Province of British Columbia

Ministry of Energy, Mines and Petroleum Resources

ASSESSMENT REPORT TITLE PAGE AND SUMMARY

TYPE OF REPORT/SURVEY(S)	TOTAL COST
DIAMOND DRILLING PROGRAM - BELL COPPER MINE	$123,598.32

AUTHOR(S) D.R. McArthur, A.Sc.T. SIGNATURE(S) [signature]

DATE STATEMENT OF EXPLORATION AND DEVELOPMENT FILED .... YEAR OF WORK 86

PROPERTY NAME(S) Maclaren Forest Products Inc., Babine Mining Division
Bell Copper Mine, Granisle, B.C. VOJ IWO

COMMODITIES PRESENT Cu, trace Au & Ag

B.C. MINERAL INVENTORY NUMBER(S), IF KNOWN

MINING DIVISION Omineca M.D. NTS 93M/1E, 93L/16E

LATITUDE 55° N LONGITUDE 126° 14'W

NAMES and NUMBERS of all mineral tenures in good standing (when work was done) that form the property [Examples: TAX 1-4, FIRE 2 (12 units); PHOENIX (Lot 1706); Mineral Lease M 123; Mining or Certified Mining Lease ML 12 (claims involved)]:

Mineral leases M134 & M135, located mineral claims

OWNER(S)

(1) Noranda Minerals Inc. (2)

MAILING ADDRESS

P.O. Box 45
Toronto, Ont., M5L 1B6

OPERATOR(S) (that is, Company paying for the work)

(1) Maclaren Forest Products Inc.
Babine Mining Division (2)

MAILING ADDRESS

Bell Mine
P.O. Box 2000
Granisle, B.C. VOJ IWO

SUMMARY GEOLOGY (lithology, age, structure, alteration, mineralization, size, and attitude):

The Bell orebody is horseshoe shaped in plan, dips steeply to NW, is 150 to 300 meters wide by 1000 meters long and dated at 48 m. years. The ore body follows and overlaps the west and north edges of a eocene plug of biotite-hornblende-plagioclase porphyry. The ore body is enclosed in a halo of hydrothermal alteration and is in a zone of hydro-thermal biotitization. Chalcopyrite, the main copper mineral, is finely disseminated or occurs as fracture coatings and stringers.

REFERENCES TO PREVIOUS WORK

(over)

Accelerated Mine Exploration Program

Number 10963 M-21

DIAMOND DRILLING PROGRAM

BELL MINE - PERIPHERY OF 2A PIT

JUNE 1986

Noranda Minerals Inc.
MACLAREN FOREST PRODUCTS INC.
Babine Mining Division
BELL MINE

GRANISLE, B. C.

by

D. R. McArthur, A.Sc.T.
Senior Mine Engineer

January 21, 1987

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1.0 INTRODUCTION

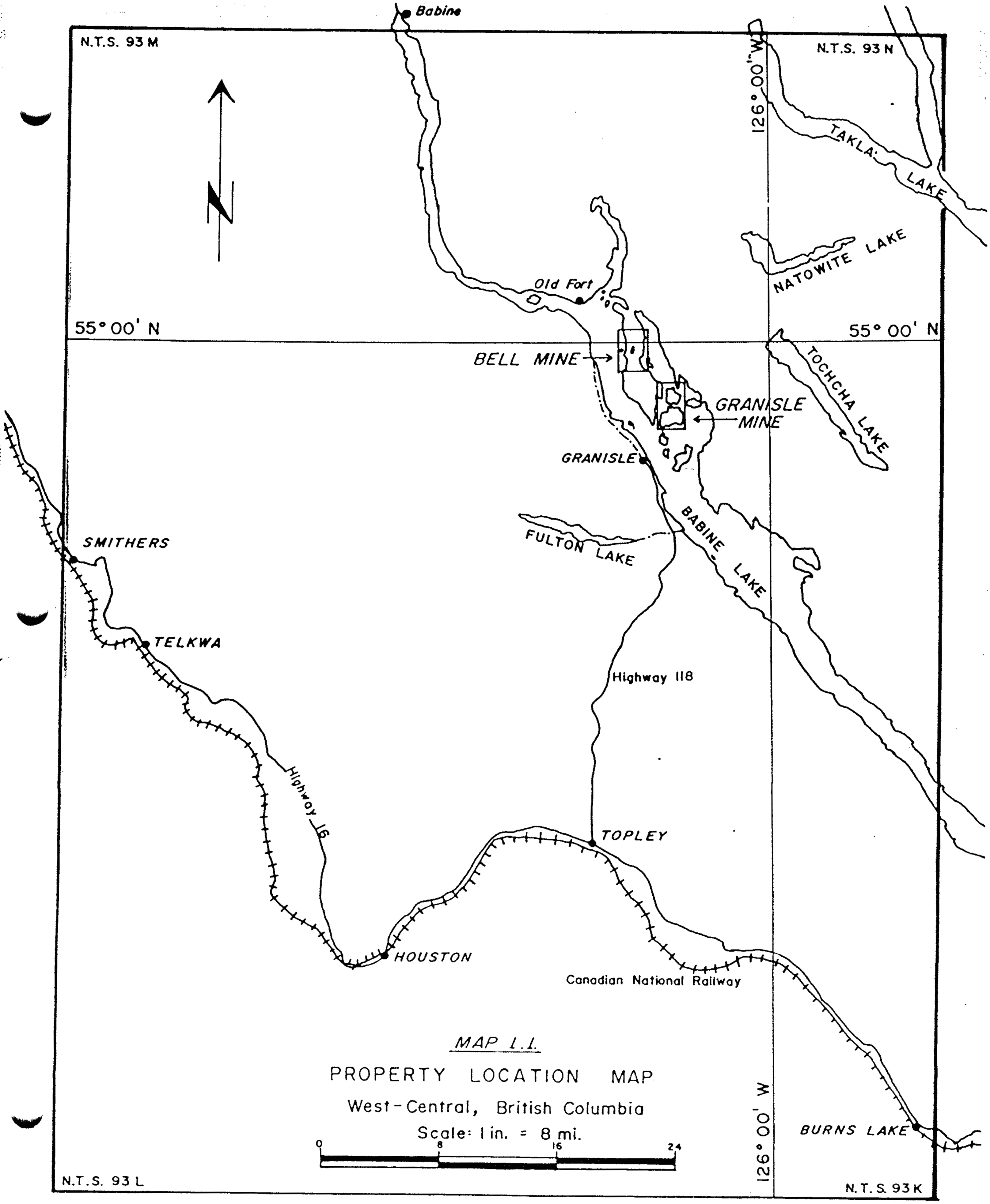
The Bell Copper Mine, owned and operated by Noranda Inc., is located on the Newman Peninsula, in Babine Lake, British Columbia. This open pit mine-mill complex is approximately 55 degrees North Latitude and 126.23 degrees West Longitude (NTS 93M/1E - 93L/16E) at an elevation of 2390 feet (728 m) A.S.L. Babine Lake is located on the Nechako Plateau which is part of the Interior Plateau physiographic region of the province. Climatic conditions are typical of the interior of British Columbia despite the moderating effects of Babine Lake.

The minesite is located approximately 8 miles (13 km) north-east of the Village of Granisle which is at the north end of Highway 118. This highway is a 30 mile (48 km) paved road travelling north from Highway 16 (Yellowhead Route) at Topley, B. C. Access from Granisle to the minesite is by an 8 mile (13 km) all season gravel road along the west shore of and a 2.5 mile (4 km) tug-barge route across Babine Lake (see Map 1.1.)

The Bell Mine mineral deposit was originally examined by C. Newman during the mid 1920's. After years of intermittent prospecting the property was staked by Noranda Mines Ltd. in 1962. Geochemical and geophysical surveys established anomalous targets for drilling. Drilling results provided sufficient reserves to justify the construction of the Bell mine and mill. Pre-production stripping commenced in 1970 and milling started in 1972 at 10,000 Short Tons per Day. In 1979 and 1980 Bell expanded the dimensions of the original open pit limits and upgraded milling capacity to what exists today. Milling tonnages at this time were increased to 16,500 Short Tons per Day which continued regularily until the mine closure in October 1982. At this closure approximately 38 million tons of sub-economic mineralized material, with a near equal amount of waste material, were available for mining.

The mine-mill operations resumed in August 1985 using a restricted ore reserves which reduced the mine life to three calendar years. This ore reserve optimized the amount of readily available ore and minimized the amount of associated waste material. This limited ore reserve and short term mining plan allowed for an expansion phase after the first year of operations.

In order to properly evaluate this potential expansion within the pit limits a drilling program was initiated. A series of sixteen (16) size NQ diamond drill holes totalling 7494 feet (2285 m) were completed by J. T. Thomas Ltd. of Smithers, B. C. However, of the sixteen (16) holes collared, only fourteen (14) holes totalling 6550 feet (1997 m) are included in this Accelerated Mine Exploration Program grant application. This diamond drilling was all completed within the open pit limits on Mineral Leases M-134 and M-135 during June of 1986.



MAP 1.1

PROPERTY LOCATION MAP

West-Central, British Columbia

Scale: 1 in. = 8 mi.

2.Ø DIAMOND DRILLING

The purpose of the drilling program was to accurately outline the ore reserves on the west periphery of the open pit for a possible increase of ore reserves and resulting extension of operations at the Bell Mine. When operations resumed in September of 1985, a three year mine life was planned using an optimized pit design called '2A'. The ore reserves for this pit design were calculated at 19.2 million tons compared to 38 million tons when operations ceased in 1982. A second plan, to be activated within one year of start up, was considered which would expand on the '2A' pit design and possibly extend the mine life by up to two years. This extension involved the mining of deferred material on the west periphery of the original '2A' pit design but within the 1979-8Ø expansion limits. The limited three year mine life and reasonably sucessful operating results after start-up were the reasons that the decision was made to further investigate this possible extension of operations. The drilling program was initiated to gain more sound information which could justify the extended mining and solve some other operations problems.

After operations resumed in September 1985 the mining of the '2A' expected ore reserves conflicted with actual ore extraction due to deficiencies in the Mineral Inventory File (MIF) calculations. Since this geological reserve was to be used for the possible expansion on the west periphery of the pit and because of these volume losses the drilling program proceeded to firm up information and to develop a more accurate ore reserve in the expansion area.

The somewhat unreliable ore reserve information was partly due to random diamond drill hole spacing which resulted in some mis-interpretation in the MIF. Consequently, the drill hole locations were selected where areas could be best filled in on the drilling grid on the west periphery of the '2A' pit design.

As stated above, the south, west and north edges of the open pit were targeted for expansion. In the '2A' mining plan a fixed reserve of tons and grade was calculated for this area using a Ø.3ØØ% Copper cut-off grade. However, two items reduced this reserve which also warranted the drilling program. First, when the '2A' mining commenced and with the operating sucess very sensitive to the price of copper, the cut-off grade was adjusted upwards from Ø.35Ø% to Ø.4ØØ% Copper to be economic and thus reduced the ore reserve. Secondly, while mining using the most up-to-date MIF, some predicted ore was not available in specific areas or the grade was not accurate which further reduced the ore reserve. Although the mined grades were higher than predicted in the MIF a sharp cutoff rather than gradational trending to waste increased the stripping ratio.

Since Bell was losing this gradational material using the current MIF and since the outer periphery of the pit is not structurally similar to the center of the pit the drilling program was necessary to redefine the expansion potential on the south, west and north walls of the '2A' pit. The geological profile of this area trending down from the surface indicated waste to low grade to high grade mineralization. The drilling results were also used to define the grade change by elevation for mine planning, stripping ratios and overall extraction sequences.

All the drilling was targeted to fill in suspected gradational areas where there was no previous drilling or to vertically extend information where previous work was limited by insufficient depth. This additional information reduced three dimensional block parameters used to develop the MIF and more accurately determined the ore reserves of the Bell Mine.

A surface location plan showing drill hole collars in relation to the property, mineral leases and geography is attached (see APPENDIX I).

3.Ø RESULTS

This diamond drilling program yielded results which proved that a portion rather than all of the expected pit expansion is economically viable. The information from this diamond drilling program, including the assays, dip tests and coded rock types, were added to the MIF and a new ore reserve was generated. The new ore reserve showed that the south wall of the '2A' pit was uneconomical to mine but that the west and north walls contained more mineralization than originally predicted. The west and north walls of the expansion area are included in a new pit design designated as '2C'. The geological reserve of the '2C' area increased from an estimated 7 million tons to 8.2 million tons at a cutoff grade greater than Ø.3ØØ % copper. This increase resulted in an complementary reduction of waste tons for the same areas and a more attractive stripping ratio.

Although the ore reserve increased by the stated amount, and approval has been received from upper management to extend the mine life, economics applied to budgetting have shown that approximately 5.8 million tons will be mined at a grade cutoff of Ø.35Ø% copper or greater. The remainder of this reserve, approximately 1.6 million tons of gradational material, will be stockpiled for later utilization if prices warrant. This tonnage will extend the Bell Mine operations by fourteen (14) months after the completion of the '2A' pit. Closure of operations is now predicted for December 1989 rather than September 1988.

4.Ø GEOLOGICAL INTERPRETATION

Similar rock types were encountered in the recent core drilling that have been reported by previous drilling. This indicates that the expansion area is either in the pit core at depth or on the fringe of the vertically structured ore body. The rock types, with stratigraphic and lithologic information, can be found on the attached paper, titled:

> "Bell Copper: Geology, Geochemistry and Genesis Of A Supergene-Enriched, Biotitized Porphyry Copper Deposit With A Superimposed Phyllic Zone"

in that section sub-titled "Local Rock Types". This paper, authored by David J. T. Carson; John L. Jambor; Peter L. Ogryzlo; and Tom A. Richards can be found in the CANADIAN INSTITUTE OF MINING AND METALLURGY, Special Volume 15, titled "PORPHYRY DEPOSITS OF THE CANADIAN CORDILLERA, Part B, pages 245 to 263, 1976" (see APPENDIX II).

Drill core evaluation commenced immediately after the drilling program was completed. The geological logging was completed by a consulting geologist, Mr. Anthony L'Orsa, of Smither, B. C.

Copies of all the drill hole logs are attached to this report in APPENDIX III. Although hole numbers 86-9 and 86-10 were drilled within the '2A' pit limits and that footage is not included in this grant application the logs are included in the report. A summary of the drill hole core logging by the consultant is also attached to this report in APPENDIX IV.

5.0 COST STATEMENT

The following costs were incurred by the Bell Mine from June 12, 1986 to present. The costs include the diamond drilling by contractor, being J. T. Thomas of Smithers; consultative core logging; in-house core splitting, pulverizing and assaying; and the final evaluation of results. The sixteen (16) diamond drill holes were all collared within the open pit boundary. However, two (2) of these holes have not been included in the costs because the holes were drilled in the existing '2A' pit or proven reserved ore rather than on the periphery and are not applicable to the grant parameters. Therefore, a portion of the total footage is used for this grant application. The factor for the grant application, which is 87.4 percent of the total costs, has been calculated into the listing below.

Cost Summary

a) WAGES

Drilling-	included in contractors invoice	
Core Logging-	included in consultants invoice	
Core Crushing-	30.5 days; $92/day; July 10 to 27;	$ 2786.14
Core Pulverizing-	12.0 days; $100/day; July 13 to 27; see item (f)	
Core Assaying-	23.0 days; $96/day; July 14 to 28; see item (f)	
Moving Drill-	3.5 days; $156/day; June 11 to 30;	545.80
	sub-total	$ 3331.94

b) FOOD & ACCOMMODATION

Drilling-	included in contractors invoice
Core Logging-	included in consultants invoice
Remainder- "In-house"	no charges applied
sub-total	$ .00

c) TRANSPORTATION

Drilling-	included in contractors invoice
Core Logging-	included in consultants invoice
Remainder- "In-house"	no charges applied
sub-total	$ .00

d) INSTRUMENT RENTAL

no charges applied

e) SURVEYS

no charges applied

f) ANALYSES

Core Assays- 704 determinations; Copper; $5.05 per;	$ 3555.20
Ore Reserves- Noranda Computer; 60.5 hours;	3033.00
sub-total	$ 6588.20

g) REPORT PREPARATION

Engineering Department- "In-house"	$ 2000.00
sub-total	$ 2000.00

h) OTHER

Drilling- 18 days; June 11 to 30; $16.15 per foot;	$ 105,782.50
Fuel- 18 days; June 11 to 30; $0.278 per litre;	2,120.00
Geologist- 10 days; $40/hour; June 16 to July 11;	3,775.68
sub-total	$ 111,678.18
TOTAL	$ 123,598.32

6.0 DRILLING REPORTS

The required information to complete this assessment report including a location map and the drill logs are enclosed in the appendix. The location map shows the drill hole collar location by co-ordinate on the mine grid system. The grid system is tied to common longitude and latitude as shown on the location map. The drill logs include inclination, azimuth, dip tests, core diameter and collar elevation of each drill hole. The drill logs also include all the assay results for copper, other mineral identification, rock type coding for computer analysis and geological description on 10 foot (3 m) increments.

All the drill core was crushed in 10 foot sections for assay after the geological logging was completed. One-half portions of every section were bagged; identified by hole number and footage; and stored in wooden enclosed pallets. These pallets are stored, with other drill cuttings and core boxes, near the minesite explosives storage magazine area.

7.0 AUTHOR'S QUALIFICATIONS

The author, D. R. McARTHUR, is Senior Mine Engineer of the Bell Mine, Granisle, B. C. The author is a graduate of the B. C. Institute of Technology, Mining, 1972. Since 1972 the author has been actively employed by Granby and Noranda in all aspects of mine engineering positions including exploration duties, surveying, pit engineer, mine engineer and, presently, is the head of the Engineering Department at the Bell Mine. The author is also a registered Applied Science Technologist of B. C., member Nr. 7621.

A resume of qualifications submitted by Mr. A. L'Orsa, the consulting geologist, is attached to this report in APPENDIX V.

APPENDIX I

SURFACE LOCATION PLAN

APPENDIX II

PROPERTY GEOLOGICAL DESCRIPTION

Bell Copper: Geology, Geochemistry and Genesis Of A Supergene-Enriched, Biotitized Porphyry Copper Deposit With A Superimposed Phyllic Zone

David J. T. Carson,
Noranda Exploration Co. Ltd., Toronto
John L. Jambor,
Geological Survey of Canada, Ottawa
Peter L. Ogryzlo,
Noranda Mines Limited,
Bell Copper Division, Granisle
Tom A. Richards,
Geological Survey of Canada, Vancouver

Abstract

Bell Copper was discovered in 1963 and was put into production in 1972. The Bell orebody is horseshoe-shaped in plan, dips steeply, and is 150 to 300 meters wide by 1000 meters long. The orebody follows and overlaps the western and northern edges of a typical Babine-type, Eocene, plug of biotite-hornblende-plagioclase porphyry. This plug, which was emplaced along a major block-fault, the Newman fault, intruded Jurassic and Cretaceous volcanic and sedimentary rocks and Eocene rhyodacite. Chalcopyrite and minor bornite are the main ore minerals; abundant pyrite occurs in a peripheral 300-meter-wide halo. Before mining commenced, geological reserves were 116 million tonnes averaging 0.48 per cent copper, about 0.35 ppm gold and less than 0.005 per cent molybdenum.

Enclosing the Bell orebody is a halo of hydrothermal alteration that is approximately 3500 by 2500 meters at surface. The orebody is in a zone of strong hydrothermal biotitization which changes outward progressively to sporadic weak biotitization. Rocks peripheral to the biotite zone are strongly chloritized. This concentric biotite and chlorite zoning is common to all Babine porphyry copper deposits. However, the Bell deposit also has a concentric zone of sericite-carbonate alteration which coincides with the pyrite halo, and an irregularly shaped zone of intense quartz-sericite-pyrite-chalcopyrite that was superimposed on part of the earlier biotite-chalcopyrite ore. The superimposed alteration and sulphide mineralization were probably caused by an influx of meteoric or connate water into the upper part of the hydrothermal system during late-stage structural adjustments on the Newman and subsidiary faults. Copper in the superimposed assemblage seems to have been derived, by leaching, from the biotite-chalcopyrite ore which underlies the quartz-sericite-pyrite-chalcopyrite ore. Similar leaching processes may have occurred in many of the numerous other porphyry copper deposits of the world that exhibit late-stage, superimposed quartz-sericite-pyrite-copper mineralization.

Dispersion of copper laterally outward from the orebody during the mineralizing process was very limited. In contrast, zinc and lead were very mobile and both metals occur in anomalous amounts at the outer edge of the pyrite halo.

Moderate supergene chalcocite enrichment occurred in the upper 50 to 70 meters of the quartz-sericite-pyrite-rich segment of the orebody during pre-Pleistocene time.

Location, Topography and History

THE BELL COPPER DEPOSIT, owned and operated by Noranda Mines Limited, is at latitude 54°59'N, longitude 125°14'W (NTS 93M/1E) on Newman Peninsula in Babine Lake, British Columbia (Fig. 1). Originally referred to as the Newman prospect, it was named to honour Archie M. Bell, former manager of Noranda Exploration Company, Limited. Bell Copper is one of several porphyry copper deposits of both economic and sub-economic grade, including Granisle and Morrison, that occur in the Babine Lake area (Carson and Jambor, 1974). All are related to small Eocene intrusions of biotite-hornblende-plagioclase porphyry, known locally as BFP, which were emplaced during the latter part of a major period of block-faulting.

The Bell orebody is in the center of a large, relatively flat area that is 2500 to 2550 feet in elevation and approximately 50 meters above the level of Babine Lake (Fig. 2). This area of subdued topography coincides with the alteration halo surrounding the Bell deposit (Fig. 3). The original surface of the orebody was irregular, but sloped gently southward. Before exposure in the open pit, the orebody was covered completely by 3 to 30 meters of glacial clay and drift.

In 1962, Noranda Exploration Company, Limited staked several claims on Newman Peninsula over an area that included and extended to the east of some small lead-zinc veins which are exposed in three old adits on the eastern shore of Babine Lake opposite Newman Island (Fig. 3). Pyrite-bearing porphyry, similar to that at the known Granisle deposit, was found on the shore of Babine Lake and northeast of the lead-zinc veins.

A soil survey done in late 1962 and early 1963 gave anomalous copper values in some samples from about 800 meters northeast of the lead-zinc veins and near the southwestern edge of the orebody. A very strong electromagnetic anomaly that extended several thousand meters northeast of the lead-zinc veins was later found to be coincident with the southwestern part of the pyrite halo and the pyrite-rich western segment of the orebody.

