

A tectonic discrimination diagram using Th-Hf-Ta (Wood et al., 1979, 1980) has been plotted using the analyses from volcanic rocks in the Eagles Nest area (Figure 7). This diagram suggests that the volcanic rocks in the region are associated with a volcanic arc setting.

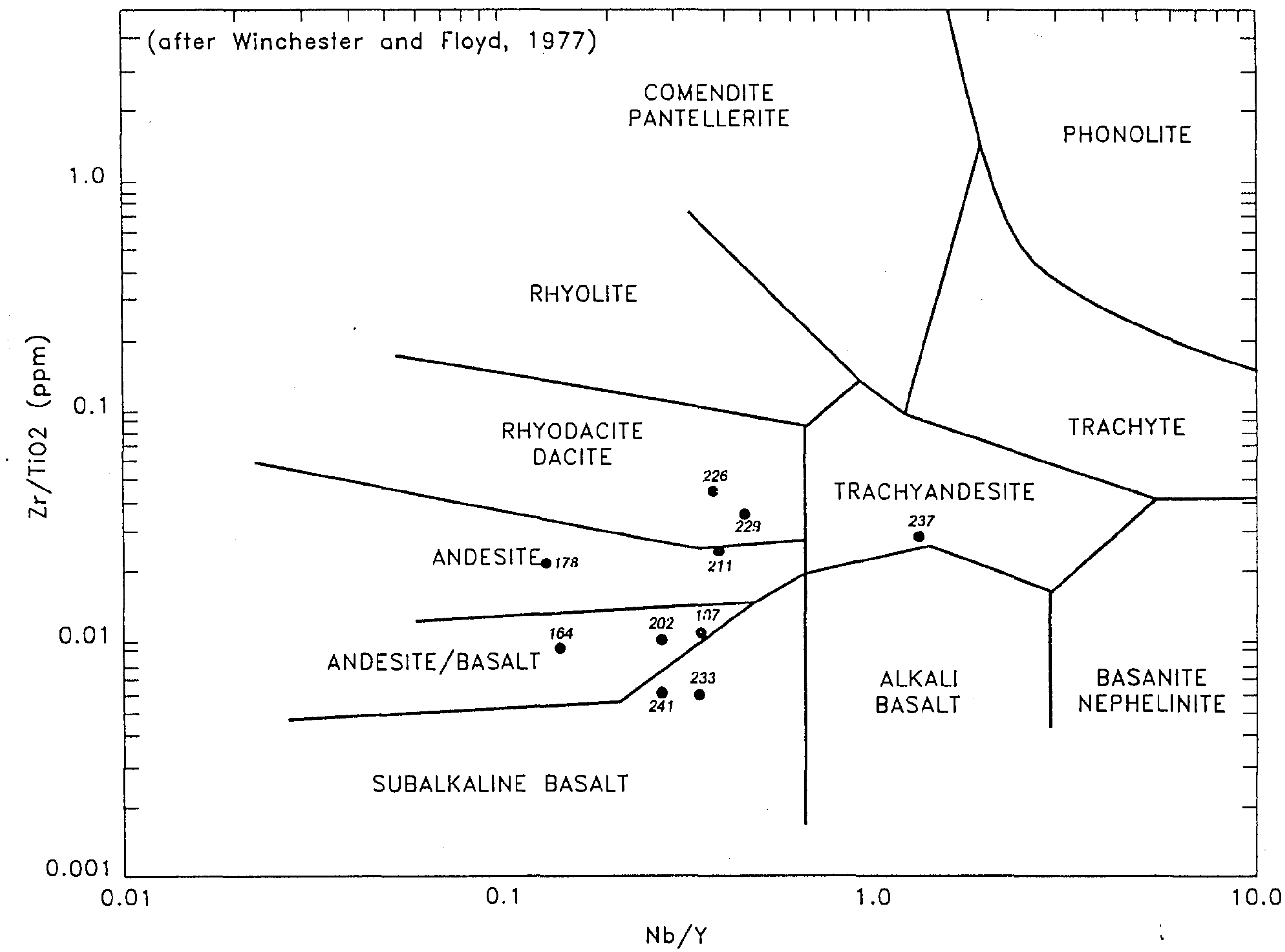

Figure 6. Immobile element classification of samples from the Eagles Nest prospect.

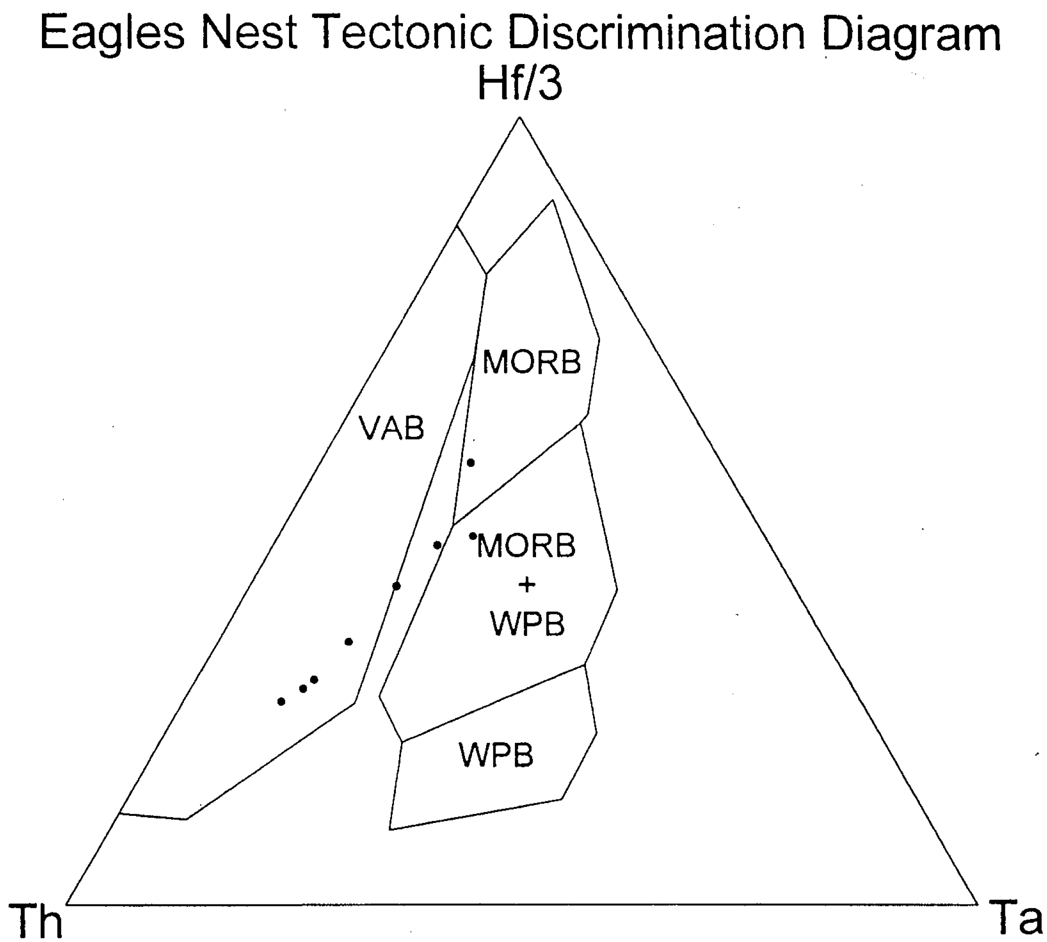

Figure 7. Tectonic discrimination diagram (after Wood et al., 1979, 1980). VAB = volcanic arc basalt, MORB= mid ocean ridge basalt, WPB = within plate basalt. MORB + WPB field is transitional between mid ocean ridge basalt and within plate basalt.

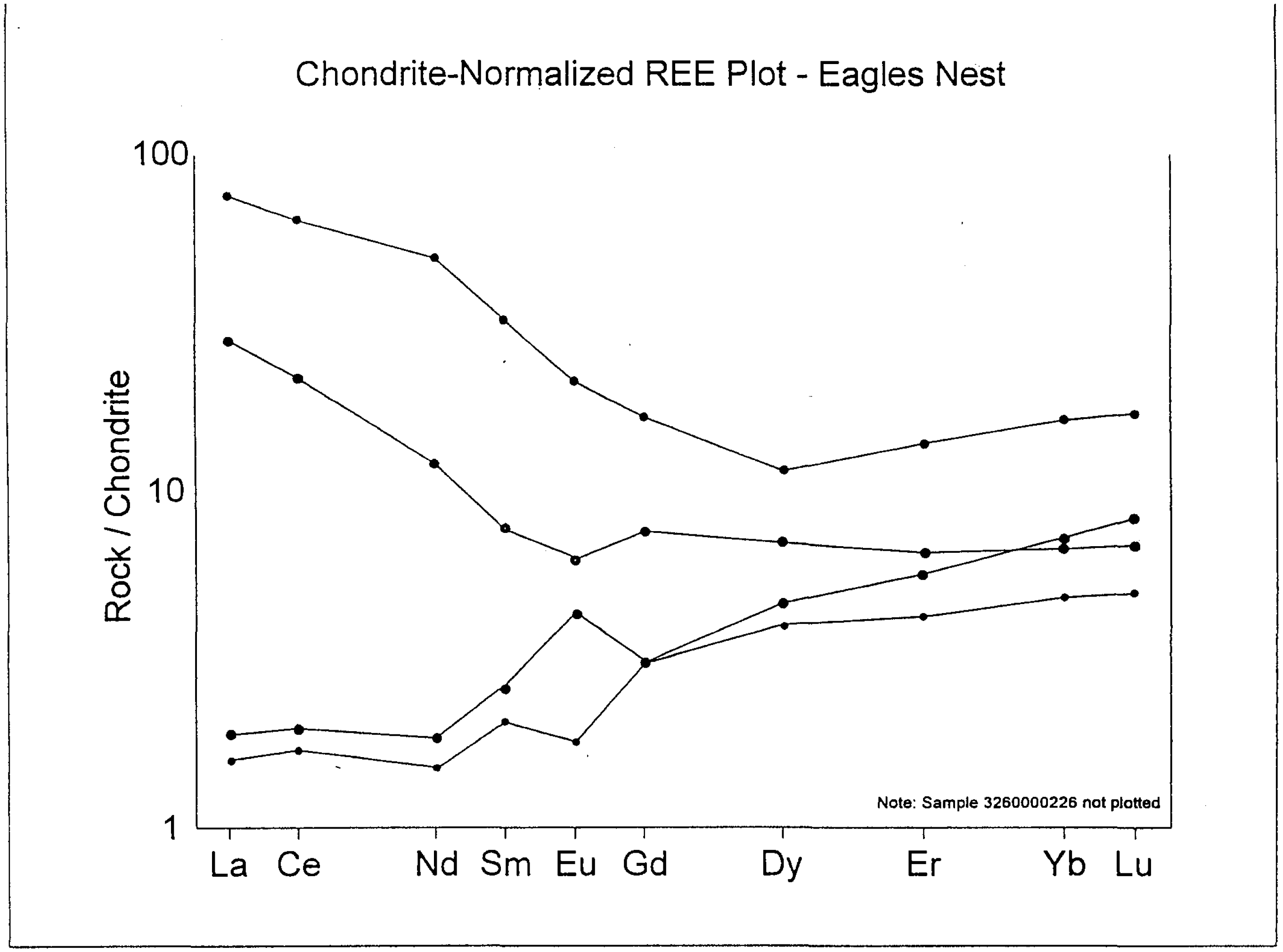

Figure 8. Chondrite normalized REE plot for felsic volcanic rocks (after Lesher et al., 1986). Chondrite normalizing values are those of the Leedy chondrite (Masuda et al., 1973) divided by 1.2.

A rare earth element plot (after Lesher et al., 1986) of felsic tuffs or tuffaceous siltstone deposits is shown in Figure 8. Chondrite-normalized values (Leedy chondrite (Masuda et al., 1973) divided by 1.20) range from 0.26-14.11. Chondrite-normalized values of Zr/Y range from 8 to 24.8 for these rocks. Negative Eu anomalies occur in two samples, and a positive Eu anomaly exists for one sample.

The Quartz Hill Investigation

The Quartz Hill Prospect (Shagawa Lake Quadrangle, St. Louis County) was the subject of mineral exploration by St. Joe America Corporation in 1984 and 1985. Two diamond drill holes from this exploration program, QH-84-2 and QH-85-4, were relogged and resampled during the present investigation. Logs for these drill holes are included in Appendix 2. The results of petrographic and lithogeochemical analyses on samples from these cores are included in Appendix 3 and Appendix 4, respectively.

Quartz Hill Lithology

The diamond drill holes investigated from the Eagles Nest prospect (QH-84-2 and QH-85-4) contain the following lithological units: a) mixed volcaniclastic and chemical sediments; b) iron formation: c) massive to amygdaloidal basalt/andesite lava flows; and d) bedded ash tuff and interbedded exhalite (chert± sulfides) deposits. Semi-massive sulfide mineralization occurs locally within diamond drill hole QH-84-2. Stratigraphy in the two diamond drill holes may be correlative, but further mapping and diamond drill core re-logging should be conducted to verify this preliminary interpretation.

Mixed volcaniclastic and chemical sediments in diamond drill hole QH-84-2 comprise variably altered, vaguely banded (bedded?) light tan to pink carbonate-rich exhalites (carbonate facies iron formation), light tan to pink fine-grained ash tuff/tuffaceous siltstone deposits, and pale to medium green very fine grained intermediate to mafic mudstones. This sequence of sediments is at least 26 feet thick. Petrographic analyses of a sample of carbonate-facies iron formation (QH-84-2-23') indicates that this rock is composed of iron carbonate (33%), iron-rich chlorite (10%), sericite (30%), and quartz (17%) with lesser amounts of pyrite and ilmenite.

Two types of iron formation occur in diamond drill hole QH-85-4; a) dark green chlorite-magnetite silicate facies iron formation; and b) reddish-brown hematite-chlorite-rich oxide facies iron formation. This iron formation is at least 15 feet thick. No samples of these iron formations were investigated by petrographic methods during this study.

Basalt/andesite lava flows occur in two distinct stratigraphic horizons in both QH-84-2 and QH-85-4. In QH-84-2, these flows occur between 18-71 feet and 84-303 feet. In drill core, these flows vary from massive to slightly amygdaloidal. Amygdules are oval in shape, up to 6mm in diameter, and are composed of chlorite. In thin section, a flow breccia from this uppermost horizon (QH-84-2-68.5') contains a fine grained matrix composed of iron-rich chlorite, iron carbonate, quartz/feldspar, and ilmenite. This breccia contains 20% rounded scoriaceous lava flow fragments which contain up to 50% amygdules. In drill core, the lowermost basalt/andesite flows vary from apple green (epidote-rich) to dark green (chlorite-rich), and contain up to 5% quartz-filled amygdules that are up to 8mm in diameter. These basalt flows locally contain fine-grained interflow sediment horizons that are up to 1 foot thick. In thin section, these flows contain a very fine-grained groundmass composed of quartz and <1mm skeletal plagioclase laths (7-29%), epidote (up to 48%), zoisite (up to 38%), actinolite (31-38%), and local ilmenite (up to 2%). A six foot thick intersection of semi-massive to massive sulfide (py 20-70%, trace cp) occurs immediately above these lavas.

The uppermost intersection of basalt/andesite lava flows in drill hole QH-85-4 contains dark green massive to amygdaloidal (1-15% 3mm-1cm oval quartz amygdules) flows. The lowermost intersection comprises variably altered, apple green (epidote-rich) to dark green (chlorite-rich) massive to amygdaloidal lavas that contain up to 2% <5-10mm oval quartz-filled amygdules. Petrographic analyses were not performed on samples from these intersections.

Bedded ash tuff and interbedded exhalite (chert± sulfides) deposits comprise a 61 foot intersection in drill hole QH-84-2. These deposits are aphyric to quartz phyric (up to 2% 1-2mm quartz phenocrysts) that are exceptionally well laminated and bedded (individual deposits vary from 1-10 mm in width). Chert horizons up to 1 foot thick are interbedded with the ash tuffs. Sulfides vary from semi-massive to massive, mimic bedding, and appear to be replacing or impregnating the ash tuff horizons. In thin section, these ash tuffs comprise a very fine-grained recrystallized quartz matrix (8-69%) which contains up to 5% subangular to angular quartz phenocrysts up to 1mm in diameter, and blocky to tabular, commonly extensively altered potassium feldspar phenocrysts (sanadine?) up to 2mm in diameter. Pumice (up to 2%) and accessory felsic plutonic fragments (up to 1%) are locally present. Alteration minerals occurring in these deposits include sericite (7-35%), pyrophyllite (up to 10%), iron-rich chlorite (up to 8%), chloritoid (up to 30%), andalusite (up to 10%), epidote (up to 12%), zoisite (up to 111%), stilpnomelane (up to 10%). Pyrite varies from 1-15% within the thin sections investigated.

A 13 foot intersection of finely bedded aphyric ash tuff and quartz phyric ash tuff deposits (1-2% <1-2mm quartz phenocrysts) occurs between 71 and 84 feet in diamond drill hole QH-85-4. These deposits are replaced by 20-80% pyrite over a four foot intersection within this unit. No samples of these deposits were investigated via petrographic means during this investigation.

Quartz Hill Alteration

Alteration at the Quartz Hill prospect appears to be, in part, dependent upon lithology. Basalt/andesite lava flows have been altered to two distinct assemblages: a) iron-rich chlorite + carbonate ± epidote; and b) epidote ± chlorite ± silicification. Clastic sedimentary deposits are commonly altered to alteration assemblages comprising iron-rich chlorite ± iron carbonate ± sericite. Alteration assemblages associated with massive sulfide mineralization in felsic tuff deposits include: a) chloritoid ± chlorite ± silicification; b) andalusite ± chloritoid ± silicification; and c) sericite

An iron-rich chlorite + iron carbonate ± epidote assemblage occurs in basalt/ andesite lava flows in diamond drill hole QH-84-2 (42'-69'). This assemblage comprises mottled to banded iron carbonate (up to 50%) and locally, pale apple green disseminated epidote (5-8%) in a fine-grained dark to medium green chlorite-rich groundmass. A single sample of basalt/andesite lava containing this assemblage (QH-84-2-68.5') has been investigated petrographically, and contains 43% iron-rich chlorite, 25% iron carbonate, 18% fine-grained quartz/feldspar groundmass, 12 % sericite, and minor amounts of ilmenite and epidote.

The epidote ± chlorite ± actinolite ± silicification assemblage occurs throughout the lowermost basalt unit in drill hole QH-84-2 and within both basalt units in QH-85-4. This assemblage is commonly characterized by a chlorite-rich groundmass containing up to 40% disseminated, patchy, or vein-associated epidote. Locally, 2mm-2cm wide grey to white patches of silicification are present. This alteration assemblage is locally associated with minor (up to 5%) sulfide mineralization (primarily pyrite). In thin section, this assemblage is characterized by epidote (up to 48%), zoisite (up to 38%, actinolite (31-38%), and quartz (7-29%) with associated iron carbonate (up to 5%), pyrite (up to 2%) and ilmenite (up to 2%).

An iron-rich chlorite ± iron carbonate ± sericite alteration assemblage occurs in mixed clastic and chemical sediments within diamond drill hole QH-84-2. This assemblage contains variable amounts of dark green chlorite (10-70%) and up to 75% tan to pink fine-grained carbonate and sericite. A single thin section containing this assemblage (QH-84-2-23') contains 10% iron-rich chlorite, 33% iron carbonate, 30% sericite, 17% quartz, and 10% opaques (pyrite and ilmenite).

Massive and semi-massive sulfide mineralization at the Quartz Hill prospect is most closely associated with three alteration mineral assemblages: a) chloritoid ± chlorite ± silicification; b) andalusite ± chloritoid ± silicification; and c) sericite. In drill core, the chloritoid ± chlorite ± silicification assemblage is characterized by a pale-gray to greenish grey, commonly silicified matrix. These rocks also contain 5-20% 1-3mm disseminated chloritoid and up to 15 % very fine grained chlorite. In thin section, this assemblage contains 8-66% quartz, 6-30% chloritoid, up to 5% iron-rich chlorite, up to 12% epidote, and locally, minor amounts of zoisite and/or stilpnomelane. One sample (QH-84-2-142') contains 53% massive, untwinned secondary feldspar.

The andalusite ± chloritoid ± silicification assemblage comprises pale grey to greenish grey silicified rocks containing 5-15% 1-3mm disseminated chloritoid and bands and patches of pale pink andalusite (5-15%). This assemblage is most closely associated with the sulfide mineralization that occurs in drill hole QH-84-2. In thin section, these rocks contain a fine grained quartz-rich matrix (59-69%), andalusite (tr-10%), chloritoid (2-3%), sericite (11-22%), iron-rich chlorite (up to 4%), and locally stilpnomelane or biotite (up to 5%).

Sericite altered felsic tuff deposits also occur in close proximity to the sulfide mineralization in both diamond drill holes investigated. These rocks vary from pale green to tan-pink in color and lack significant amounts of chlorite, chloritoid, and/or andalusite. Based on the thin sections investigated, this assemblage comprises quartz (40-67%), sericite (16-25%), iron-rich chlorite (1-4%), zoisite (3-11%), stilpnomelane (up to 1%), and pyrite (6-12%).

Quartz Hill Geochemistry

Major and trace element lithogeochemical analyses were performed on 6 samples from the two diamond drill holes investigated. The results of these analyses, as well as the detection limits and analytical methods, are included in Table 4a (Appendix 4).

Due to locally intense hydrothermal alteration, immobile elements (Winchester and Floyd, 1977) have been used to classify the compositions of the volcanic rocks at this prospect (Figure 9). Based on this analysis, rocks at the Quartz Hill prospect vary from andesite/basalt to rhyodacite/dacite in composition.

A tectonic discrimination diagram using Th-Hf-Ta (Wood et al., 1979, 1980) has been plotted using the analyses from volcanic rocks in the Eagles Nest area (Figure 10). This diagram suggests that the volcanic rocks in the region are associated with a volcanic arc setting.

A rare earth element plot (after Lesher et al., 1986) of felsic tuff deposits from the Quartz Hill prospect is shown in Figure 11. Chondrite-normalized values (Leedy chondrite (Masuda et al., 1973) divided by 1.20) for La/Yb range from 7.64-19.81. Chondrite-normalized values of Zr/Y range from 10.4 to 32 for these rocks. Minor negative Eu anomalies occur in three samples.

<u>Interpretation of Results</u>

Volcanogenic massive sulfide deposits (VMS) are predominantly stratiform accumulations of sulfide minerals that precipitate from hydrothermal fluids at or immediately below the seafloor (Barrie and Hannington, 1997). These deposits occur in a wide variety of geological settings within volcano-sedimentary stratigraphic successions. These include oceanic ridges, thickened oceanic crust, sedimented oceanic ridges, sedimented continental margin rifts, and a variety of rifted arc settings (Barrie and Hannington, 1997). Detailed descriptions of VMS

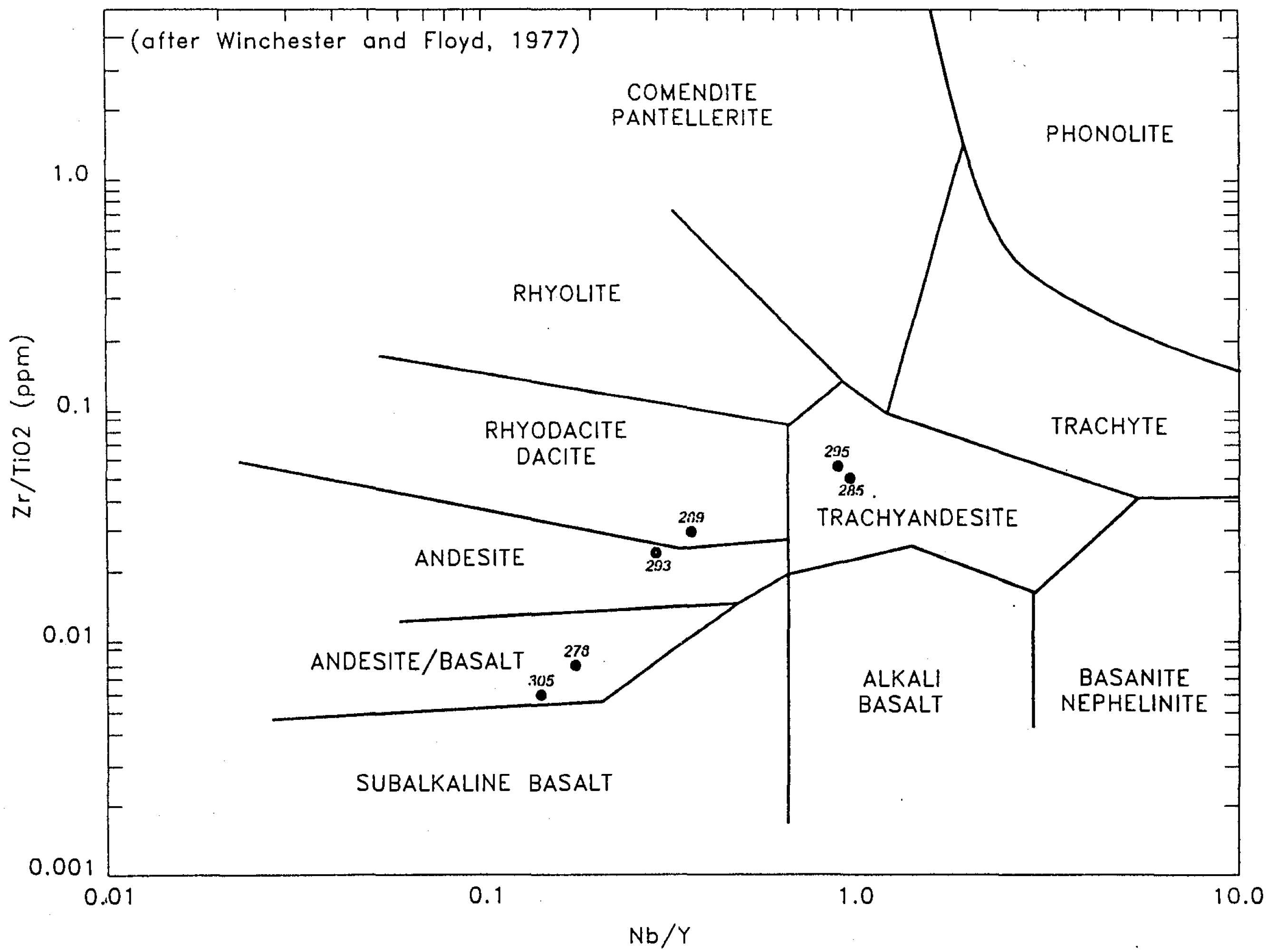

Figure 9. Immobile element classification of samples from the Quartz Hill prospect.

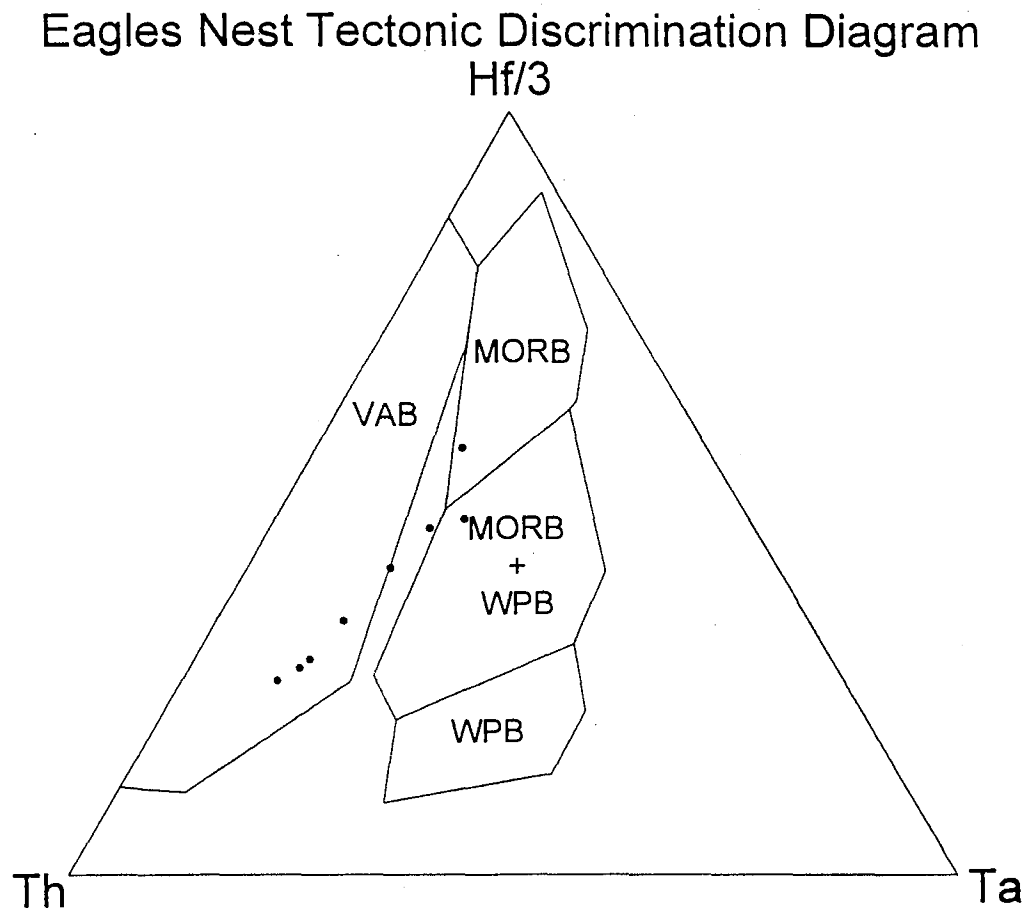

Figure 7. Tectonic discrimination diagram (after Wood et al., 1979, 1980). VAB = volcanic arc basalt, MORB= mid ocean ridge basalt, WPB = within plate basalt. MORB + WPB field is transitional between mid ocean ridge basalt and within plate basalt.

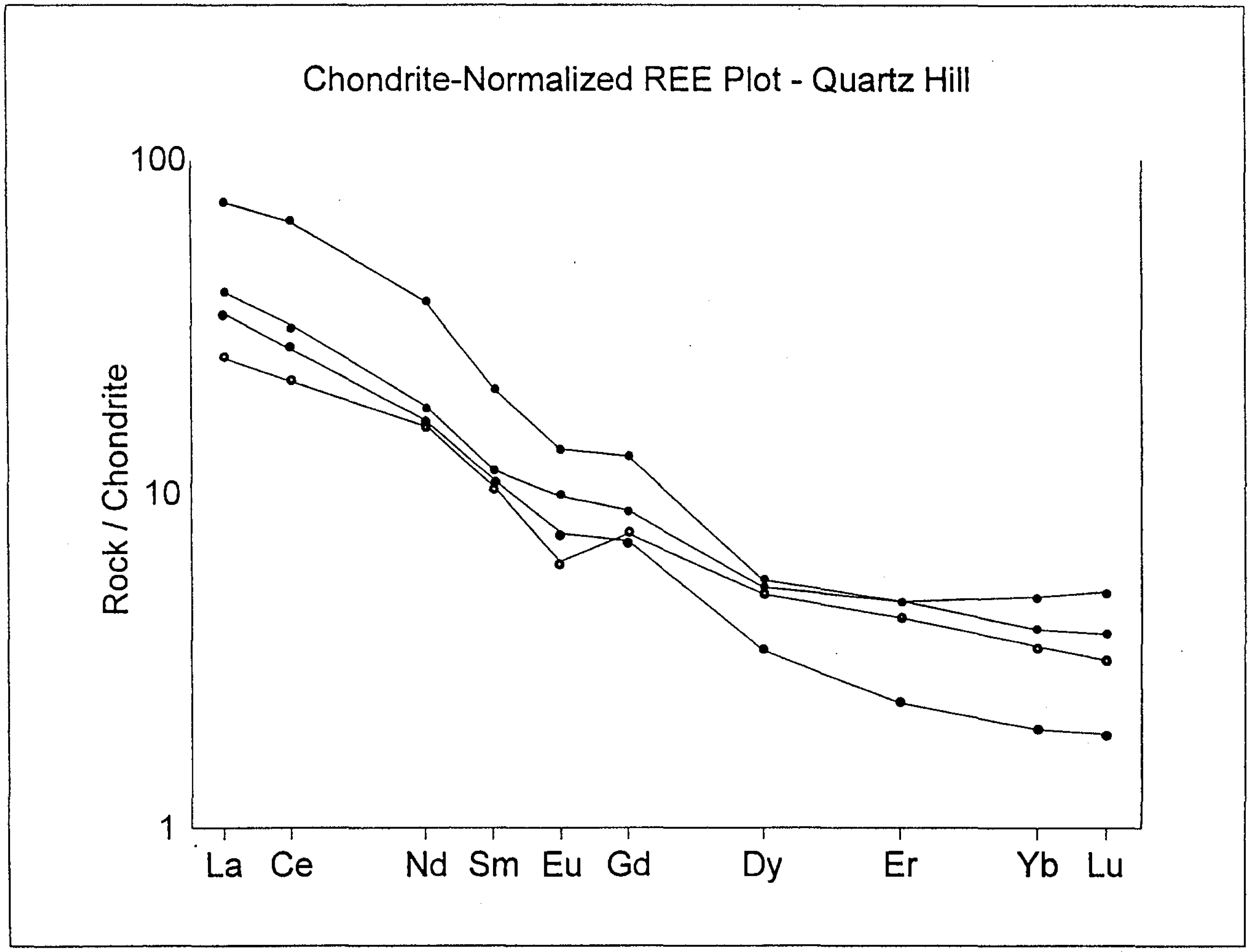

Figure 11. Chondrite normalized REE plot for felsic volcanic rocks (after Lesher et al., 1986). Chondrite normalizing values are those of the Leedy chondrite (Masuda et al., 1973) divided by 1.2.

deposits, and genetic models for VMS formation are included in Franklin et al. (1981), Franklin (1986), Lydon (1988), Cas (1992), Large (1992), Franklin (1993), Herzig and Hannington (1995), Ohmoto (1996), and Sillitoe et al. (1996).

According to Franklin et al. (1981), hydrothermal systems associated with VMS deposits consist of three parts: a) a fluid phase which is capable of leaching, carrying, and depositing various chemical components within the system; b) zones of high permeability which allow hydrothermal fluid to pass through the system: and c) a heat source which is capable of driving fluid flow through the system. Hydrothermal alteration mineral assemblages (and their post-metamorphic mineral assemblages) are the vestiges of fluid-rock interactions associated with mineralization (Santaguida et al., 1999).

It has been generally accepted that the fluid phase associated with seafloor hydrothermal systems is composed of modified seawater with possible contributions from magmatic water (Franklin et al., 1981; Gamo et al, 1997; Hannington and Jonasson, 1999). Zones of high permeability may be achieved in relatively non-permeable rocks (e.g. massive lava flows) if these rocks have been fractured or faulted. Chemical reactions during alteration that involve volume loss may also enhance permeability (Berndt and Seyfried, 1993). The heat source that drives convective hydrothermal circulation is believed to be a synvolcanic intrusion emplaced at shallow levels below the seafloor (Franklin, 1986). Such shallow intrusions may also be the source of magmatic vapors associated with VMS mineralization (Hudak, 1996).

One of the most prolific periods of VMS mineralization in terms of the numbers of deposits represented in the rock record is the Late Archean (2750-2700 m.y.; Barrie and Hannington, 1997). Morton and Franklin (1987) have characterized Archean VMS deposits into two types based on volcanic environments, volcanic rock types present, and alteration mineral assemblages. These are known as *Noranda-type deposits* and *Mattabi-type deposits*.

Noranda-type deposits are characterized by well defined alteration pipes, lower semiconformable zones of alteration comprising epidote-actinolite-quartz-rich rock, and dominantly mafic and felsic lava flows and associated hyaloclastites. Volcanic rocks associated with *Noranda-type deposits* formed at water depths of more than 500 meters (deep water).

Noranda-type deposits are named after the VMS orebodies that occur in the Noranda region of Quebec, Canada.

Mattabi-type deposits are named after the Mattabi orebody at Sturgeon Lake in northwestern Ontario, Canada. These deposits contain a higher proportion of footwall felsic volcanic rocks than Noranda-type deposits. *Mattabi-type deposits* have the following characteristics: a) a relatively broad alteration pipe which lacks sharp boundaries and contains variable abundances of iron-rich chlorite, chloritoid, iron carbonate (ankerite, siderite), and aluminum silicate minerals (andalusite, kyanite, and/or pyrophyllite); b) large, mineralogically well-defined semiconformable alteration zones which typically contain variable abundances of iron carbonate (ankerite or ferro-dolomite), iron-rich chlorite, chloritoid, sericite, quartz, and aluminum silicates (andalusite, kyanite, and/or pyrophyllite); and c) dominantly fragmental (volcaniclastic and pyroclastic) rocks. Semi-conformable alteration zones commonly merge with "pipe-like" alteration zones in *Mattabi-type deposits.* Volcanic rocks associated with *Mattabi-type deposits* are believed to have been emplaced at water depths less than 500 meters (shallow water). *Mattabi-type deposits* may be ancient analogs to shallow subaqueous epithermal-like VMS systems currently active on the seafloor. Recent work (Sillitoe et al., 1996; Hannington et al., 1997) suggests that such systems may be transitional between seawater-dominated deep water VMS deposits and subaerial high-sulfidation epithermal deposits which have been influenced by contributions from magmatic volatiles.

