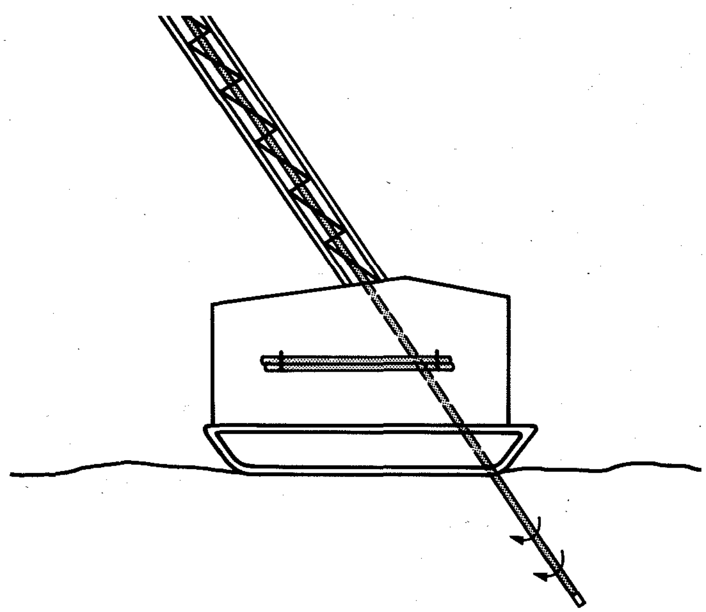
1984-1985 GEODRILLING REPORT

Minnesota Department of Natural Resources
Division of Minerals

Report 242



Hibbing, Minnesota
1985

ERRATA SHEET TO REPORT 242
DDH IS-1 GOLD ANALYSES
SEPTEMBER 5, 1991

The gold values of $\geq$ 1 ppm reported on p. 57, Table IS-1 have not been confirmed in subsequent assays. However, different intervals were sampled. For one of these, see below:

Report	Year	Sample #	Footage	AU assay
242	**1985**	**L-10812**	**306.7-306.8**	**1 ppm**
255-1	**1989**	**20153**	**301.0-310.6**	**2 ppb***

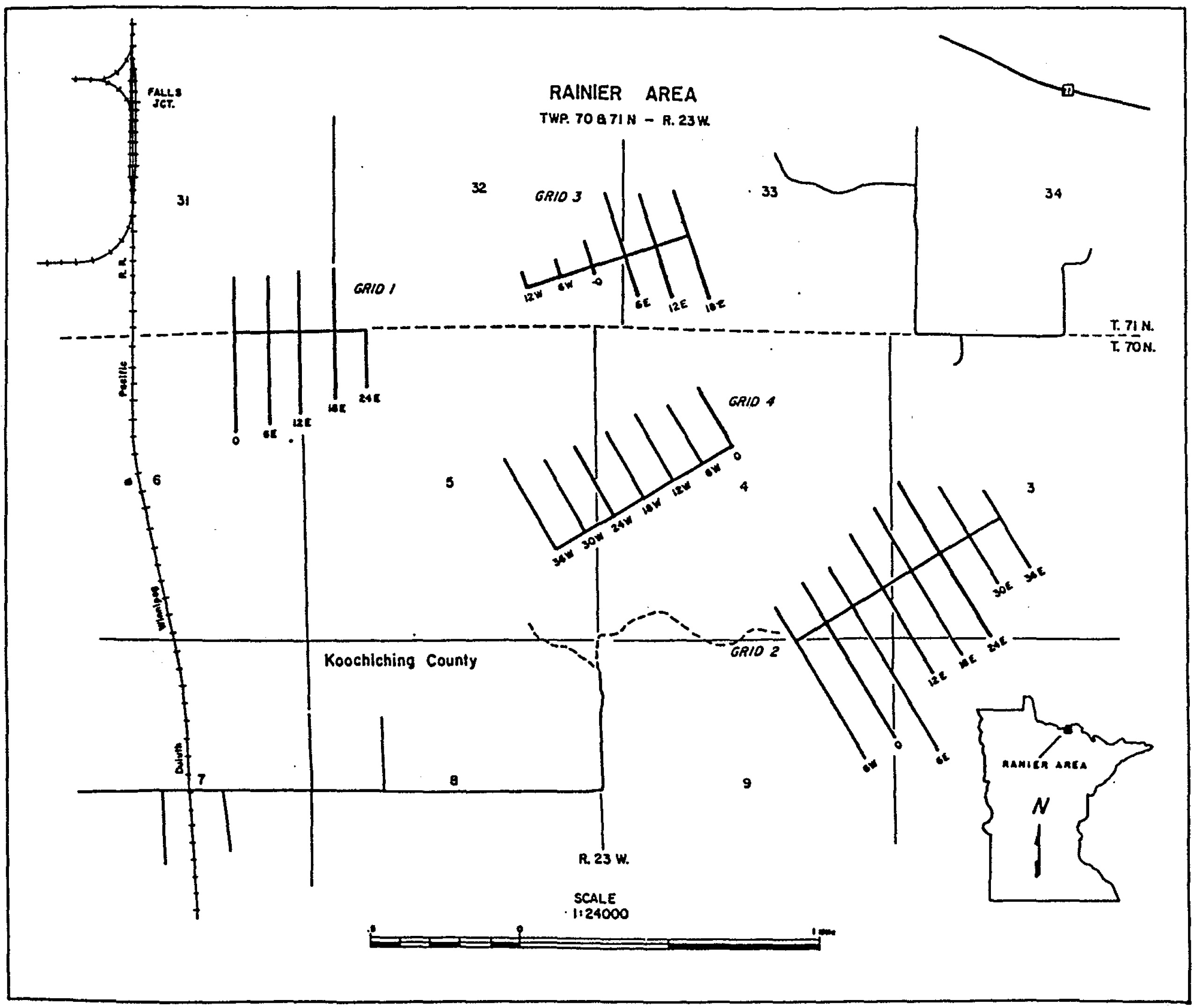
*** Analyzed by Bondar-Clegg**

ERRATA SHEET

Report 242

Correction to Page 4 and Plates 10-12 (Inside back cover)

The line numbers on Grid 3 in Sections 32 and 33-T71N-R23W are incorrect. The correct line numbers are 12W through 18E as shown below. Please make the proper corrections. These changes do not affect the data pertinent to Grid 3.



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P. 28 REFERENCE
Chandler, V. W., 1983, Shaded Relief Aeromagnetic Map of Northeastern and East Central Minnesota, Illuminated from the Northwest at 45 Degree Inclination, Minnesota Geological Survey (MGS), University of Minnesota.

P. 29 The first sentence should read, "The following list is a compilation of mineral occurrences encountered as a result of the activities covered by this report."

P. 30 Mineral Occurrence Reference Drill Hole SR-1
Ti value is not high enough (3.7' Ti 13.00-14.90%) to be listed as occurrence, since % are for TiO_2 not Ti.

P. 31 Mineral Occurrence Reference Drill Hole FHL-1
Cu occurrence footage should read 268.6' not 278.6'.
C occurrence amounts should read .30-.52% not .30-5.2%
S occurrence footage should read 74.3' not 45.9'.

P. 40 Table BM-2 - Analytic Results

Sample No.	Footage	Corrected Au Values
C-CA-15820	835.0-849.0	<5
C-CA-15828	877.0-881.0	10
C-CA-15838	949.0-961.0	<5
C-CA-15845	971.0-983.0	10

Additional samples (not currently in table):

Sample No.	Footage	Au Values
C-CA-15769	567.0-568.5	<5
C-CA-15867	1163 -1165	<5

Rock Sample: R C-12756 had 10 ppm Te not <10 ppm

P. 42 Interval 1022.9'-1051.8' should read "dark grey-black, aphanitic-medium-grained gabbro dike with chilled contacts."

P. 51 Table RR-2
Enough errors resulted so that a new replacement Page 51-52 is included (indicated by -51- at bottom of page).

P. 54 Table RR-1
Sample C-K-13922 should have the values of <5, 150, and 80 ppm for As, V, and Zn, respectively.

P. 56 Interval 470'-1038' T.D. The second sentence should read "and fine-grained oxide olivine bearing gabbro, oxide".

P. 57 Table BL-1
All sample numbers should have a "SL" prefix.

Pd value for sample SL-11230 should read 12 ppb not 2 ppb.

DNR Laboratory, Hibbing, MN also analyzed all four samples for Au (all samples 0 ppm) and Ag (all samples <.1 ppm).

Table R-1
V values are in %, not ppm.

P. 58 First paragraph, line three, should read "MAGNETITE and RUTILE inclusions occur as oikocrysts".

P. 61 The fifth line from the end of the section on PEGMATOIDS should have the word "spinel" capitalized.

P. 67 Within interval 492'-576', the fourth line below TRACHYTE, should read "Altered mafic to ultramafic basalts and cherts (529.6'-531.8')." This should not be indented and should appear in bold print.

P. 68 DDH NR-1
In interval 298.6'-406.3', line six and seven should read "gabbro, the latter section assaying 1650 ppm V. 391.7'-395.6', mesocratic oxide-bearing gabbro."

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DDH RR-1
Additional Assays Page 54
Fire Assay with AA Finish

Sample No.	Footage	Au ppb	Pt ppb	Pd ppb
R K-12341	700 - 701	<5		
R K-12342	701 - 702	10		
R K-12343	702 - 703	5		
R K-12344	703 - 704	265		
R K-12345	704 - 705	<5		
R K-12346	705 - 706	10		
R K-12348	900.1- 901.2	165		
R K-12349	901.2- 902	25		
R K-12350	902 - 903	55		
R K-12351	903 - 903.9	95		
R K-12352	903.9- 905	20		
R K-12353	905 - 906	45		
R K-12354	906 - 907	85		
R K-12355	907 - 907.9	85		
R K-12370	944.1- 945.1	5	<50	5
R K-12371	945.1- 946	5	<50	<5
R K-12372	946 - 947	10	55	20
R K-12373	947 - 948	5	<50	<5
R K-12374	948 - 949.1	<5	<50	<5
R K-12375	949.1- 950.1	20	<50	<5
R K-12405	995.5- 996.5	<5	<50	<5
R K-12406	996.5- 997.5	<5	<50	15
R K-12407	997.5- 998.5	<5	<50	<5
R K-12478	1131 -1132	50	<50	5
R K-12479	1132 -1133	390	<50	5
R K-12480	1133 -1134	25	<50	5
R K-12481	1134 -1135	50	<50	5
R K-12482	1135 -1136	20	<50	5
R K-12483	1136 -1137	10	<50	10
R K-12484	1137 -1138	10	<50	10
R K-12485	1130 -1131	70	<50	<5
R K-12487	1163 -1164	35		
R K-12488	1164 -1165	50		
R K-12489	1165 -1165.9	5		
R K-12490	1165.9-1167	5		
R K-12491	1167 -1168	40		
R K-12492	1168 -1169.1	15		
R K-12493	1169.1-1170	5		
R K-12494	1170 -1171	10		
R K-12496	1182 -1183.1	180		

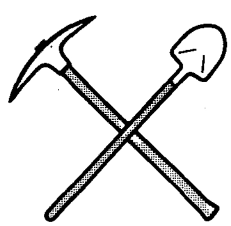
Sample No.	Footage	Au ppb	Pt ppb	Pd ppb
R K-12497	1183.1-1184	360		
R K-12498	1184 -1185	40		
R K-12499	1185 -1186	195		
R K-12500	1186 -1187	45		
R K-12501	1187 -1188	15		
R K-12502	1188 -1189	15		
R K-12503	1189 -1190	40		
R K-12505	1293.9-1295	55		
R K-12506	1295 -1296.1	10		
R K-12507	1296.1-1297	25		
R K-12508	1297 -1297.9	25		
R K-12509	1297.9-1299	25		
R K-12510	1299 -1300	20		
R K-12511	1300 -1300.9	15		
R K-12512	1300.9-1302	5		
R K-12513	1302 -1303.5	10		
R K-12515	1304 -1305	15	<50	5
R K-12516	1305 -1306	290	<50	15
R K-12517	1306 -1307	20	<50	5
R K-12518	1307 -1308	15	<50	15
R K-12519	1308 -1309	15	<50	10
R K-12520	1309 -1310	20	<50	5
R K-12521	1310 -1310.9	20	<50	<5
R K-12522	1310.9-1312	<5	<50	<5
R K-12533	1342 -1343	<5	<50	<5
R K-12534	1343 -1344		<50	5
R K-12535	1344 -1345.1	10	55	10
R K-12536	1345.1-1346	145	<50	<5
R K-12537	1346 -1347	<5	<50	<5
R K-12538	1347 -1348.1	6	<50	<5
R K-12539	1348.1-1349	40	<50	<5
R K-12540	1349 -1350	50	<50	5
R K-12542	1438 -1439	5		
R K-12543	1439 -1440	5		
R K-12544	1440 -1441	15		
R K-12545	1441 -1442	75		
R K-12546	1442 -1443	555		
R K-12547	1443 -1444	45		
R K-12548	1444 -1445	40		
R K-12549	1445 -1446	115		

1984-1985 GEODRILLING REPORT

By:
J.M. Sellner, T.L. Lawler
E.H. Dahlberg, B.A. Frey
and M.P. McKenna

Minnesota Department of Natural Resources
Division of Minerals

Report 242



Hibbing, Minnesota
1985

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SECTION B—GEOPHYSICAL SURVEYS

SECTION D—GEOLOGIC DRILL LOGS AND ASSAYS

This section lists the laboratories which performed analytical work and describes the analytical techniques, analytical precision and sampling methods used to evaluate drill core. It includes drill core log summaries and complete assay results on all holes drilled during the 1984-1985 reporting period. These drilling activities are summarized below.

County	S-T-R Location	DNR Hole No.	Footage	Formation
Aitkin	21-46-25	A-2	0-1008′	Glen Township
	2-47-26	A-5	0-1332′	Rabbit Lake Fe-Fm.
Carlton	16-47-19	BM-1	0-3143′	Thomson
	23-47-20	BM-2	0-1723′	Thomson
Koochiching	31-71-23	RR-1	0-1602′	Archean Volcanics
	4-70-23	RR-2	0- 553′	Archean Volcanics
Morrison	36-40-26	R-1	0-207.3′	Hillman Migmatite
Lake	2-59-9	IS-1	0- 439′	Duluth Complex
	26-60-10	NE-2	0-1038′	Duluth Complex
	25-59-9	NR-1	0- 953′	Duluth Complex
	25-57-11	SE-3	0- 403′	North Shore Volcanics—Duluth Complex
	36-58-9	SR-1	0- 600′	Duluth Complex
St. Louis	36-55-13	BL-1	0- 563′	Duluth Complex
	10-52-15	FHL-1	0-1003′	Duluth Complex—Virginia Formation
	18-60-11	NE-1	0- 331′	Duluth Complex
	35-57-13	SE-1	0-1344′	Duluth Complex
	31-52-15	TS-1	0- 241′	Duluth Complex—Virginia Formation
	9-56-18	ZM-1	0-1303′	Virginia Formation

GEODRILLING REPORT

SECTION A

GEOCHEMICAL SURVEY

By: J. M. Sellner

INTRODUCTION

During the spring of 1984, the Division of Minerals of the Minnesota Department of Natural Resources conducted a pilot survey to investigate the potential of A-horizon soil and vegetation as a geochemical sampling media for mineral evaluation. This field survey was performed over the Rainy Lake-Seine River fault zone near Ranier, Minnesota in Koochiching County (Fig. 1). Three different sampling media were analyzed for Au and Ag over a sequence of Archean metasedimentary and metavolcanic rocks. The three sample types include vegetation (Aspen, Alder and Black Spruce), A_0 horizon (forest litter) and A_1 horizon (organic-rich soil).

Previous surveys by Dunn (1980, 1983, 1984) in Saskatchewan, Canada; Girling, et al.(1979) in British Columbia; and Curtin et al.(1968) in the United States; have shown that biogeochemistry and A-horizon soil layers can reflect gold mineralization in the underlying bedrock. Other geochemists, including Jones (1970), Shacklett et al. (1970), Boyle (1979), and Brooks (1982) have researched biogeochemical exploration techniques for gold as well as the mechanisms for gold uptake by plants. A-horizon soil samples taken earlier (1984) by the Minerals Division from Little American Island on Rainy Lake (a known gold occurrence six miles northeast of the survey area) show anomalous gold values (up to 76 ppb).

The A-horizon has advantages over other soil horizons because it is organic-rich and derives trace elements through plant roots from depths within the glacial drift (Meineke et al., 1978). Hydromorphic transport of trace elements through glacial till may produce anomalies in the A-horizon which are not reflected in the B and C-horizon (Bradshaw, 1975).

Geochemical samples were analyzed for gold by Neutron Activation Services Ltd., Hamilton, Ontario, Canada and for Ag by X-Ray Assay Laboratories Ltd., Don Mills, Ontario. Funding for this project was provided by the Legislative Commission on Minnesota Resources (LCMR).

Geology & Physiography

The bedrock geology of the study area is illustrated in Fig. 2 (Ojakangas, 1982). The primary area of interest is over the northeast trending greenstone belt immediately south of Ranier and International Falls, Minnesota. This greenstone belt consists mainly of mafic to intermediate metavolcanic and hypabyssal rocks. Flanking the greenstone belt to the north and south are zones of metagreywacke. Lying within the greenstone belt is a unit of feldspathic quartzite and conglomerate. To the south, the greenstone belt is broken by the Rainy Lake-Seine River fault. Whole rock Rb-Sr ages show that the rocks are Archean in age, and were formed between 2700 and 2750 m.y. ago (Peterman et al., 1972).

The physiography of the survey area is composed of glacial overburden and numerous outcrops. Geophysical grids (Fig. 1) were constructed over resistive outcrop units that rise above adjacent low-lying glacial overburden. The glacial till surrounding and, in some instances, covering these rocks is predominantly glacial Lake Aggassiz sediments consisting of clay and clayey silts (Hobbs & Goebel, 1982). These glacial deposits were formed during the Alborn Phase of Wisconsin glaciation and, are derived from the St. Louis sublobe of the Des Moines lobe (Wright, 1972). These glacial lake sediments are overlain by large areas of postglacial Holocene peat.

The topography in the survey area is well-drained on the higher elevations (outcrops), but impeded on the lower swampy elevations (hydromorphic soil, peat). Samples were collected primarily over the well-drained areas.

Sample Collection

The soil in the survey area is a moderately-well developed podzol (Levinson, 1974). The A-horizon is made up of two and sometimes three different layers, namely A_0, A_1 and A_2. At the soil surface the A_0 or humus layer (forest mull) is made up of partially decomposed leaves, pine needles, grass and small twigs. The A_1 horizon lies immediately below the A_0 zone and consists of dark organic-rich humus. In a well developed podzol profile, the A_2 horizon is present (directly beneath the A_1 zone) and consists of partially leached A_1 soil. A_0 and A_1 soil horizons are easily recognized throughout the survey area, but the A_2 horizon is not always present.

A_0 samples were hand collected from the forest floor at each sample site (Fig. 2), whereas A_1 material was sampled

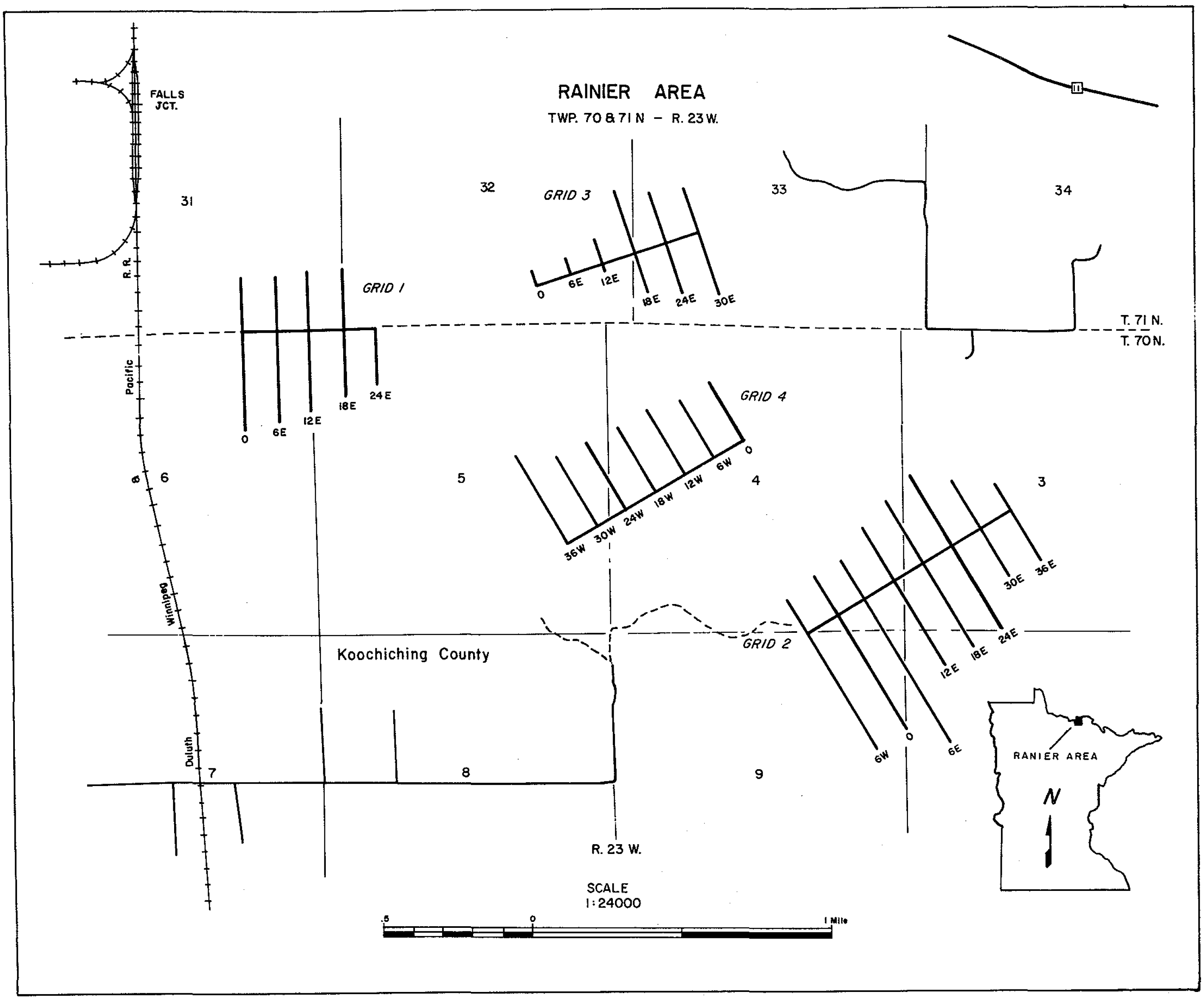


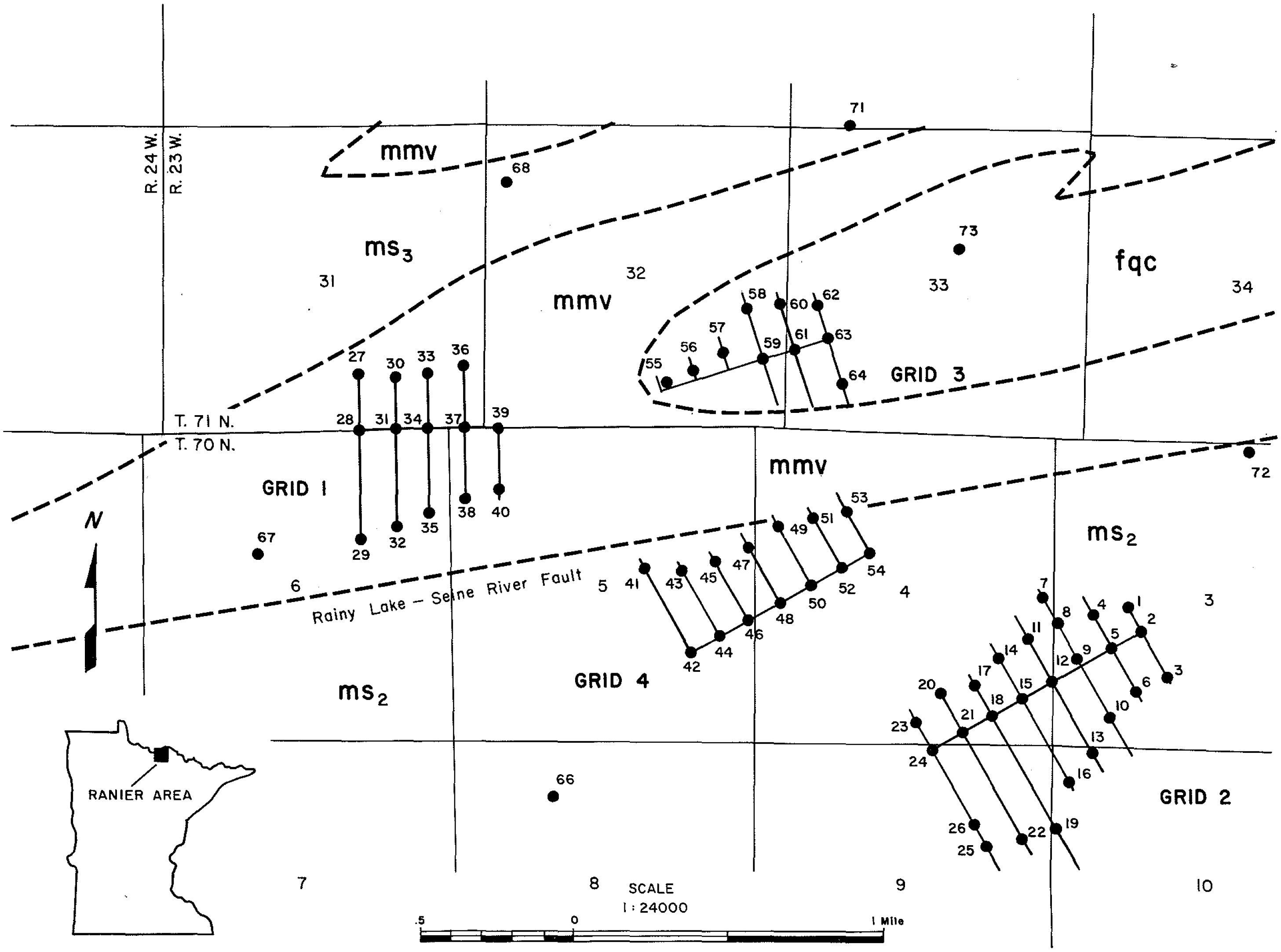
Figure 1: Sample location map of geochemical survey area south of Ranier, Minnesota.

with a shovel at a depth interval of 1-4 inches. Three to five year old alder and aspen were sampled with a pruning shears by cutting away the branches and discarding them. The remaining trunk was saved and then cut into one inch lengths. Black spruce was sampled by cutting concentric boughs growing around the circumference of the tree. The boughs were then stripped of their needles and discarded, leaving barren branches which were cut into one inch lengths. All geochemical samples were placed in olefin bags.

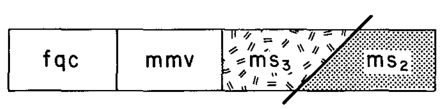
The A_0 and/or A_1 soil horizons were not present at some locations. As a result, it proved impossible to collect the complete suite of samples at each sample site throughout the entire survey area. This problem also occurred with the vegetation sampling. Black spruce, alder and aspen occurred together at only 1 of 73 sample sites. However, in most cases, one or more types of desired tree vegetation could be collected at each sample location.

Sample Preparation

A_0 samples were oven dried (80°C) followed by mulching in a blender. Next, the samples were screen rotapped for 15 minutes to −80 mesh (Tyler). Plus 80 mesh material was remulched and rotapped again. After the second rotapping, the inorganic fraction and other material remaining on the 80 mesh screen was discarded. Finally, the −80 mesh sample was thoroughly mixed and placed in appropriate containers for assay.



Geology Legend



fqc – well-bedded feldspathic quartzitic metaconglomerate containing pebbles of felsic to intermediate porphory, quartzite, schist and vein quartz.

mmv – mixed volcanic and volcaniclastic rocks including tuffaceous biotite-chlorite schist, pillowed greenstone and intermediate mafic and ultramafic plutonic rocks.

ms_3 – metasedimentary rocks, undivided; dominantly metagreywacke and slate with abundant fine-grained biotite.

ms_2 – metasedimentary rocks, undivided; well-bedded, fine- to medium-grained biotite-quartz plagioclase schist and metagreywacke.

Figure 2: Bedrock geology and sample site location map of survey area. (geology adapted from Ojakangas, 1982)

A_1 samples were oven dried (80°C) followed by grinding with mortar and pestle. The samples were then transferred to a combination of 35 and 80 mesh screens for rotapping. Plus 35 mesh material, including organics, were discarded. Any material remaining on the 80 mesh screen was reground and the procedure repeated. Finally, the −80 mesh material was mixed and placed in sample containers for assay.

Vegetation samples were oven dried (80°C) followed by maceration in a Wiley mill (to saw dust consistency). Samples were then placed in appropriate sample containers.

In recent years, there has been much literature and discussion on the subject of ashing vs. unashing of humus and vegetation samples prior to assaying (Girling et al., 1979, Hoffman and Brooker, 1983 and Dunn, 1984). Therefore, an experiment was performed to investigate gold volatization due to ashing from samples representative of the survey area. Table 1 shows A_0 horizon humus samples that have undergone various degrees of ashing. These samples were collected near Ranier, Minnesota, prior to this geochemical pilot survey. Samples K-12053 and K-12054 had initial unashed gold contents of 1.1 ppb, but after ashing, their gold concentrations increased ten-fold. This is due to Loss-on-Ignition (LOI) by which carbons and other organics are burned off leaving a concentrated inorganic sample. However, sample K-12052's gold content from unashed to ashed increased by only a factor of 3. This inconsistency may be due to volatilization of organic gold complexes, such as $Au(CN)_2$, $Au(OH)_4$, and $Au(CL)_4$ (Boyle, 1979). Table 1 also shows that unashed samples depict the greatest contrast between background and anomalous Au values. Samples K-12053 and K-12054 were collected away from any known Au mineralization whereas K-12052 was sampled near a proven Au occurrence. Consequently, in this survey, A_0 and vegetation samples were unashed prior to assay to avoid gold losses due to volatilization.

TABLE 1. Variable Gold Content in Ashed vs. Unashed A_0-Horizon Samples.

	K-12052 (ppb)	K-12053 (ppb)	K-12054 (ppb)
Unashed	10.0	1.1	1.1
Charred	10.0	7.0	8.0
Totally Ashed	29.0	11.0	10.0

Note: LOI = 90% for all three samples

Analytical Methods

Geochemical samples from this survey were assayed for Au by Neutron Activation Services Limited, Hamilton, Ontario, Canada. Instrumental Neutron Activation Analysis (INAA) was the analytical technique used to determine trace element Au concentrations. First, 8 grams of dried, macerated vegetation (or A_0 horizon sample) is briquetted in a press at 30,000 PSI to a 40 mm (diameter) disk approximately 6 mm thick. The briquette is then irradiated in thermal neutron fluxes (7×10^{12} n $cm^{-2}S^{-1}$) for one hour. The irradiated sample is then allowed to decay for four to five days to obtain optimum resolution of the Au peak (411.8 KeV). After the decay period, the gamma spectrum is counted using a hyperpure germanium detector linked to a Canberra multichannel analyzer. A digital PDP 1144 computer is connected to the analyzer to record Au values.

A_1 horizon samples were analyzed for Au by a combination fire assay-neutron activation (FANA) technique. The first step in the fire assay procedure is to weigh out 20 grams of A_1 soil (-80 mesh). Next, flux ingredients including sodium carbonate, pure silica, borax and baking flour are mixed with the sample in a fireclay crucible (Williams et al., 1975). An excess of litharge (PbO) is then added to the mixture and the crucible is placed in a muffle furnace. As the sample is being heated the lead oxide is reduced to lead by the flour. The minute droplets of lead extract out the precious metals from the molten charge as they settle to the bottom. The molten charge is poured into a mold where the lead button collects beneath the now barren gangue. After cooling the lead button is broken from the gangue and brushed clean.

The last step in fire assaying is known as cupellation. Here, the lead button is placed in a preheated bone ash cupel in an oxygen-rich hot muffle furnace. The lead is then reoxidized to litharge, which is absorbed to the cupel, leaving a pure bead of precious metals. The precious metal bead then undergoes irradiation analysis (neutron activation, as noted earlier).

Ag analyses from vegetation and A_0 horizon samples were performed by X-Ray Laboratories, Ltd., Don Mills, Ontario, Canada, using Direct Current Plasma (DCP). First, samples are wet-ashed using nitric acid. The samples are then analyzed by DCP using emission spectrophotometry. The technique measures the emission spectra from excited atoms that have passed through a thermal plasma (8000°C).

Ag analysis of A_1 soil samples were also performed by DCP except that the samples had to first undergo a total digestion using nitric acid. Detection limits for the various analytical techniques are shown in Table 2.

TABLE 2. Detection Limits for Au and Ag Analysis

	Method	Detection Limit
Au	INAA (vegetation)	0.1 ppb
Au	INAA (humus)	0.5 ppb
Au	FANA (A_1, soil)	1.0 ppb
Ag	DCP (V, A_0, A_1)	0.5 ppm

Results

Chemical analyses were performed for Au and Ag. Most Ag concentrations were at or below the detection limit for each of the media sampled, therefore, statistical analyses were performed only on Au.

From visual examination of the raw data it appeared that some of the sample types exhibited a log normal distribution.

TABLE 3. Distribution Statistics of Gold Analysis from Vegetation, A_0 and A_1 Media.

Element	Sample Type	N	Range	Arith.$\bar{X}$	$Log_{10}\bar{X}$*	Std. Dev.	C.V.%**	Median
Au(ppb)	Aspen	31	0.0-3.6	0.80	0.56	0.86	0.75	0.60
Au(ppb)	Alder	39	0.0-1.0	0.43	-	0.27	0.07	0.40
Au(ppb)	Black Spruce	16	0.0-0.8	0.43	-	0.24	0.06	0.40
Au(ppb)	A_0 (humus)	61	0.0-9.3	1.03	1.18	1.73	3.00	0.80
Au(ppb)	A_1 (soil)	65	1.0-43.0	9.32	6.80	8.55	73.26	7.00

* Calculated from $\log_{10}$ transformed data and antilogged for the arithmetic mean values shown. All other statistical parameters are non-log data.

**Coefficient of variation, % = $\frac{\text{(std. dev.)(100)}}{\text{(Arith. }\bar{X})}$

These sample types include aspen, A_0 and A_1 horizon. The data for these samples were log transformed prior to statistical analysis. Data from alder and black spruce depicted normal distributions, therefore, no transformations were completed.

The trace element concentrations of Au and Ag from vegetation, A_0 horizon and A_1 horizon samples are shown in the appendix. Distribution statistics for Au are given in Table 3. Figures 3, 5 and 7 illustrate shaded trace element concentration plots for unashed aspen, alder, and black spruce, respectively. Among the three types of vegetation sampled, aspen displayed the greatest contrast between background and anomalous Au concentrations. The corresponding histogram and cumulative frequency plots are shown in Figures 4, 6 and 8.

A_0 horizon forest litter depicted variations in gold values over all four grids (Figure 9). The histogram and cumulative frequency plots are shown in Figure 10.

Figure 11 illustrates A_1 horizon soil samples by cumulative percent Au concentration. Again, variations in gold values are indicated over all the grids. The accompanying histogram and cumulative frequency plots are shown in Figure 12. According to Boyle (1979) the average background value for Au in soil ranges from 0.5 to 5 ppb.

CONCLUSION

Under favorable conditions, biogeochemistry has the potential of reflecting gold mineralization beneath soil and glacial drift. Recent advances in instrumental chemical analysis have brought the detection limit for Au down to 1 ppb (0.1 for vegetation, 0.5 for A_0) making it cost-effective for the number of samples required in a geochemical survey.

The A_1 horizon displayed a typical lognormal distribution indicative of other geochemical sampling media (Sinclair, 1981). The A_1 horizon at Ranier compares favorably to geochemical surveys over geologically similiar auriferious greenstone belts in Canada (Boyle, 1979).

The A_0 horizon has previously been shown to be useful as an indicator of gold mineralization (Curtin, 1968). At Ranier, A_0 horizon forest litter compares favorably to a similar survey performed over auriferous volanic rocks in the Flin Flon area of eastern Saskatchewan (Dunn, 1980).

Aspen was selected as a biogeochemical sampling media because it occurs evenly distributed over the survey area. Alder and black spruce samples were chosen to compare their geochemical Au values to that of aspen.

Of the three vegetation types selected, aspen showed the greatest contrast in Au values throughout the survey area. A_1, A_0 and vegetation (aspen) sampling have proven to be an effective geochemical tool for Au evaluation in the Ranier area.

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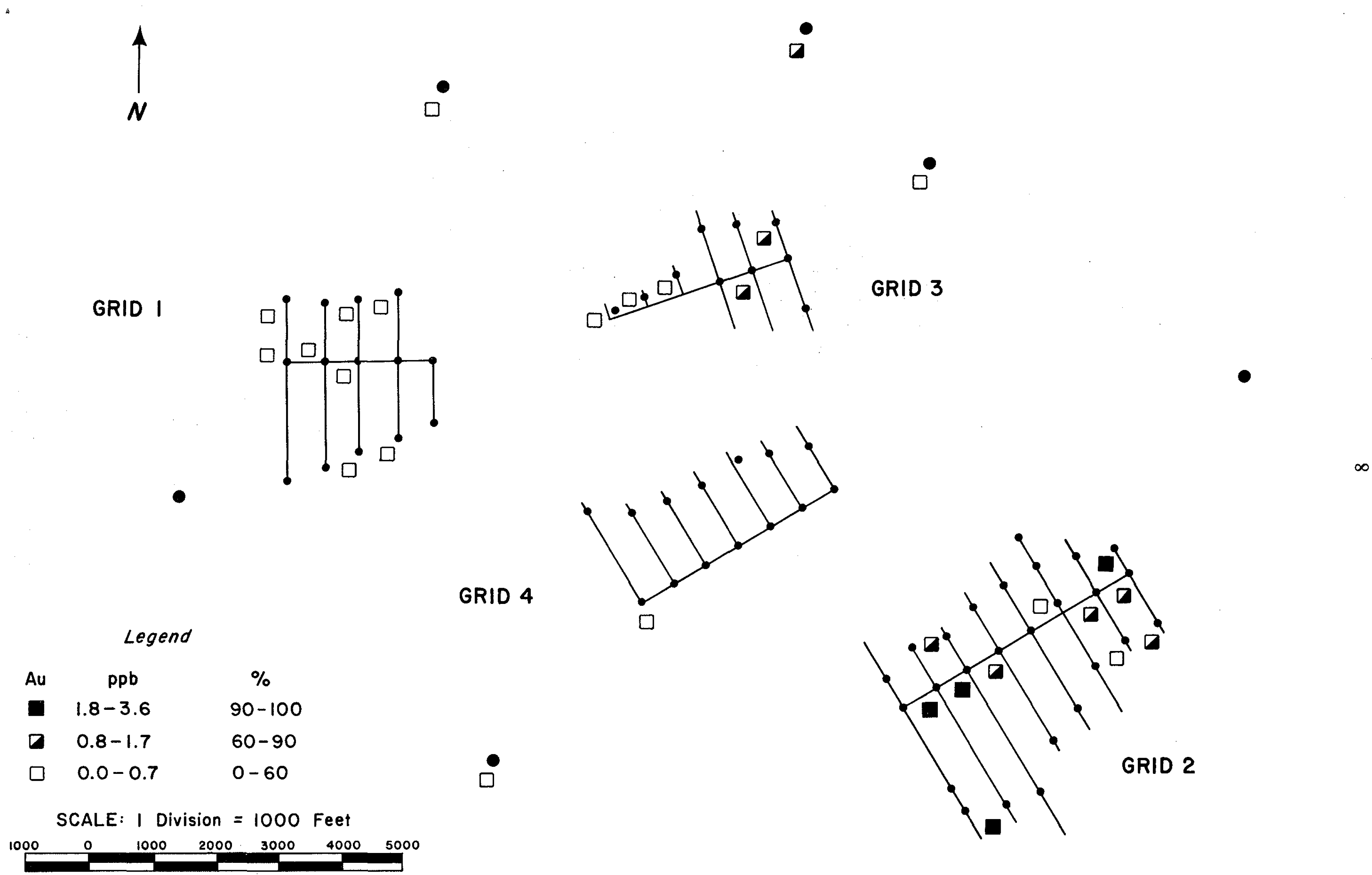


Figure 3: Sample location map showing aspen sample sites with cumulative percent concentration of Au.

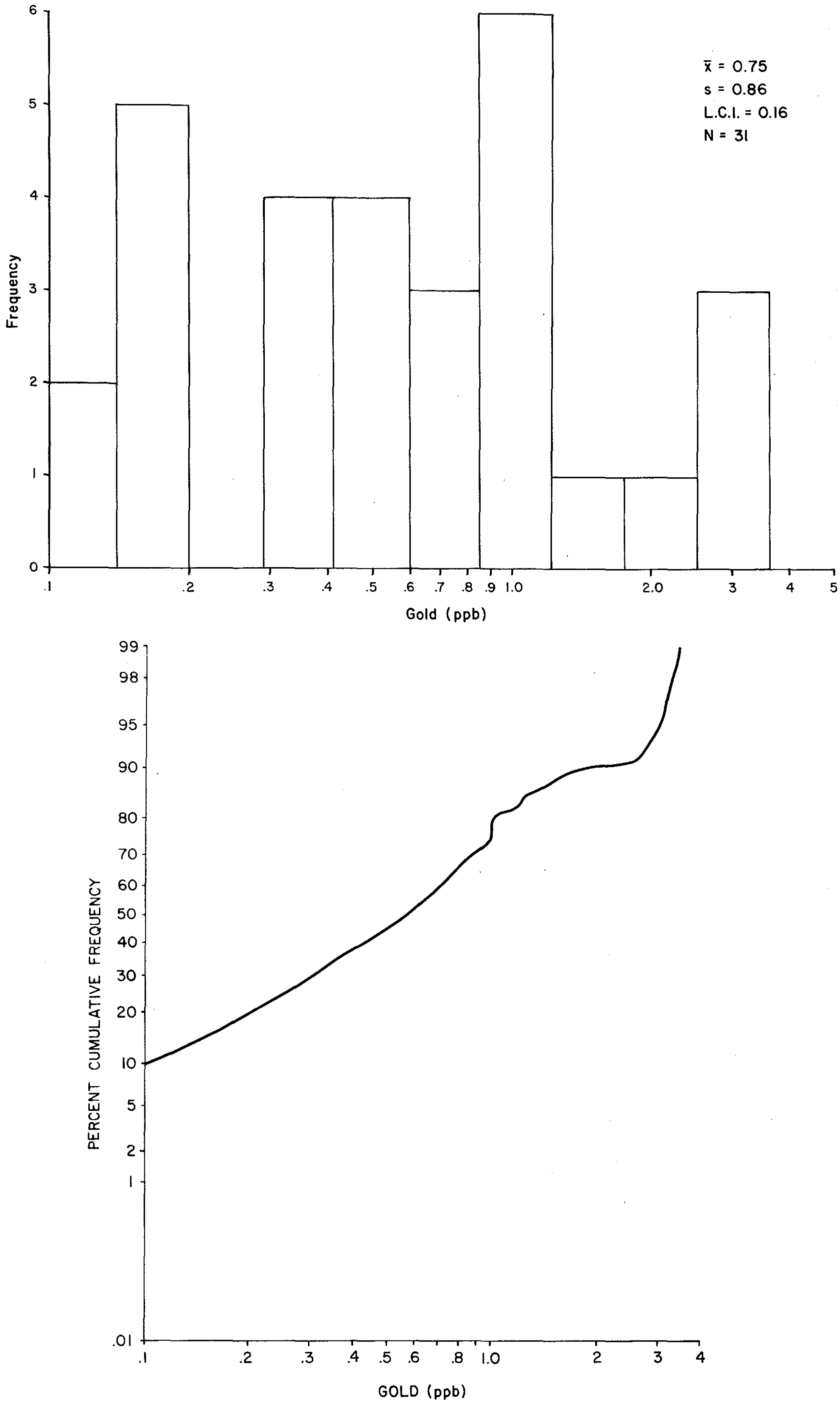


Figure 4: Histogram and cumulative frequency distribution of Au using unashed aspen stems.

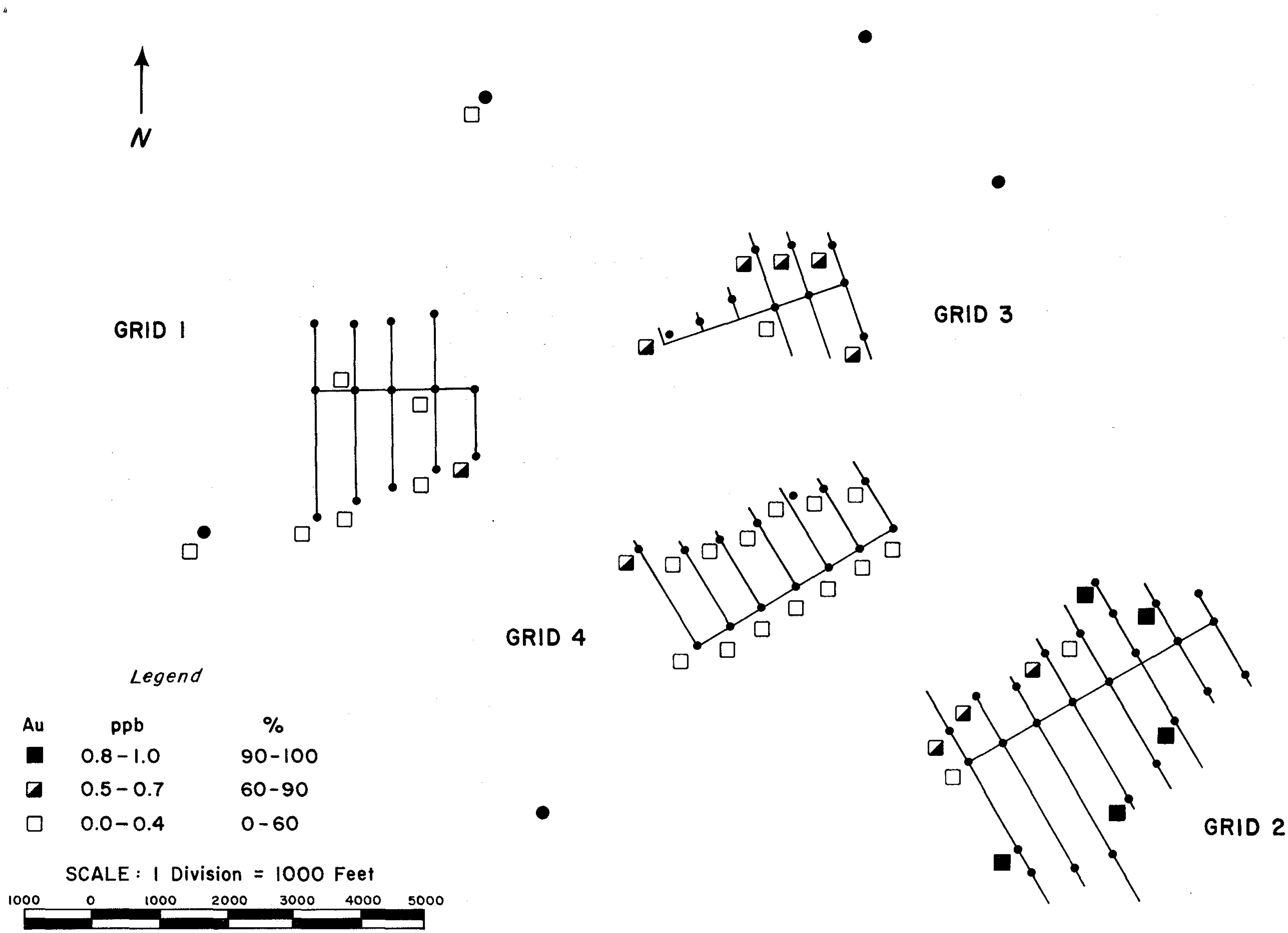
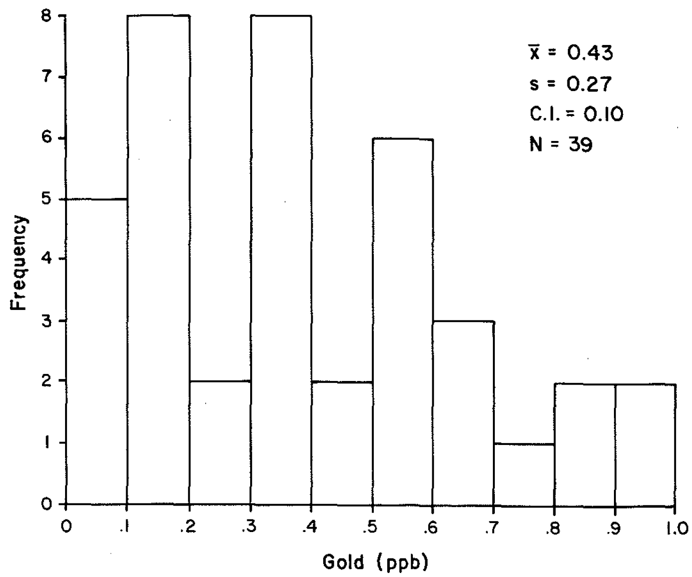


Figure 5: Sample location map showing alder sample sites with cumulative percent concentration of Au.