On the basis of the above work, three holes were drilled in the summer of 1963. The first was about 100 meters northeast of the lead-zinc veins, the second was at the southwestern edge of the orebody and the third was in its highest-grade western part. However, because it penetrated a narrow vertical zone of oxidized and leached rocks, the third hole gave only random high copper values, and the drilling results, therefore, were not as encouraging as they should have been. Nevertheless, drilling was resumed in 1964 and the first hole, about 70 meters from the original third, averaged 0.9 per cent copper over its length of 70

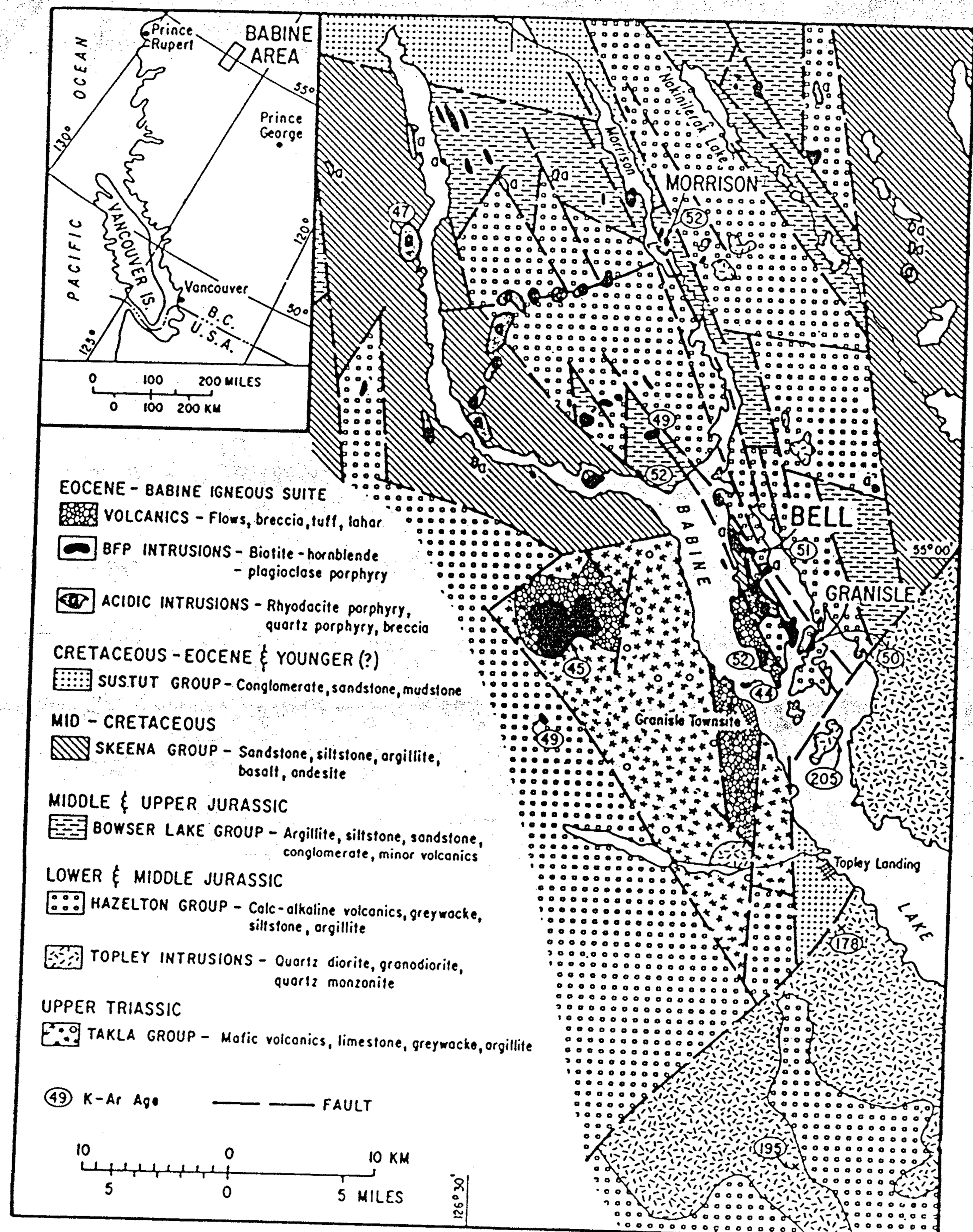


FIGURE 1 — Geology of the Northern Babine Lake Area and Location of the Bell Copper Porphyry Deposit. K-Ar age determinations are after Carter (1974) and the Geological Survey of Canada.

meters. In the next few years, about 100 vertical holes were drilled to delimit the Bell orebody. A similar number of exploration holes were drilled throughout Newman Peninsula, and one very small porphyry copper deposit of sub-economic grade was discovered about 3 km north of the Bell orebody (North Newman deposit — see Carson and Jambor, 1974).

Feasibility studies completed in 1967 showed that the Bell orebody had geological reserves of 116 million tonnes averaging 0.48 per cent copper, and mineable reserves of 42 million tonnes grading 0.50 per cent copper (Hall and Kraft, 1969). Both were calculated to the 1540-foot elevation level (300 meters depth) and at a cutoff of 0.3 per cent copper. The stripping ratio for the life of the pit was calculated to be 0.50. Molybdenum in the Bell ore averages much less than 0.01 per cent. Gold and silver average about 0.35 and 1.0 ppm, respectively.

Production of a gold-bearing copper concentrate began in October, 1972. As of January 1975, 17,150,000 tonnes of material had been removed and the pit was 80 meters deep by 800 meters in diameter. Current extraction is scheduled at 17,700 tonnes per day, of which 11,350 is ore. About one-sixth of the mined material grades 0.3-0.45 per cent copper and is stockpiled. Waste material is used for the construction of tailings-impoundment dams in the Workburn Lake basin (Fig. 2).

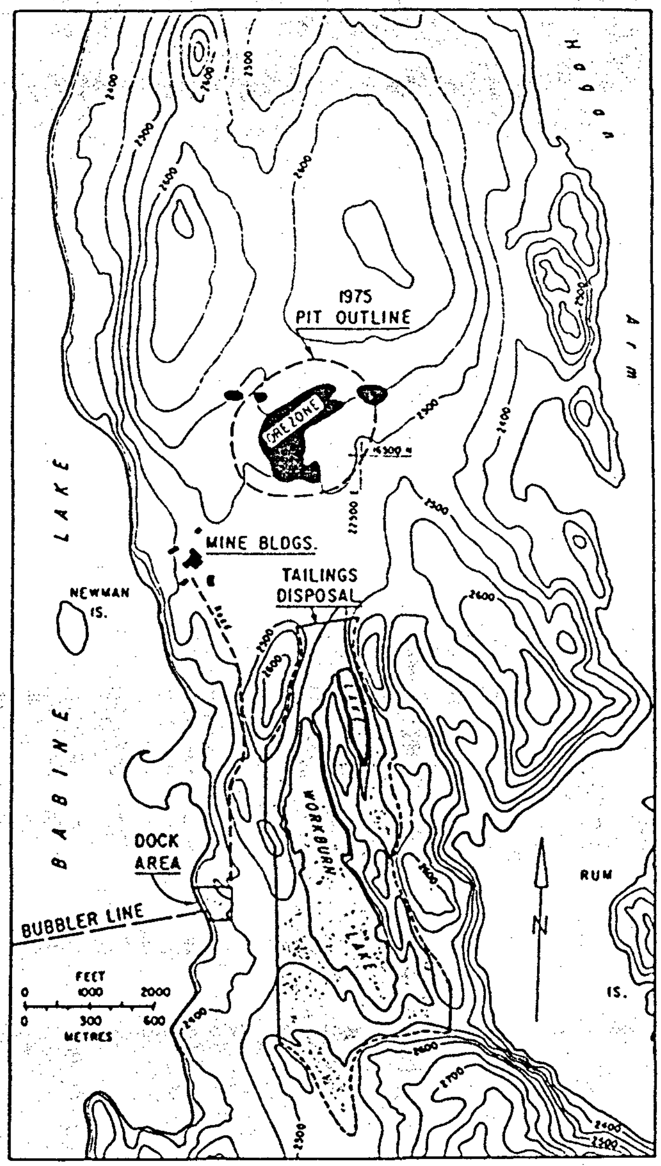


FIGURE 2 — Topography of Central Newman Peninsula and Location of the Bell Ore Zone, Mine Buildings and Tailings-Impoundment Basin.

Regional Geology

The regional geological setting (Fig. 1) has been outlined by Carter (1966, 1973, this volume), Tipper (1972), Richards (1974), and Tipper and Richards (1976). Volcanic and sedimentary rocks belong to five major groups: the Triassic Takla Group, the Jurassic Hazelton and Bowser Lake groups, the Cretaceous Skeena Group and the Late Cretaceous - Early Tertiary Sustut Group. Oldest intrusive rocks are the Early Jurassic Topley intrusions. Eocene intrusive bodies and their extrusive equivalents collectively are referred to as the Babine Igneous Suite. Exposure in the area is generally poor.

The Takla Group consists of black shale, siltstone, augite porphyry and limestone, which are exposed in a large block west of Babine Lake. The Hazelton Group on Newman Peninsula comprises a suite of eugeosynclinal volcanic and sedimentary rocks. The oldest rocks known on the peninsula, at least 1000 meters thick, are greenish marine calc-alkaline volcanics and sediments of the Sinemurian Telkwa Formation (Tipper and Richards, 1976). In fault contact with the Telkwa Formation are non-marine pyroclastics of the upper part of the Lower Jurassic Nilkitkwa Formation (Red Tuff member). These are overlain by shallow-water marine greywackes of the Bajocian Smithers Formation.

The Middle to Upper Jurassic Bowser Lake Group is not exposed on the peninsula, but underlies much of the area between Babine and Morrison lakes. It comprises a lower, fine-grained, clastic, distal siltstone-argillite facies (the Ashman Formation, Tipper and Richards, 1976) and an upper, coarse-grained clastic marine and non-marine deltaic assemblage. The mid-Cretaceous Skeena Group consists of both marine and non-marine volcanic and sedimentary rocks of varied lithology. Along Babine Lake, most are shallow-water, silty argillite and sandstone intercalated with basic and intermediate flows and coarse breccias. The Sustut Group is exposed mainly to the north of Babine Lake and consists of muscovite-bearing sandstone and conglomerate. The upper members of this group contain locally derived angular clasts of rhyodacite and dacite, the source of which may have been the nearby Babine Igneous Suite. The Topley intrusions are probably coeval with the Hazelton Group. Compositionally, they vary from quartz diorite to quartz monzonite.

Eocene intrusions and their extrusive equivalents form numerous small bodies and isolated, down-faulted volcanic outliers. Rhyodacitic bodies are the most common, but these have little economic significance. Stocks, plugs and dykes of biotite-hornblende-plagioclase porphyry (BFP) are hosts for the Eocene porphyry copper mineralization, including the Bell Copper deposit. K-Ar ages of several BFP and rhyodacite bodies overlap (Fig. 1), suggesting that they were emplaced during the same event, but at different times at different localities. At Bell Copper, however, most BFP appears to be younger than the rhyodacites. The extrusive rocks, equivalent to the intrusions, now form piles isolated by later block faulting, and are cut by dykes of both rhyodacite and BFP.

The Babine Igneous Suite was emplaced during the latter stages of major block-fault tectonism, which, in part, formed the prominent north-northwest structural grain in the region. The BFP intrusions and their genetically related copper deposits appear to have been emplaced along faults which have the greatest vertical displacement. Movement on some of these faults, such as the Newman fault at Bell Copper (Figs. 1, 3), ceased after BFP emplacement. However, movement continued on some other faults after the igneous event, as is evident from the juxtaposition of the BFP-related volcanics against older rock units, and from the major offset of the Morrison porphyry copper deposit (Carson and Jambor, this volume).

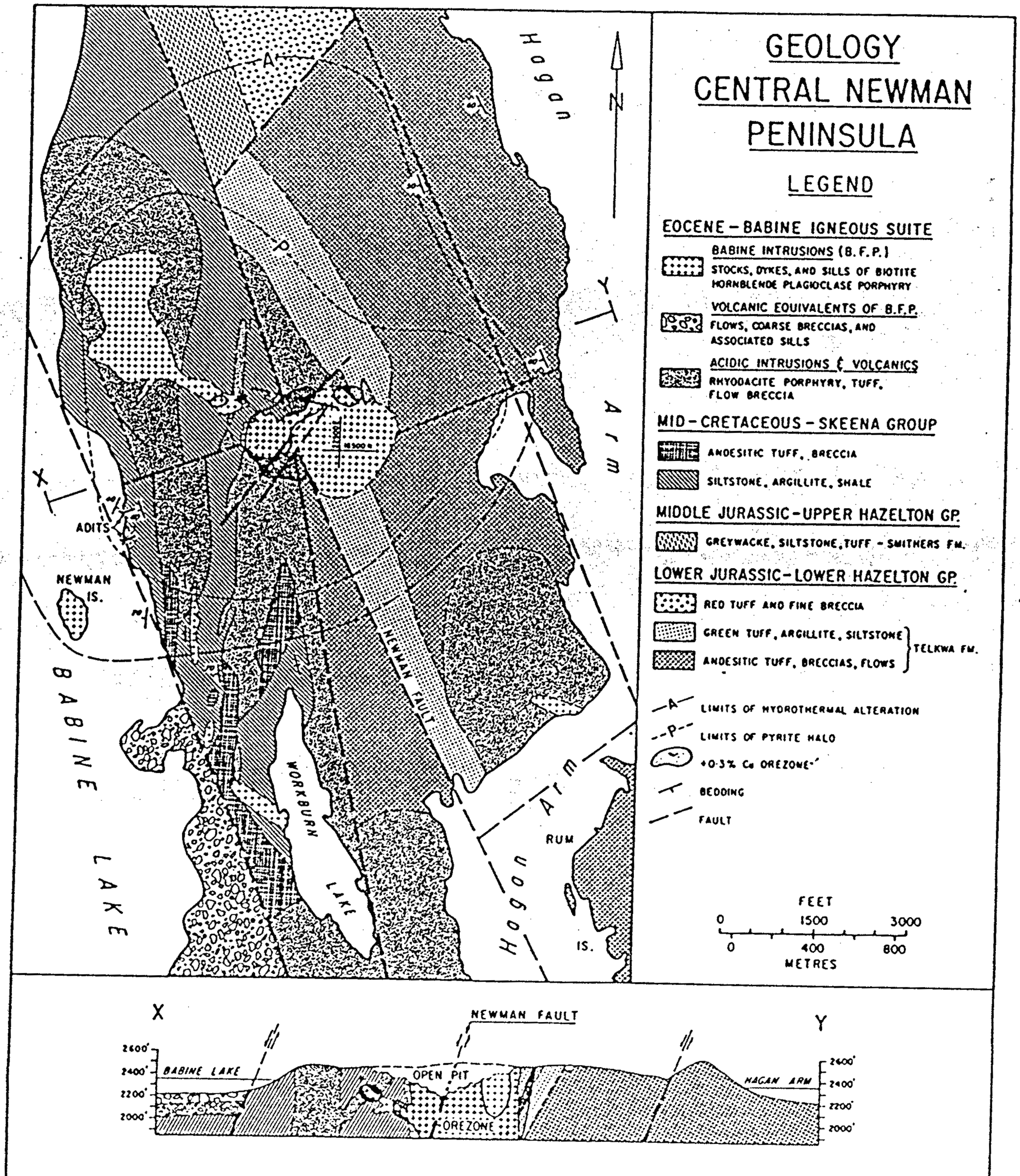


FIGURE 3 — Geology and Cross Section of Central Newman Peninsula.

Local Rock Units

Most of the volcanic, sedimentary and intrusive rocks near Bell Copper have been altered intensely. The hydrothermal alterations are described fully in a subsequent section. The stratigraphic and primary lithological features which identify the rocks are outlined here.

HAZELTON GROUP

The oldest rocks at Bell Copper belong to the lower part of the Hazelton Group (Telkwa Formation) and are exposed east of Newman fault (Fig. 3). The oldest facies are light green flows, aquagene tuff, lapilli tuff and breccia that contain clasts of chilled, microporphyritic and amygdaloidal basalt and minor pink and buff rhyolite. These rocks have a fine, green, dense aphanitic matrix of chlorite, epidote, calcite and prehnite. Few flows are amygdaloidal and bedding is massive except in the finer tuffaceous units. Green tuffaceous argillite and siltstone of probable mid-Lower Jurassic age overlie the volcanic rocks. All have been metamorphosed to subgreenschist facies and contain variable amounts of epidote, chlorite, prehnite, albite, calcite and actinolite.

Subaerial red, maroon and purple andesitic to dacitic lapilli tuffs belonging to the Red Tuff member of the Lower Jurassic Nilkitkwa Formation occur near the northern end of the peninsula and are thought to overlie the green volcanic and volcano-sedimentary rocks of the Telkwa Formation. Age relationships were not found in the area shown in Figure 3, but these rocks appear to be Toarcian in the Hazelton map-area to the north (Richards, 1973). Overlying the red tuffs are fossiliferous lithic-feldspathic greywackes and wackes of the Bajocian Smithers Formation, some with a glauconite matrix.

SKEENA GROUP

West of the Hazelton Group and in fault contact with it are interbedded, fine-grained sedimentary and pyroclastic rocks of the Skeena Group. An ammonite fragment from shales west of the Bell orebody was tentatively identified by H. W. Tipper of the Geological Survey of Canada as *Cleoniceras*, indicating an Albian age. The Skeena sedimentary rocks are fine-grained gritty shales with common 0.16- to 2.5-cm lenses and laminations of fine sand. Their minor scour marks, bioturbation features and small-scale crossbedding indicate a tidal or pro-deltaic depositional environment. Highly contorted feldspathic greywackes and fine tuff along the west shore of the peninsula are tentatively correlated with rocks of the Skeena Group, but may be older. The shoreline rocks contain the original lead-zinc showings.

BABINE IGNEOUS SUITE

Volcanic Rocks

Two types of coarse pyroclastic rocks of lahar or mudflow origin are preserved along the western side of the peninsula. These are most plausibly the extrusive equivalents of the rhyodacite and BFP intrusions. One type is dominated by angular, light-coloured, flow-banded, dense, massive quartz-albite porphyry clasts, 0.6 to 1.2 cm in diameter. The other type contains a chaotic mixture of unaltered mauve, purple and light green, fine-grained biotite-hornblende-plagioclase porphyry clasts up to 0.6 m in diameter. In places, clasts of both types of volcanic rocks occur with rare sandstone, argillite, green volcanic and charred wood fragments. Massive rhyodacite and BFP dykes and small sills, such as occur on Newman Island, have intruded the volcanic pile.

Rhyodacite Intrusions

The large rhyodacite intrusions exposed near Bell Copper are white, light brown, pale greyish-green or buff-coloured. Some are coarsely to finely porphyritic, with phenocrysts of quartz and albite; others are dense, massive or flow-banded, and many are, in part, breccia bodies.

Most rhyodacites at Bell are probably coeval with BFP. Both are closely associated throughout the Babine Lake area and both yield similar K-Ar ages (Fig. 1). In many localities, including Bell and Morrison (Carson and Jambor, this volume), the BFP intrusions are central to the rhyodacites. At Bell, BFP intrudes rhyodacite at several localities and, in addition, many bodies mapped as rhyodacite appear to have been much more extensively affected by Eocene faulting than the BFP. However, it is possible that some of the acidic intrusive and volcanic rocks shown as Eocene rhyodacite on Figure 3 are actually Mesozoic.

Biotite-Hornblende-Plagioclase-Porphyry (BFP)

The main BFP intrusion at Bell (Fig. 3) is a plug that is pear-shaped in plan. Although only 200 meters wide at its western end, the plug mushrooms to 600 meters in diameter in its eastern part. Several contacts observed in the western part of the plug dip steeply and have numerous small apophyses intruded along joints between jostled blocks of country rock.

The western lobe of the BFP plug has intense quartz-sericite alteration and therefore has a bleached appearance (Fig. 16). This type of alteration is absent or only minor at other Babine deposits. Except for this local but important effect of superimposed sericitic alteration, BFP at Bell and other Babine porphyry deposits are similar. A detailed description of BFP, including chemical and microprobe analyses, is given by Carson and Jambor (1974).

As at Morrison and Granisle (Kirkham, 1971), many phases of BFP are present in the Bell plug. Most predate the copper ore zone and associated hydrothermal alterations. A large northwesterly trending apophysis of the BFP plug cuts the Skeena shales and rhyodacite and is the locus of the narrow, northwesterly extension

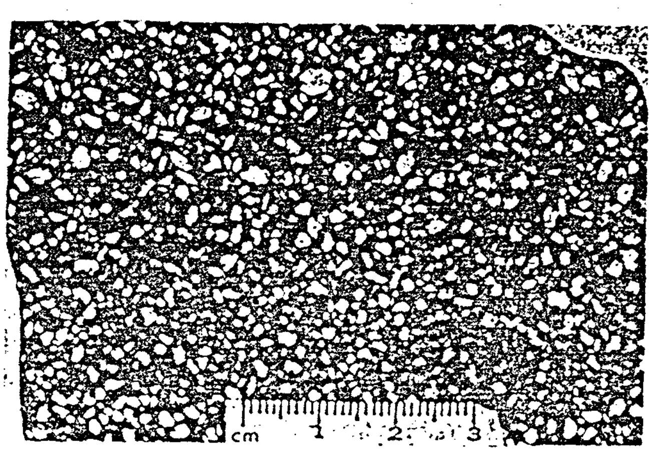


FIGURE 4 — Biotitized BFP. All hornblende is replaced by dark brown, sucrose, hydrothermal biotite.

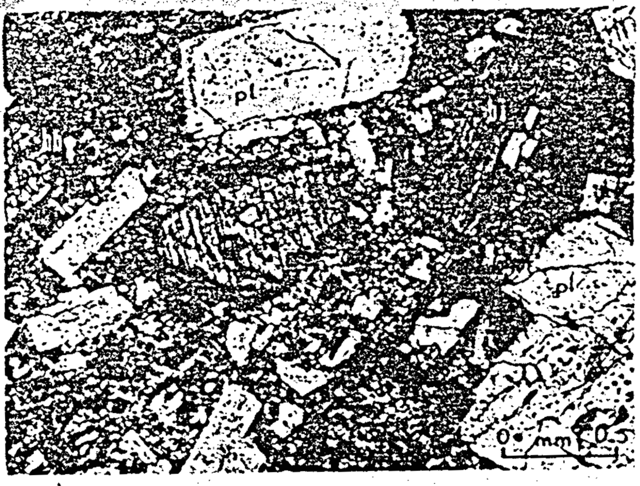


FIGURE 5 — Photomicrograph of Unaltered BFP. Phenocrysts of biotite, hornblende and plagioclase are unaltered.