The Five Mile Lake prospect appears to be a *Noranda-type* VMS system based on the following criteria: a) the sparse amygdules and lack of abundant felsic pyroclastic rocks suggests that this region was formed within deep (>500 meters) water; b) the extensive epidote + quartz ± chlorite ± actinolite alteration zone is consistent with alteration associated with *Noranda-type deposits* (Morton and Franklin, 1987; Santaguida et al., 1999). The abundant stringer mineralization comprising chalcopyrite and sphalerite indicates: a) that this hydrothermal system was capable of transporting significant quantities of base metals; and b) that at least some of the hydrothermal system circulated in a diffuse manner through the sub-seafloor strata and deposited base metals.

The Eagles Nest region is also interpreted to represent a *Noranda-type* hydrothermal system that occurred in a relatively deep water (>500 meters) environment. This interpretation is based on the same criteria used for the Five Mile Lake prospect. The great thicknesses of massive sulfide and Algoma-type iron formation are indicative of a long-lived hydrothermal system in the region.

The relative abundance of felsic tuffs and tuffaceous material, coupled with hydrothermal alteration assemblages comprising andalusite, chloritoid, and iron-rich chlorite indicates the Quartz Hill mineralization may represent either a) a "Mattabi-type" VMS system (Morton and Franklin, 1987); or b) an ancient shallow subaqueous or subaerial high-sulfidation (White and Hedenquist,1990, 1995; Sillitoe,1995). Mattabi-type VMS systems are characteristic of shallow water (<500 meters water depth) hydrothermal systems, reflect extreme acid leaching of the rocks by the hydrothermal fluids, and may be analogous to "high sulfidation" epithermal systems within shallow water environments. Such hydrothermal systems commonly produce gold-rich massive sulfide deposits (Hannington et al., 1997).

Recommendations

The following recommendations are based on the results of this study:

Five Mile Lake Area

Further work in the Five Mile Lake area should be completed to locate possible synvolcanic fault zones. These fault zones may focus metalliferous hydrothermal fluids, and massive sulfide mineralization (rather than stringer mineralization) may occur in areas where these fault zones intersected the paleoseafloor.

Eagles Nest Area

Further work in the Eagles Nest area should include a detailed examination of the remaining diamond drill core from the prospect, detailed surface mapping (1:100 - 1:2000 scale), and further petrographic and lithogeochemical studies. Such work will allow further characterization of the volcanic environment and synvolcanic hydrothermal system that was active in the region.

Quartz Hill Area

Further work in the Quartz Hill region should include a detailed examination of the remaining diamond drill core from the prospect, detailed surface mapping (1:100 - 1:2000 scale), and further petrographic and lithogeochemical studies. It will be extremely important to better understand the volcanic environment (e.g. shallow subaqueous versus subaerial) to determine with confidence the type of hydrothermal and mineralizing system(s) that was (were) active within this region. Once the mineralizing system is characterized, effective mineral exploration criteria for the region can be established.

List of Digital Files

File Name	Explanation
326finalreport.wpd	Project 326 Report with figures (WordPerfect 8)
Appendix1wp.doc	Appendix 1 (WordPerfect 5.x)
Appendix2wp.wpd	Appendix 2 (WordPerfect 8)
log23-3/wplog23-3	drill log for 23-3 in Word and Wordperfect 5.x formats
log23-6/wplog23-6	drill log for 23-6 in Word and Wordperfect 5.x formats
log5406/wplog5406	drill log for 5406 in Word and Wordperfect 5.x formats
log6214-2-1/wplog6214-2-1	drill log for 6214-2-1 in Word and Wordperfect 5.x formats
logEN4/wplogEN4	drill log for EN-4 in Word and Wordperfect 5.x formats
logEN7/wplogEN7	drill log for EN-7 in Word and Wordperfect 5.x formats
logGL-1/wplogGL-1	drill log for GL-1 in Word and Wordperfect 5.x formats
logGl-14/wplogGl-14	drill log for GL-14 in Word and Wordperfect 5.x formats
logLL-1/wplogLL-1	drill log for LL-1 in Word and Wordperfect 5.x formats
logLL-2/wplogLL-2	drill log for LL-2 in Word and Wordperfect 5.x formats
logLL-3/wplogLL-3	drill log for LL-3 in Word and Wordperfect 5.x formats
logQH-84-2/wplogQH-84-2	drill log for QH-84-2 in Word and Wordperfect 5.x formats
logQH-85-4/wplogQH-85-4	drill log for QH-85-4 in Word and Wordperfect 5.x formats
logRZ-1/wplogRZ-1	drill log for RZ-1 in Word and Wordperfect 5.x formats
logRZ-3/wplogRZ-3	drill log for RZ-3 in Word and Wordperfect 5.x formats
logSL-2/wplogSL-2	drill log for SL-2 in Word and Wordperfect 5.x formats
logSP-90-1/wpLogSP-90-1	drill log for SP-90-1 in Word and Wordperfect 5.x formats
logSXL-1/wplogSXL-1	drill log for SXL-1 in Word and Wordperfect 5.x formats
logSXL-2/wplogSXL-2	drill log for SXL-2 in Word and Wordperfect 5.x formats
logSXL-3/wplogSXL-3	drill log for SXL-3 in Word and Wordperfect 5.x formats
logSXL-4/wplogSXL-4	drill log for SXL-4 in Word and Wordperfect 5.x formats
logTL-4/wplogTL-4	drill log for TL-4 in Word and Wordperfect 5.x formats
Appendix3.wp8	Appendix 3 legend (WordPerfect 5.x)
326finalpet.wb3	Appendix 3 petrographic data (Quattro-Pro)
Appendix4wp.doc	Appendix 4 legend (WordPerfect 5.x)
326finalchem.wb3	Appendix 4 lithogeochemistry (Quattro-Pro)

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APPENDIX 1

GEOLOGY AND ALTERATION LEGENDS

APPENDIX 1
GEOLOGY AND ALTERATION LEGEND*

GEOLOGY

Ultramafic - Mafic Volcanic Rocks

1a	Massive Basalt/Andesite
1b	Pillowed Basalt/Andesite
1c	Pillow Breccia
1d	Mafic Hyaloclastite
1e	Mafic Sediments
1f	Amphibolite
1g	Komatiite Flows
1h	Scoria Deposits
1i	Variolitic Basalt Flows
1ab	Massive & Pillowed Basalt/Andesite

Felsic Volcanic Rocks

2a	Massive Felsic Lava Flows
2b	Felsic Pyroclastic Deposits
2c	Debris Flow Deposits
2d	Felsic Breccia Deposits
2e	Felsic Tuff Deposits
2ab	Mixed Lavas and Pyroclastics
2f	Epiclastic Felsic Rocks
2af	Mixed Lavas and Sediments
2a4	Interbedded Rhyolite and BIF
2adf	Felsic Lava, Breccia, Sediments
2ef	Felsic Tuff & Epiclastic Sediments

Clastic Sedimentary Rocks

3a	Greywacke / Slate
3b	Shale – Phyllite
3c	Siltstone
3d	Conglomerate
3e	Graphite-rich Argillite
3f	Biotite Schist
3bc	Mixed Shale & Siltstone
3dc	Mixed Siltstone & Conglomerate
32b	Mixed Wackes and Felsic Pyroclastics

Proterozoic Rocks

GOW	Gowganda Formation
YR	Younger Rocks

Late Veins

QV	Quartz Vein

Chemical Sedimentary Rocks

4a	Oxide Facies BIF
4b	Sulfide Facies BIF
4c	Carbonate Facies BIF
4d	Silicate Facies BIF
4e	Interflow Sedimentary Rocks
4f	Chert
4g	Massive/Semi-Massive Sulfide
4abc	Mixed Facies BIF

Sheared Rocks

5a	"Poker Chip" Phyllite
5b	Quartz-Sericite Schist
5c	Quartz-Ankerite Schist
5d	Quartz-Sericite-Ankerite Schist
5e	Chlorite Schist - Phyllite
5f	Carbonaceous Phyllite
5g	Talc-Chlorite Schist
5h	Carbonate-Fuchsite Schist
5i	Quartz-Sericite-Green Mica Schist

Felsic Intrusive Rocks

Qfp	Quartz-Feldspar Porphyry
Fp	Feldspar Porphyry
Gr	Granite
Gd	Granodiorite
Gp	Granitoid Pluton
M	Monzonite
Tn	Tonalite
Tj	Trondjhemite
D	Diorite
Mt	Migmatite
Sy	Syenite
Qm	Quartz Monzonite
BX	Diatreme Breccia

Mafic Intrusive Rocks

Db	Diabase Dikes
Gb	Gabbro
Pr	Peridotite
L	Lamprophyre

* Geological legend after Peterson (in progress)
Alteration legend derived from Hudak (1996)

APPENDIX 1 (continued)
GEOLOGY AND ALTERATION LEGEND*

ALTERATION

0	No Apparent Alteration
1	Least Altered
2	Silicified (>75% Quartz Matrix)
3a	Epidote + Quartz ± Chlorite ± Actinolite ± Sulfides
3b	Epidote + Chlorite ± Actinolite ± Albite
3c	Epidote + Carbonate ± Chlorite ± Actinolite
4	Iron Chlorite ± Iron Carbonate
4a	Iron Chlorite ± Iron Carbonate ± Magnetite ± Garnet
4b	Dolomite ± Calcite
4c	Ankerite ± Sericite
5	Chloritoid ± Iron Chlorite ± Iron Carbonate
5a	Chloritoid = Iron Chlorite ± Iron Carbonate (retrograde reaction of chloritoid)
6	Aluminum Silicate (Andalusite/Kyanite) + Chloritoid/Iron Chlorite ± Iron Carbonate
7	Aluminum Silicate ± Pyrophyllite ± Sericite
8a	Sericite ± Pyrophyllite
8b	Sericite ± Carbonate (ankerite/dolomite)
8c	Sericite + Green Mica ± Carbonate
9	Magnesium Chlorite
10a	Secondary Feldspar (Plagioclase Feldspar) ± Chlorite ± Sericite
10b	Secondary Feldspar (Potassium Feldspar) ± Chlorite ± Sericite
11	Biotite ± Iron/Magnesium Chlorite
11a	Stilpnomelane ± Iron/Magnesium Chlorite
12	Tourmaline (veins to massive)

APPENDIX 2

DIAMOND DRILL HOLE LOCATION DATA AND DRILL LOGS

Appendix 2a:	Diamond Drill Hole Collar Location Data
Appendix 2b:	Diamond Drill Hole Logs from Project 326

Appendix 2a
Diamond Drill Holes Investigated During Project 326

Drill Hole Number	Lessee	UTME NAD27	UTMN NAD27	UTME NAD83	UTMN NAD83
LL-1	Humble Oil	583684	5309542	583665	5309744
LL-2	Humble Oil	583846	5309967	583977	5309989
LL-3	Humble Oil	583984	5309784	583931	5310067
GL-1	Garden Lake	596552	5309534	596539	5309741
GL-14	Garden Lake	596446	5309225	596443	5309432
5406	J & L Steel	590706	5307234	590693	5307442
RZ-1	Whiteside	580707	5306183	580722	5306383
RZ-3	Whiteside	580732	5306258	580746	5306745
SP-90-1	BHP-Utah	586000	5308002	585984	5208213
23-3	Kerr-McGee	587165	5308665	587152	5308873
23-6	Kerr-McGee	587102	5308658	587089	5308866
6214-2-1	Kerr-McGee	568350	5303380	568318	5303574
SXL-1	Teck	564962	5296883	564915	5297995
SXL-2	Teck	564477	5297015	564430	5297126
SXL-3	Teck	564318	5296966	564271	5297079
SXL-4	Teck	564869	5296940	564822	5297053
EN-4	Newmont	570630	5297990	570616	5298199
EN-7	Newmont	570222	5297943	570278	5298138
SL-2	Exxon	563506	5291986	566791	5262554
TL-4	Bear Creek	582039	5300580	582095	5300790
QH-84-2	St. Joe	580246	5305954	580265	5306112
QH-85-4	St. Joe	580224	5305904	580160	5305950

Data from Peterson (personal communication, 1998, unpublished data) and Dzuck (personal communication, 1999).

Appendix 2b: Diamond Drill Hole Logs From Project 326

	DDH: LL-1 TOTAL DEPTH: 343 feet T 63 R 12 S 16	PROJECT 326 COMPANY: Humble Oil AZIMUTH: 160 COLLAR DIP: -45° NAD27 UTME: 583684 UTMN: 5309542 NAD83 UTME: 583665 UTMN: 5309744			LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA - DULUTH DATE CORE LOGGED: 4-6-98	
FROM	**TO**	**LITHOLOGY**	**FROM**	**TO**	**ALTERATION**	**OTHER**
0	11	OVERBURDEN	0	11	OVERBURDEN	
11	180	DIORITE/TONALITE INTRUSION Medium-grained to fine-grained green-grey diorite intrusion. Varaibale grain sizes are gradational.Feldspar laths 1-3mm, tan to cream-colored: Rare dissemenated <1mm grey quartz phenocrysts locally up to 2%. 11-106: medium-grained feldspar-eich diorite 106-112: Finer grained equivalent of above, with <1-2% <1mm grey quartz phenocrysts 112-114: Same as 106-112 with 10-15%5-15mm quartz veins 114-125: Same as 106-112with local 5-10 mm quattz-carbonate veins that may be associated with localized shear zones. 125-178: Fine grained dacite lava same as 106-112.	11 114 125	114 125 178	EPIDOTE Fine grained matrix variably epidotized up to 5%. Cream colored feldspar loclly carbonate-rich. Minor (up to 5%) chlorite LOCALIZED SILICIFICATION Loclly silicified with associated quartz veins. Groundmass light green in color due to silicification. LEAST ALTERED Relatively fresh with minor (up to 5%) epidote	11-180: <1-1% dissemenated pyrite
180	198	SHEAR ZONE Medium to dark green chlorite-rich matrix with lenses and bands of quartz. Quartz veining most intense at 187-189.	178 187 189	187 189 198	CHLORITE + QUARTZ Chlorite 70%, quartz 25%, sericite 5% CHLORITE + QUARTZ Quartz 80%, chlorite 20% CHORITE + QUARTZ + EPIDOTE Chlorite 65%, quartz 25%, epidote (?) 5%: <1mm lenses of pale pink mineral up to 5% (carbonate?)	195-198: 1-3% pyrite concentrated along fractures
198	204	FELDSPAR-PHYRIC DACITE Grey fine-grained groundmass with up to 5% <1-2mm	198	204	LEAST ALTERED Relatively fresh and unaltered.	

		cream-colored feldspar laths				
204	343	<u>SEDIMENTS</u> Interbedded sediments ranging from very fine grained graphite-rich shales to heterolithic volcaniclastic debris flow and associated volcaniclastic siltstone horizons 204-205: Normally graded debris flow horizon with fragmental base and fine-grained silty top 205-209: Bedded siltstone and graphite-rich shale horizons up to 2cm thick 209-213.5: Felsic heterolithic debris flow deposits: matrix supported contained 15-20% light to dark grey lensoid fragments up to 1 cm in diameter. Aspect ratios of fragments up to 5:1. Coarser fragments at 213-213.5 suggest normal grading 213.5-214: Fine-grained siliceous siltstone with 3-5% light to dark grey felsic fragments up to 1 cm in diameter 214-230: Debris flow units with felsic matrix and siliceous and graphitic fragments (5-20%) 230-236: Siliceous, massive to bedded ash tuff/siltstone horizons 236-248: Debris flow units similar to 214-230 248-251: Graphite-rich shale horizons 251-266: Debris flow units similar to 214-230 266-280: Massive to finely-bedded ash tuff/siltstone horizons 280-343: Massive heterolithic volcaniclastic breccia deposits. Light grey, matrix-supported with 5-20% light grey piumice (0.2-1.0 cm), 5-10% dark grey felsic (?) lithic fragments, 2-5% <1-2mm light to dark grey quartz chips	204 267 268 277	267 268 277 343	<u>LEAST ALTERED</u> Relatively fresh greenschist facies metasediments with local patches and/or bands of ivory-colored silicification. Silicified bands up to 3cm across, 1-2%. Patchy silicification encompasses 1-3mm ivory patches/veinlets concentrated at 217-220. <u>HEMATITE STAINING</u> Hematized carbonate is pale pink, very fine-grained, concentrated along bedding fractures <u>PATCHY EPIDOTE + CARBONATE</u> 1-3cm oval to rounded patches of epidote and carbonate. Epidote 5-10%, carbonate 5-15% <u>LEAST ALTERED</u> Relatively unaltered greenshcist facies metasediments	204-225: 1% dissemenated pyrite with concentrations of pyrite in lensesup to 15-20% (esp. at 213-214) Late fractures contain 5010% pyrite at 208-209 209-213.5: 1-3% dissemenated pyrite 230-236: 1-2 % dissemenated pyrite 248-251: 5-10% pyrite in late fractures
343		<u>END OF HOLE</u>	343		<u>END OF HOLE</u>	

	DDH: LL-2 TOTAL DEPTH: 572 feet T: 63 R: 12 S: 16	PROJECT 326 COMPANY: Humble Oil AZIMUTH: 160 COLLAR DIP: -45° NAD27 UTME: 583846 UTMN: 5309967 NAD83 UTME: 583977 UTMN: 5309989	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-6-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	9	OVERBURDEN	0	9	OVERBURDEN	
9	92	BASALT LAVA Massive green-grey to green aphyric to 1mm feldspar-phyric basal lavas. Grain size variations suggest several lava flows, but flow contacts are indistinct. 89-92: Dark green, chlorite-rich, highly fractured with abundant quartz veinlets adjacent to quartz vein	9	40	LEAST ALTERED Relatively fresh with up to 5% epidote. Locally cut by 10-15% pinkish-grey quartz-carbonate veins and bands up to 10cm wide.	9-92: Nil *Sample: 3260000003 (17.0')*
			40	43	BLOTCHY EPIDOTE Coarse texture due to 10-15% blothcy to patchy epidote-quartz alteration	
			43	45	LEAST ALTERED Same as 9-40.	
			45	50	CARBONATE + QUARTZ VEINS Up to 40% pinkish-grey, commonly contorted quartz-carbonate veins and bands ranging from 0.5-10 cm wide.	
			50	86	BLOTCHY EPIDOTE + QUARTZ + CARBONATE Similar to 40-43.	
			86	92	CHLORITE Dark green chlorite-rich groundmass with 20-40% white quartz veins.	
92	114	CALCITE + QUARTZ VEIN White calcite ± quartz vein; carbonate has good cleavage and readily reacts with HCl (calcite)	92	97	CHLORITE 5-10% lenses and veinlets of green chlorite.	Nil
			97	114	QUARTZ + CARBONATE Intermixed quartz and calcite within vein.	
114	121	MIXED CHLORITE + QUARTZ + CARBONATE VEIN Vein composed of a mixture of chlorite, carbonate, and quartz	114	121	CHLORITE + CARBONATE + QUARTZ Chlorite + carbonate + quartz vein	Nil
121	207	DIABASE (DIKE?) Grey to light geen-grey fine-grained matrix, with 5-10% creamy colored feldspar laths up to 1.5 mm in diameter	121	148	MINOR EPIDOTE + CARBONATE Relatively fresh with 5-15% carbonate ± epiodote.	Nil

		(similar to diorite in LL-1). Cut by 5-10% 0.5-1.0 cm quartz ± carbonate veinlets. Groundmass composed of fine-grained chlorite-epidote-carbonate-feldspar. Locally sheared. 121-148: Green-grey with 5-10% feldspar phenocrysts: massive appearance 148-197: Moderately to strongly sheared. Local veins/bands up to 15cm thick with quartz – diabase breccia. Shearing at 30-50° to core axis 197-207: Green-grey to light green, slightly coarser grained than above with 5-10% <1-2mm feldspar laths in fine-grained green-grey chlorite-feldspar-epidote groundmass. Contorted, sharp, fine-grained contact at 65° to core axis at 207'.	148 197	197 207	CHLORITE + SERICITE + QUARTZ + CARBONATE Mixed fine-grained groundmass contains variable amounts of chorite, sericite, quartz, and carbonate. LEAST ALTERED Relatively fresh with cream-colored, possibly carbonate-rich tabular feldspar. Also 5% disseminated dark green to black chlorite.	
207	376	ANDESITE/DACITE LAVA Grey to grey-green, massive andesite/dacite lava. Contains 3-5% <1-2mm cream-colored feldspar laths. No apparent flow contacts present. Contains 2-5% 0.5-5.0 cm white to cream-colored quartz ± carbonate± chlorite veins and bands. 375-376: Verie fined grained contact at 40° to core axis.	207 323 350	323 350 376	LEAST ALTERED Relatively unaltered with up to 5% epidote in groundmass. EPIDOTE + CARBONATE Green-grey blotches of epidote ± carbonate 0.5-0.75 cm in diameter, 20-30%. Quartz ± chlorite veins up to 4.0 cm in diameter, 5-8%. LEAST ALTERED Same as 207-323.	Nil *Sample: 3260000004 (344.5')*
376	384	SEDIMENT (DEBRIS FLOW) Same as LL-1, 214-230.	376	384	LEAST ALTERED Relatively unaltered sediments.	Nil
384	392.5	SHEAR ZONE Interlayered graphite-rich shale and debris flow units and green aphyric chlorite-rich dike/sill. Silicified amygdules or fragments present.	384	392.5	MINOR CHLORITE + SILICIFICATION Minor chloritization with patchy silicification around oval to angular dark grey siliceous fragments and amygdules	Nil
392.5	402	DIABASE (DIKE?) Dark green, very fine-grained, massive.	392.5	402	LEAST ALTERED Relatively unaltered diabase.	Nil
402		End of Hole	402		End of Hole	

	DDH: LL-3 TOTAL DEPTH: 653 feet T: 63 R: 12 S: 16	**PROJECT 326** COMPANY: Humble Oil AZIMUTH: 160 COLLAR DIP: -45° NAD27 UTME: 583984 UTMN: 5309784 NAD83 UTME: 583931 UTMN: 5310067
	LOGGED BY: G. HUDAK **UNIVERSITY OF MINNESOTA - DULUTH** **DATE:**	

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	7	OVERBURDEN	0	7	OVERBURDEN	
7	72	BASALT / ANDESITE LAVA FLOWS Grey-green, massive to amygdaloidal (up to 1% 0.5-1cm oval quartz amygdules); up to 5% <1mm cream-colored tabular interstitial feldspar 63-66: Broken core 66-71: Foliation increases in intensity toward lower contact; foliation @35° to core axis. 71-72: Strongly sheared shear zone or faulted contact	7 62	62 72	LEAST ALTERED Epidote 5-10% with patchy to disseminated chlorite-rich groundmass MINOR CHLORITIZATION Chlorite increases to 15-15% and defines strong foliation	
72	208	SEDIMENTS Grey to grey-green clastic sediments varying from graphite-rich shales to heterolithic debris flows containing volcaniclastic, cherty, and graphitic lapilli. 72-88: graded sediments comprising graphite fragment-rich bases and fine grained argillaceous siltstone tops; fragments lens-shaped, up to 10% 88-90: strongly foliated graphite-rich shale with 5-10% lensoid to banded py-po: slickensides present 90-107: interbedded siliceous siltstones and graphite-rich shales 107-203: graded sediments comprising siliceous to intermediate siltstone/greywacke and heterolithic debris flow deposits containing 5-20% 2mm-2cm grey siliceous fragments, up to 5% 2-10mm lens shaped dark grey graphite fragments, and 3-5% dark green mafic fragments ranging from 1-5mm in diameter; at 146-152, 3% banded cherty exhalite fragments up to 1cm in diameter along with 3-5% oval sulfide (po+py) fragments 203-208: graphite-rich shale	72 203	203 208	LEAST ALTERED MINOR SILICIFICATION Minor silicification (<5%) in 1-3mm wide veinlets, locally associated with sulfides	88-90: 5-10%po-py 97-107: <1-5% stringer to lens-shaped py-po ± sp? 203-208: 1-10% disseminated to ovid py-po lenses
208	211	DIABASE DIKE	208	211	LEAST ALTERED	
211	251	SEDIMENTS	211	251	LEAST ALTERED	211-212: 10-20%

		Similar to sediments described above: 211-212: graphite-rich shale 212-251: graded seds similar to 107-203 with slighly more mafic composition				veins/bands of po-py
251	257	DIABASE DIKE Dark green, fine grained , sharp, contorted contacts	251	257	MINOR CARBONATE	
257	276	SEDIMENTS Similar to 212-251 263-264: cherty py-rich exhalite with 1-3% massive py-sp: locally fragmental	257	276	LEAST ALTERED	263.5-264: 80% pyrite ± sp? 264-265: 5-7% disseminated 1-3mm py±po in graphite
276	286	SHEAR ZONE Sheared green fine grained sediemt or diabase diek with 1-10mm wide black to dark green graphite /chlorite bands; contorted quartz-chlorite-graphite-sulfide at 279-280, 285-286.	276	286	CHLORITE + QUARTZ Lenses and bands of quartz, 5-105; chlorite most prevalent, dissemenated 20-30%, and as late bands and veins, 10%	277-279: 3-5% 2-5mm disseminated pyrite cubes
286	316	SEDIMENTS Similar to sediments described above. 286-293: Graphite rich shale with local siliceous horizons 293-316: similar to 257-276: interbedded, graded debris flow deposits and fine grained greywacke/shale horizons	286	316	PATCHY SILICIFICATION Patchy silicification adjacent to sulfides	286-293: 5-10% lenses and disseminated py 309-313: generally 1-3% disseminated py/po 5-10%
316	322	DIABASE DIKE Local xenoliths up to 3cm in diameter	316	322	LEAST ALTERED	
322	325	SEDIMENTS Very fine grained sediments	322	325	LEAST ALTERED	
325	343	DIABASE DIKE Same as 316-322.	325	343	LEAST ALTERED	
343	441	VOLCANICLASTIC SEDIMENTS Graded fine siliceous to intermediate fine grained sediments downward into coarse heterolithic volcaniclastic debris flows with 10-25% lapilli-sized angular to subangular fragments	343	441	MINOR CHLORITE Minor chorite up to 5%.	Disseminated py/po 410-441:<1%; local po-rich lenses up to 1cm long and 2mm wide, 1-2%
441	459	DIABASE DIKE Dark green, very fine grained, with rare quartz amygdule up to 0.5 mm in diameter.	441	459	LEAST ALTERED	
459		STOPPED LOGGING HOLE	459		STOPPED LOGGING HOLE	

	DDH: GL-1 TOTAL DEPTH: 348 feet T: 63 R: 11 S: 22	<u>PROJECT 326</u> COMPANY: Garden Lake AZIMUTH: No data COLLAR DIP: No data NAD27 UTME: 596552 UTMN: 5309534 NAD83 UTME: 596539 UTMN: 5309541	**LOGGED BY: G. HUDAK** **UNIVERSITY OF MINNESOTA – DULUTH** **DATE CORE LOGGED: 4-8-98**

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	6	<u>OVERBURDEN</u>	0	6	<u>OVERBURDEN</u>	
6	210	<u>BASALT LAVA FLOWS</u> Massive to slightly amygdaloidal basalt lava flows. Amygdules 1-2%, round, quartz-filled, up to 3mm in diameter. 6-21: Massive basalt 21-23: Possible flow contact encompasses autobreccia with 5-20% angular dark green aphyric basalt fragments 23-114: Massive basalt, same as 6-21. 114-115: Possible flow contact, same as 21-23. 115-154: Massive basalt; foliation increasing and contains up to 5% quartz-pyrrhotite-pyrite veins commonly associated with epidote. 154-154.5: Quartz vein. 154.5-180: Sheared basalt lava flows containing 5-15% ,1-3cm wide white to pink quartz-carbonate veins at 40° to core axis. 180-226: Sheared basalt and basalt fault gauge; chlorite/epidote-rich with dissementated bands of sulfides (py + po ± cp, sp)	6	123	<u>CHLORITE + EPIDOTE</u> Dark green fine-grained chlorite-rich basalt cut by 1-15mm wide bands and veins of pale green epidote; epidote veins (3-7%) locally cut by quartz veinlets up to 1cm wide.	123-154': 1-5% disseminated pyrite . locally associated with epidote. 154-178': 1-10% disseminated to patchy pyrite – very fine-grained brown mineral may be traces of sphalerite. 178-180': Nil 180-210': Up to 2% very fine-grained disseminated pyrite.
			123	154	<u>EPIDOTE + CHLORITE</u> Gradational contact into epidote-rich alteration zone. Epidote in veins and bands up to 8-10 cm wide. Locally epidote veins are associated with quartz veins which locally may be associated with very fine grained hematite. Sulfides (when present) are associated with epidote-rich alteration.	
			154	154.5	<u>QUARTZ VEIN</u>	
			154.5	178	<u>CHLORITE</u> Strongly sheared chloritized basalt. Chlorite 50-60%, commonly in 1-10mm wide veins that define foliation at 40-45° to core axis. Locally pink hematite is present in minor amounts. Pinkish quartz-carbonate veins 5-10% at 160-178'.	
			178	180	<u>CHLORITE + EPIDOTE</u> Similar to 154.5-178', but pale green very fine-grained epidote ± quartz up to 30%.	
			180	210	<u>CHLORITE</u> Chlorite-rich fault gauge.	
210	226	<u>FAULT ZONE</u> Highly broken core with quartz-carbonate veins and locally strong hematite staining.	210	226	<u>QUARTZ + CARBONATE + CHLORITE</u> Dominantly broken, locally hematized quartz vein with associated carbonate+ chlorite (5-8%)	
226	240	<u>SERICITE SCHIST</u>	226	240	<u>SERICITE</u>	243-246': Up to 3% <1-

		Pale-grey to green, well foliated; core broken throughout section; gradational lower contact over 3-5 feet.			Sericite (up to 50%) and quartz rich rock grades downward into chlorite-rich alteration.	2mm dissemenated pyrite
240	246	CHLORITE SCHIST Massive chlorite; protolith may have been strongly sheared basalt lava flows	240	246	CHLORITE Massive chlorite with locally mm-scale quartz + carbonate veins.	
246	299	BANDED IRON FORMATION Sub-1mm to centimeter-scale interbanded chert and massive magnetite. Strongly folded based on variable angle of banding to core axis. Local horizons of sulfide facies iron formation appear to have been remobilized into late mm-scale fracture. Many microfaults present with apparent displacements on mm- to cm-scale.	246	299	UNALTERED Relatively unaltered Algoma-type iron formation.	Bands of sulfide-facies iron formation at 258-258.25', 259.25-259.5' are the same unit. Pyrite locally occurs in mm-cm wide bands, <5% 291-299': 3-5% dissemenated pyrite in late quartz-filled fractures; minor chalcopyrite also present.
299	309	DIABASE DIKE Fine-grained contact at 229' grades into fine-grained feldspar-phyric diabase; lower contact sheared	299	309	UNALTERED Relatively unaltered dike with 3-5% 1mm-1cm late quartz veins present.	
309	325	BANDED IRON FORMATION Same as 246-299; sharp lower contact with basalt lava flows.	309	325	UNALTERED Relatively unaltered Algoma-type iron formation.	Similar to 291-299'.
325	348	BASALT LAVA FLOWS Moderately to strongly altered massive to amygdaloidal feldspar-phyric mafic lava flows. Quartz-filled amygdules up to 1%, <1-5mm in diameter, oval to round in shape. Feldspar phenocrysts <1mm, tabular, cream-colored.	325	348	EPIDOTE Patchy epidote (5-15%) in bands up to 10 cm wide. Chlorite-rich matrix. Local brown iron carbonate (?) up to 5%.	1-3% patchy dissemenated pyrite; local traces of brassy sulfide may be cghalcopyrite, and traces of red-brown very fine grained mineral may be sphalerite.
348		End of hole	348		End of hole	

DDH: GL-14 TOTAL DEPTH: 463 feet T: 63 R: 11 S: 22	<u>PROJECT 326</u> COMPANY: Garden Lake AZIMUTH: No data COLLAR DIP: No data NAD27 UTME: 596446 UTMN: 5309225 NAD83 UTME: 596443 UTMN: 5309432	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-9-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	15	<u>OVERBURDEN</u>	0	15	<u>OVERBURDEN</u>	
15	245	<u>METABASALT</u> Variably altered and deformed dark green to greenish-pink (altered) basalt lava flows intruded by dikes/sills of pink, locally feldspar-phyric syenite/monzonite 15-100: Dark green, aphyric basalt intruded by dikes/sills of pink, locally feldspar-phyric (up to 4mm in diameter, up to 7%) monzonite/syenite.	15	100	<u>EPIDOTE + QUARTZ</u> Fine-grained chlorite-rich matrix cross-cut by bands up to 5cm wide of silicification/epidotization (up to 20%); late mm scale cross-cutting white to orange-brown quartz-carbonate veins.	0-100': Condensed core
		100-123: Fine-grained to medium-grained biotite-rich mafic flow; feldspar phenocrysts 1-2mm, 20-25, are pale green and epidotized.	100	121	<u>EPIDOTE</u> Patchy pale green due top 30-40% <1-2mm epidotized fefldspar in fine-grained chlorite – biotite-rich groundmass.	
		123-137: Fine-grained to medium-grained biotite-rich mafic flow; pink hematized feldspar wilth local hematite-rich felsic dikes/sills.	121	137	<u>HEMATITIZATION</u> Fine-grained pinkish color due to hematite-rich feldspar in fine-grained chlorite-rich groundmass	
		137-139: Shear zone: very fine-grained chlorite+quartz+ carbonate bands; strong foliation at ~20° to core axis.	137	139	<u>CHLORITE + CARBONATE</u> Chlorite and carbonate veins concentrated in shear zone	
		139-170: Medium-grained to coarse-grained hematized feldspar-phyric lava flow; average grain size 1-2mm (amphibolite-grade metamorphic recrystallization?)	139	156	<u>HEMATITIZATION</u> Medium-grained pinkish hematized feldspar (25%) up to 4mm long, tabular; rock has strong fabric at 40-50° to core axis.	
		170-171: Quartz vein 171-180: Same as 139-170'; 5-15 cm reddish to maroon iron carbonate + quartz veins up to 50% from 178-180'.	156	177	<u>EPIDOTE</u> Same concentration of feldspar as above is now epidote-rich, green-grey.	
		180-185: Fault zone/shear zone: broken core with chlorite+carbonate schist at ~20° to core axis.	177	242	<u>QUARTZ + HEMATITE + CARBONATE</u> Very fine-grained dark green chlorite-rich groundmass cut by pale-grey to pinkish-red quartz+hematite+carbonate veins.	