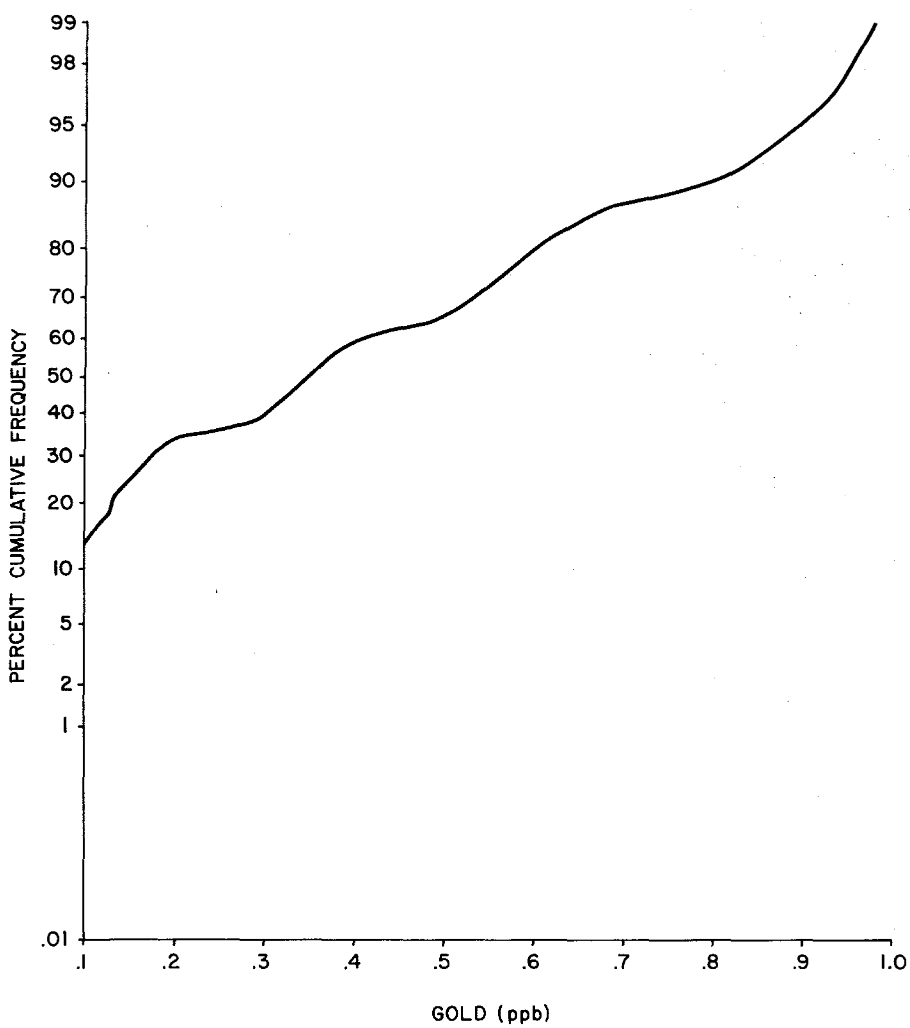


Figure 6: Histogram and cumulative frequency distribution of Au using unashed alder stems.

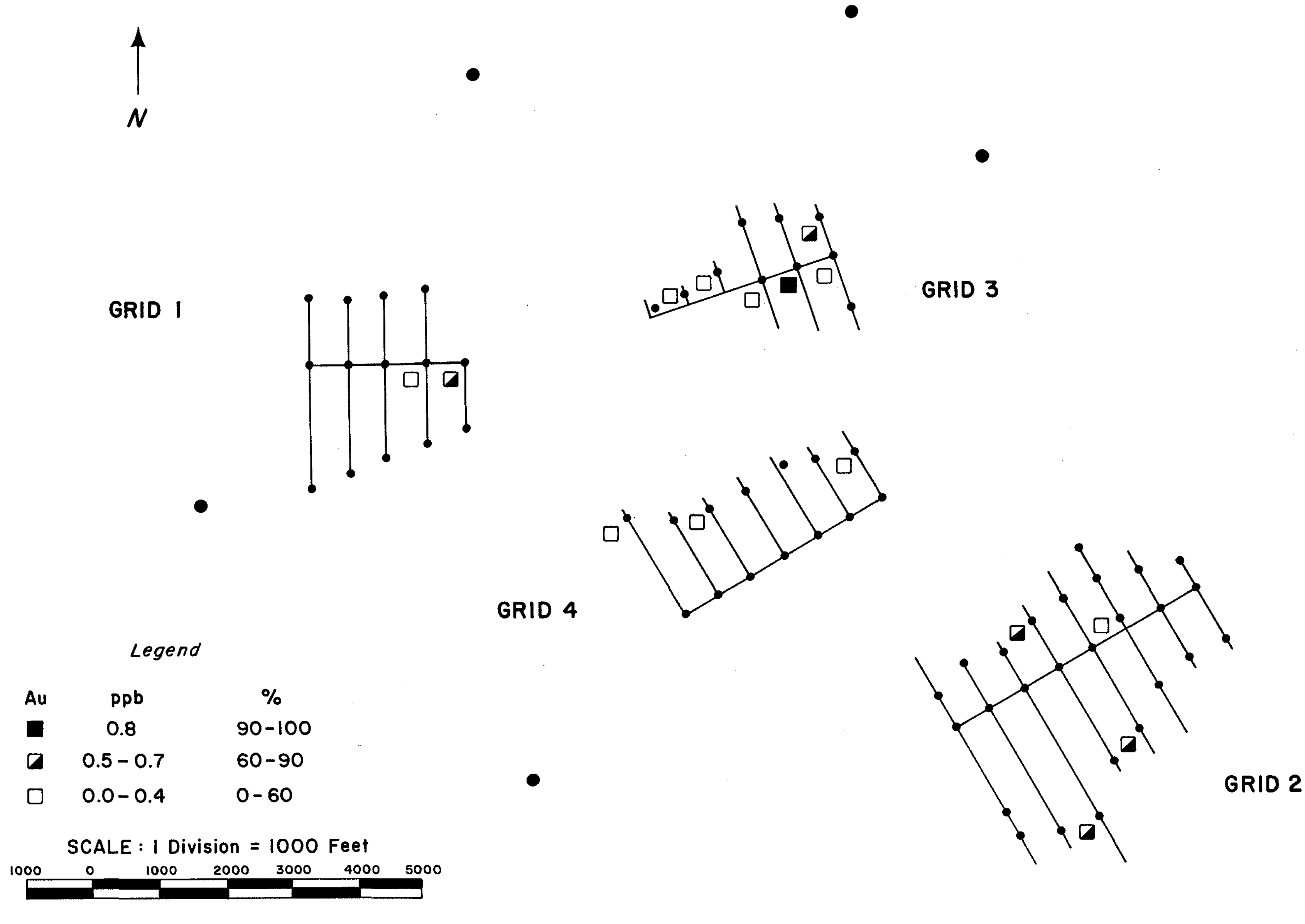
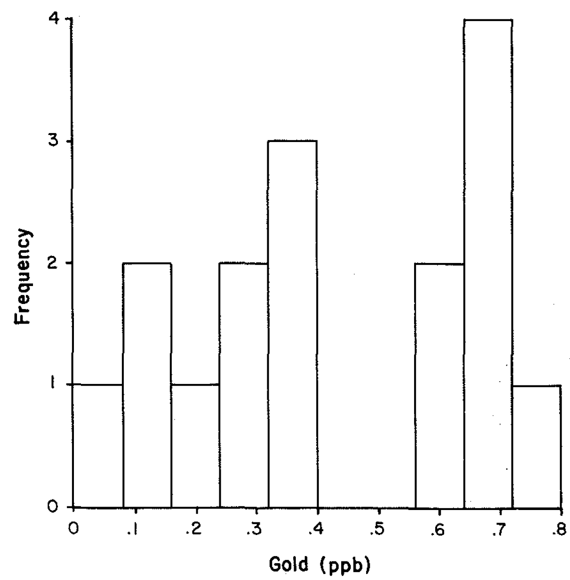


Figure 7: Sample location map showing black spruce sample sites with cumulative percent concentration of Au.

$\bar{x} = 0.43$
$s = 0.24$
C.I. = 0.08
N = 16



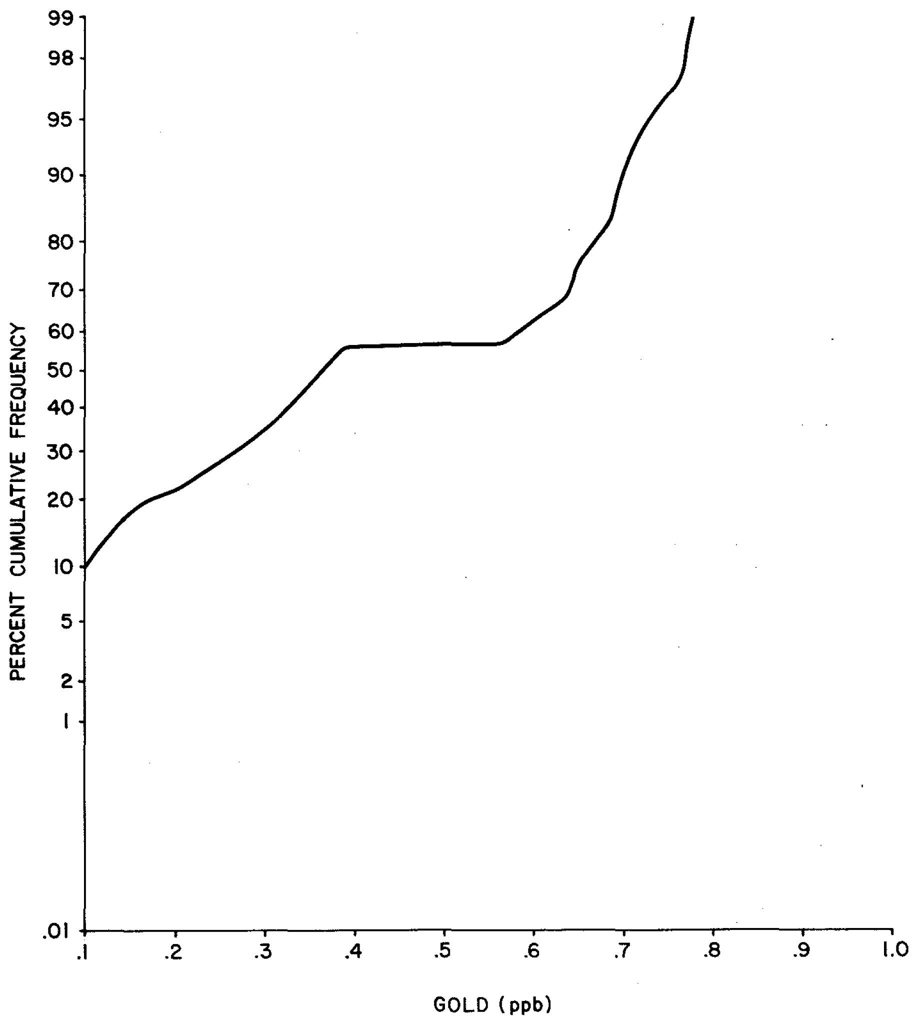


Figure 8: Histogram and cumulative frequency distribution of Au using unashed black spruce.

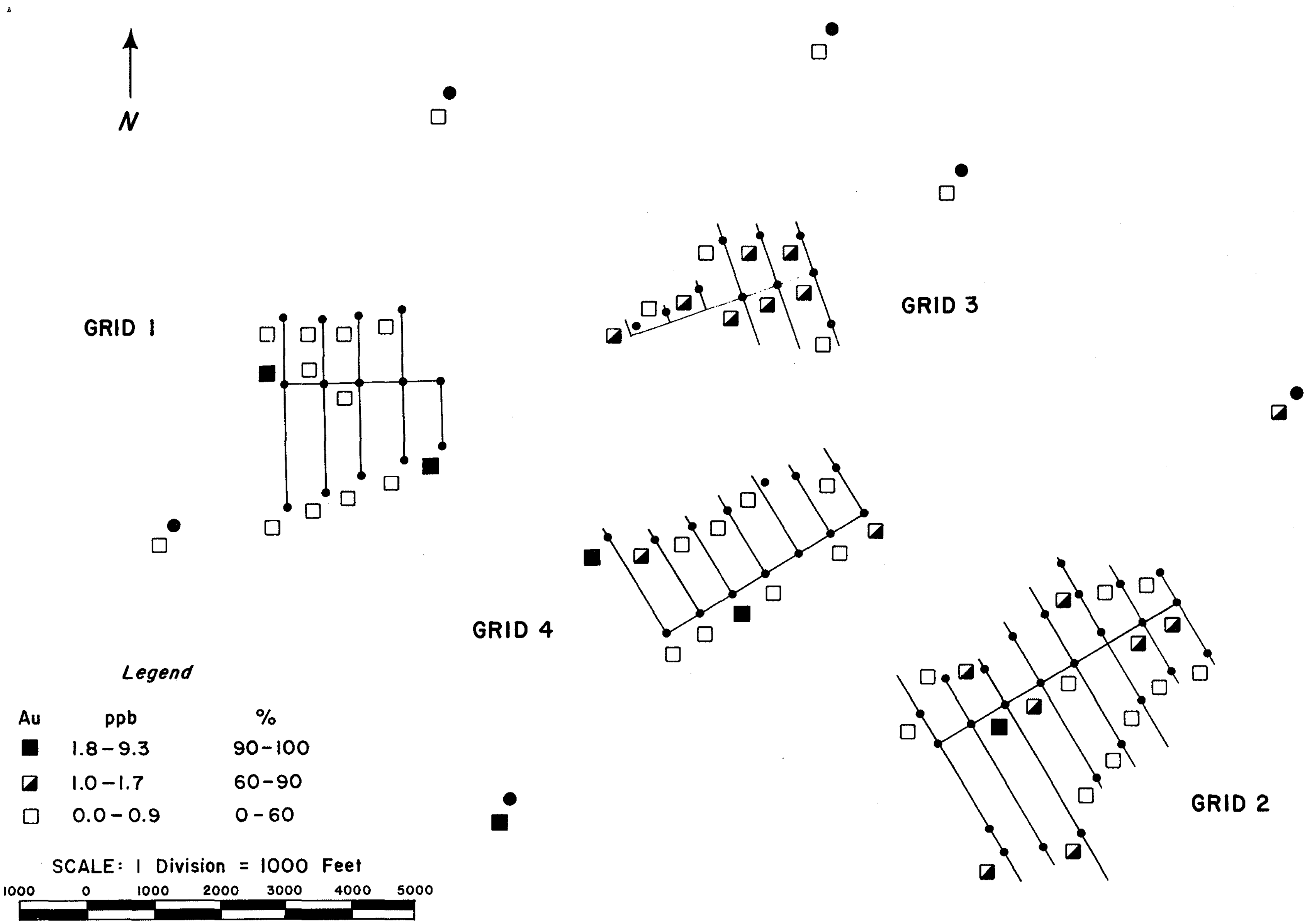
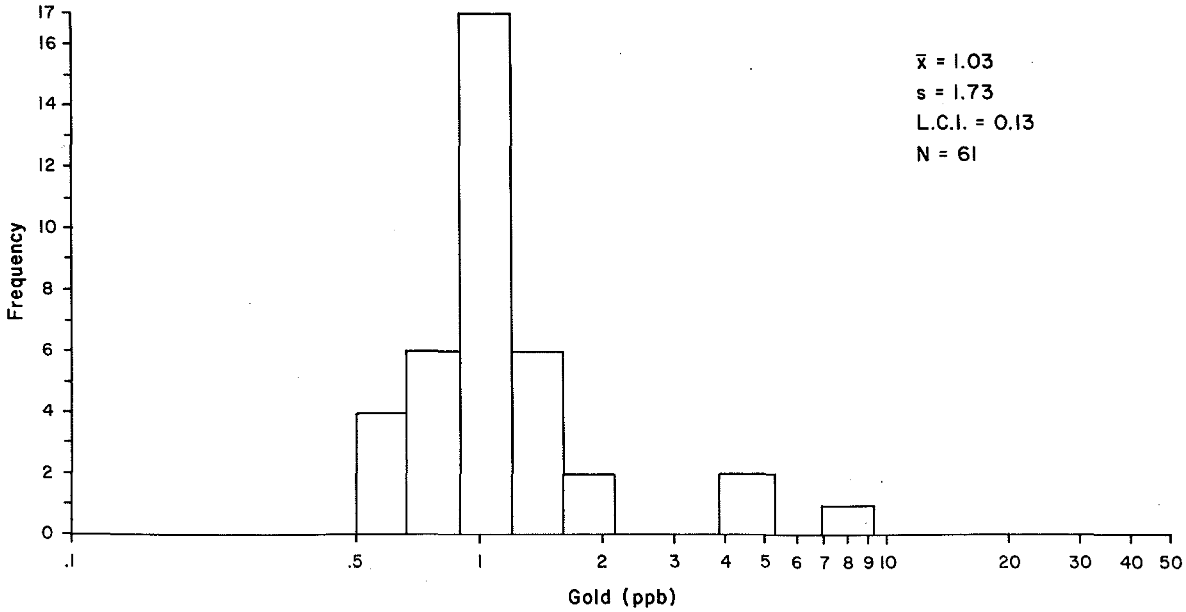


Figure 9: Sample location map showing A_0 horizon sample sites with cumulative percent concentration of Au.



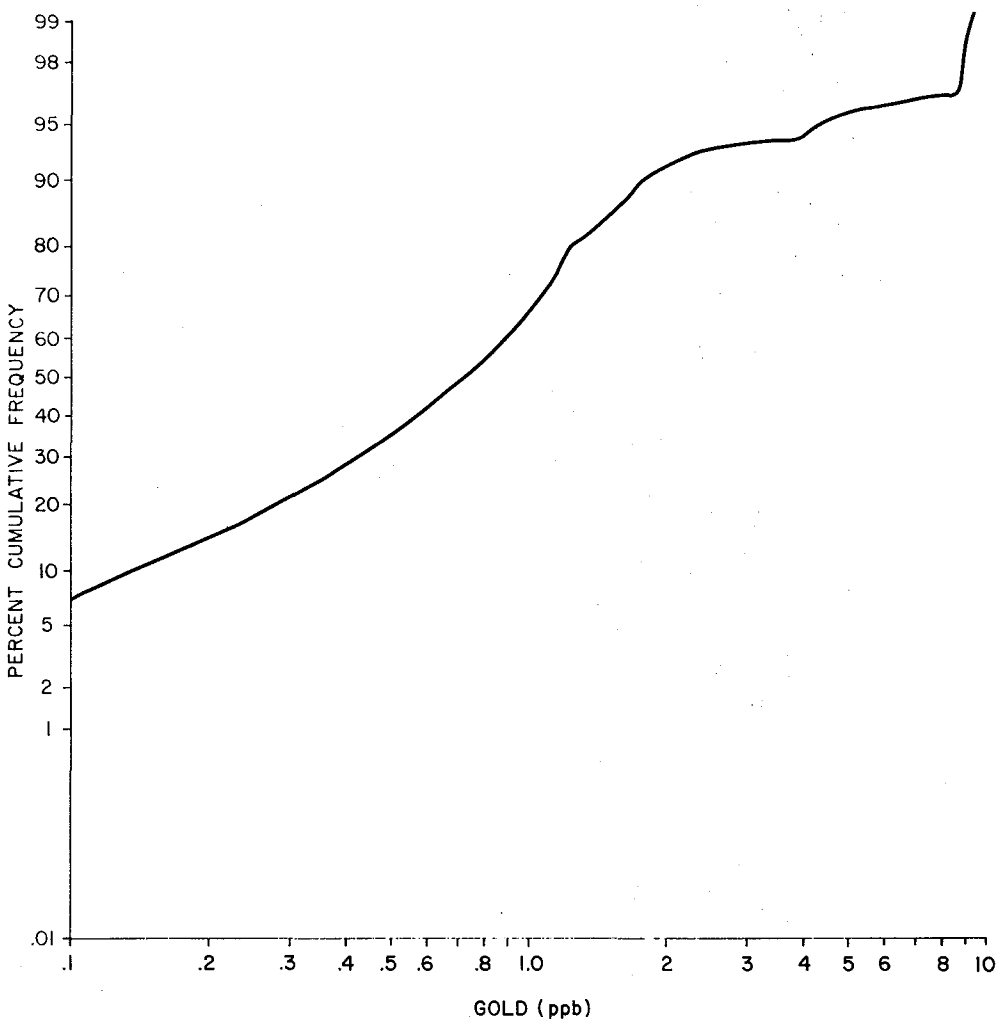


Figure 10: Histogram and cumulative frequency distribution of Au using A_0 horizon forest litter.

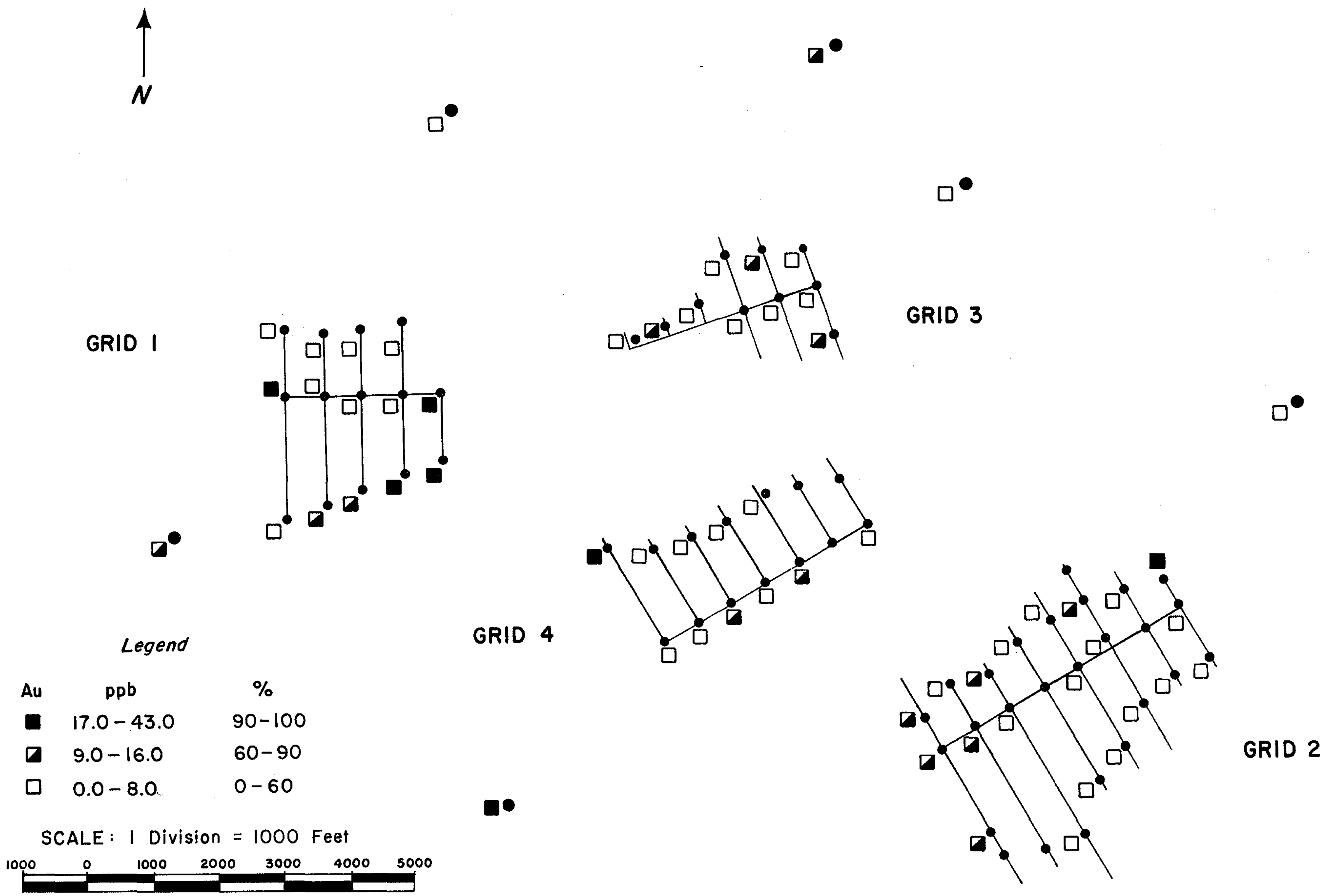


Figure 11: Sample location map showing A_1 horizon sample sites with cumulative percent concentration of Au.

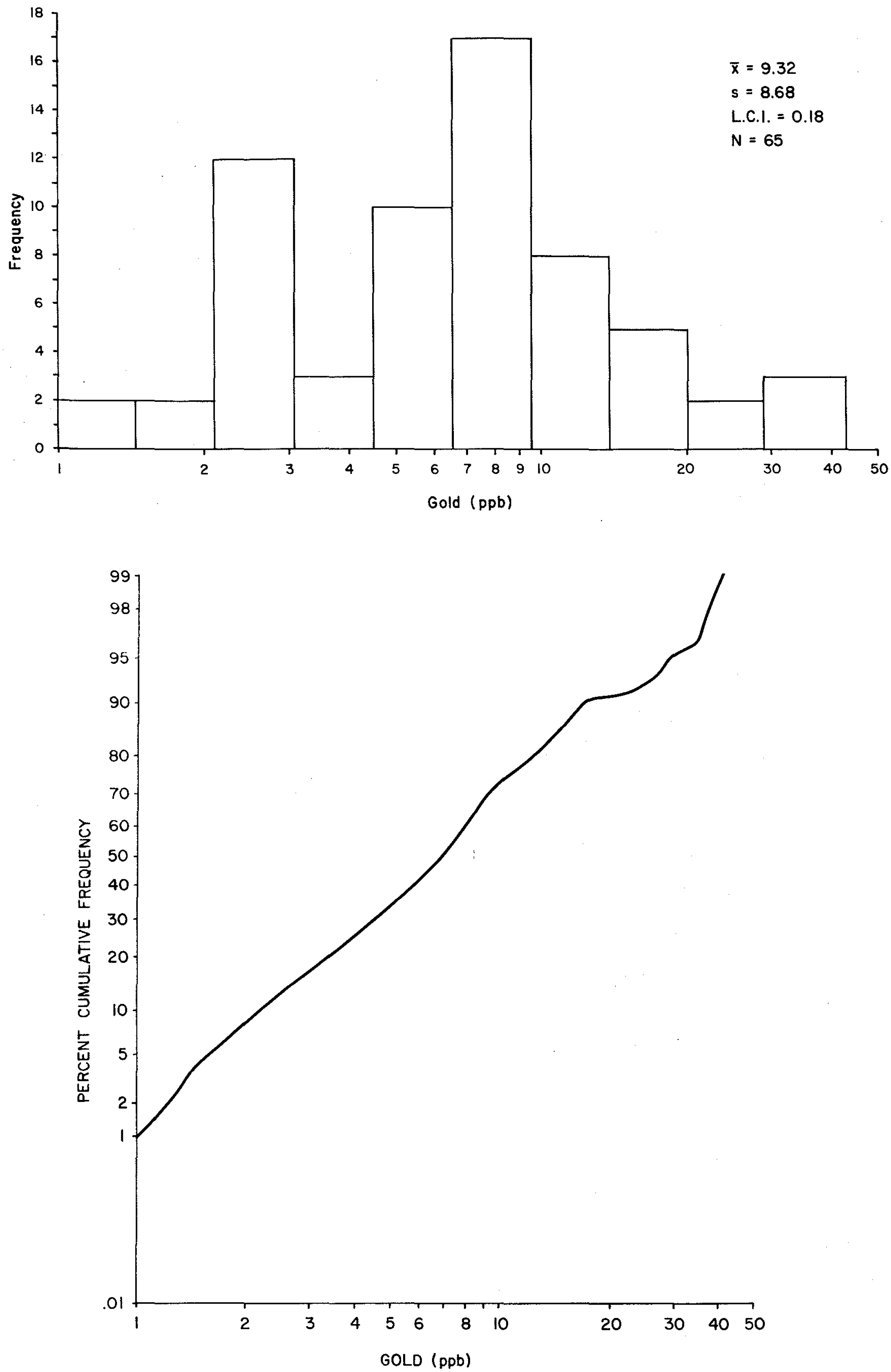


Figure 12: Histogram and cumulative frequency distribution of Au using A_1 horizon soil.

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Appendix

SITE NO.	AUAO (PPB)	AUAI (PPB)	AUP (PPB)	AUA (PPB)	AUB (PPB)	AGAO (PPM)	AGAI (PPM)	AGP (PPM)	AGA (PPM)	AGB (PPM)	GRID NO.
1	.0	17.00	3.60			.0	.0	.0			GB
2	1.90	6.00	1.30			.5	1.00	.0			GB
3	.9	3.00	.9			.5	.5	.0			GB
4	.7	7.00		1.00		.5	.0		.0		GB
5	1.10		1.10			.5		.0			GB
6	.8	3.00	.6			.0	.5	.0			GB
7				.9					.0		GB
8	1.00	13.00				.5	.5				GB
9		8.00	.7				1.00	.0			GB
10	.9	2.00		.8		.0	.5		.0		GB
11		2.00		.4			.5		.0		GB
12	.6	7.00			.4	.5	1.00			.0	GB
13	.6	3.00			.6	.5	.0			.5	GB
14		1.00		.7	.7		.5		.0	.0	GB
15	1.00	4.00	.9			.5	.5	.0			GB
16	.6	3.00		1.00		.5	.0		.0		GB
17	1.00	9.00	.9			.5	.5	.0			GB
18	9.30	3.00	3.10			1.00	.5	.5			GB
19	1.20	3.00			.7	.5	.5			.0	GB
20	.0	6.00		.6		.5	1.00		.0		GB
21		14.00	2.70				.0	.0			GB
22			1.80					.0			GB
23	.0	9.00		.6		.0	.0		.0		GB
24		12.00		.2			.5		.0		GB
25	1.00	11.00				.0	1.00				GB
26				.9				.0			GB
27	.7	9.00	.2			.5	1.00	.0			GA
28	.0	37.00	.5			.0	.0	.0			GA
29	.8	3.00		.4		.5	.5		.0		GA
30	.5	3.00				.5	.5				GA
31	.8	8.00	.3	.4		.5	1.00	.0	.0		GA
32	.0	14.00		.2		.5	.5		.0		GA
33	.0	6.00	.0			.5	.5	.0			GA
34	.0	6.00	.2			.5	1.00	.0			GA
35	.0	12.00	.1			1.00	.5	.0			GA
36	.0	3.00	.3			1.00	.5	.0			GA
37		6.00		.3	.3		.5		.0	.5	GA
38	.9	25.00	.2	.4		.5	1.00	.0	.0		GA
39		28.00			.7		.0			.0	GA
40	5.00	35.00		.7		.0	.0		.0		GA
41	4.00	43.00		.6	.0	.0	.0		.0	.0	GD
42	.0	3.00	.1	.2		.5	.5	.0	.0		GD
43	1.40	3.00		.2		.5	1.00		.0		GD
44	.0	8.00		.1		.5	.5		.0		GD
45	.0	3.00		.1	.3	.5	1.00		.0	.0	GD
46	1.80	9.00		.2		.5	1.00		.0		GD
47	.0			.0		.5			.0		GD
48	.0	5.00		.4		1.00	.5		.0		GD
49	.0	8.00		.0		1.00	.5		.0		GD
50		10.00		.4			1.00		.0		GD
51				.2					.0		GD
52	.9			.2		.5			.0		GD
53	.0			.0	.1	1.00			.0	.0	GD
54	1.00	7.00		.5		.0	.0		.0		GD
55	1.00	7.00	.7	.6		1.00	.0	.0	.0		GC
56	.8	9.00	.2		.1	1.00	1.00	.0		.0	GC
57	1.10	8.00	.4		.4	1.00	.5	.0		.0	GC
58	.9	8.00		.5		.5	.5		.0		GC
59	1.30	7.00		.3	.2	1.00	1.00		.0	.0	GC
60	1.20	10.00		.6		.5	.5		.0		GC
61	1.40	4.00	.8		.8	.5	.5	.0		.0	GC
62	1.30	5.00	.9	.6	.7	.5	1.00	.0	.0	.0	GC
63	1.50	8.00			.4	1.00	.5			.5	GC
64	.0	15.00		.7		.0	.0		.0		GC
65	.0	14.00	.6			.0	.0	.0			RS
66	9.00	30.00	.0			.0	.0	.0			RS
67	.0	10.00		.4		1.00	1.00		.0		RS
68	.0	5.00	.5	.4		.5	1.00	.0	.0		RS
69	.9	6.00	.4			1.00	.5	.0			RS
70	.0	4.00			.6	.0	.0			.0	RS
71	.0	10.00	.9			1.00	.0	.0			RS
72	1.30	1.00		.2		.5	.5		.0		RS
73	.9	5.00	.2			.5	1.00	.0			RS

Legend: 1. Headings represent trace element types, i.e. Au and Ag as prefixes; suffixes represent sample types, i.e. P = Poplar, B = Black Spruce, A = Alder. For example AUAO represents gold in A_0 horizon forest litter.

2. Grid Numbers: GA = Grid 1, GB = Grid 2, GC = Grid 3, GD = Grid 4, RS = Regional Sample

Note: 3. Sample locations do not appear in Figure 2. These sites are beyond the boundaries shown. The respective site numbers and locations are as follows:

Site No.	Location
65	SW 1/4, SW 1/4, S1, T70N R23W
69	NE 1/4, NE 1/4, S35, T71N R23W
70	NE 1/4, SW 1/4, S31, T71N R22W

GEODRILLING REPORT

SECTION B

GEOPHYSICAL SURVEYS

By T. L. Lawler

INTRODUCTION

The objectives of Project 242 are to evaluate the mineral potential of state-owned lands for land use planning and to encourage exploration by private enterprise. To accomplish these objectives, the areas examined were those where potential mineral deposits, host rocks and associated features are deeply buried or difficult to detect in outcrop exposures and are not currently receiving attention from private enterprise. Geophysical methods, therefore, must be used to evaluate these areas. Because some of these methods are of recent development, they have not been thoroughly tested and are not being extensively used by industry. A part of the program is to evaluate some of these methods. Project objectives include detailed sample examination and analysis. The usual method for obtaining samples was by drilling geophysical survey targets.

Footwall Duluth Complex

Copper-nickel sulfides often occur near the footwall of basic rock units such as the Sudbury District in Canada and the Kambalda Area deposits in Australia. Recent studies indicate that the addition of sulfur and silica from underlying lithologic units or xenoliths assimilated in the basic igneous rock play an important role in the genesis of these deposits (Naldrett, 1981). Sulfides also accumulate by gravitational settling in footwall depressions. It is not always clear why ore deposits are associated with fault structures or footwall depressions, but they are the loci for many of the major economic copper-nickel deposits (Sawkins, 1984) and (Gresham et al., 1981).

A part of the footwall of the Duluth Complex from Township 56 North to the B.W.C.A. wilderness has been extensively explored for copper-nickel mineral potential by industry. Several subeconomic deposits have been defined which are associated with structural deformation of footwall rocks. In some places, faulting coincides with the mineralization and there are numerous inclusions of footwall rock in the igneous host. From the city of Duluth north to Township 57 North, the contact has been relatively unexplored and its mapped location is questionable.

A modified second derivative algorithm which exaggerates the along-strike component of airborne magnetic surveys flown by the Minnesota Geological Survey was used to map the footwall of the Duluth Complex and indicate areas of known mineralization (Plates 1-8). A comparison of second derivative results with areas well defined by drilling shows that the method effectively maps the footwall, and does indeed indicate footwall structures associated with mineralization.

In areas where the footwall is relatively unknown, this survey was followed by reconnaissance horizontal loop electro-magnetic surveys (H.L.E.M.) using an Apex Parametrics Ltd., Max-Min II instrument. Survey lines were run east-west perpendicular to the footwall contact. A 200 meter coil separation was used with 100-foot station interval and frequencies of 444 and 1777 hertz. Magnetic profiles were also run using a GeoMetrics, Unimag, Model G-836 proton magnetometer. The station interval for the magnetics was also 100 feet. The H.L.E.M. located a strong anomaly in the SE1/4, SW1/4, Section 10, T52N-R15W and diamond drill hole FHL-1 was subsequently drilled (Plate 9). The hole intersected interesting quantities of subeconomic mineralization (Table FHL-1).

Reconnaissance surveys on the Fish Lake Reservoir located another strong H.L.E.M. anomaly. Consequently, in January, 1985, detailed surveys were made in Section 6, T51N-R15W and Section 31, T52N-R15W. Again the survey used a 200 meter coil separation with frequencies of 444 and 1777 hertz and a station spacing of 100 feet. A very strong conductor with the characteristics of a massive sulfide was mapped in the S1/2 of the SE1/4 of Section 31, T52N-R15W. The axis of the conductor trends East Ten degrees North (Plate 9). A comparison of profiles using a 100 meter coil separation and 200 meter coil separation indicates a depth of burial greater than 150 feet. The length of the conductive zone and reduced conductivity at both ends suggests it is following down the dip of the footwall contact of the Duluth Complex. Hole TS-1 was drilled on this anomaly in the Fish Lake Reservoir in the SW1/4-SE1/4-SE1/4 of Section 31, T52N-R15W, at station 7+00N on Line 4+00E. The vertical hole was drilled through the ice, and intersected various sediments to 96 feet, then hornfels to 241 feet. The core is sulfide-bearing and somewhat conductive although not as conductive as would be expected from the H.L.E.M. survey and the depth of burial. Bedding is contorted and at shallow angles to the core. It is very broken in places and shot with pyritic quartz veins. These features suggest close proximity to a fault. Preliminary assays showed two short intervals with anomalous gold to 35 and 50 ppb (Table TS-1). Unseasonably warm weather with melt water and radial cracks developing in the ice around the rig forced termination of the hole at 241 feet with inconclusive results.

Most of the electro-magnetic surveys over the footwall area of the Duluth Complex have been done with equipment that would not penetrate more than 200 feet. Many of these surveys were oriented for a maximum response from conductors parallel to the footwall contact. The Project 242 investigation suggests further surveys be oriented for maximum response from structures disrupting the footwall and capable of deeper penetration to better locate economic copper-nickel deposits modeled after Sudbury. Second derivative maps define some of these structures; others are clearly shown on shaded relief displays of aeromagnetic surveys compiled by Val Chandler of the Minnesota Geological Survey (Chandler, 1984).

Ranier Area

Of the ten major Canadian gold camps which have produced more than a million ounces, nine are near the contact of a sedimentary-volcanic sequence. At six of these camps major faults or "breaks" are present and coincide in a large part with sedimentary-volcanic sequence contacts (Hodgson, et al., 1981). In the Ranier Area, east of International Falls just south of the Canadian border, the Rainy Lake-Seine River Fault constitutes a major structural feature. The fault strikes N80°E and forms the contact between metavolcanic rocks to the north and metasedimentary rocks to the south. In 1894 the Bevier Mining Company milled about 500 tons of ore from Little American Island, on the fault zone from which they recovered $5,535.33 in bullion, which would indicate at least some of the mined rock is ore grade at present day prices (Winchell and Grant, 1895). A preliminary outcrop study along the twelve mile strike length of the Rainy Lake-Seine River Fault from International Falls to the Little American Island located encouraging indications of mineralization.

Reconnaissance very low frequency electro-magnetic profiles were run across the mine site at Little American Island using a Geonics Ltd., Ronka EM-16 VLF-EM instrument. The traverse was north-south with fifty-foot station spacings. Signals from transmitters at Cutler, Maine and Annapolis, Maryland were recorded. A very distinctive profile was observed, with two strong positive and negative half cycles in a back to back relationship, facing weak half cycles across their respective conductors (Figure 1). The profile is interpreted as a very resistive unit flanked by two modest conductors. Quartz is observed in outcrops forming the resistive unit, and the geophysical interpretation fits the geologic concept of silicification invading a fault zone. The silicification is also resistive to weathering and forms ridges. Reconnaissance traverses repeated this distinctive profile, or half of it, at a number of places along the fault zone and four grids were brushed for more detailed surveys (Plates 10-12).

Total field magnetic profiles were also run using the GeoMetrics Model G-836 proton magnetometer. At the Little American Mine the magnetic profile shows a very subtle indication of a metasedimentary unit to the south and a metavolcanic unit to the north with the contact near the south shore of the island. This does not appear to be a distinctive characteristic and was not pursued extensively, although a more sensitive survey instrument could improve definition of these geologic units.

At most Superior Province type gold mines the gold is associated with sulfides and silicification. The silicification is indicated by high resistivity and the sulfides, which are often found as discrete, non-conductive metallic particles, by chargeability anomalies. An induced polarization survey was run on portions of the four grids using a TSA Systems Inc. MicroTerra 10, multifunction earthmeter in Wenner configuration with 100-foot "A" spacing. Both frequency and time domain modes were used with numerous observations at several current levels, although only anomalies from time domain readings are plotted. Figures 2 and 3 display profiles of chargeability and resistivity on those grid lines where holes were drilled. Good repeatability was obtained using a frequency of 5.0 hertz and current flows of 1, 2, 5 and 10 milliamps. Normal background chargeability levels were less than 20 millivolts per volt. Twenty to 60 millivolts per volt are weakly anomalous, 60 to 100 millivolts per volt moderately anomalous, and greater than 100 millivolts per volt strongly anomalous.

At Grid one (Plate 10) topography and VLF-EM data indicate the east-west trending silicified zone was broken by repeated fault movement. The north side was then offset to the northwest by a northwest trending fault. This doubled the distinctive VLF-EM profiles. Structurally, there should be an area of "open ground" between the silicified segments. Along this zone there is a roughly linear group of chargeability anomalies trending east-west. These features were tested by drill hole RR-1 on Line 12+00E. The hole intersected several encouraging intervals of silicificaton, sulfides and brecciation with assays as high as 3.6 ppm gold (Table RR-1).

Plate 12 displays Grids three and four which also have interesting geophysical indications of mineralization. On Grid three, Line 6+00E there is a strong chargeability anomaly near the center of the silicified zone. This might be an indication of repeated fault movement with late silicification and mineralization. On Grid four, Lines 30+00W and 36+00W, a strong chargeability anomaly is observed, and on Line 30+00W, silicification as mapped by the VLF-EM survey appears to be offset to the east. More detailed surveys are needed in this area to define a target.