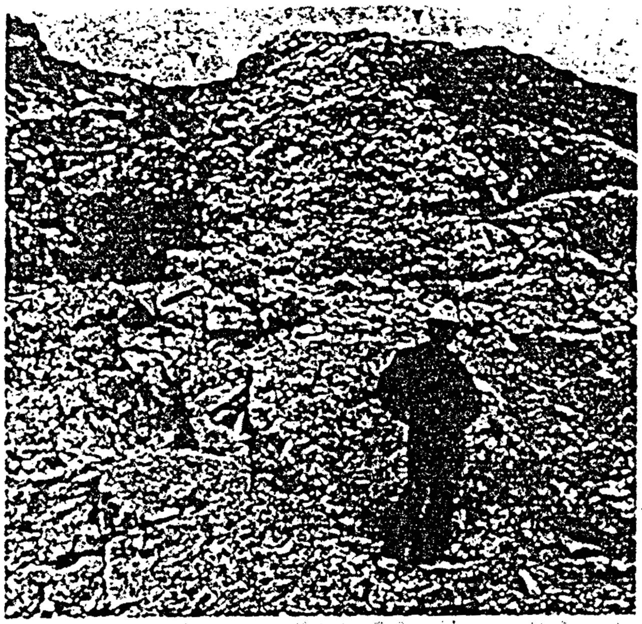


FIGURE 6 — Breccia Pipe in the BFP Plug. Note the vertical, sheeted contacts (arrows).

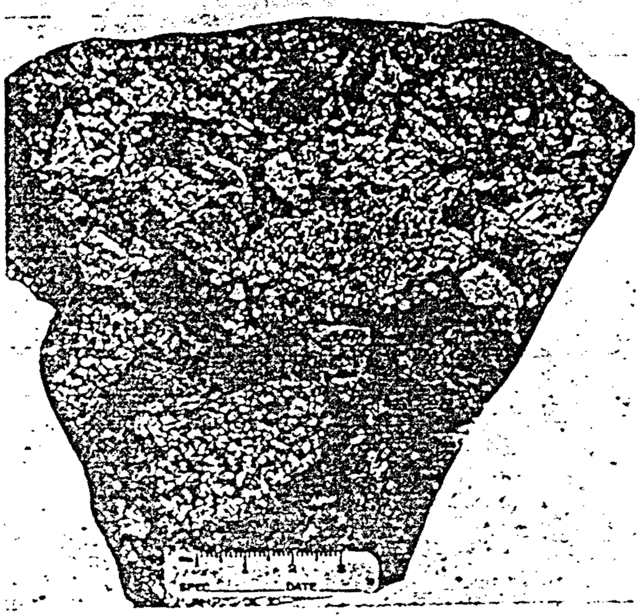


FIGURE 7 — Hand Specimen of Breccia from Breccia Pipe Near the Southwestern Edge of the BFP Plug.

of the orebody (Figs. 3, 9, 13). Other, smaller BFP intrusions occur on Newman Peninsula to the north and south of the Bell plug.

Unaltered BFP south of the Bell alteration zone is medium grey, with abundant ¼- to 5-mm phenocrysts of zoned oligoclase-andesine, biotite and hornblende in a fine-grained to aphanitic matrix of the same minerals plus quartz and K-feldspar (Fig. 5).

Unaltered BFP is megascopically very similar to biotitized BFP from the central part of the biotite zone (Fig. 4). The only major difference is that in the biotitized variety all hornblende has been converted to sucrose hydrothermal biotite and the rock is dark grey to black. In the chlorite-carbonate zone, BFP is light, medium or greenish-grey. In intensely altered BFP of the quartz-sericite zone, the mafic minerals and matrix have been completely obliterated, and only highly sericitized plagioclase phenocrysts are distinguishable (Fig. 16). In some places, the quartz-sulphide stringers are unusually wide and, because they are randomly oriented, the BFP between the stringers has the appearance of breccia fragments.

Breccia Pipes

A cluster of small breccia pipes occurs in the western part of the BFP plug (Fig. 9). Nearly all are adjacent to the concave perimeter of the orebody, in rock very low in copper. Most are aligned along the projected trace of the Newman fault, but one is near the western edge of the plug and another is well within the orebody.

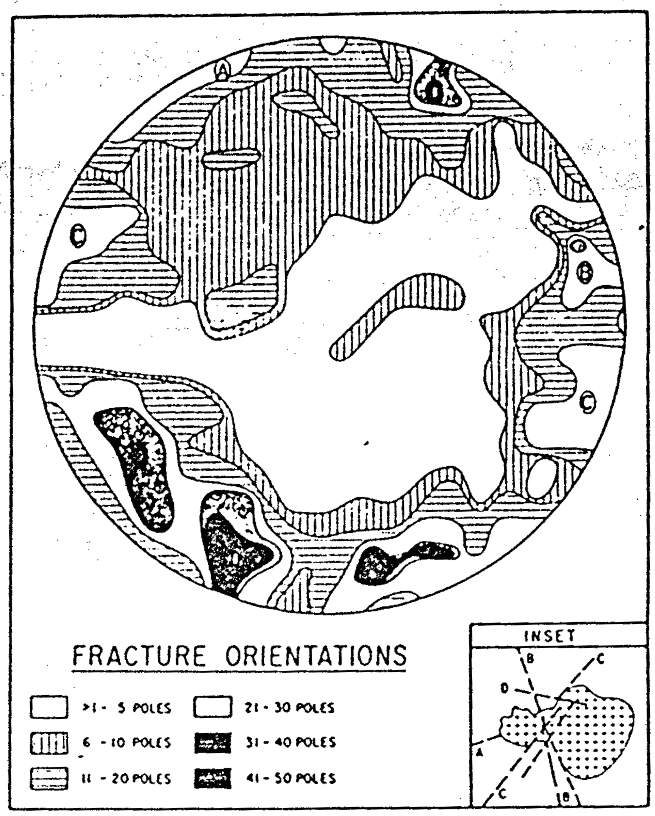


FIGURE 8 — Poles to Fractures in the Bell Open Pit. Plotted are 991 fracture attitudes adjusted by Terzaghi's method. The fractures include mineralized and unmineralized joints and faults traceable vertically for at least one bench (10 meters). The inset relates the diagram to the pit geology shown in Figure 9. Group "A" is related to pre-ore fault A; group "B" is related to the northwestern regional structural trend, including the Newman fault; groups "C" and "D" are related to pre(?)- and post-ore faults C and D.

The breccia pipes are 2 to 10 meters in diameter and have very sharp, vertical contacts (Fig. 6). Most contain angular to subrounded fragments that are less than 1 cm to 10 cm in diameter. Fragments in each pipe reflect the character of the adjacent host rocks. Therefore, most fragments are predominantly bleached, silicified and sericitized BFP, but pipes near the edge of the BFP plug contain a variety of rock fragments (Fig. 7). Several pipes have a compact matrix of grey to brownish clay; the matrix in others is a porous mixture of quartz and well-crystallized pyrite. In a few pipes, fragments are welded together with little cement and voids are numerous.

The Bell breccia pipes appear to have been localized along a major conduit, the Newman fault, and along smaller subsidiary joints or fractures. The pipes are post-ore, but adjacent rocks seem to have been depleted in copper. This depletion is particularly evident around the small pipe about 50 meters to the northwest of the main cluster (Figs. 9, 10).

Local Structures

Three normal faults dissect the rocks of Newman Peninsula into four northwesterly trending blocks (Figs. 3, 26). The block on the western side of each fault has been dropped relative to the eastern side. The copper-bearing BFP plug at Bell was localized by one of these major faults, the Newman fault. Juxtaposition of the lower parts of the Hazelton and Skeena groups across the Newman fault indicates a stratigraphic separation of 700 to 1300 meters. This is the greatest known vertical displacement on faults of the immediate area.

Other faults in the vicinity of the Bell pit include an east-northeasterly fault that terminates at the western edge of the BFP, but appears to offset rhyodacite, and some north-northeasterly faults that extend into the BFP plug and are therefore at least partly younger than the BFP. Attitudes of the fracture systems related to all major faults in the Bell open pit are plotted on Figure 8.

Because the Bell orebody lacks appreciable offset along the projected strike of the Newman fault, and because faulting at the appropriate position is not visible in the pit, post-ore movement on the Newman fault must have been small or negligible. Most of its movement, and probably that of the other two major block-faults, seems to have been pre-Eocene. However, although fault contacts have not been observed, some movement apparently occurred after the Eocene igneous activity, because in many places BFP

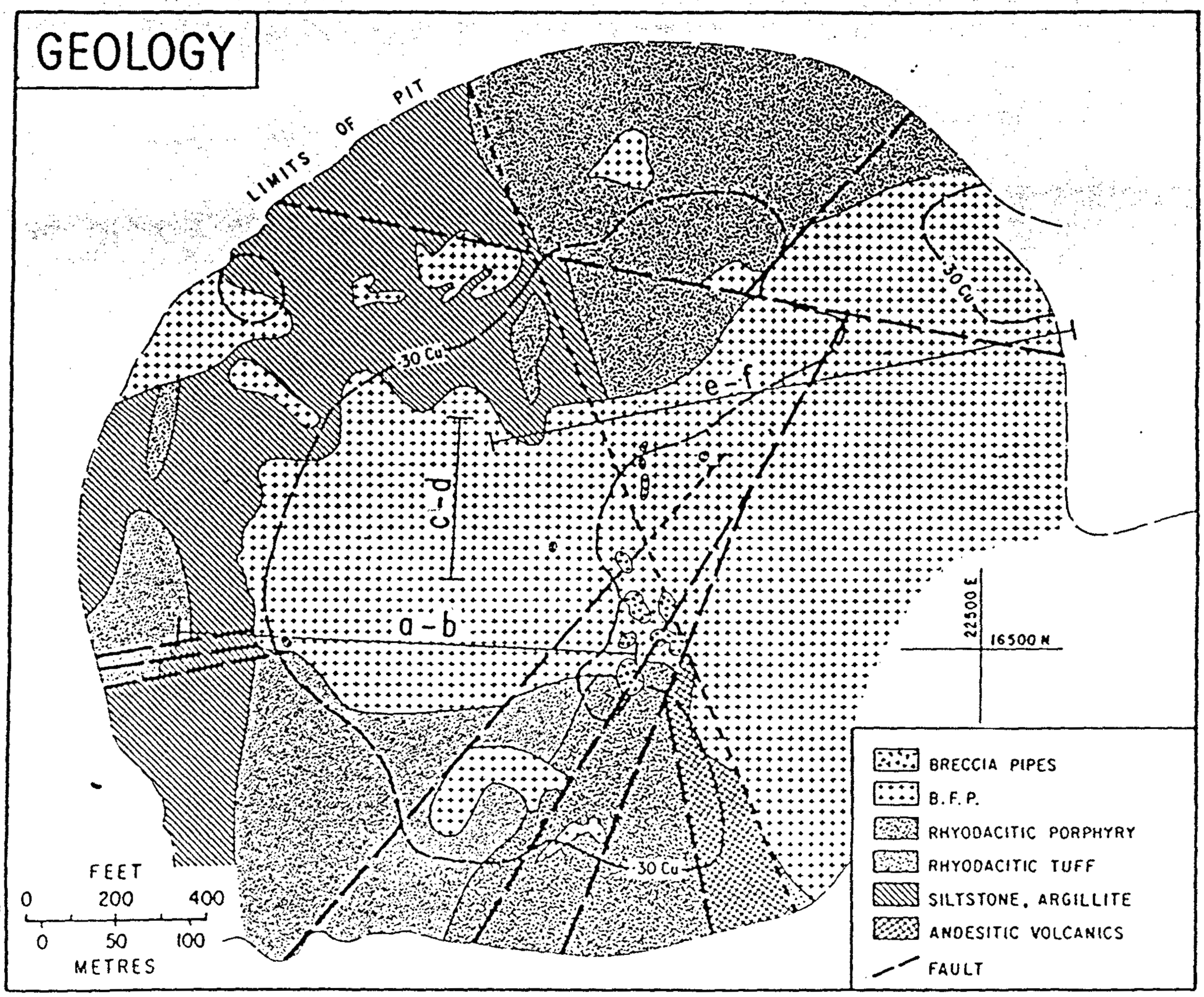


FIGURE 9 — Geology of the Bell Copper Pit. The projection of the Newman fault across the pit is shown as a dashed line.

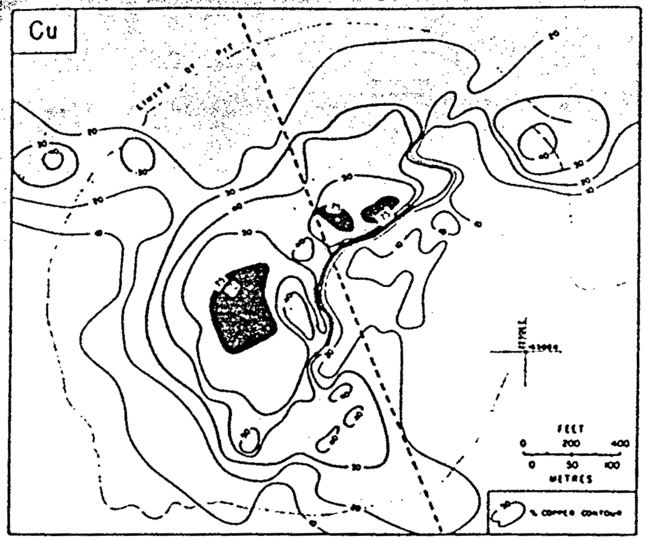


FIGURE 10 — Copper Grade-Zoning of the Bell Orebody. The contours are based on average assays of blast holes drilled on a maximum of four levels in the open pit. The same or similar samples were used for Mo and Au of Figures 11 and 12.

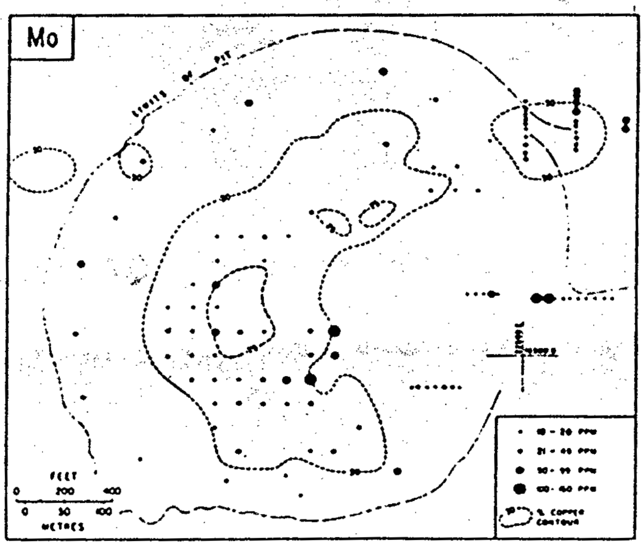


FIGURE 11 — Molybdenum Content of Rocks in the Bell Pit.

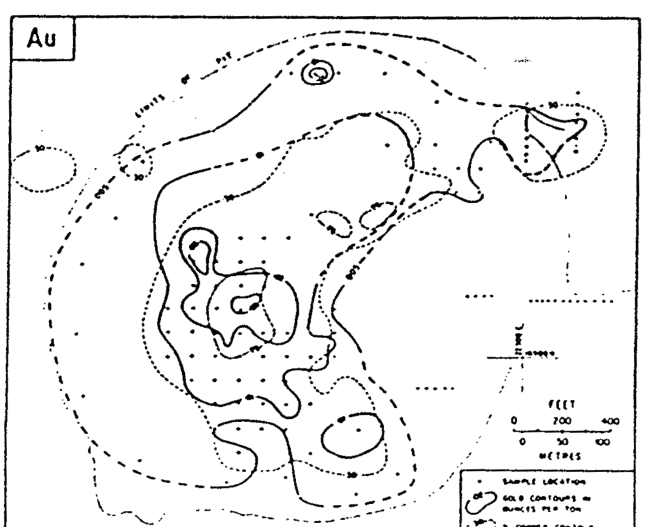


FIGURE 12 — Gold Zoning of the Bell Orebody.

and rhyodacitic porphyries and their coeval volcanic rocks appear to be in fault contact with older rocks (Fig. 3). Some of this apparent offset may reflect Eocene structure and topography; edges of some rhyodacitic intrusions may have been fault contacts, and some of the volcanic rocks may have been deposited in fault-bounded valleys.

The Newman fault has not appreciably offset the copper zone, but it and others appear to have controlled the localization and shape of the BFP plug and the distribution of copper and some hydrothermal alteration. In Hazelton rocks east of the Newman fault, the BFP plug is much wider than it is in the Skeena rocks west of the fault. As neither the BFP nor the ore zone shows offset, this widening must be an original feature. Enlargement of the BFP may have been easier in Hazelton than in Skeena rocks. On the inner southeastern perimeter of the orebody, copper grades fall off sharply along the trace of the Newman fault (Fig. 10). The fault may have acted as a barrier to copper mineralization at this locality. The fairly distinct saddle of copper values of less than 0.4 per cent that crosses the orebody in a northwesterly direction along the trace of the Newman fault may reflect a similar influence during mineralization. That the Newman fault was a major conduit which traversed the BFP immediately after its consolidation is strongly suggested by the distribution of small breccia pipes (Fig. 9).

Biotitic and chloritic alterations are concentric about the orebody and do not exhibit structural control. In contrast, the quartz-sericite zone exhibits strong structural control along its eastern and northeastern edges. The Newman fault and others shown on Figure 9 (faults C and D on Fig. 8) may have acted as barriers during this late-stage alteration (see Evolution). Post-ore movement on faults C and D may have accentuated the northeasterly extension of quartz-sericite alteration.

Although orientations of mineralized stockwork fractures in the Bell orebody vary widely, stringers of quartz-sericite-pyrite-chalcopyrite in the upper, western segment of the orebody tend to be vertical, with north-northwesterly and northeasterly strikes. Major fractures, some of which are mineralized, parallel the main faults of the pit area.

Major folds have not been observed near Bell Copper and, except for local contortion of incompetent beds near faults, the bedding of all strata dips moderately to steeply westward.

TABLE 1 — Analysis of high-grade quartz-sericite-pyrite-chalcopyrite ore from the west-central part of the Bell Copper orebody

The sample consists of 115 kg representing 370 meters of split core from 5 drill holes

Cu	.95%	Zn	.07%	FeO	9.90%
Mo	.006%	Pb	.02%	CaO	0.79%
Au	.72 ppm	Ni	.04%	MgO	0.78%
Ag	2.1 ppm	Co	.003%	SiO_2	68.2%
		S	6.66%	Al_2O_3	8.94%

Specific Gravity = 2.72

Copper Deposit

The Bell orebody is crescent-shaped in plan (Figs. 10, 13). Approximately three-fifths of the ore is within the BFP plug. The orebody plunges inward at about 70 degrees toward a focal point at a depth of about 800 meters. The arc-shaped southwestern limb terminates abruptly near the Newman fault; the northeastern limb extends 500 meters to the east of the Newman fault. A very low-grade gap, 70 meters wide and 100 meters deep, occurs in the central part of the northeastern limb (cross section X-Y of Fig. 3; Fig. 13). This gap coincides with a very weakly altered and mineralized BFP dyke(?). Because the northeastern limb is narrow and is low grade in much of its uppermost portion, the present open pit is largely in the southwestern segment, west of the Newman fault. However, the northeastern limb widens at depth and by the 1500-foot level comprises half of the ore zone. A few drill holes indicate that the ore zone extends deeper than 700 meters below surface, but probably narrows and its grade declines.

Zoning of copper grades in the Bell orebody is shown in Figure 10. Along most of the inner southern and eastern edges of the orebody, grades decline sharply to less than 0.2 per cent copper. However, along the western, northwestern and northern edges, grades decline outward more gradually and a northwesterly extension of 0.2-0.4 per cent copper follows along the large dyke-like offshoot of the BFP plug (Figs. 9, 10, 13). The orebody contains two internal high-grade zones that are 80 to 100 meters in diameter and average approximately 0.9 per cent copper.

Molybdenum at Bell probably averages about 0.005 per cent. Although molybdenite is closely associated with copper sulphides, the highest values of up to 0.015 per cent molybdenum are peripheral to the inner edge of the higher-grade copper zone (Fig. 11). This lack of coincidence is in striking contrast to the strong spatial relationship between gold and copper (Fig. 12). In the portion of the ore zone which has + 0.3 per cent copper, gold and silver average approximately 0.45 and 1.5 ppm respectively. Zinc and lead both average less than 0.01 per cent. Table 1 gives the composition of high-grade quartz-sericite-pyrite-chalcopyrite ore from the center of the southwestern limb of the orebody.

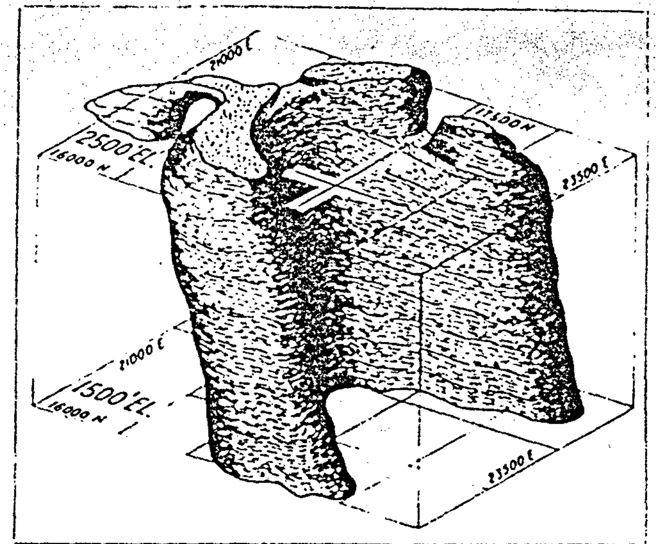


FIGURE 13 — Schematic Block Diagram of the Bell Orebody (courtesy of J. E. Kraft).

The major part of the ore zone in the open pit consists of very intense quartz-sericite-pyrite-chalcopyrite mineralization in BFP and rhyodacite (Figs. 15, 16, 17). Chalcopyrite is the main copper mineral. More than half of it is finely disseminated and the remainder occurs as fracture coatings and in 2-8-mm quartz stringers with pyrite. Pyrite is largely in fractures and in quartz stringers.

Minor to moderate amounts of bornite occur throughout the orebody, but a well-formed zone of bornite is not apparent. The mineral is present in biotitic and quartz-sericite alteration assemblages, and does not vary systematically with depth. However, a crude lateral zonation is present in that bornite/chalcopyrite is highest in the area of + 0.3 per cent copper.