		185-201: Very fine-grained to fine-grained dark green to pinkish green massive metabasalt cross-cut by 5-10% 1-6mm red to white quartz + hematite ± carbonate veins; local apophyses of syenite/monzonite up to 5 cm wide. 201-201.5: Fault zone 201.5-245: Same as 185-201.	242	245	HEMATITIZATION Strongl;y veined (up to 25%) with very fine-grained reddish to green-brown hematite; chlorite, sericite associated with lower contact.	
245	265	SYENITE/MONZONITE Pink-green, medium-grained reddish hematite stained feldspar (<1-5mm); nearly pegmatitic at 260-265'.	245	265	HEMATITIZATION Hematite (5-10%) concentrated on feldspar phenocrysts similar to 121-137.	
265	318	METABASALT Fine-grained, green to green-grey, to locally red-staiend aphyric metabasalt; apophyses of syenite/monzonite up to 5cm wide.	265 275	275 318	HEMATITIZATION Pink, strongly hematized basalt with thin (<1-3mm) chlorite-rich domains and veinlets. HEMATITIZATION Pale green, faintly hematized with very fine-grained bands and massive silcification and epidote (up to 5%).	
318	463	MONZONITE/SYENITE PORPHYRY Dark green to black chlorite (30-35%) – biotite (<10%) –rich groundmass with 1-8mm pink to red hematite stained feldspar; Coarser-grained with increasing depth; grain size sharply increases at 389'; from 389-463', average feldspar 4-6mm, tabular, locally up to 1.0-1.5cm in diameter; feldspar 30-40%, hematized.	318	463	HEMATITIZATION Hematized feldspar throughout unit.	
463		End of Hole	463		End of Hole	

	PROJECT 326	LOGGED BY: G. HUDAK
	DDH: 5406 TOTAL DEPTH: 720 feet T: 63 R: 11 S: 30	COMPANY: J & L Steel AZIMUTH: 180 COLLAR DIP: -30° NAD27 UTME: 590706 UTMN: 5307234 NAD83 UTME: 590693 UTMN: 5307442	UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-9-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	5	OVERBURDEN	0	5	OVERBURDEN	
5	23.5	BANDED IRON FORMATION Banded magnetite-chert iron formation; bands <1-5mm wide, very evenly spaced; chert horizons composed of nearly pure silica with up to 5% disseminated sulfides commonly present	5	23.5	LEAST ALTERED	19-19.5: 5-20% disseminated to banded py ± sp(?) 23-23.5: 5-25% disseminated to semi-massive py ± sp(?)
23.5	72.5	AMYDALOIDAL BASALT Dark green, aphanitic, with <1-2% 1-4mm oval chlorite-rich amygdules	23.5 60	60 72.5	LEAST ALTERED Relatively fresh with 5-10% disseminated epidote MINOR SILICIFICATION + EPIDOTE Slightly more siliceous than above; pale grey-green color with 10-20% 1-2mm chlorite, and up to 10% epidote	
72.5	84	FAULT ZONE Highly broken core composed of yellow brown iron oxides and clay	72.5	84	IRON OXIDE/CLAYS Highly broken core composed of yellow brown iron oxides and clay	
84	156	ANDESITE/BASALT LAVA Pale grey green, aphanitic, locally with 1% 1-3mm dark grey oval quartz amygdules; foliation at 30° to core axis and broken core at 152-156.	72.5 152	152 156	LEAST ALTERED CHLORITE Increase in chlorite to 20-30%	Tr-1% disseminated py locally present
156	214	BANDED IRON FORMATION Banded hematite-chert iron formation; localized lenses of graphite-rich siltstone 156-208: banded iron formation 208-210: graphite-rich siltstone 210-212: banded iron formation with black chert 212-214: chert with black to dark green chlorite-rich sediment; hornfels present at lower contact with dike	156	214	LEAST ALTERED	156-156.5: sheared contact with up to 5% patchy py. 156.5-208: <1% locally disseminated py 208-210: up to 15% disseminated py-po in graphite-rich sediments 210-214: up to 2% disseminated py
214	254.5	DIABASE DIKE Grey green to green very fine-grained groundmass with 5% <1mm tan to ivory colored tabular feldspar phenocrysts; very fine grained aphyric upper and lower	214	232	PATCHY CARBONATE Patchy carbonate alteration on feldspar phenocrysts	Nil

		contact zones	232	254.5	LEAST ALTERED Relatively fresh dark green groundmass due to chlorite (~35%) and biotite (up to 10%); carbonate phenocrysts locally altered to carbonate; minor disseminated epidote (up to 5%)	
254.5	444	INTERBEDDED CLASTIC/CHEMICAL SEDIMENTS Interbedded clastic and chemical sediments composed of chert-banded iron formation and graphite-rich shales; banded iron formation variable from magnetite to hematite rich; individual bands within iron formation locally <1mm wide: chert horizons typically interbedded with black magnetite to bright red hematite; locally these bands are up to several cm thick: Graphite horizons dark black with up to 10% rounded to oval po-py bands up to 1cm in thickness; total sulfides range from <5-20% within individual graphite-rich shale horizons. Unit composed of banded iron formation except at the following intersections: 254-257: chert with interbanded po-py ovoids 258-259: graphite-rich shale 278-282: graphite-rich shale with 10-15% sulfides 324-325: graphite-rich shale with 10-15% sulfides; shear zone at 325' 332-333: graphite-rich shale with 10-15% sulfides 335-337: graphite-rich shale with 10-15% sulfides 391-397: graphite rich shale with up to 25% sulfides 410-413: graphite-rich shale with tr-5% sulfides	254	257	CHLORITE Dark green chlorite associated with py-po vein	254-257: <5-20% py
			257	324	LEAST ALTERED	
			324	325	CHLORITE Very fine grained dark green chlorite in graphite-rich matrix associated with sulfides	
			325	410	LEAST ALTERED	
			410	413	CHLORITE Chlorite associated with graphite-rich shale	
			413	415	LEAST ALTERED	
			415	417	CHLORITE Dark green chlorite in bands up to 2cm wide (10-20% overall) associated with banded iron formation	
			417	444	LEAST ALTERED	
444	448	DIABASE DIKE	444	448	LEAST ALTERED	
448	720	BANDED OXIDE FACIES IRON FORMATION Banded magnetite – black chert iron formation; magnetite bands <1mm-1cm thick; chert, rhythmically banded at 1mm-1cm; oxidized at 448-449'. Condensed core 490-720'	448	720	MINOR CHLORITE Local dark green chlorite associated with magnetite horizons	455-456: up to 10% py along fracture Local py along banding up to 1%
720		END OF HOLE	720		END OF HOLE	

	DDH: RZ-1 TOTAL DEPTH: 454 feet T: 63 R: 12 S: 30	<u>PROJECT 326</u> COMPANY: Whiteside AZIMUTH: 295 COLLAR DIP: -45° NAD27UTME: 580707 UTMN: 5306183 NAD83UTME: 580722 UTMN: 5306383

LOGGED BY: G. HUDAK
UNIVERSITY OF MINNESOTA – DULUTH

DATE CORE LOGGED: 4-15-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	15	OVERBURDEN	0	15	OVERBURDEN	
15	35	FELSITE (?) DIKE Pale pink to pinkish grey, aphanitic	15	26	LEAST ALTERED	15-35: tr-2% <1-2mm disseminated py cubes
			26	35	SERICITE Up to 5% mustard yellow very fine grained sericite ± carbonate in patches up to several cm in diamter; loally associated with increases in sulfides	
35	37	QUARTZ VEIN	35	37	LEAST ALTERED 3% 1-5mm quartz + chlorite ± carbonate veins	
37	52	HORNBLENDE-BIOTITE SYENITE PORPHYRY Pink to pinkish grey, K-spar-rich (20-30%) and plagioclase (grey, 15-20%) in biotite-hornblende groundmass	37	47	SERICITE Pale yellowish tan matrix with 5-10% <1-4mm patches of yellow tan sericite ± carbonate; pale green epidote up to 5%	Tr-1% very fine grained disseminated pyrite
			47	52	LEAST ALTERED Up to 5% yellowish tan sericite present	
52	58	FELSITE (?) DIKE Same as 15-35	52	58	SERICITE Same as 37-47	1-2% 1-3mm disseminated py cubes
58	81	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52: variable alteration yields variable color from fresh pinkish grey to altered tan to pink	58	63	MINOR SERICITE Relatively unaltered with up to 7% <1-3mm tannish yellow sericite patches; local alteration of ferromagnesian minerals to biotite ± sericite	Tr-1% disseminated <1mm py cubes
			63	81	SERICITE + CARBONATE Strongly altered; pale pink to tan with 10-15% interstitial sericite ± carbonate	
81	84	QUARTZ VEIN	81	84	CHLORITE VEINS Chlorite present on fractures	Nil
84	96	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 58-81	84	96	SERICITE + CARBONATE Same as 63-81	Local py-sericite-chlorite veins up to 2cm wide containing py 10-15%
96	101	FELSITE (?) DIKE	96	101	HEMATIZATION (?) + MINOR EPIDOTE Maroon red oxidized groundmass with 2-3% <1mm pale green epidotized plagioclase	Nil
101	113	HORNBLENDE-BIOTITE SYENITE PORPHYRY	101	113	CHLORITE	Local py-sericite-chlorite

		Same as 58-81: variable altered with zones varying from pink to medium green - gry			Increased abundance of chlorite ± sulfides with depth; chlorite variable from 5-10%, concentrated along fractures and in veins associated with sulfides	veins up to 2cm wide containing py 10-15%
113	124	DIABASE DIKE (?) Altered and locally sulfide rich dark green grey to maroon aphanitic diablase dike; rare 3-5mm oval quartz amygdules present	113	124	HEMATIZATION Hematized to maroon color with associated biotite ± chlorite	Veinlets up to 1cm wide associated with coarse (up to 4mm diameter) py cubes, <5-15%
124	139	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	124	139	LEAST ALTERED	<1% sulfides
139	140	QUARTZ VEIN	139	140	LEAST ALTERED	Nil
140	150	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	140	142	LEAST ALTERED	142-150: tr-1% disseminated <1mm py
			142	150	SERICITE + CARBONATE Same as 63-81; tr-2% 1-4mm biotite locally present	
150	152	QUARTZ VEIN	150	152	CARBONATE Pink calcite 1-3%	Nil
152	169	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	152	156	SERICITE + CARBONATE Same as 142-150	tr-1% disseminated <1mm py
			156	169	LEAST ALTERED	
169	173	FELSITE (?) DIKE	169	173	LEAST ALTERED	Tr-1% <1-3mm disseminated py
173	177	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	173	177	LEAST ALTERED	Same as 152-169
177	179	QUARTZ VEIN	177	179	CARBONATE Up to 5% veins of pink carbonate	Tr-1% py up to 3mm in diameter
179	186	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	179	186	LEAST ALTERED	Tr. Disseminated <1mm py
186	189	FELSITE (?) DIKE	186	189	LEAST ALTERED	Same as 169-173
189	233	HORNBLENDE-BIOTITE SYENITE PORPHYRY Pale pink to pinkish black feldspar porphyry with 50-60% 3-8mm pink to grey tabular feldspar in very fine grained hornblende ± biotite groundmass	189	233	LEAST ALTERED	Tr-1% <1mm disseminated py cubes
233	237	QUARTZ – CARBONATE VEIN	233	237	LEAST ALTERED	
237	247	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 189-233	237	247	LEAST ALTERED	
247	251	FELSITE (?) DIKE	247	251	LEAST ALTERED	
251	271	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	251	271	LEAST ALTERED	
271	272	FELSITE (?) DIKE	271	272	LEAST ALTERED	
272	277	HORNBLENDE-BIOTITE SYENITE PORPHYRY	272	277	LEAST ALTERED	

		Same as 37-52				
277	279	QUARTZ VEIN	277	279	LEAST ALTERED	
279	296	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	279	296	LEAST ALTERED	
296	298	FELSITE (?) DIKE	296	298	LEAST ALTERED	
298	300	HORNBLENDE-BIOTITE SYENITE PORPHYRY Same as 37-52	298	300	LEAST ALTERED	
300	320	FELSITE (?) DIKE	300	320	LEAST ALTERED	
320	454	HORNBLENDE-BIOTITE SYENITE PORPHYRY Pale pink to pinkish tan with 30-40% 3-8mm pink to grey subhedral to euhedral tabular feldspar phenocrysts; up to 5% 1-4mm biotite; at 335', chlorite on fracture may be indicative of small shear zone	320 324 339	324 339 454	LEAST ALTERED SERICITE Pale pink to tan containing 5-10% sericite/white mica; ferromagnesian minerals present in unaltered rocks are completely destroyed here; LEAST ALTERED Relatively unaltered with chlorite common on fractures	
454		END OF HOLE	454		END OF HOLE	

	DDH: RZ-3 TOTAL DEPTH: 452 feet T: 63 R: 12 S: 30	PROJECT 326 COMPANY: Whiteside AZIMUTH: 295 COLLAR DIP: -45° NAD27 UTME: 580732 UTMN: 5306258 NAD83 UTME: 580746 UTMN: 5306745	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-16-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	8	OVERBURDEN	0	8	OVERBURDEN	
8	65	BASALT LAVA FLOWS Massive, very fine grained aphyric basalt; possible fault zone at 44-45.	8	44	CHLORITE + EPIDOTE + HEMATITE Chlorite-rich groundmass with 5-8% veins and patches of epidote; very fine grained groundmass stained to a maroon color due to presence of very fine grained hematite	Tr. – 1% disseminated to vein py locally present
			44	45	QUARTZ + EPIDOTE Massive tan to greenish mix of ep + qtz, minor chlorite	
			45	65	EPIDOTE + QUARTZ + CHLORITE Pale grey green, very fine grained matrix with 5% <1mm chlorite; rock stained pale pink locally due to very fine grained hematite; very fine grained pale green epidote disseminated in groundmass; minor silicification	
65	67	FELSITE DIKE Pale pink to tan, homogenous	65	67	CHLORITE Chlorite present on fractured surfaces	Tr.-2% disseminated 1-2mm py
67	121	BASALT LAVA FLOWS Same as 8-65; locally 1-2% quartz amygdules present 91-92: quartz vein	67	74	EPIDOTE + QUARTZ + CHLORITE Plae green-grey very fine grained epidote groundmass; faint to strong foliation defined by 5-10% 1mm wide chlorite lenses/veins	67-85: tr 1mmpy 85-91: 2-5% disseminated to veins (up to 1cm wide) of py; py associated with yellowish-tan carbonate + quartz veins 92-110: tr-1% <1mm disseminated py 110-111: 2% disseminated py 111-116: tr L<1mm py 116-117: 2% 1mm disseminated py 117-121: 1-2% 1mm disseminated py
			74	85	CHLORITE + EPIDOTE Medium to dark green very fine grained chlorite-rich matrix with veins up to 1cm wide of mixed chlorite/epidote ± carbonate (ankerite?)	
			85	91	EPIDOTE +QUARTZ + CHLORITE Same as 74-85	
			91	92	QUARTZ VEIN	
			92	101	CHLORITE + EPIDOTE	

			101	104	EPIDOTE + QUARTZ + CHLORITE Same as 67-74	
			104	110	CHLORITE + EPIDOTE Same as 74-85	
			110	111	EPIDOTE + QUARTZ + CHLORITE Same as 67-74	
			111	115	CHLORITE + EPIDOTE Same as 74-85	
			115	116	EPIDOTE + QUARTZ + CHLORITE Same as 67-74	
			116	121	CHLORITE + EPIDOTE + HEMATITE Same as 8-44.	
121	123	SYENITE/MONZONITE PORPHYRY Same as present in diamond drill hole RZ-1	121	123	MINOR SERICITE 3-5% fine grained sericite	
123	135	FELSITE DIKE (?) Same as above	123	135	LEAST ALTERED Up to 5% <1-5mm quartz ± carbonate veins cutting pink fine grained least altered dike; chlorite up to 3% on fractures	
135	140	SYENITE/MONZONITE PORPHYRY Same as present in diamond drill hole RZ-1	135	140	EPIDOTE Pale green epidote alteration on ferromagnesian minerals, up to 10%; sericite 5-10%	
140	147	FELSITE DIKE (?) Same as above	140	147	LEAST ALTERED Same as 123-135	
147	174	SYENITE/MONZONITE PORPHYRY Same as present in diamond drill hole RZ-1	147	157	EPIDOTE Pale green epidote alteration on ferromagnesian minerals is incomplete to complete; epidote 5-12%	
			157	164	LEAST ALTERED	
			164	174	EPIDOTE + SERICITE Increasing epidote + sericite alteration with depth; epidote up to 10%, sericite ranges from 10-15%	
174	404	BALSALT LAVA FLOWS Very fine grained, massive basalt; local zones with 1-	174	180	EPIDOTE + QUARTZ + CHLORITE Same as 67-74	

		2% 2-4mm oval quartz amygdules may define flow contacts	180	305	CHLORITE + EPIDOTE Very fine grained medium to dark green chlorite-rich matrix with up to 5% patchy to disseminated pale green epidote; at 250-260, up to 5% hematite gives rock maroon color	
			305	337	CHLORITE+QUARTZ+EPIDOTE+HEMATITE Fine grained groundmass pale green grey in color; chlorite 1-4mm, and in patches, 10-15%; local maroon bands with up to 5% hematite up to several cm wide	
			337	351	CHLORITE + HEMATITE Dominantly dark green very fine grained chlorite-rich groundmass locally cut by veins up to several cm wide of 5-10% very fine grained hematite	
			351	372	CHLORITE + EPIDOTE Dominantly dark green very fine grained chlorite in grey to pink siliceous or carbonate-rich groundmass; local epidote-rich veins present.	
			372	374	BANDED EPIDOTE + CHLORITE Pale green to greenish tan bands of epidote with <1mm veins of chlorite	
			374	404	CHLORITE+QUARTZ+EPIDOTE+HEMATITE Similar to 305-322; hematite <3%	
404	415	SYENITE/MONZONITE PORPHYRY Same as present in diamond drill hole RZ-1	404	415	EPIDOTE ± CHLORITE Variable from unaltered ferromagnesian minerals to epidote – chlorite ± sericite of ferromagnesian minerals, 10-15%	
415	422	FELSITE DIKE Same as above	415	422	LEAST ALTERED	
422	427	SYENITE/MONZONITE PORPHYRY Same as present in diamond drill hole RZ-1	422	427	EPIDOTE ± CHLORITE Same as 404-415	
427	449	BASALT LAVA FLOWS Very fine grained chlorite-rich matrix	427	449	PATCHY EPIDOTE 5-10% veins/patches of epidote	
449	450	FELSITE DIKE Same as above	449	450	LEAST ALTERED	

450	452	BASALT LAVAS Same as 427-449	450	452	PATCHY EPIDOTE Same as 427-449	
452		END OF HOLE	452		END OF HOLE	

	DDH: SP-90-1 TOTAL DEPTH: 583 feet T: 63 R: 12 S: 22	**PROJECT 326** COMPANY: BHP - Utah AZIMUTH: 335 COLLAR DIP: -54° NAD27 UTME: 586000 UTMN: 5308002 NAD83 UTME: 585984 UTMN: 5208213			LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-21-98	

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	116	OVERBURDEN	0	116	OVERBURDEN	
116	187	GRAPHITE-RICH SHALE/ARGILLITE Pale to dark grey, finely laminated (<1-2mm); locally kink-banded and isoclinally folded; overall, rock finely laminated and intensely folded, indicative of extreme deformation and intense shearing 136-136.5: quartz vein, fault? 166-168: broken core, possible fault? 177-177.5: quartz-carbonate vein, fault?	116	134	QUARTZ + CARBONATE Tr-2% quartz-carbonate in very fine grained thin lamellae	116-134: <1-4mm euhedral py, 2-3% 138-187: tr-3% <1-4mm subhedral to euhedral py
			134	138	SERICITE + QUARTZ + CARBONATE Similar to above; tannish color due to 15-20% sericite	
			138	187	QUARTZ + CARBONATE Same as 116-134; relatively unaltered with 5-8% greenish tan sericite lamellae	
187	198	TUFFACEOUS SILTSTONE Pale grey, very fine grained, ash/silt matrixl non graded; quartz vein marks lowermost contact	187	198	CHLORITE + SERICITE Pale green grey very fine grained mix of chlorite and sericite	
198	211	HIGHLY DEFORMED ARGILLITE Highly contorted, well laminated argillite; locally brittle deformation is present; many microshears and microfaults also present; <1-3mm wide graphite-rich lamellae	198	211	QUARTZ + CARBONATE VEINS 5-10% quartz ± carbonate veins up to several cm wide; patchy disseminated ankerite, 5-15%; reddish brown hematite stains locally present on core	
211	233	LAMINATED GRAPHITIC/SILICEOUS ARGILLITE <1-10mm wide alternating graphite-rich and siliceous silty horizonsl moderately to strongly shearedl locally isoclinally folded 226-229: strong shearing with 10% late quartz-carbonate veins; deformation increases substantially toward lower, gradational contact	211	233	QUARTZ + CARBONATE VEINS Quartz-carbonate veins vary from <5-10%, 1mm-15mm in width; sericite increases to 10 % between 229-233.	
233	236	MYLONITE Pinkish-tan, with local graphite-rich lenses	233	236	SERICITE + CARBONATE + FUCHSITE Carbonate 5-105, sericite 10-15%, hematite up to 5%, fuchsite tr-2%	
236	240	FAULT ZONE 10-15% 1-10mm quartz-carbonate veins in graphite-rich matrix	236	240	GRAPHITIC PSEUDOTACHYLITE Graphite locally highly polished and psuedotachylitic	
240	241	MYLONITE	240	241	SERICITE + CARBONATE + FUCHSITE	

		Same as 233-236			Same as 233-236	
241	273	SHEARED ARGILLITE / GREYWACKE Medium grey to black, finely laminated argillite with 3-5% lens-shaped graphite-rich fragments up to 2cm longl appears to be strongly sheared greywacke with deformed graphite-rich fragments;may also represent sheared fault breccia composed of sheared and broken graphite-rich argillite and shale lenses	241	273	QUARTZ+ANKERITE VEINS Quartz veins up to 1cm wide, 5%; reddish brown ankerite associated with quartz veins and locally as 1-2mm disseminate porphyroblasts in sheared matrix, 5-8%; local hematite stains adjacent to quartz-carbonate veins at 267-267.5'; trace fuchsite locally present	241-273: tr disseminated py
273	300	SHEARED CONGLOMERATE Light tan sericitic and black graphite-rich banded argillaceous matrix with 5-30% lens-shaped lapilli-sized fragments including: a) white quartz ± carbonate fragments (10%); b) tan siltstone (5-10%); c) black argillite (5-10%); fragments increase in size and abundance from 273-290'; below 290', very strongly sheared	273	300	SERICITE ± ANKERITE Tan sericite 15-20% as alternating lenses with 1-5mm thick graphite-rich lensesl disseminated to patchy ankerite up to 5%;	273-284: 1-3% disseminated py 284-285: 5-10% py 285-297: 1-3% disseminated py 297-298: 10-15% py 298-300: 1-3% py
300	310	SHEARED ARGILLITE / GREYWACKE Similar to 241-273; <1mm laminae strongly sheared and folded	300	310	SERICITE ± ANKERITE Sericite / carbonate 25-35%; graphite 25-40%; up to 5% quartz ± carbonate veins, up to 1cm wide	
310	340	QUARTZ-SERICITE-ANKERITE SCHIST Tan, well foliated; individual lamellae 1-5mm thick; alternating sericite-rich and grey siliceous layers; local quartz veins up to 1cm wide, sub parallel to foliation; intensely sheared and locally folded; quartz veins locally boudinaged	310	340	SERICITE ± ANKERITE Quartz 50%; sericite 40-45%; local <1-2mm ankerite porphyroblasts, up to 5%	
340	341	QUARTZ-SERICITE-CHLORITE SCHIST	340	341	SERICITE + CHLORITE Possible fault zone	
341	364	QUARTZ-SERICITE-ANKERITE SCHIST Similar to above; chlorite lenses 5-10%; rock is darker green than above	341	364	SERICITE + CHLORITE ± ANKERITE Qyartz 50%; sericite 30-40%; chlorite 5-10%; local ankerite porphyroblasts 2-10%, up to 4mm in diameter.	Tr-1% py; 2-5% py at 349-351
364	365	QUARTZ VEIN	364	365	QUARTZ VEIN	
365	403	QUARTZ-SERICITE-ANKERITE SCHIST Tan to greenish-tan very fine-grained sericite-quartz-chlorite matrix; well foliated, strongly sheared; local almond-shaped quartz boudins up to 5mm long, 1-2%; shearing increases in intensity from 398-403.	365 378	378 403	SERICITE + CHLORITE ± ANKERITE Same as 341-364 SERICITE + CHLORITE ± ANKERITE Quartz 50%, sericite 20-30%, chlorite 10-15%; <1-3mm ankerite porphyroblasts 5-10%	Tr-1% disseminated py
403	404	QUARTZ VEIN	403	404	QURTZ VEIN	
404	441	QUARTZ-SERICITE-CHLORITE-ANKERITE SCHIST Same as 365-403: loal quartz-rich clasts 1-2cm in diameter, 415-417'; gradational lower contact; locally folded and strongly sheared	404	406	SERICITE + CHLORITE ± ANKERITE Similar to above with 30-40% <1-5mm lens-shaped ankerite porphyroblasts	Tr-1% py; 3% py at 319-321

			406 412 423	412 423 441	SERICITE + CHLORITE ± ANKERITE Quartz 50%, sericite 30%, chlorite 10%; <1-3mm ankerite <5-10% SERICITE + CHLORITE Yellow tan sericite schist with 5% dark green to black chlorite ± graphite lenses up to 5mm long	
441	475	QUARTZ-SERICITE-CHLORITE-GRAPHITE SCHIST Similar to above; 5-10% dark green to black chlorite ± graphite; sheared, sericitized argillite; kink bands locally present; gradational lower contact	441 455	455 475	CHLORITE + SERICITE Chlorite 10-12%; sericite 30% CHLORITE + SERICITE + ANKERITE Similar to 441-455; 3-10% <1-5mm rhomb shaped ankerite porphyroblasts	
475	478	QUARTZ-SERICITE SCHIST	475	478	QUARTZ + SERICITE	
478	493	QUARTZ-SERICITE-ANKERITE SCHIST Moderately to well foliated	478	493	SERICITE + ANKERITE 10-35% 1-4mm ovoid to rhomb-shaped orange to red-brown ankerite porphyroblasts in sericite-rich matrix	Tr-1% disseminated py
493	523	QUARTZ-SERICITE ± ANKERITE SCHIST Fine grained, moderately foliated; <1-1mm quartz grains suggest greywacke or silty sandstone protolith	493	523	SERICITE + ANKERITE ± CHLORITE Quartz 40-50%; sericite 30-35%; ankerite 5-10%, 1-2mm disseminated porphyroblasts; chlorite <5%; trace pale green mica	
523	526	SERICITE – FUCHSITE SCHIST	523	526	SERICITE + FUCHSITE Sericite 30% with 1-3% disseminated 1-4mm fuchsite	
526	529	QUARTZ-SERICITE-ANKERITE SCHIST	526	529	SERICITE + ANKERITE ± CHLORITE	
529	533	QUARTZ-SERICITE-CHLORITE SCHIST Local pure quartz boudins present	529	533	CHLORITE + SERICITE Chlorite 10-12%; sericite 10-40%; quartz up to 50%;	
533	535	SERICITE-ANKERITE SCHIST Sheared argillite?	533	535	SERICITE + ANKERITE Ankerite 1-3mm, 10-15% in sericite-rich matrix	Local 1-2cm lens with 5-10% oy
535	571	SERICITE-CHLORITE-ANKERITE SCHIST Finely banded/laminated tan to dark grey; moderately well foliated with local box and chevron folds present	535 541 543 558	541 543 558 562	CHLORITE + SERICITE Chlorite 10-15% in sericite-rich matrix CHLORITE + SERICITE + ANKERITE 5% 1-4mm ankerite porphyroblasts SERICITE + CHLORITE Chlorite 20-30%; sericite 25-40% CHLORITE + SERICITE ± FUCHSITE Chorite 20-30%; sericite 30-50%; 5-10% disseminated <1mm ankerite; trace pale green	541: massive py band is 5 cm wide 555-557:2-5% disseminated to patchy py; locally up to 30%

			562	571	fuchsite SERICITE+CHLORITE Sericite schist with up to 5% dark green chlorite veins/bands up to 5mm wide	
571	583	DEFORMED SERICITE-CHLORITE-ANKERITE SCHIST Contorted,sheared, and faulted chlorite-sericite±carbonate bands; quartz veins and oval boudins up to 1cm wide, 5-10%	571	583	SERICITE + CHLORITE + ANKERITE Chlorite 5-15%; sericite 25-35%; ankerite 5-10%	Tr-2% disseminated py
583		END OF HOLE	583		END OF HOLE	

	DDH: 23-3 TOTAL DEPTH: 583 feet T: 63 R: 12 S: 23	PROJECT 326 COMPANY: Kerr - McGee AZIMUTH: 330 COLLAR DIP: -45° NAD27 UTME: 587165 UTMN: 5308665 NAD83 UTME: 587152 UTMN: 5308873	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-21-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	8	OVERBURDEN	0	8	OVERBURDEN	
8	187	MASSIVE/AMYGDALOIDAL BASALT LAVA FLOWS Tan to dark green, massive to amygdaloidal basalt lava flows; variably deformed from strongly sheared to mylonitized; late faults illustrate brittle deformation 8-83: strongly sheared, well foliated basalt; local lens-shaped with to grey quartz augen present, up to 5%; white to light grey quartz veins sheared parallel to the foliation and locally boudinaged; 1-5mm quartz augen at 30-35' are amygdules (3%) 83-84: broken core = fault zone 84-138: mylonitized basalt; dark green and brownish tan laminae, <1-3mm wide; laminae locally kink banded and isoclinally folded; quartz amygdules up to 1cm long, <2mm wide 138-140: broken core with 5-10% blocky light grey siliceous fragments; possible fault zone 140-145: strongly mylonitized basalt; <1-2mm laminae kink banded and isoclinally folded. 145-148: fault zone composed of broken, angular, siliceous fragments within mylonitized basalt 148-177: same as 140-145 177-180: broken core = fault 180-184: same as 148-177 184-188: broken core; possible fault	8	20	CHIORITE ± SERICITE Weathered quartz-chlorite-sericite schist, now friable reddish-brown clay	8-30: TR-2% PY 30-31: quartz vein with 5-10% py 31-63: 1-2% disseminated py, olocally parallel to foliation 63-64:3-5% py parallel to foliation 64-83: tr-2% py 84-87: tr-1% py, but 5% py at 85-86 87-140: tr-1% disseminated py 140-143: 3-5% <1-2mm py 143-186: tr-2% disseminated py 186-188: tr-nil py
			20	30	SERICITE-ANKERITE-CHLORITE Weathered, pale green to red brown, sericite 10-15%, chlorite 15-10%, ankerite 10-15%	
			30	83	CHLORITE – SERICITE Chlorite 30-40%, sericite 5-15%; banded dark green to tan; tr-3% <1mm reddish-brown ankerite	
			83	84	WEATHERED CHLORITE – SERICITE Now composed of friable pale green clays	
			84	87	CHLORITE-SERICITE-ANKERITE Pale green to green chlorite (20-30%), sericite (20-30%) with 5-15% <1-3mm pale red brown to tan ankerite	
			87	101	FUCHSITE-CHLORITE-SERICITE Bright green very fine grained fuchsite 5-10% associated with dark green chlorite (10-30%) and tan sericite (10-15%); 5-8% <1-3mm ankerite patches; fuchsite most common 90-99'.	
			101	136	CHLORITE – SERICITE ± ANKERITE Well sheared, well laminated chlorite (25-40%), sericite (10-25%) and ankerite (up to 10%); local quartz veins up to 1cm wide are contorted and strongly folded	
			136	138	SERICITE – ANKERITE Sericite 30-60%; tan ankerite 10-15%	

			138	153	CHLORITE - SERICITE ± ANKERITE Similar to 101-136; patchy tan to red brown ankerite, up to 2mm in diameter, lens-shaped, 3-7%	
			153	155	SERICITE –CHLORITE - ANKERITE Sericite 35-55%, chlorite 10%, 5-10% <1mm ankerite	
			155	187	CHLORITE – SERICITE ± ANKERITE Same as 138-153	
			187	188	CHLORITE – SERICITE BROKEN CORE Sericite-rich (30-50%) with 20-40% chlorite	
188	250	LAMINATED GRAPHITIC ARGILLITE 1mm-1cm well laminated, strongly deformed; variable from black (graphite-rich) to greenish tan (altered to sericite); pale grey siliceous horizons and lenses suggest initial graphite shale and interbedded chert or greywacke horizons: local blocky fragments up to 1cm in diameter suggest local brittle deformation	188	198	SERICITE + ANKERITE Greenish-tan sericite (25-35%) with <1mm yellow to yellow-brown ankerite porphyroblasts	188-250: tr-1% disseminated py
			198	201	GRAPHITE Graphite-rich horizon	
			201	206	SERICITE + ANKERITE + GRAPHITE Interbedded to patchy sericite (30-50%) associated with ankerite and/or graphite	
			206	235	CHLORITE+SERICITE+ANKERITE+GRAPHITE Locally highly contorted, strongly foliated graphite ± chlorite (30-40%), sericite (10-20%), ankerite and/or leucoxene (3-10%)	
			235	238	CHLORITE+SERICITE+ANKERITE+GRAPHITE Same as above; 10-15% mustard yellow 1-7mm wide ankerite ± leucoxene veins	
			238	250	CHLORITE+SERICITE+ANKERITE+GRAPHITE Same as 206-235	
250	267	GRAPHITIC SHALE / SHEAR ZONE Black, highly broken, highly foliated; local foliation planes contain psuedotachylite; <1mm wide slickensides present	250	258	ANKERITE 1-3% <1-2mm ankerite	
			258	260	ANKERITE + HEMATITE Mustard yellow ankerite and red hematite stained quartz vein or chert	

			260	267	ANKERITE Same as 250-258	
267	318	LAMINATED GRAPHITIC ARGILLITE Similar to 188-250, but not as extensively deformed; intensity of foliation decreases with depth; 1mm-1cm wide interbanded graphite horizons and yellowish-brown, sericite-carbonate-rich greywacke-siltstone deposits up to 1' thick Quartz veins at 276-278 and 292-295 may mark fault zones 295-318: well banded chert horizons and graphite horizons 1-10mm wide, locally microfaulted, isoclinally folded	267	276	SERICITE + GRAPHITE Graphite 30-35%; sericite 25-35%; <5% disseminated <1mm ankerite	
			276	278	QUARTZ VEIN	
			278	280	SERICITE + CARBONATE Mustard yellow sericite-carbonate matrix	
			280	292	SERICITE + GRAPHITE Same as 267-276	
			292	295	QUARTZ VEIN	
			295	318	SERICITE + GRAPHITE Interbanded graphite-sericite-quartz; graphite/chlorite increases toward base of unit from 20-40%	
318	343	SHEARED ARGILLITE / GREYWACKE Similar to SP-90-1, 241-273'; green grey, very fine grained matrix with 3-4% <1mm quartz grains and 1-5% elongate to sheared black graphite-rich fragments, up to 2cm long	318	343	SERICITE + CHLORITE Green-grey sericite-rich matrix (20-30%) with 5-10% dark green to black chlorite and/or graphite	
343	461	INTERBEDDED ARGILLITE / GREYWACKE Dark green to black, well laminated and sheared argillite interbedded with greywacke deposits containing 3-5% 2-10mm felsic clasts and 5-10% lens-shaped and sheared black argillite fragments with aspect ratios 5:1 to 10:1 450-461: rock increasingly deformed with contorted banding and local brecciation with depth.	343	448	SERICITE Yellowish-green finely disseminated to banded sericite, 10-20%, in chlorite-graphite-rich argillite	343-461: tr.py locallly
			448	461	CARBONATE + SERICITE Yellow brown carbonate up to 20% in sericite (20-30%) – chlorite (0-15%) rich matrix; local quartz veins up to 1cm wide.	
461	466	BROKEN CORE Fault zone	461	466	CHLORITE + ANKERITE Chlorite-rich broken core with 1-3% 1-2mm ankerite porphyroblasts	
466	508	SHEARED/MYLONITIZED ARGILLITE Highly deformed, well banded grenn to yellow green, highly folded and locally microfaulted 496-500: <1mm-15mm white quartz veins, contorted	466	470	CHLORITE + SERICITE Chlorite-sericite schist with 20-30% chlorite	
			470	476	SERICITE Sericite schist with 30-40% sericite	
			476	483	CHLORITE + SERICITE	

					Same as 466-470	
			483	493	CHLORITE + SERICITE + ANKERITE Pale green to mustard uellow, <1-10 mm veins and bands of chlorite (20-30%), sericite (20-25%),and yellow-brown ankerite (20-30%); local quartz veins present	
			493	508	CHLORITE + SERICITE + ANKERITE Chlorite up to 40%; sericite 30%; ankerite up to 10%	
508	583	MYLONITIZED/SHEARED BASALT Dark green to green-grey, massive very fine grained groundmass 508-540: 5% 2mm-10mm white contorted quartz veins 540-583: massive, local 1-3mm microfractures present.	508 532	532 583	CHLORITE + SERICITE Chlorite 40%, sericite 5-10% CHLORITE + EPIDOTE Massive to schistose chlorite 10-30%: very fine grained pale green epidote-rich groundmass.	Tr-2% disseminated py
583		END OF HOLE	583		END OF HOLE	

	DDH: 23-6 TOTAL DEPTH: 571 feet T: 63 R: 12 S: 23	**PROJECT 326** COMPANY: Kerr - McGee AZIMUTH: 150 COLLAR DIP: -51° NAD27 UTME: 587102 UTMN: 5308658 NAD83 UTME: 587089 UTMN: 5308866	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-23-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	3	OVERBURDEN	0	3	OVERBURDEN	
3	315	SHEARED/MYLONITIZED BASALT LAVA FLOWS Variably altered massive to amygdaloidal basalt lava flows. 3-85: variably altered, dark green to tan massive to amygdaloidal basalt lava flows; strongly sheared and mylonitized with 1-3% 2mm-20mm quartz ± carbonate lens-shaped augen; 5% contorted quartz – carbonate veins. 85-157: variably altered amygdaloidal basalt protolith with 2-5% grey to white oval to lens-shaped 2-15mm shared amygdules 157-235: strongly sheared massive basalt; fine lamellae <5mm wide; 1-2% quartz – carbonate veins 235-236: quartz-carbonate veins; augen within quartz vein suggest post-quartz vein shearing 236-315: strongly sheared, variably altered basalt, similar to 157-235; local tr. – 1% 1-3mm grey to oval lens-shaped amygdules; 2-3% 3-6mm lens-shaped, sheared amygdules at lowermost contact.	3	92	CHLORITE + SERICITE ± FUCHSITE Dark to light green banded chlorite + sericite ± fuchsite schist; chlorite 50-70%; sericite 5-15%; fuchsite tr-2%; gradational lower contact	Py generally tr-1%, disseminated; locally 3-5% py in thin 1-15mm wide veins alligned parallel to foliation
			92	119	CHLORITE + SERICITE Tan to pale green with sub-equal amounts of chlorite and sericite; chlorite 20-40%, sericite 25-40%;green chlorite bands intermixed with pale greenish tan sericite-rich bands; banding variable from 1-10mm in width; banding at 40° to core axis;	92-119: local quartz augen with 3-5% <1mm disseminated to patchy py
			119	124	SERICITE Sericite schist; pale greenish-tan color; 50-75% sericite with <10% chlorite	
			124	126	CHLORITE + SERICITE Chlorite-sericite schist; 40-60% chlorite, 25-35% sericite.	
			126	133	SERICITE Same as 119-124'	
			133	135	CHLORITE + SERICITE Same as 124-126'.	
			135	142	SERICITE Sericite schist; 50-70% sericite with up to 10% 1-3mm wide chlorite bands/veins; gradational lower contact	
			142	234	CHLORITE+SERICITE+ANKERITE ± FUCHSITE Schistose; medium to pale green chlorite-sericite groundmass with 5-15% <1-3mm ankerite	

			234	271	porphyroblasts and lenses; blue-green fuchsite associated with carbonate-sericite-chlorite-pyrite at 152-156'; overall chlorite 30-50%, sericite 10-25%	
			271	293	CHLORITE + SERICITE + ANKERITE Dark green chlorite 35-60%; sericite 10%; ankerite porphyroblasts and lenses 1-5mm, 5-15%; gradational lower contact	
			293	298	CHLORITE + SERICITE + ANKERITE Simialr to 142-234: light greenish-tan color; 20-30% sericite, 30-50% chlorite, 5-12% disseminated ankerite.	
			298	302	CHLORITE + SERICITE + ANKERITE Dark green to pale green chlorite-rich (30-50%) groundmass; sericite 10-20%; 10-20% 1-6mm brownish red ankerite porphyroblasts, typically lens-shaped to ovoid.	
			302	309	SERICITE + ANKERITE Pale tan to greenish tan sericite (30-50%); ankerite 10-15%; chlorite <10%.	
			309	315	CHLORITE + SERICITE + ANKERITE Same as 293-298	
					CHLORITE + SERICITE + ANKERITE Banded, simialr to 271-293; chlorite 20-30%, sericite 10-15%, ankerite (diseeminated, 1-3mm porphyroblasts) 5-10%; up to 40% sericite at 312-316'	
315	350	VOLCANICLASTIC SEDIMENTS Tan to brownish red to pale green variably altered silty sandstone with 1-4% <1-1.5mm blocky to subrounded quartz grains; strongly sheared, with foliation at 40° to core axis; both S and Z fold presnt; local isoclinal folding of foliation; fault contact at 350'; rock may represent reworked felsic tuff	316	325	SERICITE + ANKERITE + CHLORITE Sericite 30-50%; ankerite 10-15%; chlorite 5-15%; pale blue-green color may indicate presence of very fine grained fuchsite.	
			325	350	CHLORITE + SERICITE + ANKERITE Similar to above with 15-25%chlorite, 20-30% sericite, 5-15% ankerite porphyroblasts and lenses	
350	351	FAULT ZONE Strongly sheared and broken core	350	351	FAULT ZONE Strongly sheared and broken core	