Woodall, 1979, states that "gold in structurally prepared sites in the volcanics and associated intrusives accounts for 84% of Australian Archean production." In the past, miners referred to structurally prepared sites as "open ground" and it was one of the criteria used in evaluating gold mining ventures. Usually the structures have a vertical orientation which interrupts the horizontal orientation of older geologic features. Structurally prepared sites can be defined by refraction seismic surveys because the seismic signal travels in horizon-

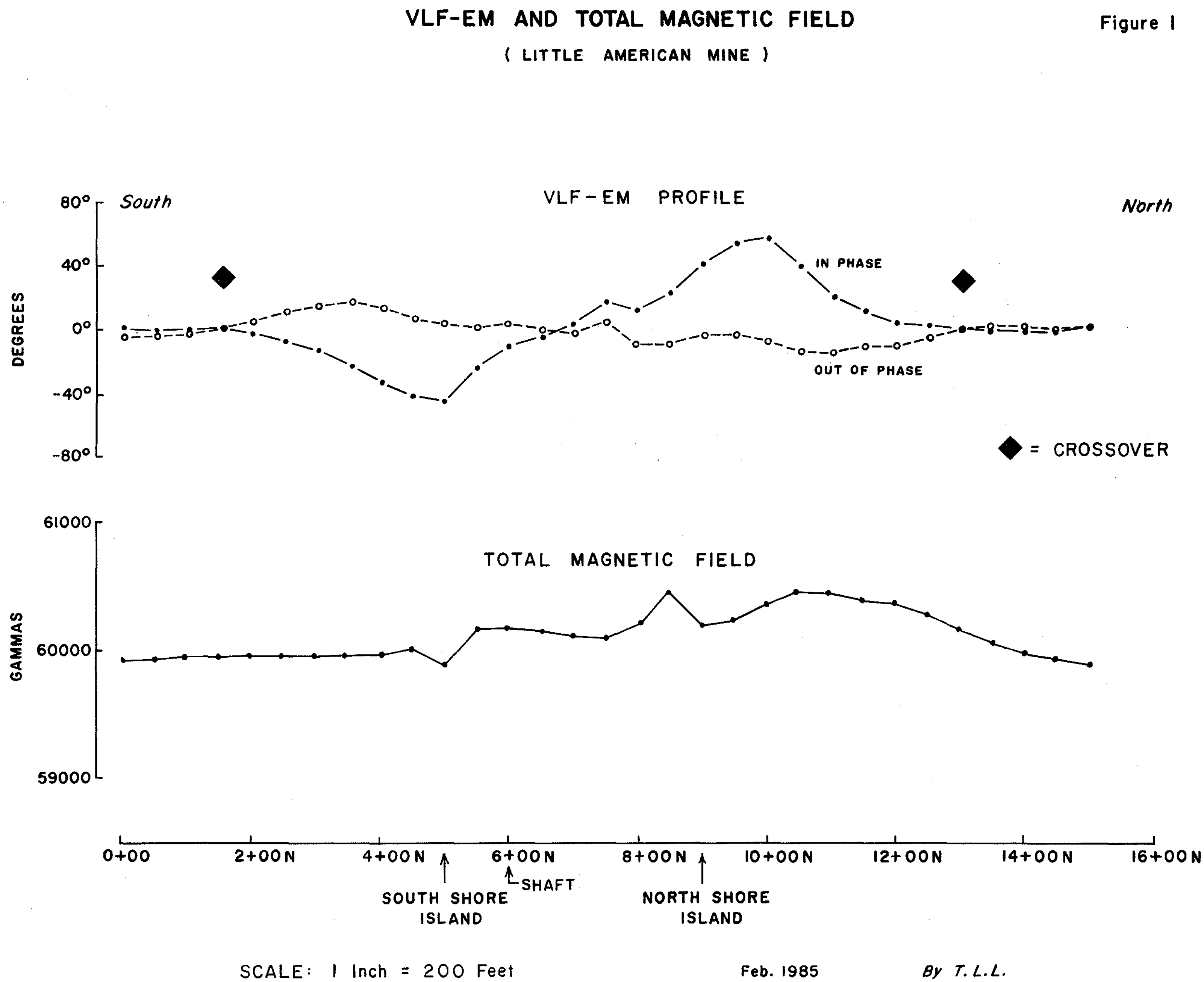

Figure 1: Profiles VLF-EM and total magnetic field, LittleAmerican Island, Ranier Area, Koochiching County, Minnesota

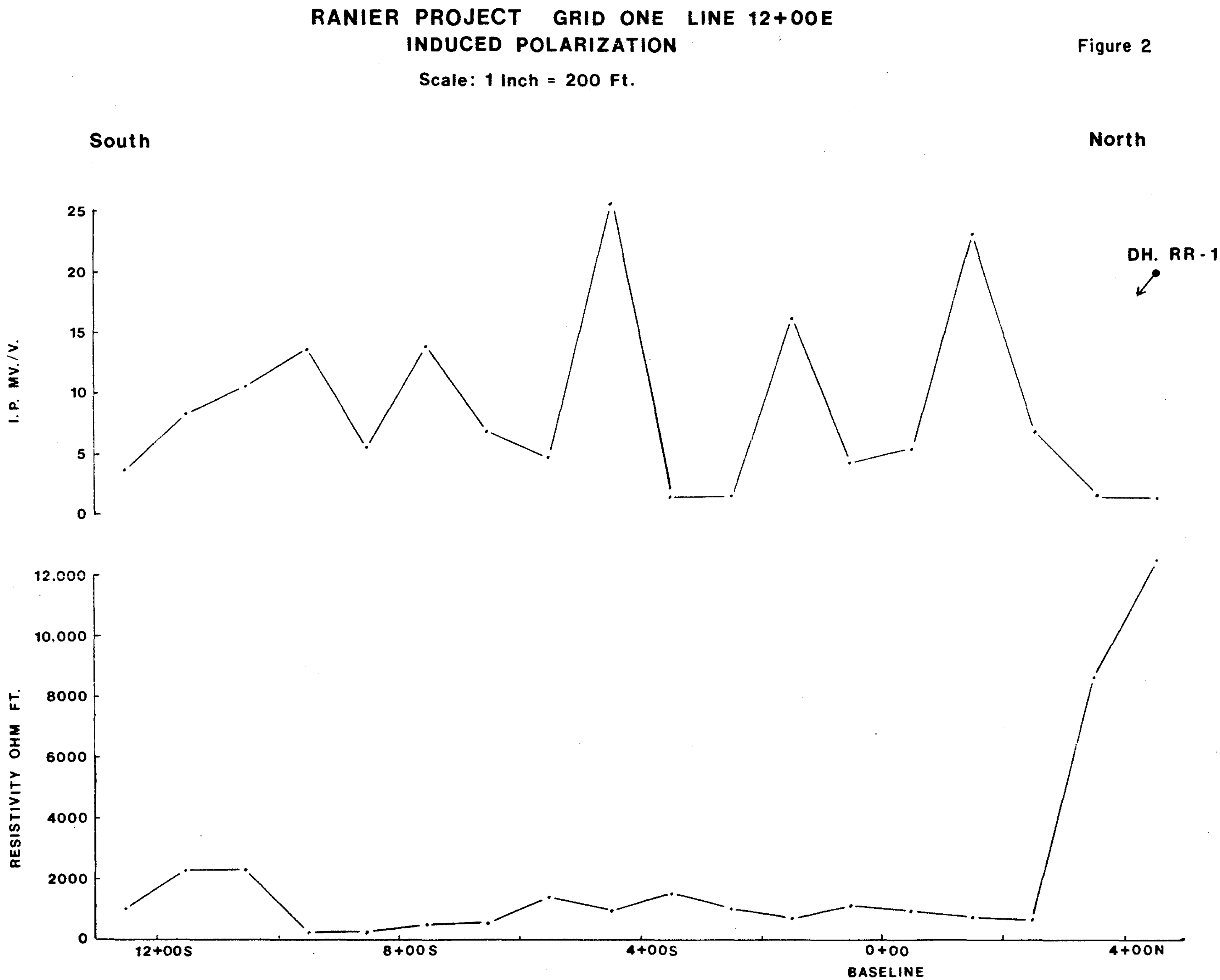

Figure 2: Profiles induced polarization and resistivity, Drill Hole RR-1, Ranier Area, Koochiching County, Minnesota

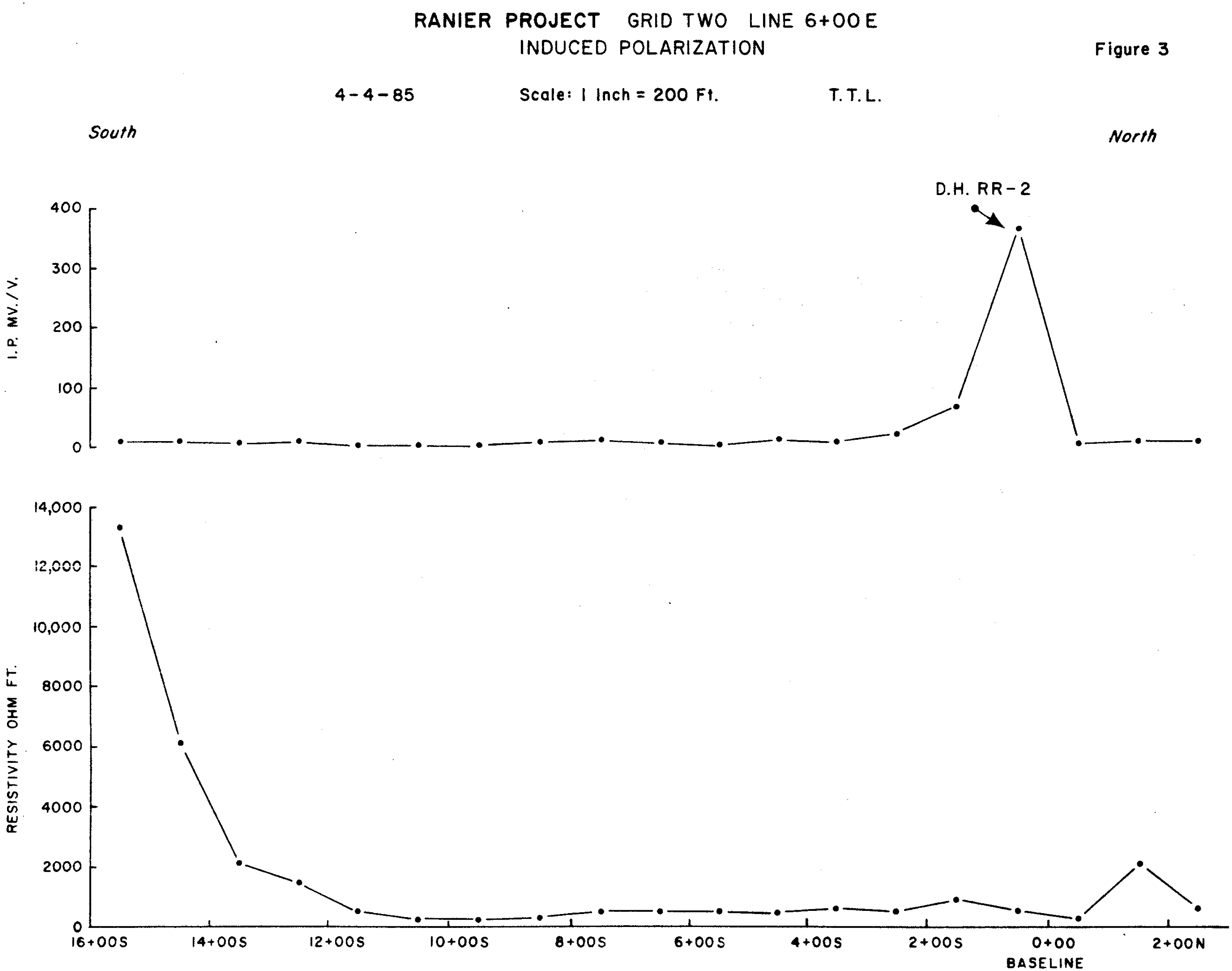

Figure 3: Profiles induced polarization and resistivity, Drill Hole RR-2, Ranier Area, Koochiching County, Minnesota

tal paths across the interrupting structure.

Because of good summer access and a strong linear induced polarization anomaly, the baseline area of the west 1,800 feet on Grid two (Plate 11) was selected as a test for a refraction seismic survey. The survey used a Bison Geo-Pro, twelve channel, signal-enhancement instrument. Shotgun shells or balls of primer cord with zero delay blasting caps were used for an energy source. A ten-foot geophone interval gave excellent structural definition. Calculations of interface depths were made using the time-delay method described by Redpath, 1973. The strongest induced polarization anomaly on Grid two is observed on Line 6+00E between stations 0+00 and 1+00S. Plate 11 shows a refraction seismic profile of part of Line 6+00E in the area of the I.P. high. An excellent fault profile is observed from 0+40S to 0+60S. The north side is downthrown and the fault zone is estimated to be 25 feet wide. Hole RR-2 was drilled to test the structure. The low velocity zone plots between 78 and 88 feet down the hole. Flanking this zone is the area of highest gold content encountered in the hole: 38 to 40 feet, 100 ppb; 47.5 to 50 feet, 40 ppb; 57.5 to 60 feet, 10 ppb; 95.5 to 96.5 feet, 10 ppb; and 120.5 to 123 feet, 5 ppb. One other short interval contained 10 ppb, and all other assays were less than 5 ppb (Table RR-2).

The fault zone was traced to the east where it intersects a linear conductive feature defined by strong VLF-EM crossovers. This intersection on Line 18+00E is also an excellent target although the I.P. anomaly is weaker. Considering the depth of the surface-bedrock interface, down to 42 feet, with oxidation likely for some distance below this, as well as the 100 foot "A" spacing of the I.P. survey, a very good target could have been missed by the I.P. survey alone. This profile shows how refraction seismic work can be used to evaluate other geophysical methods. The target could be further tested by an I.P. survey with longer "A" spacing or by another short drill hole.

The Ranier Area has many of the characteristics of large Canadian Superior Province gold camps, namely:

(1) A metasedimentary sequence in fault contact with a metavolcanic sequence;
(2) Alteration and mineral assemblages often associated with precious metal mineralization;
(3) Anomalous gold content from an area along the fault zone twelve miles in length and a mile and a half in width.

This includes ore grade mineralization at present day prices from the Little American Mine. The Ranier Area investigation clearly defined an area of precious metal potential. Geophysical surveys defined several targets within the potential area and two of these were tested with drill holes which intersected zones of increased gold content over that found in outcrops (Table RR-2). These results show the methods used have the capability of locating gold mineralization and detailed surveys using these methods have a good chance of locating an economic precious metal deposit.

Aitkin Area

There are a number of references to a close association between deformed iron formations and some gold mines. Of these the Homestake Mine in South Dakota is a world class model for this type of deposit (Sawkins, 1984). In east-central Minnesota, the Glen Township Formation is lithologically and chronologically very similar to formations containing the Homestake Mine. Parts of the formation have been mapped by magnetic methods and drilled for iron deposits. The drilling defined an iron formation of sulfide and/or carbonate facies with good iron content and some deformation including quartz veining. An airborne magnetic and electro-magnetic survey of the area donated to the D.N.R. by private industry mapped the bedrock expression of the formation and showed tight isoclinal folding with some faulting. The formation is very conductive and in places has a strong magnetic susceptibility. Abdelmonem Adelfattah Eldougdoug, 1984, published a Ph.D. Thesis on the area. His study found gold values in the formation having a grade that would be expected from a protore of a Homestake model gold deposit. Gold content increased in the vicinity of quartz-sulfide veins. A structurally deformed part of the formation could have ore grade mineralization in the event that metamorphism has redistributed and concentrated the gold.

The State of Minnesota has considerable surface and mineral ownership in T45&46N-R25W, which contains the Glen Township Formation. At the present time there are no known mineral leases in the area. To evaluate the mineral potential of this area, geophysical surveys were conducted using several methods. Magnetometer, very low frequency electro-magnetic surveys and horizontal loop electro-magnetic surveys were run on areas of State controlled land. These were initiated with reconnaissance surveys and then localized to grids on brushed lines. Plates 13 through 16 display the survey data from Sections 21 and 28, T46N-R25W. The surveys mapped the formation very well and appear also to map a fault cutting the north side of the formation near the south section line of Section 21. The fault strikes about 10° south of west and is best displayed on Plate 13 which shows contoured VLF-EM responses that have been enhanced with a Fraser filter algorithm. Plate 14 shows the crest of the magnetic anomaly and the drill holes sampled by Eldougdoug to the south of the indicated fault zone. The fault zone was further defined with a refraction seismic profile and tested with drill hole A-2 (Plate 16). The hole intersected considerable brecciation, silicification and increased sulfides which would be expected in an ore zone. The hole A-2 assay results have not been fully evaluated at the time of this report (Table A-2).

The geophysical methods discussed thus far in relation to the Glen Township Formation map the near-surface expression of the lithologic units and associated geologic features. The deepest penetration using the horizontal loop electromagnetic survey with a 200 meter coil separation is about 300 feet. Precious metal mines with the highest ore grades and largest reserves are found where favorable lithologic units are repeatedly deformed and mineralized over a long time period, and these structures often extend to great depths.

A controlled source audio frequency magneto-telluric (CSAMT) survey was conducted along twelve miles of State Highway 47 from Malmo to the north line of Township 46

North to study deeply buried features. A few stations were also tested along Highway 169 in Townships 45 and 46 North. The survey was done under contract by ElectroMagnetic Surveys, Inc. of Berkeley, California. A 20 KVA Zonge GGT-20 transmitter with an EMS transmitter controller and Zonge ZMG-25 motor generator was used. The receiver used four EMS MFD-3 induction coil magnetometers, two electric field sensors with self potential buck-out, an EMS signal reducer, an EMS 60 Hz notch filter, an EMS variable width bandpass filter, an EMS DSP-2 six channel receiver and an EMS data acquisition system.

Station spacing of a quarter mile was maintained where possible along Highway 47, while Highway 169 spacing was much wider. Power lines and substations generated strong noise levels, and in some places stations had to be moved away from these problem areas. Apparent resistivity pseudosections of the two traverses seem to map known geology very well, particularly the conductive members of the Glen Township Formation. Strongly conductive zones are interpreted at depths of 1200 to 1400 meters. One mile west of drill hole A-2, the survey mapped a strong vertical structure with a recumbent fold at an estimated depth of 200 meters. This is interpreted as a drag fold resulting from vertical displacement along the fault zone. The nose of the fold and fault zone will be tested by a drill hole in the SE1/4 of the SE1/4 of Section 20, T46N-R25W. The report of the CSAMT survey is on open file at the Hibbing office of the Department of Natural Resources.

The Glen Township Formation has many lithologic similarities to host rocks of world class gold deposits. Assayed samples of the formation have gold contents of the same magnitude as that found in protores of those deposits. Some of these samples display indications of deformation, and their assays have increased gold values over background. Economic models of this type of deposit indicate that the ore is found where the protore has been structurally deformed and the gold redistributed and concentrated by metamorphism.

In summary, Project 242 surveys have located a fault with interpreted recumbent folding trending east-west along the south boundaries of Sections 19, 20 and 21, T46N-R25W. Locally the fault is within conductive members of the Glen Township Formation, and in other places it forms the contact between the conductive member and other lithologic units. The fault and associated structural features are being tested for gold mineralization.

Rice River Area

There are many miles of mapped iron formations associated with metasediments and metavolcanic units in east-central Minnesota. Airborne magnetic surveys located one of these formations in Section 2, T47N-R26W, with what appears to be a fault offset of the magnetic trend. Reconnaissance magnetometer and horizontal loop electro-magnetic surveys using a 200 meter coil separation located a strong conductor adjacent to a positive magnetic anomaly which is clearly oxide facies iron formation (Plate 17). Detailed H.L.E.M. and magnetic surveys mapped the iron formation and a refraction seismic profile located the fault zone (Plate 17). Hole A-5 intersected the oxide facies iron formation in fault contact with sulfide facies iron formation. There has been some silicification and hydrothermal solution movement along the fault zone. One composite sample from 300 feet to 310 feet contains 35 ppb gold and several ten-foot composites contain 10 ppb gold (Table A-5).

Barnum Area

There are a number of mines and mining districts where carbon, calcium carbonate, or iron have sequestered precious and base metals from hydro-thermal solutions moving through structurally prepared hosts. An example of this type of deposit is the Carlin Gold Mine in Nevada. The deposit is near the top of the Roberts Mountains Formation, where permeable horizons of silty dolomitic limestones provided a favorable host. The Roberts Mountains overthrust and northwest trending faults were conduits for migrating solutions but are sparsely mineralized (Hausen and Kerr, 1968); also (Radtke et al., 1980).

The Sullivan orebody in British Columbia is one of the world's most important lead-zinc-silver deposits. It had about 155 million metric tons of reserves with a contained metal value of $94.00 (U.S.) per short ton at present metal prices. Although its genesis is complex, recent information indicates a model of a stratiform deposit with hot metal-rich brines pouring from a fault vent under the western (proximal) part of the deposit and spreading to the east over graphitic, carbonaceous sediments of the Aldridge Formation to form the distal part of the deposit (Ethier, et al., 1976) and (Campbell et al., 1980). Sawkins, 1984, points out the importance of faults to sediment hosted massive sulfide deposits. The Sullivan Mine has a different setting than the Carlin Mine because deposition from the metal-bearing brines is syngenetic with sedimentation, but both involve a faulted sedimentary sequence with hydrothermal solutions forming economic mineral deposits.

In Carlton County, shaded relief maps of the aeromagnetic survey trace a strong east-west trending feature across several townships of Thomson Formation sediments. In Section 15, T47N-R19W, the west fork of the Moose Horn River has uncovered outcrops of graphitic-pyritic slate. The outcrops exhibit deformation with quartz veins and pyrite. Samples from these outcrops contain the following anomalous metal values; zinc to 2500 ppm, lead to 110 ppm, copper to 350 ppm, arsenic to 130 ppm, silver to 4.5 ppm and gold to 35 ppb (Table BM-2).

Reconnaissance profiles were run on the county road along the east side of Section 16, T47N-R19W, to test the east-west trending feature. The survey used horizontal loop electro-magnetic and magnetic methods. The H.L.E.M. survey was run with a 200 meter coil separation and 100-foot station interval. Magnetometer stations were at 50-foot intervals. Frequencies for H.L.E.M. were 1777 hertz and 444 hertz. The magnetic profile failed to locate any distinctive anomalies, but the H.L.E.M. mapped a very strong conductor from station 9 + 00S to 18 + 00S (Plate 18). The road crosses the Moose Horn River at 13 + 50S. A refraction seismic profile defined a low velocity fault zone associated with the conductor (Plate 18). Hole BM-1 was drilled to test the structure and intersected a large zone of deformation with hydrothermal quartz and anomalous arsenic values to 70 ppm and copper to 300 ppm. The drill hole bottomed in mixed quartzite-marble at 3143 feet (2300 feet vertical depth), with the core becoming more siliceous near the bottom of the hole. A resistivity sounding north of drill hole BM-1 located a very conductive unit at a depth of 250 feet. This is most likely the top of a graphitic-pyritic slate. The area in the vicinity of hole BM-1 is a siliceous unit overlain by a graphitic-pyritic slate. These units have been deformed by a major fault structure. The slate could be a favorable host for base or precious metal mineral deposits. If a Carlin Mine model for mineral potential is used, metal- bearing hydrothermal solutions moving up the fault zone would deposit the metals near the lower contact of the slate unit. If the potential is modeled after the Sullivan orebody, the metal-bearing hydrothermal solutions would pour from the fault and mineralization would be syngenetic with sedimentation close to, and likely on, the basin side of the fault. Core and outcrop samples contain anomalous arsenic, gold and base metals with quartz veins indicating mineralized hydrothermal solution movement. The Barnum area fault zone appears to have excellent mineral potential.

In Section 23, T47N-R20W, four and one half miles west of hole BM-1, reconnaissance H.L.E.M. and magnetic surveys located another conductor on the trend of a structure mapped by the shaded relief display of the aeromagnetic survey. Hole BM-2 was drilled to test that conductor (Plate 19). A refraction seismic profile was put in after completion of the hole. The hole intersected mixed phyllites, tuffaceous sandstone and conglomerates, but did not intersect the anticipated structure.

Duluth Complex Area

There are several types of economic deposits related to layered mafic complexes. Models for these deposits include platinum and chromite ores of the Merensky Reef and Main Chrome Seam which are respectively at the bases of the Main Zone and Critical Zone of the Bushveld Complex (Sawkins, 1984). The platinum and chromite seams are thin, reaching a maximum thickness of about one meter for chromite and less than a meter for platinum. It would be very difficult to detect these thin seams directly by geophysical methods. Above the Main Zone is the Upper Zone of the Bushveld Complex, and at its base is found the main magnetite seam which contains significant amounts of vanadium having some economic importance (Sawkins, 1984). This unit would have a distinctive geophysical response. The Stillwater Complex in Montana would be very similar to the Bushveld Complex model.

Because the thickness and footwall configuration of the Duluth Complex is relatively unknown, models of structurally related copper-nickel massive sulfides also have implications for areas within the complex. These models were discussed under the section of the report on the footwall. For this reason, the Project 242 mineral potential evaluation of the Duluth Complex is designed from a Bushveld Complex model, or a Sudbury District model.

Two approaches were used to evaluate mineral potential within the complex. Both rely to a large extent on detailed petrographic studies of core samples to relate them to subdivisions of lithologic units of the Bushveld or Stillwater models. In the first approach, positive airborne magnetic anomalies were evaluated by ground methods and then sampled with drill holes for mineral content and layer position or zone. The second approach utilized two east-west profiles of airborne magnetic surveys enhanced by a second derivative algorithm and followed by detailed ground surveys to locate drill sites. Samples from these holes were then studied for mineral content and layer position relating to economic mineral potential.

For the first approach, positive airborne magnetic anomalies were selected based on anomaly characteristics, state-ownership and the activity of private industry. Ground magnetic surveys were performed at several locations, and most of these surveys were supplemented by electro-magnetic surveys to expand the scope of the drilling and define structures or conductive zones within the complex. Cores were studied with careful examination of lithology and mineralogy for relationships to economic minerals models.

At the Bear Lake Area a 2500 gamma airborne magnetic anomaly was investigated with a ground magnetic survey at 50-foot station spacing and an electro-magnetic survey using the Crone horizontal shootback method with a 300-foot transmitter-receiver separation on 100-foot station spacing (Plates 20-24). Drill hole BL-1 was put in to test a strong positive magnetic anomaly on the baseline of Grid 2, Plate 20, NE1/4 of NW1/4 of Section 36, T55N-R13W.

The same survey procedure was used at North Rota Lake with the addition of horizontal H.L.E.M. profiles with a 150-foot coil separation. The H.L.E.M. was run using frequencies of 444 hertz and 1777 hertz. One line was tested with a 200 meter coil separation using the same frequencies; Plates 25 and 26 display the results of this work. Hole NR-1 was drilled at station 12 + 50W on Line 41 North in the NW1/4 of SW1/4, Section 25, T59N-R9W, to test a weak conductor and a relatively strong positive magnetic anomaly.

Again the same survey procedure was used at South Rota Lake (Plates 27 and 28). At South Rota Lake the 222 hertz frequency was added to the 444 hertz and 1777 hertz for H.L.E.M. profiles. A strong magnetic anomaly of about 2500 gammas was mapped and tested by hole SR-1 drilled in the NE1/4 of the SE1/4 of Section 36, T58N-R9W.

Similar anomalies were mapped at Crest Lake in Section 2, T57N-R11W. Although the Crest Lake anomalies were not drilled the geophysical views are included with this report as Plates 29 and 30.

The second approach to providing samples for petrographic studies relating to mineral potential evaluation of the Duluth Complex started with second derivative enhancement of airborne magnetic surveys along two east-west traverses across the complex. This was followed by ground surveys along county highways 15 and 16 in Lake and St. Louis counties toward the south end of the complex and also along U.S. Forest Service Road Nos. 424 and 178, then along state highway 1 across the north end of the complex. Magnetic, very low frequency electro-magnetic, horizontal loop electromagnetic and the Crone horizontal shootback electro-magnetic methods were used (Plate 31). Drill sites were selected to test indications of structures along these profiles as well as to provide lithologic samples. Modest structures with fracturing, brecciation, slickensides, serpentinization and granitic veins were intersected in the four holes. Petrographic results will be included elsewhere in this report.

Zim Area

There is a positive airborne magnetic anomaly trending southwest from the structure known as the Virginia Horn in the Biwabik Iron Formation. This feature is very prominent on the shaded relief map of the aeromagnetic survey. Reconnaissance magnetometer and horizontal loop electro-magnetic traverses were run to select the most promising site available. These were followed by a refraction seismic profile (Plate 31). A modest structure was defined within the area of deformation indicated by the airborne magnetic survey, and hole ZM-1 was drilled in the NW1/4 of the SE1/4 of Section 9, T56N-R18W to test the structure. The hole intersected carbonate mudstones of the Virginia Formation with some breccia and carbonate veining.

Ramey NE Area

A positive, ovoid aeromagnetic anomaly was mapped by the Minnesota Geological Survey in Sections 36, T40N-R28W and Section 1, T39N-R28W, Ramey NE Quadrangle, Morrison County. The anomaly has an amplitude of about 800 gammas and a shape suggesting an intrusive plug.

Ground magnetic profiles defined the anomaly as being more like a dike in shape with a northeast-southwest trend and an amplitude of 1400 gammas. Crone horizontal shootback electro-magnetic surveys located some vague conductive features using 1830 hertz which did not respond to 390 hertz (Plates 32-35). Conductive surface is interpreted as causing these anomalies. Hole R-1 was drilled to test the magnetic anomaly and intersected a hornblende schist.

SUMMARY

In northern Minnesota there are a number of areas which have economic mineral potential. These areas are either buried under glacial cover or are very difficult to detect in outcrop exposures. The Project 242 geophysical surveys used some widely accepted methods to evaluate this potential and tested several recently developed methods which have not been extensively used in Minnesota by private industry. Surveys in the Duluth Complex Footwall, Ranier Area, Aitkin Area and Barnum Area defined encouraging geologic features including structures and mineralization often associated with economic mineral deposits. Evaluations of new methods and equipment display some exciting results and indicate these methods may be of use in locating potential mineral deposits.

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GEODRILLING REPORT

SECTION C

ORE MINERAL OCCURRENCES

By: E. H. Dahlberg, B. A. Frey, M. P. McKenna

The following list is a compilation of mineral occurrences encountered as a result the activities covered by this report. The information includes occurrences noted in diamond drill holes, as well as float and outcrop samples. It consists of the type, location, extent, and environment of those occurrences. The following is a list of the elemental parameters used in defining an occurrence:

Pd	100 ppb	Ni	500 ppm
Pt	100 ppb	Cr	500 ppm
Ir	5 ppb	Co	250 ppm
Te	10 ppm	Mo	30 ppm
Sb	20 ppm	As	20 ppm
W	30 ppm	Ti	10%
Cd	5 ppm	P	5000 ppm
Bi	10 ppm	F	5000 ppm
Mn	6000 ppm	Ba	5000 ppm
V	1500 ppm	U	50 ppm
Sn	10 ppm	U_3O_8	100 ppm
C	.3%	Th	150 ppm
Cu	500 ppm	Au	0.1 ppm
Zn	500 ppm	Ag	1 ppm
Pb	500 ppm	S	2%

These occurrences, listed below, will be added to those listed in DNR Report 231, "A Compilation of Ore Mineral Occurrences, Drill Core and Test Pits in the State of Minnesota," D. P. Martin (1985), at a future date. The parameters used in Report 231 are the same as those listed above.

Location:
Aitkin County
(NW-NW) Sec. 2, T47N-R26W

Reference:
Drill Hole A-5 (Section D this report)

Occurrences:
DDH A-5
- .5 ft. Ag (1 ppm)
- 25 ft. Cd (5-10 ppm)
- 13.8 ft. As (35-500 ppm)
- 1 ft. W (40 ppm)
- 11 ft Zn (550-2800 ppm)

Summary:
Drill hole contains silicate-oxide-sulfide iron formation of Trommald Formation (Proterozoic) and contains breccia and veins.

Location:
Koochiching County
Sec. 4, T70N-R23W

Reference:
Drill Hole RR-2 (Section D this report)

Occurrences:
DDH RR-2
- 2 ft. Mo (53 ppm)
- 2 ft. Au (100 ppb)

Summary:
Drill hole contains siliceous biotite garnet schist and semi-schist. Highly deformed. Archean.

Location:
Carlton County
Sec. 16, T47N-R19W

Reference:
Drill Hole BM-1 (Section D this report)

Occurrences:
DDH BM-1
- 6 ft. Mn (6000 ppm)
- 5.9 ft. W (30 ppm)
- 62 ft. As (20-70 ppm)
- 32 ft. Bi (10-12 ppm)
- 10 ft. Zn (500 ppm)

Summary:
Drill hole contains Thomson Formation (Proterozoic) equivalents, including volcanics, phyllites, and siliceous-dolomitic marbles. Rock is deformed-metamorphosed, and contains veining and intrusions.

Location:
Carlton County
Sec. 15 & 20, T47N-R19W

Reference:
Drill Hole BM-2 (Section D this report)

Occurrences:
Rock samples from Barnum Area
- Mo (2 samples, 35 & 60 ppm, Sec. 15)
- Ag (2 samples, 1 & 4.5 ppm, Sec. 15)
- Cd (1 sample, 14 ppm, Sec. 15)
- Cr (1 sample, 500 ppm, Sec. 15)
- As (7 samples, 30-130 ppm, Sec. 15)
- Bi (1 sample, 110 ppm, Sec. 15)
- Zn (1 sample, 2500 ppm, Sec. 15)
- W (6 samples, 30-100 ppm, Sec. 15 & 20)
- Te (2 samples, 20 ppm, Sec. 15)

Summary:
Drill hole contains Thomson Formation (Proterozoic) equivalents, namely deformed, metamorphosed conglomerates, greywackes, and phyllites. Contains veining.

Location:
Lake County
Section 26, T60-10W

Reference:
Drill Hole NE-2 (Section D this report)

Occurrence:
3' Cr (1500 ppm)

Summary:
Occurrence in northeast end of anomalous aeromagnetic zone coinciding with mixed rocks and combined As-Co-Zn lake sediment geochemical anomaly between troctolite and anorthositic series and overlying(?) fine-grained oxide gabbros of upper part of the Duluth Complex.

Location:
Koochiching County
Sec. 31, T71N-R23W

Reference:
Drill Hole RR-1 (Section D this report)

Occurrences:
DDH RR-1
- 40 ft. Au (115-3560 ppb)
- 16 ft. Sn (10 ppm)
- 8 ft. Bi (10 ppm)
- 15.2 ft. As (24 ppm)
- 13.9 ft. Mo (30 ppm)
- 27 ft. Ni (548-822 ppm)
- 74 ft. Cr (513-2131 ppm)

Summary:
Drill hole contains deformed, metamorphosed, tuffs, agglomerates, sediments. Now mica-schist, semi-schists with local amphibole and garnet porphyroblasts. Contains intrusions and veining. Archean.

Location:
Lake County
Section 25, T59N-R9W

Reference:
Drill Hole NR-1 (Section D this report)

Occurrences:
- 11.5' Cu (500-1250 ppm)
- 2' Pt (150 ppb)
- 2' Pd (300 ppb)
- 13.5' Te (10-80 ppm)
- 4.5' Ag (1. ppm)
- 5.5' V (1650-3600 ppm)
- 5.7' Ti (10.6-20.2%)

Summary:
Laminated and layered oxide gabbros of the upper part of the Duluth Complex.

Location:
Lake County
Section 36, T58N-R9W

Reference:
Drill Hole SR-1 (Section D this report)

Occurrences:
- 8.5' Cu (700-1200 ppm)
- 3.5' Te (10 ppm)
- 3.7' Ti (13.00-14.90%)

Summary:
Layered oxide gabbros of upper part of Duluth Complex

Location:
Lake County
Section 1, T59N-R9W
Reference:
Drill Hole IS-1 (Section D this report)
Occurrences:
DDH IS-1
- 0.3' and point analyses, Cu (650-2450 ppm)
- point analysis Au (1.0-1.1 ppm)

Summary:
Mainly equant oxide microgabbro with hornfelsic xenoliths with intercalations of igneous breccia of anorthosite and gabbro with chalcopyrite and bornite-bearing coarse-grained pyroxenite veins and clots. (Duluth complex).

Location:
St. Louis County
Section 10, T52N-R15W
Reference:
Drill Hole FHL-1 (Section D this report)
Occurrences:
- 278.6' Cu (500-9700 ppm)
- 247.9' Ni (550-7000 ppm)
- 18.6' Co (250-900 ppm)
- 9.4' As (20-30 ppm)
- 7.9' Sb (20 ppm)
- 110.6' Te (10-20 ppm)
- 5.3' Pt (105-255 ppb)
- 41.2' Pd (100-190 ppb)
- 19.2' Ir (5.4-9.1 ppb)
- 9.6' Au (200 ppb)
- 109.6' Ag (1-10 ppm)
- 63.9' C (.30-5.2%)
- 45.9' S (2.39-19.3%)

Summary:
Occurrence in basal zone of Duluth Complex and footwall Virginia or Thomson Formation.

Location:
St. Louis County
Section 35, T57N-R13W
Reference:
Drill Hole SE-1 (Section D this report)
Occurrences:
DDH SE-1
- 6' Cu (500-1700 ppm)
- 0.5' Pt (120 ppb)
- 0.5' Sb (25 ppm)
- 6' P_2O_5 (1.2 %)

Summary:
Occurrence in southwest end of anomalous aeromagnetic zone coinciding with mixed rocks between troctolite and anorthositic series and overlying oxide gabbros, near As-Cu lake sediment geochemical anomaly of Duluth Complex, DNR Report No. 201.

Location:
St. Louis County
T55N-R13W
Reference:
Drill Hole BL-1 (Section D this report)
Occurrences:
DDH BL-1
- copper, gold and silver, point analysis

Summary:
Equant oxide microgabbro with bornite-bearing coarse-grained to pegmatoid pyroxenite veins and clots.

GEODRILLING REPORT

SECTION D

GEOLOGIC DRILLING

By: E. H. Dahlberg and B. A. Frey

INTRODUCTION

The DNR Minerals Division has drilled fourteen diamond core holes during the current biennium. Geologic logs and analytical results from these and four previous drill holes are covered in this section. The location maps for the drill holes are Figures 1 and 2. The earlier introduction summarized the drilling footages and the drill hole locations with respect to county, section, township and range.

After the core was logged, intervals were split (or sawed), and sent in for analysis. Many samples were composited in an attempt to save analytical costs. Compositing involved combining splits from individually prepared adjoining short sections of core. Thus, one analysis could represent a large interval (generally 8-14′) of core, yet allow the shorter (1-2′) individual samples (within the composite) to be analyzed separately, if the composite shows interesting analytical results.

The commercial lab analytical techniques are summarized in Table D-1. Analyses from the Division of Minerals Chemistry Laboratory were run by atomic absorption, after a HCl, HNO_3 and HF acid digestion of the pulverized sample.

Two standard Au samples were sent into Bondar-Clegg, North Vancouver, B.C., which did most of our gold assays. Canadian Certified Reference Materials Project, Gold Ore, GTS-1 was diluted with "barren" pulp (from earlier assay work) to calculated values of 200 ppb and 50 ppb. Bondar-Clegg's results for these samples were 220 ppb and 45 ppb, respectively. Since the submission of standards is an important part of analytical quality control, the Minerals Division hopes to expand its use of known standards.

The remaining part of this section is comprised of the drill logs and the tables of analytical results that follow them. The logs are written out and/or condensed from graphic or detailed logs. Like the assay results, the logs are available for public examination, along with the core itself, and any other open file material.

CONDENSED GEOLOGIC LOG FOR DDH ZM-1

Hole drilled at a 50° angle and an azimuth of 0°.

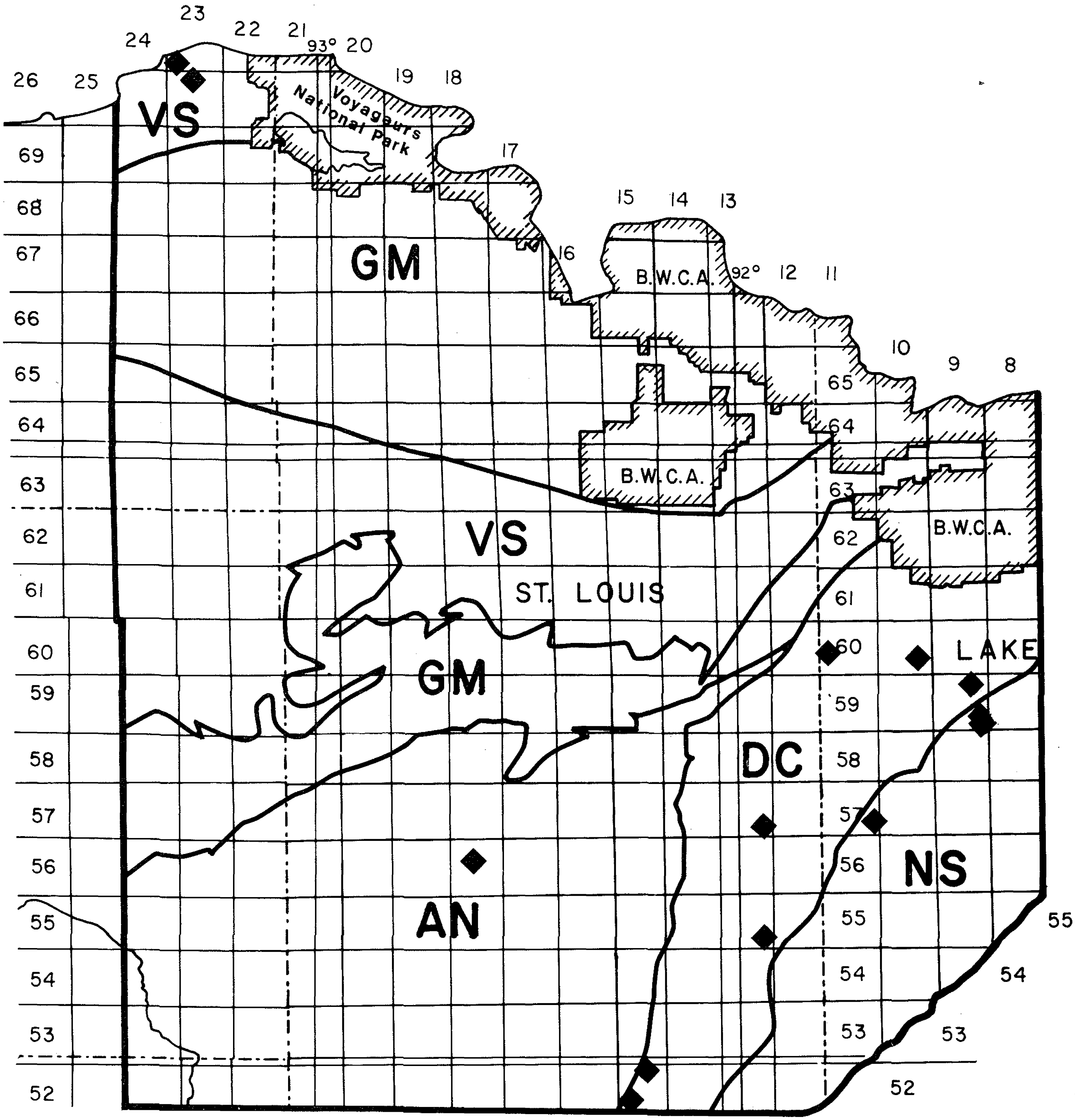
0′-110′ **Overburden.**

110′-119′ **Not Cored.**

119′-392.2′ Interlaminated-interbedded, siltstone-mudstone (dark grey) and calcareous-siliceous siltstone - fine-grained dolomitic quartzarenite-calcarenite (light grey). Light grey calcareous-siliceous siltstone - fine-grained calcareous quartzarenites typically form thicker laminae and beds. Bedding is planar to undulose, parallel to non-parallel. Contacts are fairly sharp. Sedimentary structures include load casts, pseudonodules, local graded laminae, minor slumping, and channeling(?). Calcareous subunits occur below 167′. Calcarenite subunits contain up to 95% calcite. Total carbonate in whole unit is less than 5%. Tension fractures locally cut across individual beds. Below 167′, these tension fractures contain calcite and minor pyrite. Other veins parallel bedding. Largest veins are 2-3 mm thick from 171′-173′. Few, scattered 1-2 mm calcite concretions locally.

392.2′-405.7′ Interlaminated siltstone-mudstone, minor calcareous siltstone; and interbeds of interlaminated yellow-brown-orange-green silty claystone. Similar to above unit, except for claystone. These beds are talcy and more fissile, with siltier laminae containing fine-grained quartz grains, and altered white feldspathic(?) fragments. 5 mm quartz vein at 405′. Claystone believed to be altered ashy tuff.

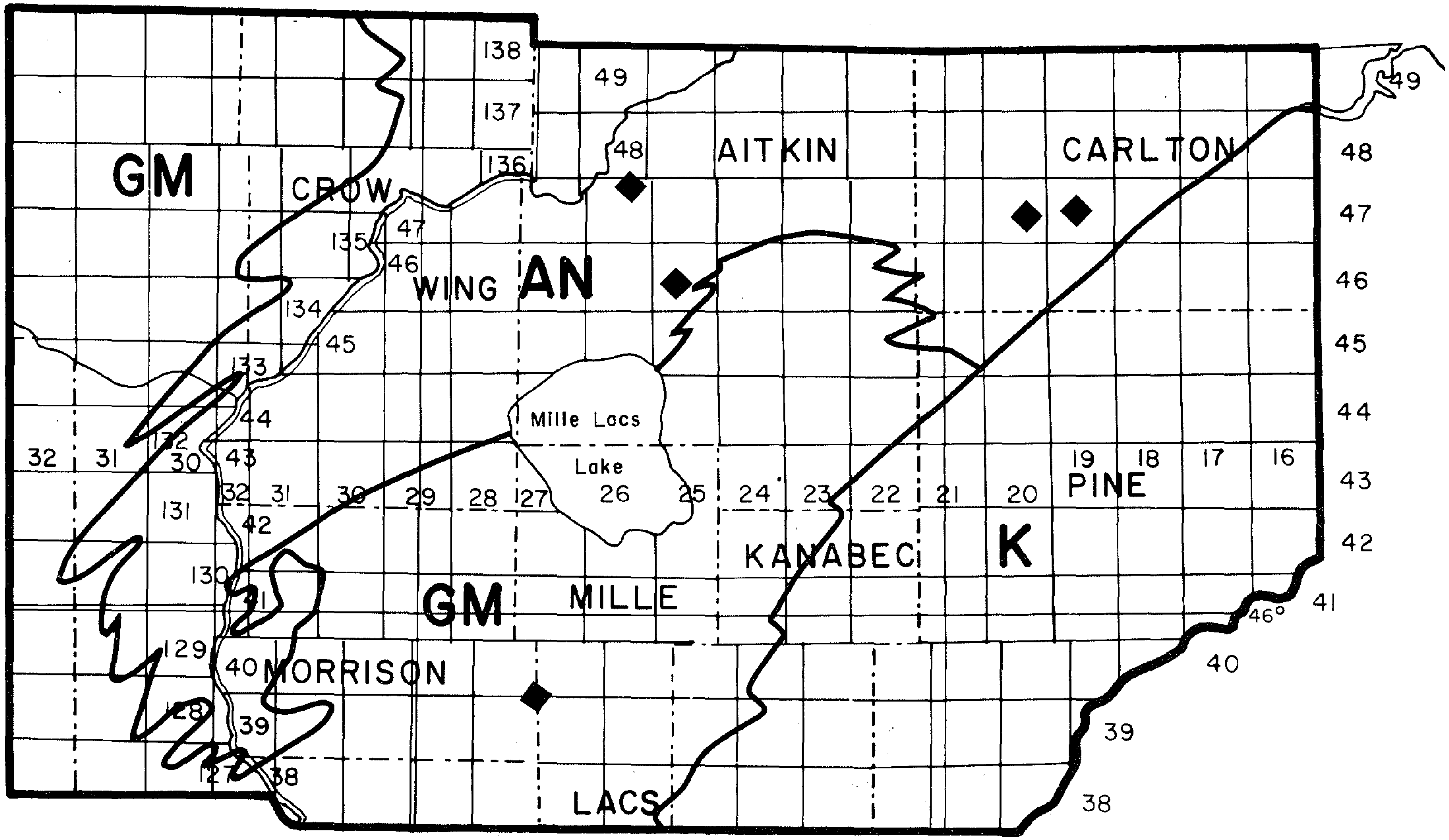
405.7′-1303′ T.D. Interlaminated-interbedded siltstone-mudstone and calcareous-siliceous siltstone- fine-grained dolomitic quartzarenite-calcarenite. Rock similar to 119′-392.2′. Unit as a whole is slightly more quartzarenitic-calcarenitic, however, with perhaps 5-10% total carbonate. Local soft sediment deformation. Soft sediment folds from 742.7′-743.5′. More soft sediment deformation than normal in unit from 803′-850′, especially slumping and loading. Steep, cross cutting, calcite-quartz-pyrite veins and associated pseudobrecciation (and minor brecciation) in intervals 410.5′-413′, 634.1′-634.3′, 706.1′-



EXPLANATION

DC — DULUTH COMPLEX	GM — DOMINANTLY ARCHEAN GRANITE (MIGMATITE TERRAIN)
NS — NORTH SHORE VOLCANICS	VS — DOMINANTLY ARCHEAN METAVOLCANIC (SEDIMENTARY TERRAIN)
AN — ANIMIKIE METASEDIMENTS	◆ DRILL HOLE

Figure 1: Location map showing drill hole locations. (Adapted from MGS State Map Series S-3, Morey, et al., 1982.)



EXPLANATION

K — KEWEENAWAN VOLCANIC SEDIMENTARY ROCKS

AN — ANIMIKIE METASEDIMENTS

GM — DOMINANTLY ARCHEAN PROTEROZOIC GRANITE (GNEISS TERRAIN)

◆ DRILL HOLE

Figure 2: Location map for east central Minnesota showing drill hole locations. (Adapted from MGS State Map Series S-3, Morey, et al., 1982.)

Table D-1

ANALYTICAL TECHNIQUE INFORMATION

Bondar Clegg, North Vancouver, B.C.