Among minor sulphides present in the ore zone, sparse primary marcasite persists to the bottoms of the deepest holes drilled. However, the mineral was common in the supergene zone. Pyrrhotite blebs in pyrite extend from surface to a depth of at least 300 meters. The absence of such blebs at greater depth may merely be a reflection of the decline in abundance of the pyrite host. Supergene chalcocite, as coatings on pyrite and

TABLE 2 — Copper grades of the four sulphide-silicate zones in the western segment of the Bell Copper orebody as determined from assays in vertical drill holes (see Fig. 14).

Holes 113, 115 and 58 are more than 600 meters deep and intersect all four zones; grades in these holes and 111 show that the copper content of the quartz-sericite-pyrite-chalcopyrite zone is 15 per cent higher than the copper content of the biotite-chalcopyrite ± pyrite zone, and 30 per cent higher than the transitional zone. The upper limit of the sericite-quartz-chalcopyrite-pyrite zone was taken at 300-ft depth in order to eliminate any effects of supergene enrichment.

Hole No.	UPPER (PHYLLIC) ASSEMBLAGE Sericite-Quartz-Chalcopyrite-Pyrite		TRANSITIONAL ZONE Phyllic-Potassic		POTASSIC (BIOTITIC) ASSEMBLAGES: Biotite-Chalcopyrite ± Pyrite		POTASSIC (BIOTITIC) ASSEMBLAGES: Biotite-Chalcopyrite-Magnetite	
	Interval in Hole	Av. Cu	Interval in Hole	Av. Cu	Interval in Hole	Av. Cu	Interval in Hole	Av. Cu
113	(300′ — 750′)	.77	(750′ — 1300′)	.59	(1300′ — 1800′)	.64	(1800′ — 2000′)	.41
115	(300′ — 800′)	.75	(800′ — 1200′)	.56	(1200′ — 1800′)	.70	(1800′ — 2001′)	.59
58	(300′ — 700′)	.77	(700′ — 1300′)	.66	(1300′ — 1650′)	.68	(1650′ — 2016′)	.68
111	(300′ — 600′)	.80	(600′ — 1030′)	.53	(1030′ — 1053′)	.54	— —	—
Average		.77/1650′		.59/1980′		.67/1473′		.58/767′

as replacements of chalcopyrite, occurred to depths of 50 to 70 meters and enriched copper grades by 12 to 15 per cent (Fig. 22). Primary chalcocite, digenite and covellite occur in trace quantities to the bottom of the known part of the ore zone. Owens (1974) found that the ore concentrate contains grains of tennantite, tetrahedrite with about 11 wt. per cent silver, and native gold. Minor galena and sphalerite, accompanied by very minor chalcopyrite and pyrite, occur in sparse but widespread quartz-carbonate veins 1 cm to 30 cm wide by up to 10 m long. These veins cut all other mineralized fractures.

As shown in Figure 14, sulphide mineralization and alteration facies change with depth in the high-grade, central part of the southwestern segment of the ore zone. Light grey BFP with quartz-sericite-pyrite-chalcopyrite extends to depths of about 250 meters. From approximately 250 to 400 meters depth, this assemblage occurs in diminishing quantities as veins and irregular patches in darker BFP containing biotite-chalcopyrite ± pyrite. The latter assemblage persists to 600 meters, below which it changes to biotite-chalcopyrite-anhydrite ± traces of pyrite. The ratio of disseminated to veinlet chalcopyrite is higher in the biotite-bearing, low-pyrite zones than in the quartz-sericite zone. In some cases, it is clear that pyrite and pyrite-sericite stringers have cut through, i.e. have been superimposed on, the biotite-chalcopyrite-anhydrite assemblage.

As shown in Figure 14 and Table 2, the copper

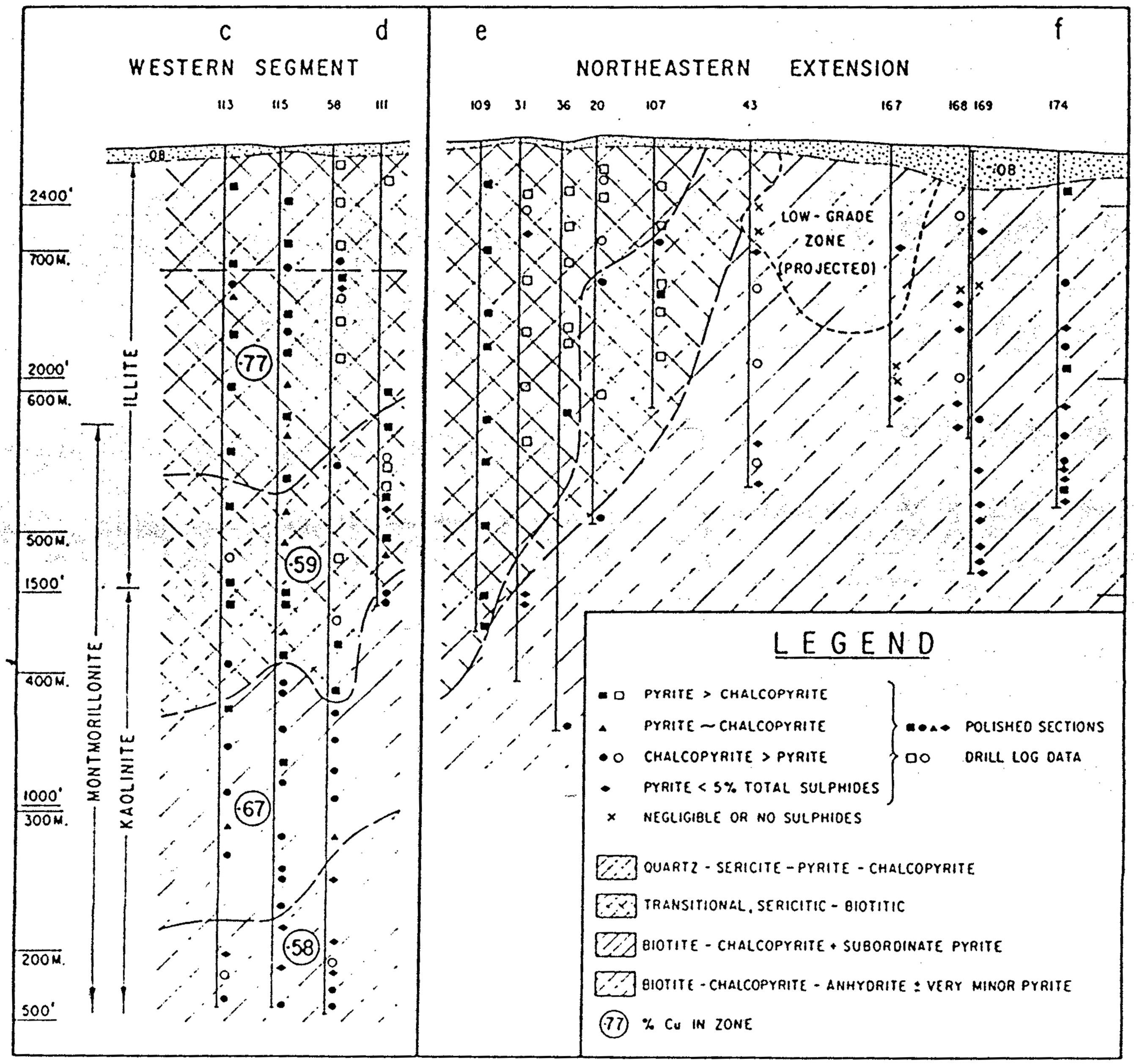


FIGURE 14 — Vertical and Lateral Mineralogical Zoning at Bell Copper (section lines c-d and e-f of Fig. 9). Note the close relationship between quartz-sericite alteration and high-pyrite ore, and between biotitization and low-pyrite ore. Kaolinite dominance below approximately 300 meters in the western segment of the orebody marks the mid-point of the transitional zone between the upper, quartz-sericite-pyrite-chalcopyrite zone and the biotite-chalcopyrite ± pyrite zone underlying it. The four mineralogical zones are defined best in section c-d, because these zones are best developed in the western segment of the orebody and because all holes in this section are within ore. Copper grades of the four zones are shown on the section and are given in detail in Table 2. The eastern segment of the ore zone (section e-f) is composed mainly of ores of biotite-chalcopyrite + subordinate pyrite and of biotite-chalcopyrite ± very minor pyrite. Because certain holes had to be projected considerable distances onto the section, zone limits in section e-f are approximate.

content of the quartz-sericite-pyrite-chalcopyrite ore is about 15 per cent higher than that of the deeper biotite-chalcopyrite ± pyrite ore, and the transitional zone between the two shows a significant depletion in copper. The deepest biotite-chalcopyrite-anhydrite assemblage is the lowest grade of all four types of ore.

In the northeastern limb of the ore zone, east of the Newman fault, the quartz-sericite-pyrite-chalcopyrite assemblage is not abundant (Figs. 14, 15) and biotite-chalcopyrite ± pyrite predominates.

Origin of the vertical and lateral changes in mineralogy and copper content of the Bell orebody are discussed in the section on Geological Evolution.

Pyrite Halo

The Bell orebody is surrounded by a prominent annular pyrite halo about 2200 meters in diameter (Figs. 3, 15). All rocks within the halo contain abundant disseminated pyrite and abundant stringers, ½ to 2 cm wide, which are generally accompanied by subordinate sericite, chlorite, carbonate and quartz. The halo averages approximately 10 per cent pyrite by volume, but the pyrite ranges from 5 to 25 per cent. The outer boundary of the halo is well within the outer limits of hydrothermal alteration and is marked by a decrease in pyrite from greater than 5 per cent to less than 2 per cent. The inner boundary of the halo encloses an area about 800 meters in diameter that includes the orebody. This central area is relatively low in pyrite, except for the zone of superimposed quartz-sericite-pyrite-chalcopyrite.

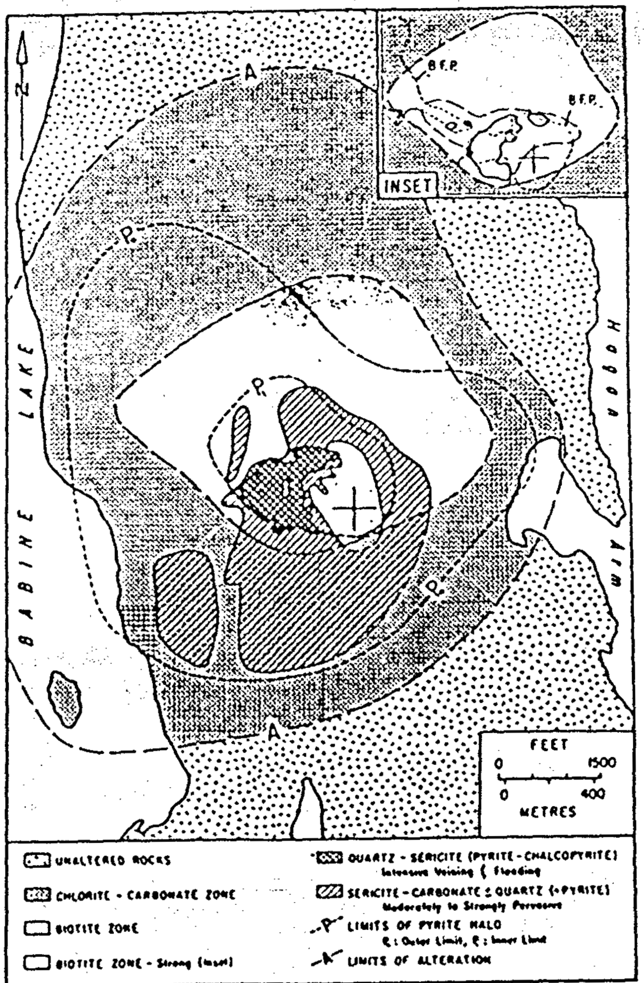


FIGURE 15 — Hydrothermal Alteration Zones at Bell Copper. Hydrothermal biotite is abundant only within the sparse-pyrite central area enclosed by the line P_1, but the biotite zone has been enlarged to include sporadic peripheral occurrences in otherwise strongly chloritized rocks. The inset shows a much smaller area enclosing the orebody in which hydrothermal biotite is not only abundant, but is of good quality. The quartz-sericite and sericite-carbonate alteration have been superimposed on the earlier biotitic and chloritic alterations. Only areas of very intense sericite-carbonate alteration are shown.

Hydrothermal Alteration

GENERAL STATEMENT

The halo of hydrothermal alteration surrounding the Bell Copper orebody is approximately 3500 by 2500 meters in surface dimensions (Figs. 3, 15). The halo has concentric zones of biotite and chlorite typical of all Babine deposits (Carson and Jambor, 1974). In addition, however, the Bell halo has an irregularly shaped zone of moderate to very intense quartz-sericite and a concentric zone of sericite-carbonate alteration. In plan, the quartz-sericite alteration envelopes much of the orebody and the sericite-carbonate alteration extends outward into the pyrite halo. The quartz-sericite alteration, and possibly also the peripheral sericite-carbonate alteration, appears to have been superimposed upon the earlier biotite and chlorite alterations in the upper part of the porphyry system.

BIOTITE ZONE

The biotite zone shown in Figure 15 includes all the hydrothermal biotite observed during detailed thin-section studies. In the peripheral part of the zone, pale green and brown fine-grained hydrothermal biotites, accompanied by chlorite, replaced primary mafic minerals in BFP dykes and in sedimentary and volcanic rocks. As the orebody is approached, chlorite diminishes and hydrothermal biotite becomes deeper brown and coarser. A sub-zone of "good-quality" hydrothermal biotite (see Table 2 *in* Morrison by Carson and Jambor, this volume) corresponds closely in plan with the orebody (Fig. 15, inset). Hydrothermal biotite occurs at surface, except where the ore zone consists of quartz-sericite-pyrite-chalcopyrite (Fig. 14). Hydrothermal K-feldspar is present in very minor quantities in some quartz-biotite-sulphide veinlets within the better-quality part of the biotite zone.

A very weakly altered postmineral BFP dyke(?) transects the northeastern limb of the Bell orebody in the east-central part of the biotite zone.

CHLORITE-CARBONATE ZONE

The chlorite-carbonate zone at Bell is characterized by the replacement of original mafic minerals in all rocks by chlorite and carbonate. Their first appearance, together with that of minor but anomalous quantities of pyrite, marks the perimeter of the chlorite-carbonate zone. The inner boundary of the zone is delimited by the appearance of hydrothermal biotite. Epidote, common throughout the chlorite-carbonate zone, is particularly abundant in the outer fringes, where it imparts an apple-green colour to many rocks. BFP in the chlorite-carbonate zone is typically greenish grey, in contrast to its dark grey colour in the biotite zone.

For detailed petrographic descriptions of rocks typical of the biotite and chlorite-carbonate zones, see Carson and Jambor (1974) and Carson and Jambor (this volume, Morrison deposit).

QUARTZ-SERICITE ZONE

Minor amounts of sericite are present throughout the biotite and chlorite-carbonate zones. However, intense quartz-sericite alteration, accompanied by considerable pyrite and some chalcopyrite, has obliterated the biotite zone in the upper western part of the orebody (Figs. 14, 15). Parts of the BFP plug and the rhyodacites are cut by closely spaced quartz-sulphide stringers, and flooded with silica and sericite (Figs. 16, 17). Quartz in many of the veinlets is pale purple. Except for scattered chalky feldspar phenocrysts, the original rock textures have been destroyed by the quartz-sericite alteration. However, intensely altered BFP has larger and more abundant remnant plagioclase phenocrysts which serve to distinguish it from rhyodacite.

The quartz-sericite-pyrite zone extends to a depth of about 250 meters in the west-central part of the orebody. Between 250 and 400 meters is a transitional zone in which textural features indicate that the quartz-sericite-sulphide veins and irregularly shaped bleached zones have been superimposed on dark grey BFP which contains biotite-chalcopyrite. Below 400 meters, the quartz-sericite-sulphide assemblage is absent. A somewhat similar, but sharper, transition occurs laterally to the east, both at surface and at depth (Figs. 14, 15). The eastern extension of the orebody is almost entirely of the sparse pyrite, biotite-chalcopyrite type.

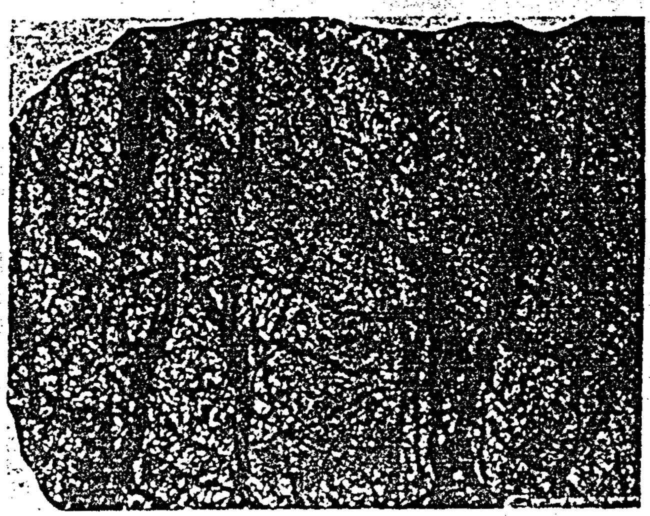


FIGURE 16 — BFP With Intense Quartz-Sericite-Pyrite Alteration and Veining.

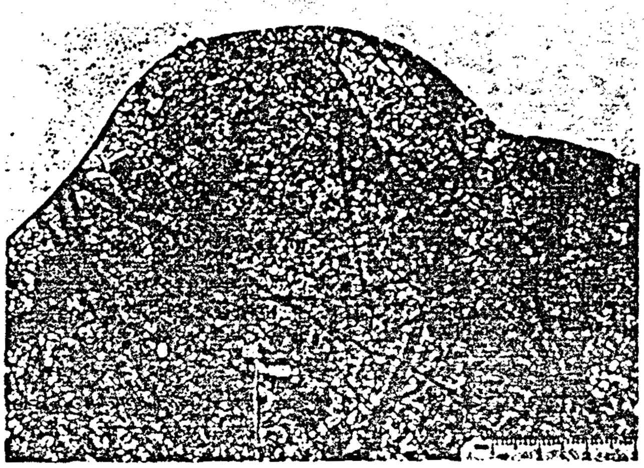


FIGURE 17 — Rhyodacite With Intense Quartz-Sericite-Pyrite Alteration and Veining.

The concentric biotite, chlorite and sericite-carbonate zones are centered on the Bell ore zone, whereas the superimposed quartz-sericite alteration overlaps the orebody and shows strong structural control. The quartz-sericite alteration is in a highly fractured zone within the western nose of the BFP plug, and the eastern and northeastern limits of the alteration coincide with the Newman fault and subsidiary northeasterly faults (Figs. 3, 8, 9, 15).

SERICITE-CARBONATE ZONE

To the west, south and north, the quartz-sericite-pyrite - chalcopyrite assemblage changes relatively sharply to sericite-carbonate-pyrite. Although data for the southeast are sparse, the sericite-carbonate alteration appears to ring and overlap the contact of the BFP plug and coincide with much of the pyrite halo. This alteration formed most intensely in salic to intermediate rocks, particularly rhyodacites, and is weakest in shales and siltstone.

Because of their high quartz content and coarser sericite, rocks of the quartz-sericite zone generally have a more compact, vitreous appearance than those of the peripheral sericite-carbonate zone, which seem chalky.

SUSCEPTIBILITY OF HOST ROCKS TO ALTERATION

At Bell, abundances of all three major alteration types, biotitization, sericitization and chloritization, were affected by original rock compositions. Biotitization and chloritization were developed best in mafic-bearing rocks, such as BFP and andesites, whereas sericitization is most pronounced in siliceous feldspathic rocks, particularly rhyodacite. However, it should be emphasized that although the different susceptibilities have affected the abundance of specific alteration minerals, the susceptibilities have not significantly affected the mineralogy. For example, siltstones in the sericite-carbonate zone, although distinctly less reactive than adjacent rhyodacites, are generally mildly bleached and contain minor sericite and carbonate.

Biotitization and chloritization are restricted largely to hornblende phenocrysts and matrix hornblende in BFP, and to amphibole and chlorite in volcanic and sedimentary rocks. As at other Babine deposits, primary biotite was largely stable in all alteration zones; only where sericitization was intense was biotite totally replaced. Thus, unaltered books of biotite are common in BFP throughout all but the quartz-sericite and sericite-carbonate zones. In contrast, hornblende has been observed at only two localities within the entire alteration zone; incompletely biotitized phenocrysts were found in BFP at the southwestern edge of the biotite zone, and unaltered hornblende occurs in the late-stage, weakly altered BFP dyke (?) in the northeastern extension of the orebody.

Destruction of plagioclase phenocrysts in BFP shows a systematic concentric variation if the superimposed effects of quartz-sericite alteration are disregarded. Plagioclase in the center of the biotite zone is largely unaltered, but replacement of plagioclase by sericite, carbonate and minor kaolin increases outward and is most intense in the sericite-carbonate zone and the central part of the chlorite-carbonate zone. This area of maximum alteration of plagioclase coincides with the strongest part of the pyrite halo. Alteration of plagioclase decreases outward to the edge of the chlorite-carbonate zone.

CLAY MINERAL ZONING

Clay minerals other than illite are not abundant at Bell Copper. Jambor and Delabio (1975) have shown that minor to moderate amounts of kaolinite are present in most of the Bell alteration zone, whereas montmorillonite is restricted to the orebody. No "classic" argillic zone peripheral to the sericitic (phyllic) alteration ring has been defined.

Primary clay minerals in the western, quartz-sericite segment of the orebody are zoned vertically (Fig. 14). Kaolinite dominates in the deep biotite-chalcopyrite ± pyrite zone, whereas montmorillonite occurs in both this and the zone transitional to sericite-quartz-pyrite-chalcopyrite. Sericite (= illite) is present through the entire vertical range, but is most abundant in the upper 400 meters as a result of its late-stage superimposition on pre-existing biotitic alteration.

Although the clay mineral zonation is obviously a primary feature, the upper 50 to 70 meters of the orebody have undergone supergene enrichment and alteration, as described later.

OTHER ALTERATION MINERALS

Dolomite, calcite and some siderite are common in all rocks in the chlorite-carbonate and sericite-carbonate zones. The carbonates are also fairly common in the Bell orebody, but are least abundant in the highly biotitized parts. The disappearance of carbonates clearly marks the outer edge of alteration at Bell.