351	370	SHEARED/MYLONITIZED BASALT LAVA FLOWS Dark green to tan, variably altered, well foliated, kink banded and microfaulted; lamellae 1-5mm thick; quartz-carbonate veins 2-5%, commonly present within kink banded hinges	351	363	CHLORITE + ANKERITE Schistose; darke green chlorite 30-60% with 5-10% <1-3mm disseminated ankerite porphyroblasts; <10% sericite	
			363	370	SERICITE + CHLORITE + ANKERITE Sericite 30-35%; chlorite 30%; ankerite 10-15%.	
370	372	BROKEN CORE Broken core with quartz veins may represent fault zone	370	372	BROKEN CORE	
372	464	SHEARED/MYLONITIZED BASALT LAVA FLOWS Variably altered, dark green to tan, massive; fine foliation commonly kink banded and strongly folded; 1-4% 3-10mm quartz-carbonate veins present; at 405-407', quartz-carbonate vein may represent fault zone.	366	385	CHLORITE + SERICITE + ANKERITE Schistose; same as 325-350'; ankerite <1-4mm, 10-20%	463-464: 10% pyrite in bands/veins up to 1cm wide.
			385	415	SERICITE + ANKERITE ± CHLORITE Schistose; pale green to tan, sericite-rich (30-60%) with local bands up to 10cm wide with 10-20%1-5mm brownish-red ankerite porphyroblasts; chlorite typically occurs in veins that are up to 20 mm in width, typically <10%	
			415	435	CHLORITE + ANKERITE + SERICITE Schistose; chlorite-rich groundmass (30-60%) with 10-20% 1-5mm ovoid to lens shaped ankerite porphyroblasts, lenses; sericite up to 20%	
			435	451	CHLORITE + SERICITE + ANKERITE Schistose; pale green chlorite (20-30%); sericite 20-30%; 15% 1-3mm disseminated ankerite porphyroblasts	
			451	456	SERICITE + ANKERITE Schistose; tan, sericite-rich (30-60%) groundmass with 10-15% disseminatd ankerite; <10% chlorite	
			456	465	CHLORITE + SERICITE + ANKERITE Same as 435-451	
464	465	QUARTZ VEIN	464	465	QUARTZ VEIN	
465	571	SHEARED/MYLONITIZED BASALT LAVA FLOWS Massive tan to pale green; variably altered; 1-3% quartz-carbonate veins locally present; 502-530: 3-7% 2-50mm white to pale grey quartz-	465	550	SERICITE + ANKERITE ± CHLORITE Tan to pale green sericite-rich groundmass(35-65%) with 5-15% 1-3mm red-brown ankerite porphyroblasts; local bands containing 10-12% chlorite, up to 10mm wide; gradational lower	
			550	560		
			560	571		

		carbonate viens; grey color may be indicative of fine kyanite within vein 565-571: 5% grey quartz veins (up to 10mm wide) and quartz-rich augen (up to 20mm in diameter)			contact CHLORITE + SERICITE + ANKERITE Medium to dark green chlorite-rich groundmass (20-30%) with 20-30% sericite and 10-15% <1-5mm anmkerite porphyroblasts SERICITE + ANKERITE ± CHLORITE Same as 466-550.	
571		END OF HOLE	571		END OF HOLE	

PROJECT 326

DDH: 6214-2-1 — **COMPANY: Kerr - McGee**
TOTAL DEPTH: 600 feet — **AZIMUTH: 340** — **COLLAR DIP: -50°**
T: 62 R: 14 S: 02 — **NAD27 UTME: 568350** — **UTME: 5303380**
NAD83 UTME: 568318 — **UTMN: 5303574**

LOGGED BY: G. HUDAK
UNIVERSITY OF MINNESOTA – DULUTH

DATE CORE LOGGED: 4-28-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	29	OVERBURDEN	0	29	OVERBURDEN	
29	285	DIABASE INTRUSION Dark green, variable from aphanitic to fine-grained phaneritic; typically contains <1-2% 1-10mm wide straight to dendritic quartz veins. 29-72: coarser grained with 1-3mm green chlorite after pyroxene. 72-75: massive 75-96: same as 29-72 96-98: same as 72-75 98-109: same as 29-72 109-111: same as 72-75 111-125: same as 29-72 125-127: same s 72-75 127-129: coarse grained green chlorite after pyroxene, 10-15% 129-200: massive, aphyric 200-214: 5-10% 1-3mm green chlorite pseudomorphs in dark green fine grained massive groundmass; rock slightly more fractured and foliated than 129-200 214-235: massive, aphyric 235-250: 2-5% 2-20mm quartz carbonate veins in moderately sheared and foliated massive diabase 250-257: same as 214-235; 257-280: rock increasingly sheared and foliated 280-285: strongly foliated, with 3-5% 1-20mm quartz veins and local tourmaline-rich veins up to 2mm wide	29	215	CHLORITE + EPIDOTE + CARBONATE Dominantly fine grained chlorite + epidote ± carbonate (<5%); groundmass epidote rich, contains 5-15% 1-4mm chlorite-rich lenses	119: quartz vein up to 1cm wide with 50% po 190-198: quartz veins with 5-20% po 270-285: 1-5% disseminated to vein-like po±py
			215	270	CHLORITE + EPIDOTE + CARBONATE Pale green fine grained groundmass with increase in epidote relative to above; 2-3% <1mm tan ankerite porphyroblasts are disseminated.	
			270	285	CHLORITE + EPIDOTE + CARBONATE Similar to above; 3-8% <1mm pale tan andhedral to subhedral, locally lens-shaped disseminated ankerite porphyroblasts; 10-20% ankerite disseminated in groundmass from 250-285'	
285	288	SHEAR ZONE Chlorite-and graphite-rich shear zone (285-286) and sheared quartz-carbonate vein; possible fault zone	285	288	SHEAR ZONE	
288	378	ALTERED AND SHEARED BASALT LAVA FLOWS Tan to yellowish tan; massive, fine-grained; moderately to strongly foliated and sheared basalt at 35° to core axis. 292: broken, sheared core with slickensides = shear	288	300	CARBONATE + CHLORITE + SERICITE Moderately to well foliated with sericite (40-65%) and 5-10% disseminated to banded chlorite; carbonate 10-15%	

		zone 308-325: strongly foliated, broken core; abundant quartz veins; possible fault zone. 358-378: strongly foliated and sheared; foliation at 38° to core axis (363')	300 308 325 336 360	308 325 336 360 378	SERICITE + CARBONATE Tan, sericite-rich (up to 75%) with carbonate; <10% chlorite SERICITE + CARBONATE ± CHLORITE Intensely broken, sericite-rich (50-70%) with fine grained tan to brown ankerite (<10%); abundant quartz-chlorite-carbonate veins in microfractures SERICITE + CARBONATE + CHLORITE Tan to pale green sericite + carbonate with up to 10% disseminated to patchy chlorite. SERICITE + CARBONATE + CHLORITE Sericite 30-40%; chlorite 20-30%; ankerite <1mm, up to 10% SERICITE + CARBONATE Dominantly fine grained sericite +carbonate with <10% chlorite.	
378	381	SHEAR ZONE Graphite-chlorite-carbonate-quartz; broken core, possible fault zone	378	381	SHEAR ZONE	
381	425	ALTERED AND SHEARED BASALT LAVA FLOWS Same as 288-378: foliation consistent at 35-40° to core axis.	381 390	390 425	SERICITE + CARBONATE Same as 360-378 SERICITE + CARBONATE ± CHLORITE Pale tan to greenish tan sericite-rich groundmass with up to 5% 1-3mm patchy to disseminated ankerite poprphyroblasts; tr fuchsite in 3mm wide vein at 411'	
425	434	SHEARED GRAPHITE-RICH SHALE Black, strongly foliated graphite-rich shale; 5-10% quartz veins are rotated parallel to foliation	425	434	CARBONATE + QUARTZ Patchy yellow-tan carbonate, up to 10%	
434	464	ALTERED AND SHEARED BASALT LAVA FLOWS Tan to pale green; massive, aphyric; foliation at 55°to core axis at 447'	434 450	450 464	SERICITE + CARBONATE Tannish-brown, very fine grained sericite and carbonate-rich matrix with <10%chlorite. SERICITE + CARBONATE + CHLORITE Same as above with chlorite up to 10%; gradational upper and lower contacts	
464	600	MASSIVE TO PILLOWED BASALT LAVA FLOWS Pale green to dark green massive to pillowed basalt	464	502	CHLORITE + EPIDOTE ± CARBONATE Chlorite-epidote groundmass with up to 5%	

		lava flows; pillows have 1-2cm rinds with 20-50% pale yellow green blocky interflow hyaloclastite			<1mm disseminated carbonate	
			502	503	QUARTZ-CARBONATE-CHLORITE VEIN Quartz-carbonate-chlorite vein.	
			503	510	CHLORITE + EPIDOTE ± CARBONATE Same as 464-502	
			510	513	EPIDOTE + CHLORITE Blotchy epidote (15-20%) in chlorite-rich fine grained groundmass	
			513	516	CHLORITE + EPIDOTE + CARBONATE Same as 464-502	
			516	517	QUARTZ-CHLORITE VEIN	
			517	558	CHLORITE + EPIDOTE ± CARBONATE Same as 464-502	
			558	560	PATCHY EPIDOTE-CHLORITE-CARBONATE 25-30% patchy 1-3mm chlorite in pale tan to tannish grey quartz-carbonate-rich groundmass.	
			560	570	EPIDOTE + CHLORITE + CARBONATE Same as 517-558.	
			570	577	PATCHY EPIDOTE-CHLORITE-CARBONATE Same as 558-560.	
			577	600	EPIDOTE + CHLORITE + CARBONATE Same as 558-560; 10% dark green patches of chlorite around 1-2mm quartz filled fractures at 584-585; quartz-tourmaline veins up to 10mm wide, 1-2%, 595-600.	
600		END OF HOLE	600		END OF HOLE	

DDH: SXL-1 TOTAL DEPTH: 483 feet T: 62 R: 14 S: 28	PROJECT 326 COMPANY: Teck AZIMUTH: 188 COLLAR DIP: -45° NAD27 UTME: 564962 UTMN: 5296883 NAD83 UTME: 564915 UTMN: 5297995	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 4-28-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	31	OVERBURDEN	0	31	OVERBURDEN	
31	143	ANDESITE LAVA FLOWS Green grey to green massive to amydaloidal andesite lava flows. Local flow breccias and possibly hyaloclastite present. Interlflow tuffaceous siltstone deposits typically occur between amygdaloidal flow tops and bottoms. Abundance of massive/ amygdaloidal zones suggests presence of either thin lava flows or pillow lavas. 31-34: amygdaloidal andesite flow with 5-8% 2-6cm quartz + carbonate round to oval amygdules 34-36: interflow sediments 36-53: amygdaloidal andesite flow with 1-4% 2-4mm round to oval quartz + carbonate amygdules; brecciated with 2-4% 2-6mm oval quartz – carbonate amygdules at 50-53; sharp lower contact. 53-53.5: fine-grained tuffaceous siltstone, vaguely bedded 53.5-54.5: amydaloidal andesite 54.5-54.6: fine grained siltstone with dissemenated sulfides 54.6-66: amygdaloidal andesite flow; 5% 1-6mm oval quartz carbonate amygdules at contact, grades down into massive to slightly amydaloidal andesite 66-75: tuffaceous siltstone/sandstone interflow sediments (may be hyaloclastite) 75-98: andesite lava flow; upper and lower contacts contain 5-7% 2-6mm oval quartz ± chlorite amygdules; contact zones contain flow breccias; massive to slightly amygdaloidal (1%) at center of flow; hyaloclastite at lower contact 98-100: interflow sediments, like 66-75 100-143; altermating massive/amygdaloidal andesite; amygdaloidal zones 1-4 feet wide, with 3-6% 2-6mm oval to lens-shaped quartz ± chlorite amygdules;	31	93	EPIDOTE + CHLORITE Green grey epidote finely dissemenated in groundmass (5-10%); chlorite up to 5% as 1-2mm sub-tabular pyroxene pseudomorphs or as amygdule fillings; amygdules commonly have siliceous rims with chlorite-rich cores; chlorite as fracture fillings along flow contacts; thin veins/patches of pale grey-green silicification locally up to 3%, up to 1cm wide.	54-58: 2-5% patches to lenses of po up to 2cm long; tr cp; py cubes, 1-5cm in diameter @54-55'. 58-101: tr-nil sulfides 101-101.5: late po-vein with tr cp on fracture 101.5-143: tr-nil po.
			93	108	MOTTLED EPIDOTE + CHLORITE + QUARTZ Patchy silicification as above, 5%; pale green grey epidote chlorite groundmass cut by 3-10 cm wide dark green chlorite-rich bands; alteration most intense at flow contacts	
			108	113	EPIDOTE + CHLORITE Same as 31-93	
			113	115	EPIDOTE + CHLORITE + QUARTZ Amygdules with chlorite-rich cores and quartz-rich rims; pale green to green grey patchy and wispy epidote + quartz	
			115	143	CHLORITE + QUARTZ Relatively fresh, typical greenschist grade assemblage with local patchy grey silicification (up to 2%); trace disseminated iron carbonate.	

		interflow tuffaceous siltstones up to 1 foot thick between flows; flow breccia at 126-127'.				
143	151	INTERFLOW SEDIMENTS Reversely (?) graded debris flow with silty to sandy matrix; 5-10% <1-4cm lens-shaped cherty fragments	143	151	LEAST ALTERED Relatively fresh chlorite matrix, typical greenschist grade assemblage	Trace to nil po.
151	151.5	BRECCIATED CHERT	151	151.5	CHLORITE VEINS 15-120% chlorite-rich fractures and veins in chert.	
151.5	156	AMYGDALOIDAL ANDESITE LAVA FLOW 1-3% round to oval quartz amygdules up to 3mm in diameter	151.5	156	EPIDOTE + CHLORITE Similar to 143-151, but slightly more epidote-rich	
156	158	BRECCIATED CHERT	156	158	CHLORITE VEINS 10-20% chlorite associated with disseminated pyrite	156-158: 2-5% py on late fractures as 1-4mm wide veins; trace sphalerite + pyrite concentrated at contact
158	163	AMYGDALOIDAL ANDESITE LAVA FLOW Same as 151.5-156.	158	163	MOTTLED EPIDOTE + CHLORITE + QUARTZ Chlorite, <1-4mm, 20%: very fine-grained epidote in groundmass; patchy silicification of fragments near flow contacts; local sphalerite associated with chlorite	
163	216	VOLCANICLASTIC SEDIMENTS Grey to green grey, variably altered fine-grained matrix with 10-30% angular to oval light grey to dark green fragments; pale grey to green grey vesicular fragments may be altered pillow flow fragments; angular to subangular, dark green chlorite-rich fragments 5-20mm in diameter, contain up to 25% vesicles, may be pillow hyaloclastite	163 195	195 216	PATCHY SILICIFICATION + CHLORITE Fine grained matrix with moderately silicified fragments; silicification 5-10%, mottled; local sphalerite associated with chlorite; disseminated <1-2mm chlorite, 5-10%l chlorite veins/bands up to 2cm wide, locally associated with chlorite. MOTTLED CHLORITE + QUARTZ Gradational from above with 15-30% patchy to disseminated chlorite; wispy veins and bands of pale grey-green silicification, up to 5%.	163-216: Generally nil to trace sulfides, with localized patched and lenses of red-brown very fine grained sphalerite at 161-163'(3%), 173'(2%) at flow contact; disseminated py-po 2-5% at 195-197'.
216	228	DIABASE DIKE Dark green, fine-grained, phaneritic, with 5-7% <1-1mm grey tabular feldspar laths; 5-10% <1-2mm chlorite pseudomorphs after pyroxene; sharp, fine-grained contacts	216	228	CHLORITE + CARBONATE Relatively fresh with 5-8% chlorite pseudomorphs after pyroxene; faint orange-brown staining on core suggests up to 5% disseminated iron carbonate in groundmass.	
228	326	SCORIACEOUS ASH TUFF/TUFFACEOUS SILTSTONE Pale grey to green-grey very fine-grained matrix with tr-1% <1mm angular to subangular quartz grains; scoria fragments up to several cm in diameter, with 10-50% round to oval quartz filled amygdules up to 3mm in diameter; scoria fragments commonly only identifiable by concentrations of amygdules; approximately 10-15%	228	255	CHLORITE + SERICITE Dominantly very fine grained chlorite (30-50%) with patches and lenses of p[ale grey green very fine grained sericite; sericite up to 10% from 228-235, decreases to 5-7% from 235-255; 10cm wide pale yellow sericite-rich band/vein at 248-249; overall, sericite decreases whereas chlorite increases with depth	Patchy to disseminated sulfides 3-10% throughout unit as 0.5-2cm lenses and as thin (up to 1cm wide) veins/veinlets. Dominantly po lenses with localized inclusion of cp (up to 2-3%);

		scoria present; overall, unit massive with no internal grading or sorting	255	256	SILICIFICATION Pale grey green silicification associated with band of po-cpy	Overall patchy disseminated sulfides with local veinlets of po±cp, or sphalerite rich veins/veinlets.
			256	275	CHLORITE + SILICIFICATION Dominantly very fine grained chlorite with patchy silicification (up to 3%)	
			275	326	CHLORITE + SILICIFICATION Similar to above, with patches of silicification up to 10 cm wide, up to 10%; locally fragments completely silicified at gradational contacts.	
326	348	AMYGDALOIDAL ANDESITE LAVA FLOWS Variably altered green-grey to green andesite lavas with 2-5% 2-6mm round to oval quartz ± pyrrhotite-filled amygdules	326	352	CHLORITE + EPIDOTE + SILICIFICATION Patchy epidote-qurtz (20-30%) in chlorite-rich groundmassl chlorte varies from medium green to very dark green (Fe-rich?) associated with sphalerite; gradational alteration contact	Po-filled amygdules up to 5%; local veins/veinlets of sp up to 5% locally.
			352	363	CHLORITE + EPIDOTE + SERICITE + QUARTZ Pale yellowish-green sericite (up to 15%) in chlorite-epidote groundmass; silicification less intense than above.	
348	363	INTERFLOW SEDIMENTS Variably altered, very fine-grained green-grey matrix with 1-2% <1mm angular quartz grains	348	363	CHLORITE + SERICITE Patchy grey-green chlorite and sericite	Sphalerite 1-3% in 1-2mm thin veinlets occurring throughout unit.
363	367	CHERT Pale white chert with angular chlorite	363	367	PATCHY CHLORITE 10-15% chlorite patches/veins in chert	Trace to 2% sp in veins
367	370	INTERFLOW SEDIMENTS Same as 348-363	367	370	CHLORITE + SERICITE Dominantly chlorite-rich with 5% sericite	Trace –3% sphalerite in veins up to 3mm wide
370	371	FELDSPAR PORPHYRY INTRUSION Feldspar-phyric diorite intrusion.	370	371	LEAST ALTERED Fresh dike	Nil
371	374	CHERT Similar to 363-367	371	374	PATCHY CHLORITE Same as 363-367	Trace – 1% disseminated to patchy py cubes up to 2mm in diameter
374	380	INTERFLOW SEDIMENTS Green-grey fine grained matrix with 1-3% <1mm angular quartz grains; possible scoria marked by concentration of <1mm rounded amygdules(?)	374	380	CHLORITE + SILICIFICATION Dominantly chlorite-rich with 5% sericite	<1-3mm wide sp-rich veins, 1-3%
380	382	CHERT Same as 371-374.	380	382	PATCHY CHLORITE Same as 371-374.	<1-3mm wide sp-rich veins, 1-4%
382	483	AMYDALOIDAL ANDESITE LAVA FLOWS Medium to dark green, variably altered andesite lavas with very amygdaloidal to scoriaceous flow contacts; contact zones contain up to 15% <1-2mm round to oval	382	397	PATCHY EPIDOTE + CHLORITE Bands of pale green epidote 10-12% in very fine grained chlorite-rich groundmass; epidote bands <1-2cm wide, patchy; chlorite locally massive, very dark green, cut by silicification and/or	382-384:sphalerite-rich amygdules at 2-6%; 384-396: 5-8% sulfides as po-patches, local cp; sp veins/patches,

		quartz amygdules; fine-grained interflow siltstones and pillow breccia/hyaloclastite locally present between individual lava flows; unit overall may be pillowed.	**397**	**483**	epidote with 10-15% sulfides. CHLORITE Dominantly very fine grained chlorite with localized patches of pale green silicification and/or epidote (<1%)	up to 5% commonly associated with deep green chlorite. 396-411: Nil to trace sulfides 411-480: thin veins and disseminated patches of po±cp up to 5%; sp in thin veins, 3-4%, dissemenated throughout unit; at 452-475, cp1-3% in patches and veins associated with po±sp.
483		END OF HOLE	**483**		END OF HOLE	

	PROJECT 326 DDH: SXL-2 COMPANY: Teck TOTAL DEPTH: 471 feet AZIMUTH: 188 COLLAR DIP: -45° T: 62 R: 14 S: 29 NAD27UTME: 564477 UTMN: 5297015 NAD83 UTME: 564430 UTMN: 5297126	**LOGGED BY: G. HUDAK** **UNIVERSITY OF MINNESOTA – DULUTH** **DATE CORE LOGGED: 5-1-98**

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	13	OVERBURDEN	0	13	OVERBURDEN	
13	19	QUARTZ-FELDSPAR PORPHYRY DIKE Weathered, broken core; Same as SXL-3, 59.5-65.5	13	19	CLAY-CARBONATE WEATHERING Broken, weathered to carbonate + clay	
19	71	ANDESITE LAVA FLOWS Pale green-grey, variable from massive to amydaloidal near flow contacts (within 2-4 feet of contact); closely spaced flow contacts suggest either thin flows or pillows.	19	71	DISSEMINATED CHORITE + QUARTZ Pale green grey, with minor patchy silicification; disseminated <1-2mm chlorite, 10-12%, possibly after pyroxene; pale green-grey to tan feldspar is relatively fresh, with minor alteration to carbonate	
71	90	QUARTZ-FELDSPAR PORPHYRY DIKE Grey (fresh) to green grey (epidote sericite altered) to whitish-grey (silicified); fresh rock with 10% 1-5mm ivory colored, locally zoned plagioclase; up to 5% <1`-3mm quartz in very fine-grained siliceous matrix	71 81 85	81 85 90	EPIDOTE Pale greenish-tan epidotization of feldspar; blotchy, mottled appearance SILICIFICATION Intense silicification of matrix; 5-10% patchy mottled epidote; trace-1% disseminated fuchsite MINOR CHLORITE + EPIDOTE Minor chloritization / epidotization of mafic minerals; feldspars are bleached white.	
90	104	PILLOW BRECCIA / HYALOCLASTITE Mottled appearance due to 20-25% angular cream-colored fine grained altered fragments up to 1cm in diameter; amygdules, up to 5%; fragments commonly merge with matrix	90	104	PATCHY SILICIFICATION Patchy silicification (10-15%) in chlorite – epidote ± carbonate matrix	
104	148.5	ANDESITE LAVA FLOWS AND HYALOCLASTITE Pale green-grey massive to amygdaloidal (up to 3%) andesite flows with interflow andesite hyaloclastite 104-118: amygdaloidal andesite lava flow 118-118.5: hyaloclastite 118.5-133: andesite lava flow 133-133.5: hyaloclastite 133.5 – 137: andesite flow (pillow?) 137-144: hyaloclastite 144- 148.5: amygdaloidal andesite flow with flow breccia / hyaloclastite at 148-148.5.	104	148.5	PATCHY SILICIFICATION Green-grey faint to moderate silicification of matrix with local veins and patches of intense silicification; amygdules generally chlorite-rich; locally late veins /veinlets of chlorite up to 1cm wide; epidote and silicification most intense 140-148.5.	Trace to 2% disseminated sphalerite; patches locally up to 1cm 141-148.5: 2-3% po-filled amygdules; trace blotchy chalcopyrite with po; trace sphalerite; po associated with epidote; 1% sphalerite at 148' in vein

148.5	156	INTERFLOW SEDIMENTS Variable from tan to grey green tuffaceous siltstones	148	156	CHLORITE + SILICIFICATION Green chlorite-rich matrix cut by veins and bands of intense silicification	
156	161.5	RHYODACITE LAVA Grey quartz and plagioclase-phyric lava; quartz, up to 1mm diameter, up to 2%; cream colored tabular feldspar, up to 2mm diameter, 1-3%	156	161.5	CHLORITE + EPIDOTE Pale green epidotization/chloritization of matrix	
161.5	164	TUFFACEOUS SILTSTONE Tan with 1-2% 1mm quartz grains	161.5	203	SERICITE Tan to pale grey sericitized matrix with up to 15% sericite, up to 5% disseminated chlorite	
164	219	QUARTZ-PHYRIC RHYOLITE LAVA Tan to dark green, variably altered very fine grained groundmass contains 1-4% gray to grayish blue square to sub-angular quartz phenocrysts <1-2.5mm in diameter; dominantly massive with up to 1% rounded gray quartz amygdules up to 5mm in diameter; 203-204.5: quartz-carbonate-sericite shear zone with 6cm of massive sphalerite at 204-204.5 217-219: very fine grained flow contact zone with 1% quartz phenocrysts up to 1mm in diameter	203 204.5	204.5 219	CARBONATE + QUARTZ Quartz (40-50%), carbonate + sericite 30% in dark grey quartz-feldspar groundmass CHLORITE + SERICITE Dominantly dark grey green chlorite (10-20%) in groundmass with local bands up to 1 foot thick of up to 20% tan sericite; chlorite-rich towards base of unit	Local disseminated py ± po up to 2%; thin veins and stringers of massive sphalerite (up to 8cm wide, average 5-8mm wide, locally present, average 1-2% over unit; commonly associated with silicification + carbonate + seriicite alteration.
219	221	QUARTZ-CARBONATE-SERICITE SHEAR ZONE Foliation at 45-50° to core axis	219	221	QUARTZ + CARBONATE ± FUCHSITE Quartz 30-40%; sericite + carbonate, 60%; trace fuchsite	3% sphalerite veins up to 4mm wide parallel to foliation
221	224	TUFFACEOUS SILTSTONE Andesitic composition fine tuffaceous siltstone	221	224	CHLORITE Very fine grained chlorite-rich matrix, chlorite 30-40%, sericite 20%, trace fuchsite	
224	226	QUARTZ-CARBONATE-SERICITE SHEAR ZONE Quartz 65%, chlorite 15%, carbonate + sericite 20%; trace fuchsite	224	226	QUARTZ + CARBONATE ± FUCHSITE Quartz 65%, chlorite 15%, carbonate + sericite 20%; trace fuchsite	1-2% sphalerite veins, patches
226	263	PLAGIOCLASE-PHYRIC RHYOLITE/DACITE LAVA Variably to strongly altered fine grained massive to amygdaloidal lava with 3-5% <1-2mm creamy carbonate-rich to pale green epidote/chlorite-rich feldspar phenocrysts; grey quartz-rich amygdules, up to 5mm in diameter, <1-2%	226 233 235	233 235 263	PATCHY SILICIFICATION + CHLORITE Patchy silicification with 10-25% chlorite; feldspar tan to pale green altered to mix of chlorite, epidote, carbonate INTENSE SILICIFICATION Intense silicification with sharp upper and lower contacts EPIDOTE + SILICIFICATION Greenish tan sillcification with sericite (up to 10%) and epidote; feldspar pale tan to green, sausseritized; up to 10% 1-5mm wide chlorite/sericite veins throughout; overall mottled appearance	226-228: silica veins form crackle breccia adjacent to quartz vein

263	265	QUARTZ-CARBONATE-SERICITE –FUCHSITE SCHIST Quartz 20-40%; sericite + carbonate, 20-25%, epidote 10%, disseminated fuchsite 3-5%	263	265	QUARTZ+CARBONATE+SERICITE±FUCHSITE Quartz 20-40%, sericite + carbonate, 20-25%, epidote 10%, disseminated fuchsite 3-5%	5% 1-18 mm veins of sphalerite at 45° to core axis
265	274	ALTERED RHYOLITE/DACITE LAVA Massive, silicified, and sericite/carbonate alteration obliterated feldspar; pale green-grey to tan massive matrix.	265	274	EPIDOTE + SILICIFICATION Same as 235-263	1-3% 2mm-8mm veinlets of sphalerite associated with sericite – carbonate alteration 273.5-274: 50-60% po /sp band 8cm wide
274	284	QUARTZ-CARBONATE-SERICITE-FUCHSITE ROCK Either quartz vein or intensely silicified hyaloclastite; fragmental, angular appearance locally preserved; angular silicified fragments, up to 1cm in diameter, 10%	274 278 282	278 282 284	QUARTZ-SERICITE-CARBONATE-FUCHSITE Quartz 20-40%; fuchsite 3%; sphalerite 1% QUARTZ + CARBONATE + SERICITE Quartz 40%; sericite + carbonate, 50%, fuchsite tr-1% QUARTZ + CARBONATE+ SERICITE +_FUCHSITE Quartz 70-80%; Carbonate + sericite, 10-15%; fuchsite tr-1%; sphalerite 1-3% as veins, patches	
284	349.5	AMYDALOIDAL ANDESITE LAVAS/HYALOCLASTITE Dominantly dark to medium green amygdaloidal andesite with local 1-2 foot thick sections of flow breccia and/or hyaloclastite; amygdules, oval, <1-6mm in diameter (avg. 2-3mm); locally, up to 1% ameboid shaped tan to pale green fragments associated with flow breccia/pillow breccia	284	349.5	PATCHY SILICIFICATION Moderately silicified groundmass is green grey with pale grey to tan bands and patches of locally more intense silicification; locally, 10-15% <1mm disseminated chlorite present; flow breccias mottled with silicification and chlorite alteration with patchy epidote (greenish yellow); amygdules are typically chlorite rich 336-337: 80% epidote in 10cm wide vein with 5-7% disseminated chlorite, tr fuchsite	Trace disseminated po in local veins
349.5	353.5	QUARTZ-FELDSPAR PORPHYRY DIKE Same as 13-19'	349.5	353.5	EPIDOTE + SERICITE ± HEMATITE Pale greet to tan epidote – sericite (sausseritized); pinkish hematite at lowermost 6" of unit	Nil
353.5	471	AMYGDALOIDAL ANDESITE LAVAS/FLOW BRECCIA Amygdaloidal andesite lavas with <1-15 foot thick intersections of flow breccias and/or hyaloclastite; amygdules are chlorite + quartz filled, up to 6mm in diameter (2-3mm average), <1-5%; 353.5-358: amydaloidal andesite lava flow 358-361: flow breccia/hyaloclastite 361-397: amgdaloidal andesite lava flow; 1-2% <1-2mm tabular feldspar phenocrysts 397-402: flow breccia/hyaloclastite 402-408: amygdaloidal andesite lava flow 408-423: flow breccia with 40-50% fragments up to 5cm in diameter	353.5	471	EPIDOTE ± SILICIFICATION 353.5-471: Same as 284-349.5, with local silicified or epidote-rich veins or bands 353.5-389: described above 389-390: massive silicification with epidote; up to 5% disseminated chlorite 390-450: Same as 353.5-389; mottled appearance in breccia/hyaloclastite 450-451: Intense silicification (>90%) with 5% chlorite, trace epidote 451-453: Same as 390-450 453-454: Intense silicifiation as in 450-451	Nil

		423-452: amygdaloidal andesite with minor flow breccia 452-453: flow breccia/hyaloclastite 453-462.5: amygdaloidal andesite lava flow 462.5-463: flow breccia/hyaloclastite 463-469.5: amygdaloidal andesite lava flow 469.5-471: flow breccia / hyaloclastite			454-471: Same as 390-450	
471		END OF HOLE	471		END OF HOLE	

	PROJECT 326	**LOGGED BY: G. HUDAK**
	DDH: SXL-3 COMPANY: Teck	UNIVERSITY OF MINNESOTA – DULUTH
	TOTAL DEPTH: 487 feet AZIMUTH: 188 COLLAR DIP: -45°	
	T: 62 R: 14 S: 29 NAD27 UTME: 564318 UTMN: 5296966	DATE CORE LOGGED: 4-30-98
	NAD83 UTME: 564271 UTMN: 5297079	

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	3	OVERBURDEN	0	3	OVERBURDEN	
3	59.5	DACITE/ANDESITE LAVA FLOW Pale green, massive to locally amygdaloidal, locally plagioclase-phyric andesite lava flows 3-16: weathered and broken core, incomplete recovery 16-27: Pale green to grey green amygdaloidal andesite; quartz filled amygdules, round to oval, 2mm-6mm in diameter, 1-4% 27-53: Pale grey, massive to slightly amygdaloidal, feldspar phyric andesite / dacite? 53-54: quartz carbonate vein 54-59.5: variably altered tannish-green to grey green massive andesite; moderately developed foliation at 30° to core axis.	3	22	LEAST ALTERED Typical chlorite-epidote with local broken chlorite rich rocks due to weathering	5-35: nil to trace py 35-37: tr-2% <1-2mm euhedral pyrite 37-48: tr <1-2mm disseminated py 48-48.5: 3-5mm massive pyrite vein associated with quartz and chlorite 48.5-53: nil to tr. py 53-54: tr 1-2mm py 54-59.5: nil to tr py
			22	43	SILICIFIED Patchy grey silicified andesite with local chlorite veins and bands, up to 1cm wide, 5-10%	
			43	59.5	SERICITE + CARBONATE + CHLORITE Tan sericite (30-40%), carbonate (<10%), and chlorite (5-10%) as wispy veins, patches	
59.5	66.5	QUARTZ-FELSPAR PORPHYRY DIKE Pale grey granodiorite with 25-30% 3-6mm tabular to subangular grey plagioclase phenocrysts	59.5	66.5	CARBONATE Disseminated carbonate up to 5%	Nil
66.5	74.5	QUARTZ + CARBONATE ± SPHALERITE VEIN 66.5-70: quartz 40%; carbonate 50%; chlorite 10% 70-74.5: quartz 50-60%; chlorite 15-20%; sericite 10-15%	66.5	74.5	QUARTZ + CARBONATE ± SPHALERITE VEIN 66.5-70: quartz 40%; carbonate 50%; chlorite 10% 70-74.5: quartz 50-60%; chlorite 15-20%; sericite 10-15%	66.5-70: Nil to tr py 70-74.5: 1-3% veins/ patches of sphalerite; veins up to 5mm wide, patches <1-8 mm wide, lensoid
74.5	137	AMYGDALOIDAL DACITE/ANDESITE LAVA FLOWS Pale grey to grey green andesite with local zones 1-3feet thick containing 1-3% 2-5mm rounded to oval quartz amygdules; no obvious interflow hyaloclastite 80-84: quartz-carbonate-fuchsite vein; quartz 30%; carbonate (50-70%); fuchsite disseminated, emerald green, 1-2%, patchy, 5-7mm	74.5	80	CHLORITE Minor chloritization: chlorite green, 10-20%;	
			80	84	QUARTZ + CARBONATE ± FUCHSITE quartz-carbonate-fuchsite vein; quartz 30%; carbonate (50-70%); fuchsite disseminated, emerald green, 1-2%, patchy, 5-7mm	80-84: 1-3% disseminated to thin 1-3mm veins of red to red-brown sphalerite
			84	237	LEAST ALTERED Typical greenschist grade assemblage fo chlorite-epidote-carbonate	

137	137.5	QUARTZ-CHLORITE VEIN (LATE FAULT?) Broken, sheared contact				
137.5	251	AMYGDALOIDAL ANDESITE LAVA FLOWS Pale grey to green grey groundmass with local amygdaloidal zones 1-3 feet wide containing 1-5% <1-4mm rounded to oval amygdules	237	240	PATCHY SILICIFICATION Pale grey to ivory colored silicification; 5-8% 1-2mm disseminated chlorite in silicified groundmass	
251	252	BROKEN CORE (LATE FAULT ZONE) Weathered, tan to pale green broken core; possible fault or joint				Trace pyrite
252	265	AMYGDALOIDAL ANDESITE LAVA FLOWS Same as 137.5-251.	240	265	LEAST ALTERED Same as 84-237	
265	279.5	QUARTZ-FELSPAR PORPHYRY DIKE Pale grey to green grey fine grained groundmass with 15-20% tabular to sub-tabular cream-colored zoned 2-6mm feldspar phenocrysts (plagioclase) and 10-15% 2-6mm round to subangular grey quartz phenocrysts	265	279.5	LEAST ALTERED Relatively fresh quartz – feldspar porphyry	Trace <1mm disseminated pyrite
279.5	473	AMYGDALOIDAL ANDESITE LAVA FLOWS Pale grey green to pale green amygdaloidal andesite containing 1-5% 2-5mm round to oval quartz amygdules; local flow breccias present, notably at 413-418.	279.5	473	LEAST ALTERED Typical greenschist assemblage with localized patchy silicification; chlorite generally increases in abundance within flow breccias	
473	487	QUARTZ-FELSPAR PORPHYRY DIKE Light grey to pale green groundmass with 20-30% 2-6mm cream colored feldspar phenocrysts and 10-15% light grey quartz phenocrysts up to 4mm in diameter.	473	483	SILICIFICATION + CARBONATE Washed out appearance varies from grey to cream colored as a result of silica and/or carbonate	473-483: <1% sulfides concentrated up to 20% on late 1-2mm wide fractures; contains po ± cp.
487		END OF HOLE	483		END OF HOLE	