ELEMENT NAME	SIZE FRACTION	METHODS	UNITS	LOWER LIMIT	UPPER LIMIT
Cu	-100	DCP	PPM	1	20000
Pb	-100	DCP	PPM	5	10000
Ag	-100	DCP	PPM	.5	50.0
Ni	-100	DCP	PPM	1	20000
Co	-100	DCP	PPM	1	20000
Fe	-100	DCP	PCT	.1	10.0
Cr	-100	DCP	PPM	1	20000
As	-100	DCP	PPM	5	2000
Te	-100	DCP	PPM	10	20000
Bi	-100	DCP	PPM	2	20000
V	-100	DCP	PPM	1	20000
Sb	-100	DCP	PPM	5	20000
Cu	-100	AA	PPM	1	20000
Pb	-100	AA	PPM	2	10000
Zn	-100	AA	PPM	1	20000
C Tot	-100	LECO	PCT	.02	100.00
Rb	-100	XRF*	PPM	5	10000
Sr	-100	XRF*	PPM	5	10000
Ti	-100	XRF*	PPM	30	20000
Ir	-100	INAA	PPB	1	30000
Rh	-100	INAA	OPT	.002	30.000
Th	-100	XRF**	PPM	1	10000
Zr	-100	XRF**	PPM	1	10000
U	-100	XRF**	PPM	1	10000
P2O5	-100	DCP	PCT	.01	100.00
Fe2O3	-100	DCP	PCT	.01	100.00
FEO	-100	DCP	PCT	.01	100.00
FE TOT	-100	DCP	PCT	.01	100.00
C	-100	LECO	PCT	.01	100.00
Cl	-100	Titre	PPM	100	20000
F	-100	SPIon	PPM	20	20000
Ce	-100	XRF	PPM	5	10000
B	-100	DCP	PPM	10	20000
P	-100	Color	PPM	50	20000
TiO2	-100	DCP	PCT	.01	100.00
S	-100	LECO	PCT	.01	100.00
Au	-100	FA-AA	PPB	5	10000
Pt	-100	FA-AA	PPB	15	20000
Pd	-100	FA-AA	PPB	2	20000
Na2O	-100	DCP	PCT	.01	100.00
K2O	-100	DCP	PCT	.01	100.00
Mo	-100	DCP	PPM	1	20000
Mn	-100	DCP	PPM	1	20000
W	-100	DCP	PPM	10	2000
Sn	-100	DCP	PPM	10	20000
Ru	-100	INAA	PPB	1	20000
Os	-100	INAA	PPB	1	20000
Cd	-100	DCP	PPM	1	20000
Zn	-100	DCP	PPM	1	20000
Se	-100	DCP	PPM	5	20000

X-RAY LABS (Don Mills, Ontario)

Element Name	Size Fraction	Methods	Units	Lower Limit
Au	-100	FADCP	PPB	2
Ag	-100	DCP	PPM	.5

Abbreviations

DCP= DC PLASMA (Atomic Emission Spectroscopy)
(HF-HCL04-HNO3-HCL Dissolution)
AA= ATOMIC ABSORBTION ANALYSIS
(HF-HC204-HNO3-HCL Dissolution)
LECO= LECO INDUCTION
XRF= X-RAY FLUORESCENCE ANALYSIS
*Energy Dispersive Spectrometer
**Wavelength Dispersive Spectrometer
INAA= INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS after NICKEL SULFIDE FIRE ASSAY
TITRE= TITRATION
SPIon= SPECIFIC ION ELECTRODE
COLOR= COLORIMETRIC
FA-AA= Combination FIRE ASSAY- ATOMIC ABSORBTION ANALYSIS
FA-DCP= Combination FIRE ASSAY- DC PLASMA

PPM= Parts per million
PPB= Parts per billion
PCT= Percent
OPT= Ounce per ton

706.2', 938'-948', 973'-975' (scattered), 1246'-1270' (scattered). Stratiform veins at 421.7'-421.8', 630'-669' (scattered), 973'-975' (scattered), 975'-1303' (few, scattered). Local, scattered 1-2 mm calcite concretions. 3 x 1/2 cm pyrite concretion at 952'.

Acid Test Results

Footage	Angle of Hole from Horizontal	Bedding Angle with Core Axis
120	49°	60°
420	56°	67°
720	63°	75°
1000	65°	79°

Notes: Eight thin section heels have been cut. Six composite samples have been sent in for analysis. Analytical results follow in Table ZM-1. Can tuffs be correlated with volcanism in other parts of the basin? Detailed log is available for study.

CONDENSED GEOLOGIC LOG FOR DDH TS-1

Hole drilled at 90° angle (vertical).

0'-3' **Ice.**

3'-10' **Water.**

10'-32' **Gyttja.**

32'-99' **Overburden.**

99'-241' T.D. Interlaminated-bedded black-dark brownish grey-grey hornfelsed siliceous-sideritic siltstone. Minor color variations due to graphite, pyrite, and/or siderite content. Bedding angles to core axis are 35° near top to 5° at base. Schistosity is poorly developed near the top (37° to core axis), but becomes more recognizable with depth (50° to core axis). Schistosity cuts across bedding, and locally offsets it. Core is locally very broken. Pyrite varies from 2-10%, with higher disseminated amounts in darker bands. Pyrite also found along cleavage and in quartz-calcite veinlets (often subparallel to core axis). 155'-156.7' is a disturbed (folded-brecciated), recrystallized, somewhat calcareous zone with local coarse-grained calcite; very fine-grained brown sideritic mudstone; green-black serpentine-chlorite; and medium-grained altered plagioclase(?) (calcite) and pyroxene-olivine (serpentine-chlorite). Believed to be edge of dike from Duluth Complex.

Notes: Ten thin section heels have been cut. Rock may show slightly increased recrystallization with depth. Onecomposite and seven individual samples have been sent in for analysis. Analytical results follow in Table TS-1. Detailed log is available for study.

CONDENSED GEOLOGIC LOG FOR DDH BM-2

Hole drilled at a 51° angle and an azimuth of 182°.

0'-85' **Overburden.**

85'-97' **No core.**

97'-554.3' Medium-dark grey phyllitic siltstone. Slightly graphitic. Very minor, thin, white siliceous-clayey altered tuff(?) laminae. Phyllite may contain up to 5% fine disseminated pyrite. Core fairly broken to 323' and sporadically to 554.3' (decreasing in general with depth). Foliation is typically 45-60° to core axis. Bedding is folded and is often at a low angle to core axis. Graphite decreases(?) with depth. Local hairline fractures-veinlets with pyrite. Local thicker, irregular quartz-pyrite veins-masses. They typically appear deformed to broken and are subsequently healed. Veins at: 212.8'-213'; 529'-540' (with few scattered irregular masses to .2'); 545-545.2' (irregular with minor vugs and chlorite); 546.4'-546.8'; 552'-555.7' (interval with irregular veining with vugs and chlorite).

554.3'-1025' Interbedded phyllite, para- and orthoconglomerate, and siliceous-tuffaceous greywacke. Ratio phyllite:conglomerate:greywacke = 4.0:4.7:1. Phyllite similar to above unit, except black to dark grey to dark grey-brown. Typically with good cleavage, local tuffaceous laminae and slightly calcareous. Greywacke poorly to moderately sorted, typically very siliceous with grey silty-graphitic to green chloritic matrix. Orthoconglomerate composed of coarse to fine pebbles and is generally polymictic, largely quartz pebbles, with lesser pink felsic pebbles, K-spar and plagioclase phenocrysts, phyllite pebbles, chloritic pebbles, and tuffaceous greywacke intraclasts and/or volcaniclasts. Quartz is typically sub-moderately rounded, with other pebbles less rounded. Some quartz pebbles appear to be embayed (phenocrysts?). Matrix is usually fine-grained, chloritic, and may be tuffaceous. Minor sand also in matrix. Monomictic-oligomictic "greywacke" intraclast orthoconglomerate, may be volcaniclastic (in either case, matrix is similar to clasts). Grain shapes tend to be subangular, subprismoidal. As conglomerate pebbles become finer grained, grain size distribution becomes less bimodal, and sediment grades into paraconglomerate and coarser greywackes. There is also some tendency for finer greywackes to grade into tuffaceous phyllites. In general, lithologic contacts are fairly sharp. Some contacts show slickensides and may, in part, be tectonic. Little grading within beds. Quartz pebbles-grains

Table ZM-1

D.D.H. ZM-1 ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	C-SL-15968	C-SL-15974	C-SL-15977	C-SL-15984	C-SL-15991	C-SL-15998
Footage	163.0-173.0	393.2-393.6 & 404.1-405.7	393.6-404.1	410.0-422.0	937.0-949.0	1263.0-1273.0
Au (PPB)	10	5	5	5	<5	<5

Table TS-1

D.D.H. TS-1

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	C-SL-15431	C-SL-15432	C-SL-15433	C-SL-15438	C-SL-15434	C-SL-15437	C-SL-15435	C-SL-15436
Footage	120.0-122.0	136.0-140.0	147.0-148.0	154.7-157.0	181.0-183.0	215.0-216.5	216.5-217.0	233.5-235.0
Au (PPB)	<5	5	<5	<5	<5	<5	35	50

often bluish (strained). Within the unit there are 20 phyllite beds between .2′ and 95′ with a mean thickness of 9.7′ (standard deviation 21.7′), for a total thickness of 193.4′. There are 14 conglomerates and conglomeratic greywacke beds between .4′ and 58.7′, with a mean thickness of 16.0′ (standard deviation 17.4′) for a total thickness of 224.4′. There are 9 greywacke beds between .1′ and 20.9′ with a mean thickness of 5.3′ (standard deviation 7.3′) for a total thickness of 47.8′. There are 2 units, 3.3′ and 1.8′ thick, where the 3 rock types are more intermixed on a finer scale. Pyrite abundances vary from 1-3% in greywacke and conglomerate matrix to occasionally 5% in the phyllite as disseminations and small masses. Veins also contain minor pyrite. Veining is typically irregular to folded, and contains quartz, calcite, dolomite, chlorite, and pyrite, with local vugs and minute sphalerite crystals (628′). Very minor chalcopyrite also. Cleavage is 35-60° to core axis. Bedding occurs at all angles to bedding.

1025′-1445.5′ Mixed-interbedded, fine-coarse-grained, light to dark grey siliceous-tuffaceous greywacke, and dark grey phyllite. Greywacke and phyllite similar to previous units. Local fine pebble conglomerate 1431′-1435′ with chloritic matrix and downward coarsening. Greywacke: phyllite is equal to 3.3:1. Contacts are fairly sharp to gradational, with slip along some of them. Unit contains 26 phyllite beds from .4′ to 20.5′ (total thickness 96.8′), with a mean thickness of 3.7′ (standard deviation 4.5′). Twenty-eight greywacke beds from .5′ to 58.5′ combine to give a total thickness of 322.9′, with a mean thickness of 11.5′ (standard deviation 13.4′). Pyrite content is from 2-5% as disseminations and within veins. Chalcopyrite occurs in trace amounts. Veining is typically quartz with lesser chlorite, pyrite and dolomite. Local muscovite, biotite, chalcopyrite, and K-feldspar alteration occur with some veins (1177′-1186′, 1232′-1264′, 1390′-1413′, 1443.1′-1445′). Veining composes 1-20% of the core. Cleavage is typically 50° to core axis. Bedding is at all angles to core axis, but typically 10-30°.

1445.5′-1485′ Interbedded ortho- and paraconglomerate and siliceous-tuffaceous greywacke. Rock types similar to previously described units. The lower conglomerate beds are coarser than previous units (contain small cobbles, not just pebbles), and contain chlorite-biotite pebbles, and intraclast greywacke-volcaniclast pebbles and cobbles. Matrix is chloritic-biotitic-pyritic. Unit contains 5 greywacke beds from .8′ to 9.8′ (total thickness 19.5′), with a mean thickness of 3.9′ (standard deviation of 4.1′). Unit contains 6 conglomeratic beds from .8′ to 7.3′ (total thickness 20.0′), with a mean thickness of 3.3′ (standard deviation 2.7′). Pyrite amounts vary from 2-7%, with largest amounts in conglomerate matrix (and clasts?). Chalcopyrite occurs in trace amounts. Veining increases with depth from very minor, quartz-dolomite veinlets near top, to chlorite-pyrite-calcite-dolomite veinlets, to quartz-dolomite-chlorite-pyrite veins which make up 30% of the rock. Unit has more brittle deformation-tension veining than most units in hole. Bedding generally 0-30° to core axis. Separate schistosity not as obvious, but appears to subparallel bedding.

1485′-1514.8′ Interbedded dark grey phyllite and medium-dark grey siliceous-tuffaceous greywacke. Rock types similar to those previously described. Unit contains 8 phyllite intervals from .2′ to 1.8′ (total thickness 8.0′) with a mean thickness of 1.0′ (standard deviation .6′). Unit contains 8 greywacke beds from 1.0′ to 4.4′ (total thickness 21.8′) with a mean thickness of 2.7′ (standard deviation 1.4′). Grain size variations somewhat gradational and show coarsening in different directions (*possible* tectonic reversals in slices?). Pyrite ranges from 2-5%, with a trace of chalcopyrite. Veining increases downward from minor thin quartz-dolomite veinlets grading into quartz veins with minor chlorite-dolomite-pyrite. Vuggy vein at 1500.5′-1500.6′ also with calcite. Veins in basal 11′ make up 20% of the rock and contain scattered biotite. 1496′-1509′ contains local pink K-feldspar(?) in quartz veins adjacent to phyllite fragments, and in gouge 1511′-1511.5′. Brittle deformation and fabric similar to previous unit. Phyllite occasionally disrupted-brecciated.

1514.8′-1585′ Interbedded medium-dark grey greywacke, light-medium grey conglomerate-conglomeratic greywacke, and dark grey phyllite. Lithologies similar to above units. Unit contains 8 beds of greywacke from .3′-24.0′ (46.6′ total thickness), with a mean thickness of 5.8′ (standard deviation 8.2′). Unit contains 5 beds of conglomeratic rocks from .4′-9.6′ (15.8′ total thickness), with a mean thickness of 3.2′ (standard deviation 3.9′). Phyllite occurs as 4 beds, .1′, 3.7′, 3.8′, and .2′ thick (2.0′ mean, 2.1′ standard deviation). Pyrite amounts vary from 2-7% with a trace of chalcopyrite. Veining consists of minor quartz-dolomite-chlorite veins, with basal 15′ being composed of 5% veins, with pyrite and a few pink K-feldspar veinlets. Brittle deformation and fabric similar to above unit.

1585′-1666′ Interbedded medium grey greywacke and dark grey phyllite. Bedding contacts tend to be fairly gradational, with one sharp contact at 1657.8′. Greywacke is fine-medium-grained, silty, siliceous, tuffaceous, poorly sorted, and consists of 5 beds from 4.5′-26.0′ in thickness, with a mean thickness of 11.2′ (standard deviation 8.6′). The phyllite consists of 5 beds from .5 to 13.0′ thick, for a total thickness of 25′ (5.0′ mean, 6.0′ standard deviation). Local graded beds appear to coarsen uphole. Locally intervals are brecciated(?)-intraclastic(?), especially in phyllite zones. Pyrite varies from 1-5%. Trace chalcopyrite(?). Veining is minor with quartz (often drusy) and lesser chlorite, dolomite, and pyrite. Superimposed bedding-schistosity is 45-60°, but closer to 20° near slip surfaces.

1666′-1723′ T.D. Medium grey, fine-medium grained, silty, siliceous, tuffaceous greywacke. Minor fairly gradual clast size changes, with local graded beds coarsening uphole. Contains 1-5% pyrite and a trace of chalcopyrite(?) Minor quartz (drusy) veins with lesser chlorite, dolomite and pyrite. Superimposed bedding-schistosity 45-60°, but closer to 20° near slip surfaces.

Acid Test Results

Footage	Drill Angle from Horizontal	Bedding Angle with Core Axis	Schistosity Angle with Core Axis
100	51°	0-5°	51°
400	52°	47°	53° (across bedding)
703	46°	-	78° (conglomerate)
1003	36°	17°	51° (subparallel with bedding)
1303	30°	7°	43° (?)
1603	30°	5°?	56°

Notes: Graded beds *may* indicate a major reversal in the stratigraphic section, as in drilling across a fold hinge (1485'-1514.8'?). Limb stratigraphy may not match *because* of tectonism, and/or facies changes. Sixteen thin section heels have been cut. Thirty-one composite and two individual samples, along with area rock samples, have been sent in for analysis. Analytical results follow in Table BM-2. A detailed log is available for study.

CONDENSED GEOLOGIC LOG FOR DDH SE-3

Hole drilled at a 60° angle and an azimuth of 263°.

0'-158' **Overburden.**

158'-163' **No core.**

163'-191' **Dark grey basalt with slight red tinge near top.** Minor hairline fractures-veinlets with local hematite staining, calcite, epidote, and zeolites. Core broken at base.

191'-198.5' **Dark red-grey amygdaloidal flow top basalt with hairline fractures and brecciation.** Amygdules contain quartz, zeolites, epidote, and chlorite. Fractures contain zeolites, epidote, hematite, chlorite, quartz, talc, and Na-plagioclase(?).

198.5'-201.3' **Dark grey amygdaloidal basalt.** Slightly magnetic with 3-7% magnetite. Amygdules with quartz, zeolites, epidote and chlorite. Few fractures.

201.3'-202.6' **Dark grey basalt, nonmagnetic.**

202.6'-222.5' **Dark grey amygdaloidal basalt.** Somewhat magnetic with 7-10% magnetite. Amygdules with quartz, chlorite, and zeolites. Contains minor fractures with talc, calcite, chlorite, hematite, and zeolites. Local minor flow structure and brecciation. 1 cm, oxide layered, oxide bearing microgabbro dike with 5-60% magnetite (average 15%) at 204.5'.

222.5'-225.6' **Variegated altered basalt.** Dark grey-red-green. Inter-flow contact with hematite, epidote, zeolite, talc(?), and chlorite(?) alteration.

225.6'-232' **Dark grey, somewhat magnetic amygdaloidal hornfelsed basalt with xenoliths(?), and phenocrysts.** Contains 7-10% magnetite. Amygdules contain quartz, chlorite, calcite, zeolites. Plagioclase phenocrysts to 1 cm. Xenoliths(?) slightly coarser (microgabbro?). Could also be related to amygdules or more volatile rich areas. Minor fractures with talc, epidote, calcite, and zeolites. Basalt texture almost microgabbroic, granular.

232'-237' **Dark grey, somewhat magnetic hornfelsed basalt with xenoliths(?) and phenocrysts.** Similar to above unit except no amygdules. Fractures contain calcite with quartz, K-feldspar, and plagioclase toward base of unit.

237'-244' **Dark grey, slightly magnetic hornfelsed basalt with xenoliths(?) and phenocrysts.** Similar to above unit except only 3-7% magnetite. Contains scattered fine-medium-grained diorite-granodiorite dikes (largest one 239'-239.5'). Magnetic oxides decrease toward base. Basal footage contains trace amounts of pyrite-pyrrhotite.

244'-245' **Fine-grained, chilled, somewhat magnetic, dark grey, noritic(?) gabbro.** 7-10%(?) magnetite.

245'-288.5' **Dark grey, medium-grained gabbro with oxides.** Slightly to somewhat magnetic with trace to 10% oxides (averages 7%). Plagioclase 40-50%, clinopyroxene 25-35%, altered orthopyroxene-clinopyroxene 15-25%. Subophitic(?). Green pyroxene alteration is chloritic, serpentinitic, and deuteric(?); more noticeable near hairline fractures. Hairline fractures with chlorite, serpentine, calcite, and talc. Plagioclase locally albitized (also with K-feldspar). 1 cm basaltic dike at 281' and 1 cm altered brecciated basaltic dike at 282'. Locally pegmatoidal.

288.5'-303' **Dark grey, medium-coarse-grained noritic(?) gabbro with magnetite (7-10%).** Similar to above unit except 25-35% greenish, altered pyroxene slightly coarser grained; and fewer hairline fractures cutting rock, with associated alteration (calcite, chlorite).

303'-314' **Dark grey, medium-coarse-grained gabbro with 7-10% magnetite.** Similar to 245'-288.5' but without hairline fractures and associated alteration minerals.

314'-365' **Dark grey, medium-coarse-grained noritic(?) gabbro with 7-10% magnetite.** Similar to 288.5'-303', except contains more hairline fractures; and associated calcite, talc, chlorite, Na-plagioclase, and dolomite. Some with slickensides.

365'- 403' T.D. **Dark grey, medium-coarse-grained gabbro with 7-10% magnetite.** Similar to 245'-288.5'. 370.5'-381' locally brecciated with corroded plagioclase altered to Na-plagioclase and K-feldspar with a chloritic matrix and slightly less magnetite. Hairline fractures and alteration decrease with depth.

Table BM-2

D.D.H. BM-2

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Au PPB	Sample #	Footage	Au PPB
C-CA-15745	529.0-543.0	5	C-CA-15852	989.0-1003.0	<5
C-CA-15753	543.0-559.0	<5	C-CA-15860	1011.0-1023.0	<5
C-CA-15762	573.0-585.0	<5	C-CA-15868	1177.0-1187.0	<5
C-CA-15770	593.0-605.0	<5	C-CA-15874	1229.0-1241.0	<5
C-CA-15777	619.0-633.0	<5	C-CA-15881	1241.0-1253.0	<5
C-CA-15785	651.0-663.0	<5	C-CA-15888	1337.0-1351.0	<5
C-CA-15792	713.0-725.0	<5	C-CA-15896	1393.0-1405.0	<5
C-CA-15799	725.0-739.0	<5	C-CA-15903	1419.0-1429.0	<5
C-CA-15807	803.0-813.0	<5	C-CA-15909	1435.0-1449.0	<5
C-CA-15813	813.0-825.0	<5	C-CA-15917	1463.0-1475.0	<5
C-CA-15820	835.0-849.0	10	C-CA-15924	1475.0-1487.0	<5
C-CA-15828	877.0-881.0	<5	C-CA-15931	1494.0-1504.0	5
C-CA-15831	929.0-941.0	<5	C-CA-15937	1504.0-1516.0	35
C-CA-15838	949.0-961.0	10	C-CA-15944	1522.0-1532.0	5
C-CA-15845	971.0-983.0	<5	C-CA-15950	1570.0-1582.0	<5
			C-CA-15957	1713.0-1723.0	<5

ROCK SAMPLES (Barnum area)

Sample #	Location T	R	S	Au PPB	Ag PPM	Bi PPM	Te PPM	As PPM	Sb PPM	Fe PCT	V PPM	Cr PPM	Co PPM	Ni PPM	Cu PPM	Zn PPM	Pb PPM	Sn PPM	Mo PPM	Cd PPM	Mn PPM	U PPM	W PPM	Se PPM
R C-12754	47N	19W	15	<5	<0.5	5	<10	5	<5	0.6	5	500	<1	60	5	25	20	<10	3	<1	100	<10	<10	<5
R C-12755	47N	19W	15	<5	1.0	2	20	130	<5	>10.0	110	250	75	200	350	7	10	<10	65	4	170	<10	30	<5
R C-12756	47N	19W	15	10	<0.5	<2	<10	30	<5	>10.0	100	200	25	100	250	15	30	<10	30	1	300	<10	20	<5
R C-12757	47N	19W	15	35	4.5	110	20	65	<5	5.9	80	250	15	40	120	35	110	<10	6	<1	350	<10	30	5
R C-12758	47N	19W	15	<5	<0.5	<2	<10	5	<5	4.0	10	150	4	20	15	10	5	<10	2	<1	450	<10	<10	<5
R C-12759	47N	19W	15	<5	<0.5	4	10	50	<5	>10.0	200	120	65	85	350	85	5	<10	10	3	1800	<10	100	<5
R C-12760	47N	19W	15	<5	<0.5	4	10	5	<5	>10.0	5	200	2	20	20	5	5	<10	3	1	350	<10	10	<5
R C-12761	47N	19W	15	<5	<0.5	<2	10	10	<5	>10.0	15	140	7	35	30	20	<5	<10	5	2	1000	<10	10	<5
R C-12762	47N	19W	15	<5	<0.5	<2	<10	100	<5	8.0	110	250	25	35	140	2500	60	<10	5	14	800	<10	40	<5
R C-12763	47N	19W	15	10	<0.5	<2	<10	100	<5	8.0	55	300	65	50	130	25	30	<10	5	1	1500	<10	30	<5
R C-13497	47N	19W	15	30	<0.5	2	<10	70	<5	8.5	75	250	30	65	200	20	35	<10	16	1	100	<10	10	<5
R C-13498	47N	19W	20	<5	<0.5	<2	<10	<5	<5	1.0	5	250	8	20	40	8	5	<10	2	<1	200	<10	<10	<5
R C-13499	47N	19W	20	35	<0.5	<2	<10	15	<5	1.3	2	250	7	30	25	3	<5	<10	1	<1	200	<10	<10	<5
R C-13500	47N	19W	20	<5	<0.5	<2	<10	<5	<5	6.7	120	300	25	100	60	70	15	<10	5	1	1500	<10	40	<5
R C-13501	47N	19W	20	5	<0.5	6	10	<5	<5	>10.0	8	150	4	45	25	15	<5	<10	6	3	2400	<10	10	<5

Acid Test Results

Footage	Drill Angle from Horizontal
163	60°
403	60°

Notes: Alteration may be the major difference between the gabbro and noritic gabbro units. Twelve thin sections are available for inspection. Hole logged on graphic form.

CONDENSED GEOLOGIC LOG FOR DDH BM-1

Hole drilled at a 45 angle and an azimuth of 0.

0′-38′ **Overburden.**

38′-50′ **No core.**

50′-173.1′ Metamorphosed-recrystallized-altered, interbedded tuffs, flows, minor sills(?); and minor thin sediments and/or mylonite. Sequence largely volcanic. Apparent compositions range from basaltic-andesitic (grey-green) to dacitic (green-grey) to microgranitic (pink-grey). Typically very fine-fine-grained. Some intervals show gradational mafic to felsic changes (downward), where there is a sharp contact with the mafic rock directly below it. These intervals are at 67′-69.8′, 69.8′-71.4′ (slightly differentiated), and 138.5′-143.1′. 115′-126′ and 149′-156′ are similar except 125.4′-126′ and 152′-156′ show gradually increasing mafics with depth (result of chilling of flows? composition change if tuffs?). Other K-feldspar rich, irregular intervals within 143.2′-144.9′, 158′-159′, 162′-164.4′, 168′-170′, 172′-173.1′. More felsic-microgranite areas 35-60% K-feldspar; 20-35% hornblende, chlorite and biotite; 5-20% plagioclase; 10-20% quartz; 5-10% pyrite; and trace-1% chalcopyrite(?). More mafic and plagioclase rich intervals may be flows, breccia flows-tuffs, or sills; or may be parts of differentiated felsic intervals listed above. Local textures are pillowed and fragmental, although alteration and deformation obscure textures. Locally calcareous. Thin .1′ black, cherty, interflow sediments or recrystallized ultramylonite(?) occur at 126′, 143.1′, 144.9′, and 156.4′. Sulfides range from 1/4-20% and are generally pyrite with very minor chalcopyrite. Highest amounts occur in felsic intervals associated with veins and adjacent areas. Occasionally massive. Veins in unit are either hairline fractures with chlorite, quartz, calcite, pyrite, chalcopyrite and K-feldspar or larger, irregular veins-segregations with quartz, chlorite, calcite and pyrite. Fabric of rock is generally massive from recrystallization or was not as conducive to schistosity formation as other units. Bedding-contacts are 18-59° to core axis with penetrative(1st?) schistosity averaging(?) 38° to core axis. Bedding often rotated subparallel to schistosity.

173.1′-254.7′ Green, fine-grained, chloritic, intermediate-mafic, crystal metatuff. Probably recrystallized breccia flow tuff of andesitic to rhyodacitic(?) composition. Local pinkish K-feldspar (differentiation) 205.5′-206.5′. Hornblende phenocrysts ubiquitous, up to 2 mm in size. Plagioclase phenocrysts(?) scattered. Feldpsar/mafics = 1. Moderately calcareous locally. Original *recognizable* volcaniclast sizes to 1 cm. Rock fabric semi-schistose; becoming more schistose with depth in general, probably reflecting finer original volcaniclast size. Also more laminated with depth. Minor, scattered calcite, K-feldspar, pyrite, and quartz(?) veins. Unit contains trace-1% pyrite and a trace of chalcopyrite. Sulfides occur in veins and disseminations. Schistosity is 55-66° (average 56°); with bedding often the same down to 38° to core axis.

254.7′-451′ Dark green-green grey metatuff-greywacke with minor phyllite. In general, rock becomes less chloritic (green) and more siltier-siliceous (grey) and calcareous with depth. Typically it is fine-grained. Rock more highly deformed (broken, folded, brecciated, pseudobrecciated) 257′-283′, and has a well developed foliation. Deformed interval contains irregular quartz, pink dolomite-ankerite, and calcite veins with minor pyrite. Below 283′ rock is more massive-semi-schistose and veins are irregular, and filled with quartz, chlorite and calcite. 401.5′ has irregular bursts-veins with calcite, K-feldspar, minor black chlorite(?) and chalcopyrite. 427′-437′ has scattered 1-2 mm hornblende phenocrysts. Superimposed bedding-schistosity is 40-75°, with bedding at 51-70°. Schistosity measures 22° and 57-63° to core axis. Two lineations are present.

451′-641.5′ Dark green-green grey metatuff-tuffaceous greywacke with minor graphitic phyllite laminae, veining and brecciation. Graphitic phyllite from 451′-457′, 635′-641.5′, and often is associated with slip surfaces. 457′-635′ is chloritic, fine-medium-grained, somewhat siliceous, with silty matrix. Locally moderately calcareous and broken. Core locally brecciated-pseudobrecciated-veined within 451′-496′ (with dolomite-pyrite-calcite breccia cement); 529′-559′ (with less dolomite, more clay gouge); and 631′-641.5′ (graphitic). 467′-507′ contains scattered veinlets of quartz, K-feldspar, calcite, dolomite, chalcopyrite and pyrite(?). 562′-582.5′ similar, but less chalcopyrite, more pyrite. Vein paragenesis: quartz early; calcite, K-feldspar, pyrite early(?); dolomite later; and chalcopyrite last.
Pyrite varies from 1/2-5%; chalcopyrite, trace-1/2%. Rock fabric is massive-semi-schistose, except with local schistosity associated with phyllites and slip surfaces. Bedding-schistosity measures 55-77° to core axis, and generally the two cannot be separated.

641.5′-762′ Black, graphitic-pyritic phyllite. Locally folded, broken and/or brecciated, with good penetrative cleavage. Graphite is powdery, but shiny and crystalline on slip surfaces. Pyrite is fairly ubiquitous (3-7%) and occurs as disseminations, concretionary masses, and occasionally as broken, corroded cubes. Trace chalcopyrite; as coating on pyrite cubes, as cleavage fillings, and in hairline fractures cutting pyrite. Scattered quartz-dolomite-calcite veins with minor pyrite, some of which are deformed or, pseudobrecciated. Minor tuffaceous component throughout, but also contains scattered fine-grained andesitic-dacitic crystal tuff beds. Phyllitic schistosity predominant fabric with bedding rotated-subparallel except in fold closures. Bedding-schistosity (superimposed) measures 32-80° to core axis. Bedding measures 0-80°, while schistosity measures 53-85°. Fold axial planes 55-66°, and 30-32°.

762′-1022.9′ Brown-grey, fine-medium-grained metatuff with minor argillite-phyllite. Locally calcareous. Veining is minor but relatively ubiquitous. Largely semi-schist fabric with much flattening, recrystallization. Tuff is 20-60% plagioclase (locally altered to calcite), 5-20% quartz, 10-50% chlorite (basal 30′ more chloritic), 0-20% biotite, and 0-30% actinolite. Also contains up to 5% pyrite and trace-1% chalcopyrite. Tuff is andesitic-dacitic, but locally more K-feldspar bearing. Local quartz pebbles-eyes. Coarser volcaniclasts to 5 cm. Good cleavage, folding, slip surfaces in phyllites, with thicknesses up to 5.6′. Unit contains scattered quartz-dolomite-calcite-chlorite bursts and irregular veining. Other sulfides include the following: trace bornite in calcite veinlets with pyrite and chalcopyrite 839′-846′; trace galena in 2 mm calcite-potassium feldspar vein with chalcopyrite and pyrrhotite at 962′-963′; and bornite in 1 cm calcite- potassium feldspar-pyrrhotite-chlorite-chalcopyrite vein at 966.8′. Base of unit hornfelsed? Bedding-schistosity (superimposed) measures 42-70° to core axis (65° average). Bedding measures all angles. Schistosity measures 45-68°. Axial planes measure 65-75° to core axis.

1022.9′-1051.8′ Dark grey-black, aphanitic, medium-grained gabbro dike with chilled contacts. Mode: 50% plagioclase, 30% titanaugite, 10% olivine, 10% oxides. Not very magnetic for amount of oxides (ilmenite?). Rock massive without foliation; however, scattered fractures and serpentine-calcite-chlorite alteration occur in coarsest, central portion. Fractures often appear sheared with slickensides and minor pyrite. Pyrite averages a trace. Upper contact sharp but folded. Lower contact not distinct and grades into hornfelsed basalt.

1051.8′-1243.2′ Dark green-grey-green very fine-medium-grained metatuff-tuffaceous greywacke, and breccia flows(?). Massive to semi-schistose. Recrystallization makes original texture difficult to recognize. Sediments and volcaniclasts interchange very gradationally. Largely tuffaceous with little sedimentary reworking. Mode: 30-35% chlorite, 30-35% actinolite-hornblende, 30-35% plagioclase, 0-10% calcite. Few scattered, thin sediment beds (phyllite, chert, argillaceous quartzite). 1070.6′-1071′ black, porphyritic metadiabasic dike or sill (related? to previous unit). Scattered, irregular quartz-chlorite-calcite veins and segregations, some broken-mylonitic, some containing pink dolomite, pyrite, pyrrhotite, chalcopyrite, and biotite. All appear to be disrupted quartz veins with later carbonate, chlorite, and sulfides.
Unit contains trace-1% pyrite-pyrrhotite and trace-1/2% chalcopyrite. Basal 40′ shows gradual increase in graphitic argillite. Superimposed bedding-schistosity measures 43-75° to core axis. Bedding measures 60-68° and 42°. Schistosity measures 58-65°.

1243.2′-1362′ Interbedded-interlaminated dark grey-brown tuffaceous argillite, argillite, siliceous tuffs-sandstone, and light-medium tan grey marble and siliceous-silty marble. Color depends on relative proportions of argillite, graphite, biotite versus felsic-siliceous tuffaceous material, calcarenite, and quartz sand. Tuffaceous rock appear to be biotitic, and semi-schistose to massive (recrystallized). Unit, in general, gets finer with depth. Finer-grained argillitic rock, often with 2 cleavages, but phyllitic texture only poorly-moderately developed. Folding shows up best in the argillites. Much flattening with many scattered slip surfaces throughout, with mylonitization in lower 50′. 1243.2′-1260.6′, 1266.7′-1268.7′ are argillaceous tuffs with plagioclase phenocrysts and quartz eyes. 1260.6′-1266.7′, 1268.7′- 1271.1′ are argillitic, siliceous sandstone with pinkish, graded, sericitic (reworked?) tuff laminae (coarsen downward). 1271.1′-1276′ siliceous, dolomitic fine-grained calcarenitic marble. 1276′-1299′, 1331′-1362′ are silty, altered, somewhat calcarenitic-dolarenitic tuffaceous argillite. 1299′-1331′ interlaminated, folded argillites, siliceous tuff, and carbonates with local mylonitization.
Veining, more than in previous unit, is ubiquitous and usually less than 2 mm. Veins predominantly contain the following: calcite, quartz, pyrite, dolomite, pyrrhotite, K-feldspar, chlorite; along with minor amounts of chalcopyrite, galena and sphalerite. Unit contains trace-4% pyrite, trace-1/2% chalcopyrite, trace-1/2% sphalerite locally, and trace galena locally. Superimposed bedding-schistosity measures 25-30° and 42-80° (average 54°) to core axis. Bedding measures all angles. Schistosity measures 33-76°. Axial planes measure 50-67°.

1362′-1545.8′ Interlaminated-interbedded, pale-medium grey carbonate cemented quartzarenite-quartzite-quartz dolarenite; dark brown argillite; and pale orange-brown-tan siliceous tuffs. Tuffs are sericitic and reworked. Sequence is largely graded, turbidite laminae, with local soft sediment deformation. Rock is massive to fairly schistose (sericitic tuffs). Much recrystallization; rock is now siliceous marble to carbonate quartzite to sericitic metatuff schist. Carbonate quartzarenite/tuff/argillite = 40/35/25. Local veining grades into pseudobreccia and breccia, which is scattered between 1372′-1479′. Hairline veinlets are scattered throughout and typically contain quartz, pyrite, calcite, dolomite, minor chalcopyrite. Veinlets within 1362′-1404′ contain voids, dolomite rhombs, black sphalerite (1/4%?), pyrite, chalcopyrite, galena (trace), chlorite and calcite.
Rock averages trace-1/2% pyrite, pyrrhotite. Superimposed bedding-schistosity 43-65° to core axis. Bedding measures 0-56°. Schistosity measures 62-65°.

1545.8′-3143′ T.D. Light to medium grey, recrystallized metadolomitic-calcareous quartzarenite and siliceous dolomitic marble. Lithology often laminated. Much folding, flattening, pseudobrecciation, and brecciation; yet rock is massive-recrystallized with breccia usually well healed. Much pressure solution, occasional stylolites. Breccia largely tectonic, although some may be sedimentary. Coloration variation due to graphite, pyrite, minor silt. Graphite occasionally concentrated into slip surfaces. Breccia's often associated with relatively undeformed tectonic slivers of rock. Mode is 0-90% quartz (average 35%); 0-30% calcite (15% average); 5-80% dolomite (45% average); and 0-80% graphite (5% average). Average 1/2%(?) pyrite. Siliceous intervals may be quartzarenite, chert, or silicified carbonate. Recrystallization makes textures obscure. Deformation increases downward from 1599′-1783.5′ and is fairly continuous to 3143′. From 2689′-2727′, 3029′-3043′, core is somewhat broken and leached; with breccia not as well healed as usual. More siliceous (scattered) from 1701.5′-1748′, 2115′-3143′. Local calcite-dolomite porphyroblasts to 1 cm are found locally1559′-1654′ and 1862′-1863.3′. Minor yellow tuff laminae from 1628.9′-1629′. Local minor pyrite (to 5%) associated with some argillitic marble, graphitic slip surfaces and breccia matrix. Veining is variable and is typically quartz-dolomite-calcite with complex cross-cutting relations that grade into pseudobreccia-breccia. Veins contain local vugs, with pyrite and chalcopyrite(?). Veining in general lessens below 1884′. They are locally brecciated, indicating continuing or multiple deformation. Some fold closures are very complex. Bedding measures at all angles to core axis. Schistosity-flattening most prominent feature, and is often superimposed on bedding, and measures 20-80° (increase downward?) with values predominantly 55-70°. Minor fold axial planes are 30-80° with most from 55-58°.

Acid Test-Eastman Whipstock Survey Results

Footage	Acid Test Angle of Hole from Horizontal	Bedding-Structure Angle with Core Axis	Eastman-Whipstock Survey	
			Azimuth	Vertical Drift (from Horizontal)
50′	47°	-	-	-
53′	-	-	6°	46°
143′	-	53°S_0-S_1	356°	45°
343′	-	-	355°	43°
350′	44°	57°S_0-S_1	-	-
543′	-	-	354°	43°
650′	43°	62°S_0-S_1		-
743′	-	52°S_1-S_1 Schistosity	351°	45°
943′	-	-	345°	49°
950′	48°	68°S_0-S_1	-	-
1143′	-	75°S_0-S_1	343°	49°
1250′	48°	48°S_0-S_1 0-5°S_2	-	-
1343′	-	65°Ax Plane	340°	50°
1543′	-	43°S_0-S_1	338°	53°
1550′	53°	42°S_0-S_1	-	-
1743′	-	39°S_0-S_1	336°	52°
1850′	53°	43°Ax Plane	-	-
1943′	-	62°S_1	335°	51°
2143′	-	68°S_1	333°	50°
2150′	51°	45°S_0	-	-
2343′	-	30°Ax Plane	331°	49°
2450′	51 1/2°	0°S_0	-	-
2543′	-	66°S_1-S_0	330°	49°
2743′	-	-	326°	49°
2750′	52°	45°S_1	-	-
2943′	-	65°Qtz Vein	324°	48°
3143′	-	0-40°Vns	322°	48°

S_0 = Bedding
S_1 = 1st Folding Schistosity
S_2 = 2nd Folding Schistosity

Notes: Lithologic and structural logs are available for study, as are 156 thin sections and 48 other cut heels. Twelve individual and 95 composite samples were sent in for chemical analysis, with analytical results following in Table BM-1. Analytical results of rock samples taken in the area may be found in Table BM-2.

CONDENSED GEOLOGIC LOG OF DDH A-2

Hole Drilled at a 45° angle and an azimuth of 180°.

0′-34′ **Overburden.**

34′-40′ **No core.**

40′-194.5′ Fine-medium-grained, medium-dark grey brown-green brown, altered, recrystallized metabasalt-andesite flows and tuffs. Generally massive to semi-schistose. Some flattening evident. Mode: 20-65% calcite (partially in voids), 5-45% chlorite, 5-25% hornblende (needles to 5 mm), 5-35% biotite, 5-20% quartz and plagioclase and 0-5% pyrite-pyrrhotite(?), with a trace of chalcopyrite. Calcite, quartz, and sulfides occur as disseminations and in thin veinlets. Rock alternates between darker, more mafic, and lighter grey, more siliceous-calcareous intervals. Unit contains local pseudobreccia-breccia with scattered black ultramylonite bands. Minor thick veining and flow top breccia(?), with quartz-calcite-chlorite-pyrite and local traces of Mn oxides and rhodochrosite. Some veins appear brecciated and healed. Local pillows and flow tops. Layering-bedding-flattening oriented about 20-35° to core axis.