Veinlets of gypsum have been observed in the upper part of the orebody. Anhydrite is apparently a significant component in the biotite-chalcopyrite assemblage, but has not been observed in other alteration facies, including pyrite-bearing biotitized rocks (Fig. 14). Monomineralic veinlets of anhydrite are rare. The mineral is typically disseminated in BFP and is also a minor constituent in quartz veinlets. The anhydrite in both characteristically occurs along grain boundaries.

Tourmaline occurs predominantly as microscopic sunbursts in the western part of the ore zone, but is also present in the middle part of the pyrite halo. Although most occurrences are in rocks with intense sericitic alteration, the association is not considered to be significant because of alteration superimposition and because the mineral has also been noted in biotitized BFP. However, no tourmaline has been observed in the biotite-chalcopyrite-anhydrite assemblage.

Hydrothermal amphibole is common at the Morrison deposit (Carson and Jambor, this volume), but has been observed only in one thin section of BFP at Bell.

Magnetite is a primary disseminated constituent of fresh BFP and is also a stable component in the biotite-chalcopyrite ± anhydrite alteration assemblage. Most magnetite in other assemblages has been altered to hematite, with sieve-textured pseudomorphs being very common. Specularite plates and hematite veinlets also occur locally, generally where magnetite oxidation is at an advanced stage. Some iron oxides are in contact with sulphides, and hematite veinlets are cut locally by pyrite and chalcopyrite. There are rare indications that magnetite also may have formed in veinlets and was subsequently converted to hematite.

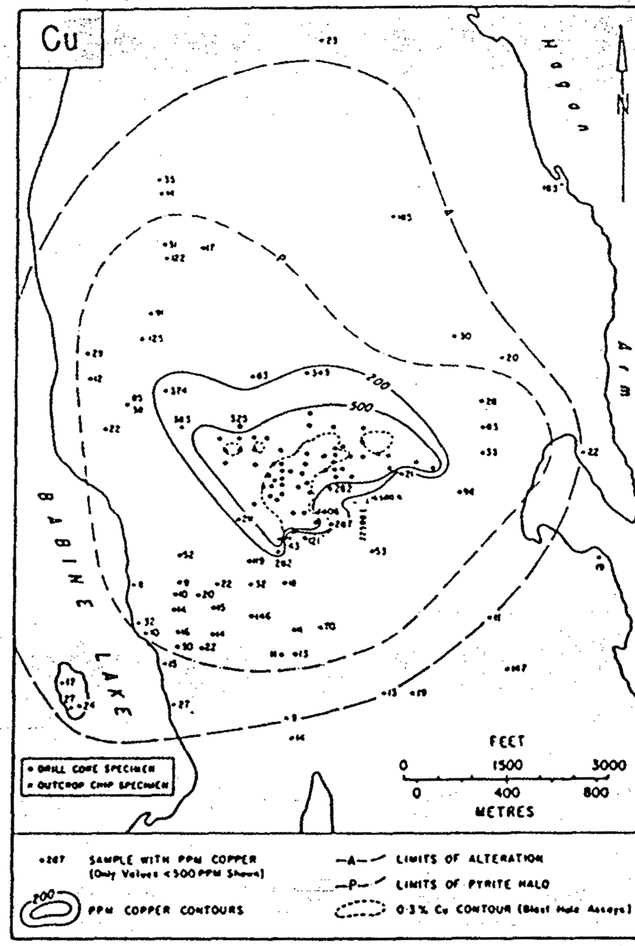


FIGURE 18 — Copper Distribution in Rocks at Bell Copper.

Microprobe analyses of a few grains of primary magnetite indicate that its TiO_2 content is variable and averages about 0.5%. Thus, most of the microscopic rutile crystals, and turbid granular aggregates of rutile which are common in the non-potassic alteration zones, have apparently been derived by the release of titanium from amphibole and both primary and hydrothermal biotites. Altered mica phenocrysts are accompanied by rutile granules and some are sagenitic.

Primary Dispersion Haloes

Samples of diverse rock types from the Bell copper zone, the alteration halo and the unaltered peripheral rocks were analyzed for copper, zinc, lead and mercury (Figs. 18-21). Because only the outermost parts of the alteration halo and the unaltered rocks beyond the halo are exposed, most samples are of drill core. The samples were carefully chosen to avoid leached material and prominent veins.

Dispersion of copper outward from the ore zone, which was the focal part of the hydrothermal system, was remarkably limited. Copper values diminish outward very regularly to the 200-ppm contour, beyond which all analyses are at background level. The area with copper greater than 200 ppm coincides closely with the biotite zone (Fig. 16), whereas the area of background values includes most of the pyrite halo surrounding the ore zone, and virtually all of the

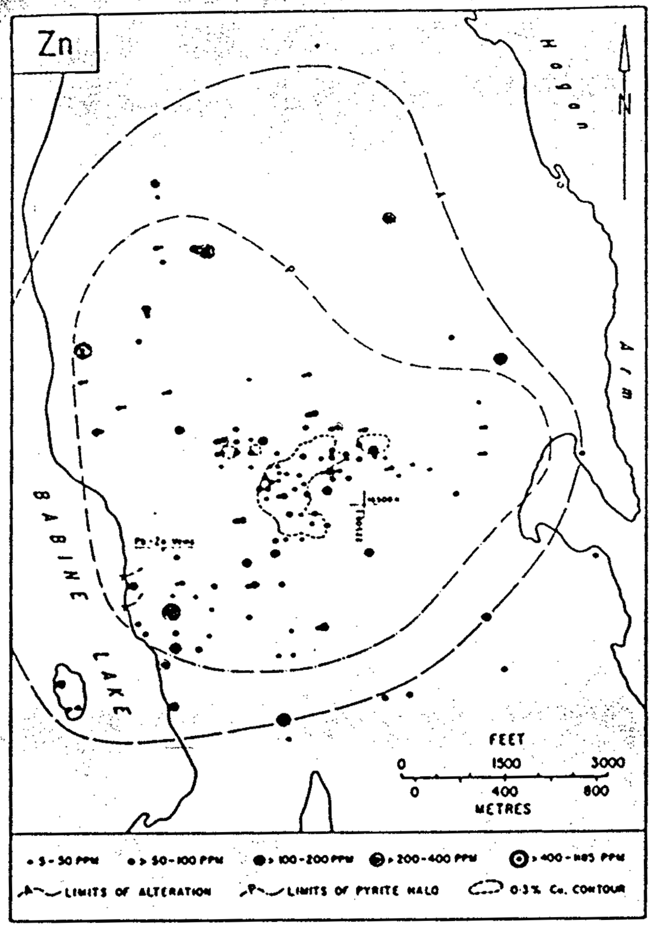


FIGURE 19 — Zinc Distribution In Rocks at Bell Copper.

chlorite-carbonate zone. Except for the quartz-sericite zone, which overlaps the orebody, copper values show no relationship to sericite distribution.

The geochemical analyses for copper agree well with blast-hole assays (Fig. 10) and diamond drill assay results. All show a very sharp cutoff of copper along the south and southeastern edge of the orebody and a more gradual decline to the north and northwest, particularly along the northwestern apophysis of the BFP plug (Figs. 3, 13).

Blast-hole assays and diamond drill results show that both zinc and lead average less than 100 ppm in the Bell orebody, but are slightly higher in the adjacent periphery. Rock geochemistry likewise shows that contents of both metals are distinctly low in the orebody, but increase outward to maximum abundance near the outer edge of the pyrite halo (Figs. 19, 20). The lead and zinc values are unrelated to lithology. The largest veins of lead and zinc found to date are the original showings at the southwestern edge of the pyrite halo on the shore of Babine Lake. The distribution of zinc at Bell is remarkably similar to that at Granisle (Carson and Jambor, 1974).

Mercury is erratic; some high values are in the Bell orebody and others are in the alteration zone. Only very low values occur in unaltered rocks.

Additional data on the primary dispersion haloes at Bell and other Babine deposits are given in Jambor (1974).

Supergene Enrichment and Oxidation

Beneath the thin mantle of glacial debris, 5 to 30 meters thick, the western quartz-sericite-pyrite-rich segment of the Bell Copper deposit had an enriched

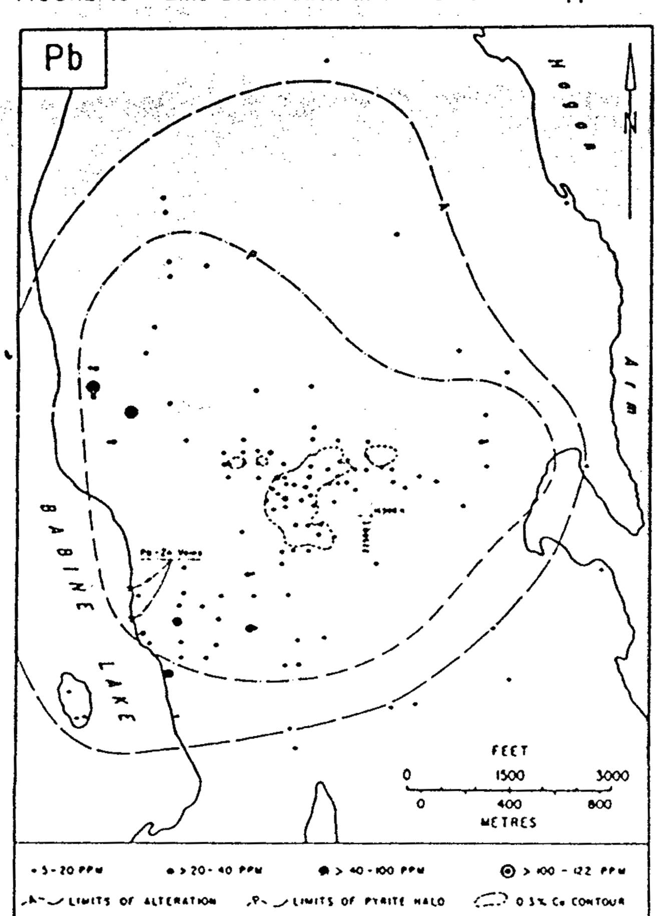


FIGURE 20 — Lead Distribution in Rocks at Bell Copper.

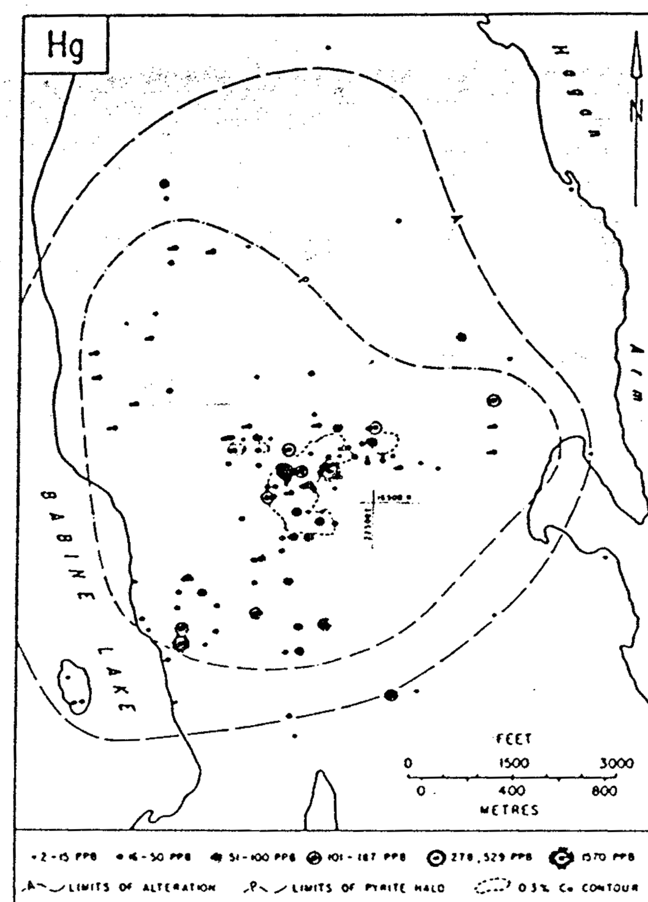


FIGURE 21 — Mercury Distribution in Rocks at Bell Copper.

cap containing supergene chalcocite which extended from bedrock surface to depths of about 50 to 70 meters. Within the enriched capping, now mined out, an elongate oxide zone striking N 40°E was characterized by abundant dark brown iron oxides. In the center of the pit, the oxide zone was very irregular in profile, but extended to a maximum depth of about 40 meters from bedrock surface (Fig. 22).

The Bell Copper supergene-enriched zone apparently was formed after Eocene BFP intrusion and mineralization, but prior to Pleistocene glaciation. The development of the Bell chalcocite blanket may have been interrupted by minor uplift. The uplift resulted in a new level of oxidation, as represented by the zone of dark brown iron oxides, which penetrated the chalcocite blanket.

In the enriched and oxidized zone, average primary copper grades were increased by as much as 10 to 15 per cent (Fig. 22). Maximum enrichment occurred 20 to 35 meters below present ground surface in the quartz-sericite-pyrite-rich western part of the ore zone, where primary copper grades were highest. Primary sulphides were supplemented principally by sooty chalcocite, with common covellite and minor digenite. The supergene sulphides were deposited in small pits and as coatings on chalcopyrite, pyrite and marcasite. In most cases, chalcocite coated and replaced chalcopyrite, leaving the associated pyrite untouched (Fig. 25). In many cases, however, chalcocite was deposited directly on pyrite, or on thin rinds of marcasite which coated pyrite (Fig. 24).

Principally in the oxidized part of the enriched zone, supergene chalcocite was in turn coated with very thin layers of brochantite and malachite. These coatings were not readily evident megascopically, but they were abundant nevertheless. This abundance was evident both from detailed mineralogical studies of the oxidized material and from assays for oxide copper, as shown in Figure 23.

In plan, the area of + 0.05 per cent assay CuO on the 2420 bench, which was approximately 30 meters below bedrock surface, occurred as a northeasterly zone approximately 315 meters long and 30 meters wide. This zone is shown in cross section in Figure 23 and is between drill holes 22 and 40. The zone consisted of two parts, a smaller northeastern one of approximately 25 by 60 meters, and a larger zone trending N 40°E which was 30 by 190 meters. Both disappeared rapidly with depth — on the 2380 bench (only 13 meters deeper), the area of 0.05 per cent CuO was negligible, and the area of 0.30 per cent CuO was only about a fifth of that on the higher bench. The contours of 0.03 per cent CuO on the 2380 bench enclosed only one fairly large northerly striking zone, approximately 30 meters wide and 120 meters long. This zone was roughly in the same plan area as the overlying southwesterly part of the zone of 0.05 per cent CuO.

A comparison of the grade contours for CuO and total copper indicates that, during oxidation and enrichment, copper apparently did not move laterally for any significant distance. Thus, the largest area of 0.05 per cent CuO coincided approximately with that of highest-grade primary copper. Oxidation and enrichment may have been enhanced because this area contained intense quartz-sericite alteration, was particularly rich in both pyrite and chalcopyrite, and was locally more porous and permeable than strongly biotitized rocks.

In the paleo-oxidation zone, in addition to the iron oxides, the sulphides, and the brochantite and malachite mentioned previously, traces of intergrown devilline, $Cu_4Ca(SO_4)_2(OH)_6 \cdot 3H_2O$, and serpierite, $Ca(Cu,Zn)_4(OH)_6(SO_4)_2 \cdot 3H_2O$, occurred as minute flaky coatings on brochantite-coated pyrite and chalcocite. Associated with some devilline and serpierite were coatings and aggregates of poorly formed crystals, averaging 0.2 mm in length, of deep blue posnjakite, $Cu_4(SO_4)(OH)_6 \cdot H_2O$. Other supergene minerals identified are kaolinite, thin coatings of montmorillonite on chalcocite, minute yellow clusters of framboidal siderite and clear calcite crystals up to 0.5 mm in width. Green to chocolate-brown mitridatite, $Ca_3Fe(OH)_6(H_2O)_3(PO_4)_4$, was found as millimeter-thick microcrystalline coatings on one specimen from the pit. White barite prisms, averaging 1 mm in length, were present in limonite-coated fractures, and centimeter-wide pockets of ocherous jarosite occurred in leached, porous quartz-sericite rocks near the top of the oxidized zone. In such rocks, quartz stringers provided a rigid framework on which supergene minerals, including new quartz growths, were deposited. One of the last minerals precipitated as coatings in this porous environment was white to cream-coloured gibbsite, $Al(OH)_3$, which represented the residuum of aluminum-bearing minerals leached above the paleo water table.

Less certain in origin, but probably formed during recent weathering, are small amounts of hematite, malachite and jarosite, abundant goethite and limonite,

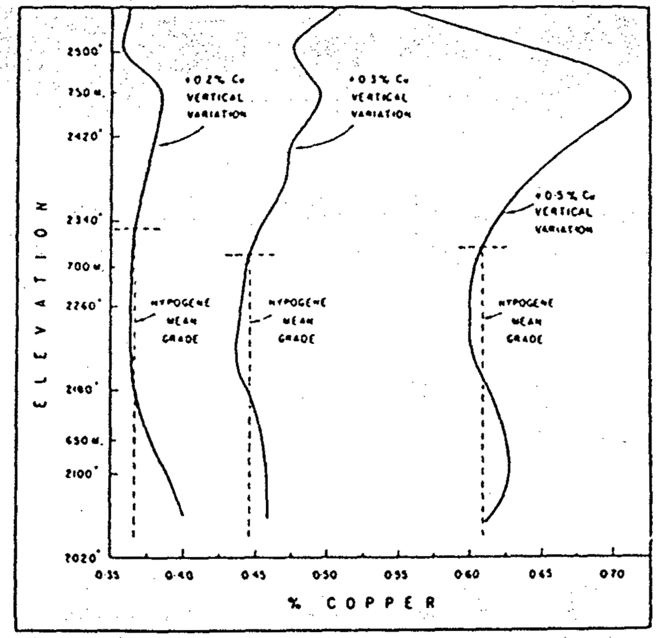


FIGURE 22 — Effects of Oxidation and Supergene Enrichment at Bell Copper. The effects are shown as vertical copper-grade profiles and with geological reserves to the 2060-foot level calculated as + 0.2% Cu (91 million tons), as + 0.3% Cu (55 million tons) and as + 0.5% Cu (17 million tons). The increase in hypogene grade below 2340 ft is an apparent increase only and is due to the fact that only high-grade holes were continued to depth — thus this apparent increase is most pronounced in the + 0.2% Cu profile. Dashed vertical lines give the mean grades of the three classes of hypogene ore below the 2340-ft elevation. The sections show that: (1) maximum enrichment occurred at about 2460 ft (27 m below bedrock surface); (2) oxidation and enrichment were limited to the upper 50 to 70 meters of the deposit; (3) maximum grades attained in the enriched zone are roughly proportional to the mean grade of the hypogene ore — the higher the grade of the hypogene ore, the higher the grade of the enriched ore. From this relationship, it may be inferred that migration of copper in the supergene zone was essentially vertical.

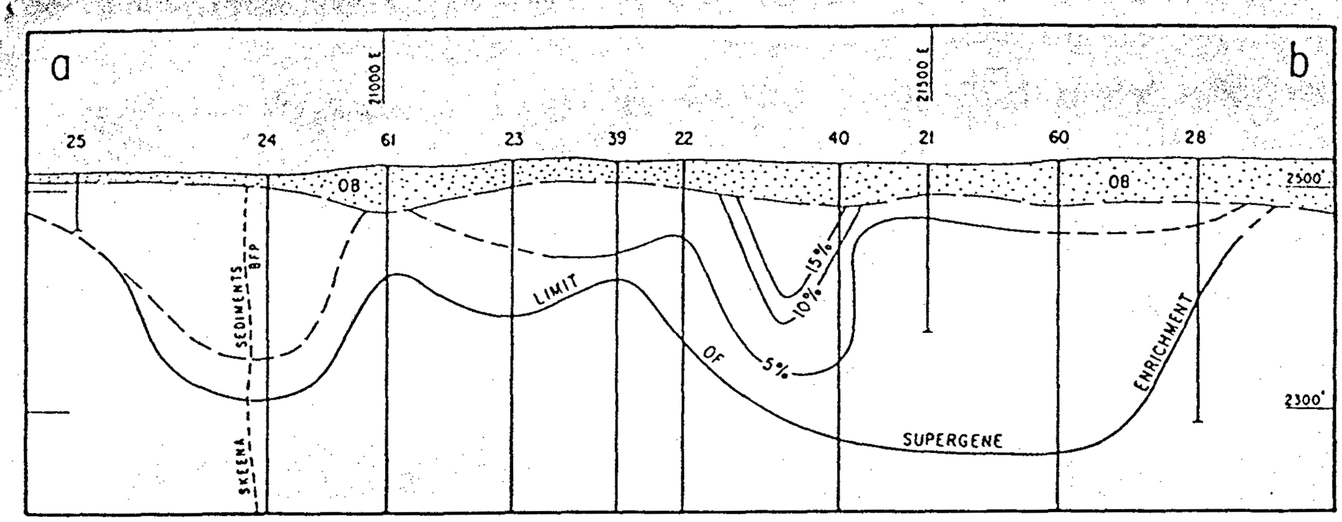


FIGURE 23 — Profiles of Oxidation and Supergene Enrichment Across the Western Segment of the Bell Copper Orebody (see Fig. 9, line a-b, for location). Contours of 5%, 10% and 15% Cu oxide/total Cu are shown.

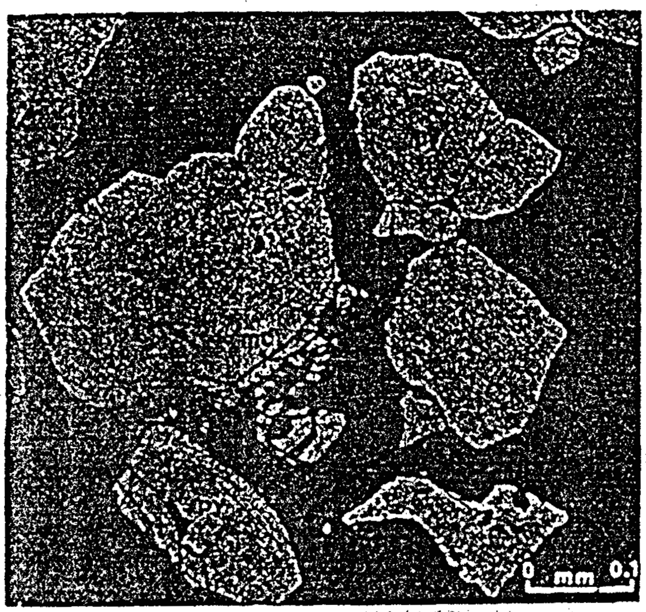


FIGURE 24 — Photomicrograph of Grain-Mount of Supergene Ore. Pyrite (py) is rimmed by supergene marcasite (mc), which is in turn rimmed by supergene chalcocite (cc).