	PROJECT 326	LOGGED BY: G. HUDAK
DDH: SXL-4 TOTAL DEPTH: 505 feet T: 62 R: 14 S: 28	COMPANY: Teck AZIMUTH: 188 COLLAR DIP: -45° NAD27 UTME: 564869 UTMN: 5296940 NAD83 UTME: 564822 UTMN: 5297053	UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 5-27-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	4	OVERBURDEN	0	4	OVERBURDEN	
4	165.5	ANDESITE LAVA FLOWS / INTERFLOW SEDIMENTS Pale green to grey green variably altered andesite lava flows and local interflow sedimentary horizons; andesite flows locally amygdaloidal (up to 2% 2mm-1cm, round to oval, filled with quartz ± chlorite); flow breccias common at flow contacts vary from 1-5' thick; interflow sediments are grey, massive siltstones or tuffaceous siltstones, localted at 77-80', 109-111.6'.	4	55	PATCHY SILICIFICATION + CHLORITE Pale grey groundmass slightly silicified with 5-155 "ghosty" dark green chlorite patches and veins up to 1cm wide; rock pale grey and green mottled; gradational lower contact	141-145: 5% sphalerite in 2-8mm wide veins within quartz-sericite-masive chlorite 147-148: 3% cpy in 2-5mm veins, associated with sphalerite
			55	78	PATCHY SILICIFICATION + CHLORITE 0.5-2.0 cm oval to ameboid quartz chlorite patches in green-grey chloritized/silicified groundmass; chlorite patches and veins, 10-15%	
			78	80	SILICIFICATION + EPIDOTE? Pale grey silicified groundmass with 10-15% chlorite; massive, very fine grained pink colored regions may be zoisite	
			80	90	PATCHY SILICIFICATION + CHLORITE Same as above, but accentuated in flow breccia	
			90	93	SILICIFICATION Pale grey, moderately silicified	
			93	109	PATCHY SILICIFICATION + CHLORITE Same as 55-78'; strong silicification (up to 30% quartz) at 101-104'	
			109	114	MINOR SILICIFICATION Same as 90-93'	
			114	141	CHLORITE + SERICITE Pale grey green to dark green massive to mottle chlorite (20-30%) with up to 10% pale yellow-green sericite	

			141	164	CHLORITE + EPIDOTE + SERICITE Similar to above, but locally up to 5% pale greenish yellow very fine grained epidote, associatee with sphalerite mineralizationl; 10-15% <1mm disseminated chlorite porphyroblasts present	
			164	165.5	SERICITE + CHLORITE + QUARTZ Similar to above, but slightly more siliceous	
165.5	166	BROKEN CORE (FAULT ZONE?)	165.5	166	QUARTZ –CHLORITE – HEMATITE VEIN	
166	182	ALTERED ANDESITE FLOW BRECCIA Variable from pale greenish tan to green grey; broken core makes identification difficult; local very fine grained matrix suggests local sedimentary horizons	166	168	SERICITE + CHLORITE Sericite 30-40% with 5-15% <1mm disseminated chlorite	
			168	182	MOTTLED SERICITE + CHLORITE Pale grey green very fine grained mottled matrix; 5-10% <1mm chlorite; gradational lower contact	
182	220	ANDESITE (?) FLOW BRECCIA Pale grey green matrix supported breccia with 5-15% 5mm-2cm angular to subrounded , locally amygdaloidal (up to 4%) pale grey silicified fragments; subangular to subround quartz amygdule, ,1mm, 2-3%	182	220	SILICIFICATION + CHLORITE More chloritic than above (up to 40%) with local patches of silicification and silicified fragmentsl chlorite closely associated with disseminated to wispy sphalerite bands and stringers	209-210: up to 5-7% bands (up to 1cm) and stringers of sphalerite
220	222	QUARTZ VEIN	220	222	QUARTZ VEIN WITH CHLORITE	
222	267	INTERMEDIATE TUFFACEOUS SILTSTONE Dark green to grey green very fine grained massive siltstone	222	267	CHORITE Chlorite 20-35% in matrix of sediments	229-232: 1-3% sphalerite veins up to 1 cm wide 237-240: Same as 229-232, with 1-2% py, tr-1% cpy
267	278	DIORITE DIKE / INTRUSION Pale green grey groundmass with 5-10% <1mm tabular feldspar phenocrysts and 10-20% 1-3mm chlorite pseudomorphs after amphibole or pyroxene; massive, vine grained sharp contacts	267	278	CHLORITE ± HEMATITE Chloritized psuedomorphs of mafic phenocrysts with up to 3% reddish staining due to fine grained hematite	Nil
278	446	ALTERED ANDESITE (?) FLOWS/ SEDIMENTS Amygdaloidal to massive; amygdaloidal zones mark flow contacts, which are also locally brecciated; amygdules are up to 5mm in diameter, round to oval, quartz rich with local chlorite 278-285: flow breccia 285-302: massive andesite 302-309: up to 3% quartz filled amygdules	278	385	SILICIFICATION + CHLORITE Dominantly fine-grained chlorite (20%) with loal patches and veins (1-30cm wide) of pale green grey to white silicified andesite; most sphalerite – chalcopyrite mineralization associated with chlorite-rich alteration zones; minor epidote up to 5%	412-414: stringer to semi-massive sphalerite up to 10% in veins / bands ranging from <1mm-2cm wide
			385	392	SILICIFICATION + CHLORITE	

		309-351: massive andesite 351-360: amygdaloidal andesite, with 4% round, quartz-rich oval amygdules up to 5mm in diameter 360-369: 1% amygdules up to 3mm in diameter 369-370: 20 % angular fragments in flow breccia 370-374: 3% 1-5mm quartz amygdules 374-392: 1-2% 1-5mm quartz amygdules in andesite/dacite lava flow 392-398: very fine grained dark green siltstone 398-416: 1-5% 1-5mm amygdules in andesite/dacite lava flow 416-431: pale green, massive, fine-medium grained interflow sediment 431-446: altered flow with 1-2% 1-5mm quartz amygdules	 392 398 431	 398 431 446	Pale green grey, 10-15% chlorite, slightly more silceous than above CHLORITE Massive very fine grained chlorite 20-40% SILICIFICATION + CHLORITE Similar to 385-392: silicification occurs adjacent to sphalerite mineralization CHLORITE Similar to 392-398, with 2% very fine grained disseminated epidote	
446	447	QUARTZ VEIN (FAULT?)	446	447	QUARTZ VEIN WITH CHLORTE 10-20% chlorite in quartz vein	
447	453	ALTERED ANDESITE (?) LAVA FLOW Same as 278-446; massive	447	453	PATCHY TO MASSIVE CHLORITE Light grey, granular groundmass, with 5-10% chlorite patches and local chlorite masses up to 20%	
453	457	QUARTZ-FELDSPAR PORPHYRY DIKE Light grey tonalite (?) with 5-10% 1-4mm pale grey to tan feldspar; also 5-10% <1mm chlorite after hornblende or biotite	453	457	SILICIFICATION ? Pale grey groundmass with faint silicification	
457	505	ALTERED ANDESITE (?) LAVA FLOW Light green grey to green groundmass with local zones containing up to 5% 2mm-5mm rounded to oval quartz ± chlorite ± sphalerite filled amygdules; amygdules locally pipe-like; presence of amygdaloidal zones with 0.5-1.0foot wide zones of flow breccia and/or hyaloclastite suggests either pillows or relatively thin flow lobes (up to 5-6 feet thick)	457	505	PATCHY SILICIFICATION + EPIDOTE Patches (up to 1cm diameter) to ameboid lenses and zones (up to 4cm wide) containing a combination of pale green grey very fine grained quartz and epidote disseminated throughout unit (5-15%); alteration most intense in amygdaloidal zones and flow breccias	457-505: 1-3% patchy to stringer brown to honey colored sphalerite stringers 2mm-1cm wide, associated with patchy silica-epidote; trace-1% cp, 1-3% disseminated to patchy po - py
505		END OF HOLE	505		END OF HOLE	

PROJECT 326

DDH: EN-4 COMPANY: Newmont
TOTAL DEPTH: 752 feet AZIMUTH: 164 COLLAR DIP: -45°
T: 62 R: 14 S: 24 NAD 27 - UTME: 570630 UTMN: 5297990
NAD 83 - UTME: 570616 UTMN: 5298199

LOGGED BY: G. HUDAK
ECONOMIC VOLCANOLOGY RESEARCH LAB
UNIVERSITY OF MINNESOTA – DULUTH

DATE CORE LOGGED: 5-29-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	MINERALS/OTHER
0	29	OVERBURDEN	0	20	OVERBURDEN	
29	301	BASALT/ANDESITE LAVA FLOWS Medium to dark green , commonly amygdaloidal lava flows, pillow lavas, flow breccias / hyaloclastite and chlorite-rich interflow sediments. 29-40: pillow lavas with up to 3% 3mm-1cm round to oval amygdules; associated flow breccia and fine-grained chlorite-rich selvages. 40-75: Massive andesite lava with up to 1% 1-5mm round to oval qtz-filled amygdules; possible flow contact at 68-69' gradational into hyaloclastite. 75-77: flow contact zone characterized by very fine (<1-3mm) chlorite-rich hyaloclastite with up to 5% oval to round 1-3mm qtz amygdules. 77-200: Amygdaloidal pillow lavas and associated hyalo-clastite/flow breccia/interflow sediments; individual lava flows with fine-grained chlorite-rich pillow rinds that are associated with breccia/hyaloclastite; amygdules generally increase in size toward center of pillows (from 1-3mm to 5mm-1cm); patchy tan glomeroporphyritic 1-4mm feldspar lathes (locally alt'd to epidote) form squarish, rectangular, or ameboid-shaped glomerocrysts up to 1cm in diameter; very fine-grained flow selvages are locally brecciated, typically pale green due to epidote; hyaloclastite and flow breccias range from 0.5-2.0 feet thick; local chlorite-rich very fine-grained interflow sediments present 188-189: cherty interflow exhalite with sulfides 199-200: base of flows, top of massive flows stronglyepidotized 200-226: Massive to faintly amygdaloidal massive lava flow 226-301: Amydaloidal pillow lavas / hyaloclastite / interflow sediments similar to 77-200.	29	301	LEAST ALTERED Greenschist facies mafic assemblage (chlorite-epidote-albite) with local patchy silicification and local concentrations of chlorite and/or epidote along flow contacts: local hematite veins 1-3mm wide, 1%. 45-47: Patchy silicification with 10-15% wispy to ameboid patches of grey very fine grained quartz ± epidote. 68-69: Chloritized and silicified flow contact. 128.5-130: Epidotized flow contact with 0-20% pale green disseminated epidote. 149-150: S. A. 128.5-130. 156.5-157: S. A. 128.5-130. 169-171: Chlorite-rich matrix to hyaloclastite. 177-178: Quartz vein with vfg massive epidote, 20%: 5-10% hematite in late fractures. 187-189: Patchy epidotization of feldspar glomerocrysts, 2-5%. 200-201: S. A. 128.5-130. 230-270: Slightly chloritized (20-30%) flow: 5% 1-5mm quartz veins at 242-245. 285-301: Chloritized matrix with up to 5% 1-5mm wide quartz veins: 5-10% red-brown hematite, quartz, and iron carbonate from 296-297.	29-301: Tr-1% dissemenated py/po, locally as 1-3mm subhedral to euhedral crystals

301	303	<u>QTZ-FSP PORPHYRY DIKE</u> 10-15% 1-6mm quarz phenocrysts and 5-10% 1-4mm plagioclase phenocrysts in fine-grained groundmass.	301	303	<u>LEAST ALTERED</u> Relatively fresh groundmass and feldspar phenocrysts.	
303	305	<u>MAFIC VOLCANICLASTIC SEDIMENT</u> Chloritic with 1% <1mm qtz grains	303	305	<u>SLIGHT CHLORITIZATION</u> Chlorite 20-30%, otherwise relatively fresh.	Tr-1% diss. py
305	307	<u>QTZ-FSP PORPHYRY DIKE</u> S. A. 301-303.	305	307	<u>LEAST ALTERED</u> S. A. 301-303.	
307	308	<u>MAFIC VOLCANICLASTIC SEDIMENT</u> Chloritic with 5-10% <1mm feldspar grains	307	308	<u>LEAST ALTERED</u> Relatively fresh albite indicates little alteration.	
308	308.5	<u>QTZ-FSP PORPHYRY DIKE</u> S. A. 301-303.	308	308.5	<u>LEAST ALTERED</u> S. A. 301-303.	
308.5	335	<u>BASALT/ANDESITE LAVA FLOWS / SEDIMENTS</u> Massive to amygdaloidal mafic flows interbedded with fine-grained mafic hyaloclastite or volcaniclastic siltstones: up to 2% 1-3mm quartz ± chlorite amygdules	308.5	335	<u>EPIDOTE ± HEMATITE</u> Chlorite-rich matrix/groundmass with 5-8% 1-5mm wispy veins of epidote: hematite in late veins and fractures, 1-3%.	Tr-2% py; 1-3% hem; Tr sphalerite
335	394	<u>MIXED IRON FORMATION/MASSIVE SULFIDE</u> Interbanded oxide-facies/silicate facies iron formation with local semi-massive to massive sulfide horizons 335-336: Oxide facies banded magnetite-chlorite iron formation 336-337: Chlorite-rich silicate facies iron formation 337-343.5: S.A. 335-336. 343.5-345: S. A. 336-337. 345-346: Massive sulfide with 90% py, up to 2% cp, tr-1% sp. 346-381: Banded chert/magnetite ± chlorite iron formation with local 1cm-5cm silicate facies chlorite-rich iron formation; magnetite horizons <1mm-2cm, interbanded w/ vfg grey chert; local thin black/black-green chlorite ± graphite cross-cut by up to 5% dendritic veins and stringers of py±cp±sp up to 1cm wide. 381-383: Green chlorite-rich silicate facies iron formation 383-392: S.A. 346-381; local carbonate facies iron formation also present. 392-393: Semi-massive sulfide 393-394: S. A. 346-381.	335 345 346 373 374 388 389	345 346 373 374 388 389 394	<u>CHORITIZED IRON FORMATION</u> Chloritized iron formation with up to 10% chlorite-rich bands of silicate facies iron formation. <u>MASSIVE SULFIDE</u> See lithological description. <u>SERICITE ± CHLORITE</u> Patches, bands, veins (up to 1cm wide) of greenish-tan sericite (up to 10%). <u>MASSIVE CHLORITE</u> Massive chlorite within silicate facies iron formation. <u>LEAST ALTERED</u> Relatively unaltered oxide-facies iron formation with 1-5% sulfide veins; local silicification? <u>IRON CARBONATE</u> Semi-massive pinkish-grey coalescing 3-5mm ovoids, 85%, w/ black chlorite/graphite. <u>LEAST ALTERED</u> Same as 374-388.	335-336: 5% vien py 336-337: 1-3% diss. py 337-345: Tr-3% diss. to vein py 345-346: 90% <1mm py; up to 2% cp; Tr –1% sp 346-381: <1-5% patchy py± cp, sp 381-383: 1-3% vein py 383-392: 1-5% diss. to vein py; locally psuedobx 392-393: 40% banded py assoc. with chert 393-394: S.A. 383-392
394	396	<u>PILLOW BASALT/ANDESITE LAVA FLOW</u> Similar to 308.5-335.	394	396	<u>EPIDOTE ± CHLORITE</u> Similar to 308.5-335.	
396	401	<u>MONZONITE DIKE</u>	396	401	<u>LEAST ALTERED</u>	
401	406	<u>AMYGDALOIDAL ANDESITE/BASALT LAVA FLOW?</u> Pale green to tan, w/ 1-2% 1-5mm oval quartz-filled	401	406	<u>SERICITE ± CARBONATE ± CHLORITE</u> Very fine-grained tan carbonate + sericite	

		amygdules; contact at 406 missing.			groundmass: 5-8% 1-5mm diss. chlorite.	
406	414	SILICATE FACIES IRON FORMATION Green, vfg massive chlorite-rich iron formation cut by patched to banded silicification associated with py±cb±ser.	406	414	CARBONATE ± SILICIFICATION 5-10% <1-3mm bands of silicification ± sulfides: 3-8% <1mm blocky dissemenated carbonate.	1-5% dissem. to patchy py assoc. w/ silicified bands/veins at 30° C. A..
414	423	QTZ-FSP PORPHYRY DIKE Light grey dacite/diorite with 5-7% grey to clear, <1-5mm quartz phenocrysts, 10-15% white cloudy tabular to subhedral, subrounded plagioclase up to 6mm in diam.	414	423	LEAST ALTERED Least altered with local 0.5' thick silicified zones adjacent to contacts which contain tr-1% 1-3mm dissemenated fuchsite.	
423	427	SILICATE FACIES IRON FORMATION S. A. 406-414.	423	427	CARBONATE ± SILICIFICATION Same as 406-414'.	Up to 10% py in bands up to 4cm wide
427	441.5	DIABASE DIKE (?) Fine-grained contacts merge into medium-grained feldspar-phyric (5-10%, up to 5mm) diabase/gabbro; strongly altered; very fine-grained lower contact is sharp, 30° C. A.	427 431	431 441.5	SERICITE ± FUCHSITE Aqua-green colored fuchsite-rich matrix with 10-15% 1-5mm wide veins of light brown mica (sericite/phlogopite?) CARBONATE ± CHLORITE Mottled carbonate-rich matrix with 5-10% disseminated 1-4mm chlorite flakes.	431-433: 2-4% diss. py 441-441.5: up to 2% py
441.5	448	DIABASE DIKE (?) Very fine grained with gradational lower contact	441.5	448	FUCHSITE ± SERICITE ± CARBONATE Aqua-green to tan fuchsite/sericite + carbonate altered matrix; tan, 1-3mm diameter feldspar present.	
448	450	DIABASE DIKE (?) Medium-grained equivalent to 441.5-448.	448	450	CARBONATE ± CHLORITE Same as 431-441.	
450	478	CLASTIC SEDIMENTS 450-453:Very fine-grained, tan, sheared tuffaceous siltstones?; foliation at 40-45° C.A. 453-473: Banded/bedded fine-grained grey tuffaceous sediments with local feldspar-phyric diabase dikes up to 0.4 feet wide. 473-478: Very fine-grained black, highly altered mudstone with 10-20% oval to dissemenated 1-5mm ankerite.	450 454	454 478	FUCHSITE ± SERICITE ± CARBONATE Same as 441.5-448. PATCHY CARBONATE Dark green very fine-grained matrix with 5-10% tan-brown 1-5mm blocky to oval ankerite porphyroblasts	470-473: Tr-3% diss. py
478	484	QTZ-FSP PORPHYRY DIKE Tan, 5-10% 1-5mm quartz phenocrysts, 5% 1-6mm cloudy feldspar.	478	484	SERICITE Tan very fine-grained sericite alteration 5-10%.	
484	502	CLASTIC SEDIMENTS Same as 473-478.	484	502	PATCHY CARBONATE Similar to 454-478: 10-20% oval tan to ivory colored ankerite porphyroblasts.	
502	507	DIABASE DIKE Dark green, fine-grained to medium-grained groundmass contains 10-15% <1mm tabular feldspar phenocrysts.	502	507	DISSEMINATED CARBONATE Dissemenated carbonate alteration of feldspar 5-10%.	1-2% 1-5mm euhedral py cubes

507	519	ASH TUFF/TUFFACEOUS SEDIMENTS Greenish-tan to pink, massive tuffaceous siltstone. 518-519: dark grey hornfels with 5% 1-2mm square feldspar.	507	519	SERICITE ± ANDALUSITE (?) Tan to pink sericite-rich matrix with 5-20% <1-2mm pink blocky andalusite (?) or carbonate.	
519	531	DIABASE DIKE Pale-green chlorite-rich very fine-grained groundmass with 10-25% <1mm tabular plagioclase phenocrysts.	519	531	CARBONATE Similar to 502-507.	
531	561	MAFIC SEDIMENTS Very fine-grained, green chlorite-rich matrix; massive; trace-1% local <1mm angular (broken) quartz grains; NOTE: 546-547 composed of broken chlorite-rich finely broken core, and may be fault zone.	531 536 538 540 546 547	536 538 540 546 547 561	CHLORITE ± CARBONATE Chlorite-rich matrix with 1-5% 1-4mm blocky tan carbonate porphyroblasts PATCHY SILICIFICATION White cherty bands associated with sulfides. CHLORITE ± CARBONATE Same as 531-536. PATCHY CARBONATE + CHLORITE Chlorite-rich matrix with 5-20% 1-4mm ankerite. CHLORITE Chlorite-rich fault (?) zone. BANDED SILICIFICATION White cherty bands 1-8mm wide associated with sulfides in chlorite-rich matrix; 5-10% 1-10mm wide sericite veins from 550-561.	531-536: 5% patchy/banded py assoc. w/ 2-5% veins/bands of honey-colored sp 536-541: 5% patchy py 541-546: 5-7% honey-colored patches of sp assoc. w/ 3%py, up to 2% cp 547-561: banded po in veins up to 7%; cp in viens up to 5%
561	566	QTZ-FSP PORPHYRY DIKE Same as 414-423.	561	566	LEAST ALTERED	
566	576	MAFIC SEDIMENTS Very fine-grained dark to medium green matrix; sericite alteration may be along original bedding planes at 40-45° C. A.	566	576	SERICITE ± CHLORITE Tan very fine-grained sericite bands up to 1 cm wide in dark green chlorite-rich matrix: fuchsite ± honey-colored sphalerite (?) at 569-570'.	patches/veins py parralel to foliation: tr sp.
576	578	DIABASE DIKE Same as above.	576	578	CARBONATE Same as 519-531.	
578	581	MAFIC SEDIMENTS Same as 566-576.	578	581	SERICITE ± CHLORITE Same as 566-576.	SA 566-576
581	643	DIABASE DIKE Green, massive with 5-10% <1mm tan to ivory, locally carbonate-rich feldspar phenocrysts. 610-611: broken core = fault. 639-640: 1-3% 1-5mm oval quartz amygdules 635-643: Foliation increases in intensity, possible shear.	581	643	CARBONATE Same as 519-531: local 3-8mm wide lenses of carbonate ± quartz, 5%.	tr-2% dissem. py; tr cp
643	714	MIXED FACIES IRON FORMATION Mixed chert-magnetite, sulfide-chlorite, chlorite-rich,	643	662	LEAST ALTERED	643-650: 20%mag, tr-3% py/po

		and carbonate-rich iron formations with local banding on mm-cm scale. 643-650: Banded magnetite-chert iron formation, banding 2-8mm wide. 650-653: Pyrite-chert exhalite, with 4cm hematite seam at 651'. 653-661: Black to dark grey chert with up to 5% magnetite. 661-662: Carbonate facies iron formation with chert. 662-663: Black to grey very fine-grained to fine-grained siltstone 663-679: Interbedded chert-magnetite and carbonate-chert iron formations 679-684: Chert and carbonate-rich horizons; bedding at 30° C.A. 684-687: Banded magnetite-chert iron formation with local sulfides, locally brecciated. 687-689: Altered grey silty mudstone 689-691: Chert and pyrite exhalite. 691-694: Grey siltstone/greywacke; quartz grains <1mm, 2% at bottom of unit. 694-695: Chert and pyrite exhalite. 695-696: Grey siltstone/greywacke. 696-700: Banded chert-magnetite iron formation. 700-703: Chert and pyrite exhalite. 703-705: Sheared siltstone (?) 705-710: Chert-magnetite iron formation. 710-714: Banded carbonate-chert iron formation.	662 663 673 679 684 687 689 691 703 705 710	663 673 679 684 687 689 691 703 705 710 714	PATCHY CARBONATE Patchy ankerite (10-20%) in fine-grained siltstone. LEAST ALTERED Relatively unaltered with local thin py veins. LEAST ALTERED ± CARBONATE Patchy ankerite as in 662-663. PATCHY CARBONATE 5-10% patchy carbonate ± quartz. CHLORITE VEINS 1-2mm fine grained chlorite veins associated with cherty breccia. PATCHY CARBONATE Patchy ankerite 10-15%. MINOR CHLORITE VEINS 1-5% <1-2mm chlorite veins. LEAST ALTERED FUCHSITE + CARBONATE Sheared fuchsite (up to 5%), sericite (20-30%), ankerite (5%) schist. LEAST ALTERED DISSEMINATED CARBONATE 5-20% disseminated ankerite porphyroblasts.	650-653: 10-40% dissem/banded py to semimassive py 653-661: up to 5% mag assoc. w/ chert, 5-10% py in 1-3mm wide vein 661-662: 10-15% py in veins 662-663: p% py 663-666: 10% diss/veins py 666-679: 1-5% diss. py 681-689: tr-5% diss/stringer sulfides in apparent crackle bx 689-691: 5-10% stringer/veins py 691-703:tr-2% diss. py 703-705: 20-30% banded/stringer py 705-710: 5-15% stringer/veins py 710-714: tr-2% py
714	730	VOLCANICLASTIC SEDIMENTS Green, massive fine-grained mafic to intermediate tuffaceous siltstones/sandstones with local <1mm quartz grains 1-2%	714	730	PATCHY CARBONATE Chlorite-rich (20-30%) matrix with 5-10% patchy carbonate alteration (ankerite)	
730	732	QTZ-FSP PORPHYRY DIKE Same as above.	730	732	LEAST ALTERED	
732	752	CLASTIC SEDIMENTS 732-734: Banded siltstone. 734-737: Debris flow horizon with grey-green matrix containing 5-12% 3mm-2cm normally graded cherty quartz-rich clasts. 737-752: Bedded normally graded siltstones overlying normally graded debris flow horizons.	732	752	CHLORITE Relatively unaltered chlorite-rich matx of sediments.	732-752: tr. diss. py
752		End of Hole			End of Hole	

	DDH: EN-7 TOTAL DEPTH: 648 feet T: 62 R: 14 S: 24	PROJECT 326 COMPANY: Newmont AZIMUTH: 165 COLLAR DIP: -45° NAD 27 - UTME: 570222 UTMN: 5297943 NAD 83 - UTME: 570278 UTMN: 5298138
		LOGGED BY: G. HUDAK ECONOMIC VOLCANOLOGY RESEARCH LAB UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 6-3-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	MINERALS/OTHER
0	70	OVERBURDEN	0	70	OVERBURDEN	
70	93	ANDESITE LAVA FLOWS Dark to medium green fine-grained feldspar-phyric massive to slightly amygdaloidal lava flows; feldspars up to 1mm, grey (fresh) to grey-green (chlorite-altered); sharp, but broken, contact at 93'	70	93	CHLORITIZED FELDSPAR Groundmass generally fresh with 5-10% chloritized and locally hematized feldspar; 5-10% 1-2mm black biotite at 92-93' = hornfels.	
93	101.5	MAFIC DIKE (LAMPROPHYRE?) Green to red-brown fine-grained pyroxene-amphibole phyric mafic dike; phenocrysts now altered to chlorite, 1-2mm, ellongate to tabular, 5-7%.	93	101.5	HEMATITE ± CHLORITE Red-brown stained groundmass due to fine hematite; pyroxene/amphibole now retrograded to chlorite.	Tr.-1% disseminated py
101.5	128	ANDESITE LAVA FLOWS Variable from massive to locally amygdaloidal, aphyric to plagioclase-phyric (locally glomeroporphyritic) andesite. 101.5-117.5: Alternating massive and amygdaloidal zones suggest possible pillows; vfg chlorite-epidote-rich rinds up to 5cm in width; plagioclase glomerocrysts 5mm-1cm, tan to pale green (epidote alt'd) 3-5%. 117.5-128: Massive fine-grained plagioclase-phyric (,1mm, tabular, 10-15%); local 1cm wide epidote-rich bands may be pillow selvages.	101.5	189	CHLORITE + EPIDOTE Minor chloritization of groundmass with local epidotization (up to 5%) of plagioclase phenocrysts; rock overall relatively unaltered.	Tr-1% disseminated py, up to 2mm; anhedral to cubes. 174.3': 5mm wide py vein
128	134	MAFIC DIKE (LAMPROPHYRE?) Same as 93-101.5				
134	182	PILLOWED ANDESITE LAVA FLOWS Pale to medium-green andisite pillows typically containing 1-5% 1-7mm grey oval quartz amygdules near pillow margins; hyaloclastite(?) between flows is very fine grained and locally difficult to recognize; local greenish-yellow epidote-rich 2-5mm feldspar glomero-crysts; many small lamprophyre dikes at 158-159', 161-163'; quartz-feldspar porphyry dikes at 170=-171', 173-174'.				
182	189	MAFIC DIKE (LAMPROPHYRE?) Similar to 93-101.5'; 10-15% disseminated 1-3mm chlorite blades, possibly after amphibole.				
189	223	PILLOWED ANDESITE LAVA FLOWS	189	223	CHLORITE + PATCHY EPIDOTE	Tr-2% disseminated py

		Same as 134-182: local 0.5-2.0 cm chlorite-rich selvages containing 1-3% <1-2mm pyrite cubes. 205': selvages at 45° C.A.			Similar to 134-182;major difference is local 5-20cm wide bands of epidote which comprise up to 5% of this section of core; groundmass generally fresh to slightly chlorite-rich.	within lava flows; up to 5% <1-2mm py cubes within selvages.
223	276	<u>QUARTZ-FELDSPAR PORPHYRY INTRUSION</u> Pale grey to pale white quartz-feldspar porphyry with 1-8mm (avg. 2-3mm) pale white to grey tabular feldspar phenocrysts, 10-15%; 1-2% grey to clear, <1mm angular quartz phenocrysts; locally intrude by lamprophyre dikes described above; intrusion and dike contacts vary from 20-30° C.A..	223	276	<u>MINOR CARBONATE</u> Generally least altered with local grey-pink carbonate ± quartz veining which is most intense at 229-231', 240-250', 271-272'. 267-273: patchy quartz ± epidote bands,10%, 1-5cm wide.	247-248: 1-2% <1mm disseminated py 248-251: 2-5% <1-5mm blocky disseminated to vein py, locally associated with chlorite-quartz veins 265.3-265.4: 3% disseminated py in yellowish band of quartz-carbonate.
276	288	<u>MAFIC VOLCANICLASTIC SEDIMENTS</u> Interbedded mafic to intermediate siltstones that grade downward into debris flow deposits that contain epidote-rich scoria/pumice lapilli, up to 5%; possible very fine grained (<<1mm) quartz grains present in matrix.	276	288	<u>CHORITE ± EPIDOTE</u> Generally fresh with up to 5% patchy epidote alteration of vesicular fragments.	276.2-276.5: 5-10%py
288	322	<u>ANDESITE LAVA FLOWS/FLOW BRECCIAS</u> Dark green, locally moderately foliated massive basalt/andesite lava with local zones of flow breccia.	288 312 316	312 316 322	<u>CHLORITE + EPIDOTE</u> Chlorite-rich groundmass with 5-10% blotches of apple green epidote. <u>CHLORITE + QUARTZ + HEMATITE</u> Chlorite-rich matrix with 10-15% 3-8mm wide quartz-rich veins; red-brown hematite, up to 5%. <u>CHLORITE + EPIDOTE</u> Same as 288-312: hematite stringers parallel to foliation, tr-5%; up to 5% 1-3mm chlorite-rich pyx/amph pseudomorphs.	Tr-1% disseminated py with local 1-3mm wide py-rich veins.
322	328	<u>MAFIC DIKE (LAMPROPHYRE?)</u> Same as 93-105'.	322	326	<u>HEMATITE ± CHLORITE</u> Same as 93-105.	
328	339	<u>AMYGDALOIDAL PILLOWED ANDESITE LAVAS</u> Pale to medium green andesite with local 1-6mm oval-round white/grey quartz-filled amygdules; local mafic hyaloclastite/siltstone horizons	326	339	<u>CHLORITE + EPIDOTE</u> Same as 276-288': 5% 1-3mm hematite veins at 337-338'.	
339	343.5	<u>OXIDE FACIES IRON FORMATION</u> Banded magnetite-chert iron formation with 3-10mm wide magnetite bands and chert horizons up to 5cm wide. Banding at 25 248° C.A.	339	343.5	<u>LEAST ALTERED</u>	1-5% py in 1-5mm wide veins parallel to magnetite-chert banding.
343.5	358	<u>AMYGDALOIDAL ANDESITE LAVA FLOWS</u> Pale green grey aphyric andesite with 5-15% 1-6mm (avg 2mm) grey oval quartz filled amygdules. Sharp	343.5	358	<u>EPIDOTE (MINOR)</u> Relatively fresh with minor increase in vfg epidote in matrix (5-7%)	

		lower contact.				
358	369	FELDSPAR-PHYRIC ANDESITE LAVA FLOWS Pale green grey massive to amygdaloidal andestite; 1-2% 2-5mm oval chlorite filled amygdules; sharp basal contact at 15° C.A.	358	369	EPIDOTE Very fine-grained epidote, 10-20%.	
369	387	BANDED OXIDE FACIES IRON FORMATION Finely to coarsely banded (1mm- 3 cm) magnetite chert iron formation; local gritty horizons may be silty to fine sand intermediate to felsic volcaniclastic sediments.	369	387	LEAST ALTERED Relatively unaltered Algoma-type iron formation with minor thin veins of py.	369-380: Tr-1% py in 1-3mm wide veins. 380-381: 1-2cm massive po veins. 381-385: Up to 5% po/py veins 385-386: semi-massive banded py. 386-387: Same as 381-385.
387	396	AMYGDALOIDAL ANDESITE LAVA FLOW Same as 328-334.	387	396	EPIDOTE Very fine grained epidote, 10-15%; chloritized feldspars, 5-10%.	
396	410	BANDED OXIDE FACIES IRON FORMATION Grey to white chert with impure chert magnetite horizons (0.5-3.0cm thick); slightly to moderately magnetic.	396	410	CHLORITE 5-10% very thin (<1-5mm) veins of dark green chlorite in chert-magnetite iron formation.	408-410: 2-5% <1-6mm euhedral py cubes and veins (up to 1 cm wide) of 1-2mm py cubes.
410	412	FRAGMENTAL OXIDE FACIES BANDED IRON FORMATION Fragmental and broken iron formation.	410	412	EPIDOTE Same as 396-410.	2-5% 1-2mm pyrite cubes
412	425	BEDDED VOLCANICLASTIC SILTSTONES Silicified light grey to green-grey very fine grained felsic tuffaceous siltstones; vaguely banded with tr-1% <1mm quartz grains.	412	425	SILICIFICATION + CHLORITE Soilicified matrix cut by pale blue-green chlorite veins, 5-10%; at 420-425', 10-15% dark green chlorite	1-8% disseminated to banded (up to 5cm wide) massive to semi-massive py
425	431	SULFIDE-CHERT EXHALITE Stringer sulfides in chert matrix.	425	431	BANDED CHLORITE/AMPHIBOLE 1mm-30cm thick veins of pale blue-green chlorite/amphibole.	5-15% stringery pyrite gradational at 430-431 into massive sulfide
431	443	MASSIVE SULFIDE Banded to brecciated chert/pyrite exhalite and banded to brecciated py-sp; banding at 440-443'; breccaited at 437-440', may = chimney collapse breccia (?) NOTE: from 431'-443', only 42" of core recovered.	431	443	CHLORITE 10-30% chlorite veins and stringers mixerd with banded breccia and massive sulfide.	431-432: 10-80% stringer to massive py, tr. sp. 432-440: py breccia, 50-75% with tr-5% very fine grained sp 440-443: banded py-sp massive sulfide; py 50-60%, sp 10-30%.
443	462	ALTERED RHYOLITE ASH TUFF Very fine grained, strongly altered banded (bedded?) ash tuff deposits containing tr-2% <1mm clear to grey	443	454	SERICITE Pale grey green to tan sericite (20-30%) interbanded with up to 10% fine 1-3mm chlorite-	443-453: bands up to 1cm wide of disseminated py (2-10%)

		angular quartz phenocrysts.			rich bands; pinkish color at 443-445 may be very fine grained andalusite.	with up to 1% sp. 453-462: trace <1mm disseminated py
			454	462	SERICITE + KAOLINITE 40-80% tan to white sericite with local white massive to semi-massive kaolinite (pyrophyllite/)	
462	492	BEDDED RHYOLITE ASH TUFF/TUFFACEOUS SEDIMENTS Variable from green, massive sediment with 10-20% fragments up to 5mm (462-465') to grey to grey brown bedded ash containing tr. <1mm quartz grains/ phenocrysts; banding at 25-50° C.A. suggests alteration; appears to gradually coarsen down hole; gradational lower contact.	462	483	SERICITE ± CHLORITE Tannish-grey sericite-rich matrix with local 1-2mm chlorite patches up to 5%; Brown sericite/chlorite matrix with 5-10% patchy brown iron carbonate. 466-468: faint green stain on core may = copper staining or fuchsite.	Tr-5% <1-2mm disseminated euhedral py. 489-492: tr-3% disseminated to banded (up to 1cm wide) py
			483	492	SERICITE ± CHLORITE Grey-tan fine grained sericite-rich matrix (20-25%) with tr-3% disseminated chlorite.	
492	589	ALTERED FELSIC TUFF/TUFFACEOUS SEDIMENTS Strongly altered very fine grained ash tuff or tuffaceous sediments; faint banding suggests relict bedding; faint mottled texture may be indicative of fragment-rich horizons; rock best described as chlorite-sericite schist; foliation variable from 521-582' at 20-30° C. A. 541-542: bedding contact at 25° C.A.	492	510	MASSIVE CHLORITE ± SERICITE Massive chlorite + sericite with 1-3mm silicified bands (10-15%) associated with stringer py.	tr-3% disseminated to banded (up to 1cm wide) py
			510	521	CHLORITE ± SERICITE ± SECONDARY FSP Massive chlorite + sericite with secondary feldspar psuedomorphs ranging from 5-20%.	
			521	536	MASSIVE CHLORITE ± SERICITE Same as 492-510.	
			536	554	MASSIVE CHLORITE ± SERICITE Massive chlorite-sericite matrix with local 0.5-2.0 foot wide zones with 5-10% red-brown to tan kaolinite ± carbonate-altered feldspar pseudomorphs; white kaolinite at 541-542	
			554	589	MASSIVE CHLORITE ± SERICITE Same as 536-554; strong sericite + iron carbonate at 567-570.	
589	592	LOST CORE No core recovered.	589	592	LOST CORE No core recovered.	
592	613	ALTERED FELSIC TUFF/TUFFACEOUS SEDIMENTS Similar to 492-589: variable from green to pale tan color; possible synvolcanic fault zone at 592-585' represented by kaolinite (592-593), banded chlorite-sericite (593-593.5), kaolinite + sulfides (593.5-595); 599-606: altered felsic tuff/tuffaceous sediments	592	593	MASSIVE KAOLINITE	
			593	593.5	BANDED SERICITE + CHLORITE	
			593.5	595	KAOLINITE + SERICITE	
			595	599	CHLORITE Same as 510-521.	
			599	606	KAOLINITE + SERICITE (PYROPHYLLITE?)	
			606	610	LOST CORE	
			610	613	SEMI-MASSIVE CHLORITE + SERICITE Massive chlorite with up to 10% sericite.	
613	625	SYNVOLCANIC FAULT ZONE	613	616	BANDED KAOLINITE + CHLORITE	613-624: 2-5% <1-3mm