Table BM-1

D.D.H. BM-1

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Au PPB	Ag PPM	Bi PPM	Te PPM	As PPM	Sb PPM	Fe PCT	V PPM	Cr PPM	Co PPM	Ni PPM	Cu PPM	Zn PPM	Pb PPM	Sn PPM	Mo PPM	Cd PPM	Mn PPM	U PPM	W PPM	Se PPM
C-CA-13622	54.0- 61.9	<5	<0.5	<2	<10	<5	<10	>10.0	300	55	45	100	140	130	5	<10	7	<1	1750	<10	20	<5
C-CA-13626	61.9- 68.0	<5	<0.5	<2	<10	<5	<10	>10.0	300	60	45	95	170	110	5	<10	7	<1	1650	<10	20	<5
C-CA-13627	68.0- 69.9	<5	<0.5	4	<10	10	<10	>10.0	300	45	45	70	110	95	10	<10	6	<1	1100	<10	10	<5
C-CA-13631	69.9- 76.0	<5	<0.5	4	<10	35	<10	>10.0	250	60	35	65	110	95	10	<10	6	<1	1200	<10	10	<5
C-CA-13666	87.1- 91.0	<5	<0.5	<2	<10	5	<10	>10.0	350	30	50	75	300	100	5	<10	9	<1	1700	<10	20	<5
C-CA-13671	103.4-111.0	<5	<0.5	<2	<10	5	<10	>10.0	300	50	50	100	170	130	10	<10	8	<1	1850	<10	10	<5
C-CA-13676	119.0-126.1	<5	<0.5	2	<10	60	10	>10.0	300	70	50	90	140	70	10	<10	7	<1	1150	<10	10	<5
C-CA-13677	134.3-135.3	<5	<0.5	2	<10	<5	<10	10.0	300	70	50	120	140	90	10	<10	7	<1	2200	<10	10	<5
C-CA-13681	141.6-147.0	<5	<0.5	2	<10	35	<10	>10.0	250	100	50	105	130	95	10	<10	9	<1	1200	<10	<10	<5
C-CA-13685	147.0-153.0	<5	<0.5	<2	<10	35	<10	10.0	300	90	55	105	120	90	10	<10	8	<1	1200	<10	10	<5
C-CA-13689	153.0-158.9	<5	<0.5	4	<10	10	<10	>10.0	300	65	50	100	120	80	5	<10	7	1	1550	<10	10	<5
C-CA-13693	161.9-166.0	<5	<0.5	2	<10	60	<10	>10.0	300	55	50	95	120	100	5	<10	8	<1	1600	<10	<10	<5
C-CA-13697	167.6-171.4	<5	<0.5	<2	<10	70	<10	>10.0	300	80	45	90	130	110	10	<10	9	<1	1250	<10	<10	<5
C-CA-14174	171.4-177.0	<5	<0.5	<2	<10	15	<10	9.5	300	45	40	70	125	100	5	<10	10	1	1300	<10	20	<5
C-CA-14193	202.0-208.0	<5	<0.5	2	<10	10	<10	8.0	250	45	40	60	100	85	<5	<10	10	1	1100	<10	10	<5
C-CA-14200	234.9-243.4	<5	<0.5	<2	<10	15	<10	8.5	250	40	40	65	110	100	<5	<10	8	2	1100	<10	<10	<5
C-CA-14218	258.0-269.1	<5	<0.5	6	<10	5	<10	6.7	250	120	45	70	140	160	<5	<10	10	1	1300	<10	20	<5
C-CA-14224	269.1-283.0	<5	<0.5	2	<10	15	<10	7.8	250	40	35	45	125	80	<5	<10	10	1	1400	<10	20	<5
C-CA-14229	365.0-367.0	<5	<0.5	4	<10	5	<10	6.0	150	80	30	50	50	75	<5	<10	7	2	1200	<10	<10	<5
C-CA-14230	399.0-403.0	<5	<0.5	<2	<10	15	<10	8.2	250	50	40	75	100	85	5	<10	8	2	1400	<10	<10	<5
C-CA-14242	451.0-463.0	<5	<0.5	6	<10	10	<10	7.2	250	40	35	60	120	120	<5	<10	9	2	1200	<10	10	<5
C-CA-14249	468.0-473.9	<5	<0.5	4	<10	10	<10	8.2	250	35	35	65	110	85	5	<10	9	2	1200	<10	30	<5
C-CA-14253	479.0-487.0	<5	<0.5	<2	<10	5	<10	7.8	200	50	35	65	85	60	<5	<10	9	<1	1800	<10	20	<5
C-CA-14258	487.0-497.0	<5	<0.5	<2	<10	10	<10	8.4	250	60	40	80	85	110	10	<10	10	2	1200	<10	<10	<5
C-CA-14264	503.0-505.0	<5	<0.5	<2	<10	10	<10	9.2	250	45	65	70	130	90	5	<10	10	<1	1100	<10	<10	<5
C-CA-14276	531.0-538.9	<5	<0.5	2	<10	15	<10	6.9	200	70	35	50	95	80	<5	<10	9	<1	900	<10	<10	<5
C-CA-14281	545.0-555.0	<5	<0.5	6	<10	10	<10	7.1	200	70	35	60	90	70	<5	<10	9	2	1000	<10	<10	<5
C-CA-14287	575.0-583.0	<5	<0.5	4	<10	<5	<10	6.6	200	45	35	55	120	100	5	<10	9	2	1000	<10	<10	<5
C-CA-14292	597.0-604.9	<5	<0.5	2	<10	10	<10	7.0	200	35	30	50	100	100	<5	<10	10	2	1100	<10	10	<5
C-CA-14297	630.9-639.0	<5	<0.5	<2	<10	10	<10	8.2	300	30	40	40	110	65	<5	<10	13	<1	1000	<10	10	<5
C-CA-14302	646.9-655.0	<5	<0.5	<2	<10	10	<10	2.8	130	95	8	50	50	30	<5	<10	8	<1	250	<10	<10	<5
C-CA-14307	673.0-683.0	<5	<0.5	<2	<10	10	<10	3.1	150	100	8	40	60	45	10	<10	10	<1	70	<10	<10	<5
C-CA-14313	709.0-721.0	5	<0.5	<2	<10	5	<10	2.3	150	100	10	55	60	30	10	<10	12	<1	90	<10	<10	<5
C-CA-14320	721.0-731.1	5	<0.5	2	<10	5	<10	2.5	200	90	15	55	80	30	5	<10	10	<1	250	<10	<10	<5
C-CA-14327	731.1-741.0	<5	<0.5	8	<10	5	<10	4.2	190	75	25	55	60	60	<5	<10	10	<1	600	<10	<10	<5
C-CA-14332	749.1-758.0	<5	<0.5	2	<10	15	<10	3.1	120	90	8	50	80	40	<5	<10	10	<1	100	<10	<10	<5
C-CA-14336	758.0-766.0	<5	<0.5	<2	<10	10	<10	5.5	200	65	25	50	90	70	<5	<10	10	2	500	<10	<10	<5
C-CA-14341	782.1-788.9	<5	<0.5	6	<10	10	<10	7.3	250	20	35	30	80	110	<5	<10	10	2	900	<10	<10	<5
C-CA-14345	797.0-811.0	<5	<0.5	<2	<10	<5	<5	8.9	250	30	35	20	140	250	15	<10	3	1	1250	<10	10	<5
C-CA-14353	811.0-819.0	<5	<0.5	<2	<10	<5	<5	9.1	250	25	35	25	130	200	5	<10	2	<1	1200	<10	<10	<5
C-CA-14358	839.0-855.0	<5	<0.5	<2	<10	<5	<5	7.5	250	80	30	50	80	75	5	<10	4	<1	1600	<10	<10	<5
C-CA-14367	921.0-927.0	<5	<0.5	<2	<10	<5	<5	9.5	250	30	40	35	120	95	10	<10	2	<1	1250	<10	<10	<5
C-CA-14538	941.1-953.0	<5	<0.5	<2	<10	<5	<5	9.4	250	60	40	40	100	100	15	<10	3	<1	1400	<10	<10	<5
C-CA-14545	953.0-960.9	<5	<0.5	<2	<10	<5	<5	9.8	250	50	40	40	140	140	25	<10	3	<1	1400	<10	<10	<5
C-CA-14550	960.9-963.0	<5	<0.5	<2	<10	<5	<5	>10.0	300	55	50	50	140	95	20	<10	2	3	1450	<10	<10	<5
C-CA-14551	963.0-966.0	<5	<0.5	<2	<10	<5	<5	>10.0	250	40	40	45	130	80	10	<10	3	<1	1300	<10	<10	<5
C-CA-14552	966.0-968.0	<5	<0.5	<2	<10	<5	<5	>10.0	250	80	45	50	350	85	10	<10	1	<1	1400	<10	<10	<5
C-CA-14553	970.0-981.0	<5	<0.5	<2	<10	<5	<5	9.2	250	45	40	50	110	80	10	<10	2	<1	1200	<10	10	<5
C-CA-14559	1007.0-1013.0	<5	<0.5	<2	<10	<5	<5	>10.0	250	50	45	55	130	110	15	<10	1	<1	1450	<10	<10	<5
C-CA-14563	1017.0-1022.9	<5	<0.5	<2	<10	<5	<5	9.0	250	35	40	40	120	90	20	<10	2	<1	1250	<10	<10	<5
C-CA-14567	1023.0-1024.0	<5	<0.5	<2	<10	<5	<5	9.5	200	100	45	120	200	100	15	<10	2	<1	1250	<10	<10	<5
C-CA-14568	1033.0-1041.0	5	<0.5	<2	<10	<5	<5	>10.0	250	120	50	140	200	100	15	<10	2	<1	1300	<10	<10	<5

Table BM-1 (cont)

D.D.H. BM-1

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Au PPB	Ag PPM	Bi PPM	Te PPM	As PPM	Sb PPM	Fe PCT	V PPM	Cr PPM	Co PPM	Ni PPM	Cu PPM	Zn PPM	Pb PPM	Sn PPM	Mo PPM	Cd PPM	Mn PPM	U PPM	W PPM	Se PPM
C-CA-14573	1051.0-1059.0	<5	<0.5	<2	<10	<5	<5	>10.0	250	70	45	60	130	85	15	<10	1	<1	1250	<10	<10	<5
C-CA-14578	1068.0-1076.0	<5	<0.5	2	<10	<5	<5	9.5	250	50	40	50	170	110	15	<10	1	<1	1350	<10	<10	<5
C-CA-14583	1076.0-1084.0	<5	<0.5	<2	<10	<5	<5	>10.0	250	70	45	60	95	85	15	<10	2	<1	1350	<10	<10	<5
C-CA-14588	1191.0-1193.0	<5	<0.5	<2	<10	<5	<5	9.6	250	50	40	50	120	80	10	<10	2	<1	1200	<10	<10	<5
C-CA-14589	1206.7-1211.2	<5	<0.5	<2	<10	<5	<5	9.3	250	70	40	55	85	85	10	<10	2	<1	1100	<10	<10	<5
C-CA-14644	1253.0-1261.0	<5	<0.5	<2	<10	<5	<5	7.4	250	80	50	65	110	100	10	<10	3	<1	900	<10	<10	<5
C-CA-14649	1263.0-1274.0	<5	<0.5	2	<10	<5	<5	3.0	140	70	25	45	40	25	10	<10	4	<1	1350	<10	<10	<5
C-CA-14656	1279.0-1289.0	<5	<0.5	<2	<10	<5	<5	5.0	80	110	25	40	35	60	5	<10	2	<1	200	<10	<10	<5
C-CA-14662	1289.0-1299.0	<5	<0.5	<2	<10	<5	<5	5.8	80	120	25	45	60	50	<5	<10	2	<1	160	<10	<10	<5
C-CA-14668	1303.0-1313.0	<5	<0.5	<2	<10	<5	<5	5.0	200	90	25	40	200	85	15	<10	2	<1	650	<10	<10	<5
C-CA-14674	1313.0-1319.0	<5	<0.5	4	<10	<5	<5	6.6	35	70	45	70	85	60	10	<10	3	<1	3900	<10	<10	<5
C-CA-14678	1319.0-1325.0	<5	<0.5	<2	<10	<5	<5	7.3	30	60	40	70	30	80	15	<10	4	<1	6000	<10	<10	<5
C-CA-14682	1333.0-1343.0	<5	<0.5	<2	<10	<5	<5	6.4	75	110	25	50	40	130	15	<10	1	<1	250	<10	<10	<5
C-CA-14688	1343.0-1353.0	<5	<0.5	6	<10	5	<5	6.0	75	100	25	50	40	110	15	<10	1	<1	250	<10	<10	<5
C-CA-14694	1353.0-1363.0	<5	<0.5	<2	<10	<5	<5	4.0	85	130	50	70	60	100	25	<10	1	<1	350	<10	<10	<5
C-CA-14700	1363.0-1373.0	<5	<0.5	<2	<10	<5	<5	4.9	170	180	30	100	90	120	5	<10	3	<1	1750	<10	<10	<5
C-CA-14706	1373.0-1383.0	5	<0.5	4	<10	<5	<5	4.9	170	150	25	100	85	140	5	<10	1	<1	1300	<10	<10	<5
C-CA-14712	1383.0-1393.0	<5	<0.5	2	<10	<5	<5	6.5	130	130	20	90	100	60	15	<10	2	<1	1800	<10	<10	<5
C-CA-14718	1393.0-1403.0	<5	<0.5	10	<10	<5	<5	7.5	95	200	30	80	100	500	40	<10	2	3	1900	<10	<10	<5
C-CA-14724	1403.0-1413.0	<5	<0.5	<2	<10	<5	<5	7.0	120	250	25	90	90	40	15	<10	3	<1	1900	<10	<10	<5
C-CA-14730	1413.0-1423.0	<5	<0.5	<2	<10	<5	<5	6.2	150	160	25	75	90	55	15	<10	3	<1	1050	<10	<10	<5
C-CA-14736	1423.0-1433.0	<5	<0.5	2	<10	<5	<5	5.4	140	130	25	75	100	30	10	<10	3	<1	900	<10	<10	<5
C-CA-14757	1439.0-1445.0	<5	<0.5	2	<10	<5	<5	4.5	160	190	25	85	120	15	5	<10	4	<1	750	<10	<10	<5
C-CA-14761	1463.0-1473.0	<5	<0.5	10	<10	<5	<5	4.2	180	250	30	110	10	15	10	<10	2	<1	550	<10	<10	<5
C-CA-14767	1473.0-1483.0	<5	<0.5	2	<10	60	<5	3.7	200	180	35	120	130	15	10	<10	1	<1	800	<10	<10	<5
C-CA-14773	1491.0-1501.0	<5	<0.5	2	<10	50	<5	8.2	150	300	45	140	120	65	25	<10	1	<1	2200	<10	<10	<5
C-CA-14779	1536.0-1546.0	<5	<0.5	<2	<10	<5	<5	5.0	140	200	20	80	120	60	15	<10	2	<1	650	<10	<10	<5
C-CA-14785	1546.0-1558.0	<5	<0.5	6	<10	<5	<5	4.5	35	200	25	160	50	75	20	<10	2	<1	1550	<10	<10	<5
C-CA-14792	1609.0-1619.0	<5	<0.5	4	<10	20	<5	1.0	19	65	7	15	35	15	5	<10	2	<1	750	<10	<10	<5
C-CA-14798	1637.0-1647.0	<5	<0.5	4	<10	<5	<5	1.0	10	30	6	10	5	10	10	<10	4	<1	600	<10	<10	<5
C-CA-14804	1693.0-1703.0	<5	<0.5	2	<10	<5	<5	0.9	6	25	6	6	1	20	10	<10	5	<1	200	<10	<10	<5
C-CA-14810	1724.9-1737.0	<5	<0.5	4	<10	<5	<5	0.8	5	20	4	3	3	10	10	<10	5	<1	300	<10	<10	<5
C-CA-14817	1737.0-1747.0	5	<0.5	<2	<10	<5	<5	2.2	5	10	7	7	7	25	10	<10	5	<1	250	<10	<10	<5
C-CA-14823	1753.0-1767.0	<5	<0.5	<2	<10	<5	<5	0.5	3	30	3	7	1	25	10	<10	6	<1	200	<10	<10	<5
C-CA-14831	1773.0-1785.0	<5	<0.5	4	<10	<5	<5	0.5	4	25	3	3	1	9	10	<10	4	<1	180	<10	<10	<5
C-CA-14838	1790.5-1803.0	<5	0.5	4	<10	<5	<5	0.5	3	15	4	1	1	10	5	<10	5	<1	180	<10	<10	<5
C-CA-14845	1821.0-1835.0	10	<0.5	2	<10	<5	<5	0.4	5	15	3	5	<1	15	10	<10	3	<1	170	<10	<10	<5
C-CA-14853	1883.0-1893.0	<5	<0.5	<2	<10	<5	<5	0.5	3	20	2	1	2	10	10	<10	4	<1	200	<10	<10	<5
C-CA-14877	1923.0-1933.0	<5	<0.5	<2	<10	<5	<5	0.8	1	20	3	2	2	25	10	<10	3	<1	300	<10	<10	<5
C-CA-14883	1939.0-1949.0	<5	<0.5	4	<10	<5	<5	0.5	3	100	3	1	2	9	5	<10	3	<1	250	<10	<10	<5
C-CA-14889	1963.0-1965.0	<5	<0.5	4	<10	<5	<5	0.9	3	20	5	6	2	25	5	<10	2	<1	250	<10	<10	<5
C-CA-14890	1975.0-1985.0	<5	<0.5	4	<10	<5	<5	0.8	2	20	6	2	1	15	5	<10	5	<1	250	<10	<10	<5
C-CA-14896	1989.0-2001.0	<5	<0.5	4	<10	<5	<5	1.0	4	25	3	5	2	10	5	<10	5	<1	250	<10	<10	<5
C-CA-14903	2003.0-2015.1	<5	<0.5	4	<10	10	<5	0.7	2	15	3	3	1	10	5	<10	4	<1	250	<10	<10	<5
C-CA-14910	2031.0-2041.0	<5	<0.5	2	<10	<5	<5	0.8	4	25	3	3	3	35	5	<10	4	<1	250	<10	<10	<5
C-CA-14916	2053.0-2055.0	<5	<0.5	10	<10	<5	<5	0.8	5	15	3	3	1	10	5	<10	4	<1	300	<10	<10	<5
C-CA-14917	2103.0-2115.0	<5	<0.5	2	<10	<5	<5	1.0	3	20	2	2	1	9	10	<10	4	<1	300	<10	<10	<5
C-CA-14924	2115.0-2125.0	10	<0.5	12	<10	<5	<5	0.5	2	25	2	1	1	6	5	<10	5	<1	350	<10	<10	<5
C-CA-14930	2243.0-2253.0	<5	<0.5	6	<10	<5	<5	0.3	2	10	2	1	1	8	5	<10	4	<1	180	<10	<10	<5
C-CA-14936	2508.0-2510.0	10	<0.5	6	<10	<5	<5	0.2	<1	50	6	<1	2	12	40	<10	1	<1	60	<10	20	<5
C-CA-14937	2693.0-2705.0	10	<0.5	8	<10	<5	<5	0.4	<1	15	3	<1	1	11	15	<10	<1	<1	200	<10	10	<5
C-CA-14944	2933.0-2943.0	<5	<0.5	9	<10	<5	<5	0.1	1	25	2	<1	2	15	20	<10	<1	<1	35	<10	10	<5
C-CA-14950	3031.0-3043.0	10	<0.5	<2	<10	<5	<5	0.2	<1	10	3	<1	<1	17	10	<10	<1	<1	200	<10	40	<5
C-CA-15016	3113.0-3123.0	<5	<0.5	7	<10	<5	<5	0.3	3	30	3	5	2	7	10	<10	<1	<1	30	<10	20	<5
C-CA-15022	3123.0-3133.0	<5	<0.5	<2	<10	<5	<5	0.6	2	30	3	3	3	4	5	<10	<1	<1	50	<10	10	<5

194.5′-292.1′ Fine-medium-grained, medium-dark grey-grey-green, altered, recrystallized meta-andesite-dacite tuffs and agglomerate(?). Appears more siliceous than previous unit. Quite calcareous. Mode: 20-65% calcite, 5-20% hornblende, 5-30% chlorite, 5-20% biotite(?), 20-60% quartz; and fine plagioclase, some quartz eyes, and 2-7% pyrite-pyrrhotite with a trace chalcopyrite. Coarse fragments to 1/2′ within 194.5′-230.5′, 239′-283′(?), and 192′-292′(?). These may be brecciated flow tops, boudinaged beds, and/or agglomerate with a matrix of similar material. Below 224′ unit contains up to 30% round-flattened calcite-quartz grains to 1 cm. Probably felsic tuff fragments with few scattered quartz eyes. Basal 3′ of unit is more mafic. Minor, scattered, thin calcite-quartz veins with local folding or brecciation. 3 mm quartz-calcite-pyrite-ankerite(?) veinlet at 229′. Bedding-stretching direction is 7-27° to core axis.

292.1′-367′ Very fine to medium-grained, dark green grey, diabase-gabbro dike. Grain size increases toward center. Coarsest 304′-342′. Mode of center: 40-50% plagioclase, 30-40% medium green hornblende (chloritized?), 15-25% dark green pyroxene (uralitized?), and 1-2% pale pyrite. Carbonate alteration and minor veining more common near contacts. Rock approaches 50% calcite near contacts. Base of unit may be contact metamorphosed tuffs.

367.0′-387.7′ Fine-medium-grained, medium-dark grey-grey green altered-recrystallized meta-andesite-dacite tuffs-agglomerate. Volcaniclasts to several cm. Not agglomeratic below 375′, with tuffs getting more laminated, folded, silicified with depth. Some quartz eyes. Mode: 20-55% calcite, 5-20% hornblende, 5-30% chlorite, 5-20% biotite(?), 20-60% quartz and fine plagioclase, and 2-5% pyrite-pyrrhotite. Similar to 194.5′-292.1′.

387.7′-402.1′ Fine-medium-grained, medium-dark grey-green and light grey-pink-grey banded intermediate-felsic tuffs with agglomerate(?) and minor dark grey, slightly graphitic siliceous metasediments. Local silicification and pseudobreccia veining. Felsic tuffs may be somewhat potassic. Biotite-chlorite somewhat coarser than usual. Intermediate tuff mode: 40-50% biotite, 40-50% chlorite, 5-20% calcite pseudobreccia veins, hornblende, quartz(?), and 0-10% pyrite-pyrrhotite. Felsic tuff mode: 5% actinolite, 40% calcite, 55% quartz and very fine-grained plagioclase and K-feldspar, and trace pyrite. Metasediment mode: 55% quartz, cherty, tuffaceous; 30% calcite; 0-5% very fine-grained graphite; 0-5% very fine-grained pyrite-pyrrhotite and 10% silt and clay. Flattening-bedding is 0-30° to core axis. Pseudobreccia veining largely tectonic(?); although some quartz-calcite veining and silicification (and sulfides?), chlorite may be hydrothermal, although original cross-cutting(?) relationships now tectonically obscured. Most sulfides in biotite-chlorite tuff.

402.1′-430.1′ Dark brown, dark green-grey-brown, fine-medium-grained semi-schist with fragmental texture. Originally lithic lapilli tuff, breccia flow, or tectonic breccia? Original fragments to 2 cm. Mode: 20-40% muscovite, increasing with depth; 10-40% calcite; 20-40% biotite; 0-20% chlorite; decreasing with depth; 3% K-feldspar phenocrysts(?) and felsic fragments; 10-30% quartz, with local silicification(?); 5% pyrite and pyrrhotite, trace chalcopyrite; and up to 30% argillic altered feldspar(?). Similar to other tuffs but mica recrystallization slightly coarser. Weak schistosity almost parallel to core axis. If breccia was tectonic, recrystallization has obscured deformational fabric.

430.1′-601.5′ Predominantly green-gray, fine-medium-grained andesitic-dacitic semischistose tuffs, tuffaceous metasediments and minor sulfide-graphitic argillite iron formation. Typically chloritic, argillitic and somewhat calcareous; with quartz-calcite felsic fragments and plagioclase, quartz phenocrysts. Mode similar to above unit but with varying sulfide-graphitic argillite component and locally laminated in 430.1′-522.3′. Interval 522.3′-590.6′ is a tuff with little graphitic argillitic dilution. Interval 590.6′-601.5′ is a fine-coarse-grained, light-medium grey calcareous, tuffaceous, siliceous sandstone.

Unit is recrystallized, with flattening-shearing. Fabric is semi-schistose, locally phacoidal. Local boudinage and brecciation. Veining is very minor, quartz, calcite, pyrite. Sulfide amounts vary from 2-20% (average 5-7%) pyrite and trace-1/2%(?) chalcopyrite. Sulfides disseminated. Bedding occurs at various angles to core axis. Orientation of sheet silicates (schistosity) roughly 65° to core axis.

601.5′-848.4′ Black graphitic argillite and sulfide iron formation with locally tuffaceous intervals. Textures grade from laminated to folded to brecciated intervals. Much flowage. Locally phyllitic. Argillite often slightly tuffaceous. Local scattered coarse-grained intraclasts-tuff fragments. Unit contains laminae of syngenetic sulfides (up to 60% of rock). Pyrrhotite predominates, with pyrite replacement 747′-793′ and 820′-848.8′. Minor sulfide oxidation below 820′. Trace chalcopyrite. Locally broken 834′-844′ with minor veinlets of pyrrhotite, pyrite, chlorite, calcite, chalcopyrite(?) and bornite(?). 720′-722′ is quartz-pyrrhotite-calcite-pyrite-chalcopyrite vein. Other smaller scattered masses-attenuated veins 654′-678′.
Bedding occurs at all angles to core axis, while schistosity and shearing typically run 0-30° to core axis. Crystalline, shiny graphite often occurs on slip surfaces and slickensides.

848.4′-1008′ T.D. Interbedded black graphitic argillite-sulfide iron formation, green-grey tuffs and light grey siliceous tuffaceous sandstone. Scattered lamination of lithotypes occur within each other. Iron formation similar to above unit (up to 60% sulfide), but gets more calcareous toward base. Tuffs and tuffaceous sandstone varies from green, more chloritic, to light grey, more siliceous coarser volcaniclastic-clastic. These beds contain up to 10% pyrite-pyrrhotite. Some of the more quartz-rich areas may be recrystallized cherts, or siliceous tuffs (namely 898′-899.7′ 905.6′-906.3′, 907′-907.6, 987′-989′). Other tuff beds with local very coarse lapilli-agglomerate are 848.4′-869′, 928′-938.1′ 945′-963.5′ with scattered laminae, 982.5′-983.6′ and 991.8′-1006.1′. Other intervals are graphitic argillite-sulfide iron formation. Below 873′ unit contains scattered 1-

3 mm chloritic-calcareous fragments, with porphyroblastic growth(?).
Unit locally folded. Tuffs below 902′ have local strain slip cleavage, 0-15° from core axis.

Acid Test Results

Footage	Angle of Hole from Horizontal	Bedding Angle with Core Axis	Schistosity Angle with Core Axis
50	40	22	26
500	43	13?	13
792	46	45	45
1008	44	54	54

Notes: Twenty-six thin section heels have been cut. Forty-nine composite and thirteen individual samples have been assayed for gold. Analytical results follow in Table A-2. Detailed log is available for study.

CONDENSED GEOLOGIC LOG FOR DDH A-5

Hole drilled at a 45° angle and an azimuth of 150°.

0′-200′ Overburden.

200′-280′ No Core.

280′-430′ Dark grey pyritic siltstone. Somewhat phyllitic. Often laminated. Very slightly sideritic-calcareous. Core is locally broken and locally has limonite staining. Rock contains 1-5% pyrite, with higher amounts in 301′-310′, 312′-322′, 330′-337′, 367′-368′, 392′-430′. Minor weathered out grains-crystals smaller than 1 mm (carbonate? sulfides? evaporites??). White, siliceous, fine-grained sand laminae in basal 20′. Bedding measures 0-40° to core axis. Schistosity and tight fold axial planes measure 65-70° to core axis.

430′-463′ Dark-light grey siltstone grading into laminated siliceous (chert-chamosite) iron formation. Somewhat sideritic laminated and pyritic (to 5%) in basal 30′. Both contacts have laminations with 50% dissolved out crystals. Basal 16′ contains intraclastic conglomerate or boundinaged laminae.

463′-547.7′ Laminated chamosite-stilpnomelane(?)-chert iron formation. Typically dark green-light grey. Iron silicate to chert ratio equals about nine. Core locally broken. Laminae with dissolved out grains decrease downward. Magnetite lamina at 513.2′. Locally sideritic in laminae and few, thin veins. Locally several % (largely syngenetic) pyrite. This occurs as disseminations in chert (locally migrated toward chert rims), and in thin scattered veinlets. Quartz-siderite veinlets also scattered. Most veins late, except 3 mm quartz vein with grunerite margins at 532.9′. Local coarse-grained clastic laminae at 471′.

547.7′-811.3′ Laminated-bedded, black-green-white, magnetite-chamosite-chert iron formation with lesser stilpnomelane and siderite. Unit contains roughly 18% magnetite laminae (varies from 0% to 40% locally); 13% chert-siderite laminae (varies from 0%-40% locally); and 69% chamosite-stilpnomelane laminae (varies from 0%-95% locally). Below 622′, lighter colored beds are more sideritic, less cherty. Basal 40′ is fairly sideritic (20%?, with some as porphyroblasts) and slightly graphitic. 799.8′-800.1′ and 804.4-804.7′ is black, somewhat vuggy and leached(?). These intervals and scattered intervals below 703.5′ have white crystals (sulfates) growing on core. Local load casting and soft sediment deformation. Laminae truncate others at 711′ (younging downhole?). Basal 17′ with disrupted beds-brecciation. Minor dissolved out grains 615.8′-616.4′. Bedding subparallel to flowage with associated en echelon fractures (and quartz-siderite veins) increasing downward. Local bed disruption-brecciation in basal 16′. Minor quartz-siderite ± pyrite ± calcite veins locally throughout.

811.3′- 827′ Brecciated, silicate iron formation (above 819′) grading into sulfide iron formation (below 819′). 811.3′-819′ largely interbedded green chamositic(?) and white-light grey cherty iron formation. Brecciated, with deformation increasing downward. Chert tends to behave more brittley, while iron silicates flow. Unit contains local disrupted argillite fragments-laminae (less ductile than iron silicates). Chert and disseminated-laminated pyrite (0-7%) increase downward. Minor pyrite, quartz, siderite veins. Unit 10% siderite in general. Chert may be clastic.
819′- 827′ deformed, medium-dark grey-brown siliceous pyritic argillite (sulfide iron formation) with minor chert. Brecciated at top, grading into rock with much flattening (mylonitic) and flowing. Locally recrystallized-silicified. Local chert, solutioned out crystals, and/or poor core recovery. Pyrite varies from 7% to 25% as very fine-grained pyritic mud; scattered, coarse, deformed crystals; and minor pyrite veinlets.

827′-1332′ T.D. Black, sulfide iron formation (pyritic-graphitic argillite). Both pyrite and graphite decrease with depth, while rock becomes more sideritic, clastic, siliceous, and lighter colored. Local very coarse-grained graded beds become finer downhole. Rock is somewhat phyllitic with generally conformable bedding and moderately developed schistosity. Slip laminae, flattening and boudinage are common, with scattered, local, minor fold closures. Pyrite ranges from 50% at top of unit to 7% at base. Pyrite occurs as syngenetic laminations (some brecciated-vuggy); disseminations; local very coarse-grained concretionary(?) masses, with a slight green tinge (marcasitic appearing), minor gypsum growth on core; and minor cross-cutting pyrite-sideritic veinlets.

Table A-2

D.D.H. A-2

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	footage	Au PPB	Sample#	Footage	Au PPB
C-A-15341	52.0- 54.0	<5	C-A-15364	609.8-613.0	5
C-A-15447	119.8-132.0	10	C-A-15368	616.0-619.5	<5
C-A-15454	132.0-144.0	<5	C-A-15372	627.0-632.0	10
C-A-15342	155.0-159.0	<5	C-A-15652	634.0-646.0	5
C-A-15461	159.0-165.0	<5	C-A-15659	668.0-680.0	<5
C-A-15465	182.0-194.0	<5	C-A-15378	691.0-692.0	5
C-A-15472	194.0-206.0	35	C-A-15379	703.0-704.0	5
C-A-15479	206.0-218.0	<5	C-A-15666	704.0-718.0	<5
C-A-15486	218.0-230.0	<5	C-A-15380	720.0-722.0	<5
C-A-15493	260.0-272.0	<5	C-A-15674	728.0-740.0	<5
C-A-15550	288.0-302.0	<5	C-A-15383	740.0-742.0	<5
C-A-15528	302.0-314.0	<5	C-A-15386	753.0-758.0	10
C-A-15347	314.0-315.0	<5	C-A-15681	758.0-769.0	<5
C-A-15535	330.0-344.0	<5	C-A-15392	769.0-772.0	<5
C-A-15543	358.0-372.0	<5	C-A-15396	784.0-788.0	5
C-A-15559	375.0-387.0	<5	C-A-15401	800.0-803.0	10
C-A-15348	387.0-392.0	<5	C-A-15410	811.0-813.0	10
C-A-15566	392.0-402.0	10	C-A-15688	832.0-844.0	10
C-A-15572	402.0-414.0	<5	C-A-15695	844.0-852.0	10
C-A-15579	428.0-440.0	15	C-A-15411	852.0-853.5	<5
C-A-15586	451.0-463.0	<5	C-A-15700	864.0-876.0	<5
C-A-15354	463.0-466.0	<5	C-A-15412	878.0-879.0	10
C-A-15405	466.0-469.0	<5	C-A-15413	899.0-901.0	<5
C-A-15593	469.0-474.0	<5	C-A-15707	902.0-912.0	15
C-A-15358	474.0-478.0	<5	C-A-15414	923.0-924.0	10
C-A-15596	478.0-486.0	<5	C-A-15713	924.0-936.0	<5
C-A-15615	518.0-532.0	5	C-A-15415	946.0-948.0	<5
C-A-15623	558.0-572.0	<5	C-A-15720	948.0-960.0	5
C-A-15631	572.0-584.0	5	C-A-15416	961.5-963.5	<5
C-A-15645	590.0-602.0	<5	C-A-15727	982.0-992.0	5
C-A-15363	605.0-606.0	<5	C-A-15417	992.0-993.0	<5

Acid Test Results

Footage	Angle of Hole from Horizontal	Bedding Angle with Core Axis	Cleavage Angle with Core Axis
300	46	62	65
540	44	43	43(?)
780	42	41	46
990	35	23	68
1320	29	52	77

Notes: Twenty-six thin section heels have been cut. Sixty composite and individual samples have been sent in for analysis. Analytical results follow in Table A-5. Detailed log is available for study.

CONDENSED GEOLOGIC LOG FOR DDH RR-2

Hole drilled at a 43° angle and an azimuth of 348°.

0′-11′ Overburden.

11′-553′ T.D. Pale to dark brown, siliceous biotite-garnet schist and semi-schist. Rock is typically very fine-fine grained. Recrystallized. Unit contains numerous white to pale brown, more siliceous laminae and thin beds; and fewer thin (3 cm) green chloritic, tuffaceous layers. Unit as a whole is believed to be metasediments (tuffaceous) and locally contains 1-4 mm relict quartz-plagioclase volcaniclasts. Mode of darker bands: 20-40% biotite, muscovite, phlogopite; 40-65% quartz; 0-25% pink garnets; 5% plagioclase; and a trace of carbonate. Mode of paler brown bands: 50-75% quartz; 5-50% plagioclase (sodic); 0-20% pink garnet; 5-10% biotite (and other micas); 1% chlorite; and a trace of carbonate. Unit contains 1/2-5% pyrite and 0-1/2% chalcopyrite, in veins, minor veinlets and as disseminated grains. Unit contains local, deformed, irregular milky-white quartz veins and bursts. There appear to be several cross-cutting sets of these, with thicknesses up to 2 1/2′. Besides quartz, these veins and bursts contain local vugs, biotite, chlorite, pyrite, yellow muscovite, garnet, calcite, epidote, plagioclase, and bent-brecciated tourmaline. More siliceous (less ductile) laminae-beds are often cut by hairline fractures with minor chloritization, carbonatization, and albitization(?). These internal fractures form-pseudobreccia patterns. Unit also contains minor veinlets with red fluorescent calcite. Other pseudobreccia intervals are associated with local brecciation and thin ultramylonites. Breccia zones also have associated chloritic-argillitic alteration and are typically garnet free. Fabric of bedding is generally subparallel to schistosity, with local minor folds and kinks. Rock is much flattened and has local boudinage. Recrystallization appears to have subdued schistosity locally to form a semischistose fabric. It has also healed the fracturing-brecciation of the rock, even though core is locally broken. Local graded beds occur but recrystallization makes younging direction difficult to determine.

Acid Test Results

Footage	Angle of Hole from Horizontal	Bedding-Schistosity Angle with Core Axis
300	31	50
553	33	57

Notes: Thirty-three thin and polished thin sections have been made and are available for study. Forty-two composite and individual core samples and rock samples have been sent in for analysis. Analytical results follow in Table RR-2. Compared with DDH RR-1, rock in RR-2 is much more uniform. Detailed lithologic and structural log are available for study.

CONDENSED GEOLOGIC LOG FOR DDH RR-1

Drilled at a 48° angle and an azimuth of 180°.

0′-6′ Overburden.

6′-329.8′ Interbedded intermediate-felsic-mafic metatuffs, tuffaceous greywacke, and magnetite laminations. Rock is now fine to medium-grained semi-schist-schist, with much flattening, folding and local breccia. Moderate to well developed schistosity subparallels bedding. Volcanic fragments locally coarse lapilli-agglomerate originally.

Mode of intermediate-mafic metatuff (grey-green): 25-40% mafics and alteration products (chlorite, actinolite, hornblende); 5% quartz-carbonate veins; 40% quartz-carbonate veinlets or compositional laminae; 15-30% quartz-carbonate-plagioclase (more felsic component of groundmass).

Mode of intermediate-felsic metatuff (brown-grey) similar to above except only 10-30% mafics and alteration products; and 15-45% felsic component. Sheet silicates largely sericite-biotite.

Mode of the intermediate tuff-tuffaceous greywacke (green-grey): 10-30% chlorite; 10-30% biotite; 10-20% muscovite; 20-40% quartz; 10-15% plagioclase; 10-20% actinolite; and 0-5% carbonate.

Intermediate-mafic tuff intervals are 6′-13.5′ and 33.5′-35.5′. Felsic-intermediate tuff is from 13.5′-18.0′. Other intervals predominantly intermediate metatuffs. Local scattered 1 mm magnetite grains (up to 5% of rock) and 1-10 mm dark green hornblende phenocrysts(?)-porphyroblasts (up to 10% of rock) from 35.5′-271.5′. Magnetite and hornblende appear to vary antithetically (on the small scale). Laminae with up to 80% magnetite occur in close proximity to

Table A-5

D.D.H. A-5

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample#	Footage	Au PPB	Ag PPM	Bi PPM	Te PPM	As PPM	Sb PPM	Fe PCT	V PPM	Cr PPM	Co PPM	Ni PPM	Cu PPM	Zn PPM	Pb PPM	Sn PPM	U PPM	Mo PPM	Cd PPM	Mn PPM	W PPM	Se PPM
C-A-15095	300.0-310.0	35	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15101	428.0-442.0	10	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15109	452.0-463.5	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15033	463.5-465.3	(5	0.5	2	(10	(5	(5	)10.0	75	90	8	45	90	170	30	(10	(10	5	5	300	(10	(5
C-A-15034	465.3-467.0	(5	(0.5	2	(10	(5	(5	)10.0	55	65	6	25	130	110	55	(10	(10	8	4	1100	(10	(5
C-A-15115	467.0-479.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15122	479.0-491.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15129	502.0-512.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15135	512.0-522.0	10	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15035	522.0-523.0	(5	(0.5	4	(10	(5	(5	10.0	10	75	3	4	20	40	70	(10	(10	5	4	550	(10	(5
C-A-15141	528.0-542.2	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15036	542.2-542.7	(5	0.5	(2	(10	(5	(5	)10.0	45	30	9	20	300	60	60	(10	(10	11	8	600	10	(5
C-A-15149	546.0-556.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15155	556.0-566.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15161	566.0-576.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15037	597.0-598.0	(5	0.5	(2	(10	(5	(5	)10.0	25	60	5	7	50	55	50	(10	(10	11	10	450	(10	(5
C-A-15167	601.0-611.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15173	612.0-622.0	10	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15179	652.0-662.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15185	662.0-672.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15191	672.0-686.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15199	686.0-698.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15206	732.0-742.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15212	742.0-752.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15218	752.0-762.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15224	762.0-772.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15230	772.0-782.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15236	782.0-792.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15242	792.0-802.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15248	802.0-807.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15038	807.0-812.0	(5	(0.5	(2	(10	(5	(5	)10.0	20	35	5	7	30	35	35	(10	(10	7	8	1650	10	(5
C-A-15044	812.0-817.0	(5	(0.5	(2	(10	10	(5	)10.0	40	60	2	6	40	90	50	(10	(10	6	7	2200	(10	(5
C-A-15050	817.0-820.5	5	(0.5	(2	(10	170	(5	5.7	70	85	5	10	50	550	35	(10	(10	(1	2	300	(10	(5
C-A-15054	820.5-821.0	(5	(0.5	2	(10	15	(5	3.7	160	85	3	10	30	1700	20	(10	(10	2	5	190	10	(5
C-A-15055	821.0-826.0	5	0.5	(2	(10	130	(5	8.6	190	65	15	45	45	1150	95	(10	(10	11	5	250	(10	(5
C-A-15056	826.0-827.0	(5	(0.5	2	(10	450	(5	9.4	300	55	45	55	75	2800	55	(10	(10	15	9	350	40	(5
C-A-15252	827.0-829.3	10	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15057	829.3-829.8	25	1.0	8	(10	45	(5	)10.0	180	75	75	150	250	45	55	(10	(10	20	6	170	20	5
C-A-15253	829.3-832.0	10	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15058	832.0-832.8	5	(0.5	(2	(10	200	(5	8.0	140	65	15	60	120	400	25	(10	(10	15	4	400	20	(5
C-A-15254	832.8-836.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15059	836.0-836.5	(5	(0.5	6	(10	15	(5	)10.0	110	120	11	130	200	65	25	(10	(10	15	3	250	(10	(5
C-A-15257	836.8-848.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15060	857.1-857.9	10	(0.5	4	(10	500	(5	)10.0	60	85	25	70	160	450	60	(10	(10	13	7	700	10	(5
C-A-15264	862.0-874.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15271	902.0-912.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15277	932.0-943.6	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15061	943.6-944.6	(5	(0.5	(2	(10	35	(5	)10.0	10	55	35	40	200	650	25	(10	(10	6	5	2600	(10	(5
C-A-15284	982.0-992.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15290	1012.0-1022.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15296	1042.0-1052.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15302	1082.0-1092.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15062	1127.2-1127.7	(5	(0.5	(2	(10	10	(5	)10.0	90	65	35	50	180	300	30	(10	(10	9	4	2800	10	(5
C-A-15063	1136.2-1136.6	(5	(0.5	4	(10	(5	(5	)10.0	35	35	3	7	120	15	(5	(10	(10	12	9	6400	(10	(5
C-A-15308	1136.6-1142.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15312	1151.0-1151.8	10	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15064	1172.0-1174.0	10	(0.5	2	(10	60	(5	)10.0	20	65	35	45	300	40	25	(10	(10	6	5	2000	(10	(5
C-A-15313	1190.0-1204.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15321	1280.0-1292.0	5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--
C-A-15328	1312.0-1322.0	(5	---	--	---	--	--	----	---	--	--	--	---	---	--	---	---	--	--	----	---	--

Table RR-2

D.D.H. RR-2

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Au PPB	Ag PPM	Bi PPM	Te PPM	As PPM	Sb PPM	Fe PCT	V PPM	Cr PPM	Co PPM	Ni PPM	Cu PPM	Zn PPM	Pb PPM	Sn PPM	Mo PPM	Cd PPM	Mn PPM	U PPM	W PPM	Se PPM
K-12928	38.0-40.0	100	<0.5	<2	<10	<5	5	0.7	18	150	5	9	42	53	55	<10	2	<1	248	<10	<10	8
K-12929	47.5-50.0	40	<0.5	<2	<10	<5	<5	4.0	96	254	20	62	77	113	93	<10	4	<1	732	<10	<10	<5
K-12930	57.5-60.0	10	<0.5	<2	<10	<5	<5	1.7	46	223	9	31	59	46	22	<10	1	<1	305	<10	<10	12
K-12931	95.5-96.5	10	<0.5	<2	<10	<5	<5	5.6	137	325	24	97	47	154	50	<10	<1	<1	1088	<10	<10	7
K-13928	107.0-112.0	<5	<0.5	<2	<10	<5	<10	2.9	80	120	15	80	50	55	40	<10	3	<1	400	<10	<10	<5
K-12932	120.5-123.0	5	<0.5	<2	<10	<5	<5	5.2	125	345	25	105	52	96	48	<10	3	<1	790	<10	<10	<5
K-12933	142.0-144.0	<5	<0.5	<2	<10	<5	<5	4.6	115	224	22	74	56	86	29	<10	3	<1	750	<10	<10	<5
K-12934	158.0-160.0	<5	<0.5	<2	<10	<5	<5	4.5	112	283	22	72	76	79	26	<10	2	<1	732	<10	<10	<5
K-12935	222.5-224.5	<5	<0.5	<2	<10	<5	<5	4.9	116	219	23	74	60	90	26	<10	53	<1	676	<10	<10	5
K-13933	239.6-243.0	<5	<0.5	<2	<10	<5	<10	3.9	130	170	20	90	65	70	40	<10	6	<1	450	<10	<10	<5
K-13936	243.0-245.0	<5	<0.5	<2	<10	<5	<10	4.6	140	160	25	120	60	55	40	<10	5	<1	450	<10	<10	<5
K-12936	256.3-257.3	<5	<0.5	<2	<10	<5	<5	1.0	16	147	4	10	42	57	63	<10	4	<1	258	<10	<10	<5
K-13940	257.3-260.3	<5	<0.5	<2	<10	<5	<10	5.0	160	190	25	110	75	80	40	<10	7	<1	600	<10	<10	<5
K-13944	267.0-270.0	<5	<0.5	<2	<10	<5	<10	3.9	160	180	25	100	85	90	45	<10	7	<1	550	<10	10	<5
K-12937	273.0-274.0	<5	<0.5	<2	<10	<5	<5	4.1	97	222	18	58	50	47	24	<10	5	<1	596	<10	<10	6
K-13948	283.0-286.0	<5	<0.5	<2	<10	<5	<10	4.4	150	180	25	110	70	80	45	<10	7	<1	550	<10	<10	<5
K-12938	291.0-292.5	<5	<0.5	<2	<10	<5	<5	4.8	120	244	21	69	55	96	25	<10	4	<1	696	<10	<10	<5
K-12939	294.5-297.0	<5	<0.5	<2	<10	<5	<5	4.8	114	221	22	71	54	51	22	<10	3	<1	636	<10	<10	<5
K-12940	300.0-302.0	<5	<0.5	<2	<10	<5	<5	5.0	122	230	22	72	53	92	28	<10	4	<1	845	<10	<10	8
K-13953	308.0-312.0	<5	<0.5	<2	<10	<5	<10	4.4	160	200	25	120	70	85	40	<10	7	<1	550	<10	<10	<5
K-12941	323.0-325.4	10	<0.5	<2	<10	<5	<5	2.0	46	154	9	29	21	42	33	<10	1	<1	749	<10	<10	<5
K-13958	325.4-328.4	<5	<0.5	<2	<10	<5	<10	4.4	110	200	20	100	65	70	35	<10	6	<1	550	<10	<10	<5
K-12942	335.0-336.5	<5	<0.5	<2	<10	<5	<5	4.7	129	222	23	76	61	87	28	<10	4	<1	761	<10	<10	<5
K-12943	343.0-344.0	<5	<0.5	<2	<10	<5	<5	5.9	149	370	25	84	22	63	12	<10	2	<1	958	<10	<10	<5
K-13306	348.0-352.0	<5	<0.5	<2	<10	<5	<10	3.0	80	190	20	85	55	65	35	<10	3	<1	400	<10	<10	<5
K-12944	353.0-355.5	<5	<0.5	<2	<10	<5	<5	5.3	130	254	23	74	67	89	27	<10	4	<1	800	<10	<10	<5
K-13962	356.1-358.9	<5	<0.5	<2	<10	<5	<10	3.8	110	180	20	140	60	65	30	<10	7	<1	500	<10	<10	<5
K-12945	367.5-370.0	<5	<0.5	<2	<10	<5	<5	3.7	89	198	17	56	50	75	24	<10	2	<1	538	<10	<10	<5
K-12946	398.8-401.1	<5	<0.5	<2	<10	13	<5	3.4	88	253	16	51	38	45	17	<10	2	<1	360	<10	<10	<5
K-12947	416.3-418.0	<5	<0.5	<2	<10	7	<5	5.2	115	387	27	149	43	99	33	<10	4	<1	937	<10	<10	<5
K-13311	419.0-423.0	<5	<0.5	<2	<10	<5	<10	5.4	130	350	25	300	30	200	75	<10	4	1	900	<10	<10	<5
K-13423	444.0-450.0	<5	<0.5	<2	<10	<5	<10	4.3	110	160	25	110	75	95	50	<10	5	<1	550	<10	<10	<5
K-12948	461.0-462.0	<5	<0.5	<2	<10	<5	<5	4.4	101	254	19	57	63	65	29	<10	4	<1	1013	<10	<10	<5
K-13428	465.0-469.1	<5	<0.5	<2	<10	<5	<10	4.4	95	190	25	120	85	120	50	<10	4	<1	550	<10	<10	<5
K-13433	469.1-473.0	<5	<0.5	<2	<10	<5	<10	3.9	105	140	20	100	70	80	45	<10	5	<1	550	<10	<10	<5
K-13439	474.4-481.0	<5	<0.5	<2	<10	<5	<10	3.5	85	150	20	95	60	70	40	<10	3	<1	450	<10	<10	<5
K-12949	488.5-490.2	<5	<0.5	<2	<10	12	<5	4.5	114	223	21	67	58	78	30	<10	3	<1	752	<10	<10	<5
K-12950	491.5-493.0	<5	<0.5	<2	<10	<5	<5	6.2	141	342	32	151	64	129	29	<10	4	<1	1153	<10	<10	<5
K-12451	519.5-521.0	<5	<0.5	<2	<10	<5	<5	4.4	109	234	20	69	46	66	28	<10	1	<1	688	<10	<10	<5
K-13450	528.0-533.0	<5	<0.5	<2	<10	<5	<10	3.8	90	150	20	95	65	70	40	<10	3	<1	500	<10	<10	<5
K-13455	541.0-545.0	5	<0.5	<2	<10	<5	<10	3.5	75	140	15	100	50	55	40	<10	2	<1	400	<10	<10	<5

Ranier Area Rock Samples (Bondar Clegg, North Vancouver, B.C.)