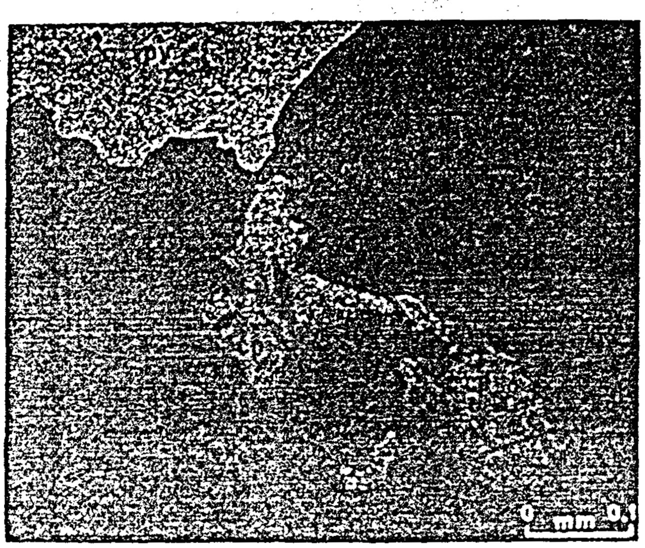


FIGURE 25 — Photomicrograph of Polished Section of Supergene Ore. Selective replacement of chalcopyrite (cp) by rims of chalcocite, with pyrite (py) unaffected.

and traces of wad. Smithsonite, $ZnCO_3$, is present as pulverulent white coatings on sphalerite at the lead-zinc showings on the lake shore west of the deposit. Several supergene minerals on the pit walls obviously have been precipitated since mining began. Among these are pale green and pale blue water-soluble sulphates, chiefly chalcanthite, $CuSO_4{\cdot}5H_2O$. Greenish ferroan varieties are common, and some cuprian siderotil, $(Fe,Cu)SO_4{\cdot}5H_2O$, has been found. Also present on the walls are prismatic crystals, averaging 1 mm in length, of cuprian melanterite, $(Fe,Cu)SO_4{\cdot}7H_2O$. In areas where such sulphates are common, the rocks are permeated with brick-red hematitic stains and are soft and friable because of destruction of the feldspars and pyrite. Gypsum is present and ocherous coatings of geothite and other iron oxides are common; yellowish patches usually indicate that jarosite is present.

Geological Evolution

The geological evolution of Newman Peninsula and Bell Copper during the early Eocene is depicted in Figure 26. By earliest Eocene, the major block-fault units were established and most of the observable displacement on the bounding faults had already occurred. The Bell orebody, which is related to a BFP plug, shows little, if any, offset along the trace of the Newman fault. It seems, therefore, that although block faulting at Bell continued well into the Eocene, subsequent movement on the Newman fault waned and was at most only minor after the emplacement of the BFP and deposition of the orebody had begun.

The BFP plug at Bell Copper was emplaced along the Newman fault and may have been localized at its intersection with a composite pre-ore fault (Fig. 8, fault A; Fig. 9). The plug widens east of the Newman fault, but its northern contact does not show a sharp offset along the fault trace. Widening of the plug may be related to the lithological change across the Newman fault — Hazelton rocks to its east may have been less constrictive than the Skeena rocks and rhyodacites to the west. Although primary textures in the western part of the plug were largely obliterated by quartz-sericite alteration, indications are that the Bell plug is multi-phase. As at Morrison (Carson and Jambor, this volume), the porphyry system at Bell was established after nearly all phases of the BFP plug had crystallized.

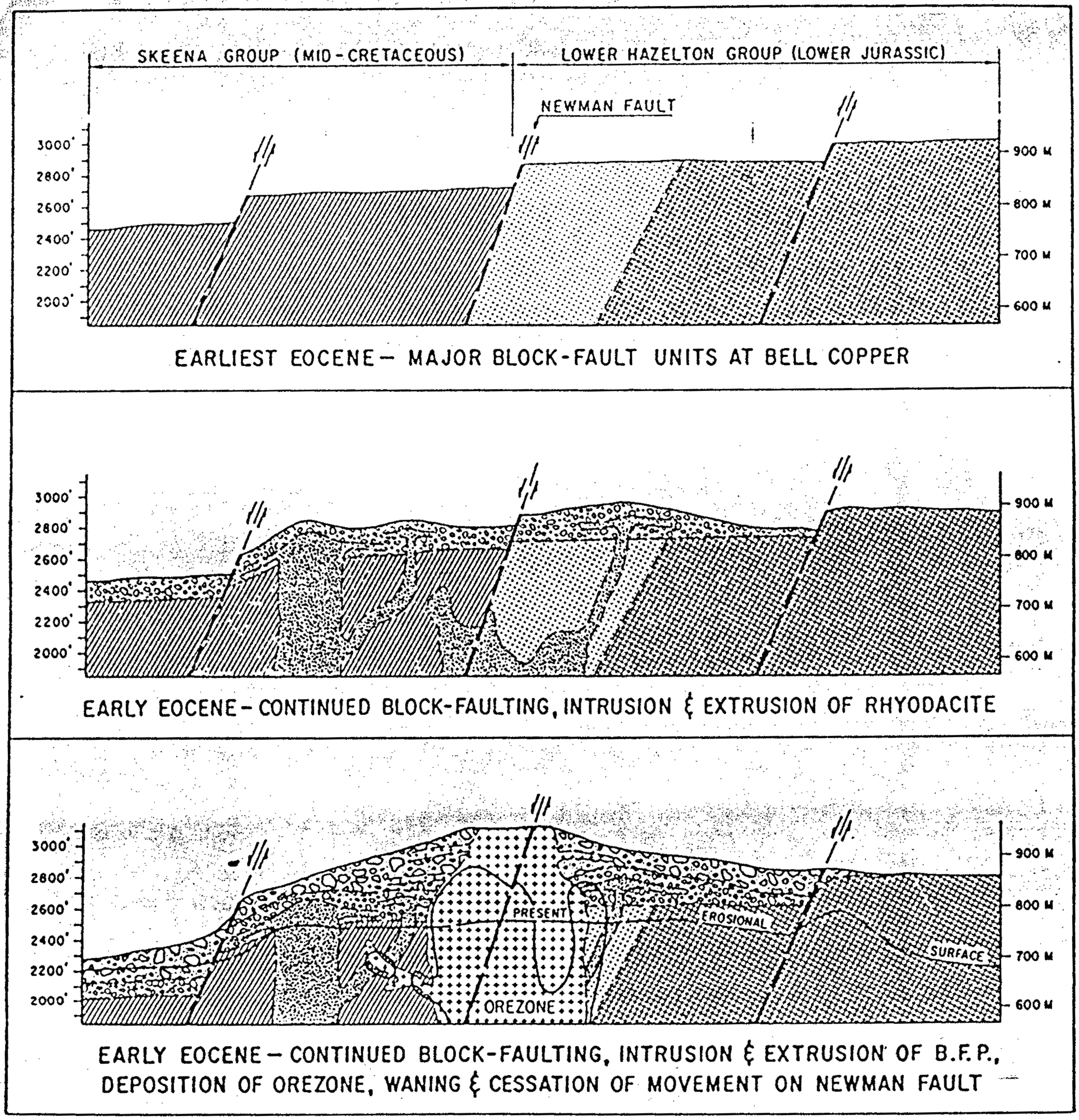


FIGURE 26—Schematic Cross Sections Illustrating the Geological Evolution of Newman Peninsula and the Bell Copper During the Early Eocene.

Copper mineralization and hydrothermal alteration at Bell Copper seem to have occurred in the following sequence.

1 — **Main-Stage Sulphide Deposition and Biotite-Chlorite Alteration Zoning.** The Bell orebody formed along the western and northwestern edges of the BFP plug, and along a northwestern apophysis of the plug. Copper was accompanied by roughly proportional quantities of potassic alteration; the total area of anomalous copper coincided with biotitization, and highest copper grades coincided with the most intense biotitization. Sulphides were distributed zonally, with chalcopyrite and minor bornite in the orebody, and pyrite peripheral. Copper is most abundant to depths of about 600 meters below the present surface, below which grades gradually decline, residual primary magnetite is present in BFP, and the assemblage is biotite-chalcopyrite ± anhydrite.

Chloritization of mafic minerals occurred in the cooler, peripheral parts of the system and at this stage, therefore, Bell Copper was a typical concentrically zoned porphyry copper deposit. A central copper zone was enclosed in a potassic zone of biotite and K-feldspar surrounded by propylitic alteration, and there was a concentric, zonal distribution of copper and pyrite. This main stage of development at Bell was the only one developed at Morrison.

2 — **Initial Cooling and Retrograde Sericitization.** The formation at Bell of sericite-carbonate alteration at the same position as the phyllic zone of many other porphyry copper deposits probably occurred as the system began to cool, as discussed by Carson and

Jambor (1974). Potassic minerals (biotite and K-feldspar) of the main stage were stable, and sericite subsequently formed at their boundary with the propylitic zone. Reactions at this stage were still principally magmatic hydrothermal. Minor influx of non-magmatic water may have intensified sericitization and pyritization. Lead and zinc may have been deposited at the outer edge of the pyrite halo. At the end of this stage, the Bell deposit had all the main characteristics of Granisle (Carson and Jambor, 1974).

3 — **Continued Cooling and Major Influx of Non-Magmatic Water.** The western nose of the altered BFP plug was extensively shattered, conceivably as a consequence of adjustments on the Newman and subsidiary faults. The shattering may have facilitated the infusion of connate and/or meteoric waters, thus abruptly changing both the hydrothermal milieu and the environment. Initially, the hydrothermal mix was probably largely barren of copper, but the solutions appear to have derived copper by reaction with the existing biotite-chalcopyrite zone. Redeposition of the copper was accompanied by intense quartz-sericite-pyrite alteration in the upper part of the highly shattered zone. Thus, the upper western part of the biotitized orebody was completely altered to a quartz-sericite assemblage, and copper grades were increased by about 15 per cent. A concomitant depletion of copper by about 15 per cent occurred in the leached transitional zone which underlies the stockwork of intense quartz-sericite-pyrite alteration.

The superimposition of quartz-sericite alteration on earlier potassic alteration has been noted at many deposits, including Butte (Miller, 1973; Roberts, 1973), Bingham (Moore and Nash, 1974), Chuquicamata (Sillitoe, 1973) and El Salvador (Gustafson and Hunt, 1975). Data from the Bell deposit given in this paper may indicate that the copper which accompanies quartz-sericite alteration at many porphyry copper deposits was derived by interaction with pre-existing copper-potassic zones. Although such interaction may occur under quiescent conditions, it is probably spurred by structural events.

4 — **Late-Stage Intrusion of Breccia Pipes.** Numerous small breccia pipes were bored along the Newman fault and subsidiary fractures. The main cluster of pipes occurs in a zone that is very low in copper, and one isolated pipe within the orebody is surrounded by a distinct zone of copper depletion. This feature may indicate that the pipes formed while the porphyry system was still active and copper was still relatively mobile. Copper in rocks surrounding the pipes may have migrated into the pipes and transferred to a higher part of the system.

Although negligible displacement occurred on the Newman fault after the Bell orebody formed, movement on the east-southeasterly and northeasterly faults may have slightly offset the western segment of the ore zone. The major block fault along the western side of Newman Peninsula appears to have offset BFP-related volcanic rocks, but the displacement may not have been very great.

Post-Eocene erosion exposed the copper deposit, and mid-Tertiary(?) supergene enrichment occurred in the western, pyrite-rich half of the orebody. Chalcocite deposition, to depths of 50-70 meters, resulted in an enrichment of copper by 12 to 15 per cent.

Indications are that the supergene enrichment was pre-Pleistocene, because part of the orebody is overlain by interglacial material that contains fossil wood dated at 42,900-43,800 years BP, and mammoth bones dated at 34,000 years BP (Harrington, Tipper and Mott, 1974). Therefore, late Pleistocene and Recent erosion did not greatly affect the orebody. Additional oxidation of part of the western segment of the orebody may have occurred in the Tertiary or at a later time.

Environmental Considerations

The objective is to return the disturbed land to the ecological condition which existed prior to mining. The rehabilitation will include contouring of disturbed areas where possible and, where practicable, the stimulation of vegetation. Although no disturbed areas have reached the stage at which final reclamation can be started, a program of testing and research is establishing the best types of natural vegetation and fertilizers, the best methods of site preparation, and field procedures required to attain optimum results.

Concentrator tailings are pumped to the Workburn Lake tailing-impoundment basin (Fig. 2). The capacity of the basin is continuously enlarged by the construction of rock-fill dams and dykes at low points around its periphery. All streams flowing into the basin have been diverted, and all seepage from the basin is reclaimed for use in the mill. Water from Babine Lake and Hagan Arm is systematically sampled and analyzed to determine whether the metal content of these waters is changing due to mining operations.

Acknowledgments

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APPENDIX III

DRILL HOLE LOG SHEETS

noranda MINES LIMITED BELL COPPER DIVISION

Collared JUNE 16	Completed JUNE 18	Core Size N	Logged by A. L'ORSA	Project No	Date 22/6/1986
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 1 of 5
Lat. 17510 N	Elev. 2150	Dip -55°	Lat. 17517.14	Elev. 2302.73	Dip 58°
Dep. 21400 E	Depth 725'	Bearing DUE SOUTH	Dep. 21400.13	Depth 727'	Bearing S 1°56'18 E
Hole No. 86-1					

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au
0									
14	—	Casing	pyrite & chalcopyrite in	less than 5%	MIF CODE [illegible]				
20	50%	Felsic Tuff (rhyodacite?)	fracture fillings & diss-	"	31				
30	100	dark greenish grey to dark grey. Local bleaching	emination (±1% diss.	"	"	79282		.154	
40	"	softer sections suggest interbedded sediments	very fine grained) Magnetite - minor & local	"	"	81		.134	
50	"	BFP dykes, dark grey, at:	Hematite - veinlets	"	"	80		.137	
60	"	15' @ 45° 3 cm wide	Weak quartz stockworks Cp + py + calcite veins	"	"	79		.119	
70	"	18' @ 65° 10 " " 34' @ 10° 1 " "	Covellite - minor.	"	"	78		.178	
80	"	42.5 - 46'	Fault gouge: 77-78	"	"	77		.096	
90	"		Few vuggy calcite veins with cp. Py in host. 87' - 2 cm grey qz-cp vein cuts core at 70°	"	"	76		.134	
100	"		Hematite + py veinlets	"	"	75		.168	
110	"	Breccia dyke @ 45°, 4 cm dia.	cut by tiny py veinlets	"	"	74		.189	
120	"	5% diss. chalcopy.	116-118 poorly defined breccia	"	"	73		.259	
130	"		126-127 — " —	"	"	72		.178	
140	"	137.5' BFP contact @ 15° grain size av. < 2mm	Local weak quartz stockworks Hematite + Mi. Magnetite, cut	"	41	71		.164	
150	"	Biotite: fresh to brownish BFP end 150' @ 70° to core	by cp veins. Xenoliths, dark grey, very fine grained.	"	41	70		.036	

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-1

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade (MIF code)	Sample No.	Lt.	% Cu	OPT Au		
160	100%	sediments (?) greenish grey	Pyrite fracture filling	less than 3%	61	69		.091			
170	"		Few carbonate veins Sulphides sparse	"	61	68		.079			
180	"	BFP – {172' @ 25°. Biotite zone; 177 @ 50° light olive green	Carb. – quartz – cp breccia filling. Minor hematite	"	41	67		.087			
190	"	BFP 179' @ 45° —"— to dark green. Biotite zone to 184' at base.		"	41	66		.032			
200	"	plagioclase average 3mm up to 8mm. Sericite	Few grey quartz veins + sulph.	"	41	65		.041			
210	"	207 lower BFP contact 80° Sediments? Brecciated, Sericitized		"	81	64		.083			
220	"	BFP start 214' & probably		up to 5%	41	63		.189			
230	"	continues to end of hole! Locally alteration is so	cp – diss. & frac. fill.	up to 5%	"	62		.246			
240	"	intense that original rock identification is impossible	Py – "Mottly", early & fine grain	"	"	61		.312			
250	"	with hand lens. Colour: light olive green	Local quartz stockworks with cp & py (py>cp)	"	"	60		.327			
260	"	to 228'. Medium light grey below	Local hematite frac. fill.	"	"	59		.431			
270	"	Alteration: Sericite & quartz		"	"	58		.295			
280	"	Local plagioclase "ghosts"		"	"	57		.343			
290	"	Feldspar obliterated in many sections. Local breccia		"	"	56		.417			
300	"		Quartz stockworks erratically developed.	"	"	55		.337			

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Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 3 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-1
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
310	100%	BFP. Altered: Seri-q.	Local white carb. veins	Up to 5%	HIE CUDG 41	54		.294			
320	"	Plag. visible at 315'. Greenish grey to light grey.	Quartz veins generally small	"	"	53		.348			
330	"	BFP obvious 338-344 -		"	"	52		.403			
340	"	may be a dyke with 10° basal contact. No bio.	Hematite appears to be gone	"	"	51		.258			
350	"	Obvious BFP fades into	Xenolith: grey quartz vein + cp.	"	"	50		.247			
360	"	fine-grained sericitized rock	'Mottled' early py continues	"	"	49		.223			
370	"			"	"	48		.331			
380	"		cp + py	"	"	47		.354			
390	"			"	"	46		.225			
400	"		Minor calcite	"	"	45		.192			
410	"	Sericitized BFP	Approx. end "mottled" py	"	"	44		.321			
420	"	Light olive grey. Tectonic breccia - grey quartz	Many quartz veins, some ± 2.5cm	"	"	43		.291			
430	"	filling - disseminated sulphides. BFP - 430', cuts breccia 15°	in diameter. Py + cp. Hematite in back; frac. fill.	"	"	42		.254			
440	"	Feldspars up to 5mm. Sericitized rocks - 435, prob.		"	"	41		.238			
450	"	altered BFP. Chalky white locally		"	"	40		.286			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 4 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-1

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
460	100%	BFP, probably. Highly sericitized	chalcopy. + py, diss. & frac.	upto 5	HIF CODE 41	39		.327			
470	"	i.e. Quartz – sericite zone	Local red hematite frac. fill with white calcite & dolomite	"	"	38		.436			
480	"		Disseminated cp up to ±1%	"	"	37		.437			
490	"			"	"	36		.353			
500	"			"	"	35		.355			
510	"	Highly sericitized, unrecognizable.	cp in massive frac. fill,	"	"	34		.272			
520	"	May include clay alteration. Chalky in part	& in grey quartz veins. Local minor calcite &	"	"	33		.236			
530	"	Light olive green grey to very light grey.	brown carbonate. cp > py	upto 7	"	32		.444			
540	"	May include breccia	Local quartz stockworks " hem. veins; red & spec.	upto 5	"	31		.439			
550	"		with cp in quartz.	"	"	30		.331			
560	"	Relict green areas, = andesite?	Local silica flooding Quartz darker – prob. diss.	"	"	29		.348			
570	"		specularite. Brecciated = quartz fill. +	"	"	28		.348			
580	"		cp. Dism. hem. 3mm cp veins @ 15° to core	"	"	27		.385			
590	"	Probably altered BFP	"Mottled" early py again. Local vugs: py, cp & qz xls	"	"	26		.376			
600	"			"	"	25		.417			

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Collared	Completed	Core Size	Logged by		Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES			Sheet 5 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-1
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est.~~ Grade	Sample No.	Lt.	% Cu	OPT Au		
610	100%	BFP, brecciated	Grey quartz flooding	up to 5	HIF CODE 41	24		.317			
620	"	BFP. Sericitized + quartz	Diss. py ± 2% plus frac. fill. Fe sulphides	"	"	23		.389			
630	"		Diss. hematite continues	"	"	22		.373			
640	"			"	"	21		.475			
650	"		Local "mottled" early py (fine grained)	"	"	20		.453			
660	"		Quartz flooding continues	"	"	19		.577			
670	"		Specularite & py frac. fill.	"	"	18		.593			
680	"		Post-mineral faulting. Late stage brown carb. veins ≤ 1 mm.	"	"	17		.730			
690	"	Silicified BFP. Includes	Cp disseminations > frac. fill.	"	"	16		.695			
700	"	silica flooding & quartz breccia fillings	Few large (≤ 2 cm) quartz v. - cut core @ 45° or less.	"	"	15		.600			
710	"	colour: medium grey	Short "gash" quartz veinlets common.	"	"	14		.850			
720	"	BFP - less altered. Sericitized - biotite (sericitized) visible.	"Mottled" early py + lesser diss. cp. continues	"	"	13		.720			
730		727' End of hole MINOR DISSEMINATED MOLYBDENITE WITH CP IN QUARTZ		"	"	79212		1.00			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared: June 19	Completed: June 20	Core Size: N	Logged by: A. L'ORSA	Project No:	Date: 27 June 1986
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 1 of 4
Lat. 17300N	Elev. 2300	Dip -80°	Lat. 17299.06	Elev. 2298.58	Dip 81°
Dep. 21030E	Depth 455'	Bearing Due South	Dep. 21027.87	Depth 487'	Bearing S 2-03-32W

Hole No. 86-2

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
0				Up	MIF						
10	0	CASING	Pyrite & chalcopyrite	To:	CODE						
20	95%	BFP - QUARTZ - SERICITE ZONE	in various amounts in fracture fillings (generally	.5%	41	79175		.230			
30	100	BFP to end of hole	with quartz) & disseminations to end of hole.	"	"	174		.223			
40	"	Intense sericitization, Quartz veins to microveinlets, stock-works.	First ± 100' includes very fine grained early pyrite	"	"	173		.270			
50	"	Feldspar "ghosts"	Vugs, local, with calcite crystals up to 1.5 cm	"	"	172		.158			
60	"	Rock looks like 86-3 below 60'	Local red hematite	"	"	171		.205			
70	"	Colour: light grey to		"	"	170		.300			
80	"	yellowish grey to light brownish grey		"	"	169		.185			
90	"	81-87' - crushed, brecciated zone quartz filling.	Late stage carbonate veins	"	81	168		.214			
100	"			"	41	167		.132			
110	"	103': Post mineral shear ±2cm @ 10°; 106-140 Brecciated with Quartz filling.		"	81	166		.219			
120	"		Local vuggy calcite - dolomite veins.	"	"	165		.186			
130	"	Relict feldspars average	Molybdenite, diss., very minor with cp & py. Hem. + cp	"	"	164		.245			
140	"	± 3 mm in length		"	"	163		.285			
150	"		Local hematite fracture fill. with minor magnetite.	"	41	162		.286			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-2