		Highly fractured; moderately foliated at 30° C.A; composed of alternating bands of kaolinite/sericite, chlorite, iron carbonate.			Trace-5% brown iron carbonate also present.l	euhedral; py, locally banded; tr-1% sp?
			616	618	CHLORITE + Fe-CARBONATE Chlorite-rich (30-40%) with 20% 1-5mm blocky to rhomb-shaped brown iron carbonate.	
			618	622	KAOLINITE + SERICITE	
			622	625	BANDED CHLORITE + SERICITE	
625	648	INTERMEDIATE/FELSIC (?) TUFFACEOUS SILTSTONES Massive, fine-grained medium green chlorite-rich tuffaceous sediment. NOTE: Lost core 641-646 has fragments of quartz-pyrite mineralization and may be a synvolcanic fault	625	629	KAOLINITE + CHLORITE Massive 50/50 mix of chlorite and kaolinite	629-632: up to 5% <1mm euhedral py in vugs 632-641: tr-2% disseminated py. 641-648: 1-2% disseminated <1mm py
			629	630	CHLORITE Same as 510-521.	
			630	632	BANDED CHLORITE + QUARTZ Quartz lenses up to 1cm wide.	
			632	634	BROKEN CORE – SYNVOLCANIC FAULT? Associated with banded quartz and chlorite.	
			634	641	MASSIVE CHLORITE	
			641	648	BROKEN CORE – SYNVOLCANIC FAULT Chlorite-rich with local kaolinite.	
648		END OF HOLE	648		END OF HOLE	

PROJECT 326

DDH: SL-2
COMPANY: Exxon
TOTAL DEPTH: 400 feet
AZIMUTH: 180 COLLAR DIP: -50°
T: 61 R: 14 S: 08
NAD27 UTME: 563506 UTMN: 5291986
NAD83 UTME: 566791 UTMN: 5262554

LOGGED BY: G. HUDAK
UNIVERSITY OF MINNESOTA – DULUTH

DATE CORE LOGGED: 6-9-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	60	OVERBURDEN	0	60	OVERBURDEN	
60	129	INTERMEDIATE VOLCANICLASTIC SEDIMENTS Grey, massive, fine grained; vague normal grading present	60	129	LEAST ALTERED Green chlorite-rich matrix with 3-8% apple green very fine grained disseminated epidote	
129	180	AYGDALOIDAL ANDESITE LAVA FLOWS Massive to amydaloidal pillows with 0.5-2.0' thick interflow sediments and/or hyaloclastite horizons; amygdules up to 5%, 2mm – 1 cm in diameter; feldspar phenocrytst <1mm, 5-10%, tabular 175-179: Amygdules increase from <1-5%, 2-6mm in diameter, oval, quartz + chlorite filled 179-180: Very fine grained chlorite ± biotite with local ameboid to angular lapilli flow breccia	129	180	LEAST ALTERED Typical greenschist grade assemblage with local 1mm-1cm quartz veins; quartz and chlorite concentrated at flow margins;	
180	205	FELSIC ASH TUFF/TUFFACEOUS SILTSTONE Grey to dark green, variably altered and mineralized very fine grained felsic ash/tuffaceous siltstone; trace <1mm quartz phenocryts/grains present; vague banding may be bedding	180	196	CHLORITE Very fine grained replacement of matrix with chlorite + quartz; local banded green chlorite with quartz ranging from 5-10mm in thckness	180-201: tr-3%po 201-202: 10% po, 1-3% cp(?) in qtz-chlorite vein 202-205: tr po
			196	205	PATCHY SILICIFICATION Grey to pale grey silica rich matrix cut by thin chlorite – sulfide veins 1mm-1cm wide	
205	208	CHEMICAL SEDIMENTS Variable from chert to chert-magnetite banded iron formation; semi-massive sulfide at 206-206.5.	205	205.5	SILICIFIED Chert with 10% 1-5mm veinlets of black chlorite or graphite	205-206; nil 206-206.5: 1-2% po 206.5-207: 2" massive to semi massive sulfide 207-207.5: 5%po, tr cp 207.5-208: chert-magnetite banded iron formation
			205.5	207.5	CHLORITE 40% chlorite associated with sulfide mineralization.	
			207.5	208	LEAST ALTERED Chert-magnetite banded iron formation	
208	373	AMYDALOIDAL ANDESITE LAVA FLOWS/BRECCIAS Grey green to green, variably altered amygdaloidal andesite lava flows; flow contacts brecciated and locally contain hyaloclastite; locally feldspar phyric (3-8% <1mm tabular tan to ivory colored plagioclase)	208	210	SILICIFIED Light grey silicified matrix (up to 80%) with 10-15% 1-5mm chlorite-rich veins give pseudobreccia appearance.	208-210: up to 5% patchy po 210-231: tr-nil sulfides 231-232: 2-5% patchy po 232-235: nil 235-236: 50% sulfides

		208-210: altered flow breccia 210-219: amygdaloidal flow with 5% 2-8mm quartz ± chlorite amygdules 219-222: brecciated, altered amygdaloidal flow breccia 222-228: amygdaloidal andesite flow with 5% 3-13mm (avg. 5mm) grey oval quartz-rich amygdules. 228-228.5: very fine grained chlorite-rich massive flow selvedge 228.5-229: angular flow breccia fragments up to 2cm in diameter 229-234.5: altered andesite lava flow locally containing 2-3% quartz-chlorite-pyrrhotite amygdules up to 5mm in diameter 234.5-236: semi-massive po with 3-5% patchy cp 236-238: flow breccia 238-252: amygdaloidal andesite with 2-5% 3-10mm quartz rich oval amygdules 252-258: altered amygdaloidal flow breccia with possible flow contact at 254-255. 258-274: amygdaloidal andesite with up to 2% 2-5mm oval quartz amygdules 274-287: dominantly angular flow breccia and hyaloclastite containing up to 50% angular chlorite-rich andesite fragments 287-364: grey-green amygdaloidal andesite flow; flow contact zones (287-295, 355-364)_ have up to 5% quartz-rich oval amygdules up to 5mm in diameter; 364-373: altered amydaloidal flow breccia with 5% 1-5mm oval quartz ± chlorite amygdules	210	218	CHLORITE + BIOTITE Relatively unaltered chlorite-rich matrix with up to 5% <1mm finely disseminated biotite	associated with patchy epidote alteration 236-274: nil 274-280: up to 5% disseminated po, up to 2% cp replacing hyaloclastite matrix 280-370: nil to tr po 370-371: 1% disseminated po 371-373: nil to tr. po
			218	221	PATCHY SILICIFICATION + CHLORITE Grey matrix contains 5mm-2cm patches with silicified margins and chlorite-rich cores: also fracture controlled veins containing silicified margins and chlorite-rich cores; chlorite characterized by pale blueish-green color	
			221	229	CHLORITE + BIOTITE Same as 210-218.	
			229	231	PATCHY SILICIFICATION + CHLORITE Similar to 218-221: patches with silicified rims and chlorite-quartz cores; patches up to 1.5cm in diameter, 5-10%; silicified bands up to 2cm wide contain 10-20% <1mm finely disseminated chlorite	
			231	234.5	CHLORITE + BIOTITE Same as 210-218	
			234.5	238	PATCHY SILICIFICATION + CHLORITE Similar to 229-231: dominantly silicified with 10-25% chlorite bands up to 5mm in width	
			238	252	CHLORITE + BIOTITE Same as 210-218	
			252	258	PATCHY CHLORITE – SILIC. – EPIDOTE Patchy silicification and pale green epidote (up to several cm width), 30-50%; chlorite –rich groundmass with chlorite rich amygdules	
			258	269	CHLORITE + BIOTITE Same as 210-218	
			269	273	PATCHY SILICIFICATION + CHLORITE Same as 218-221: good angular alteration breccia at 272-273 composed of silicified fragments with chlorite-rich veins	

			273	279	CHLORITE Chlorit-rich matrix in flow breccia	
			279	282	PATCHY SILICIFICATION + CHLORITE Same as 269-273	
			282	285	CHLORITE Same as 273-279	
			285	291	BANDED SILICIFICATION + CHLORITE Greyish-pink silicified bands with 10-15% patchy chlorite (up to 4cm in diameter); local fracture controlled silicification 290-291.	
			291	364	LEAST ALTERED Relatively unaltered andesite flows with local grey areas of minor silicification	
			364	371	PATCHY SILICIFICATION + CHLORITE Same as 279-282	
373	378	INTERFLOW SEDIMENTS Grey green, very fine grained	371	400	CHLORITE ± BIOTITE Same as 210-218; local zones up to 1 foot thick of patchy silicification at 383-384, 395-396.	Nil
378	400	AMYGDALOIDAL ANDESITE FLOW BRECCCIA Similar to above; flow breccias most obvious at 383-385, 393-395, 398-400; lavas contain 2-3% oval to subrounded quartz-rich amygdules up to 5mm in diameter				378-400: nil to 1% disseminate po, concentrated in flow breccias
400		END OF HOLE	400		END OF HOLE	

	PROJECT 326		
	DDH: TL-4 TOTAL DEPTH: 313 feet T: 62 R: 12 S: 17	COMPANY: Bear Creek AZIMUTH: 360 COLLAR DIP: -45° NAD27 UTME: 582039 UTMN: 5300580 NAD83 UTME: 582095 UTMN: 5300790	LOGGED BY: G. HUDAK UNIVERSITY OF MINNESOTA – DULUTH DATE CORE LOGGED: 6-10-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	43	OVERBURDEN	0	43	OVERBURDEN	
43	63	BANDED OXIDE FACIES IRON FORMATION Banded black-grey-red brown-green oxiode facies iron formation with minor (5-15%) amounts of green silicate facies iron formation, 5-10% carbonate facies iron formation	43	63	IRON CARBONATE-GARNET-CHLORITE 5-10% brown iron carbonate, 10-15% <1-3cm bands of green chlorite, and 1-2% 1-3mm red almandine garnet	43-60: 20-50% magnetite 60-63: mixed facies iron formation
63	81	SILICATE FACIES IRON FORMATION Dark green massive to banded chlorite-rich iron formation with <1-5% disseminated <1-5mm subhedral garnet porphyroblasts; cherty, 79-81'.	63	81	CHLORITE + GARNET Garnet, 1-5%, <1-5mm within chlorite-rich matrix; 5-10% <1-2cm red brown bands of iron carbonate (?)	Nil
81	105	CHERT Tan to dark grey, massive to banded (bands up to 1' thick) chert / cherty exhalite	81	105	CHLORITE + IRON CARBONATE Up to 10% (generally <10%) 1-5mm veins of green chlorite; thin veins/bands up to 1cm wide of iron carbonate (up to 5%)	Generally no sulfides; up to 5% 1-5mm veins/patches of . hematite
105	152	QUARTZ FELDSPAR PORPHYRY INTRUSION Pale to medium grey tonalite porphyry with 20-25% 1-5mm subhedral grey to reddish tan plagioclase, and 1-2% 1-3mm grey quartz in fine grained siliceous groundmass 118-122: xenolith of cherty iron formation	105	152	MINOR HEMATITIZATION Relatively fresh with 2-5% reddish stains due to hematization of plagioclase	Nil
152	173	CHERTY CARBONATE/OXIDE FACIES IRON FMTN Banded iron formation varies from orange to brown carbonate facies to thinly banded (1-10mm) hematite-chert iron formation; banding at 35° to core axis at 165'.	152	173	LEAST ALTERED Relatively unaltered Algoma-type iron formation	Nil
173	238	GRAPHITE-RICH SHALE/ARGILLITE Dark grey, vaguely banded graphite shale with local (up to 10%) 1-5mm thick white chert horizons	173	238	LEAST ALTERED Relatively unaltered graphite shale/argillite; locally enriched in chlorite (<5-10%)	Up to 5% py locally associated with thin chert horizons
238	245	CARBONATE FACIES IRON FORMATION Pale brown carbonate-chert iron formation.	238	245	LEAST ALTERED Relatively unaltered iron formation	Tr-3% disseminated to banded <1mm pyrite
245	274	GRAPHITE-RICH SHALE/ARGILLITE Same as 173-238; gradational contact from 273-274.	245	274	LEAST ALTERED Same as 173-238.	245-274: tr-1% <1mm pyrite associated with chert horizons
274	313	FELSIC ASH TUFF/TUFFACEOUS SEDIMENT Light grey to dark grey banded ash/volcaniclastic	274	290	CHLORITE + GRAPHITE Dark green to dark grey banded	Tr-nil py, disseminated, <1mm

		siltstone with 1-3% <1mm clear quartz phenocrysts/grains and <1-2% <1mm tan to ivory colored tabular feldspar (plagioclase) phenocrysts/grains;appears to be bedded and normally graded.	290	313	chlorite/graphite (graphite 40-70%) 288-289: 50% white silicified veins (up to 5cm wide) with 5-10% <1mm disseminated chlorite CHLORITE + SERICITE Banded black to dark green chlorite(30-40%) and tan sericite (5-15%)	
313		END OF HOLE	313		END OF HOLE	

	PROJECT 326	LOGGED BY: G. HUDAK
	DDH: QH-84-2 TOTAL DEPTH: 243 feet T: 63 R: 13 S: 36	ECONOMIC VOLCANOLOGY RESEARCH LAB UNIVERSITY OF MINNESOTA – DULUTH
	COMPANY: St. Joe America AZIMUTH: 220 COLLAR DIP: -60° NAD 27 - UTME: 580246 UTMN: 5305954 NAD 83 - UTME: 580265 UTMN: 5306112	DATE CORE LOGGED: 6-12-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	OTHER
0	16	OVERBURDEN	0	16	OVERBURDEN	
16	42	MIXED CHEMICAL / CLASTIC SEDIMENTS Altered, vaguely banded light tan to pink carbonate-rich exhalites/ash tuff deposits and pale to medium green very fine grained intermediate to mafic mudstones.	16	19	CARBONATE ± SERICITE ± CHLORITE Up to 75 % pale tan to pink carbonate/sericite with 5-10% <1mm diss. chlorite, locally as 1-2mm wide by 1cm long lenses.	16-19: 2-5% py 19-20: Tr-1% py 20-25: 2-5% py 25-27: tr-2% py 27-30: tr-5% py 30-32: tr-1% py 32-33: 2-5% py 33-40: tr-2% py 40-42: tr-5% py
			19	20	CHLORITE ± CARBONATE ± SERICITE 50-70% chlorite, 20-25 % very fine gained carbonate/sericite	
			20	25	CARBONATE ± SERICITE ± CHLORITE S. A. 16'-19'.	
			25	27	CHLORITE ± CARBONATE ± SERICITE 30-40% <1mm diss-massive chlorite with 20-30% vfg carbonate/sericite	
			27	30	CARBONATE ± CHLORITE ± SERICITE Tan to pink carbonate ± sericite-rich (40-60%) matrix with 20% 1-3mm stringer chlorite.	
			30	32	CHLORITE ± CARBONATE ± SERICITE Green to pink matrix comprising very fine grained chl-cb-ser.	
			32	33	CARBONATE ± CHLORITE ± SERICITE S. A. 16'-19'.	
			33	40	MOTTLED CARBONATE ± CHLORITE ± SERICITE S. A. 27-30', but mottled appearance.	
			40	42	CARBONATE ± CHLORITE ± SERICITE S. A. 16-19'. May be carbonate facies iron formation?	

42	69	<u>BASALT/ANDESITE LAVA FLOW</u> Massive to slightly amygdaloidal altered basalt/andesite lava flows. Amygdules, when present, are up to 6mm in diameter, oval, and chlorite-rich. Epidote-rich zones up to 1' thick at 46-47', 56-57', and 68-69' may be flow contacts.	42	69	<u>CHLORITE + CARBONATE + EPIDOTE</u> Mottled to banded carbonate (up to 50%) in green chlorite-rich fine-grained groundmass. Epidote is pale apple green and concentrated to 5-8% at 46-47', 56-57', 68-69',	tr dissem py
69	89	<u>CLASTIC SEDIMENTS</u> Gray to tan, poorly bedded, strongly altered tuffaceous siltstones locally interlayered with debris flow horizons. Grading is either reverse, or stratigraphic tops may be downward in hole.	69 75 78	75 78 83	<u>CHLORITE ± CARBONATE ± SERICITE</u> Dissemenated chlorite (40%) in carbonate/sericite-rich matrix. <u>SILICIFICATION ± CHLORITOID ± ANDALUSITE(?)</u> Light grey silicified bands (25%) cross-cut pinkish matrix (andalusite?) with 5-15% 1-2mm chloritoid. <u>PATCHY SILICIFICATION</u> Pale grey matrix with 10-20% bands/patches of silicification ± chlorite	69-86: tr-1% diss py, local py veins 1-2mm, 5% 86-87: 5-8% py, tr cp replacing sediments 87-88: 2-3% diss py 88-89: 5-20% stringer to semi-massive py, tr cp
89	150	<u>BEDDED ASH TUFFS / EXHALATIVES</u> Aphyric to quartz-phyric (tr-2% 1-2mm quartz phenocrysts) ash tuff deposits with exceptional 1mm-1cm wide well preserved beds interlayered with cherty exhalite horizons up to 1 foot thick. Sulfides vary from semi-massive to massive, mimic bedding, and appear to be replacing/impregnating ash tuff deposits.	83 89 111 115 124	89 111 115 124 127	<u>SILICIFICATION + ANDALUSITE(?)</u> Pale-grey to pinkish-tan matrix (possibly andalusite-rich, 5-10%); tan color may be due to very fine grained sericite ± carbonate. <u>SILICIFICATION ± CHLORITOID ± ANDALUSITE (?)</u> Pale grey to greenish grey silicified matrix with 5-15% very fine grained chloritoid/chlorite; bands and patches of pink andalusite (?; 5-15%) locally associated with 5-20% 1-3mm dissemenated chloritoid. <u>BANDED ANDALUSITE (?) ± CHLORITOID</u> Pale grey to greenish grey silicified matrix with 5-15% very fine grained chloritoid/chlorite; bands and patches of pink andalusite (?; 5-15%) locally associated with 5-20% 1-3mm dissemenated chloritoid. <u>SILICIFICATION ± CHLORITOID ± ANDALUSITE (?)</u> Same as 89-111. <u>ANDALUSITE (?) ± CHLORITOID ± SILICIFICATION</u>	89-102: 1-5% diss / veins py 102-105: semi-massive to massive py (60%) w/ tr cp 105-127: 2-20% py replacing ash tuff horizons 127-133: massive py (up to 80%) w/ tr cp is banded, replaces ash tuff horizons 133-150: tr-1% py replacing bedding.

					Tan-pink quartz – andalusite(?) matrix with 5-10% dissemenated 1-3mm green chloritoid which is closely associated with sulfide mineralization.	
			127	132	SILICIFICATION ± CHLORITOID ± ANDALUSITE (?) Same as 89-111.	
			132	150	BANDED CHLORITOID ± ANDALUSITE/FELDSPAR Banded grey to pink silicified / andalusite (?) / secondary feldspar altered bedded ash with tr-5% dissemenated 1-3mm chloritoid.	
150	155	CHERT Light to dark grey, massive; may be very silicified fine ash tuff deposits.	150	155	CHLORITOID ± CHLORITE Up to 5% disseminated 1-2mm chloritoid; minor hematization present.	150-152: up to 10% py as fracture fillings
155	161	SEMI-MASSIVE TO MASSIVE SULFIDE Banded py (up to 20%), cp (trace) semi-massive sulfide graded downward into massive py (50-70%) at 157-161'.	155	161	SILICIFICATION ± CHLORITE Very fine-grained chlorite-rich matrix with local grey to reddish hematized chert horizons.	155-161: py-cp massive sulfide
161	243	BASALT/ANDESITE LAVA FLOWS Apple-green to dark green, massive to amygdaloidal (up to 5% qtz-filled oval amygdules up to 8mm in diameter) variably altered basalt/andesite lava flows. Local 1-foot thick interflow sediment horizons present locally. 240-243: Foliation at 10° C. A. becomes more prominent; end of hole may be near shear zone/fault. NOTE: Split core makes identification of exact location of flow contacts, and their contact relationships to adjacent flows/sediments difficult.	161 173 240	173 240 243	EPIDOTE ± CHLORITE Dark green chlorite-rich groundmass with 1-20% apple green epidote in veins/patches up to 2 cm wide; typically associated with stringer/disseminated sulfides and associated with up to 5% red brown vfg hematite. CHLORITE ± EPIDOTE ± SILICIFICATION Dark green chlorite-rich groundmass with 2-10% 2mm-2cm grey to white silicified patches; epidote patchy and in veins 5-10%, commonly associated with py; <1-3% hematite commonly present. EPIDOTE ± CHLORITE Apple green epidote 15-20% in dark green chlorite-rich matrix.	161-170: 2-5% stringer py assoc. w/ patchy ep altn 170-243: 1-4% patchy-stringer py; mainly fracture-controlled mineralization associated with ep altn.
243		END OF HOLE	243		END OF HOLE	

	PROJECT 326	LOGGED BY: G. HUDAK
	DDH: QH-85-4 TOTAL DEPTH: 303 feet T: 63 R: 13 S: 36	COMPANY: St. Joe America AZIMUTH: 021 COLLAR DIP: -60° NAD 27 - UTME: 580224 UTMN: 5305904 NAD 83 – UTME:580160 UTMN: 5305950

ECONOMIC VOLCANOLOGY RESEARCH LAB
UNIVERSITY OF MINNESOTA – DULUTH

DATE CORE LOGGED: 6-30-98

FROM	TO	LITHOLOGY	FROM	TO	ALTERATION	MINERALS/OTHER
0	3	OVERBURDEN	0	3	OVERBURDEN	
3	18	IRON FORMATION Variable from a) dark green chlorite-magnetite silicate facies to b) red-brown hematite-chlorite-rich oxide facies. Silicate-facies iron formation is magnetic, whereas oxide facies is faintly magnetic to non-magnetic.	3	18	CARBONATE ± EPIDOTE Tan iron-carbonate locally up to 30% in carbonate-rich horizons; up to 10% epidote in veins <1-2cm in width	tr diss. py
18	71	AMYGDALOIDAL BASALT/ANDESITE LAVA FLOW Dark green massive to amygdaloidal (1-5% 3mm-1cm amygdules). Amygdules oval, contain pale grey quartz, but locally have pyrite present. NOTE: Lower contact obscured by split core	18	71	PATCHY/BANDED EPIDOTE Dark green chlorite-rich groundmass with 5-15% apple green epidote in veins up to 2cm wide; up to 5% brownish-tan ankerite present; sulfides associated with both epidote and carbonate mineralization.	tr-5% py as diss. <1mm grains and in viens w/ epidote; locally py as amygdule fillings
71	84	ASH TUFF DEPOSITS Finely-bedded aphyric ash tuff deposits interbedded with ash tuff deposits containing 1-2% <1-2mm quartz phenocrysts. Ash tuff deposits replaced by py from 71-76 feet depths.	71 80	80 84	SILICIFICATION ± CHLORITOID Massive sulfide contains matrix of grey cherty silica with up to 5% disseminated 1-2mm chloritoid SERICITE ± ANDALUSITE (?) Tan sericite (± carbonate?) rich matrix with faint pinkish tinge which may be very fine grained andalusite (up to 5%)	71-76: 20-80% py replacing vfg ash; local oval py concentrations may be replacement of pumice 76-84: tr-2% diss. py
84	303	MASSIVE/AMYDALOIDAL BASALT ANDESITE LAVAS Variably altered, apple-green (epidote-rich) to dark green (chlorite-rich) lavas. Groundmass contains up to 2% <5-10mm oval quartz-filled amygdules. Rock is generally massive with little foliation or discernable flow contacts. 175-200: Foliation becomes better developed at 20° C.A. (179') to 10° C. A. (188'); Shear zone present at 190-195'. 278-281: Quartz-epidote-carbonate rock with many quartz veins may be a post-volcanic fault zone.	84 175 190	175 190 195	EPIDOTE ± CHLORITE Apple green veins of epidote (5-15%) in greenish-grey groundmass; rock locally pseudo-brecciated by 1-5mm wide veins of dark green chlorite CHLORITE ± QUARTZ Chlorite-rich, moderately to well-foliated groundmass w/5% 1-3mm wide quartz veins that are parallel to the foliation EPIDOTE ± CARBONATE ± QUARTZ Apple green epidote mixed with tan carbonate	84-303: tr-2% py in veins assoc. w/epidote

					± white quartz veins in intense part of shear zone; Ep 30-40%, Cb 30-40%, Qtz 20-30%	
			195	200	<u>**CHLORITE ± QUARTZ**</u> S.A. 175-190'	
			200	278	<u>**EPIDOTE ± CHLORITE**</u> S. A. 84-175'.	
			278	281	<u>**EPIDOTE ± CARBONATE ± QUARTZ**</u> Pale green epidote ± chlorite rich matrix (60-65%) cut by <1-2cm wide quartz ± ankerite veins	
			281	303	<u>**EPIDOTE ± CHLORITE**</u> S. A. 84-175	
303		<u>**END OF HOLE**</u>	**303**		<u>**END OF HOLE**</u>	

APPENDIX 3

PROJECT 326 PETROGRAPHY

APPENDIX 3
DIAMOND DRILL HOLE SAMPLE PETROGRAPHY

LITHOLOGICAL CODES

See Appendix 1 for description of lithological codes

ALTERATION CODES

See Appendix 1 for description of alteration codes

SAMPLE ABBREVIATIONS

SNUM	Sample Number	**PA**	Primary Alteration
DDH	Diamond Drill Hole	**SA**	Secondary Alteration
FOOTAGE	Sample location	**CHEM**	Chemistry (yes/no)
UTME	UTM Easting	**XTALS**	Phenocrysts/Grains
UTMN	UTM Northing	**MTX**	Matrix/Groundmass
RXTYPE	Rock type (Appendix 1)	**FRAG**	Fragments
TEXTURES	Textures (see below)	**AMYG**	Amygdules

TEXTURAL ABBREVIATIONS

1	Porphyritic	**7**	Ash (no Phenocrysts/Grains)
1a	Microporphyritic/Pilotaxitic	**8**	Quartz Chips
2	Massive	**9**	Banded Iron Formation
3	Amygdaloidal	**10a**	Crystal-rich Sediments (tuffaceous Sandstones)
4a	Fragmental (Pumice ± Scoria)		
4b	Fragmental - Monolithic	**10b**	Chemical Precipitate
4c	Fragmental - Heterolithic	**11**	Sheared/Well Foliated
5	Bedded/Laminated	**12**	Massive Sulfide
6	Graded Bedding	**13**	Stringer Sulfides
		14	Fault Gauge

MINERAL ABBREVIATIONS

QP	Quartz phenocryst	**PP**	Plagioclase phenocrysts
FP	K-spar phenocryst	**AM**	Amphibole Phenocrysts
PX	Pyroxene phenocrysts	**QM**	Quartz matrix
PM	Plagioclase matrix/groundmass	**FM**	K-spar matrix
QFM	Quartz/Feldspar matrix/groundmass	**HB**	Hornblende
S	Sericite	**P**	Pyrophyllite
BI	Biotite	**IC**	Iron-rich Chlorite
MC	Magnesium-rich Chlorite	**GR**	Graphite
EP	Epidote	**ZST**	Zoisite
CB	Carbonate (all varieties)	**CT**	Chloritoid
STP	Stilpnomelane	**ACT**	Actinolite
ANTH	Anthophyllite	**GT**	Garnet
RT	Rutile	**AN**	Andalusite
KY	Kyanite	**TO**	Tourmaline
Z	Zircon	**AP**	Apatite
SF	Secondary Feldspar	**BR**	Brookite
LX	Leucoxene	**PY**	Pyrite
PO	Pyrrhotite	**CPY**	Chalcopyrite
SP	Sphalerite	**GN**	Galena
MG	Magnetite	**IL**	Ilmenite
TR	Tremolite	**SC**	Scapolite
H	Hematite	**L**	Limonite/Iron Oxide
AL	Allanite	**F**	Fuchsite
U	Unknown		

FRAGMENT ABBREVIATIONS

PU	Pumice	**SC**	Scoria
PS	Pumice / Scoria	**BP**	Banded Pumice
FL	Felsic Lithic Fragment	**ML**	Mafic Lithic Fragment
CF	Chlorite-rich Fragment	**CHT**	Chert
FP	Felsic Plutonic Fragment	**MP**	Mafic Plutonic Fragment
GF	Graphite-rich Fragment	**IF**	Iron Formation Fragment

TABLE 3a
PETROGRAPHIC DATA
TECK FIVE MILE LAKE

SAMPLE NUMBER	HOLE	DRILL FT	MTR	UTME NAD27	UTMN NAD27	LITH	PA	SA	TX	CHEM	P/G	MTX	CL	AMY	OP	PP	FP	QFM	S	IC	MC	CB	ACT	EP	OP	SUM	SC	LF
							Summary Data											*Mineralogy*									*Clasts*	
3260000093	SXL-1	115	34.898	564958.57	5296858.56	1a	0			X	0	98	0	2	0	0	0	70	0	0	0	7	0	20	3	100	0	0
3260000094	SXL-1	158	48.004	564957.28	5296849.39	4f	1			X	0	100	0	0	0	0	0	72	15	0	3	5	0	0	5	100	0	0
3260000096	SXL-1	209	63.7	564955.73	5296838.4	1d	3a			X	5	90	0	5	0	5	0	22	10	0	25	2	0	35	1	100	0	0
3260000097	SXL-1	259	78.939	564954.23	5296827.72	1a	4	8		X	2	83	0	15	0	2	0	20	25	52	0	0	0	0	1	100	0	0
3260000098	SXL-1	302	92.045	564952.94	5296818.54	1h	4	8			0	25	35	40	0	0	0	20	40	30	0	1	0	0	9	100	35	0
3260000099	SXL-1	327	99.512	564952.21	5296813.32	1h	3a			X	0	45	25	30	0	0	0	22	25	5	0	1	0	45	2	100	25	0
3260000100	SXL-1	361	110.03	564951.17	5296805.95	1e	8a	9			0	100	0	0	0	0	0	68	20	0	10	1	0	0	1	100	0	0
3260000101	SXL-1	375	114.14	564950.77	5296803.08	1h	4	8			0	85	20	15	0	0	0	25	35	35	0	2	0	0	3	100	20	0
3260000102	SXL-1	384	117.04	564950.48	5296801.05	1h	3a			X	0	100	0	0	0	0	0	1	30	0	24	5	0	40	0	100	0	0
3260000105	SXL-1	461	140.51	564948.17	5296784.61	1a	4	8		X	0	95	0	5	0	0	0	32	15	50	0	0	0	3	0	100	0	0
3260000106	SXL-3	27	8.2292	564317.19	5296960.24	2a	3a	8		X	15	85	0	0	0	15	0	30	34	5	0	0	0	15	1	100	0	0
3260000108	SXL-3	115	35.05	564314.55	5296941.46	Db	1				0	100	0	0	0	0	0	60	0	0	0	3	33	0	4	100	0	0
3260000109	SXL-3	238	72.539	564310.86	5296915.21	2a	3a	8		X	5	85	0	10	0	5	0	37	32	0	0	0	0	25	1	100	0	0
3260000111	SXL-3	336	102.41	564307.82	5296894.29	1a	3a	8		X	0	100	0	0	0	0	0	40	13	0	5	0	25	15	2	100	0	0
3260000112	SXL-3	420	127.86	564305.42	5296876.47	1c	3a	8			0	100	0	0	0	0	0	40	26	3	0	10	0	20	1	100	0	0
3260000113	SXL-3	434	132.28	564304.98	5296873.37	1a	1				0	97	0	3	0	0	0	52	0	0	5	3	38	0	2	100	0	0
3260000115	SXL-2	33	9.9055	564476.02	5297008.06	1a	3a			X	0	100	0	0	0	0	0	53	5	0	0	0	30	10	2	100	0	0
3260000116	SXL-2	81	24.688	564474.57	5296997.71	1d	1	8			5	84	25	6	0	5	0	87	28	0	0	0	0	0	0	100	0	25
3260000119	SXL-2	111	33.831	564473.67	5296991.31	1d	3a	8			0	100	0	0	0	15	0	35	14	0	5	0	0	30	1	100	0	0
3260000121	SXL-2	179	54.557	564471.63	5296978.8	2a	1	8		X	20	80	0	0	20	5	0	50	13	0	0	0	0	10	2	100	0	0
3260000122	SXL-2	202	61.414	564470.96	5296972	2a	2	8		X	23	77	0	0	0	3	0	65	30	0	0	0	0	0	2	100	0	0
3260000124	SXL-2	238	72.539	564469.86	5296964.21	2a	3a	8		X	0	100	0	0	0	0	0	65	13	0	0	0	0	20	2	100	0	0
3260000125	SXL-2	264	80.463	564469.08	5296958.66	5i	4	8			0	97	3	0	0	0	0	72	17	10	0	0	0	0	1	100	3	0
3260000127	SXL-2	289	87.931	564488.35	5296953.43	1h	3a	8		X	0	15	45	40	0	0	0	27	22	0	2	2	0	45	2	100	45	0
3260000129	SXL-2	376	114.6	564465.72	5296934.75	1a	1				15	80	0	5	0	15	0	47	0	0	0	0	35	0	3	100	0	0
3260000131	SXL-2	423	128.92	564464.31	5296924.73	1h				X	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3260000132	SXL-2	453	138.07	564463.41	5296918.32	1h	3a			X	0	10	55	35	0	0	0	15	0	0	0	20	5	56	2	100	55	0
3260000133	SXL-4	6	1.8287	564868.82	5296938.72	1e	4	8		X	8	87	5	0	3	5	0	67	15	8	0	0	0	0	1	100	5	0
3260000134	SXL-4	44	13.411	564867.68	5296930.61	1e	4	8			0	100	0	0	0	0	0	65	15	20	0	0	0	0	0	100	0	0
3260000135	SXL-4	80	24.23	564866.62	5296923.03	1h	3a	8		X	0	0	60	40	0	0	0	20	33	0	10	10	0	25	2	100	55	5
3260000146	SXL-4	320	97.379	564859.42	5296871.61	1h	4			X	0	0	55	45	0	0	0	33	10	36	0	0	0	20	1	100	55	0
3260000152	SXL-4	473	144.16	564854.81	5296839.06	1h	3a	8		X	0	43	52	5	0	0	0	7	18	0	12	7	0	55	1	100	50	2
3260000155	SXL-4	489	149.04	564854.33	5296835.64	1a	3a	8		X	5	95	0	0	0	5	0	0	30	0	0	10	0	55	0	100	0	0

TABLE 3b
PETROGRAPHIC DATA
NEWMONT EAGLE'S NEST

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	SA	TX	P/G	MTX	CL	AMY	OP	PP	QFM	S	P	IC	MC	CB	ACT	GRN	EP	TO	PY	PO	SP	MG	IL	OTH	SUM
								Summary Data																	*Mineralogy*								
3260000164	EN-4	210.5	64.16	570642.51	5297946.39	X	1a	3b		1a,2	5	95				5	27			18			30		18					2			100
3260000168	EN-4	335.5	102.26	570649.93	5297920.49		4abc	4		9		100					12	1		24		19	10		10			10		14			100
3260000178	EN-4	388.0	118.26	570653.05	5297909.62	X	4c	4	9	2		100					5			15		77					3					ZR tr	100
3260000185	EN-4	495.5	151.02	570659.43	5297887.35		3c?	8		2		100					1	64		32					3								100
3260000187	EN-4	512.0	156.05	570660.41	5297883.93	X	2e	8a(7)		7		100					35	37	10								8					KA? 10	100
3260000195	EN-4	651.5	198.57	570668.70	5297855.03		4b	4		2		100					5			66		2						25				IO 2	100
3260000202	EN-4	723.5	220.51	570672.98	5297840.12	X	1e	4	3b	4c	13	85	2		3	10	24			30		20			12			1					100
3260000208	EN-7	158.0	48.16	570230.81	5297910.11		1a	3b		1a,3	2	93		5		2	32			17			35		13		1						100
3260000211	EN-7	279.0	85.04	570237.56	5297884.92	X	1e	4		10a, 4a	1	99			1		34	17		25		20			3		tr						100
3260000217	EN-7	358.0	117.34	570243.47	5297862.86		4abc	4		9		100					1	tr		22		59						7		10		IO 1	100
3260000221	EN-7	427.0	130.14	570245.82	5297854.11		4d	4		2		100					3					15		78				3				IO 1	100
3260000224	EN-7	442.5	134.87	570246.68	5297850.88		4g	4		1a, 13	tr	100			tr		17			35		26						20	1			RT tr, IO 1	100
3260000226	EN-7	457.0	139.29	570247.49	5297847.86	X	2e	8		7	tr	99	1		tr		48	51									tr					BR? 1	100
3260000229	EN-7	487.5	148.50	570249.19	5297841.52	X	2b	8a	9?	1,4a	6	91	3		6		46	25		20							3					BR? tr	100
3260000233	EN-7	544.0	165.80	570252.34	5297829.76	X	2e	9		7,11	tr	100			tr		51				45	3					tr					BR? 1	99
2360000237	EN-7	603.5	183.94	570255.66	5297817.37	X	2e	8	9	7,11	tr	100			tr		43	49	3		4					tr	1					BR? tr, FP !	100
3260000238	EN-7	617.5	188.20	570256.44	5297814.46		2e	4		14		100					42			20		30						6	2				100
3260000241	EN-7	638.0	194.45	570257.59	5297810.19	X	2e?	4		1a,7,147	tr	100			tr		15			84											1	SF tr	100

EXPLANATION

FT	Footage	PA	Primary Alteration	MTX	Matrix / Groundmass
MTR	Meters	SA	Secondary Alteration	CL	Clasts
CHEM	X indicates available	TX	Textures	AMY	Amygdules
LITH	Rock Type	P/G	Phenocrysts / Sedimentary Grains		

SEE APPENDIX ONE LEGENDS FOR EXPLANATION OF LITHOLOGICAL, ALTERATION, MINERALOGICAL, AND CLAST CODES.