Sample #	Location T-R-S	Au PPB	Ag PPM	Bi PPM	Te PPM	As PPM	Sb PPM	Fe PCT	V PPM	Cr PPM	Co PPM	Ni PPM	Cu PPM	Zn PPM	Pb PPM	Sn PPM	Mo PPM	Mn PPM	Cd PPM	U PPM	W PPM	Se PPM
R-K-12088	70-23W-5	35	0.6	<2	15	<5	<5	13.6	194	456	22	128	268	136	21	<10	3	2313	<1	<10	<10	<5
R-K-12447	70-23W-5	<5	<0.5	<2	<10	<5	<5	7.1	160	385	23	83	51	114	19	<10	4	1224	<1	<10	<10	<5
R-K-12448	70-23W-5	<5	<0.5	<2	<10	<5	<5	1.8	62	319	7	26	24	35	7	<10	<1	234	<1	<10	<10	<5
R-K-12449	70-23W-5	<5	0.7	<2	<10	7	<5	0.9	18	228	3	21	4	29	8	<10	<1	113	<1	<10	<10	<5
R-K-12450	70-23W-3	<5	<0.5	<2	<10	5	<5	2.8	74	277	9	36	29	49	13	<10	3	267	<1	<10	<10	<5
R-K-12451	70-23W-3	<5	<0.5	<2	<10	<5	<5	4.1	126	263	17	55	33	73	18	<10	3	502	<1	<10	<10	6
R-K-12452	70-23W-3	5	<0.5	<2	<10	11	<5	1.6	36	283	5	15	23	29	9	<10	3	237	<1	<10	16	<5
R-K-12453	70-23W-3	<5	<0.5	<2	<10	<5	<5	2.1	46	242	6	21	29	28	18	<10	<1	796	<1	<10	16	11
R-K-12454	70-23W-3	10	<0.5	<2	18	<5	<5	9.4	244	118	33	43	12	139	19	<10	4	4244	<1	<10	<10	5
R-K-12455	70-23W-3	<5	<0.5	<2	<10	<5	<5	1.9	36	269	6	23	30	27	14	<10	<1	218	<1	<10	28	<5
R-K-12456	70-23W-3	<5	<0.5	<2	<10	<5	<5	3.4	67	244	11	26	61	60	20	<10	<1	958	<1	<10	<10	<5
R-K-12457	70-23W-3	<5	<0.5	<2	<10	<5	<5	4.9	152	309	21	67	59	90	18	<10	2	560	<1	<10	<10	<5
R-K-12681	70-23W-3	<5	<0.5	<2	11	<5	7	7.4	274	423	49	204	89	105	12	<10	4	2559	<1	<10	<10	<5
R-K-12682	70-23W-8	<5	<0.5	<2	<10	<5	6	2.0	52	231	6	23	29	25	13	<10	<1	349	<1	<10	<10	<5
R-K-12683	70-23W-8	5	<0.5	<2	<10	<5	9	4.0	99	276	12	45	35	62	19	<10	4	553	<1	<10	<10	<5

Ranier Area Rock Samples (X-Ray Assay Laboratories)

Sample #	Au PPB	Ag PPM	Sample #	Au PPB	Ag PPM
R-K-12208	3	<0.5	R-K-12733	<2	0.5
R-K-12209	10	0.5	R-K-12734	<2	<0.5
R-K-12210	<2	<0.5	R-K-12735	<2	1.0
R-K-12211	<2	0.5	R-K-12736	<2	<0.5
R-K-12212	<2	<0.5	R-K-12737	<2	0.5
R-K-12213	<2	0.5	R-K-12738	<2	<0.5
R-K-12214	<2	<0.5	R-K-12739	5	<0.5
R-K-12215	<2	<0.5	R-K-12740	2	0.5
R-K-12216	19	<0.5	R-K-12741	<2	0.5
R-K-12217	33	<0.5	R-K-12742	<2	<0.5
R-K-12688	<2	<0.5	R-K-12743	<2	0.5
R-K-12723	<2	0.5	R-K-12744	5	<0.5
R-K-12724	<2	1.0	R-K-12745	2	0.5
R-K-23725	<2	0.5	R-K-12746	<2	0.5
R-K-12726	<2	1.0	R-K-12747	3	0.5
R-K-12727	<2	<0.5	R-K-12748	<2	1.0
R-K-12728	3	1.0	R-K-12749	4	0.5
R-K-12729	<2	<0.5	R-K-12750	<2	<0.5
R-K-12730	15	0.5	R-K-12751	<2	0.5
R-K-12731	7	0.5	R-K-12752	<2	0.5
R-K-12732	<2	0.5			

felsic tuff intervals from 271.5′-329.8′ and is fairly magnetic. This interval also contains hornblende phenocrysts-porphyrobasts.
Veining is relatively ubiquitous, comprises 5% of the rock, and contain the following minerals: quartz, calcite, ankerite, pyrite, pyrrhotite, chalcopyrite, chlorite, muscovite, and K-feldspar. Veins are often brecciated-deformed-irregular. Some appear to be bursts where tension openings have sucked in the mineralogy of the surrounding rock. Several sets of veins appear to be present. Sulfides of unit consist of trace-5% pyrite and pyrrhotite, and up to 1/2% chalcopyrite. Basaltic dike from 184.2′-186.3′.

329.8′-477′ Grey brown and green grey, fine-medium grained mica schist-semi-schist. Generally intermediate-felsic metatuff with irregular laminations. Similar to previous unit, except it is more biotitic-sericitic, calcareous, less chloritic-amphibolitic, with this trend progressing with depth. Rock is much flattened, with local brecciation, fold closures, and broken core. Unit contains local magnetite grains, hornblende phenocrysts-porphyroblasts, and almandine garnets (predeformation). Unit contains 5-10% veins with the following minerals: quartz, calcite, ankerite, chlorite, biotite, muscovite, and K-feldspar. Unit also contains intervals cross-cut by hairline fractures with associated sericitic(?)-argillic alteration. Unit contains largely disseminated 1-5% pyrite-pyrrhotite, and up to 1% chalcopyrite. Coarse lapilli are locally found.

477′-764.3′ Fine-medium grained, medium-dark brown, grey brown to pale green-grey (altered) quartz eye schist-semi-schist. Strained, blue quartz eyes 1-2 mm are set in a siliceous-micaceous matrix with biotite, sericite, talc, actinolite, plagioclase, and local chlorite. Very little carbonate excluding veins (1-2% average). Original rock was laminated dacite-rhyodacite(?) tuff (with minor andesite) containing local coarse lapilli, and flattened, sericitized glass shards(?). Unit has much flattening, with local kink banding, folds, brecciation, and cross-cutting hairline fractures with light green (sericite(?) epidote(?), actinolite(?), chlorite(?) alteration. Other veining minor compared to previous units. Vein mineralogy includes quartz, ankerite, chlorite, biotite, muscovite, pyrite, plagioclase, K-feldspar, and minor calcite. Pyrite is less than 1% (disseminated), except in veins and more mafic intervals (to 2%). Chalcopyrite is a trace at most except for 1/2-1% in more mafic (chloritic) intervals.

764.3′-922.9′ Fine-grained, interbedded interlaminated, pale to medium grey green-grey brown-green semi-schist and schist. Major mineralogy of unit is biotite, chlorite, quartz, hornblende, sericite, plagioclase, carbonate, and actinolite. Original rock was tuffaceous clastic and felsic to intermediate tuffs that become more mafic with depth. Rock is much flattened, with local fold closures that are often disharmonic, are brecciated, and have sheared limbs. Rock fabric changes from a well developed planar schistosity (non brecciated rock) at the top of the unit, to a less well developed linear fabric (brecciated rock). Unit is also recrystallized which obscures the deformational fabric. Unit locally contains quartz eyes, magnetite blebs-laminae, and locally is very amphibolitic. Veining is fairly minor, with the following mineralogy: quartz, ankerite, calcite, biotite, plagioclase, pyrite, and hornblende. Sulfides are less than 2%, and is predominantly pyrite in the veins. Some of the sulfide are blebby pyrrhotite and minor chalcopyrite.

922.9′-958.1′ Fine-grained, medium-dark green-grey green chlorite-talc-biotite-plagioclase-sericite, somewhat siliceous schist. Original rock was mafic-intermediate (andesitic?) tuff. Rock has good planar fabric. Unit contains attenuated laminae and/or coarse-grained clasts, with 1/2-2% pyrite-pyrrhotite and 1/4-1/2% chalcopyrite interstitially (slightly magnetic). Local veins and quartz-biotite-pyrite masses make up 5% of rock.

958.1′-996.5′ Fine-medium grained, light-medium grey siliceous schist-semi-schist with sericite, biotite, and plagioclase. Originally siliceous greywacke(?). Unit contains minor quartz eyes, brecciation, and fold closures. Planar fabric weakly predominates over linear fabric. Unit contains little carbonate.

996.5′-997.5′ Fine-grained, medium-dark, yellow green, altered oxide-sulfide bearing metapicrite(?) dike. Mode: 5% pyrite-pyrrhotite; 5% magnetite; 15% quartz-ankerite veins; 75% serpentinized, epidotized(?) olivine(?). Unit fairly magnetic. Unit biotitic at contacts.

997.5′-1006.5′ Light to medium grey siliceous schist breccia-pseudobreccia fragments (with some orientation); generally subangular-abraded, with poorly developed slickensides, and sizes up to 6 cm. Rock is recrystallized, and also contains local mylonite. Sulfides in pseudobreccia fractures increase with depth (up to 1% chalcopyrite, up to 5% pyrite-pyrrhotite). Rock fragment lithology appears similar to 958.1′-996.5′.

1006.5′-1295′ Fine-grained, medium-dark brown, green, and grey to pale grey-white, interbedded-interlaminated semi-schist. Lithologies similar to previous lithologies. Rock is recrystallized, and fairly massive without good foliation in general. Original rock was clastics, volcaniclastics, and possible dikes or flows. Unit locally contains breccias, magnetite grains and laminations, good lineation, fold closures, coarse lapilli, non magnetic oxides, and black chert. Bedding tends to exist, on the average, at a shallower angle to the core axis than previous units. Quartz bursts and veins, locally with ankerite, calcite, biotite, hornblende, pyrite, actinolite, and tourmaline are fairly ubiquitous although mineralogy varies. Unit contains trace-1% chalcopyrite, and 1/2-5% pyrrhotite-pyrite. Sulfides occur as disseminations, and in laminae with oxides. Concentrations tend to be higher in chloritic, more mafic intervals.

1295′-1312′ Fine-medium grained, green chloritic-amphibolitic schist with minor siliceous laminae, and hornblende porphyroblasts, which increase with depth. Fabric becomes less planar, more linear-mylonitic with depth. Rock is recrystallized. Sulfides (1/4-3% pyrite, and trace chalcopyrite) less evenly distributed than normal. This includes a vuggy, brecciated quartz vein with pyrite cement at 1303.7'-1304'. Other veins-bursts are calcite, ankerite, and quartz.

1312'-1602' T.D. Fine-medium grained, interlaminated-interbedded grey brown, brown grey, white, and green semi-schists. Original lithologies similar to previous units. Rock is recrystallized, and relatively massive. Rock structurally contains local breccia, pseudobreccia, and fold closures which are often sheared, jumbled, and/or complexly deformed with inconsistent orientations. Rock lithologically contains local garnets, and fragments with hornblende and tourmaline. Veins and bursts are typically irregular-deformed, and include the following mineralogy: quartz, ankerite, calcite, and minor sulfides. Unit contains 1/4-3% pyrite-pyrrhotite (with less pyrite and more pyrrhotite with depth), and trace-1/2% chalcopyrite.

Acid Test Results

Footage	Angle from Horizontal	Bedding Angle with Core Axis	Schistosity Angle with Core Axis
142	41°	35°	35°
542	22 1/2°	70°	70°
862	17°	55°	75°
1590	23°	48°	-

Notes: RR-1 with depth has changed its structural fabric from a more schistose one in which schistosity and bedding are subparallel-superimposed; to a weaker, more linear component (bedding-schistosity are less parallel semi-schistose, and, or shearing has modified the planar fabric found in the upper part of the hole). There are several generations of veins, which along with the fabric, suggest a rather complex deformational-metamorphic history. Rock locally contains garnets and porphyroblastic amphiboles, and may contain sillimanite. Locally chalcopyrite-pyrite-pyrrhotite may oxidize somewhat, leaving anomalous colors that may be confused with free gold. Sixty-one composite and individual samples have been analyzed (see Table RR-1 below). Highest gold values (3560 and 2240ppb) came from intervals (899.4'-900.1', and 1303.5'-1304.0'respectively) containing pyrite cemented brecciated quartz veins. Quartz veins often are brecciated, but they are usually healed with quartz or carbonate. Outcrop and float samples of the area have analytical results reported in Table RR-2. Forty-eight thin and polished sections are available for study, along with lithologic and structural logs.

CONDENSED GEOLOGIC LOG FOR DDH BL-1

The hole was drilled at a 90° angle (vertical).

0'-130' Overburden.

130'-132.4' Fine to medium-grained layered gabbro with pyroxenite lenses oriented at about 80° to the core axis.

132.4'-135' Medium to coarse-grained norite-anorthosite with pegmatoidal aspects. The interval 130'-135' may reflect boulders.

135'-200' Equant microgabbro with faint relicts of layering and lenses of clinopyroxene pegmatoid.

200'-218.5' The same, with contorted coarse-grained to pegmatoid clinopyroxene lenses showing a steady increase of oxide content downwards up to about 30%. Faint layering subparallel to core axis. At 202' bornite and chalcopyrite-bearing clinopyroxene pegmatoid lens occurs almost perpendicular to the core axis. A cataclastic and chloritized granite dike subparallels the core axis and transects at 212'-215.8'.

218.5'-225.9' Oxide-rich equant microgabbro (30-50% oxide) with pegmatoidal clinopyroxene-oxide lenses.

225.9'-235.1' The same with oxide content up to 90% and chalcopyrite + bornite content up to 10% in ultramafic lenses. Intercalation of cataclastic and chloritized diorite subparallel core axis.

235.1'-252.2' Equant microgabbro with oxide content decreasing from 90% downwards to about 30%, with intercalations of an aplite dike up to 2" thick which subparallels to core axis.

252.2'-306.5' Oxide-bearing equant microgabbro (5-15% oxide). At 255.3'-255.8', a cross-cutting coarse-grained granophyric dike occurs about 70° to core axis. Intercalations of disseminated and impregnated bornite-rich spots associated with pegmatoidal clinopyroxenite lenses are found at 287'-292'.

306.5'-321.7' Equant micrograbbro with contorted coarse-grained clinopyroxenite layers and feldspathic pockets and veins.

321.7'-563.0' T.D. Equant microgabbro with pegmatoidal clinopyroxenite, plagioclase lenses and clots, with faint layering subparallel core axis.

Intercalations of granite dikes and veins about 45° to almost parallel to core axis occur at 336.9', 364.9', 388.4'-399.8' and 492'-492.6'. Retrogressive crystallization with chlorite along joints, associated with feldspathic pockets is observed at 339.2'-348.6' and 429.3'-438.8'. Fragmented coarse-grained clinopyroxene veins, represented as clots, are present at 476.2'-501.5'. Intercalations of olivine and chalcopyrite-bearing lenses about 70° to core axis, occur at 455.4'-479.2'.

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ALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

		Au	Ag	Bi	Te	As	Sb	Fe	V	Cr	Co	Ni	Cu	Zn	Pb	Mo	Cd	Mn	U	W	Se	Sn	Hg	Ba
		PPB	PPM	PPM	PPM	PPM	PPM	PCT	PPM	PP	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPB	PPM
C-K-12231	8.1- 13.5	(5	(0.5	(2	(10	(5	(5	7.0	180	267	37	145	19	151	28	1	(1	1648	(10	(10	(5	(10	--	---
C-K-12233	13.5- 18.0	(5	(0.5	(2	(10	(5	(5	6.2	185	89	29	65	78	102	26	(1	(1	1311	(10	(10	(5	(10	--	---
C-K-12234	18.0- 28.5	(5	(0.5	(2	(10	(5	(5	7.0	197	234	36	117	64	114	32	1	(1	1862	(10	(10	5	(10	--	---
C-K-12235	28.5- 33.5	(5	(0.5	(2	(10	(5	(5	6.5	190	274	38	114	68	111	26	1	(1	1542	(10	(10	6	(10	--	---
C-K-12239	45.0- 52.0	(5	(0.5	(2	(10	(5	7	6.7	200	58	30	53	96	97	29	(1	(1	1213	(10	(10	(5	(10	--	---
C-K-12244	54.0- 60.0	(5	(0.5	(2	(10	(5	(5	6.7	200	58	30	54	125	94	30	1	(1	1313	(10	(10	(5	(10	--	---
C-K-12248	103.0-110.4	(5	(0.5	(2	(10	(5	7	7.2	190	237	39	100	66	107	25	(1	(1	2109	(10	(10	(5	(10	--	---
C-K-13917	110.0-112.0	(5	(0.5	(2	(10	5	(10	6.0	200	140	30	120	130	100	15	5	1	1100	(10	10	(5	(10	--	---
C-K-12265	119.0-126.1	(5	(0.5	(2	(10	(5	(5	8.6	200	270	46	156	77	117	32	1	(1	2648	(10	(10	12	(10	--	---
C-K-12259	187.0-192.0	(5	(0.5	(2	(10	(5	(5	6.8	185	265	40	118	35	92	25	(1	(1	1778	(10	(10	7	(10	--	---
C-K-12273	216.0-222.0	(5	(0.5	(2	(10	(5	(5	7.3	205	301	43	134	46	103	25	2	(1	2172	(10	(10	(5	(10	--	---
C-K-13922	239.0-243.0	(5	(0.5	(1	(10	8	(10	9.1	15	130	30	150	70	96	5	6	(1	1850	(10	(10	(20	(10	--	---
C-K-12281	247.5-254.0	(5	(0.5	(2	(10	(5	(5	7.4	205	278	41	104	110	105	24	1	(1	2034	(10	(10	(5	(10	--	---
C-K-12290	276.0-286.2	(5	(0.5	(2	(10	(5	(5	9.0	171	146	36	74	114	100	31	2	(1	2392	(10	(10	(5	(10	--	---
C-K-12303	321.0-327.0	(5	(0.5	(2	(10	(5	7	9.6	170	232	40	106	110	291	32	1	(1	2809	(10	(10	(5	(10	--	---
C-K-12322	376.0-385.0	(5	(0.5	(2	(10	(5	(5	7.0	140	144	22	51	66	75	25	2	(1	2263	(10	(10	(5	(10	--	---
C-K-12311	428.0-436.0	(5	(0.5	(2	(10	(5	(5	6.9	163	142	32	78	144	95	24	1	(1	1478	(10	(10	(5	(10	--	---
C-K-12333	643.0-649.2	5	(0.5	(2	(10	24	6	3.7	84	264	20	61	54	72	28	1	(1	504	(10	(10	(5	(10	--	---
C-K-13640	690.0-693.3	10	(0.5	4	(10	(5	(10	3.6	60	180	10	60	45	45	15	4	(1	350	(10	(10	(5	(10	--	---
C-K-13644	693.3-700.0	10	(0.5	(2	(10	(5	(10	3.6	60	190	10	65	45	45	20	5	(1	350	(10	(10	(5	(10	--	---
C-K-12340	700.0-706.0	40	(0.5	(2	(10	(5	(5	5.6	100	368	33	99	79	93	27	1	(1	851	(10	(10	(5	(10	--	---
C-K-13903	706.0-711.0	5	(0.5	2	(10	(5	(10	2.3	55	160	15	50	40	50	20	1	(1	250	(10	10	(5	(10	--	---
C-K-13909	711.0-715.0	5	(0.5	(2	(10	(5	(10	2.3	65	160	15	50	45	50	20	1	(1	250	(10	10	(5	(10	--	---
C-K-12362	838.0-844.0	10	(0.5	(2	(10	(5	7	7.1	240	513	46	194	155	138	72	1	(1	1482	(10	(10	(5	(10	--	---
C-K-13127	890.0-895.0	15	(0.5	(2	(10	(5	(10	)10.0	120	190	20	100	85	70	15	4	1	500	(10	10	(5	(10	--	---
C-K-13315	895.0-899.0	10	(0.5	(2	(10	45	(10	3.3	75	190	15	70	75	50	15	2	1	400	(10	10	(5	(10	--	---
C-K-27019	899.4-900.1	3560	----	--	---	--	---	---	---	---	--	---	---	--	--	--	--	----	---	---	--	---	25	730
C-K-12347	900.1-907.9	265	(0.5	(2	(10	(5	(5	6.9	160	241	46	112	315	108	31	3	(1	951	(10	(10	(5	(10	--	---
C-K-12356	910.2-915.2	5	(0.5	(2	(10	(5	(5	7.9	170	331	45	138	131	108	26	10	(1	2255	(10	(10	(5	(10	--	---
C-K-12376	922.9-928.0	(5	(0.5	(2	(10	(5	6	7.8	200	437	52	165	169	122	30	6	(1	1282	(10	(10	(5	(10	--	---
C-K-12369	944.1-950.1	5	(0.5	(2	(10	(5	10	9.5	160	1393	70	575	152	141	34	2	(1	2139	(10	(10	(5	(10	--	---
C-K-12382	951.4-958.1	(5	(0.5	(2	(10	(5	(5	5.9	195	321	40	121	103	118	31	2	(1	603	(10	(10	(5	(10	--	---
C-K-12390	958.1-964.3	(5	(0.5	(2	(10	(5	(5	3.4	85	262	19	63	58	70	27	1	(1	344	(10	(10	7	(10	--	---
C-K-12397	972.0-977.5	(5	(0.5	(2	(10	(5	8	2.8	65	239	14	48	44	46	25	1	(1	271	(10	(10	(5	(10	--	---
C-K-12404	995.5-998.5	(5	(0.5	(2	(10	(5	9	7.9	206	1464	57	422	183	69	38	4	(1	1306	(10	(10	(5	(10	--	---
C-K-12408	998.5-1006.5	(5	(0.5	10	(10	(5	7	5.5	110	227	21	86	77	50	26	7	(1	929	(10	16	(5	(10	--	---
C-K-12417	1018.1-1024.0	5	0.6	(2	(10	(5	7	9.3	165	472	50	241	475	100	36	30	(1	1961	(10	24	(5	(10	--	---
C-K-12424	1024.0-1030.0	(5	(0.5	(2	(10	(5	7	6.8	105	278	36	122	290	59	27	3	(1	975	(10	(10	6	(10	--	---
C-K-12431	1042.0-1047.5	(5	(0.5	3	(10	(5	(5	8.9	145	206	36	189	362	102	30	13	(1	2199	(10	16	5	(10	--	---
C-K-12437	1060.0-1066.0	(5	0.5	(2	(10	(5	(5	8.2	150	220	30	117	343	141	31	23	(1	2389	(10	24	(5	(10	--	---
C-K-12459	1070.3-1077.3	10	(0.5	(2	(10	(5	(5	9.7	170	262	43	159	595	154	35	21	(1	2604	(10	20	(5	(10	--	---
C-K-12467	1098.4-1107.4	(5	(0.5	(2	(10	(5	(5	7.1	180	434	41	158	224	128	26	7	(1	1585	(10	(10	(5	(10	--	---
C-K-12477	1130.0-1138.0	25	(0.5	(2	(10	(5	(5	8.1	190	1396	83	548	318	135	33	7	(1	1442	(10	24	6	(10	--	---
C-K-12486	1163.0-1171.0	35	(0.5	(2	(10	(5	(5	7.1	150	935	47	420	98	136	31	15	(1	1362	(10	(10	(5	(10	--	---
C-K-13321	1171.0-1177.0	95	(0.5	(2	(10	(5	(10	7.2	110	250	20	180	75	90	5	15	1	600	(10	10	(5	(10	--	---
C-K-13328	1177.0-1182.0	140	(0.5	(2	(10	5	(10	6.0	120	300	30	250	100	100	(5	2	1	800	(10	20	(5	(10	--	---
C-K-13305	1190.0-1195.0	100	(0.5	(2	(10	10	(10	)10.0	180	500	50	650	130	110	(5	5	2	1200	(10	10	(5	(10	--	---
C-K-12495	1182.0-1190.0	115	(0.5	(2	(10	(5	(5	7.3	170	648	44	254	180	110	35	3	(1	1323	(10	(10	(5	(10	--	---
C-K-13353	1195.0-1200.0	65	(0.5	(2	(10	(5	(10	6.1	170	350	40	300	85	100	(5	4	2	900	(10	20	(5	(10	--	---
C-K-13365	1200.0-1205.0	460	(0.5	(2	(10	(5	10	7.2	120	400	25	250	65	100	(5	2	2	800	(10	20	(5	(10	--	---
C-K-13359	1205.0-1210.0	55	(0.5	(2	(10	40	(10	3.9	140	300	30	300	50	110	(5	3	2	850	(10	20	(5	(10	--	---
C-K-12504	1293.9-1303.5	20	(0.5	(2	(10	(5	(5	8.2	200	473	47	161	104	115	41	3	(1	1496	(10	(10	(5	(10	--	---
C-K-27020	1303.5-1304.0	2240	----	--	---	--	---	---	---	---	--	---	---	--	--	--	--	----	---	---	--	---	30	90
C-K-12514	1304.0-1312.0	30	(0.5	(2	(10	(5	(5	9.2	240	2131	48	822	465	149	41	13	(1	2008	(10	(10	(5	(10	--	---
C-K-12523	1312.0-1320.0	5	0.6	6	(10	(5	(5	4.8	66	176	11	58	395	131	29	40	(1	697	(10	24	(5	11	--	---
C-K-12532	1342.0-1350.0	35	(0.5	(2	(10	(5	(5	9.0	220	1120	73	461	358	126	42	4	(1	1424	(10	(10	(5	(10	--	---
C-K-13885	1428.0-1433.0	10	(0.5	(2	(10	(5	(10	6.8	120	300	20	190	70	90	10	(1	1	650	(10	(10	(5	(10	--	---
C-K-13371	1433.0-1438.0	5	(0.5	(2	(10	(5	(10	7.9	130	350	30	200	80	70	5	1	1	700	(10	10	(5	(10	--	---
C-K-12541	1438.0-1446.0	115	(0.5	(2	(10	(5	(5	6.9	140	237	38	101	233	116	41	3	(1	1168	(10	(10	(5	(10	--	---
C-K-12663	1476.0-1482.0	10	(0.5	(2	(10	(5	(5	8.3	170	624	45	271	246	123	40	1	(1	1717	(10	(10	(5	(10	--	---
C-K-12670	1544.0-1552.0	(5	(0.5	(2	(10	12	5	8.9	205	932	55	412	126	118	36	2	(1	1981	(10	(10	(5	15	--	---

Notes: A detailed log is available for study. Four thin sections and three polished thin sections were made. Four core samples were assayed. Point analyses of coarse-grained ultramafics at depths of about 194′ and 232.2′ yielded copper and gold contents of 0.75-1.75% and 11-380 ppb, respectively and 1-4 ppm silver at 134.9′, 194.3′, 202′ and 232.2′. The analytical results follow in Table BL-1.

CONDENSED GEOLOGIC LOG FOR DDH IS-1

The hole was drilled at a 90° angle (vertical).

0′-109′ Overburden.

109′-121.3′ Mixed section of medium to coarse-grained laminated and chalcopyrite-bearing oxide gabbro and fine to medium-grained oxide-rich gabbro, with cross-cutting coarse-grained anorthosite veins(?).

121.3′-169.4′ Alternation of mainly oxide-rich equant microgabbro having plagioclase xenocrysts and medium to coarse-grained brecciated gabbro, with cross-cutting medium to coarse-grained chalcopyrite-bearing clinopyroxenite-magnetite veins and clots. Magnetite is present in a selvage against microgabbro. Mineral mode is variable. Fine-grained rocks range from 50-80% plagioclase, 15-25% clinopyroxene (locally both clinopyroxene and orthopyroxene are present in a ratio of approximately 3:1), 5-25% opaques and up to 1% apatite. Coarse-grained rocks generally are 50-60% plagioclase (locally 75-80%), 15-30% clinopyroxene, 5-20% opaques, and a trace of biotite. Veins are up to 60% pyroxene, 25% plagioclase, 5+% opaques, and possibly olivine(?) to 5%. Trace of disseminated sulfides are present throughout.

169.4′-218.7′ A mixture of equant microgabbro, medium-grained gabbro with plagioclase and (brecciated anorthosite) xenoliths, laminated anorthositic gabbro and very fine-grained microgabbro or hornfels.
At 213.1′-218.7′ coarse-grained leucocrate chalcopyrite-bearing brecciated polyschematic rock occurs composed of coarse-grained plagioclase + apatite + clinopyroxene with intergranular graphic granite.
Mineral mode of medium-grained to coarse-grained rock has a range of: 60-90% plagioclase, 3-20% clinopyroxene, 1-20% opaques, and trace-1% apatite. Fine grained to very fine-grained zones have a mineral mode generally in the range of 70-90% plagioclase, 5-20% clinopyroxene, 4-15% opaques and less than 1% apatite. One zone, in the upper part of this interval, has a mineral mode of 40% opaques, 30% plagio-clase, 30% clinopyroxene, and a trace of apatite. Three polished sections gave the following range of values for opaque minerals: 45-70% magnetite, 25-39% ilmenite, 0-25% pyrrhotite, and a trace-5% chalcopyrite. The mineral mode of xenoliths is approximately 60% pyroxene and 40% plagioclase. Two of the polished sections were taken from the hornfelsed fine-grained to very fine-grained rocks, and one came from an oxide-rich vein.

218.7′-440.6′ Equant microgabbro with coarse-grained pyroxenite-oxide veins and clots with very fine-grained hornfelsic(?) intercalations.
Very fine-grained greenish gabbronorite intercalation with strongly pleochroic orthopyroxene at 262.3′-277.7′. Chalcopyrite showings, associated with coarse-grained pyroxenite veins with strongly pleochroic orthopyroxene at 300′-307′. Relatively high concentration of pyroxenite veins and clots which are bornite and chalcopyrite-bearing at 359′-406.5′. Section with many flattened leucocrate xenoliths at 388′-396.4′.

Sulfides occur as fine disseminations, scattered blebs and interstitial concentrations, mostly associated with flattened xenoliths and veins with the coarser-grained pyroxene-rich oxide-bearing segregations. Chalcopyrite is generally most abundant followed by pyrrhotite, bornite and possibly pyrite. The mineral mode of the oxide-bearing microgabbro ranges generally from 60-90% plagioclase; 5-25% pyroxene, of which up to 10% may be orthopyroxene and the remainder clinopyroxene; 5-15% opaques; trace-1% apatite.

The mineral mode of the coarser grained oxide-bearing proxenite veins ranges from: 65-90% pyroxene, of which 25% may be orthopyroxene; 1-30% plagioclase; and 1-30% opaques.

Examination of three polished sections gave the following range of opaque mineral modes: microgabbros (2 locations) - 60-85% magnetite, 10-40% ilmenite, 0-.5% chalcopyrite; veinlets (1 location) - 30% magnetite, 10% ilmenite, 50% chalcopyrite, 5% bornite, 5% pyrite(?); pyroxenite (1 location) - 24% magnetite, 6% ilmenite, 70% pyrrhotite; flattened xenoliths (1 location) - 10% magnetite/ilmenite, 75% bornite, 15% chalcopyrite.

440.6′-458.2′ T.D. Intrusive breccia of fine to medium-grained gabbro and coarse-grained gabbro to anorthosite with intergranular quartz. Plagioclase xenocrysts up to 3.5 cm in length. Scattered small grains and blebs of chalcopyrite, apparently associated with zones of oxide-rich gabbroic anorthosite. Mineral mode: plagioclase 85-90%; clinopyroxene 10-15%; oxides .5-1%; biotite, trace.

Notes: A detailed log is available for study. Twenty-seven thin section and seven polished thin sections were made. Gold values of 1-1.1 ppm were found at 170.2′, 301.8′ and 167.1′. Thirteen rock samples were assayed. The analytical results follow in Table IS-1.

CONDENSED GEOLOGIC LOG FOR DDH R-1

The hole was drilled at a 90° angle (vertical).

0′- 69′ **Overburden.**

69′-207.3′ T.D. **Amphibole schist.** Generally medium-grained to coarse-grained, moderately magnetic, composed of medium to dark greenish-black prismatic amphibole crystals in a white to gray plagioclase feldspar matrix. Amphibole crystals exhibit foliation of approximately 20° to core axis. Fracturing and alteration is fairly common. Fracture angles generally are either approximately parallel or perpendicular to foliation or both. Traces of sulfide occur as scattered disseminated grains. The mineral mode is somewhat variable and is in the range of: 57-74% amphibole; 20-35% plagioclase; 3-7% opaques; trace-3% biotite as individual flakes and as alterations of amphiboles; trace of chlorite alteration of amphiboles and biotite; and a trace of apatite.

Altered fracture zones occur at 73.3′-83.5′, 83.5′-84.5′, 113.5′-114.7′, and 131.9′-154.4′. They are generally fractured or brecciated in appearance and lighter dull green in color. Fracture surfaces are often coated with minerals which differ somewhat from those forming the matrix. The mineral mode of the matrix has the following range in composition: Amphibole, 15-66%; plagioclase, 30-35%; biotite and biotite/chlorite, 1-50%; opaques, 3-5%; sulfides, trace as (py?)(cpy?). The mineral mode of the fracture coatings is: Calcite, up to 97%; quartz, 2-3%; biotite/chlorite, trace-1%; opaques, 1-2%; apatite, trace.

Basalt and porphyritic basalt dikes are present from 98.4′-99.7′; 154.4′-157.1′; 166.1′-182.0′. They are very fine-grained, porphyritic, mostly greenish gray, slightly magnetic, locally fractured and exhibit slight to moderate alteration. The approximate range of mineral mode is: Ferromagnesians (probably actinolite), 45-54%; plagioclase (combined phenocrysts and groundmass), 35-40%; opaques, 5-20%; chlorite, trace-1%. The phenocrysts are mostly subhedral to euhedral plagioclase and occasional opaque minerals. Sulfide is occasionally visible and amounts to probably less than 1% as pyrite and chalcopyrite(?).

Several veins occur at 69.1′, 83.5′, 161.4′, 191.8′ and at 198.7′ and range in thickness from a fraction of an inch to just under one foot. Two of these are filled with calcite and lesser amounts of highly sericitized plagioclase and dark reddish-brown biotite. One is bounded by very fine-grained quartz and the contact zone is a highly altered "grungy" red-brown biotite(?). The other veins are composed primarily of pegmatitic plagioclase (up to 30 mm crystals), quartz and biotite (books up to 12 mm across). The veins are both high and low angle and the mineral mode of the thickest vein is approximately: Plagioclase, 57-62%; quartz, 35-40%; biotite, 3%; opaques, trace. Epidote and chlorite alteration is occasionally present in some of the veins as well as are traces of pyrite and chalcopyrite.

Notes: Ten thin sections were made. A detailed log is available for study. Three rock samples were assayed. The analytical results follow in Table R-1.

CONDENSED GEOLOGIC LOG FOR DDH NE-2

The hole was drilled at an angle of 48° and an azimuth of 90°.

0′-36′ **Overburden.**

36′- 269′ **Mainly fine-grained olivine-bearing oxide gabbro and mela-olivine gabbro** with zones of plagioclase lamination, plagioclase xenocrysts, plagioclase veins and conformable and cross-cutting pyroxenite-oxide veins. Locally fine to medium-grained and medium-grained to coarse-grained members occur in the upper 50′. Joints have been observed with coatings of *THOMPSONITE* and *ANALCIME* both determined by X-Ray Diffraction. The fluorine, phosphorous, chromium, cobalt, vanadium and TiO_2 contents are slightly elevated compared with the underlying rocks.

269′-354′ **Mainly brecciated coarse-grained oxide gabbro with pyroxenite and oxide veins** and clots and higher chromium, nickel and cobalt values than the remaining part of the drill core.

354′-470′ **Slightly brecciated medium to coarse-grained oxide gabbro with plagioclase xenocrysts.**

470′-1038′ T.D. **Layered medium to coarse-grained and fine-grained oxide, olivine bearing gabbro, oxide olivine gabbro, troctolite, and anorthosite** are the major rock types. They are mixed with zones of patchy pyroxene concentrations, olivine and clinopyroxene oikocrysts, plagioclase xenocrysts and ophitic textures. Brecciated intercalations with coarse-grained pyroxenite and oxide veins and clots occur as well. Approximately the last 50′ are cataclastic and epimetamorphic with *LAUMONTITE* veins, determined by X-Ray Diffraction. 450′-477′ contains intercalated zones exhibiting pink staining on plagioclase with relatively high potash ($K_20 = 1.88\%$) and veinlets having the following composition: $Mg0 = 26.00\%$, $Al_20_3 = 11.18\%$, $SiO_2 = 49.68\%$, $Ca0 = 2.77\%$ and $Fe0 = 10.43\%$. Analyses by Energy Disperser Spectrometer. The plagioclase lamination at 220′ and the layering at 825′ have an angle of respectively 60 and 90° with core axis.

PETROGRAPHY DDH NE-2

The following major rock types were found in this drill hole.

Fine-grained oxide gabbro

Fine-grained oxide gabbro, and occasionally oxide-rich olivine-bearing gabbro and mela-olivine gabbro are found between 36 and 268.5′. These are composed of anhedral to subhedral crystals with laminated to equant texture and isomodal layering of the coarser-grained oxide pyroxenite and fine-grained oxide gabbro.

The composition of the *PLAGIOCLASE* is An 42-47%, and occurs as lensoid aggregates which accentuate the layering. The crystals, like those in the other parts of the drill core, are twinned following albite, Carlsbad, and acline laws. *AP-*

Table BL-1

D.D.H. BL-1

ANALYTICAL RESULTS (DNR LABORATORY, Hibbing, Mn.)

Sample #	Footage	Co PPM	Ni PPM	Cu PCT	Ti PCT	V PPM	*Pd PPB	*Pt PPB	*Au PPB	Zn PPM	As PPM	*Ag PPM
11228	134.9	75	400	0.17	2.32	<.1	19	10	15	75	2.52	1.0
11230	194.3	100	225	1.0	2.20	<1	2	17	11	200	1.04	2.5
11231	202.0	75	125	1.75	1.80	<1	34	27	380	150	.40	4.0
11232	232.2	100	350	0.75	4.70	<1	42	63	42	150	.04	3.5

* Starred elements were analized by X-Ray Labs

Table IS-1

D.D.H. IS-1

ANALYTICAL RESULTS (DNR laboratory, Hibbing, Mn.)

Sample #	Footage	Co PPM	Ni PPM	Cu PPM	Ti PCT	Au PPM	Zn PPM	As PPM	Ag PPM	Al PCT	Ca PCT	Fe PCT	K PCT	Mg PCT	Mn PCT	Na PCT	Si PCT
L-10782	170.2	---	90	95	1.67	1.1	---	4	<.1	22.34	6.81	5.45	0.32	2.69	.21	3.38	54.5
L-10784	176.8	70	150	810	---	0.06	190	4	<.1	---	---	---	---	---	---	---	---
L-10787	184.7	40	100	2120	---	0.04	120	3	<.1	---	---	---	---	---	---	---	---
L-10796	217.0	---	70	60	2.34	0.06	---	3	<.1	18.22	5.66	6.90	0.62	1.76	.30	3.52	59.57
L-10798	220.6	---	100	30	5.68	0.06	---	3	<.1	9.10	6.50	20.56	0.16	5.48	.39	1.78	49.30
L-10808	260.1-260.3	100	90	1740	---	0.06	150	2	<.1	---	---	---	---	---	---	---	---
L-10811	301.8	85	230	2420	---	0.09	140	4	<.1	---	---	---	---	---	---	---	---
L-10812	306.7-306.8	50	210	650	---	1.0	160	4	<.1	---	---	---	---	---	---	---	---
L-10816	344.7	---	180	50	4.68	0.06	---	3	<.1	9.19	7.50	17.53	0.16	6.84	.39	1.42	53.87
L-10822	403.1	---	170	170	4.68	0.04	---	5	<.1	10.89	7.16	15.87	0.10	6.38	.39	1.68	53.28
L-10824	425.8	---	100	350	5.10	0.08	---	7	<.1	9.49	3.94	21.53	0.20	5.68	.39	2.30	53.07
L-10828	271.3	---	180	30	1.67	0.08	---	5	<.1	9.68	6.88	8.97	0.08	6.28	.32	1.36	62.76
L-10831	167.1	50	120	710	---	1.0	220	3	<.1	---	---	---	---	---	---	---	---

Table R-1

D.D.H. R-1

Analytical Results (DNR Laboratory, Hibbing Mn.)

Sample #	Footage	Co PPM	Ni PPM	Cu PPM	Ti PCT	V PPM	Au PPB	Zn PPM	As PPM	Ag PPM	Pb PPM	Cd PPM
MR-11138	71.4	75	200	135	1.84	.09	<0.01	105	9.3	<.1	<.01	<.01
MR-11141	117.5	120	100	190	2.01	.11	<0.01	110	7.5	<.1	<.01	<.01
MR-11146	189.2	100	100	120	2.34	.13	<0.01	90	1.7	<.1	<.01	<.01

ATITE and fine-grained *OPAQUE* prisms and rods occur as inclusions. *CLINOPYROXENE* with *APATITE*, *ILMENITE*, *MAGNETITE AND RUTILE* inclusions occur as oikocrysts up to 10 mm across and as fine-grained cumulus crystals with simple twinning. *OLIVINE* occurs as cumulus crystals as well as oikocrysts. The oxides are postcumulus, enclosing the above mentioned silicates and contain up to 10% *APATITE* inclusions. *MAGNETITE* is the main *OXIDE* (about 90%) and surrounds *ILMENITE*. *OLIVINE* rims *MAGNETITE*. The average composition of these rocks is 10-45% plagioclase, 30-45% clinopyroxene, trace to 10% olivine and 15-45% oxide.

Igneous beccias

These are mainly coarse-grained polyschematic rocks most frequently found between 256′ and 354′. They are composed of plagioclase and mafic mineral-rich parts, and display cross-cutting relationships and varying degrees of mixing. Their compositions vary from anorthosite to oxide gabbro, oxide pyroxenite and peridotite.

The *PLAGIOCLASE* ranges in composition from An 26-54%, is mostly anhedral and displays a subparallel to subophitic texture. Xenocrysts have patchy zoning with relatively abundant *OPAQUE* and semi-opaque needles, scattered *CLINOPYROXENE* and *BROWN HORNBLENDE* inclusions. Smaller equant aggregates of *PLAGIOCLASE* occur with *OXIDE* and *CLINOPYROXENE* in vicinity of ultramafic veins. *CLINOPYROXENE* has purple-brownish and greenish-greyish-yellowish tones with numerous inclusions of *OPAQUE* needles and rods. *OLIVINE* occurs as oikocrysts with rounded inclusions of *PLAGIOCLASE*, simple twinned *CLINOPYROXENE*, and *OXIDE*. The *OLIVINE* crystals are rimmed by *CLINOPYROXENE* and brown *HORNBLENDE* and are part of ultramafic veins. *MAGNETITE*, the main oxide, shows exsolution lamellae of *ILMENITE* and probably a *SPINEL*, which has a gray colour with reflection of about 15 and a grey-brown anisotropic colour. *CHALCOPYRITE*, intergrown with *BORNITE* and *PYRRHOTITE* is mostly associated with *CLINOPYROXENE*-rich veins and clots. Minor amounts of *APATITE* and red brown *BIOTITE* are observed as well. The composition of this rock varies from 60-70% *PLAGIOCLASE*, 20-25% *CLINOPYROXENE*, 0-5% *OLIVINE* and 5-15% *OXIDE*.

Anorthosite

Layers have a thickness up to 10′ and are found below 470′. The texture is laminated and subophitic. Two kinds of *PLAGIOCLASE* are distinguished:

A) Larger crystals, having a composition of An 67%, make up about 20% of the rock. They are strongly zoned and contain interesting composite *PLAGIOCLASE* crystals, with zones of basic *PLAGIOCLASE-CLINOPYROXENE* symplectite along the inner crystal boundaries. These zones may coincide with patchy zoning and cut across the crystals. The zones seem to precede recrystallization of larger crystals into smaller ones, preferably along Carlsbad composition planes, and are part of vein systems.

B) Smaller crystals, having a composition of An 54%, showing less zonal variation and occur as anhedral to equant clusters in voids between the larger crystals.

CLINOPYROXENE surrounds larger plagioclase crystals as part of the *PLAGIOCLASE* symplectite and transects plagioclase along zones. *REDDISH-BROWN BIOTITE* surrounds *OXIDE*.

Medium to coarse-grained olivine-bearing gabbro and oxide olivine gabbro.

These layered rocks alternate with oxide troctolite and anorthosite. They display laminated and subophitic textures and occur below 470′. The *PLAGIOCLASE* crystals, which have a composition of An 35-65, are clouded with semi-*OPAQUE* dots that coincide with patchy zoning and display a parallel orientation of *CLINOPYROXENE* inclusions. The cumulus crystals are slightly bent and exhibit wavy extinction. Large variations in composition can be observed in the same thin section. *CLINOPYROXENE* is strongly zoned in places, has purple tones, extinction dispersion and a + 2V 50-60°. Cumulus crystals show wavy extinction as a result of strain. Post cumulus *MAGNETITE* and *ILMENITE* occur in roughly equal amounts and the magnetite tends to surround *ILMENITE*. Exsolution lamellae of *ILMENITE* and *SPINEL* are observed in *MAGNETITE*. To a far lesser degree oxides also occur as discrete cumulus crystals. *OLIVINE* forms rims on the *OXIDES*. Minute specks of intergrown *CHALCOPYRITE*, *BORNITE* and *PYRRHOTITE* are associated with *CLINOPYROXENE-PLAGIOCLASE* symplectite and *SPINEL* along cracks in *PLAGIOCLASE*. These rocks are characterized by complex embayments of *OXIDES*, *PLAGIOCLASE*, *CLINOPYROXENE* and *OLIVINE* with reaction rims of *PLAGIOCLASE-CLINOPYROXENE SYMPLECTITE* and *OLIVINE*. The composition of these rocks averages 50-70% plagioclase, 25-35% clinopyroxene, trace to 20% olivine and 10-20% oxides.

Troctolite

The *PLAGIOCLASE* has an An-content of 47-55%, has a subophitic texture and is anhedral to subhedral. Relatively basic *PLAGIOCLASE* forms symplectic intergrowths with *CLINOPYROXENE* in embayments of *OLIVINE* and *OXIDES*. Simple acline twins are observed as well. The cumulus tablets and prisms are slightly bent and molded between cumulus *OLIVINES*. Larger *PLAGIOCLASE* crystals may envelope earlier silicates as oikocrysts. *CLINOPYROXENE* is present as oikocrysts. *OLIVINE* is both cumulus and poikilitic and has wavy extinction. *ILMENITE* and *MAGNETITE* occur in roughly equal amounts and are associated with redbrown *BIOTITE*. *MAGNETITE* has *SPINEL* exsolution lamellae. *CHALCOPYRITE* and *BORNITE* intergrowths occur in direct contact with *PLAGIOCLASE-CLINOPYROXENE* symplectites.

Acid Tests Results

Footage	Angle from Horizontal
100′	51°
400′	52°
700′	55.5°
1030′	52°

Notes: A total of ten polished thin sections and ten analytical samples were prepared from this hole. A detailed graphic log is available for study. The analytical results follow in Table NE-2.

CONDENSED GEOLOGIC LOG FOR DDH SE-1

The hole was drilled at an angle of 51°, and an azimuth of 90°.

0′-66′ Overburden.

66′-401′ Rythmic layered(?) fine, medium and coarse-grained subophitic poikilitic gabbro with brecciated recrystallized textures and dark grey plagioclase. Size-graded layering is indicated by increase and decrease of grain size downhole. At places the question arises whether the plagioclase is recrystallized or if there is an intrusion of very fine-grained gabbro or anorthosite into the fine to coarse-grained rock. Intercalations of the laminated sections increase in abundance towards the lower part of this zone. Veins and dikes of 0.02′-2.5′ thickness of fine to medium-grained pink granophyric alkali granite, amphibole granite and tonalite occur all through this section. Intercalations of zoned veins up to 0.8′ thick with quartz-microcline-carbonate-chlorite-epidote-saussurite cores, associated with fine-grained syenite and aplite and surrounded by epigabbro, occur at 240.6′-322′.

401′- 954′ Mainly olivine-bearing rocks; olivine gabbros, troctolites and olivine-bearing anorthositic rocks. These rocks alternate as a result of graded mineral layering. Micro-gabbros occur as intercalations of veins and clots. Rather persistent occurrence of alkalifeldspar frequently associated with apatite and quartz at 400′-750′. Olivine- graded layering culminating with picritic and ultramafic layers at 488′-664′. At 516′-623′ intercalations of olivine-poor pegmatoidal anorthosite occur with dark coarse-grained plagioclase and grey fine to medium-grained intergranular plagioclase. The lower 10′ carry biotite booklets and show pink discolouration of plagioclase.
Mixed zone of brecciated and recrystallized layered olivine-bearing anorthositic rocks, olivine gabbros, troctolites and anorthosites with ragged contacts at 680′-954′. As a whole, the plagioclase is lighter coloured than higher up in the drill hole. Plagioclase and pyroxene xenocrysts and traces of chalcopyrite occur in the upper 32′. At 680′-776′ intercalations of veins of coarse-grained to pegmatoidal anorthosite, pyroxenite, amphibole-bearing granophyric granite, quartz and carbonate-chlorite occur. Up to 3′intercalations of cataclastic rock with secondary Fe-Mg hydrosilicates are present at 691′-735′. Intercalations of up to 2.2′ of granite and diorite veins and dikes occur at 822′-875′. Intercalations of sulfide-bearing oxide and oxide-rich lenses of gabbroic composition are observed at 808′-967′.