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est.~~ Grade	Sample No.	Lt.	% Cu	OPT Au
150	%		Local breccia	up to	MIF				
160	100	BFP, sericitized & silici-	cp>py, at least locally	5	41	161		·210	
170	"	fied. Locally "chalky"		"	"	160		·208	
180	"	Local quartz stockworks	Local breccia with grey qz "	"	"	159		·220	
190	"		Hematite locally abundant	"	"	158		·215	
200	"			"	"	157		·300	
210	"	colour: locally dark grey	Hem. vein ± lun dia. in grey qz	"	"	156		·181	
220	"	to light greenish grey.		"	"	155		·192	
230	"	Orange grey alteration		"	"	154		·193	
240	"	(limonitic sericite) locally. 238-243 Breccia, vuggy carb. fill. 1 cm gouge @ 20°	Calcite crystals.	"	"	153		·195	
250	95			"	"	152		·170	
260	100	Darker: secondary biotite ? Dark greenish grey to greyish		"	"	151		·222	
270	"	olive green to orange grey. Relict feldspars average 2 to 3		"	"	150		·152	
280	"	mm. Up to 4 mm. Medium grey predominates	Hematite continues	"	"	149		·136	
290	"	Includes breccia with grey qz. fill.		"	"	148		·241	
300	"	Qz vein sheeting @ 70°		"	"	147		·155	

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-2

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au
300 – 310	% 100	quartz flooding BFP: Sericitized & silicified		up to 3	M/F 41	146		.175	
320	"	Medium grey, incl. greyish olive green.	Magnetite vein ≤ 1cm @ 60°	"	"	145		.214	
330	"			"	"	144		.174	
340	"	Includes quartz-flooded breccia with grey qz frags. & sericitized frags. Local biotitization (?)	Cp in grey qz of bx filling. Hematite frac. fill. common	"	81	143		.253	
350	"			5	41	142		.177	
360	"		10 cm carbonate vein @ 45° Local vugs with cp crystals	"	41	141		.235	
370	"	Breccia; quartz flooding	363 - 365.5 grey qz vein @ 15° with cp - hem veins	"	81	140		.500	
380	"	" incl. 10 cm silicic fragment. 382 - 15 cm fault gouge	Hematite veins common	3	"	139		.292	
390	"	" Many highly sericitized frags, soft & chalky.		"	"	138		.375	
400	"	" Med. grey to dark greenish grey		"	"	137		.298	
410	"	Rocks locally brecciated & shattered		"	41	136		.200	
420	"		Few carbonate veins Local diss. specularite	"	"	135		.220	
430	"	423 Bx, ≤ 3 cm angular frags., sericitized, Qz flooding.		"	"	134		.200	
440	"	Quartz veins common; "micro"-veinlets to several cm.		"	"	133		.230	
450	"		442 2.5 cm grey quartz vein with cp @ 15°	"	"	132		.316	

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Collared	Completed	Core Size	Logged by	Project No	Date
					Sheet 4 of 4

FIELD COORDINATES			SURVEYED COORDINATES			Hole No. 86-2
Lat.	Elev.	Dip	Lat.	Elev.	Dip	
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est ~~Grade~~	Sample No.	Lt.	% Cu	OPT Au		
450				up to	MIF						
460	100%	BFP. Sericitized & Silicified		± 3	41	131		.330			
470	"	Med. grey to almost white (477-487) to mod. reddish brown		"	"	130		.286			
480	"	chalky between quartz veins		"	"	129		.397			
487	"	quartz increasing below 460'.	Minor disseminated Molybdenite with cp & py.	"	"	79128		.245			
END											

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Collared June 1?	Completed June 19	Core Size N	Logged by A. LORSA	Project No	Date 27 June '86
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 1 of 3
Lat. 17400 N	Elev. 2300	Dip -45°	Lat. 17398.86	Elev. 2300.98	Dip 45°
Dep. 21170 E	Depth 360'	Bearing DUE SOUTH	Dep. 21169.61	Depth 365'	Bearing S 1-44-15 W

Hole No. 86-3

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
0											
20	/	Casing	Pyrite & chalcopyrite	UP TO	MIF CODE						
30	90 95	local epidote Tuff- chloritized, silicic in part. Mi. Qz stockwks	throughout hole, in frac. fill. & dissemin.	.3	31	79126		.145			
40	100	Dark greenish grey > light olive grey	Diss. py + cp very fine; ≤0.1mm Hematite frac. fill (≤2mm) common	"	"	125		.136			
50	"	.53' Breccia (Bx) 20 cm wide @ 50° Mylonitized sulphides, Carbonate. Post-mineral slickensides.		"	"	124		.200			
60	"	BFP (60') sericitized + Qz		"	"	123		.131			
70	"	Light grey Sericite & Qz; very altered	Massive grey Qz veins up to 10 cm. Locally vuggy.	5	41	122		.149			
80	"	Few feldspar "ghosts" to 3mm.	Cp best in grey Qz veins ± 1% diss. in host locally	"	"	121		.143			
90	"	Breccia - 15 cm @ ± 30° Poorly defined. Qz filling	Cp diss. in Bx filling.	7	"	120		.140			
100	"	Rock highly altered.	Few late carb. veins; 45-10°	5	"	119		.132			
110	"	Qz vein distribution & size	Qz veins not well mineralized.	"	"	118		.175			
120	"	erratic. Size generally 2mm to "micro." in diameter		"	"	117		.164			
130	"	Locally "microfractures" about 1mm apart		"	"	116		.200			
140	"			"	"	115		.187			
150	"		Hematite first noted. Few frac. fillings	"	"	114		.204			
160	"	2.5 cm Qz. vein @ 45°		"	"	113		.182			

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Collared	Completed	Core Size	Logged by	Project No	Date 27-6-86
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 2 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-3

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
160											
170	"	RFP, sericitized & silicified light grey; local greyish green	Py + cp continue	Generally up to 5%, locally may be higher	MIF 41	112		.147			
180	"		Hematite common		"	111		.226			
190	"		Few brown carb. veinlets		"	110		.209			
200	"	Feld. phenocrysts av. ±2mm; upto 4mm where visible			"	109		.252			
210	"	Good Qz veining & Stockwork	Py > cp		"	108		.300			
220	"	Post min. fault @ 30° Local Qz flooding			"	107		.363			
230	"				"	106		.270			
240	"	10cm Qz vein + cp @ 10°. Carb. .237 Sample: Ground support test			"	105		.334			
250	"				"	104		.253			
260	"	±10 cm Qz veins @ 20-30° carbonate centres, Tourmaline?	Minor fine grained Bornite?		"	103		.457			
270	"		Local covellite Massive py veinlets cut Qz veins with mi. cp.		"	102		.308			
280	"	Heavy Qz veining, including			"	101		.255			
290	"	micro fractures. Generally @ 50° or less. No Qz flooding			"	100		.388			
300	"	Local post mineral shearing → sulphide mylonite @ 50° (296')			"	99		.343			
310	"	Feld. phenocrysts now generally visible. Average 2mm. Upto 6mm			"	98		.255			

308: ±13 cm Bx

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Collared	Completed	Core Size N	Logged by A, L'ORSA	Project No	Date 27/6/86
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86 - 3

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est.~~ ~~Grade~~ HIF	Sample No.	Lt.	% Cu	OPT Au		
310											
320	"	BFP: sericitized &	Py & Cp continue		41	97		.330			
330	"	silicified			"	96		.378			
340	"	Qz veins ± 1mm in diameter occur generally less than 5/ft.			"	95		.401			
350	"	Local pervasive silicification			"	94		.445			
360	"	& Qz stockworks			"	93		.423			
365	"	Larger Qz. veins cut core	Py > Cp in frac. fill.		"	79092		.437			
END		@ 30° or less.	& as diss. along fractures & in Qz veins. Very minor dissemination in matrix.								
		Drill stopped by fault.									

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Collared JUNE 27	Completed JUNE 29	Core Size N	Logged by A. LORSA	Project No	Date 11 July 1986
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 1 of 4
Lat. 17020 N	Elev. 2150	Dip -90°	Lat. 17018.20	Elev. 2188.66	Dip 90°	Hole No.
Dep. 20980 E	Depth 480'	Bearing NA	Dep. 20978.03	Depth 496'	Bearing	86-4

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
20	0	Casing. unmarked	Pyrite & chalcopyrite	up to	MIF CODE						
30	100%	BFP to end of hole	in fracture fillings & disseminations to end of hole.	7	41	79729		.370			
40	"	Silicified & sericitized but bio. looks fresh. ±2mm feld	Pyrite generally more	5	"	28		.342			
50	"	.46-47 Breccia (Bx) Less Qz than above 33'	abundant than chalcopyrite (cp)	"	"	27		.432			
60	"	Dominant colour: light olive grey	cp rare; diss. & frac. fill. + py	"	"	26		.427			
70	"	.60-75 Fault zone: 30-55°		"	51	25		.395			
80	"	Qz increasing	Host sulphides in clear Qz vein-	"	51/41	24		.497			
90	"	Good Qz stockworks. Few Carb. v. Larger Qz veins at low angles to core	lets. Very little disseminated	"	41	23		.425			
100	"	Very altered. Few feldspar "ghosts" Medium light to light grey. Hi. olive		"	"	22		.394			
110	"	Bx ±160 - 138 well altered. Qz filling. Locally indistinct		"	81	21		.454			
120	"	Good stockworks. Few Qz veins up to 1.5 cm, @ ±35°		"	"	20		.300			
130	"	Local carbonate veins Bx intermittent	Qz veinlets cut by massive py veinlets	"	"	19		.279			
140	"	138 end Bx		"	"	18		.439			
150	"	Highly altered BFP (?) .144-149, ±1.5 cm Qz-sulph. vein		"	41	17		.505			
160	"	.149, fault @ 40°. Crushed sulphides. Silicification predominates over sericitization.	Very minor cp. Local Calcite	"	"	16		.399			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-4

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est. Grade~~ MIF	Sample No.	Lt.	% Cu	OPT Au
160–170	100	Bx Zone start ± 164'. In places vague or intermittent.	Py - minor cp	5	81	15		.485	
180	"	Qz + rock flour matrix. Vague fragments of gen. uniform		"	"	14		.482	
190	"	composition - i.e. prob. altered BFP with rare grey Qz vein frags.	Py > mi cp in fractures &	10	"	13		.517	
200	"	Frags. angular to subrounded. Good Qz stockworks & veining	diss. Diss. average ±0.2mm Locally ± 5% disseminated	5	"	12		.603	
210	"	Few vuggy carb. veins + calcite xls. ·210-226 intense silicification		"	"	11		.675	
220	"	Local mylonite (not gouge) + Qz vein frags. + mi diss. py. Local chalky sericitized rock		7	"	10		.459	
230	"	·226 end Bx Zone		"	"	09		.475	
240	"	BFP - light olive grey to greyish black. Bio. books + fine-grained dark biotite	Py > mi cp in clear Qz veins	5	41	08		.310	
250	"	light brown to 257', then light dark greenish grey. Bio. shows brown alt.	& diss. on frac. surfaces.	"	"	07		.266	
260	"	Local carb. veins to 5 cm. Good to mod. Qz veining to 257'		"	"	06		.279	
270	"	BIOTITE: coarse, black, to 279' & locally to 291. Lots of fine-grained secondary bio.	cp > py locally	"	"	05		.120	
280	"	Silica increasing - good stockworks		"	"	04		.218	
290	"			"	"	03		.622	
300	"	·296-298 - few magnetite veinlets. Highly silicified		7	"	02		.770	
310	"	Colour: generally medium grey	Py up to 5% diss.	"	"	01		.520	

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-4
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est Grade~~ M.I.F	Sample No.	Lt.	% Cu	OPT Au		
310											
320	100	BFP. Highly silicified to 317.5'	Py > cp	7	41	79700		.626			
330	"	Greenish black below 317.5' with local lighter areas.	Several small magnetite + grey Qz veins.	3	"	99		.311			
340	"	.331-336 mod. silicification Qz veins & local stockworks		"	"	98		.278			
350	"	secondary, dark, fine-grained biotite abundant.	— " — Molybdenite, minor, diss.	"	"	97		.236			
360	"	.355 - BFP generally lighter in colour	with cp. in grey Qz v.	5	"	96		.355			
370	"	Med. to dark greenish grey. Strong grey Qz veining		"	"	95		.630			
380	"		.370-400 - local magnetite vnlts	"	"	94		.645			
390	"	Good stockworks	Locally ± 5% diss. cp > py Hi. specularite. Av. diss. ± 0.3mm	10	"	93		.850			
400	"	Hi. coarse black biotite	but range to less than 0.1mm	5	"	92		.940			
410	"	Local chalky sericite		"	"	91		.520			
420	"	.416-427 BFP dyke (?) "Fresh" bio. books. No 2nd bio.	Grey Qz veins + cp + py	"	"	90		.840			
430	"	Plag. almost fresh. Twinning clear BFP. dark olive green, etc.	+ mi. magnetite specularite veinlets.	"	"	89		.820			
440	"	Local black biotite. Generally bio. is sericitized.	crackled grey Qz veins + diss. & frac. fill. cp + py	"	"	88		.950			
450	"	.444.5 becoming lighter in colour	Local carb.	"	"	87		.215			
460	"	Strong Qz veins + stockworks	Local magnetite + hem. veinlets.	"	"	86		.475			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 4 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-4
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
160 470	100	BFP. Silicified + seri.	py + cp	5	141F 41	85		.765			
480	"	Local Bx with grey Qz. Local chloritic (?) sections. Note: actually 2nd bio ???		"	"	84		.719			
490	"	.493.5 to end: black coarse biotite visible.	Local mag. + hem. veins ≤1 cm	"	"	83		1.20			
496	"	colour: ± medium olive grey	cp > py. Includes diss. averaging ± 0.2 mm & ranging down below 0.1 mm.	10	"	79682		.699			
END											

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noranda MINES LIMITED BELL COPPER DIVISION

Collared June 14	Completed June 16	Core Size N	Logged by A. L'ORSA	Project No	Date 20/6/86
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 1 of 4
Lat. 16640 N	Elev. 2420	Dip -55°	Lat. 16640.20	Elev. 2423.59	Dip 60°
Dep. 20535 E	Depth 600'	Bearing Due EAST	Dep. 20540.89	Depth 607'	Bearing E
					Hole No. 86-5

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
0				up to	MIF CODE						
22	—	Casing	Pyrite is dominant sulphide. Local cp.								
30	100%	TUFF (?) Highly sericitized & locally silicified. Original composition uncertain.	Py frac. fill. ≤ 2mm	5	31	79407		.064			
40	"	Colour: Orange grey	Specularite, minor, diss. Cp present in frac.	"	"	06		.060			
50	"	Prob. tuff to end of hole		3	"	05		.058			
60	"	Local dolomite frac. fill., cuts py	Py frac. fill. ≤ 2mm dia	"	"	04		.069			
70	"	Local vugs in Qz & calcite veins		"	"	03		.091			
80	"	Orange grey to light grey		"	"	02		.053			
90	"	Sericite 55%, Qz 40%		"	"	01		.099			
100	"	SEE PETROGRAPHIC REPORT	Local cp frac. fill. Hi Azurite	4	"	79400		.071			
110	"	3cm wide gy Qz-Py vein @ 40°		5	"	99		.053			
120	"	Local carbonate		10	"	98		.069			
130	"			5	"	97		.101			
140	"		Small, sulphide-bearing fractures numerous	"	"	96		.123			
150	"	Grain size of alt. rock may have been ± 2mm.		4	"	95		.109			
160	"			"	"	94		.079			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 2 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-5

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au
160		Orange grey			MIF				
170	"	Tuff? Sericitized - silicified	Qz + sulphide fractures	5	31	93		·047	
180	"	carbonate, including calcite	1mm or wider, ± 3/ft. Numerous smaller frac.	"	"	92		·065	
190	"	white dolomite veins ≤10mm	Py	"	"	91		·076	
200	"	Grey Qz veins common to 242		"	"	90		·063	
210	"		Vfg hematite? with py-Qz	"	"	89		·101	
220	95	Light grey in heavy Qz	Massive 2 cm py vein @ 25°	"	"	88		·072	
230	100			"	"	87		·080	
240	"	Orange grey to med. light grey		"	"	86		·148	
250	"	·242-256 Fault zone. Bx + gouge	5mm py vein @ 60°	"	51	85		·049	
260	"	Qz veins less abundant	Py, massive frac. fill, less Qz.	"	31	84		·013	
270	"	Fault Bx at 270, 12 cm, @ 30°		"	"	83		·094	
280	"	·273 Qz veins common again. ·276 - Rock change - med. light grey with very light grey frags.		"	"	82		·076	
290	"	Tuff with lapilli? Silic. + Seri.	± 2 frac./ft., Py - Qz, ± 2mm	"	"	81		·043	
300	"	Local carb. in py - Qz veins	2 cm Py vein cuts @ 14°	3	"	80		·077	
310	"	Greyish orange predominates		"	"	79		·089	

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-5

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au
310					MIF				
320	100	Tuff? Orange grey, i.e. limonitic sericite. Gradual	Py ± 1% diss.	3	31	79		·104	
330	"	colour change to dark yellow green	small frac. fillings. Few large - e.g. 1cm.	"	"	77		·098	
340	"	Locally brecciated + grey Qz. Bx + Qz, top contact		"	"	76		·137	
350	"	Andesite? 344-355.5 dk gn gy	Py in grey Qz veins	"	"	75		·133	
360	"	May be a dyke. Massive, fine-gr. Lower contact @ 45°	Py > cp - local covellite. Hi. calcite in mass. py veins	"	"	74		·151	
370	"	Tuff? ±0.5mm sericite spots. 368 Andesite?, as above		"	"	73		·128	
380	"	dark greyish green chloritized		2	"	72		·167	
390	"	387 - lower contact @ 25°	Local hematite	3	"	71		·089	
400	"	Tuff? Qz vein much more abundant	" carbonate	"	"	70		·107	
410	"	various greys. Andesite? dark greenish grey	Grey Qz veins + py ≤ 1.5cm	4	"	69		·152	
420	"	fine-grained; relicts < 1mm. To 458.5		"	"	68		·175	
430	"		Py frac. fillings. cp? very fine-grained, diss.	"	"	67		·172	
440	"			"	"	66		·163	
450	"		Py-cp frac. fill. @ 20°	3	"	65		·204	
460	"	458.5, contact @ 45°, and Andesite?	cp + py in grey Qz veins. Specularite diss. in grey to clear Qz.	"	"	64		·211	

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
					Sheet 4 of 4

FIELD COORDINATES			SURVEYED COORDINATES			Hole No. 86-5
Lat.	Elev.	Dip	Lat.	Elev.	Dip	
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est ~~Grade~~ MIF	Sample No.	Lt.	% Cu	OPT Au		
460											
470	100	Tuff? Low feldspar dyke? sericitized with Qz veins	Py + cp in grey Qz veins & cont in vein	3	31	63		·179			
480	"	Andesitic? Varying amounts of chloritization; sericitization	Hem. + Magnetite, minor	"	"	62		·114			
490	"	Colour: green-grey. Need a thin section.		"	"	61		·137			
500	"	Not sure this is not biotitized!		"	"	60		·171			
510	"	Grey Qz veins common but not abundant		"	"	59		·189			
520	"			5	"	58		·226			
530	"			"	"	57		·210			
540	"	·533 - contact marked by grey Qz vein. Grey green / orange grey	Local hem.	"	"	56		·252			
550	"	·548-549 Fault gouge: Mod. sericite - Qz		"	"	55		·272			
560	"	·555 Bx - 3 cm wide · @ 12° "Bx dyke, Includes prob. BFP.	Minor calcite	"	"	54		·316			
570	"	·562-565.5 Bx dyke. Includes prob. alt. BFP, some rounded + Py-Qz frags	Bx matrix carries ± 3% Py dissem.	"	"	53		·342			
580	"	·570.5 contact @ 45° sericitized above & chloritized below		"	"	52		·327			
590	"	colours reflect alteration, not Rx. type Dark greenish grey	Cp frac. filling	"	"	51		·432			
600	"	·594 contact, chl. above; seri. below; Orange grey	mi. magnetite at contact + grey Qz vein	3	"	50		·372			
607	"	Tuff(?) continues	Py > Cp. unidentified, radiating translucent crystals.	5	-	79349		·135			

END

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noranda MINES LIMITED BELL COPPER DIVISION

Collared JUNE 27	Completed JUNE 27	Core Size N	Logged by A. L'ORSA	Project No	Date 11/7/86
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 1 of 3
Lat. 16420 N	Elev. 2180	Dip -90°	Lat. 16422.32	Elev. 2186.30	Dip 90°
Dep. 20895 E	Depth 360'	Bearing NA	Dep. 20883.68	Depth 366'	Bearing
Hole No. 86-6					

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est Grade~~	Sample No.	Lt.	% Cu	OPT Au		
0				UP +U	MIF CODE						
14	/	Casing									
20	80	BRECCIA. Highly silicified & sericitized. Original rock	Pyrite is the most	10	81	79091		.012			
30	100	unidentified. Local gouge	abundant sulphide	"	"	90		.018			
40	"	Colour: generally light grey. Local good grey Qz veins +	by far. Fracture	5	"	89		.128			
50	"	moderate Qz stockworks. Some alt. BFP? frags. Grey Qz matrix	fillings & dissemin-	"	"	88		.099			
60	"	carbonate present. Sericite chalky in places	ations. Small amounts	"	"	87		.154			
70	"	.65' ± end of Bx. Sericitized & silicified rocks	of chalcopyrite low	"	"	86		.162			
80	"	to end. Unidentified. Most are probably igneous but may incl. seds.	in hole	"	61?	85		.132			
90	"	Stockworks (Qz) & Qz veins (gen < 1cm) throughout. Sericitized & soft between		"	"	84		.126			
100	"	Few vague frags. suggest Bx in part.		"	"	83		.126			
110	"	Dominant colour: light orange brown. 104-108 broken core.		"	"	82		.080			
120	"	Altered Sediments?		"	"	81		.126			
130	"			"	"	80		.110			
140	"	132-136.5 Bx dyke. Includes BFP frags., sericitized, rounded to		"	"	79		.065			
150	"	angular. Grey Qz matrix + small rock frags. + diss py. Local vugs, py xls.		"	"	78		.139			

noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 2 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-6

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est.~~ Grade	Sample No.	Lt.	% Cu	OPT Au		
150					M/F						
160	100	Altered sediments? ·166-68 broke	Py. Frac. fill. + few diss.	5	61?	77		·142			
170	"	1 cm grey Qz vein @ 10°	Spec., local & diss.	"	"	76		·044			
180	"			"	"	75		·197			
190	"	181-186 - grey Qz + Py vein ≤1 cm wide parallels core		"	"	74		·217			
200	"	Rocks darker in colour local dark greenish grey		"	31?	73		·163			
210	"	Mod. to good grey Qz veins Looks like alt. intrusion other		"	"	72		·212			
220	"	than BFP.		"	"	71		·218			
230	"	Less Qz veins Med. dark grey. Alt. volcanic?	Very mi. diss. cp	3	"	70		·170			
240	"			"	"	69		·169			
250	"	Good Qz stockworks Greyish olive green	minor disseminated cp Average ± 0.1 mm, up to 0.3 mm	5	"	68		·177			
260	"	·254-257'4" Feld. Porph. Dyke, 20° greyish olive green. ± 1 mm feld. in	mi. diss. specularite ← ± 1' of explosion Bx extend.	"	"	67		·156			
270	"	f.g. matrix. Feld. = ± 10% of rock More Qz veins & Qz stockworks	below base of dyke. Incl. BFP frags Py > mi cp	10	"	66		·169			
280	"	than above dyke. Few green tourmaline "sunbursts"?	·271-277 ± 2 cm grey Qz vein + sulphides, parallel.	10	"	65		·137			
290	"	Greenish grey	Py > mi. cp. diss. in	5	"	64		·126			
300	"	·294 Fault @ 20° ·295.5 - 297 highly seri. BFP	grey Qz. veins.	"	"	63		·180			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-6

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au
300					MIF				
310	100	Tuffs? Mod. Qz stockworks "Qz" Microfractures" ≤0.1mm	Py. Veinlets > diss.	5	31	62		.175	
320	"	.312-318 bleached to very light grey		"	"	61		.140	
330	95	colour; ± light olive grey	Very mi. cp	"	"	60		.162	
340	100	local greyish orange 339 ±	Py > mi cp	"	"	59		.185	
350	"	Less Qz than above	local specularite	"	"	58		.161	
360	"	Qz veins brecciated, with white carbonate fill., incl. calcite	Mi. cp	"	"	57		.176	
366	"	.363 Highly alt. Bx, including subangular Qz vein. Hi. seri.		"	41	79056		.136	
END		.365 fault @ 70°. gouge .365 BFP - altered. Don't know if this is main body of intrusion.							