TABLE 3c
PETROGRAPHIC DATA
ST. JOE QUARTZ HILL

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD2T	UTMN NAD2T	LITH	PA	SA	TX	CHEM	P/G	MTX	CL	AMY	QP	PP	FP	QFM	S	P	IC	CB	CT	AN	EP	CZ	STP	ZR	PY	IL	OTH	SUM	PU	SC
							Summary Data																		*Mineralogy*								*Clasts*	
3260000273	QH-84-2	23.0	7.01	580243.75	5305951.32	4c	4		10b			100						17	30		10	33							4	6	LX? 6	100		
3260000278	QH-84-2	68.5	20.88	580238.29	5305946.00	1a, 1d?	4		3,4a	X	tr	65	20	15		tr		16	12		43	25			tr					2		100		20
3260000281	QH-84-2	89.0	27.13	580237.28	5305943.61	2e	5b		4a,7		tr	100	tr		tr			66	7		5						10		12			100	tr	
3260000282	QH-84-2	96.5	29.41	580236.55	5305942.74	2e	8	3a	1,4b		25	74	1		5	1	8	40	25		4					11			6			100		
3260000283	QH-84-2	104.0	31.70	580235.81	5305941.86	2e	5 (67)	8	1,4a		15	83	2		3		4	44	26				8						15		SP tr	100	2	
3260000285	QH-84-2	114.0	34.75	580234.83	5305940.69	2e	6		1a (10a	X	2	98			2			59	22				3	10		2		tr	2		TO tr, AP tr	100		
3260000289	QH-84-2	131.0	39.93	580233.17	5305938.71	2e	8 (7?)		1a (10e	X	tr	100			tr			67	16		1					3	1	tr	12			100		
3260000290	QH-84-2	132.0	40.23	580233.07	5305938.59	2e	6		7			100						69	11	10			2	tr			5		3			100		
3260000293	QH-84-2	142.0	43.28	580232.09	5305937.42	2e	5	10a	1	X	6	94			4			6	13				6		12	2			2		SF 53	100		
3260000295	QH-84-2	148.0	45.11	580231.50	5305936.72	2e	5 (67)	8	7	X	tr	100			tr			38	30				30						1		IO 1	100		
3260000297	QH-84-2	155.5	47.39	580230.77	5305935.85	2e	4 (5)		1 (10a)		2	98			2			45	35		8			1			1	tr	8		AP tr	100		
3260000301	QH-84-2	171.0	52.12	580229.25	5305934.04	1a	3b		2			100						7				5			48				2		ACT 38	62		
3260000305	QH-84-2	223.0	67.97	580224.15	5305927.97	1a	3b			X		100						29	tr							38				2	ACT 31	69		

TABLE 3d
PETROGRAPHIC DATA
HUMBLE OIL LITTLE LONG LAKE

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TX	P/G	MTX	CL	AMY	QM	PM	S	IC	MC	CB	GR	EP	ZST	PY	OTH	SUM
														Summary Data											
3260000001	LL-1	26.5	8.08	583685.95	5309536.63	x	D	3c	2	0	100	0	0	12	10	10		10	25		8		3	AL? 22	100
3260000004	LL-2	344.5	105.00	583871.38	5309897.23	x	O/T	3c	2	0	100	0	0	7		17		8				20	4	:3, PYX-	100
3260000007	LL-3	289.0	88.08	584005.30	5309725.47		3e	4	5,6	0	100	0	0	31		3	4		12	50					100

TABLE 3d (continued)
PETROGRAPHIC DATA
GARDEN LAKE DRILL CORE

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TEXT	PHENO/ GRAINS	MTX	CLASTS	AMY	PP	QM	PM	FM	S	BI	IC	MC	CB	ACT	EP	ZST	PO	MG	IL	OTH	SUM
																Summary Data														
3260000011	GL-1	156.0	47.55	596552.00	5309534.00		1a	4	2	0	100	0	0		6	26				47		15				2		4	Ltr	100
3260000013	GL-1	337.5	102.86	596552.00	5309534.00	X	1a	3a	1a,2	10	90	0	0		5			5		7		15	35	25	5	2		1		100
3260000015	GL-14	136.0	41.45	596446.00	5309225.00	X	1a	3a	2	0	100	0	0			26			25	3	25			20				1		100
3260000017	GL-14	428.5	130.6	596446.00	5309225.00		Sy	4c	2	0	100	0	0		6	20	25		35			12						2	APtr	100
3260000019	GL-14	271.5	82.76	596446.00	5309225.00	X	1a	4c	2	0	100	0	0	2	42		2	10				40				2	2		U1, late alb	100

TABLE 3d (continued)
PETROGRAPHIC DATA
J & L STEEL DIAMOND DRILL CORE

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TX	P/G	MTX	CL	AMY	QP	QM	S	IC	GR	CB	PO	MG	SUM
								Summary Data									*Mineralogy*					
3260000021	5406	280	85.34	590706	5309534		3e	1	2	0	100	0	0		16	5		74	3	2		100
3260000022	5406	466	126.84	590706	5309534	x	4e	1	9	0	100	0	0		66		6	16			12	100

EXPLANATION

FT	Footage	PA	Primary Alteration	MTX	Matrix / Groundmass
MTR	Meters	SA	Secondary Alteration	CL	Clasts
CHEM	X indicates available	TX	Textures	AMY	Amygdules
LITH	Rock Type	P/G	Phenocrysts / Sedimentary Grains		

SEE APPENDIX ONE LEGENDS FOR EXPLANATION OF LITHOLOGICAL, ALTERATION, MINERALOGICAL, AND CLAST CODES.

TABLE 3d (continued)
PETROGRAPHIC DATA
WHITESIDE RASPBERRY DIAMOND DRILL CORE

Summary Data

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TX	P/G	MTX	CL	AMY	PP	FP	QM	PM	S	IC	CB	ACT	EP	PY	IL	OTH	SUM
3260000026	RZ-1	142	43.28	580679.26	5306195.93	x	M	4c	2	0	100	0	0	50	30	5		4		8			3			100
3260000028	RZ-1	333	101.49	580641.96	5306213.33		M	6a	2	0	100	0	0	33	37	10		15		3			2		Ztr	100
3260000030	RZ-3	19	5.79	580728.29	5306259.73		1a	4	3	0	97	0	3			5	38	8	35	3		5		5	H1	100
3260000032	RZ-3	90.5	27.58	580714.33	5306266.24	x	1a	4c	3	0	97	0	3			5	45	5		38			7			100
3260000035	RZ-3	257	78.33	580681.80	5306281.41		1a	3a	3	0	97	0	3			8	5	7	15	1	31	28		5		100

TABLE 3d (continued)
PETROGRAPHIC DATA
BHP-UTAH SPAULDING BAY (SHAGAWA LAKE)

							Summary Data								Mineralogy										Clasts
SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TX	P/G	MTX	CL	AMY	QP	QM	S	IC	MC	CB	PY	SP	IL	OTH	SUM	PU
3260000042	SP-90-1	322.5	98.29	585975.47	5308054.61		5d	4d	0a7,1'	1	98	1	0	1	58	25			15			1		100	1
3260000044	SP-90-1	395	120.39	585969.72	5308066.94	x	5d	4d	11	0	100	0	0		21	11	15		50			3		100	
3260000045	SP-90-1	405.5	123.59	585968.89	5308068.72	x	5d	4d	0a7,1'	10	90	0	0	10	12	25			50	2		1		100	
3260000046	SP-90-1	424	129.23	585967.42	5308071.87		5d	4d	11	0	100	0	0		5	12	3		76	4		tr		100	
3260000048	SP-90-1	480	146.3	585962.98	5308081.4		5d	4d	11	0	100	0	0		20	20		1	57	2		tr		100	
3260000050	SP-90-1	524	159.71	585958.97	5308089.69		5d	4d	10a,11	1	99	0	0	1	20	26			48	2		1	Ztr, F2	100	
3260000051	SP-90-1	438	133.5	585966.31	5308074.25	x	5d	4d	10a,11	2	98	0	0	2	30	30			33	4	1	tr		100	

TABLE 3d (continued)
PETROGRAPHIC DATA
KERR-MCGEE SPAULDING BAY & MUD LAKE

							Summary Data															Mineralogy							
SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TEXT	P/G	MTX	CL	AMY	QP	PP	QM	PM	S	BI	IC	GR	CB	EP	ZST	LX	PY	SP	OTH	SUM
3260000054	20	38.5	11.73	587160.85	5308675.17		5d	4d	11?	0	100	0	0			25		2				71				2			100
3260000055	23-3	54.5	16.61	587159.13	5308675.17		1a	4	11	0	100	0	0			33		5		25		32				5			100
3260000056	23-3	84.5	25.75	587155.90	5308680.77	x	5d	4d	11	0	100	0	0			8		18		3		68						H3	100
3260000057	23-3	90.5	27.58	587155.25	5308681.89		5d	4d	11	tr	100	0	0	tr				20		20		57				1		H2	100
3260000061	23-3	247.5	75.43	587138.33	5308711.19	x	5d	4d	0a7,1'	1	99	0	0	1		10		25	5		2	55				2			100
3260000066	23-3	581	177.08	587102.39	5308733.44	x	1a	3b	1a	2	98	0	tr		2	5		5		8		5	40	35					100
3260000069	23-6	154	46.94	587116.77	5308632.42	x	5d	4d	11	0	100	0	0			20		10		2		59			4	5			100
3260000070	23-6	192	58.52	587120.31	5308625.61		5d	4d	0a7,1'	3	97	0	0	3		20		15		2		54			5	1			100
3260000072	23-6	296.5	90.37	587137.92	5308613.22		5d	4d	11	0	100	0	0			25		22				50			1	2			100
3260000073	23-6	319.5	97.38	587136.59	5308607.99		32b	4d	10a, 11	5	95	0	0	5		10		35				48			3	1			100
3260000080	23-6	561	170.98	587139.50	5308545.58	x	32b	4d	0a?, 1	3	97	0	0	3		12		25				53			6	1			100
3260000082	6214-2-1	115	35.05	568342.29	5303401.17		Db	3b	1	3	97	0	0	3			10	1		5		5	60		4			OL12	100
3260000083	6214-2-1	184	56.08	568337.67	5303413.87	x	Db	3b	1	10	90	0	0	10			10			12		2	50		6			OL10	100
3260000084	6214-2-1	279	85.04	568331.30	5303431.37		Db	4	1	10	90	0	0	5	2	26		20		15		25	3		4	1			100
3260000086	6214-2-1	400	121.91	568323.20	5303453.84	x	1a	4	1a,3	2	98	0	2		1	1	30	10		12		25	10		4			STP7	100
3260000087	6214-2-1	429.5	130.91	568321.22	5303459.07		4f	4c	10b	0	100	0	0			61		1				33				4	1		100
3260000089	6214-2-1	529.5	161.38	568314.52	5303477.48		1d7	3c	2,11?	0	100	0	0			3		12		15		15	53			2	tr		100

TABLE 3d (continued)
PETROGRAPHIC DATA
EXXON SKELETON LAKE DRILL CORE

Summary Data

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TX	P/G	MTX	CL	AMY	PP	PX	QM	PM	S	BI	IC	MC	CB	ACT	EP	ZST	LX	PY	PO	IL	OTH	SUM
3260000242	SL-2	68	20.73	583506.00	5291972.68		1a	3a	1A	2	98	0	0	1	1		15	1					20		3					SERP25	100
3260000246	SL-2	177.5	54.1	583506.00	5291951.23	x	1a	11	2	5	95	0	0	5			18		45		8		8	20		tr				RT1	100
3260000248	SL-2	188.5	57.45	583506.00	5291949.07		2e	3a	2	0	100	0	0			39						5	8	13	2			20			100
3260000250	SL-2	208.5	63.55	583506.00	5291945.15		1a	2	1,3	2	95	0	3	2		76				3				15			2			STP2	100
3260000252	SL-2	220	67.05	583506.00	5291942.90		1a	4	1a,3	2	93	5	0	2		5	50			10		5		8					tr	STP20	100
3260000254	SL-2	257	78.33	583506.00	5291935.65		1a	11b	1,3	2	86	0	12	2		14	60			3		3		13			tr			STP5	100
3260000259	SL-2	339.5	103.47	583506.00	5291919.49		1a	3a7	1,3	2	97	0	1				55	5				1	27	10	1						100
3260000261	SL-2	364.5	111.09	583506.00	5291914.59	x	1a	3a	3	0	100	0	0			8	42			15		18		25			2				100

EXPLANATION

FT	Footage	PA	Primary Alteration	MTX	Matrix / Groundmass		
MTR	Meters	SA	Secondary Alteration	CL	Clasts		
CHEM	X indicates available	TX	Textures	AMY	Amygdules		
LITH	Rock Type	P/G	Phenocrysts / Sedimentary Grains				

SEE APPENDIX ONE LEGENDS FOR EXPLANATION OF LITHOLOGICAL, ALTERATION, MINERALOGICAL, AND CLAST CODES.

TABLE 3D (continued)
PETROGRAPHIC DATA
BEAR CREEK TWIN LAKES

SAMPLE NUMBER	DRILL HOLE	FT	MTR	UTME NAD27	UTMN NAD27	CHEM	LITH	PA	TX	P/G	MTX	CL	AMY	PP	FP	QM	S	BI	IC	GR	CB	GT	EP	MG	OTH	SUM
														Summary Data												
3260000265	TL-4	71	21.64	582039.00	5300595.30	x	4d	1	9,11	0	100	0	0			51	8	20	15			5		tr		100
3260000269	TL-4	163.5	49.83	582039.00	5300615.24		4a	1	9,11	0	100	0	0			78									H22	100
3260000271	TL-4	289	88.08	582039.00	5300642.28		2ef	3a	10a	5	95	0	0		5	62	11			12	2		8			100
3260000272	TL-4	307	93.57	582039.00	5300646.16	x	2e	8a	I, 10a7	15	85	0	0	tr	15	59	8	8	1	8	1		2		ZRtr	100

EXPLANATION

FT	Footage	PA	Primary Alteration	MTX	Matrix / Groundmass		
MTR	Meters	SA	Secondary Alteration	CL	Clasts		
CHEM	X indicates available	TX	Textures	AMY	Amygdules		
LITH	Rock Type	P/G	Phenocrysts / Sedimentary Grains				

SEE APPENDIX ONE LEGENDS FOR EXPLANATION OF LITHOLOGICAL, ALTERATION, MINERALOGICAL, AND CLAST CODES.

TABLE 3e
PROJECT 318 PEBBLES
PETROGRAPHIC ANALYSES

SAMPLE NUMBER	CHEM	LITH	PA	SA	TX	P/G	MTX	CL	AMY	QP	PP	FP	QM	PM	QFM	S	BI	IC	MC	GR	CB	ACT	EP	ZST	LX	PY	PO	SP	MG	IL	OTH	SUM	FVL
3180100006	x	1a	3a		2,11	0	100	0	0				5	14									45	35						1		100	
3180100007	x	2e	8a	9	11	10	90	0	0		10		70			15		1	10								2				L1	100	
3180100025	x	4f	1		10b	0	100	0	0				79					tr				3				8		10				100	
3180100026	x	3c	4c		5,11	0	100	0	0				77			tr				10	5					7					H1	100	
3180100043/31	x	4b	1		10b	0	100	0	0								1					48	6				40				H5	100	
3180100052	x	1	3a		2	0	100	0	0				5			5		25				20	45									100	
3180100054	x	3a	4		10a	1	99	0	0	1			55			3		7				tr	31			4						100	
3180100056	x	4b	1		10b	0	100	0	0				75				10		1		6	2				5		1				100	
3180100059	x	4f	1		5	0	100	0	0				90				tr			6						2						100	
3180100061	x	4f	4c		10b	0	100	0	0				88					1		3	3					2					H3	100	
3180100062	x	4f	1		10b	0	100	0	0				93				tr									4					chalcedony 3	100	
3180100063	x	4f	1		10b	0	100	0	0				92							tr						8						100	
3180100067	x	3a	1		10a,11	3	97	0	0	3	tr		48	32		2	7	7					1									100	
3180100075	x	FP	1		1	45	55	0	0	5	15	25	51									tr				4						100	
3180100078	x	FP	1		1	40	60	0	0	5	10	25	48									3				3					H1	100	
3180100090	x	1a	3a		2	0	100	0	0				22									37	28	8		5						100	
3180100091	x	1a	3a		2	0	100	0	0				3	15		5						65	8				4					100	
3180100093	x	2a	2		1	2	97	1	0		2		62					15					20		1	2						100	1
3180100102	x	1a	3a		2	0	100	0	0				10	13								12	55			10						100	
3180100103	x	1a	2		2	2	98	0	0		2		10	41		5	15	15									12					100	
3180100104	x	2a	4c		2	0	100	0	0					10		5					42				1	2					TR25,U15	100	
3180100105	x	1f	1		2	0	100	0	0				10	15			1					65	3				4				Z2	100	
3180100106	x	2b	4c		1,8	2	98	0	0	2	tr		38			5					50					3					H2	100	
3180100108	x	3c	11		5,11	0	100	0	0				38					2		60												100	
3180100110	x	2a	4c		1,2	9	91	0	0	1	8		73			12					4					2						100	
3180100111	x	4f	1		10b	0	100	0	0				95							1						4						100	
3180100115	x	4f	1		5	0	100	0	0				91							7	tr										H2	100	
3180100121	x	1f	1		2	0	100	0	0				6	15		7						70				2						100	
3180100124	x	4d	1		10b	0	100	0	0				77							8						5					H10	100	
3180100127	x	4f	1		10b	0	99	1	0				79							2	10		5						3		U1	100	
3180100130	x	Gd	9		2	0	100	0	0				48	40		2	tr		7							3		tr				100	
3180100132	x	Gd	4		11	0	100	0	0				32	45			5	5	5							5					STP3	100	
3180100133	x	4f	1		10b	0	100	0	0				77													8					H5, chalcedony 1	100	
3180100138	x	4f	3a		10b	0	100	0	0				60					2				3		25		6		2			H2	100	
3180100140	x	2e	3a		7	0	100	0	0				43			18	1	3				7	18	4		3		tr			STP5	100	
3180100141	x	3e	4		5	0	100	0	0				55				3	5		25		1				11						100	
3180100142	x	3a	11a		2	0	100	0	0				51				40	1					8			2						100	
3180100143	x	4f	4		10b	0	100	0	0				80			8		8							1	3						100	
3180100145	x	2a	8	9	2	0	100	0	0				11	63		19			3							4						100	
3180100146	x	1f	8a		2	0	100	0	0				7	13		18	1	7								3					HB51	100	
3180100180	x	1a	3		3	1	89	0	10		1		12	33		3			5				25	20		1					Ztr	100	
3180000035		1a	3a		3	0	93	0	7				10	47		2					12	20	5			3				1		100	
3180000041	x	1a	3a		3	2	97	0	1				3	6			1				3	61	25			1						100	
3180000046	x	4f	1		10b	0	100	0	0				96							2								1			H1	100	
3180000047	x	2a	4d		2	0	100	0	0					47		5					40					5					H3	100	
3180000051		3a	1		11	0	88	12	0				73							5						2					L20	100	
3180000055	x	3c, 4f	1		5.6.10a	0	100	0	0	tr			96							2						1					L1	100	
3180000074	x	Db	3a		2	0	100	0	0					20		20	3					25	27			5						100	
3180000086	x	4f	1		10b	0	100	0	0				94							3						3						100	
3180000090		2a	8b		1	5	95	0	0	1	4				74	13					7					1						100	
3180100001	x	1a	3a		2	0	100	0	0				8									20	64			8						100	
3180100043	x	3e	1		5	0	100	0	0				35				15			20						30						100	
3180000082	x	1b	3a		4b7	0	100	0	0				2									48	27	3		20						100	
3180100112	x	1a	3a		2	0	100	0	0						25	3						36	30			6						100	
3180100116	x	1a	3a		2	0	100	0	0				10									29		1		60						100	
3180100148	x	1a	3a		2	0	100	0	0				3									67	22			8						100	

EXPLANATION

FT	Footage	PA	Primary Alteration	MTX	Matrix / Groundmass		
MTR	Meters	SA	Secondary Alteration	CL	Clasts		
CHEM	X indicates available	TX	Textures	AMY	Amygdules		
LITH	Rock Type	P/G	Phenocrysts / Sedimentary Grains				

SEE APPENDIX ONE LEGENDS FOR EXPLANATION OF LITHOLOGICAL, ALTERATION, MINERALOGICAL, AND CLAST CODES.

APPENDIX 4

DIAMOND DRILL CORE AND

PROJECT 318 PEBBLE LITHOGEOCHEMISTRY

Table 4a	**Project 326 Diamond Drill Core Lithogeochemistry**
Table 4b	**Project 318 Pebble Lithogeochemistry**

APPENDIX 4
DIAMOND DRILL CORE AND PEBBLE LITHOGEOCHEMISTRY

The following appendix summarizes the analytical methods, detection limits, and results of lithogeochemical analyses performed on Project 326 diamond drill core samples and Project 318 pebbles. The analyses were performed by Activation Laboratories Ltd. (Actlabs) located in Ancaster, Ontario, Canada. The following lithogeochemal techniques designed for exploration and research were performed:

— Whole Rock Analysis - Research Quality Fusion ICP (Actlab Code 4b)

SiO2	detection limit 0.01%	CaO	detection limit 0.01%
Al2O3	detection limit 0.01%	TiO2	detection limit 0.01%
Fe2O3	detection limit 0.01%	Na2O	detection limit 0.01%
MgO	detection limit 0.01%	K2O	detection limit 0.01%
MnO	detection limit 0.01%	P2O5	detection limit 0.01%
Ba	detection limit 2 ppm	Sc	detection limit 2 ppm
Sr	detection limit 2 ppm	Be	detection limit 1 ppm
Y	detection limit 2 ppm	V	detection limit 5 ppm

Trace Element Package (Exploration Grade) by Fusion ICP-MS (Actlab Code 4B Option 2)

Ag	detection limit 0.5 ppm	La	detection limit 0.1 ppm
As	detection limit 5 ppm	Ce	detection limit 0.1 ppm
Ba	detection limit 1 ppm	Pr	detection limit 0.05 ppm
Bi	detection limit 0.2 ppm	Nd	detection limit 0.1 ppm
Co	detection limit 0.5 ppm	Sm	detection limit 0.1 ppm
Cr	detection limit 10 ppm	Eu	detection limit 0.05 ppm
Cs	detection limit 0.5 ppm	Gd	detection limit 0.1 ppm
Cu	detection limit 10 ppm	Tb	detection limit 0.1 ppm
Ga	detection limit 1 ppm	Dy	detection limit 0.1 ppm
Ge	detection limit 1 ppm	Ho	detection limit 0.1 ppm
Hf	detection limit 0.2 ppm	Er	detection limit 0.1 ppm
In	detection limit 0.2 ppm	Tm	detection limit 0.05 ppm
Mo	detection limit 0.5 ppm	Yb	detection limit 0.1 ppm
Nb	detection limit 1.0 ppm	Lu	detection limit 0.04 ppm
Ni	detection limit 10 oom		
Pb	detection limit 5.0 ppm		
Rb	detection limit 0.5 ppm		
Sb	detection limit 0.1 ppm		
Sn	detection limit 1.0 ppm		
Sr	detection limit 0.1 ppm		
Ta	detection limit 0.05 ppm		
Th	detection limit 0.1 ppm		
Tl	detection limit 0.1 ppm		
U	detection limit0.1 ppm		
V	detection limit 5.0 ppm		
W	detection limit 0.5 ppm		
Y	detection limit 1.0 ppm		
Zn	detection limit 10 ppm		
Zr	detection limit 0.5 ppm		

Table 4a
Project 326 Diamond Drill Core Lithogeochemistry

SAMPLE	DDH	FOOTAGE	ROCKTYPE	SITE #	UTME	UTMN	SiO2 %	Al2O3 %	Fe2O3 %	MnO %	MgO %	CaO %	Na2O %	K2O %	TiO2 %	P2O5 %	LOI %	TOTAL %
3260000001	LL-1	26.5	D	N/A	583685.95	5309536.63	44.79	17.06	10.66	0.14	9.45	8.71	1.74	0.18	0.82	0.05	5.47	98.87
3260000004	LL-2	344.5	D/T	N/A	583871.39	5309897.23	46.37	15.39	12.20	0.18	8.39	11.06	1.31	0.19	0.79	0.06	3.17	99.12
3260000006	LL-3	150	3dc	N/A	583995.06	5309753.62	64.51	13.23	7.48	0.12	1.29	3.52	1.46	3.95	0.52	0.11	3.46	99.66
3260000013	GL-1	337.5	1a	N/A	596552.00	5309534.00	45.64	8.58	22.36	0.69	3.70	15.34	0.90	1.52	0.42	0.06	0.81	100.02
3260000015	GL-1	136	1a	N/A	596448.00	5309225.00	41.87	9.28	11.73	0.23	13.27	10.59	0.84	2.98	1.00	0.99	6.54	99.32
3260000019	GL-1	271.5	1a	N/A	596446.00	5309225.00	39.06	11.34	12.77	0.16	5.07	9.43	4.45	3.22	0.81	0.06	13.00	99.37
3260000022	5406	416.5	4a	N/A	590706.00	5309534.00	87.39	1.44	10.85	0.04	0.45	0.12	0.05	0.06	0.02	0.06	0.06	100.29
3260000026	RZ-1	142	M	N/A	580679.26	5306195.93	61.29	15.22	4.25	0.07	1.65	3.23	8.39	0.73	0.34	0.37	5.14	100.67
3260000027	RZ-1	207.5	M	N/A	580666.47	5306201.90	62.67	16.55	3.61	0.05	2.01	3.37	7.54	1.78	0.30	0.27	1.46	99.83
3260000032	RZ-3	90.5	1a	N/A	580714.33	5306266.24	48.24	12.87	9.00	0.22	2.55	6.40	8.61	0.91	1.50	0.19	7.50	95.79
3260000044	SP-90-1	395	5d	N/A	585969.72	5308066.94	46.54	10.68	14.14	0.29	3.45	8.51	0.57	0.83	1.46	0.26	12.17	96.90
3260000051	SP-90-1	538	5d	N/A	585966.31	5308074.25	55.93	11.29	10.97	0.11	1.86	4.95	0.63	2.61	0.29	0.08	10.34	99.06
3260000058	23-3	84.5	5d	N/A	587155.90	5308680.77	44.22	12.83	5.05	0.12	1.57	16.36	1.80	0.58	1.80	0.01	15.19	99.51
3260000061	23-3	247.5	5d	N/A	587138.33	5308711.19	42.38	13.59	8.44	0.18	4.19	9.97	1.87	1.37	0.95	0.08	16.02	98.85
3260000066	23-3	581	1a	N/A	587102.39	5308733.44	44.05	16.31	12.73	0.21	7.77	12.85	1.34	0.04	0.82	0.06	4.08	100.06
3260000069	23-6	154	5d	N/A	587116.77	5308632.42	33.71	13.22	11.77	0.32	6.02	11.50	0.61	1.65	0.62	0.08	15.56	95.05
3260000080	23-6	561	32b	N/A	587139.50	5308545.56	40.55	12.38	15.05	0.24	5.45	6.56	1.35	0.59	1.72	0.11	14.67	98.86
3260000083	6214-2-1	184	Db	N/A	568337.67	5303413.87	48.12	13.60	15.27	0.21	6.47	8.93	2.61	0.18	1.46	0.12	3.17	100.12
3260000086	6214-2-1	400	1a	N/A	568323.20	5303453.64	47.19	15.33	6.98	0.15	3.92	7.38	4.36	2.00	0.86	0.29	11.07	99.33
3260000093	SXL-1	114.5	1a	N/A	564958.57	5296858.56	57.37	15.56	7.02	0.26	6.46	5.45	4.84	0.20	0.46	0.09	3.02	100.54
3260000094	SXL-1	157.5	4f	N/A	564957.28	5296849.39	77.38	6.26	6.75	0.13	1.47	2.26	0.09	1.70	0.22	0.06	3.65	99.96
3260000096	SXL-1	209	1d	N/A	564955.73	5296838.40	56.32	15.49	8.97	0.45	7.32	5.44	1.01	0.56	0.47	0.09	4.26	100.37
3260000045	SP-90-1	405.5	5d	N/A	585968.89	5308068.72	40.38	12.38	16.05	0.48	6.98	2.41	1.20	1.49	1.29	0.19	16.71	99.58
3260000097	SXL-1	259	1a	N/A	564954.23	5296827.72	59.68	12.98	14.67	0.15	2.49	0.26	0.06	1.67	0.72	0.12	3.72	96.53
3260000099	SXL-1	326.5	1h	N/A	564952.21	5296813.32	52.97	18.59	9.16	0.53	2.58	9.02	0.39	2.48	0.97	0.09	3.16	99.95
3260000102	SXL-1	384	1h	N/A	564950.48	5296801.05	36.28	20.95	13.67	0.82	6.49	10.31	0.15	2.05	1.15	0.10	5.31	97.28
3260000105	SXL-1	461	1e	N/A	564948.17	5296784.61	53.05	12.48	18.96	0.26	7.26	0.76	0.04	0.11	0.65	0.06	4.99	98.64
3260000106	SXL-3	27	2a	N/A	564317.19	5296960.24	69.80	14.02	6.57	0.12	1.19	3.24	1.58	1.60	0.46	0.06	1.91	100.77
3260000109	SXL-3	238	2a	N/A	564310.86	5296915.21	61.58	16.72	4.24	0.10	1.33	7.79	1.88	2.45	0.51	0.11	2.33	99.04
3260000111	SXL-3	336	1a	N/A	564307.92	5296894.29	55.75	16.28	5.96	0.14	6.32	6.80	3.53	1.09	0.48	0.09	2.27	96.70
3260000115	SXL-2	32.5	1a	N/A	564476.02	5297008.06	58.93	16.32	6.07	0.18	4.51	5.24	4.00	1.44	0.62	0.13	1.93	99.35
3260000121	SXL-2	179	2a	N/A	564471.63	5296976.80	75.84	13.38	2.92	0.07	0.49	2.60	1.03	2.69	0.30	0.06	1.37	100.55
3260000122	SXL-2	201.5	2a	N/A	564470.96	5296972.00	77.61	11.85	2.97	0.04	0.46	0.57	0.33	3.03	0.26	0.04	1.86	99.04
3260000124	SXL-2	236	2a	N/A	564469.86	5296964.21	72.43	13.45	4.25	0.12	0.98	3.76	1.51	2.02	0.35	0.08	1.51	100.44
3260000127	SXL-2	288.5	1h	N/A	564468.35	5296953.43	56.83	13.91	7.28	0.38	4.60	10.75	0.59	2.08	0.42	0.09	2.85	99.78
3260000131	SXL-2	423	1h	N/A	564464.31	5296924.73	50.79	15.79	6.39	0.36	4.79	8.51	1.35	3.16	0.49	0.10	7.17	98.89
3260000132	SXL-2	453	1h	N/A	564463.41	5296918.32	53.99	16.14	5.42	0.14	1.27	17.77	0.18	0.89	0.35	0.09	3.52	99.75
3260000133	SXL-4	6	1a	N/A	564868.82	5296938.72	69.78	13.05	7.86	0.09	2.05	0.27	0.06	3.06	0.33	0.09	2.81	99.46
3260000135	SXL-4	79.5	1a	N/A	564866.62	5296923.03	61.04	11.75	4.6	0.3	3.59	7.89	0.65	2.2	0.66	0.09	7.26	100.05
3260000146	SXL-4	319.5	2a	N/A	564859.42	5296871.81	48.17	15.01	20.44	0.26	6.84	0.54	0.03	0.54	0.86	0.1	5.76	98.53
3260000152	SXL-4	473	2a	N/A	564854.81	5296839.06	41.76	16.22	12.86	0.59	3.12	17.18	0.14	0.24	0.89	0.09	5.84	98.93
3260000155	SXL-4	489	2a	N/A	564854.33	5296835.64	43.71	15.16	9.81	0.56	2.18	15.46	0.9	1.49	0.85	0.16	8.92	99.2
3260000164	EN-4	210.5	1a	N/A	570642.51	5297946.39	49.86	12.85	16.01	0.23	6.09	7.41	2.66	0.13	1.49	0.15	2.53	99.63
3260000178	EN-4	388	4c	N/A	570653.05	5297909.62	17.56	2.81	7.47	0.33	10.39	26.94	0.01	0.02	0.12	0.005	26	91.64
3260000187	EN-4	512	2e	N/A	570660.41	5297883.93	35.51	34.38	1.55	0.02	11.49	0.66	1.47	3.24	1.87	0.01	8.38	98.59
3260000202	EN-4	723.5	1e	N/A	570672.98	5297840.12	49.01	14.66	9.79	0.12	7.62	6.3	2.27	0.05	0.71	0.11	8.71	99.56
3260000211	EN-7	279	4	N/A	570237.56	5297884.92	50.17	17.73	6.92	0.12	6.84	4.82	2.32	2.61	0.47	0.11	7.62	99.51
3260000226	EN-7	457	2e	N/A	570247.49	5297847.66	64.92	22.18	0.57	0.005	0.48	0.14	0.61	5.73	0.87	0.1	3.35	98.95
3260000229	EN-7	487.5	2b	N/A	570249.19	5297841.52	76.3	10.25	3.88	0.01	3.85	0.05	0.31	1.23	0.35	0.01	3.6	99.64
3260000233	EN-7	544	2e	N/A	570252.34	5297829.76	31.48	21.3	5.87	0.09	28.18	0.03	0.005	0.03	1.05	0.02	12.13	100.18
3260000237	EN-7	603.5	2e	N/A	570255.66	5297817.37	59.27	26.54	1.21	0.005	0.4	0.04	2.02	4.26	0.95	0.005	4.03	98.73
3260000241	EN-7	638	1e	N/A	570257.59	5297810.19	43.23	14.81	25.1	0.07	8.17	0.03	0.005	0.005	0.72	0.14	6.26	98.54
3260000246	SL-2	177.5	1a	N/A	563506.00	5291951.23	50.9	16.57	9.46	0.07	8.88	3.07	2.6	4.29	0.8	0.09	2.8	99.54
3260000261	SL-2	364.5	1a	N/A	563506.00	5291914.59	65.05	12.81	4.81	0.08	1.95	6.71	3.72	1.37	0.53	0.08	3.48	100.59
3260000265	TL-4	71	4d	N/A	582039.00	5300595.30	69.23	9.42	11.49	0.4	2.83	0.81	0.54	1.17	0.35	0.02	2.51	98.77
3260000272	TL-4	307	2e	N/A	582039.00	5300646.16	72.7	15.37	1.9	0.03	0.72	2.84	5.52	0.73	0.14	0.05	0.71	100.69
3260000278	QH-84-2	68.5	1a	N/A	580239.29	5305946.00	61.17	12.21	9.45	0.17	2.12	4.34	3.39	0.65	1.59	0.27	5.08	100.44
3260000285	QH-84-2	114	2e	N/A	580234.83	5305940.69	71.53	16.05	2.67	0.04	1.16	0.72	2.23	2.44	0.31	0.12	2.37	99.63
3260000289	QH-84-2	131	2e	N/A	580233.17	5305938.71	67.5	9.26	12.89	0.03	0.72	0.52	0.83	1.75	0.28	0.09	6.81	100.66
3260000293	QH-84-2	142	2e	N/A	580232.09	5305937.42	59.89	20.28	2.78	0.08	1.09	6.52	4.51	1.59	0.45	0.16	2.01	99.35
3260000295	QH-84-2	148	2e	N/A	580231.50	5305936.72	64.73	17.26	6.36	0.09	1.97	1.19	0.99	3.34	0.41	0.1	3.16	99.58
3260000305	QH-84-2	223	1a	N/A	580224.15	5305927.97	51.71	15.78	10.56	0.23	5.95	7.07	5.2	0.19	1.21	0.09	2.41	100.41
DETECTION LIMITS					Detection Limit		0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
					Analytical Method		icp	icp	icp	icp	icp	icp	icp	icp	icp	icp	icp	icp