954′-1057′ Mainly anorthositic rocks with diorite intrusion at 955′-1007′ and intrusion of very fine-grained granular oxide-grabbro and anorthosite at 1033′-1042′.

1057′-1344 T.D.′ Layered(?) alternation of mottled plagioclase-oxide gabbro, fine to medium-grained plagioclase xenocryst gabbro and medium-grained gabbro and anorthosite with intercalations of laminated plagioclase layers. Overall the rock is brecciated and thoroughly recrystallized along veins.

1072.4′ Pumpelyite (X-Ray Diffraction) bearing hydrothermally altered granophyre dikelet. Olivine bearing intercalations at 1129′-1147′ and 1244′-1262′. Rather continuous stretches of white altered plagioclase, wherein hair-line plagioclase and granite veinlets pinch out in intergranular material at 1163′-1263′. Up to 1′ thick intercalations of granophyric granites occur at 1167′-1191′. Up to 2.5′ thick intervals of pegmatoids with ilmenite sheet- form crystals are present at 1255′-1259′. Cataclastic and mylonitic zones cemented by quartz associated with pseudomorphs after pyroxene consisting of Mg-Fe hydrosilicates including biotite occur at 1281′-1285′ and 1329′-1336′. Granodiorite, tonalite and quartz-microcline veins rimmed by carbonate-chlorite-zeolite (?) are found at 1281′-1344′

The layering makes an angle of 20-30° to the core axis. Cross-cutting dikes and veinlets have angles to core axis varying from 20-70°. Breaks in geochemical trends are indicated by TiO_2 and Pd content as well as the Cu/Cu + Ni ratio. TiO_2 shows breaks at about 950′ and about 570′ as reflected by sharp increases above these depths with gradually diminishing values further upwards. The Cu/Cu + Ni ratio shows the same trends at about 1050′ and about 570′. Pd reflects breaks at about 900′ and about 570′, with elevated values in between which might be an indication of a potential zone of interest with a Pt kick of 120 ppb at the base. Additional elevated values found in this zone are for Cu, Ni, Co, Cr, Sb, C, Au, S, Rb, Zr, Th and U. The zone below 900′ is interesting in that it is characterized by high Cl + F values of between 530 and 2000 ppm. A possible outlier of this zone was found between 906.6′ and 808.8′ with combined Cl and F of 1925 ppm.

PETROGRAPHY OF MAIN ROCK TYPES DDH SE-1

Poikilitic gabbros

These medium to coarse-grained brecciated-appearing rocks with recrystallized subophitic texture and locally developed plagioclase lamination occur in the upper and lower part of the drill hole. *PLAGIOCLASE* shows a bimodal distribution of grain size, occurs as up to 7.5 mm xenocrysts having a composition of An 75-78%, in a medium-grained subophitic groundmass with a composition of An 42-56%. Layering is reflected by a gradual increase downwards of the xenocryst content and ends in a coarse-grained rock with void fillings of medium-grained subophitic gabbro. The macroscopically dark grey *PLAGIOCLASE* crystals are heavily clouded with very fine *SEMI-OPAQUE* inclusions in the upper and lower part of the drill hole section and these display a patchy, normal and cyclic zoning, and occasional patches of basic composition parallel to (010). Twinning follows the albite, Carlsbad, pericline and acline laws. In the lower part of the drill hole, there are composition planes of twinning at an angle of 45° to (010). *CLINOPYROXENE* occurs as cumulus crystals as well as oikocrysts up to 1.5 cm across, showing symplectic exsolution and recrystallization patterns of *CLINOPYROXENE-ORTHOPYROXENE*-PLAGIOCLASE and *OXIDE* ± *RED-BROWN BIOTITE* and *OLIVE-GREEN HORNBLENDE*. *ORTHOPYROXENE* occurs as patchy recrystallized oikocrysts above 400′. *OLIVINE* may occur as

Table NE-2

D.D.H. NE-2

Analytical Results (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Cr PPM	Co PPM	Ni PPM	Cu PPM	P PPM	TiO2 PCT	V PPM	Ru PPB	Rh OPT	Pd PPB	Os PPB	Ir PPB	Pt PPB	Au PPB	As PPM	Ag PPM	Sb PPM	Te PPM	Pb PPM	Bi PPM	TOTC PCT	F PPM	S PCT	Cl PPM	Fe PCT
L13280	100.0-103.0	300	55	160	250	1600	5.60	400	---	<0.002	10	---	---	<50	5	<5	<0.5	<5	<10	<5	<2	0.06	200	<0.02	200	>10.0
L13279	220.0-223.0	160	50	90	35	2600	5.90	400	---	<0.002	5	---	---	<50	<5	5	<0.5	5	<10	<5	<2	0.02	370	0.02	200	>10.0
L13281	300.0-303.0	1500	65	250	70	900	3.80	400	---	<0.002	<5	---	---	<50	<5	<5	<0.5	5	<10	<5	<2	0.06	200	<0.02	<200	>10.0
L13277	476.7-478.7	55	5	30	130	450	0.20	25	<5	<0.002	5	<3	0.1	<50	<5	<5	<0.5	<5	<10	<5	<2	0.02	20	<0.02	<200	1.1
L13276	510.0-513.0	35	20	30	180	250	3.60	250	---	<0.002	<5	---	---	<50	<5	<5	<0.5	<5	<10	<5	<2	0.06	25	0.04	<200	6.1
L13275	604.0-607.0	25	20	45	300	250	3.80	300	---	<0.002	<5	---	---	<50	<5	<5	<0.5	<5	<10	<5	<2	0.04	30	0.04	<200	6.2
L13274	705.0-708.0	25	15	35	150	250	2.90	250	---	<0.002	5	---	---	<50	<5	<5	<0.5	<5	<10	<5	<2	0.04	30	0.02	<200	6.8
L13272	810.0-813.0	35	25	55	400	100	4.60	500	---	<0.002	5	---	---	<50	<5	<5	<0.5	<5	<10	<5	<2	0.02	35	0.06	<200	>10.0
L13273	870.0-874.0	80	35	80	350	200	4.80	350	---	<0.002	20	---	---	<50	<5	5	<0.5	5	<10	<5	<2	<0.02	20	0.05	<200	8.0
L13278	983.5-988.6	55	30	45	200	250	4.40	300	---	<0.002	5	---	---	<50	<5	<5	<0.5	<5	<10	<5	<2	<0.02	25	0.03	<200	6.4

inclusions in the *CLINO-PYROXENE*. *ILMENITE* and *MAGNETITE* occur in roughly equal amounts and the former is partly surrounded by the latter. The granular to subhedral *OXIDE* crystals have reaction rims of *RED-BROWN BIOTITE* and *CLINOPYROXENE* symplectic with *PLAGIOCLASE*. The average modal composition of these rocks is 45-70% plagioclase, 20-45% clinopyroxene and 5-10% oxide.

Olivine gabbro and troctolite

These are medium-grained, subophitic textured rocks which occur mainly between 400′ and 954′. The *PLAGIOCLASE* has anorthite contents varying between 42% and 68% with a concentration of values around 55%. The crystals are less clouded than those of the overlying poikilitic gabbros. Patchy zoning and a composition of An 75% coincides with darker clouded parts of the crystals, as do oriented inclusions of *RUTILE* needles. The *PLAGIOCLASE* crystals exhibit cyclic zoning and simple twinning following the (001) plane additionally to twinning described in the foregoing section. *CLINOPYROXENE* occurs as inclusions parallel to the (010) plane and as cumulus crystals and oikocrysts. The latter are dusted with numerous fine *OPAQUE* inclusions and are frequently exsolved as described in the section above. *OLIVINE* has multiple coronas of *PYROXENE, PYROXENE* SYMPLECTITE and *GREENISH BIOTITE* from the inside-outwards. These reaction rims embay *OLIVINE* and may eventually replace it completely. *PYROXENE SYMPLECTITE* also occurs as a corroding intercumulus agent with respect to *PLAGIOCLASE*. Ultramafic patches and lenses may occur as picrite and dunite, with or without *ALKALI FELDSPAR* and *APATITE*. The *OXIDE*S may form oikocrysts and discrete smaller crystals surrounded by red-brown *BIOTITE* or stout euhedral *APATITE* prisms. Sheet-form oikocrysts of oxide may occur as graphic intergrowths with *PLAGIOCLASE*. *ORTHOCLASE-SANIDINE* ± euhedral *APATITE* and *QUARTZ* may occur in amounts of up to 5% in voids or as selvages around *PLAGIOCLASE* with *BIOTITE* and *OXIDE*. The average modal composition of these rocks is 50-75% plagioclase, 5-30% clinopyroxene, trace to 45% olivine and 3-10% oxide.

Anorthosite and troctolitic anorthosite

These coarse-grained rocks occur mainly between 692′ and 1058′, straddling the olivine gabbros, troctolites and underlying poikilitic gabbros. *PLAGIOCLASE*, of composition An 30-66%, exhibits, in addition to the patterns described above in the poikilitic gabbros, a crosshatch twinning following the (010) and the (001) planes as well as patchy zoning. Inclusions of *CLINOPYROXENE*, *ORTHOPYROXENE*, OLIVINE-BROWN HORNBLENDE and *OPAQUES* show a tendency to follow the crystal outline. Up to 5% *CLINOPYROXENE* may occur as oikocrysts and as equant crystals rimmed by *ORTHOPYROXENE*. *ORTHOPYROXENE* can also occur as discrete crystals. Up to 5% *OLIVINE* forms stringers surrounding and cross-cutting *PLAGIOCLASE*. *OXIDE* occurs as symplectic intergrowths with *PYROXENE*. *CLINOPYROXENE-BROWNISH HORNBLENDE-OPAQUES* and *APATITE* form veins and clots which are postcumulus with respect to *PLAGIOCLASE*. The anorthosites and poikilitic gabbros underwent rather strong recrystallization as is indicated by phenomena described in a later section on recrystallized rocks.

Pegmatoids

These rocks locally show *PLAGIOCLASE* lamination and occur mainly between 516′-565′ and 939′-950′. The *PLAGIOCLASE* with anorthite contents ranging from 35-47% to 68-70% may show heavy clouding and cyclic zoning, the latter coinciding with zones containing *CLINOPYROXENE-OPAQUE-APATITE* inclusions. In addition to the twinning patterns described under the heading of poikilitic gabbros, twinning is also present as a crosshatch pattern on the (010), and (001), and simple composition planes with an angle of 45° to (010). Prismatic or tabular crystals are also intergrown following a configuration of crosslings. *CLINOPYROXENE* occurs as large strongly exsolved oikocrysts or as part of fine to coarse-grained complex intergrowths of *PYROXENE SYMPLECTITE, OPAQUE, APATITE, ORTHOCLASE, BIOTITE* ± *QUARTZ* ± *OLIVINE* ± *ORTHOPYROXENE*. CLINOPYROXENE displays locally dense clouding with *OPAQUE* mineral inclusions. *ORTHOPYROXENE* is found as large subhedral crystals.

At 557.3′ cavity fillings are found with *CALCITE, TALC, BIOTITE* and *ANTIGORITE* (X-Ray Diffraction). *ILMENITE* comprises up to 80% of the oxide and is surrounded by *MAGNETITE* with *ILMENITE* exsolution lamellae. Christmas tree-form symplectic intergrowth of *OXIDE* with recrystallized *PLAGIOCLASE* and *PYROXENE* is common and is locally associated with *APATITE* and *ALKALIFELDSPAR* concentrations. *ILMENITE* sheets may reach dimensions up to 2.5″ between 1255′ and 1259′. The main sulfide mineral, *CHALCOPYRITE*, is intergrown with *PYRRHOTITE*. It occurs in *ILMENITE* and *PYROXENE*, mainly along crystal boundaries. Occasionally, *ARSENOPYRITE* prisms are observed between *CHALCOPYRITE, PYRRHOTITE* and a variety of spinel. *PYRITE* occurs along cracks in *PYROXENE*. The composition of these rocks varies around plagioclase 25-40%, clinopyroxene 5-35%, orthopyroxene trace-45%, oxide about 15-30% and traces of sulfide. Anorthositic compositions have been found as well.

Recrystallized subophitic microgabbro

These fine-grained slightly hornfelsic rocks are found mainly between 600′ and 940′. The anorthite content of *PLAGIOCLASE* in these rocks falls in two ranges, namely, 31-36% and 52-55%. Euhedral *PLAGIOCLASE* phenocrysts with inclusions of *RUTILE* needles are twinned following the albite law. The *PLAGIOCLASE* of the groundmass has subophitic to subparallel texture and is mostly twinned following the albite and Carlsbad laws. The crystals show patchy zoning coinciding with dusty patches and are intergrown with *APATITE* needles, *ALKALIFELDSPAR* and *CLINOPYROXENE*. Locally, granular recrystallization with *CLINOPYROXENE* and *ORTHOPYROXENE* can be observed. *ORTHOPYROXENE* oikocrysts up to 1.3 cm and crowded with *OPAQUE* grains are occasionally present. These are rimmed with a corona of *CLINOPYROXENE* at the inside and *BROWN HORNBLENDE* at the outside. *ORTHOPYROXENE* may also occur as poikiloblasts enclosing *PLAGIOCLASE*. *OLIVE-BROWN HORNBLENDE* forms poikiloblastic to granuloblastic aggregates overgrowing the subophitic texture of groundmass. A strong increase of *HORNBLENDE* content towards the contacts of granite dikes and veins was also observed. *RED-BROWN BIOTITE* forms poikiloblasts overgrowing *HORNBLENDE* and *PYROXENE*. *OXIDES* occur as small subhedral to anhedral grains, evenly dispersed and enclosed by *SILICATES*. In one sample at 601.70', xenoliths of anorthosite(?), charnockite, different kinds of gabbro, ultramafics and pyroxene with rims of hydrous Fe-Mg silicates are observed. The composition of these rocks averages 20-50% plagioclase, 35-55% clinopyroxene, trace-30% orthopyroxene, 5-50% amphibole, trace-5% biotite, trace olivine, trace-5% alkalifeldspar and about 10% oxide.

Oxide-rich gabbros
These fine-grained rocks occur as lenses ranging up to 1.4' in thickness and probably have an intrusive relationship with anorthositic rocks between 808' and 967'. The *PLAGIOCLASE* has a questionable anorthite content of 32% and 52%. It is slightly clouded and altered and may also occur as oikocrysts. The crystals are twinned following the albite law and may have oriented diaper-form colourless inclusions. *ORTHOPYROXENE* and *GREENISH-GREY CLINOPYROXENE* form granular aggregates. *ILMENITE* constitutes about 65% of oxide and may occur in symplectic intergrowth with *MAGNETITE* and *SILICATES*. *MAGNETITE* may occur as discrete crystals, with a few *ILMENITE* exsolution lamellae, and surrounding *ILMENITE*. The major sulfides, *CHALCOPYRITE* and *PYRRHOTITE*, are occasionally intergrown with *PYRITE* and *PENTLANDITE*. *PYRITE* is occasionally associated with *ARSENOPYRITE*. *PYRRHOTITE* may show the same kind of possible replacement by *MARCASITE* and *PYRITE* as observed in DDH FHL-1. The *SULFIDES* are mostly intergrown with *OXIDES* and occur as minute specks in *PYROXENE*. The modal composition of these rocks varies from 15-45% plagioclase, 25-45% orthopyroxene + clino-pyroxene, 30-40% oxide and tr-10% sulfides. At 829.6'-830.3' a Pt + Pd kick (170 ppb) was found with elevated values for S, Sb, V, Cr, Ni, Cu, Rb, Zr, Th, U and a Cu/Cu+Ni ratio of 0.89. At 117.4'-117.90' a modal layered oxide bearing gabbro occurs with *PLAGIOCLASE* of composition An 44-47%, which is laminated and shows compaction of tabular *PLAGIOCLASE*, on prismatic *ORTHOPYROXENE* cumulus paralleling the *PLAGIOCLASE* lamination. The composition of these rocks varies from 45-55% plagioclase, 35-45% clinopyroxene, 3-5% orthopyroxene, 2-3% biotite, 1-2% apatite and about 10% oxide. On a microscopic scale, layers of oxide gabbro, with a composition of 50% plagioclase, 25% clinopyroxene, 25% oxide and 2-3% apatite are intercalated. This plagioclase orthopyroxene cumulate resembles rocks found in the upper part of DDH NE-2.

Alkalifeldspar-quartz-apatite intercumulus
These minerals occur as void fillings and filaments between *PLAGIOCLASE*, mainly in the interval from 400'-750', in poikilitic gabbro, olivine- bearing gabbro, troctolite, anorthositic rocks, anorthosites and recrystallized microgabbros. Aggregates of *THESE MINERALS* ±*RED-BROWN BIOTITE* ±*OLIVE-GREEN HORNBLENDE* and *OXIDE* may constitute up to about 5% of the rock. The *APATITE* has developed as coarse-grained euhedral prisms and the alkalifeldspar is of the *SANIDINE-ORTHOCLASE* variety (-2V less than or equal to about 30°).

Recrystallized, high-temperature, anhydrous textures
These are best developed in macroscopic breccia-like, medium to coarse-grained varieties of the previously described rocks, especially between the top of the hole and 300' and from 700' to the bottom of the hole. The most characteristic features, on a microscopic scale, are fine-grained veins which occur in strongly altered *PLAGIOCLASE* domains having a composition of An 56-75%. The altered aspect is reflected by diffuse and spotted extinction as well as ragged twin composition planes. In the less altered parts of *PLAGIOCLASE*, a crosshatch twin pattern on the (010) and the (001) is present. In the altered zones the coarse-grained *PLAGIOCLASE* crystals, composition An 56%, may gradually develop as fine-grained and very fine-grained granular mosaics, composition An 56%, dissecting the larger *PLAGIOCLASE* crystals and filling voids. *CLINOPYROXENE* oikocrysts can concomitantly show increase in size and intensity of exsolved domains. Next, there is an increase in greenish tones of *CLINOPYROXENE* and *PLAGIOCLASE* inclusions appear in the *PYROXENE* crystals that have assumed the habit of poikiloblasts. The poikiloblasts continue to break up into smaller granular aggregates to end as fine-grained granuloblastic intergrowths of *CLINOPYROXENE* ±*ORTHOPYROXENE* + *PLAGIOCLASE* + *BIOTITE* + *OPAQUE*. These aggregates are sometimes overgrown by *ORTHOPYROXENE* porphyroblasts with coronas of *RED-BROWN BIOTITE* and *OPAQUE* minerals. Inclusions of *CLINOPYROXENE* and *BROWNISH HORNBLENDE* are oriented in *PLAGIOCLASE* along the (010) and (001), and non-crystallographic directions ±*SANIDINE*, *ORTHOCLASE*, *BIOTITE* and *OPAQUES*, forming a network of veins connected with voids and intergranular spaces filled with recrystallized material. *OLIVINE* and *ORTHOPYROXENE* participate as well in the recrystallization process. *ILMENITE* occurs as symplectic intergrowths with recrystallized *CLINOPYROXENE* and *PLAGIOCLASE*. These rocks have considerable similarity with the igneous breccia described in DDH NE-2 at a depth of 250'-354' and also with certain features of recrystallization in *PLAGIOCLASE* crystals of anorthosite described in the same drill hole.

Recrystallized, low-temperature, hydrous textures
Near granite veins and dikes, *BROWN-GREEN HORNBLENDE* and *BROWN BIOTITE* seem to overtake the process of gradual unmixing and recrystallization of *CLINOPYROXENE* and *ORTHOPYROXENE* oikocrysts, by replacing part of the exsolved phases and ending with poikiloblastic overgrowth of *GREY-BROWN HORNBLENDE*. Aggregates of *ACTINOLITIC HORNBLENDE, POIKILITIC BROWN BIOTITE* ± *APATITE* ±*QUARTZ* ±*SPHENE*, are formed as well.

Epimetamorphic or hydrothermally altered gabbros
These rocks show patchy replacement of *PLAGIOCLASE*, composition An3%, by *CARBONATE, COLOURLESS MICA, SPHERULITIC CHLORITE, ACTINOLITIC HORNBLENDE, EPIDOTE/ZOISITE, SPHENE, ORTHOCLASE* and probably *ZEOLITE*. The *SPHENE* is crowded with numerous unmixed short prismatic *RUTILE* inclusions.

Granitoids

Granophyric alkalifeldspar granite

These rocks occur mainly between 66′ and 423′. The *PLAGIOCLASE* seems to be replaced by *ORTHOCLASE*. The *QUARTZ* content goes up to about 60%. At 361.5′ almost complete replacement by *PUMPELLYITE* (X-ray diffraction) was observed. *BROWN BIOTITE* and *OPAQUE* minerals are associated with short, rounded, prismatic *ZIRCON, EPIDOTE/ZOISITE*, and *ALLANITE* (?) aggregates.

Amphibole granite.

These hypidiomorphic granular rocks occur mainly between 730′ and 760′. The *PLAGIOCLASE* phenocrysts, composition An 20-30%, are rounded, corroded, and twinned following albite, Carlsbad and acline laws. They also display patchy saussuritization. *ORTHOCLASE* is anhedral and twinned following Carlsbad law. *QUARTZ* is lensoid and graphically intergrown. *OLIVE-GREEN* to *BROWN HORNBLENDE* has a slightly porphyroblastic and graphic appearance. *BIOTITE* is of the brown variety.

Diorite.

A cross-cutting intrusion was observed between 999.5′ and 1006.70′ in sharp contact with gabbroic anorthosite. The *PLAGIOCLASE* is strongly zoned, composition An 20%(rim) to An 50%, and twinned following the albite and Carlsbad laws. *QUARTZ*, up to 5% present, is intergranular and intergrown with *PLAGIOCLASE*. *ORTHOPYROXENE* occurs as large crystals and is rimmed by *OLIVE-GREEN HORNBLENDE*. *CLINOPYROXENE* is granular and the exsolved phase is partly replaced by *HORNBLENDE*. *OLIVE-GREEN HORNBLENDE* forms large oikocrysts enclosing *PLAGIOCLASE*. *RED-BROWN BIOTITE* forms poikiloblasts and encloses *APATITE*. *APATITE* occurs as short euhedral to subhedral prisms. *OPAQUE* minerals occur as evenly distributed anhedral crystals.

Alkali zircon granite.

One sample of this rock was described at 920.8′ overlying an oxide-rich gabbro lens. *QUARTZ* and *ORTHOCLASE* occur in these rocks as symplectic intergrowths. *CLINOPYROXENE* is a greenish-greyish variety and *BIOTITE* has yellow-brown colours. *ZIRCON* occurs as a major mineral along the contact with the oxide-rich gabbro in the form of medium to coarse-grained euhedral prisms. *APATITE* is present as small prisms. *ILMENITE* is the main oxide and occurs in symplectic intergrowth with *SILICATES* along the contact. *CHALCOPYRITE* is intergrown with *PYRRHOTITE* and occurs mainly along the contact with oxide-rich gabbro and is intergrown with *ZIRCON* and *OXIDES*.

Acid Tests

Footage	Angle with Horizontal
100′	49°
200′	47°
500′	42°
800′	40°
1000′	36°
1345′	34°

Notes: Twenty-nine thin sections and fourteen polished thin sections were made from this drill hole. A total number of sixteen rock samples were assayed. Analytical results follow in Table SE-1.

CONDENSED GEOLOGIC LOG AND PETROGRAPHY FOR DDH FHL-1

The hole was drilled at an angle of 61° and an azimuth of 263°.

0′-129′ Overburden.

129′-189′ Fine-grained and medium-grained mottled troctolite. This unit is made up of layered alternations and subtle mixtures of fine and medium-grained mottled troctolite transected by partly saussuritized anorthosite veins and pegmatoidal intercalations showing hydrothermal alteration. *PLAGIOCLASE*, composition An 62-80%, is cumulus textured with normal, patchy and occasionally inversed zoning and twinning following albite, Carlsbad, acline and pericline laws. This pattern of twinning is repeated in the rock types described below. *OLIVINE* cumulus is *FORSTERITE*, -2V = 80-90°. Pink *CLINOPYROXENE* is anhedral and developed as oikocrysts against the basic rims of plagioclase in mottled troctolite. *ILMENITE* is present as oikocrysts and replaces part of the *OLIVINE*. *MAGNETITE* surrounds and is intergrown with *ILMENITE*.The fine-grained anorthosite has *PLAGIOCLASE* with an anorthite content of 65%, and is found in subparallel recrystallization.Intercalations of hydrothermally altered pegmatoids constitute about 10% of this unit. These are distinguished by reddish-brown *BIOTITE* poikiloblasts with inclusions of *APATITE* and *PREHNITE*, overgrowing secondary formed *CUMMINGTONITE, ACTINOLITIC AMPHIBOLE* and *CHLORITE*. Disseminated *PYRRHOTITE* and *CHALCOPYRITE*, grading up to 10% in the pegmatoids, replace altered *PLAGIOCLASE*. *PYRRHOTITE* is replaced by *PYRITE* and *MARCASITE*. *ILMENITE* occurs as poikiloblasts in *BIOTITE*. Veins of hydrous Fe-Mg silicate transecting fresh troctolite reflect hydrothermal conduits. The average sulfide content is about 0.5%.

189′-323′ Igneous and hornfelsic troctolites

This unit is composed of a mixture of medium to coarse-grained olivine gabbronorite and troctolite, fine-grained hornfelsic olivine gabbronorite and troctolite, with intercalations of pegmatoidal norite, orthopyroxenite, picrite, olivine gabbro-norite, contaminant rock and sulfide lenses. Apart from the occurrences in lenses as matrix and massive *PYRRHOTITE + CHALCOPYRITE + PENTLANDITE, SULFIDES* in this unit occur as blebs and clots. The pegmatoidal and contaminant rocks are frequently hydrothermally altered.

Medium to coarse-grained troctolites and olivine gabbronorites.

The *PLAGIOCLASE*, composition An 70-85%, is twinned following the albite and Carlsbad laws. *OLIVINE* is developed as fair-sized cumulus crystals. *ORTHOPYROXENE* is present as large oikocrysts, enclosing *PLAGIOCLASE* and *OLIVINE*. *CLINOPYROXENE* with numerous opaque needles may surround *OLIVINE* as well. A slightly differing variety includes pericline and acline twinning of *PLAGIOCLASE* with An contents down to 62%, and has

Table SE-1

D.D.H. SE-1

ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B. C.)

Sample #	Footage	Cr PPM	Co PPM	Ni PPM	Cu PPM	P2O5 PCT	TiO2 PCT	V PPM	Ru PPB	Rh OPT	Pd PPB	Os PPB	Ir PPB	Pt PPB	Au PPB	As PPM	Ag PPM
SL-13519	154.0-157.0	120	35	85	150	0.25	0.90	140	--	(0.002	(5	---	---	(50	15	(5	(0.5
SL-13520	397.0-399.4	70	30	50	110	0.15	1.20	110	--	(0.002	(5	---	---	(50	(5	5	(0.5
SL-13521	405.5-406.5	65	35	65	110	0.10	1.20	110	--	(0.002	(5	---	---	(50	(5	(5	(0.5
SL-13522	461.0-464.0	160	65	200	140	0.15	1.60	500	--	(0.002	(5	---	---	(50	(5	10	(0.5
SL-13523	526.0-529.0	250	65	160	450	1.20	2.30	350	--	(0.002	(5	---	---	(50	5	(5	(0.5
SL-13524	639.0-642.0	110	100	400	200	0.20	0.75	85	--	(0.002	20	---	---	(50	(5	(5	(0.5
SL-13525	679.6-680.3	250	60	250	250	0.20	0.80	110	--	(0.002	15	---	---	(50	25	(5	(0.5
SL-13526	684.0-686.3	300	55	250	500	0.20	0.95	110	--	(0.002	20	---	---	(50	20	10	(0.5
SL-13491	743.0-746.0	250	45	120	200	0.35	1.30	180	(5	(0.002	10	(3	0.2	(50	(5	(5	(0.5
SL-13492	806.6-808.8	80	40	75	400	1.10	1.60	170	--	(0.002	(5	---	---	(50	10	10	(0.5
SL-13196	829.6-830.3	450	50	200	1700	0.12	1.60	450	(5	(0.002	50	(3	1.8	120	40	(5	0.5
SL-13528	944.0-947.0	75	45	110	300	0.65	1.80	120	--	(0.002	(5	---	---	(50	(5	(5	(0.5
SL-13527	996.0-999.0	50	45	50	500	1.20	1.30	100	--	(0.002	(5	---	---	(50	10	(5	(0.5
SL-13529	1094.0-1097.0	85	35	85	150	0.25	1.20	150	--	(0.002	(5	---	---	(50	(5	(5	(0.5
SL-13530	1181.0-1183.0	60	25	45	250	0.25	1.80	250	--	(0.002	(5	---	---	(50	(5	(5	(0.5
SL-13535	1255.0-1257.0	50	40	55	250	0.45	2.20	200	(5	(0.002	(5	(3	(0.1	(50	(5	(5	(0.5

Sample #	Sn PPM	Sb PPM	Te PPM	Pb PPM	Bi PPM	CTot PCT	F PPM	S PCT	Cl PPM	Rb PPM	Sr PPM	Zr PPM	Ce PPM	Th PPM	U PPM	B PPM	Fe PCT
SL-13519	(10	(5	(10	30	2	0.06	420	0.03	(200	--	---	---	--	--	--	---	7.1
SL-13520	(10	(5	(10	30	2	0.06	180	(0.02	(200	--	---	---	--	--	--	---	7.8
SL-13521	(10	(5	(10	30	6	0.08	150	0.02	(200	18	245	86	(5	3	(1	(10	8.3
SL-13522	(10	(5	(10	40	(2	0.08	130	(0.02	(200	--	---	---	--	--	--	---	9.8
SL-13523	(10	(5	(10	50	(2	0.08	920	0.09	(200	--	---	---	--	--	--	---	13.4
SL-13524	(10	(5	(10	55	4	0.04	150	0.08	(200	17	175	105	(5	8	4	(10	13.5
SL-13525	(10	(5	(10	30	6	0.04	140	(0.02	(200	20	240	97	(5	9	7	(10	8.5
SL-13526	(10	(5	(10	35	(2	0.23	380	0.05	350	73	180	210	(5	8	4	(10	9.0
SL-13491	(10	15	(10	30	2	0.06	250	0.05	(200	24	240	165	(5	6	1	(10	7.9
SL-13492	(10	5	(10	55	2	0.16	1600	0.11	325	94	195	390	45	13	3	10	11.3
SL-13196	(10	25	(10	40	(2	0.06	250	0.35	(200	22	270	135	(5	6	4	(10	9.6
SL-13528	(10	(5	(10	45	4	0.10	840	0.06	600	--	---	---	--	--	--	---	10.5
SL-13527	(10	(5	(10	35	(2	0.02	1300	0.02	700	--	---	---	--	--	--	---	9.2
SL-13529	(10	(5	(10	40	4	0.04	340	(0.02	650	--	---	---	--	--	--	---	8.4
SL-13530	(10	(5	(10	35	(2	0.04	180	(0.02	350	17	250	150	(5	4	2	(10	8.3
SL-13535	(10	(5	10	50	2	0.02	360	0.02	400	--	---	---	--	--	--	---	10.8

slightly granulated *OLIVINE* oikocrysts. *PYRRHOTITE* oikocrysts are intergrown with plagioclase.

Hornfelses.

PLAGIOCLASE in these rocks is fine-grained to very fine-grained with an An content of 67 to 78%, and is poorly twinned. *OLIVINE* is equant and developed as anhedral poikiloblasts. *ORTHOPYROXENE* is present as poikiloblasts and as granulated oikocrysts, and may form rims on *OLIVINE*. *CLINOPYROXENE* occurs as poikiloblasts. Rocks with clearer igneous textures as oikocrysts and lath-shaped plagioclase are included in this subunit. *PYRRHOTITE* is observed in small amounts in the igneous rocks and hornfelses and is surrounded by a *SPINEL*.

Hydrothermally altered pegmatoids with contaminant aspects.

PLAGIOCLASE, composition An 47-74, is partially destroyed as result of incipient alteration. Oscilatory as well as patchy zoning is observed. Resorbtion by *QUARTZ* and replacement by SULFIDE is common, preceeded by alteration into masses of *SPHERULITIC CHLORITE, SERPENTINE, MUSCOVITE* and *LEUCOXENE*. *OLIVINE*, originally present, can be recognized as pseudomorphs of *SERPENTINE* in poikilitic intergrowths. *ORTHOPYROXENE* is developed as oikocrysts and intergrown with partly resorbed *PLAGIOCLASE* and replaced at the outside by *CUMMINGTONITE*. *CLINOPYROXENE* is developed as oikocrysts and smaller crystals surrounding *OLIVINE*. *QUARTZ, RED-BROWN BIOTITE* and *GREEN-BROWN AMPHIBOLE* form poikiloblastic overgrowths $\pm$*APATITE* and *CUMMINGTONITE* and *SULFIDE* on alteration products of the formerly mentioned primary silicates. Contaminant rock can be recognized in this subunit for its rather acid *PLAGIOCLASE* (An 27%) which is graphically inter-grown with *QUARTZ*. *CHALCOPYRITE* replaces secondary *AMPHIBOLE* and *PYRRHOTITE* replaces *SERPENTINE*. *PYRRHOTITE* also seems to replace *CHALCOPYRITE* through graphic intergrowth. The intergrowth bears rounded inclusions of an unknown mineral having pink-blue-grey tones and a reflectance estimated at 25. This mineral has been tentatively labeled a *SPINEL* variety. When the replacement of *CHALCOPYRITE* by *PYRRHOTITE* is almost completed *PENTLANDITE* appears. *ILMENITE* and *MAGNETITE* have inclusions of *CHALCOPYRITE* and *PYRRHOTITE* along cracks and borders. *ILMENITE* occurs as prisms in *PLAGIOCLASE*, parallel to (010), is also intergranular with respect to *PLAGIOCLASE*, and occasionally is associated with *APATITE*. *MAGNETITE* is surrounded by probably a *SPINEL* having a reflectance estimated about 10. Finely scaled symplectitic intergrowths in *ORTHOPYROXENE* of an *OPAQUE* have yellow-violet-purple-greenish reflectance and bright yellow, blue and red anisotropic colors.

Pyroxenite

Feldspatic orthopyroxenite has *PLAGIOCLASE*, composition An 52-67%, which is twinned following the albite law. *ORTHOPYROXENE* crystals display cumulus textures and *OLIVINE* oikocrysts enclose *PLAGIOCLASE* and *ORTHOPYROXENE*.

Sulfide lenses

Three *SULFIDE* lenses are present in this section. The uppermost one (224.5′-225.5′) is hosted by a contaminated orthopyroxene-bearing pegmatoidal diorite (223′-226.4′), which is underlain by about 3′ of contaminated feldspathic orthopyroxenite to diorite. This lense is characterized by patchy replacement of *PYRRHOTITE* with *MARCASITE* + *PYRITE*, probably induced by hydrosilicate veins. *PENTLANDITE* occurs as rounded blebs in *PYRRHOTITE* with many silicate inclusions. *CHALCOPYRITE* occurs as local concentrations along the fringes of *PYRRHOTITE* and also replaces *SPHERULITIC CHLORITE*. *PYRITE* $\pm$ *CHALCOPYRITE*, the former locally displaying a cubic crystal form, replace *PLAGIOCLASE* along cracks and cleavage. The lower two sulfide lenses at 255′-257.8′ are associated with olvine-bearing orthopyroxenite.

The uppermost of these lower two sulfide lenses (255′-256.20′) is composed of *PYRRHOTITE* having rather strong anisotropic colors in grey-green tones. *PYRRHOTITE*, the major sulfide, occurs as larger crystals, as matrix and as smaller prisms radiating from cracks in an anisotropic unknown mineral (*SPINEL* ?). The latter resembles *MAGNETITE* but has too low a reflection, namely 10, and it is pseudomorphic after *OLIVINE*. *PENTLANDITE* blebs in *PYRRHOTITE* have a strongly cracked habit and are typically dissected and surrounded by an isotropic unknown mineral having a reflectance of 25, pink-blue-grey tones, and provisionally labeled as a *SPINEL*. *PENTLANDITE* also occurs as unmixed parallel veinlets in *PYRRHOTITE*, parallel to the extinction position. *CHALCOPYRITE* is found as smaller blebs in *PYRRHOTITE* and frequently is associated with *PENTLANDITE*. *ARSENOPYRITE* is observed as rounded inclusions in *PYRRHOTITE* and as a discontinuous core in a *SPINEL* veinlet. *SPINEL* (?) vein systems are cross-cutting, and have *ILMENITE* (?) centers that are fringed by silicates. *ILMENITE* and *MAGNETITE* occur as symplectic intergrowths with *OLIVINE*, *ORTHOPYROXENE* and *PYRRHOTITE*. The average sulfide content in the unit is about 2.8%.

The unit is further characterized by an increase of TiO_2, Cu/Cu + Ni ratio, Pd and Sr, as well as a decrease in anorthite content of the plagioclase with depth.

323′-387′ Subophitic medium to coarse-grained troctolite.

PLAGIOCLASE, composition An 62-67%, has cumulus textures and is dusted with semi-opaque inclusions. *OLIVINE* occurs as anhedral cumulus crystals and is rimmed with *CLINOPYROXENE* symplectite and also occurs as oikocrysts. *CLINOPYROXENE* is in the form of post-cumulus crystals which are intergranular with respect to *PLAGIOCLASE* and as oikocrysts. *ORTHOPYROXENE* is observed locally as discrete crystals. *OLIVE-GREEN AMPHIBOLE* replaces *CLINOPYROXENE*. *RED-BROWN BIOTITE* + *SULFIDE* replace *OLIVINE* and are surrounded by *CLINOPYROXENE* symplectite. *BIOTITE* can also occur in voids within subophitic texture and with *CLINOPYROXENE*, *PLAGIOCLASE*, BROWNISH *AMPHIBOLE* and *OPAQUES*. *ILMENITE* forms part of large oikocrysts intergrown with *CHALCOPYRITE* and *PYRRHOTITE*, up to O-.2′ size. It is also found as smaller crystals, probably replacing *OLIVINE* and surrounded by *RED-BROWN BIOTITE* which is, in turn, rimmed by *CLINOPYROXENE* symplectite. The replacement by *ILMENITE* is preceded by invasion of *SERPENTINIZED OLIVINE* by *SPINEL*(?) along fractures. *MAGNETITE* dissects and surrounds *ILMENITE*. *PYRRHOTITE* AND *CHALCOPYRITE* occur in voids in subophitic texture and replace serpentinized *OLIVINE*. *PYRRHOTITE* encloses *CHALCOPYRITE* and is in turn rimmed by *RED-BROWN BIOTITE*. *PYRRHOTITE* can occur as symplectite-like intergrowths with *PLAGIOCLASE* reflecting segregated droplets and can invade *ILMENITE*. *CHALCOPYRITE* also is observed as inclusions and veinlets in *BIOTITE*. The average sulfide content of this unit is estimated to be about 4%. Discontinuous zones of alteration with secondary Fe-Mg hydrosilicates and greenish-white plagioclase are mostly associated with this unit.

The lithochemistry of the unit distinguishes it from the overlying and underlying rock units by the sharp breaks that result from reversed trends. These are expressed by a strong decrease of TiO_2, Sr, Cu/Cu + Ni ratios and constant low Pd contents with depth.

The two sulfide layers that straddle the boundary with the underlying rock unit will be described in that section. There, the enclosing rock shows considerable contamination and a break in lithochemistry for several elements at 400′-415′ indicating that the boundary might well be lower.

387′-492′ Mixed rocks

This unit is a mixture composed of from top to bottom the following rock types: mainly contaminant rock; an assemblage of hornfelsic metasediments with sulfide lenses and recrystallized microgabbro; olivine-bearing gabbronorite; and troctolite with hornfelsic aspects. The lower-most 35′ are composed of a mixture of the above rocks with pegmatoidal and picrite intercalations.

Sulfide Lenses

Three *SULFIDE* lenses have been observed; two at the top in a mixed zone of contaminant rock with overlying troctolite at 384.4′-385′ and 386.10′-387′, and a lower lens from 399′-400.5′ associated with metasedimentary hornfels in contaminant rock. The *SULFIDE* lens at the boundary of the troctolite and the underlying contaminant rock at 386.5′ is in pyroxenite and shows considerable similarity to the *SULFIDE* lens at 256.20′. *PENTLANDITE*, however, has more of a resemblance to that found in the uppermost *SULFIDE* layer in the contaminant rock at 224.50′. *PENTLANDITE* seems to concentrate in the margins of transecting *QUARTZ-CARBONATE-SERPENTINITE* veins in company with some *MARCASITE* that probably replaces of *PYRRHOTITE*. *CHALCOPYRITE* is dispersed as rounded inclusions in *PYRRHOTITE*.*MAGNETITE* occurs as anhedral blebs in *PYRRHOTITE* and *ILMENITE* is only occasionally observed.

The lowermost *SULFIDE* layer at 399.2′ is in pyroxenite and is very similar to the previously described lenses in pyroxenite. *CHALCOPYRITE* occurs frequently along contacts with *SILICATES*.

Contaminant rock

These are multicoloured medium-grained rocks of diorite composition, having macroscopically visible *BIOTITE* booklets, pink *FELDSPARS*, greenish *FE-MG HYDROSILICATES* and "milky" silicates (probably *CORDIERITE*). *PLAGIOCLASE* has an anorthite content varying from 37 to 80%, with patchy and cyclic zoning. The crystals are resorbed by *QUARTZ* and *ALKALI FELDSPAR*. *ORTHOPYROXENE* occurs in pyroxenitic aggregates, including *CLINOPYROXENE*, and is surrounded by *SECONDARY FE-MG HYDROSILICATES*. Porphyroblasts of *ORTHOPYROXENE* and graphic *QUARTZ* + *PLAGIOCLASE* are observed along the fringes with hornfels. *ALKALIFELDSPAR* is represented by the variety *ORTHOCLASE* (-2V = ±50°), which encloses *PLAGIOCLASE* and, in turn, is itself enclosed by *QUARTZ*. *CORDIERITE* has been observed, partly or completely altered into *CHLORITE*. *BIOTITE* is present as red-brown poikiloblasts.

Hornfelses

This subunit is a locally brecciated mixture of metasediments (pelitic, arenitic and arkosic) and igneous rocks of anorthosite to gabbronorite composition.

Very fine-grained metasedimentary hornfels:

PLAGIOCLASE has an anorthite content of 49-62% and is twinned following the albite law. It has an euhedral basic core and may locally be perthitic. Poikiloblastic intergrowths with *QUARTZ*, *OPAQUE* minerals and *ORTHOPYROXENE* are observed. *CORDIERITE* is present as euhedral to subhedral porphyroblasts showing simple and sector twinning with trillings (-2V = ±80°). *ORTHOPYROXENE* occurs as small, strongly pleochroic anhedral poikiloblasts following layering. It is also observed as prisms in pyroxenite, often associated with matrix sulfide and having many translucent *BIOTITE* inclusions. *ALKALIFELDSPAR*, with a small axial-2V, is probably a variety of *SANIDINE*. *QUARTZ* in the fine- to medium-grained clastic hornfelses is subrounded and encloses *PLAGIOCLASE*, *SECONDARY SILICATES* and *SULFIDE*. *RED-BROWN BIOTITE* forms large poikiloblasts. The secondary silicates *CHLORITE, ZOISITE, SERICITE* and *CUMMINGTONITE* are intergranular in arenites and arkoses and seem to be replaced by *MATRIX SULFIDE*. *PYRRHOTITE* forms matrix sulfide with prismatic *ORTHOPYROXENE* and is relatively strongly anisotropic. *PENTLANDITE* and *CHALCOPYRITE* blebs in *PYRRHOTITE* are veined with *SPINEL*. *PYRITE* + *PYRRHOTITE* + *CHALCOPYRITE* + *MARCASITE* replace *MG-FE HYDROSILICATES* and *PLAGIOCLASE*, forming the matrix of arenite and arkose.

Igneous hornfels:

These rocks are very fine to medium-grained equant to subophitic textured showing layered(?) alternation of quartz-bearing olivine gabbronorite to anorthosite compositions. *PLAGIOCLASE*, composition An 37-79%, is twinned following albite, Carlsbad and acline laws and has patchy zoned, euhedral basic cores. Sieve textured *CLINOPYROXENE*, *ORTHOPYROXENE* and *CHLORITE* are also present. *ORTHOPYROXENE* has a prismatic as well as equant habit with relict poikilitic texture. *OLIVINE* is present as poikiloblasts with relict poikilitic texture. *ANDRADITE* is occassionally observed in clusters with *PLAGIOCLASE* and *OPAQUE*S. *QUARTZ* forms graphic intergrowths with *PLAGIOCLASE*.

Recrystallization was observed at 433.70′ in the form of euhedral to subhedral *PLAGIOCLASE* in fine-grained equant plagioclase rock with secondary *FE-MG HYDROSILICATES*, which seems to intrude metasedimentary hornfels.

Olivine bearing gabbronorite and troctolite
A rather continuous stretch of this rock is found from 440'-457' and it macroscopically resembles the overlying troctolite unit at 323'-387'.

PLAGIOCLASE, with an anorthite content of 55-85%, is fine to medium-grained and patchy zoned with basic overgrowth on cores. Smaller crystals are subhedral to euhedral and larger crystals are anhedral. *ORTHOPYROXENE* is slightly prismatic and surrounds *OLIVINE*. It also occurs as large postcumulus crystals. *CLINOPYROXENE* forms anhedral equant *PYROXENITIC* "spots" and surrounds *OLIVINE*, which has been mostly *SERPENTINIZED*. The *OLIVINE* occurs as oikocrysts up to 6 mm across and as discrete, medium-grained cumulus crystals. Spherulitic textured *CHLORITE* forms pseudomorphs after *PLAGIOCLASE*. *RED-BROWN BIOTITE* forms poikiloblasts up to 6 mm across, overgrowing white-coulored altered *PLAGIOCLASE*, and scavenging *APATITE* and *OPAQUE MINERALS*. *PREHNITE* and *CARBONATE* are also formed during this phase of growth. *OPAQUE MINERALS* occur along cracks and as blebs.

Pegmatoidal diorite
These biotite-rich rocks with contaminated appearance occur over the about lower 30' of this unit.

PLAGIOCLASE, having an anorthite content of 47%, is coarse-grained, subhedral and twinned following the albite and Carlsbad laws. *CLINOPYROXENE* is postcumulus and forms a mixture of semi-opaque needles with *ORTHOPYROXENE*, possibly representing inverted *PIGEONITE*. *QUARTZ* occurs in graphic intergrowths with *PLAGIOCLASE*. *APATITE* is present as euhedral inclusions in *PLAGIOCLASE, SECONDARY HORNBLENDE*, and is also associated with *QUARTZ, REDDISH-BROWN BIOTITE* and *SULFIDE* poikiloblasts. Secondary *GREEN-BROWN AMPHIBOLE* is an alteration product of *CLINOPYROXENE*. *REDDISH-BROWN BIOTITE* surrounds *OPAQUE MINERALS*. *PYRRHOTITE* occurs as subhedral oikocrysts and anhedral clots, enclosing altered *PLAGIOCLASE, BIOTITE, BROWN-GREEN AMPHIBOLE* and *APATITE*. *CHALCOPYRITE* occurs in masses of altered silicates, enclosing *APATITE* and *PENTLANDITE*. It is also intergrown with *ILMENITE* sheets, and as rounded crystals enclosing *ILMENITE*. *ILMENITE* occurs as sheets intergrown with *BIOTITE* and as oikocrysts intergrown with *BROWN-GREEN AMPHIBOLE*, altered *PLAGIOCLASE* and *QUARTZ*. The textures described above point to the following hydrothermal processes.