Table 4a
Project 326 Diamond Drill Core Lithogeochemistry (continued)

SAMPLE	Ba	Sr	Y	Sc	Zr	Be	V	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
3260000001	38	117	12	31	40	0.5	201	224	443	53	164	113	14	13	2	2.5	3.1	113
3260000004	38	155	16	39	50	1	256	256	323	55	103	106	82	12	1	10	4	156
3260000006	332	35	23	12	164	0.5	56	66	22	11	26	18	116	15	0.5	2.5	128	35
3260000013	248	124	13	22	43	1	133	135	75	65	67	540	133	0.5	2	2.5	31	118
3260000015	1182	426	23	34	70	2	216	242	806	62	186	48	120	14	2	22	167	376
3260000019	558	231	15	37	28	2	242	266	191	38	88	423	46	13	1	9	91	206
3260000022	14	6	4	2	28	0.5	26	23	22	4.9	18	22	38	2	4	2.5	2.2	5.8
3260000026	355	753	12	4	117	1	28	38	58	12	24	15	110	25	0.5	6	18	650
3260000027	1546	1063	8	6	111	3	40	47	43	8.9	37	0.5	88	22	1	2.5	41	899
3260000032	150	422	37	32	100	2	124	140	132	21	47	22	58	13	0.5	2.5	29	358
3260000044	70	57	45	31	144	0.5	201	222	165	36	52	58	120	12	1	78	18	63
3260000051	332	86	10	6	87	0.5	42	47	1850	32	42	155	1340	15	1	63	50	85
3260000056	56	209	28	40	78	1	241	268	48	18	74	0.5	39	16	0.5	2.5	13	182
3260000061	260	267	18	42	56	1	263	278	255	42	88	126	218	13	1	179	35	231
3260000066	13	156	17	45	46	0.5	274	196	373	58	118	149	106	15	2	2.5	1	132
3260000069	166	61	15	29	41	1	173	191	440	65	169	48	125	5	0.5	161	38	67
3260000080	67	80	21	45	60	2	599	575	32	45	68	141	181	15	1	45	11	83
3260000083	49	136	29	49	85	2	383	300	80	51	81	159	101	16	1	2.5	3.1	124
3260000086	366	128	16	23	90	1	158	182	69	25	34	62	105	14	1	31	44	134
3260000093	75	87	11	16	63	0.5	106	124	161	35	159	30	222	10	1	6	4.2	97
3260000094	329	22	5	7	51	0.5	34	40	58	22	26	129	87	4	0.5	9	38	22
3260000096	99	154	8	18	92	0.5	120	135	194	35	113	59	370	4	1	2.5	14	165
3260000045	130	73	39	36	148	1	226	246	86	33	53	0.5	162	6	1	106	28	75
3260000097	632	6	9	22	57	0.5	168	176	150	42	44	79	22400	13	0.5	13	30	5.8
3260000099	499	56	17	32	73	1	234	257	209	45	166	115	2010	7	0.5	22	65	62
3260000102	353	55	24	46	70	1	284	310	266	46	112	120	5250	1	0.5	15	49	57
3260000105	17	6	5	23	48	0.5	155	167	144	30	73	1150	7840	8	0.5	2.5	4	6.6
3260000106	306	42	20	11	179	0.5	54	60	48	56	33	60	2910	16	0.5	114	59	44
3260000109	337	145	14	19	100	0.5	116	137	225	27	97	63	95	16	1	20	82	165
3260000111	330	159	12	18	93	0.5	111	125	207	23	79	69	82	15	0.5	2.5	33	169
3260000115	231	148	14	18	107	0.5	106	111	183	24	91	32	335	11	0.5	6	49	146
3260000121	264	31	24	6	182	0.5	19	24	14	3.7	14	0.5	53	16	1	2.5	81	31
3260000122	278	12	21	5	185	0.5	16	17	0.5	5.2	19	40	6150	16	1	2.5	85	12
3260000124	243	34	21	6	205	0.5	17	17	35	6.7	20	0.5	145	16	1	2.5	57	37
3260000127	186	45	13	17	88	1	98	95	145	22	83	12	263	4	1	2.5	62	48
3260000131	515	76	12	19	100	0.5	106	119	176	26	105	33	187	8	0.5	2.5	88	82
3260000132	309	199	9	13	71	0.5	90	99	379	11	40	0.5	202	27	7	16	17	200
3260000133	981	3	22	5	182	0.5	24	26	518	12	2280	60	233	15	1	8	77	2.3
3260000135	205	19	14	20	58	0.5	131	131	96	27	75	45	206	1	0.5	19	56	20
3260000146	115	3	13	26	67	0.5	192	197	126	25	102	0.5	379	7	0.5	2.5	12	3.1
3260000152	29	81	15	32	59	2	236	238	236	26	154	65	165	0.5	3	11	6.3	89
3260000155	167	63	17	35	58	2	243	240	221	88	113	167	5940	0.5	0.5	2.5	43	71
3260000164	24	130	38	42	112	2	356	367	76	50	48	90	167	13	2	2.5	2.4	140
3260000176	2	124	8	3	37	0.5	12	17	11	3.7	67	198	181	0.5	0.5	7	0.8	169
3260000187	567	434	27	139	194	3	616	635	96	5	72	0.5	32	10	0.5	2.5	57	436
3260000202	12	96	13	27	72	0.5	168	168	200	36	92	17	84	11	1	2.5	1.6	102
3260000211	897	63	12	15	96	0.5	98	103	121	31	216	59	102	18	2	2.5	101	71
3260000226	465	71	46	67	362	2	483	481	192	2	14	0.5	16	7	0.5	2.5	137	74
3260000229	71	22	13	19	101	0.5	133	141	58	15	105	0.5	74	15	0.5	2.5	26	24
3260000233	2	0.5	6	31	72	0.5	241	246	395	45	154	12	449	15	0.5	2.5	0.3	0.9
3260000237	328	116	11	20	267	0.5	159	157	142	3.2	0.5	0.5	10	9	0.5	2.5	97	123
3260000241	4	0.5	6	20	49	1	150	148	303	14	202	0.5	308	22	3	2.5	0.3	0.5
3260000246	530	71	9	30	54	0.5	197	209	216	38	117	0.5	44	16	1	2.5	159	76
3260000261	191	183	10	14	128	0.5	77	87	55	7.8	24	24	30	13	1	2.5	53	189
3260000265	89	43	4	14	61	0.5	80	78	63	15	70	37	31	0.5	3	2.5	69	46
3260000272	171	581	1	1	72	0.5	10	11	0.5	3.3	10	0.5	41	23	0.5	2.5	36	610
3260000278	44	72	31	37	120	2	257	260	51	20	11	70	118	12	1	2.5	24	74
3260000285	193	103	5	6	143	0.5	45	45	18	1.9	0.5	31	201	26	2	21	163	113
3260000289	119	48	7	6	77	0.5	45	46	37	61	25	85	2400	15	1	9	94	50
3260000293	218	237	10	7	90	0.5	60	63	39	7.9	20	308	109	24	1	18	96	239
3260000295	425	79	10	4	200	0.5	26	23	0.5	1.7	0.5	38	99	20	2	2.5	175	80
3260000305	78	168	18	50	88	2	350	357	155	50	77	140	140	13	2	2.5	7.7	180
DETECTION LIMITS	2PPM	2PPM	2PPM	2PPM	2PPM	1PPM	5PPM	5PPM	10PPM	0.5PPM	10PPM	10PPM	10PPM	1PPM	1PPM	5PPM	0.5PPM	0.1PPM
	icp	icp	icp	icp	icp	icp	icp	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms

Table 4a

Project 326 Diamond Drill Core Lithogeochemistry (continued)

SAMPLE	Y ppm	Zr ppm	Nb ppm	Mo ppm	Ag ppm	In ppm	Sn ppm	Sb ppm	Cs ppm	Ba ppm	La ppm	Ce ppm	Pr ppm	Nd ppm	Sm ppm	Eu ppm	Gd ppm	Tb ppm
3260000001	12	26	2	0.7	0.25	0.1	1	0.3	0.25	35	2.8	8.2	0.81	4.1	1.3	0.81	1.5	0.3
3260000004	18	47	3	0.7	0.25	0.1	0.5	0.2	0.25	35	3.5	6.6	1.15	5.8	1.9	0.87	2.1	0.5
3260000008	24	174	8	0.9	0.25	0.1	2	0.4	1.3	317	17	39	4.34	18	4.1	1.46	4	0.7
3260000013	15	34	2	1.4	0.25	0.1	1	0.9	2	211	4	8.7	1.01	4.7	1.5	0.59	1.8	0.4
3260000015	27	72	8	4.2	0.25	0.1	1	0.7	11	1160	57	124	16.9	79	16	3.6	12	1.3
3260000019	18	28	4	1.7	0.25	0.1	1	1.3	1.3	566	12	22	2.26	9.3	2.6	0.8	2.8	0.6
3260000022	4	23	0.5	1.6	0.25	0.1	1	0.6	0.25	12	2.5	5	0.51	2	0.4	0.18	0.4	0.05
3260000026	14	132	14	18	0.7	0.1	0.5	1.9	1.1	354	61	129	15.3	61	11	2.81	8.5	0.7
3260000027	9	118	5	0.2	0.25	0.1	5	1.3	2.3	1380	45	94	10.6	43	7.4	1.71	5.2	0.4
3260000032	42	119	12	112	0.9	0.1	0.5	2.3	1.1	150	11	30	3.97	19	6.1	1.91	6.1	1.2
3260000044	50	149	10	0.7	0.25	0.1	0.5	0.9	0.7	70	14	35	4.44	22	8.2	1.89	6.1	1.3
3260000051	11	89	5	0.7	1.2	0.1	4	2.8	2.2	307	9	18	2.03	8.4	1.8	0.52	1.8	0.3
3260000056	31	86	9	0.05	0.25	0.1	0.5	1.3	0.6	56	2.4	6.3	0.97	5.5	2.3	0.73	2.9	0.7
3260000061	21	58	3	0.05	0.25	0.1	0.5	33	1.5	258	4.1	11	1.48	7.8	2.3	0.66	2.5	0.6
3260000066	17	36	0.5	6.5	0.25	0.1	0.5	0.8	0.25	10	1.6	4.9	0.72	4	1.5	0.59	1.8	0.4
3260000069	18	42	3	0.9	0.25	0.1	0.5	1.7	1.5	174	3.4	8.6	1.18	5.8	1.9	0.63	2.1	0.5
3260000080	23	61	4	0.05	0.25	0.1	0.5	1.3	1	64	5.4	13	1.68	8.2	2.5	0.81	2.7	0.6
3260000083	29	80	4	2	0.25	0.1	0.5	0.9	0.25	41	4.4	12	1.71	9	3	1.02	3.5	0.7
3260000086	19	97	6	0.05	0.25	0.1	0.5	1	2.2	365	14	32	3.9	17	4.1	1.09	3.7	0.6
3260000093	12	70	4	0.3	0.25	0.1	0.5	0.5	0.25	78	12	25	2.55	11	2.3	0.88	2.2	0.4
3260000094	6	55	3	0.8	0.25	0.1	1	0.6	1	306	3.9	8.9	0.99	4.2	0.9	0.19	0.9	0.2
3260000096	10	100	6	0.2	0.25	0.1	6	0.4	0.25	101	8.8	19	2.06	8.2	1.8	0.48	1.7	0.3
3260000045	43	155	10	0.8	0.25	0.1	0.5	0.7	1.7	125	9.5	26	3.36	16	4.6	1.1	5.1	1.1
3260000097	11	62	4	2	0.25	0.5	4	0.4	0.8	614	1.1	2.6	0.31	1.5	0.6	0.12	0.6	0.2
3260000099	19	81	5	0.5	0.25	0.1	2	1.6	1.2	503	8	17	2.03	9.4	2.5	0.79	2.5	0.5
3260000102	28	82	5	1.4	0.8	1.5	59	1.6	1.1	337	12	25	2.9	13	3.8	1.39	3.9	0.8
3260000105	7	49	3	0.5	3.3	0.6	0.5	0.5	0.25	16	1.6	3.8	0.45	2.1	0.6	0.21	0.8	0.2
3260000106	21	197	10	0.9	0.5	0.1	2	0.4	1.7	296	15	34	3.54	14	3.1	0.59	3.1	0.5
3260000109	16	115	7	0.4	0.25	0.1	1	0.9	1.9	354	18	36	3.67	15	3	0.97	2.9	0.5
3260000111	14	102	6	0.05	0.25	0.1	0.5	0.6	0.9	323	14	28	2.88	11	2.4	0.72	2.3	0.4
3260000115	15	110	7	0.5	0.25	0.1	0.5	0.6	1.7	209	13	27	2.94	11	2.4	0.71	2.5	0.4
3260000121	26	196	11	1	0.25	0.1	2	0.4	1.9	252	27	56	5.86	20	4.2	0.73	3.9	0.6
3260000122	22	199	11	2	0.25	0.1	7	0.4	1.6	274	26	53	5.42	20	3.8	0.91	3.6	0.6
3260000124	22	221	11	1.4	0.25	0.1	2	0.5	1.4	239	27	54	5.47	20	4	0.97	3.8	0.6
3260000127	14	90	5	0.7	0.25	0.1	2	0.7	1.2	185	15	29	3.01	12	2.4	0.66	2.4	0.4
3260000131	14	105	6	0.7	0.25	0.1	0.5	0.3	2.2	501	14	29	2.96	11	2.5	0.75	2.3	0.4
3260000132	11	76	5	1.4	0.25	0.1	2	2.9	0.25	306	12	23	2.36	9.4	1.9	0.51	1.9	0.3
3260000133	23	206	10	6.2	0.25	0.1	3	0.2	1.5	1010	24	50	5.02	19	3.6	0.25	3.7	0.5
3260000135	14	61	3	0.5	0.25	0.1	0.5	0.3	1.1	202	7.3	15	1.66	7.9	2	0.64	2.3	0.4
3260000146	15	68	3	0.3	0.25	0.1	1	0.3	0.4	114	4	10	1.17	5.6	1.6	0.19	2	0.4
3260000152	17	64	3	0.8	0.25	0.8	66	4.6	0.2	31	7.7	17	1.91	8.7	2.3	1.55	2.7	0.5
3260000155	16	64	3	1.2	0.25	0.1	21	1.9	0.6	180	8	18	2.03	9.5	2.4	0.66	2.7	0.5
3260000164	42	130	6	1.3	0.25	0.1	2	0.2	0.2	27	7.2	19	2.64	14	4.7	1.22	5.7	1.1
3260000178	15	36	2	1.1	0.25	0.1	0.5	0.2	0.05	4	4.8	11	1.35	7.2	2.3	2.04	2.5	0.5
3260000187	27	216	9	0.2	0.25	0.1	3	0.3	1.6	562	24	53	6.19	30	6.4	1.56	4.4	0.6
3260000202	14	78	4	0.2	0.25	0.1	0.5	0.3	0.3	11	7.8	18	1.97	8.6	2.1	0.67	2.4	0.4
3260000211	13	116	5	1.6	0.25	0.1	1	0.2	1.9	936	14	29	2.91	12	2.6	0.65	2.6	0.4
3260000226	46	386	16	0.7	0.25	0.1	5	0.05	1.5	456	109	254	31.7	154	50	8.21	34	2.4
3260000229	13	119	6	0.9	0.25	0.1	1	0.05	0.2	77	9	18	1.76	7.2	1.5	0.45	2	0.4
3260000233	9	72	3	0.2	0.25	0.1	1	0.05	0.2	2	0.5	1.4	0.17	0.9	0.4	0.13	0.8	0.2
3260000237	11	273	13	0.4	0.25	0.1	2	0.2	1.7	318	0.6	1.8	0.21	1.1	0.5	0.31	0.8	0.2
3260000241	7	47	2	2.2	0.25	0.1	3	0.05	0.05	2	2.4	5.5	0.83	2.8	0.7	0.24	0.8	0.2
3260000246	10	64	3	0.4	0.25	0.1	0.5	0.05	6.6	548	4.9	12	1.37	6	1.5	0.62	1.6	0.3
3260000261	12	158	7	0.9	0.25	0.1	2	0.1	1	193	17	35	3.73	15	3	0.86	2.9	0.4
3260000265	5	68	3	0.5	0.25	0.1	0.5	0.05	4.5	92	3	6.9	0.76	3.3	0.6	0.37	0.8	0.2
3260000272	2	86	1	1	0.25	0.1	0.5	0.1	1.2	166	4.8	11	1.25	5	0.9	0.22	0.7	0.05
3260000278	32	132	6	0.9	0.25	0.1	0.5	0.4	1.4	43	8.8	22	2.79	14	4.1	1.34	4.8	0.9
3260000285	5	160	5	0.8	0.25	0.1	2	0.6	6.7	204	11	23	2.34	10	2.1	0.55	1.8	0.2
3260000289	8	86	3	0.6	0.25	0.6	4	0.2	3.8	123	8.1	18	2.12	9.6	2	0.44	2	0.3
3260000293	10	104	3	0.6	0.25	0.1	0.5	0.3	5.6	231	13	26	2.78	11	2.3	0.73	2.3	0.3
3260000295	10	226	9	0.7	0.25	0.1	1	0.2	7.2	440	24	55	5.79	23	4	0.99	3.4	0.4
3260000305	20	77	3	0.9	0.25	0.1	0.5	0.3	1	64	4.1	11	1.47	8.1	2.6	1	3.2	0.6
DETECTION LIMITS	1PPM icp/ms	0.5PPM icp/ms	1PPM icp/ms	0.5PPM icp/ms	0.5PPM icp/ms	0.2PPM icp/ms	1PPM icp/ms	0.1PPM icp/ms	0.5PPM icp/ms	1PPM icp/ms	0.1PPM icp/ms	0.1PPM icp/ms	0.05PPM icp/ms	0.1PPM icp/ms	0.1PPM icp/ms	0.05PPM icp/ms	0.1PPM icp/ms	0.1PPM icp/ms

Table 4a

Project 326 Diamond Drill Core Lithogeochemistry (continued)

SAMPLE	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Bi	Th	U
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
3260000001	2.1	0.4	1.3	0.21	1.3	0.2	0.7	0.09	0.25	0.0025	2.5	0.1	0.3	0.05
3260000004	2.9	0.6	1.9	0.31	1.9	0.29	1.2	0.13	0.6	0.09	13	0.1	0.5	0.05
3260000008	3.9	0.8	2.4	0.38	2.3	0.39	3.9	0.5	0.6	0.53	2.5	0.1	2.7	0.6
3260000013	2.3	0.5	1.5	0.25	1.7	0.27	0.6	0.1	3.6	0.12	10	0.6	0.4	0.1
3260000015	5.6	0.9	2.6	0.32	1.8	0.26	2	0.29	2.2	1.06	5	0.1	3.7	1.1
3260000019	3.4	0.7	2	0.32	2	0.3	0.9	0.1	5.3	0.47	13	0.4	1	0.9
3260000022	0.6	0.1	0.4	0.07	0.5	0.08	0.5	0.0025	0.25	0.15	19	0.3	0.5	0.1
3260000026	2.7	0.4	1.1	0.08	0.5	0.09	2.7	0.27	11	0.14	27	0.6	8.2	4.7
3260000027	1.8	0.3	0.7	0.07	0.5	0.08	2.6	0.22	0.25	0.39	16	0.4	5.6	1.4
3260000032	6.9	1.4	3.8	0.59	3.5	0.48	2.9	0.39	6.5	0.26	10	0.8	3.8	5.6
3260000044	8.1	1.7	5	0.86	5.3	0.8	3.7	0.49	1.2	0.17	5	0.1	1.1	0.3
3260000051	1.8	0.4	1	0.17	1	0.16	2	0.27	0.7	0.34	2.5	1.6	1.1	0.3
3260000056	4.7	1	3.1	0.52	3.1	0.49	2.3	0.43	2.5	0.13	2.5	0.1	0.2	0.05
3260000061	3.7	0.8	2.3	0.39	2.4	0.37	1.5	0.16	0.25	0.58	2.5	0.1	0.3	0.1
3260000066	2.6	0.6	1.7	0.28	1.8	0.27	0.9	0.0025	2.3	0.14	15	0.1	0.1	0.05
3260000069	2.8	0.6	1.9	0.32	2	0.31	1	0.12	5.7	0.4	9	0.1	0.3	0.05
3260000080	3.9	0.8	2.5	0.4	2.5	0.38	1.5	0.19	1	0.11	2.5	0.1	0.5	0.1
3260000083	4.8	1	3.1	0.5	3.1	0.48	2.1	0.19	0.25	0.13	15	0.1	0.4	0.1
3260000086	3	0.6	1.9	0.27	1.7	0.27	2.2	0.28	3.6	0.34	2.5	0.05	1.6	0.4
3260000093	2.1	0.4	1.2	0.2	1.2	0.19	1.5	0.27	0.5	0.12	6	0.2	1.3	0.6
3260000094	0.9	0.2	0.6	0.11	0.7	0.12	1.2	0.19	0.9	0.24	2.5	0.3	1.1	0.3
3260000096	1.7	0.3	1.1	0.19	1.2	0.18	2.2	0.39	0.9	0.09	15	0.3	2.5	0.6
3260000045	7.1	1.6	4.6	0.77	4.8	0.76	3.8	0.48	2	0.24	2.5	0.1	1.1	0.2
3260000097	1.5	0.3	1	0.18	1.2	0.2	1.4	0.2	1.1	0.52	32	2.8	0.7	0.2
3260000099	3.1	0.7	2	0.34	2.1	0.32	1.8	0.27	1.2	0.44	10	1.5	0.9	0.2
3260000102	4.6	0.9	2.7	0.43	2.7	0.41	1.9	0.28	2.5	0.3	42	2.8	1.2	0.3
3260000105	0.9	0.2	0.6	0.1	0.7	0.11	1.1	0.17	0.7	0.12	25	1.4	0.8	0.2
3260000106	3.2	0.7	2.1	0.36	2.2	0.36	4.2	0.69	1.1	0.48	6	1.3	5.2	1.3
3260000109	2.6	0.5	1.5	0.24	1.5	0.24	2.6	0.46	2.6	0.54	13	0.6	2.9	0.7
3260000111	2.2	0.4	1.3	0.21	1.3	0.21	2.2	0.41	0.7	0.18	2.5	0.1	2.6	0.6
3260000115	2.3	0.5	1.4	0.23	1.4	0.22	2.4	0.41	1.2	0.39	22	0.1	2.3	0.6
3260000121	3.9	0.8	2.7	0.45	2.8	0.45	4.8	0.96	1.4	0.45	5	0.1	8.4	2
3260000122	3.3	0.7	2.2	0.4	2.4	0.35	4.8	0.9	2.5	0.56	2.5	1	7	1.8
3260000124	3.6	0.7	2.2	0.37	2.4	0.38	4.9	0.86	0.8	0.36	6	0.4	6.1	1.6
3260000127	2.2	0.4	1.3	0.2	1.2	0.18	1.9	0.35	1.5	0.31	13	0.5	2.3	0.6
3260000131	2.2	0.4	1.3	0.2	1.3	0.2	2.3	0.42	0.5	0.62	2.5	0.2	2.7	0.6
3260000132	1.8	0.3	1.1	0.17	1	0.16	1.7	0.3	0.25	0.25	137	1.5	2.1	0.5
3260000133	3.5	0.8	2.4	0.39	2.4	0.39	5.1	0.89	2	0.5	2.5	0.2	5.3	1.5
3260000135	2.5	0.5	1.4	0.22	1.4	0.2	1.5	0.21	2.8	0.3	10	0.1	0.7	0.2
3260000146	2.5	0.5	1.6	0.26	1.7	0.25	1.7	0.21	1.2	0.1	2.5	0.05	0.7	0.2
3260000152	3	0.7	2	0.29	1.9	0.29	1.9	0.22	2.1	0.05	19	4.3	0.9	0.3
3260000155	3	0.7	2	0.32	2.1	0.3	1.7	0.21	1.6	0.2	14	1.2	0.8	0.2
3260000164	7	1.5	4.6	0.75	4.6	0.66	3.6	0.34	1	0.05	2.5	0.1	0.6	0.2
3260000178	2.5	0.5	1.4	0.18	1.3	0.19	0.9	0.22	2.9	0.05	195	0.1	1.7	0.4
3260000187	3.8	0.9	3	0.49	3.4	0.56	5.7	0.82	4	0.3	7	0.05	4.2	0.7
3260000202	2.4	0.5	1.5	0.24	1.6	0.25	1.9	0.26	0.7	0.05	2.5	0.2	1	0.2
3260000211	2.3	0.5	1.4	0.23	1.4	0.21	12	0.44	1	0.5	7	0.1	2.6	0.6
3260000226	7.8	1.4	5	0.69	5.1	0.89	9.2	1.23	1.6	1	2.5	0.05	7.6	1.1
3260000229	2.3	0.5	1.4	0.23	1.4	0.22	2.9	0.42	1	0.1	2.5	0.05	2	0.6
3260000233	1.3	0.3	0.9	0.16	1	0.16	2.2	0.28	1.1	0.05	2.5	0.05	0.6	0.2
3260000237	1.5	0.3	1.2	0.21	1.5	0.27	6.8	1.01	1.3	0.6	2.5	0.05	1.6	0.5
3260000241	1	0.2	0.7	0.13	0.8	0.13	1.1	0.14	0.7	0.05	2.5	0.05	0.4	0.2
3260000246	1.8	0.4	1.1	0.17	1.1	0.17	1.6	0.18	0.5	0.9	2.5	0.05	0.5	0.1
3260000261	2.2	0.4	1.3	0.18	1.1	0.17	3.6	0.56	0.8	0.2	6	0.05	3.6	0.9
3260000265	0.9	0.2	0.6	0.11	0.7	0.11	1.7	0.2	0.4	0.3	6	0.05	0.5	0.05
3260000272	0.3	0.05	0.2	0.025	0.1	0.02	2.4	0.08	0.1	0.1	8	0.1	0.4	0.2
3260000278	5.3	1.2	3.5	0.57	3.7	0.57	3.5	0.43	0.8	0.4	2.5	0.2	0.8	0.2
3260000285	1.1	0.2	0.5	0.06	0.4	0.06	4.1	0.39	0.4	2.2	15	0.3	1.6	0.8
3260000289	1.6	0.3	0.9	0.14	0.7	0.1	2.1	0.16	0.9	0.8	18	0.05	1.1	0.4
3260000293	1.7	0.3	1	0.15	1	0.18	2.6	0.21	0.8	1.8	8	0.4	0.7	0.2
3260000295	1.6	0.3	1	0.13	0.8	0.12	5.5	0.61	0.3	2.8	6	0.05	2.5	0.7
3260000305	3.7	0.8	2.3	0.37	2.1	0.31	2.2	0.16	0.3	0.1	2.5	0.05	0.3	0.1
DETECTION LIMITS	0.1PPM icp/ms	0.1PPM icp/ms	0.1PPM icp/ms	0.05PPM icp/ms	0.1PPM icp/ms	0.04PPM icp/ms	0.2PPM icp/ms	0.05PPM icp/ms	0.5PPM icp/ms	0.1PPM icp/ms	5PPM icp/ms	0.2PPM icp/ms	0.1PPM icp/ms	0.1PPM icp/ms

Table 4b
Project 318 Pebble Lithogeochemistry

SAMPLE	DDH	FOOTAGE	ROCKTYPE	SITE #	UTME	UTMN	SiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	LOI	TOTAL
							%	%	%	%	%	%	%	%	%	%	%	%
3180100025	N/A	N/A	4f	58	522805.00	5293285.00	92.16	0.26	6.30	0.04	0.19	1.07	0.02	0.03	0.01	0.02	0.74	100.83
3180100026	N/A	N/A	3c	59	547385.00	5286405.00	89.55	0.13	7.18	0.11	0.09	0.10	0.01	0.01	0.01	0.05	1.66	98.88
3180100043	N/A	N/A	4b	65	561210.00	5297460.00	56.06	0.24	41.40	0.05	0.36	0.46	0.01	0.05	0.01	0.20	0.85	99.51
3180100059	N/A	N/A	4f	72	588317.00	5305568.00	96.52	0.22	2.59	0.01	0.02	0.04	0.01	0.03	0.01	0.02	0.56	100.03
3180100063	N/A	N/A	4f	74	580877.00	5304750.00	90.35	0.18	6.29	0.02	0.02	0.04	0.01	0.02	0.01	0.03	2.71	99.66
3180100090	N/A	N/A	1a	98	449166.00	5263507.00	67.65	13.41	2.12	0.04	0.85	4.53	5.80	0.71	0.39	0.08	3.97	99.56
3180000104	N/A	N/A	2a	104	570320.00	5304452.00	34.55	16.16	10.09	0.19	4.43	8.70	1.10	4.98	0.96	0.12	15.91	99.18
3180100110	N/A	N/A	2a	107	587299.00	5305917.00	72.63	12.48	4.81	0.03	0.32	1.43	4.53	0.90	0.39	0.07	2.40	99.98
3180100112	N/A	N/A	1a	108	586268.00	5298325.00	43.67	14.20	17.72	0.45	4.07	11.33	2.58	0.50	1.00	0.12	3.07	98.91
3180100115	N/A	N/A	4f	110	577316.00	5307365.00	95.13	0.25	3.47	0.12	0.06	0.86	0.03	0.05	0.01	0.06	0.24	100.30
3180100121	N/A	N/A	1f	111	574184.00	5303323.00	50.34	11.64	12.35	0.18	11.27	9.29	2.46	0.50	0.72	0.06	1.37	100.17
3180100124	N/A	N/A	4d	114	587567.00	5296678.00	74.97	0.17	16.64	0.19	2.58	2.79	0.05	0.03	0.01	0.09	0.99	100.71
3180100132	N/A	N/A	Gd	123	470236.00	5281752.00	65.48	13.90	6.47	0.05	1.83	1.76	3.54	3.52	0.40	0.12	1.86	98.90
3180000082	N/A	N/A	1b	103	571690.00	5301072.00	43.24	11.08	21.03	0.38	5.77	12.94	1.56	0.16	0.59	0.05	2.78	99.60
					Detection Limit		0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
					Analytical Method		icp	icp	icp	icp	icp	icp	icp	icp	icp	icp	icp	

SAMPLE	Ba	Sr	Y	Sc	Zr	Be	V	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
3180100025	7	3	1	0.5	7	0.5	5	2.5	38	15	0.5	426	26	0.5	7	2.5	1.2	3
3180100026	6	3	1	0.5	4	0.5	5	2.5	15	1.7	0.5	13	46	0.5	2	27	2.9	2.1
3180100043	12	4	2	0.5	19	0.5	32	23	14	10	0.5	399	37	3	3	2.5	1.9	3.6
3180100059	9	4	3	0.5	28	0.5	2.5	2.5	17	4.6	0.5	0.5	21	2	2	23	1	3.4
3180100063	6	8	0.5	0.5	6	0.5	2.5	2.5	20	22	13	323	20	1	7	2.5	1.6	9.1
3180100090	158	125	8	5	99	0.5	57	65	94	7.7	26	43	36	15	0.5	9	17	130
3180000104	2161	1114	18	21	209	2	153	135	221	30	88	81	79	25	1	112	120	1090
3180100110	312	166	8	5	111	0.5	41	47	57	26	42	49	35	19	1	30	27	177
3180100112	140	1201	21	32	83	1	226	251	130	58	83	571	205	6	2	2.5	16	1020
3180100115	25	12	0.5	0.5	8	0.5	2.5	2.5	19	1.9	0.5	0.5	16	0.5	2	37	2.2	14
3180100121	103	212	14	38	52	1	229	262	633	58	113	117	117	11	1	2.5	20	177
3180100124	76	11	4	0.5	10	2	8	2.5	20	2.5	0.5	52	36	0.5	5	2.5	1	12
3180100132	2487	832	10	10	98	3	80	81	229	16	387	80	91	20	2	75	100	616
3180000082	29	83	14	31	44	0.5	202	222	258	105	48	1230	107	4	2	2.5	2.7	91
Detection Limit	2PPM	2PPM	2PPM	2PPM	2PPM	1PPM	5PPM	5PPM	10PPM	0.5PPM	10PPM	10PPM	10PPM	1PPM	1PPM	5PPM	0.5PPM	0.1PPM
Analytical Method	icp	icp	icp	icp	icp	icp	icp	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms

Table 4b
Project 318 Pebble Lithogeochemistry (continued)

SAMPLE	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
3180100025	1	5.7	0.5	2	0.25	0.1	0.5	0.2	0.25	5	1.5	2.8	0.29	1.1	0.2	0.0025	0.3	0.05
3180100026	2	3.2	0.5	1.1	0.25	0.1	0.5	0.5	0.25	4	1	2	0.2	0.8	0.2	0.16	0.2	0.05
3180100043	6	3	0.5	1.6	0.25	0.1	0.5	0.6	0.25	10	4.7	10	1.07	4	0.8	0.27	0.8	0.1
3180100059	2	31	0.5	2.7	0.25	0.1	0.5	0.8	0.25	8	1.3	2.9	0.32	1.3	0.3	0.21	0.3	0.05
3180100063	0.5	3.3	0.5	0.3	0.25	0.1	0.5	0.3	0.25	6	4.4	9.2	0.97	3.7	0.7	0.36	0.6	0.05
3180100090	9	110	5	0.5	0.25	0.1	0.5	0.8	0.8	149	5.5	11	1.19	5.1	1.2	0.5	1.2	0.2
3180000104	19	197	8	2.1	0.25	0.1	1	2	4.7	1700	42	88	9.6	38	7	1.43	5.4	0.7
3180100110	9	121	5	0.9	0.25	0.1	0.5	1.5	1.1	311	7.8	16	1.78	7.6	1.7	0.56	1.6	0.3
3180100112	24	87	4	4.4	0.25	0.1	1	0.2	0.25	136	11	23	2.81	12	3	1.06	3.2	0.6
3180100115	1	8.7	0.5	0.9	0.25	0.1	0.5	1	0.25	24	0.9	1.6	0.19	0.8	0.2	0.06	0.2	0.05
3180100121	16	53	3	1.3	0.25	0.1	0.5	0.2	0.6	105	3.5	9.2	1.2	5.9	1.9	0.72	2.2	0.4
3180100124	6	2	0.5	0.8	0.9	0.1	0.5	0.1	0.25	74	2.4	4.1	0.4	1.7	0.4	0.37	0.5	0.05
3180100132	10	100	5	2.1	0.25	0.1	2	1.1	4.2	1970	12	26	3.01	12	2.4	0.63	2.1	0.3
3180000082	17	45	2	6.4	0.25	0.1	0.5	0.3	0.25	31	3.7	6.4	1.07	5.5	1.7	0.57	1.8	0.4
Detection Limit	2PPM	0.5PPM	1PPM	0.5PPM	0.5PPM	0.2PPM	1PPM	0.1PPM	0.5PPM	1PPM	0.1PPM	0.1PPM	0.05PPM	0.1PPM	0.1PPM	0.05PPM	0.1PPM	0.1PPM
Analytical Method	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms

SAMPLE	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Pb	Bi	Th	U
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
3180100025	0.2	0.05	0.1	0.0025	0.1	0.02	0.1	0.0025	0.25	0.0025	2.5	0.1	0.3	0.05
3180100026	0.2	0.05	0.1	0.0025	0.2	0.02	0.1	0.0025	0.25	0.0025	14	0.3	0.2	0.05
3180100043	0.7	0.2	0.5	0.08	0.5	0.08	0.1	0.0025	0.6	0.18	2.5	0.1	0.2	0.3
3180100059	0.4	0.05	0.2	0.0025	0.2	0.02	0.1	0.0025	1.6	0.0025	2.5	0.1	0.2	0.05
3180100063	0.2	0.05	0.05	0.0025	0.05	0.02	0.1	0.0025	0.25	0.06	11	0.1	0.2	0.05
3180100090	1.3	0.3	0.8	0.12	0.8	0.13	2.3	0.31	0.25	0.4	2.5	0.1	1.2	0.3
3180000104	3.3	0.6	1.8	0.27	1.6	0.29	4.4	0.5	0.9	0.26	6	0.1	6.1	1.9
3180100110	1.6	0.3	0.9	0.15	0.9	0.13	2.5	0.36	0.6	0.6	2.5	0.1	1.3	0.4
3180100112	3.8	0.8	2.5	0.39	2.5	0.38	1.9	0.2	0.6	0.12	6	0.1	0.4	0.2
3180100115	0.2	0.05	0.1	0.0025	0.05	0.02	0.1	0.0025	0.25	0.0025	2.5	0.1	0.3	0.1
3180100121	2.7	0.6	1.6	0.26	1.6	0.23	1.3	0.13	0.25	0.24	2.5	0.1	1	0.2
3180100124	0.6	0.1	0.4	0.05	0.3	0.06	0.1	0.0025	0.25	0.16	2.5	1.3	0.2	0.05
3180100132	1.6	0.3	1	0.16	1	0.15	2.4	0.29	3.4	1.24	30	0.9	2.9	1.1
3180000082	2.7	0.6	1.8	0.32	2.1	0.33	1.1	0.1	1	0.0025	2.5	0.1	0.5	0.2
Detection Limit	0.1PPM	0.1PPM	0.1PPM	0.05PPM	0.1PPM	0.04PPM	0.2PPM	0.05PPM	0.5PPM	0.1PPM	5PPM	0.2PPM	0.1PPM	0.1PPM
Analytical Method	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms	icp/ms