1. Alteration of *PLAGIOCLASE* and *FE-MG SILICATES* to *CHLORITE-CUMMINGTONITE-SAUSSURITE-SERICITE-ZOISITE-LEUCOXENE-CARBONATE* masses. Replacement of *PYRRHOTITE* by *MARCASITE + PYRITE*. These processes seem to be spatially related to *CHLORITE-SERPENTINITE* veins.

2. Blastic growth under static conditions of *RED-BROWN BIOTITE* poikiloblasts, *BROWN-GREEN AMPHIBOLE, QUARTZ* and *SULFIDE ±PREHNITE*, enclosing euhedral *APATITE*. Replacement of *OLIVINE* by opaque minerals (*OXIDE + SULFIDE*). Replacement of *PLAGIOCLASE* in clastic hornfels by *SULFIDE*. The average sulfide content of this unit is estimated to be 5.3%.

The lithochemistry of this unit shows no clear trends except for an increase of Cu/Cu + Ni ratios and Pd with depth and C contents≥ 0.3%. Pd shows a peak value of 190 ppb at the base of the contaminant rock (399-405') that separates this unit from the overlying unit.

492'-576' Altered micaceous hornfels composed of alternating layers of arenitic, arkosic and pelitic sediments with very fine-grained trachytic(?) lenses.
Altered mafic to ultramafic flows, quartzites and rhyolite to andesite tuff occur as intercalations. Pink-buff granite veins are present near the base of this unit and these show graphic intergrowths of *QUARTZ-ALKALIFELDSPAR* and *QUARTZ-TOURMALINE*.

Arkose, arenite and wacke.
QUARTZ in these rocks is well rounded and sorted. *ALKALIFELDSPAR* occurs intergranular to *QUARTZ*. *MUSCOVITE* (*PENNINE*?) is found as porphyroblasts along the contact with trachyte. It occurs in aggregates with *CHLORITE*, probably as pseudomorphs after *CORDIERITE*. Disseminated *PYRITE* and locally *PYRRHOTITE* make up to about 5% of the rock. *PYRITE* is locally connected through veins. The *SULFIDES* with anhedral to sub-cubic crystal forms are intergranular with respect to *QUARTZ* and seem to replace *FELDSPAR* and *MICA*. *CHALCOPYRITE* is locally present as a few specks. *RUTILE* is associated with aggregates of *MUSCOVITE*.

Trachyte.
These are very fine-grained lenses of euhedral to subhedral ALKALI-FELDSPAR, that appear to be the same as the intergranular feldspar in the metasediments.

Altered mafic to ultramafic basalts and cherts (529.6'-531.8')These are indicated by lenses of *CHLORITE + CARBONATE, COLOURLESS MICA, BIOTITE, FELDSPAR, CHLORITE* and *BIOTITE* bearing cherts, containing up to 30% *SULFIDE*. The ore minerals occur as a *PYRITE* matrix, as lenses in altered mafic to ultramafic layers, as *PYRITE + PYRRHOTITE + CHALCOPYRITE* in *QUARTZITIC LENSES* and as a few very fine-grained *PYRITE + PYRRHOTITE + CHALCOPYRITE + MAGNETITE GRAINS* in a tuffaceous layer of probably andesitic composition. The tuffs are very fine-grained and are composed of *QUARTZ, SERICITE, CHLORITE* and *BIOTITE*. *ORE* minerals include *PYRITE*, *PYRRHOTITE*, *CHALCOPYRITE* and *MAGNETITE*. The average sulfide content of this unit is about 1.5%.

576'-837' Pelitic schist, gneiss, arenite and arkose.
These rocks are part of a thinly layered sequence. Plastic deformation, flowage and contortion of layering is evident from 623'-783'. This unit contains intercalations of *DRAVITIC TOURMALINE, SAPONITE, DIOPSIDE and GROSSULARITE* (X-Ray Diffraction)-bearing calcsilicate rocks (628.3'-653'), (660'-668') topped by *SULFIDE*-bearing foliated quartzite. This quartzite is very fine-grained and laminated as the result of graded(?) bedding and variable *SULFIDE*, *BIOTITE* and *TOURMALINE* content. Pseudo anisotropic *GROSSULARITE* inclusions are observed in medium to coarse-grained euhedral *QUARTZ* with *DRAVITIC TOURMALINE*. PYROXENE ± *BASIC PLAGIOCLASE ±CHLORITE ±HORNBLENDE ±ZOISITE*

with accessory *ZIRCON* show lamination in the calcsilicate rock. The *SULFIDES* show a laminated *PYRRHOTITE* network with semi-massive *PYRITE* blebs, veins and layers with lower sulfide content. *CHALCOPYRITE* specks are present locally. *CHLORITE* constitutes about 40% of the rock in the schists of the upper part of this unit. *OLIGOCLASE* and *CORDIERITE* poikiloblasts appear with *REDDISH—BROWN BIOTITE* ±*TOURMALINE* in schist and gneiss at a depth of about 750′. The arkose and arenite, with intergranular *ALKALIFELDSPAR*, tend to decrease in volume downhole and are replaced by veins with *CORDIERITE* pseudomorphs exhibiting both conformable and cross-cutting relationships to layering. These veins are conformable with respect to foliation of the surrounding metasediments.

837′-1003′ T.D. Biotite-chlorite gneiss, biotite schist and metawacke.
This unit consists of intercalated arkosic, *TOURMALINE* bearing, fine-grained biotite-chlorite gneiss, biotite schist, and metawacke with *GROSSULARITE* bearing calcsilicate, metavolcanic and *KAOLINITE* (894′-895.3′) (X-Ray Diffraction) components. Cataclastic intervals and joints cemented with *LAUMONITE* (X-Ray Diffraction) occur from 822.60′ downwards. *PLAGIOCLASE*, *ALKALIFELDSPAR* and *CHLORITE* content varies across layering with the colour of *BIOTITE* ranges from green-brown to red-brown. *TOURMALINE* and *ZIRCON* are present as accessories. Two directions of foliation are present, one parallels layering, the other crosscuts it. *GROSSULARITE*-bearing calcsilicate inclusions are observed in *QUARTZ* veins. These are associated with metavolcanics and are reflected by *CHLORITE* + *SERICITE* + *ALBITE* + *SECONDARY AMPHIBOLE INTERCALATIONS*.

The layering of the intrusive rocks in the upper 166′ makes an angle of 20-45° to the core axis, and the angle of the metasediments to the core axis varies from 0-70°.

Acid Test Results

Footage	Angle from Horizontal
133′	58°
300′	58°
500′	58°
700′	58°
900′	56.5°

Notes: A detailed graphic log is available for study. Nine thin and forty-one polished thin sections were made from this drill hole. A total number of 83 rock samples was chemically analyzed. Analytical results follow in Table FHL-1.

CONDENSED GEOLOGIC LOG FOR DDH NR-1

The hole was drilled at an angle of 52° and an azimuth of 40°.

0′-224′ Overburden.

224′-298.6′ Weakly laminated oxide and olivine-bearing gabbro containing plagioclase-rich and plagioclase-olivine lenses, and olivine graded layering.

298.6′-406.3′ Similar to above but with intercalations of oxide gabbro making up about 39% and oxide-rich gabbro making up about 15% of the section. 298.6′-311′, 325.5′-337.9′, 350′-352′, 378.3′-383.4′, 395.6′-406.3′, oxide gabbros. 353′-368.8′and 379.8′-380.5′ are oxide-rich gabbro, assaying 1650 ppm V. 391.7′-395.6′, mesocratic oxide-bearing gabbro.

406.3′-496.3′ Olivine and oxide-bearing gabbro with intercalations of 409.4′-417.8′, 459′-461.8′ mesocratic olivine and oxide-bearing gabbro, and 455.3′-458.2′, 480.5′-486.3′ tonalite and fine-grained granite veins. At 464.6′ a fault occurs with quartz filling.

496.3′-585′ Olivine and oxide-bearing gabbro with intercalations of olivine-bearing oxide gabbro making up about 42% of the section and mesocratic oxide-bearing gabbro. 496′-496.9′, 502′-510.7′, 513′-514.3′, 540.4′-541.4′, 542.3′-544′, 553.6′-556.5′, 556.8′-564.7′, 565′-568.3′, 570′-572.3′,577.4′-585′, intercalations of olivine-bearing oxide gabbro. An intercalation of layered(?) to massive fine-grained diorite-gabbro is found at 544′-553′, with amphibole-bearing coarse-grained plagioclase lenses digesting oxide gabbro at 544.4′-545.3′, 573′-575′ and 581′-581.8′.

585′-647′ Olivine and oxide-bearing gabbro with intercalations of amphibole-bearing granite veins and dikes up to 0.3′ thick.

647′-706′ Layered sequence of mainly oxide-bearing gabbro and mesocratic oxide-bearing gabbro with intercalations of oxide gabbro, making up about 43% of the section. 704.3′-705.3′, intercalation of oxide-rich gabbro, assaying 3600 ppm V, making up about 1.7% of this section.

706′-807.8′ Mainly oxide and olivine-bearing gabbro with graded layering of olivine and intercalations of mesocratic oxide-bearing gabbro at 711.8′-717′, 718′-721′, 725.3′-726′, 779.6′-781.3′. Olivine-bearing oxide gabbro, making up about 7% of the section, is found at 751.7′-757.6′ and 768.9′-769.9′. Amphibole-bearing joints occur at 707.7′-708.1′, 744′-745′, 756′-758.5′, 759.4′-760′ and 773′-774′.

807.8′-827′ Interlayered sequence of olivine-bearing oxide gabbro and olivine and oxide-bearing gabbro. The oxide gabbro makes up about 53% of the section, and assays 2400 ppm V at 816.8′-818.8′.

827′-892.6′ Olivine and oxide-bearing gabbro, with cataclastic zone having secondary Fe-Mg hydrosilicates and quartz veining at 842.3′-871.5′.

892.6′-910.4′ Alternating layers of olivine and oxide-bearing gabbro and olivine-bearing oxide gabbro. The latter makes up about 39% of this section and assays 1700 ppm V, 300 ppb Pd and 150 ppb Pt at 901.8′-903.8′.

Table FHL-1

DDH FHL-1

Analytical Results (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Cr	Co	Ni	Cu	P2O5	Ti	TiO2	V	Ru	Rh	Pd	Os	Ir	Pt	Au	Zn	As	Ag	Sn	Sb	Te	Pb	Bi	C Tot	F	S	Cl	Rb	Sr	Na2O	K2O	Fe	FEO	Fe2O3	FeTot
		PPM	PPM	PPM	PPM	PCT	PPM	PCT	PPM	PPB	OPT	PPB	PPB	PPB	PPB	PPB	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PCT	PPM	PCT	PPM	PPM	PPM	PCT	PCT	PCT	PCT	PCT	PCT
CSL-13963	160.2-164.8	180	250	950	1500	0.29	---	0.80	100	(15	(.002	40	(3	1.1	105	20	---	(5	0.5	(10	10	(10	10	(2	0.20	170	1.29	100	20	160	1.30	0.70	)10.0	---	20.00	---
CSL-14080	164.8-169.3	200	65	400	120	0.10	1120	---	45	(5	(.002	10	(3	0.1	(50	(5	---	(5	(0.5	(10	(5	(10	(5	2	0.04	40	0.02	(100	(5	250	1.20	0.30	---	7.80	1.45	10.20
CSL-14081	169.3-179.0	200	55	300	140	0.15	1440	---	45	(5	(.002	10	(3	0.2	(50	(5	---	(5	(0.5	(10	(5	(10	(5	(2	0.07	60	0.03	(100	(5	255	1.80	0.30	---	7.50	2.10	10.40
CSL-14082	179.0-188.6	190	60	400	170	0.11	1150	---	90	(5	(.002	10	(3	0.6	(50	(5	---	(5	(0.5	(10	(5	(10	(5	2	0.04	45	0.05	(100	7	250	1.00	0.40	---	5.50	3.90	10.00
CSL-14083	188.6-196.2	160	80	600	550	0.06	830	---	40	(5	(.002	35	(3	0.5	(50	(5	---	(5	(0.5	(10	(5	(10	(5	2	0.07	40	0.11	(100	(5	230	1.20	0.30	---	7.60	5.00	13.40
CSL-13964	196.2-197.2	450	130	700	1700	0.45	---	0.50	400	(15	(.002	70	(3	0.7	(50	20	---	(5	0.5	(10	10	(10	20	(2	0.08	110	0.44	100	30	320	1.20	2.40	)10.0	---	18.00	---
CSL-14084	197.2-202.0	250	50	350	190	0.08	1900	---	210	(5	(.002	10	(3	0.3	(50	(5	---	(5	(0.5	(10	(5	(10	(5	(2	0.07	75	0.08	(100	(5	235	1.80	0.40	---	7.70	1.80	10.40
CSL-13972	202.0-215.1	170	80	450	300	0.16	---	0.40	100	(50	(.002	10	(8	0.4	(50	5	---	(5	(0.5	(10	5	(10	5	2	0.06	65	0.15	(100	6	240	1.10	0.50	)10.0	---	11.90	---
CSL-13977	215.1-223.0	150	140	800	350	0.01	---	0.35	170	(30	(.002	20	(5	0.6	(50	15	---	30	(0.5	(10	20	10	10	2	0.06	95	0.29	150	15	100	0.70	0.60	)10.0	---	20.00	---
CSL-13981	223.0-224.7	600	450	3600	3400	0.12	---	0.40	350	--	(.002	70	--	---	(50	20	---	5	1.0	(10	15	10	15	(2	0.20	210	8.68	150	36	57	1.20	1.10	)10.0	---	29.00	---
CSL-13978	224.7-225.4	350	900	7000	8000	0.07	---	0.20	200	50	(.002	140	12	6.0	255	60	---	(5	3.0	(10	15	20	10	(2	0.10	120	19.30	(100	14	40	0.70	0.70	)10.0	---	47.00	---
CSL-13979	225.4-229.7	500	170	950	1400	0.11	---	0.55	400	(30	(.002	45	5	0.9	55	15	---	(5	(0.5	(10	(5	(10	10	(2	0.02	170	2.37	100	29	125	1.70	0.90	)10.0	---	18.80	---
CSL-13986	229.7-239.7	300	160	800	600	0.10	---	0.90	140	(30	(.002	35	(5	1.0	(50	10	---	(5	(0.5	(10	(5	(10	5	(2	0.04	85	0.65	(100	11	180	1.50	0.40	)10.0	---	20.50	---
CSL-13992	239.7-249.7	190	130	650	600	0.10	---	1.50	180	(10	(.002	20	(3	0.8	(50	5	---	(5	(0.5	(10	(5	(10	5	(2	0.10	85	0.68	(100	15	230	2.30	0.50	)10.0	---	18.40	---
CSL-13993	249.7-255.3	250	190	1000	1150	0.16	---	1.35	190	10	(.002	25	3	1.1	(50	5	---	(5	(0.5	(10	5	10	10	(2	0.04	80	1.68	(100	21	200	2.30	0.60	)10.0	---	21.00	---
CSL-13994	255.3-256.3	400	800	6300	6700	0.11	---	1.20	200	20	(.002	95	3	9.1	(50	25	---	10	1.5	(10	(5	20	5	(2	0.08	50	12.63	100	(5	63	0.70	0.20	)10.0	---	42.00	---
CSL-13995	256.3-258.0	250	350	1600	1350	0.09	---	0.70	140	(20	(.002	110	6	3.2	(50	15	---	(5	(0.5	(10	(5	10	5	(2	0.04	65	3.41	(100	12	200	1.90	0.20	)10.0	---	24.00	---
CSL-14085	258.0-268.0	140	80	600	300	0.09	2190	---	60	(5	(.002	40	(3	0.8	(50	5	---	(5	(0.5	(10	(5	(10	(5	2	0.07	75	0.07	(100	(5	220	1.60	0.40	---	9.90	3.10	14.10
CSL-14086	268.0-277.5	170	85	750	600	0.11	3000	---	110	(5	(.002	90	(3	1.0	65	20	---	(5	(0.5	(10	(5	10	10	2	0.11	85	0.34	(100	7	220	2.10	0.50	---	11.20	3.35	13.80
CSL-13996	277.5-282.8	300	180	900	1000	0.11	---	0.90	120	(20	(.002	55	(5	1.6	(50	10	---	(5	(0.5	(10	(5	(10	10	4	0.04	70	1.27	(100	11	235	2.60	0.70	)10.0	---	20.00	---
CSL-14087	282.8-293.0	200	75	700	800	0.19	5000	---	110	(5	(.002	60	(3	1.0	(50	25	---	(5	(0.5	(10	(5	(10	(5	2	0.09	95	0.15	(100	(5	230	1.50	0.40	---	11.30	2.35	14.90
CSL-14088	293.0-303.0	180	65	550	550	0.20	5890	---	120	(5	(.002	25	(3	0.3	(50	(5	---	(5	(0.5	(10	(5	(10	(5	(2	0.04	130	0.07	100	(5	260	1.90	0.50	---	9.10	2.15	12.30
CSL-14089	303.0-305.0	250	120	1000	850	0.20	4970	---	130	(5	(.002	75	(3	1.2	(50	10	---	(5	(0.5	(10	10	(10	20	(2	0.07	120	0.08	(100	(5	200	1.60	0.40	---	11.60	4.35	17.20
CSL-14002	305.0-315.0	190	120	1300	4300	0.18	---	1.10	95	(20	(.002	145	(3	2.2	80	50	---	(5	1.5	(10	5	(10	5	(2	(0.02	120	0.67	(100	18	230	2.10	0.60	)10.0	---	17.80	---
CSL-14008	315.0-325.0	250	120	750	2700	0.18	---	1.15	90	(20	(.002	25	(4	0.6	(50	15	---	(5	1.0	(10	(5	(10	10	(2	0.08	120	0.99	100	15	275	2.30	0.80	)10.0	---	14.10	---
CSL-14014	325.0-335.0	400	130	550	1900	0.18	---	1.50	120	(20	(.002	20	(3	0.4	(50	10	---	(5	0.5	(10	5	(10	5	2	0.12	120	1.05	(100	22	270	2.60	0.70	)10.0	---	16.00	---
CSL-14020	335.0-345.0	250	160	650	2600	0.16	---	4.40	200	(20	(.002	30	(3	6.4	(50	15	---	(5	1.0	(10	(5	10	5	2	(0.02	80	1.31	125	9	255	3.00	0.50	)10.0	---	19.00	---
CSL-14026	345.0-355.0	140	130	400	1100	0.13	---	5.50	300	(20	(.002	20	7	0.6	(50	5	---	(5	(0.5	(10	(5	(10	5	(2	0.04	85	0.61	150	8	245	2.30	0.50	)10.0	---	18.90	---
CSL-14032	355.0-365.0	170	120	400	1100	0.20	---	4.80	250	(20	(.002	20	(3	0.7	(50	5	---	(5	(0.5	(10	(5	(10	5	4	0.08	130	0.53	125	15	250	3.00	0.70	)10.0	---	17.80	---
CSL-14038	365.0-375.0	200	110	550	1650	0.11	---	3.75	200	(20	(.002	20	(4	0.4	(50	10	---	(5	0.5	(10	(5	(10	5	(2	(0.02	100	0.91	125	27	225	3.00	0.80	)10.0	---	17.50	---
CSL-14044	375.0-384.4	250	120	550	1100	0.17	---	3.30	200	(20	(.002	30	(3	0.5	80	5	---	(5	(0.5	(10	(5	(10	5	2	0.14	100	1.06	100	14	240	2.70	0.60	)10.0	---	17.50	---
CSL-14045	384.4-385.0	300	500	5200	7100	0.09	---	1.60	200	(20	(.002	115	(3	5.4	(50	35	---	20	10.0	(10	(5	10	15	(2	0.04	65	12.25	(100	(5	140	1.30	0.40	)10.0	---	38.00	---
CSL-14046	385.0-386.1	300	200	1600	3800	0.09	---	1.95	200	(20	(.002	70	(3	1.7	(50	25	---	(5	1.0	(10	(5	(10	20	2	0.12	90	5.45	(100	11	215	2.60	0.60	)10.0	---	24.00	---
CSL-14047	386.1-387.0	550	600	5600	9700	0.07	---	0.65	350	30	(.002	125	3	6.1	(50	35	---	25	1.5	(10	(5	10	5	(2	0.38	80	14.08	(100	(5	55	0.50	0.40	)10.0	---	43.00	---
CSL-14048	387.0-388.4	600	250	1800	3900	0.10	---	0.55	450	(15	(.002	55	(3	1.4	(50	15	---	5	0.5	(10	(5	(10	10	(2	0.20	120	4.70	(100	27	79	0.80	0.80	)10.0	---	24.00	---

Table FHL-1, (cont)

DDH FHL-1

Analytical Results (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Cr	Co	Ni	Cu	P205	Ti	TiO2	V	Ru	Rh	Pd	Os	Ir	Pt	Au	Zn	As	Ag	Sn	Sb	Te	Pb	Bi	C Tot	F	S	Cl	Rb	Sr	Na2O	K2O	Fe	FEO	Fe2O3	FeTot
		PPM	PPM	PPM	PPM	PCT	PPM	PCT	PPM	PPB	OPT	PPB	PPB	PPB	PPB	PPB	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PCT	PPM	PCT	PPM	PPM	PPM	PCT	PCT	PCT	PCT	PCT	PCT
CSL-14054	388.4-399.0	350	180	1300	3400	0.10	---	1.95	250	<20	<.002	60	<4	1.5	<50	25	---	<5	1.5	<10	<5	<10	15	<2	0.10	160	2.90	100	28	225	2.20	0.90	>10.0	---	18.50	---
CSL-14055	399.0-405.0	400	450	4400	6600	0.09	1370	---	300	<5	<.002	190	3	5.6	<50	<5	---	15	1.0	<10	<5	10	10	<2	0.52	110	10.90	<100	<5	215	1.20	0.40	---	15.60	14.60	32.00
CSL-14090	405.0-415.0	300	50	200	650	0.08	8780	---	300	<5	<.002	10	<3	0.2	<50	10	---	10	<0.5	<10	<5	10	10	<2	0.39	150	0.80	100	34	210	2.20	1.10	---	8.90	3.45	13.30
CSL-14061	415.0-425.0	300	120	850	3100	0.10	---	1.80	300	<30	<.002	90	<6	1.1	80	35	---	<5	2.0	<10	<5	<10	20	<2	0.20	85	3.07	<100	20	265	1.50	0.60	9.2	---	14.00	---
CSL-14091	425.0-435.0	200	65	750	1700	0.16	3020	---	150	<5	<.002	60	<3	0.6	<50	20	---	<5	1.0	<10	<5	20	20	<2	0.47	150	1.48	<100	17	245	1.50	0.80	---	6.70	2.45	9.90
CSL-14092	435.0-445.0	250	60	600	1450	0.07	4940	---	250	<5	<.002	55	<3	0.4	<50	30	---	10	<0.5	<10	<5	10	15	<2	0.35	150	1.90	<100	28	165	1.40	0.90	---	9.10	1.75	11.90
CSL-14111	445.0-455.0	300	70	900	2300	0.12	2820	---	140	<5	<.002	60	<3	0.9	<50	25	---	15	1.0	<10	<5	10	15	2	0.32	150	1.00	<100	29	195	2.10	0.90	---	9.90	3.20	14.20
CSL-14093	455.0-457.0	250	90	900	2400	0.10	2450	---	140	<5	<.002	35	<3	0.7	<50	15	---	<5	1.0	<10	<5	10	15	<2	0.30	180	0.96	<100	37	170	2.00	1.30	---	9.50	1.90	12.40
CSL-14067	457.0-466.6	350	160	1300	4200	0.15	---	1.00	95	<20	<.002	105	<4	1.5	55	200	---	<5	1.5	<10	<5	<10	10	<2	0.06	140	1.39	100	19	215	2.10	0.50	>10.0	---	17.50	---
CSL-14094	466.6-473.0	250	60	400	1200	0.27	8270	---	300	<5	<.002	30	<3	0.3	<50	40	---	<5	<0.5	<10	<5	10	15	2	0.32	240	0.86	100	42	170	1.90	1.40	---	9.80	1.85	12.70
CSL-14068	473.0-478.8	200	170	1000	3900	0.19	---	0.95	100	<10	<.002	120	<3	3.3	95	20	---	<5	1.5	<10	<5	<10	5	<2	0.12	150	0.63	150	18	180	2.40	0.40	>10.0	---	18.50	---
CSL-14069	478.8-480.3	170	150	1450	7500	0.55	---	2.40	160	<20	<.002	95	<3	2.1	95	35	---	<5	2.5	<10	<5	10	5	<2	0.08	200	1.76	175	33	220	2.60	1.10	>10.0	---	15.30	---
CSL-14070	480.3-486.2	200	150	950	3900	0.25	---	1.60	120	15	<.002	100	5	2.3	65	30	---	<5	1.0	<10	<5	10	5	<2	0.18	130	0.54	200	17	215	2.40	0.70	>10.0	---	18.80	---
CSL-14095	486.2-492.6	120	100	450	350	0.15	3910	---	100	<5	<.002	<5	<3	0.4	<50	10	---	10	<0.5	<10	<5	10	<5	<2	0.07	160	0.17	100	<5	185	1.50	0.60	---	13.30	0.85	15.60
CSL-14096	492.6-497.5	200	25	90	130	0.23	3990	---	160	<5	<.002	90	<3	0.1	<50	<5	---	15	<0.5	<10	<5	<10	15	<2	0.47	460	1.18	<100	110	60	1.30	3.60	---	5.00	2.50	8.20
CSL-14071	497.5-501.2	200	25	130	200	0.20	---	0.50	200	--	<.002	<5	--	--	<50	5	---	<5	<0.5	<10	<5	<10	10	<2	0.32	650	2.39	<100	115	15	1.60	4.30	5.7	---	8.10	---
CSL-14072	529.6-531.8	200	65	250	500	0.19	---	0.55	200	--	<.002	5	--	--	<50	25	---	10	1.0	<10	<5	10	20	2	0.12	510	8.04	<100	130	23	0.70	4.40	>10.0	---	20.00	---
CSL-14097	540.0-541.0	---	---	---	19	---	3850	---	---	---	---	--	--	---	--	--	110	--	---	---	--	---	2	--	---	---	0.85	---	93	150	1.80	3.60	---	---	---	---
CSL-14098	590.0-591.0	---	---	---	25	---	3330	---	---	---	---	--	--	---	--	--	117	--	---	---	--	---	3	--	---	---	0.03	---	155	105	1.50	5.10	---	---	---	---
CSL-14099	640.0-641.0	---	---	---	16	---	3000	---	---	---	---	--	--	---	--	--	43	--	---	---	--	---	24	--	---	---	0.03	---	24	1240	1.20	1.70	---	---	---	---
*CSL-13891	690.0-695.0	250	20	85	80	---	---	---	140	--	---	--	--	---	--	<5	150	<5	<0.5	<10	<10	<10	20	<2	---	---	---	---	--	--	---	---	6.0	---	---	---
*CSL-13897	695.0-700.0	200	20	75	55	---	---	---	100	--	---	--	--	---	--	<5	120	<5	<0.5	<10	<10	<10	30	<2	---	---	---	---	--	--	---	---	5.7	---	---	---
CSL-14073	728.6-729.2	200	20	100	110	0.17	---	0.70	180	--	<.002	<5	--	--	<50	10	---	5	<0.5	<10	<5	10	10	<2	0.02	590	1.67	<100	125	10	1.70	4.60	5.7	---	8.60	---
CSL-14100	740.0-741.0	---	---	---	60	---	3750	---	---	---	---	--	--	---	--	--	128	--	---	---	--	---	3	--	---	---	0.07	---	135	115	2.20	3.80	---	---	---	---
CSL-14101	790.0-791.0	---	---	---	22	---	3800	---	---	---	---	--	--	---	--	--	117	--	---	---	--	---	2	--	---	---	0.02	---	135	135	2.70	3.50	---	---	---	---
CSL-14102	842.0-843.0	---	---	---	20	---	3810	---	---	---	---	--	--	---	--	--	116	--	---	---	--	---	10	--	---	---	0.27	---	89	86	2.00	5.10	---	---	---	---
CSL-14103	892.0-893.0	---	---	---	26	---	4040	---	---	---	---	--	--	---	--	--	136	--	---	---	--	---	3	--	---	---	<0.02	---	160	115	2.10	4.20	---	---	---	---
CSL-14104	941.0-942.0	---	---	---	30	---	3590	---	---	---	---	--	--	---	--	--	125	--	---	---	--	---	4	--	---	---	<0.02	---	110	110	2.20	3.50	---	---	---	---
CSL-14105	992.0-993.0	---	---	---	61	---	3920	---	---	---	---	--	--	---	--	--	131	--	---	---	--	---	<2	--	---	---	0.10	---	145	100	2.40	4.40	---	---	---	---

* Additional Results		Mo	Cd	Mn	U	W	Se
		PPM	PPM	PPM	PPM	PPM	PPM
CSL 13891	690.0-695.0	6	2	300	<10	20	<5
CSL 13897	695.0-700.0	4	2	400	<10	<10	<5

910.4′-953′ T.D. Mainly mesocratic gabbro with graded layering of olivine. Intercalation of cataclastic and brecciated epi-metmorphic zones showing growth of pink feldspar, secondary Fe-Mg hydrosilicates, quartz veins and granitized zones are found at 925.6′-947′.

The foliation makes an angle of 70-80° to the core axis. The felsic veins and dikes make angles of 20-80° to the core axis with a tendency toward smaller angles at the lower part of the section.

PETROGRAPHY DDH NR-1

The vast majority of the laminated melanocratic rocks found in this drill hole are medium-grained weakly magnetic olivine and oxide-bearing gabbros, with conformable plagioclase-rich lenses. Lamination is caused by parallel orientation of plagioclase prisms and tablets. The average mineral composition of these rocks is 50-60% plagioclase, 30% clinopyroxene, 0-3% olivine and 7-15% oxide, with traces of chalcopyrite. The olivine content seems to reflect a crude layering which disappears near the top of the layers. Mesocratic varieties are frequently non-olivine bearing and have a thickness of up to about 30′.

Weakly layered olivine-bearing oxide gabbro members occur as intercalations up to 13′ thick and constitute about 13% of the rock. The lowermost contacts of the members are sharp and coincide with reappearance of olivine. The uppermost contacts are gradational. The average mineralogical composition of these rocks is 25-45% plagioclase, 30-55% clinopyroxene, 2-5% olivine and 20-25% oxide.

Strongly magnetic oxide-rich varieties are closely associated with oxide gabbro found at the base, or as intercalations, with a thickness varying from 0.5 to 16′ making up to 2.2% of the section. The average mineralogical composition of these rocks is 10-25% plagioclase, 30-45% clinopyroxene, 5-15% olivine and 35-40% oxide. The copper and vanadium content of these rocks assay respectively up to 1250 ppm and 3600 ppm at 704.3′-705.3′.

PLAGIOCLASE cumulus crystals are developed as prisms and tablets and may reflect compaction on *CLINOPYROXENE* cumulus crystals or clusters of finer grained crystals of *PLAGIOCLASE*, *OLIVINE* and *OXIDE* minerals. Compaction along larger *CLINOPYROXENE* cumulus crystals gives rise to deformation of plagioclase lamellae and breaking-up of crystals in sections made up by individuals showing acline simple twins following the (001) plane. The anorthite content varies from 40-55%, with a concentration of values around 50%, especially between 500 and 900′. The crystals are twinned following albite, Carlsbad and acline laws. Smaller, partly cumulus, subhedral to anhedral crystals occur as well, and have a ragged outline against *CLINOPYROXENE*. Purple-pink titaniferous AUGITE is found as anhedral, partly flattened larger crystals, within cumulus layering and as smaller equant clusters with *PLAGIOCLASE*, *OLIVINE* and *OXIDE*. The crystals are characterized by simple twinning and inclusions of reddish brown *BIOTITE*. Cumulus *OLIVINE* occurs as larger anhedral to subhedral slightly flattened crystals, paralleling lamination, as smaller equant cumulus crystals, and as rims on *MAGNETITE* in oxide-rich gabbros. *ORTHOPYROXENE* is occasionally observed as relicts in *CLINOPYROXENE* having ragged outlines. Subhedral to equant *APATITE* may occur in certain layers as part of the cumulus assemblage. *ILMENITE*, the most frequently occuring *OXIDE* is partly surrounded by *MAGNETITE*. In the vanadium-rich variety, however, the *MAGNETITE-ILMENITE* ratio is 3:1. The *OXIDES* are intergrown with CLINOPYROXENE and enclose sinuous *PLAGIOCLASE* tablets and prisms in the oxide-rich varieties. *MAGNETITE* shows exsolution lamellae of *ILMENITE* following crystallographic directions and patterns of cracks, and may have inclusions of a variety of *SPINEL*. *CHALCOPYRITE*, in lamellar intergrowth with *BORNITE*, is mostly observed in oxide-rich gabbros as minute specks in *CLINOPYROXENE*, along the fringes in *ILMENITE*, and occasionally with *PYRITE* and *ARSENOPYRITE* (?). These rocks can be labeled as plagioclase-clinopyroxene-olivine cumulates with oxide postcumulus. Conformable and cross-cutting brown-green and deep blueish-green *AMPHIBOLE* bearing syenite, granophyric and granite veins with euhedral *APATITE* prisms are observed throughout the core. These felsic rocks alter the layered rock through growth of spherulitic *CHLORITE*, *EPIDOTE* in *PLAGIOCLASE* and replacement of *CLINOPYROXENE* by greenish *HORNBLENDE* and greenish *BIOTITE*. The very fine-grained to medium-grained alkali syenite has an *ALKALIFELDSPAR*, resembling that of syenite veins and intergranular feldspar of the clastic metasediments described in DDH FHL-1.

Acid Tests Results

Footage	Angle from Horizontal
233′	54½°
533′	53°
833′	58°

Notes: Ten polished thin sections and one thin section were made. Ten core samples were assayed. A detailed graphic log is available for study. The analytical results follow in Table NR-1.

CONDENSED GEOLOGIC LOG FOR DDH NE-1

The hole was drilled at an angle of 50° and an azimuth of 210°.

0′-36′ Overburden.

36′-191.9′ Medium to coarse-grained laminated troctolitic anorthosite and anorthositic troctolite with evenly dispersed olivine concentrations up to 3 mm and plagioclase tablets of up to 0.1′. Olivine contents vary between 10 and 20% and define a crude layering. Troctolite is present in layers up to 6′ thick. These layers have sharp upper and lower contacts. Olivine-rich segregations and Fe-Mg hydrosilicates occur as scattered lenses throughout the interval.

191.9′-210.6′ Anorthosite with sharp upper and lower contacts.

210.6′-278.4′ Troctolitic anorthosite and anorthositic troctolite with crude layering due to variations in olivine content ranging from 10 to 20%. Olivine-rich and olivine-pyroxene-rich lenses are scattered throughout the interval. Intercalations of hornblende granite and diorite veins oriented 30° to 70° core axis occur at 235.3′-353.1′.

278.4′-315′ Troctolite.

315′-331′ T.D. Troctolitic anorthosite and anorthositic troctolite.

The dip of these strongly laminated rocks is rather consistently oriented 45° to the core axis.

Acid Test Result

Footage	Angle from Horizontal
330′	53°

Notes: A detailed graphic log is available for study. Ten heels were cut.

CONDENSED GEOLOGIC LOG FOR DDH SR-1

The hole was drilled at a 90° angle (vertical).

0′-230′ Overburden.

230′-356.2′ Layered olivine-bearing and olivine-free oxide gabbros with oxide-rich intercalations (303′-305′).

356.2′-392′ Oxide gabbro with oxide-rich intercalations at 376′-382′ and 389′-392′ containing conformable amphibole-bearing syenite veins and dikes up to 1′ thick, which gradually increase downhole until they appear to digest the country rock, forming a mixed rock.

392′-600′ T.D. Layered olivine-bearing and olivine-free oxide gabbros and olivine melagabbro with oxide-rich intercalations at 402.4′-403′ and 418′-419′. Downhole there is a decrease in thickness of the olivine-bearing stretches from 31′ down to about 1′. Intercalations of fine-grained norites occur at 432.6′-437.5′, 441.4′-444.5′, (478′-479.6′ with oxide-rich ultramafic rock present at 479.6′), 513′-515′, 523.4′-526′, 528.6′-533.6′, 558.2′-559.3′ and 570′-570.3′. Medium-grained to coarse-grained intrusions of syenite and granodioritie up to 7′ are observed more or less evenly distributed, including mixed zones at 437.5′-441.4′, 528.6′-531.1′ and 573.6′-576′.

The layering and lamination are at an angle of 20-30° with the core axis in the upper 470′. Below this depth the angle varies between 45° and 60°. Alkalifeldspar granite and syenite veins have angles varying from 20-80° to the core axis.

PETROGRAPHY SR-1

The major rock type found in this drill hole is a sequence of fine to medium-grained layered oxide-bearing and oxide gabbros, with intercalations of oxide-rich units. Plagioclase lamination is apparent in these rocks. The crystals are twinned following albite, Carlsbad and simple acline laws. Layering is enhanced by zones of olivine with sharp lower contacts. Small-scale layering is reflected by varying colour index due to modal variations of oxide and pyroxene. Amphibole pseudomorphs after clinopyroxene have a characteristic dull greenish colour. Steeply cross-cutting fine-grained norites and oxide rich ultramafites are observed from 432.6′ downwards. Both conformable and cross-cutting veins of alkali granite, syenite, granodiorite, and epi-metamorphic gabbro occur all through the drill core, with the highest density between 360′ and 390′. These constitute about 30% of the rock. The zones having a high concentration of felsic rock result in a mixed rock composed of uralitized oxide gabbro xenoliths digested to varying degrees by amphibole-bearing syenite.

The oxide gabbros

This rock unit comprises oxide-bearing gabbros (5-15% oxide), oxide gabbros to olivine melagabbro (15-30% oxide) and oxide-rich gabbro (30-50% oxide) with or without olivine.

The *PLAGIOCLASE* of the former two subunits has an An content of 40-54% and has a subparallel to subophitic texture. Coarse-grained euhedral cumulus crystals can be distinguished from a sub- to anhedral fine to medium-grained matrix. Beautiful compaction textures of tabular *PLAGIOCLASE* or prisms on equant *CLINOPYROXENE* are present. *SAUSSURITIZATION* is observed in altered varieties.

Purple-pink titaniferous *AUGITE*, is simple twinned and locally strongly altered into masses of fibrous greenish *AMPHIBOLE* with blastic growth of *ACTINOLITE* and off shoots of secondary silicates extending into the surrounding fractured *PLAGIOCLASE*. *OLIVINE* may occur as larger, slightly flattened crystals, conformable to the layering. *ILMENITE* and *MAGNETITE* are found as lamellar and complex coarse intergrowths, *MAGNETITE* dominating over *ILMENITE*. *CHALCOPYRITE* is found as specks in *CLINOPYROXENE* and *PLAGIOCLASE*. The composition of the oxide gabbros averages plagioclase 15-55%, clinopyroxene 30-50%, olivine 0-25% and oxides 15-25%.The oxide-rich gabbros have the same mineral composition as the oxide-bearing and oxide gabbros. *CLINOPYROXENE* occurs as clusters with *OLIVINE*. The *OXIDE*S show some flattening between *PLAGIOCLASE* laminae. *OLIVINE* is developed both as larger cumulus crystals and as rims on *OXIDE*. The *OXIDE*S form a continuous network with roughly equal amounts of *MAGNETITE* and *ILMENITE* as part of the layering. Total oxide content may amount to 60%. *CHALCOPYRITE* and BORNITE occur as intergrowths and discrete crystals in *CLINOPYROXENE* and *PLAGIOCLASE* and along the fringes of *ILMENITE* and *MAGNETITE* grains. The average composition of these rocks is in the order of 30% plagioclase, 25-30% clinopyroxene, 0-10% olivine and 35-40% oxide. The oxide rocks are plagioclase-clinopyroxene-(olivine) cumulates with post cumulus oxide.

Fine-grained norite and oxide ultramafic rocks.

The *PLAGIOCLASE* of these rocks has an An content of 52%. The larger prismatic or tabular crystals are strongly

Table NR-1

D.D.H. NR-1

Analytical Results (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Cr PPM	Co PPM	Ni PPM	Cu PPM	P2O5 PCT	TiO2 PCT	V PPM	Pd PPB	Pt PPB	Au PPB	As PPM	Ag PPM	Sn PPM	Sb PPM	Te PPM	Pb PPM	Bi PPM	TOT C PCT	F PPM	S PCT	Cl PPM	Zr PPM	Th PPM	U PPM	FeO PCT	Fe2O3 PCT
CL 14130	231.0-233.0	45	60	12	700	0.13	4.50	300	<2	<15	<5	<5	1.0	<10	<5	10	60	8	<0.02	130	0.07	100	86	7	<10	11.40	16.59
CL 14131	331.0-333.0	45	90	14	700	0.04	8.90	700	<2	<15	---	<5	<0.5	<10	<5	30	35	2	---	100	---	---	89	9	<10	17.00	25.00
CL 14132	351.0-353.0	30	120	25	1250	<0.10	13.70	900	<2	<15	---	<5	<0.5	<10	5	50	10	10	---	85	---	---	94	12	<10	23.80	35.22
CL 14133	379.8-380.5	25	150	25	750	<0.10	19.40	1650	<2	<15	---	<5	1.0	<10	5	80	20	10	---	50	---	---	93	6	<10	29.50	44.50
CL 14134	505.0-507.0	25	95	55	900	0.25	9.90	700	<2	<15	---	<5	<0.5	<10	<5	50	60	10	---	200	---	---	200	11	<10	21.50	30.26
CL 14135	573.0-574.2	55	45	20	350	0.23	2.90	450	<2	<15	---	<5	0.5	<10	<5	<10	35	8	---	400	---	---	315	13	<10	8.30	14.47
CL 14136	704.3-705.3	60	180	70	1250	0.01	20.20	3600	<2	<15	---	<5	0.5	<10	<5	80	25	10	---	60	---	---	86	13	<10	32.00	51.67
CL 14137	816.8-818.8	40	130	85	1200	0.06	10.60	2400	<2	<15	---	<5	1.0	<10	<5	30	5	<2	---	60	---	---	88	12	<10	24.30	37.85
CL 14138	901.8-903.8	50	100	75	300	0.07	7.20	1700	300	150	---	<5	<0.5	<10	5	20	25	10	---	55	---	---	82	10	<10	20.00	29.89
CL 14139	951.0-953.0	50	50	35	250	0.19	3.10	700	20	<15	---	<5	<0.5	<10	<5	<10	10	<2	---	100	---	---	110	3	<10	10.20	15.34

zoned with basic cores and *CLINOPYROXENE* inclusions. *CLINOPYROXENE* is finely grained, simple twinned and exhibits a fine lamellar exsolution pattern. *ORTHOPYROXENE* forms oikocrysts up to 12 mm across and displays a spotted exsolution pattern of *CLINOPYROXENE* and encloses *OLIVINE*, if present. The composition of these rocks averages plagioclase trace to 60%, clino-pyroxene 0-5%, orthopyroxene 30-45% and oxide 5-20%. The mafic compositions can be labeled as plagioclase-clinopyroxene cumulates with orthopyroxene postcumulus phases. The ultramafic composition can be labeled as olivine-oxide cumulate with orthopyroxene-plagioclase postcumulus phases.

Veins.

Anorthosite or plagioclase cumulate.

The plagioclase of these conformable veins has an anorthite content of 45-53%, shows beautiful compaction, and is twinned following albite, Carlsbad and lameller as well as simple acline laws. Green to olive green *AMPHIBOLE* occur in voids of *PLAGIOCLASE* both as primary crystals and as pseudomorphs after *CLINOPYROXENE*.

Epi-metamorphic gabbro

This rock may occur as anastomizing off-shoots of conformable anorthosite veins. Voids between plagioclase crystals are filled with *ALKALIFELDSPAR*, *QUARTZ*, *APATITE*, *SPHENE* and *AMPHIBOLE*. *AMPHIBOLE* occurs also as pseudomorphs after *CLINOPYROXENE*. *ILMENITE* and *MAGNETITE* occur as a few, intergrown grains displaying a symplectite pattern.

Graphic alkalifeldspar granite and syenite.

These are fine to coarse-grained leucocratic rocks with graphic intergrowths of *QUARTZ* and *ALBITE* (An5%). *ALBITE* occurs as unevenly distributed large crystals. The *ALKALIFELDSPAR* is twinned on (010) with discontinuous twin lamellae. *AMPHIBOLE* occurs as pseudomorphs after *CLINOPYROXENE*.

Notes: Three thin sections and eight polished thin sections were made and seven samples were assayed. A detailed graphic log is available for study. The analytical results follow in Table SR-1.

Table SR-1

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ANALYTICAL RESULTS (Bondar Clegg, North Vancouver, B.C.)

Sample #	Footage	Cr PPM	Co PPM	Ni PPM	Cu PPM	P2O5 PCT	TiO2 PCT	V PPM	Ru PPB	Rh OPT	Pd PPB	Os PPB	Ir PPB	Pt PPB	Au PPB	As PPM
CL14122	237.0-238.7	25	65	65	750	0.12	6.90	600	<5	<0.002	<5	<3	0.1	<50	<5	5
CL14123	303.0-305.0	45	100	85	1200	0.09	14.90	1100	<5	<0.002	5	<3	0.1	50	<5	10
CL14124	373.0-375.0	45	25	45	450	0.70	2.20	150	<5	<0.002	<5	<3	0.3	<50	<5	5
CL14125	409.7-411.4	30	110	110	950	0.04	13.00	1400	--	<0.002	<5	--	--	<50	<5	<5
CL14126	478.6-479.6	150	85	180	950	0.07	4.20	900	--	<0.002	45	--	--	50	20	5
CL14127	507.3-509.3	50	70	115	700	0.07	6.50	1200	--	<0.002	5	--	--	<50	35	5
CL14128	599.0-600.0	95	90	170	300	0.02	6.40	1200	--	<0.002	60	--	--	50	5	<5

Sample #	Ag PPM	Sn PPM	Sb PPM	Te PPM	Pb PPM	Bi PPM	C PCT	F PPM	S PCT	Cl PPM	Zr PPM	Th PPM	U PPM	FEO PCT	Fe2O3 PCT	FE TOT PCT
CL14122	<0.5	<10	<5	<10	130	2	<0.02	55	0.07	<100	45	5	<1	14.20	6.70	22.50
CL14123	<0.5	<10	<5	10	200	2	<0.02	55	0.08	100	64	8	5	21.20	10.20	33.70
CL14124	<0.5	<10	<5	<10	60	<2	0.02	570	<0.02	150	386	9	5	6.60	2.60	9.90
CL14125	<0.5	<10	<5	10	250	6	<0.02	50	0.06	200	37	14	5	33.50	1.25	38.40
CL14126	<0.5	<10	<5	<10	200	2	<0.02	95	0.06	100	57	13	5	17.70	6.55	26.30
CL14127	<0.5	<10	<5	<10	200	4	0.02	40	0.07	150	23	8	<1	15.30	9.15	24.70
CL14128	<0.5	<10	<5	<10	250	2	<0.02	40	0.04	200	19	10	2	24.10	6.60	33.30