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Collared JNE 24	Completed JUNE 25	Core Size N	Logged by A. L'ORSA	Project No	Date 29/6/86

FIELD COORDINATES			SURVEYED COORDINATES			
Lat. 16440 N	Elev. 2060'	Dip -90°	Lat. 16437.77	Elev. 2066.55	Dip 90°	Sheet 1 of 3
Dep. 21100 E	Depth 360'	Bearing	Dep. 21096.07	Depth 367'	Bearing	Hole No. 86-7

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp. up to	~~Est. Grade~~ MIF CODE	Sample No.	Lt.	% Cu	OPT Au		
0											
21	/	Casing									
30	95	BFP Sericitized &	Pyrite dominant.	5	41	79538		.137			
40	100	silicified to end of hole, light grey	Minor chalcopyrite	"	"	37		.221			
50	"	• 55 Bx start – to 72' ± • 57.5 Dyke, light olive green, 85°		"	"	36		.492			
60	"	± 20 cm. wide. Bx incl. rounded BFP	Hi. diss. py in Bx	"	"	35		.363			
70	"	• 72 Bx end ±. Highly altered • 76-96 Exceptionally strong		"	81	34		.473			
80	"	Qz veins, sub.parallel, ≤ ±2 cm local Qz stockworks.		"	41	33		.337			
90	"	• Dyke, ± 20 cm @ 25°, light Olive green – 96' • " , 98–114.5' @ 15°; includes		"	71	32		.428			
100	"	few chloritized biotite books. Very irregular contact.		"	"	31		.340			
110	"	± 5% diss. feldspar xen. < 5 mm, but up to 7 mm.		"	"	30		.084			
120	"	BFP, chalky seri. between		"	"	29		.208			
130	"	grey Qz veins. Strong Qz stockworks	Py > cp. ≤ 7% diss.	10	41	28		.410			
140	"	Local vuggy carbonate veins		"		27		.335			
150	"	with calcite crystals to 1.5 cm		"		26		.439			
160	"	BFP obvious. Less Qz vein Feld. average 3 mm length		"		25		.385			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 2 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-7

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au
160 - 170	160	BFP - altered • 160-161 Fault zone, gouge, @ 40°	Py continues	5	HIF 41	24		.432	
180	"	good Qz stockworks. Few feld. "ghosts"		"	"	23		.384	
190	"	Subtle breccia 177.5 - 230 ±		"	"	22		.424	
200	"	very altered: seri - Qz Prob. brecciated BFP		"	"	21		.588	
210	"	• 203 Dyke, 6.5 cm @ 30° Olive grey, clastic? Av. grain	Hi. hem. + mag. frac. fill.	5	"	20		.503	
220	"	size ± 0.5 mm. Good Qz stockworks. Qz vein		"	"	19		.348	
230	"	subparallel to core	Py up to 7% diss.	10	"	18		.443	
240	"	• 237 darkening. Light greenish to brownish grey.		5	"	17		.493	
250	"	• 246 start fresh-looking biotite May be start of biotitization	← stockworks ± gone	"	"	16		.372	
260	"	& K zone. Thin sections? colour: Med. grey to light brownish		3	"	15		.313	
270	"	grey dominant. Less Qz from ± 240'		"	"	14		.389	
280	"	Fine-grained secondary bio. probably starts at ± 240'		"	"	13		.417	
290	"	2nd bio. appears chloritized		"	"	12		.335	
300	"			"	"	11		.314	
310	"	Locally up to 4 grey Qz vein/ft (5 mm or thicker)		"	"	10		.201	

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Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 3 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-7

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
310											
320	100	BFP, Med. dark grey to med. gy.	Pyrite continues:	5	41	09		.405			
330	"	≤ 40% plagioclase pheno. 2-5% fresh-looking, coarse	frac. fillings & less than 1% dissem.	"	41	08		.639			
340	"	biotite. Local Qz stockworks	veinlets of secondary bio.?	"	41	07		.674			
350	"	340-344 transition to sericite & silicification. Med. grey to	Specularite increasing	4	41	06		.432			
360	"	light brownish gray. Feldspar ghosts rare	below 344'	10	41	05		.459			
367	"	Strong Qz stockworks ± 350 to end of hole		10	41	79504		.508			
END											

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Collared	Completed	Core Size	Logged by	Project No	Date
JUNE 20	JUNE 21	NQ	A. LORSA		28/6/1986

FIELD COORDINATES			SURVEYED COORDINATES			
Lat. 16410N	Elev. 2020'	Dip 90°	Lat. 16409.18	Elev. 2019.35	Dip 90°	Sheet 1 of 3
Dep. 21300E	Depth 440'	Bearing	Dep. 21299.85	Depth 447'	Bearing	Hole No. 86-8

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp. UP TO	~~Est. Grade~~ MIF CODE	Sample No.	Lt.	% Cu	OPT Au
0									
20	/	CASING							
30	80	BFP Fresh-looking coarse biotite Med. grey to dark greenish grey	Pyrite is dominant sulphide.	3	41	79450		.479	
40	100	•39-67 Dyke + Bx complex. Dyke(s) ..., Olive grey, up to 5%	Minor chalcopyrite Fracture fillings + diss.	"	"	49		.568	
50	"	feldspar, average ± 3 mm long, in fine-grained matrix. Includes	Magnetite & hematite local. Diss. spec. common in dyke	"	71	48		.334	
60	"	xenoliths of alt. BFP & gy Qz vein Bx 45-52 & 64-67. Incl. r'd to sub r'd. BFP, grey Qz & other frags.	Local carbonate veins, incl. cal.	"	81	47		.211	
70	"	BFP - dark to med. grey	Py + Cp + mi. covellite	7	71	46		.387	
80	"	Grey Qz veins numerous & generally 0° to 10° to core	& possible thin bornite veinlets.	10	41	45		.771	
90	"	Average plagioclase ± 2-3 mm		"	"	44		.707	
100	"	Some are soft (sericite) Biotite, looks fresh locally		"	"	43		.756	
110	"		Cp may exceed Py	"	"	42		.739	
120	"	Grey Qz veins at low angles, Many ± 2 cm diameter	Local hem. frac. fill.	"	"	41		.731	
130	"	Local stockworks	Py > Cp	"	"	40		.511	
140	"			7	"	39		.286	
150	"			"	"	38		.684	
160	"			"	"	37		.731	

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-8

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
160					HIF						
170	100	BFP - biotitized & sericitized.	Py dominant	10	41	36		.596			
180	"	Fresh-appearing coarse		"	"	35		.461			
190	"	biotite locally. Biotite is sericitized elsewhere		"	"	34		.607			
200	"	Includes fine-grained secondary bio. Med. dark grey. Local ± orange feld.		"	"	33		.496			
210	"	.197-208 - core broken	Py > cp + bornite + covellite	"	"	32		.493			
220	"	Biotite generally sericitized		"	"	31		.488			
230	"			"	"	30		.265			
240	"		Py + cp	"	"	29		.295			
250	"		Hematite; diss + frac. fils. up to ± 5%.	"	"	28		.351			
260				decreasing with depth	"	27		.291			
270		Larger grey Qz veins (+5mm)			"	26		.457			
280		at low angles to core.			"	25		.369			
290		.286 Fault @ 25°			"	24		.324			
300		GYPSUM. ± 2mm wide frac. fil. ± parallel to core. Also anhydrite?			"	23		.478			
310		Local strong Qz stockworks	Minor red hematite	↓	"	22		.479			

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Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 3 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-8

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
310											
320	100	BFP - Med. dark grey	Py + cp continue	5	MIF 41	21		.374			
330	"			"	"	20		.389			
340	"			"	"	19		.462			
350	"			"	"	18		.485			
360	"			"	"	17		.450			
370	"	Sericite increasing, lighter colour .367 chalky feldspars (seri.)		"	"	16		.443			
380	"	.376 post min/fault @ 50° ± 40% of rock is feldspar, laths ± 2mm		"	"	15		.480			
390	"	but up to 5mm in length Med grey dominant.	Minor hematite to end.	"	"	14		.376			
400	"	Sericite decreasing - darker "Fresh" coarse biotite common	Py > cp (minor)	"	"	13		.386			
410	"	Local chalky feldspar Local carbonate veins, vuggy in places.		"	"	12		.472			
420	"	Grey qz veins subparallel		"	"	11		.456			
430	"	to core (i.e. steep). Not as abundant as higher in section.		"	"	10		.610			
440	"			"	"	09		.461			
447	"	Plagioclase intensely sericitized Biotite, coarse & fine, chloritized to sericitized.		"	"	79408		.495			
END											

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noranda MINES LIMITED BELL COPPER DIVISION

Collared: JUNE 22	Completed: JUNE 23	Core Size: N	Logged by: A. L'ORSA	Project No	Date: 9 July 1986
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 1 of 4
Lat. 16450 N	Elev. 2020'	Dip -60°	Lat. 16450.55	Elev. 2019.26	Dip 64°
Dep. 21580 E	Depth 510'	Bearing DUE NORTH	Dep. 21579.53	Depth 517'	Bearing N 1-39-22 E

Hole No. 86-9

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. ~~Grade~~	Sample No.	Lt.	% Cu	OPT Au
0				OP to	MIF CODE				
20	/	CASING							
30	90	BFP, sericitized & silicified; Grey Qz veins & stockworks	Pyrite main sulphide	.15	41	79681		.277	
40	100	± 2mm feldspar = 25% sericitized biotite visible	minor chalcopyrite.	5	"	80		.204	
50	"	Distinctive light brown alteration replaces feldspars, etc. 37-40' & 63-67'	Oxydation (mi. rust in frac.)	"	"	79		.111	
60	"	Local carbonate	extends down to 59'	"	"	78		.061	
70	"	Med. light grey dominant; Few Qz veins - < 1 frac (+1mm)/ft.	Py > cp, but better than above; 1 cm py - cp - covellite ff	"	"	77		.294	
80	"	i.e. Qz relatively poor. ± 2 Qz veins @ 1 cm / box	mi. covellite; ± 1% very fine-grained diss. sulph.	"	"	76		.288	
90	"	Brown alteration common to 127'.		"	"	75		.296	
100	"			"	"	74		.332	
110	"			"	"	73		.225	
120	"			"	"	72		.339	
130	"	Qz increasing	Py	"	"	71		.322	
140	"	1 cm grey Qz-sulphide vein @ 15°	Q - py - mi gypsum(?) vein	"	"	70		.301	
150	"			"	"	69		.247	
160	"	Sericitized biotite visible; light brown alt. continues		"	"	68		.227	

noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-9
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
160				To	HiF						
170	100	BFP Sericitized & silicified	Pyrite dominant	5	41	67		.208			
180	"	Light brown alt. continues to 237. Replaces biotite & to		"	"	66		.325			
190	"	a lesser extent, feldspar. Grey Qz veins locally vuggy		"	"	65		.221			
200	"			"	"	64		.196			
210	"	Local grey Qz stockworks		"	"	63		.426			
220	"			"	"	62		.466			
230	"			"	"	61		.328			
240	"	.237 FAULT @ 30°		"	"	60		.845			
250	"	.237-241 BX .246-247 FAULT @ 30°	Massive Py in Bx	"	"	59		.677			
260	"	.248 Start strong silicification Qz stockworks & grey	Cp increasing, but	"	"	58		1.01			
270	"	Qz flooding	Py still dominant. Frac. fill. > diss.	"	"	57		.885			
280	"	Rock so sericitized & sil.	Mi. diss. spec. on frac.	"	"	56		.858			
290	"	between 237' & 488' that original rock type uncertain,	Local vugs with py crystals & doubly terminated clear Qz x.	"	"	55		.807			
300	"	but probably BFP. Main Qz vein @ 25°		"	"	54		.915			
310	"	1 cm calcite + brown carb. vein		"	"	53		1.19			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 8
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-9

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
310				To	H:F						
320	100	Highly altered BFP? Seri-Qz Good stockworks	Pyrite ≥ cp	5	41?	52		1.31			
330	"		•323 1cm cp vein @ 35°	"	"	51		1.83			
340	"		cp diss. in matrix (±0.2mm) & in Qz. veins. Cp > py	"	"	50		1.31			
350	"	contact @ 25° between •346 more silicified & more seri. rock (chalky)	cp > py, probably	"	"	49		1.04			
360	"	•352 - 359 Heavy Qz flooding	py > cp	"	"	48		1.29			
370	"		"	"	"	47		.736			
380	"	General colour: Med. grey to med. dark grey		"	"	46		.729			
390	"			"	"	45		.612			
400	"	Highly silicified	Mi. red hem	"	"	44		.855			
410	"	— " —	Py > cp	"	"	43		.966			
420	"	• 417 ±3cm Carb-Qz-py-	cp vein @ 15°	"	"	42		.721			
430	"	Probably alt. BFP		"	"	41		.689			
440	"	silicification decreasing,		"	"	40		.571			
450	"	but Qz stockworks & vein tcont. sericitization intense; locally		"	"	39		1.02			
460	"	chalky		"	"	38		1.21			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 4 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-9
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
460 - 470	100	Highly altered BFP?	Py > cp	TO 5	HIF 41?	37		1.09			
480		• 472 ± 14 cm grey Qz vein @ 40°	Diss. & frac. fill,	"	"	36		.944			
490		• 488 BFP. Bio. visible but seri. ± 2mm fld. occupy ± 30% of rock	but not always abundant in Qz veins.	"	41	35		1.11			
500			Py >> cp, Hi. hem.	"	"	34		1.32			
510		• 509 to end - grey Qz flooding. Top contact vague & irregular, @ 30° ±	"	"	"	33		.818			
517			Qz flooding accompanied	~	"	79632		1.08			
END			by increase in cp.								

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Collared JUNE 21	Completed JUNE 22	Core Size N	Logged by A. L'ORSA	Project No	Date 28/6/1986

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 1 of 3
Lat. 16605N	Elev. 2020	Dip -90°	Lat. 16604.21	Elev. 2019.24	Dip 90°	Hole No.
Dep. 21650E	Depth 440'	Bearing	Dep. 21650.10	Depth 427'	Bearing	86-10

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au
0 - 20	/	CASING		UP TO	MIF CODE				
30	90	BFP - Qz - Seri. Zone	Pyrite dominant.	5	41	79503		.772	
40	100	Grey Qz stockworks Med. grey, Loc. orange grey	Cp + mi. bornite Frac. fillings > diss.	"	"	02		.746	
50	"	chalky feld. common.	Mineralized grey Qz vein Few massive sulphide frac. fillings.	"	"	01		.941	
60	"			"	"	79500		.859	
70	"		69-74 Sulphide vein, average width 1.5 cm.	"	"	99		.761	
80	"		Mi. specularite & red hem	"	"	98		.556	
90	"	Major Qz veins subparallel to core		"	"	97		.865	
100	"			"	"	96		.741	
110	"			"	"	95		.918	
120	"			"	"	94		.792	
130	"	Good Qz stockworks		"	"	93		.264	
140	"	— " —		"	"	92		.661	
150	"	Good stockworks, grey Qz	Py mostly diss.	"	"	91		1.00	
160	"		stockwork almost barren	"	"	90		.928	

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Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Sheet 2 of 3
Dep.	Depth	Bearing	Dep.	Depth	Bearing	Hole No. 86-10

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
160 - 170	100	BFP. light grey predominates. Relict feld. visible rarely. Sericite - Qz	Py > cp; diss. > fracif. & continuing below	To 5	MIF 41	89		.965			
180	"			"	"	88		.838			
190	"	186-191 brecciated. Carb. filling		"	"	87		.358			
200	"	Qz veins mostly sub parallel to core.	Hem. + mi. cp + covellite	"	"	86		.171			
210	"	Local Qz stockworks	Qz veins carry minor sulphides, Most diss.	"	"	85		.747			
220	"			"	"	84		.767			
230	"			"	"	83		.793			
240	"	Very altered, Plag. only locally visible.		"	"	82		1896			
250	"			"	"	81		.826			
260	"			"	"	80		.798			
270	"	Alteration increasing	covellite, rare	"	"	79		.915			
280	"			"	"	78		.723			
290	"	includes rounded to • 286 - 296 Bx - angular BFP & Qz frags.		"	"	77		.532			
300	"	• 296 - 297.8 Dyke; light olive grey ± 3% diss. feld. in f.g. matrix	Mi. diss. sulphides in dyke	"	81	76		.710			
310	"	Few sub-r'ded Qz. frags. Top cont. 45°, bottom 55°		"	81	75		.628			

T3K

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Collared	Completed	Core Size	Logged by	Project No	Date
					Sheet 3 of 3

FIELD COORDINATES			SURVEYED COORDINATES			
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-10
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
310		Bx to I 320',		To	HiF						
320	100	312 FAULT @ 45°, gouge	Py > cp, continue	5	81	74		.390			
330	"	BFP - Seri - Qz to end.	to end.	"	41	73		.575			
340	"	Med. Light grey dominant grey Qz frac. fill. continues		"	"	72		.819			
350	"	very strong stockworks		"	"	71		1.16			
360	"			"	"	70		.866			
370	"			"	"	69		1.58			
380	"	Tourmaline (?) fine-grained "sunbursts"		"	"	68		1.51			
390	"	.387 Feldspar ghosts visible	Hi specularite in veinlets	"	"	67		1.88			
400	"	.387-395 alt. Bx (?) + dyke (?) .400 - 10 cm Bx		"	81	66		.976			
410	"	BFP - light to dark grey		"	41	65		1.38			
420	"	.412 seri 3cm/dark sil. zone @ 35° few carb. veins @ 45°		"	"	64		1.17			
427				"	"	79463		.677			
END											

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Collared June 26	Completed June 27	Core Size N	Logged by A. LORSA	Project No	Date 9 July 1986
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 1 of 3
Lat. 16300 N	Elev. 2180	Dip -75°	Lat. 16285·62	Elev. 2187·26	Dip 77°
Dep. 21020 E	Depth 375'	Bearing Due South	Dep. 21015·12	Depth 387'	Bearing S 8-51-02 W
					Hole No. 86-11

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est. Grade~~	Sample No.	Lt.	% Cu	OPT Au		
0				up to	HIF CODE						
14	/	CASING									
20	100	Qz-Sericite throughout. Very alt. BFP? Qz-Seri. Zone	Sulphides throughout hole. Pyrite more abundant	5	41 ?	79631		·113			
30	"	Orange grey to dark olive green. Green tourmaline (?)	than chalcopyrite. Minor covellite	"	"	30		·171			
40	90	Bx 31-68 Frags. gen. <3cm siliceous matrix	Frac. fill, more abundant than disseminations	"	81	29		·201			
50	100	includes BFP frags. Sericitized, locally chalky	Specularite common in frac.	"	"	28		·200			
60	"	Generally med. grey to light olive grey		"	"	27		·198			
70	"	End Bx-68	Py only (?)	"	"	26		·241			
80	"	Dyke (?) 68-81. ± dark greenish grey. Basal contact @ 65°		"	71	25		·166			
90	"	Bx 81-85 - as above. Dyke? 85-97 light olive grey,		"	81	24		·212			
100	"	BFP? Seri - Qz + Bx		"	41	23		·159			
* 110	"	TWO 107 TAGS IN BOX. I TOOK 2nd AS 117. 10' OUT TO END	Hematite common. Py > mi. cp	"	"	22		·131			
120	"	Dyke 115-122 Olive gy	cp + py	"	71	21		·072			
130	"	. 122-126 Brecciated. Qz flooded. . 126-130.75 Dyke? light olive		3	81	20		·101			
140	"	Brecciated. Qz flooded + Qz veins . 136 - Dyke? Val.?		"	"	19		·104			
150	"	"		"	71	18		·103			

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* Mistake probably above 107'. Vance has been alerted to watch for it.

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-11

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est.~~ Grade	Sample No.	Lt.	% Cu	OPT Au		
50				TO	MIF						
160	100	Dyke (?) May include Bx & local secondary biotite, fine-grained.	Pyrite dominant to end.	3	71	17		.114			
170	"			"	"	16		.102			
180	"	. 180 approx. end dyke?		"	"	15		.087			
190	"	Bx 180-193. Sil. matrix. 2 cm frags common. sericitized frags. Qz. frac. fild.		"	81	14		.125			
200	"	Dyke (?) light olive grey		"	71	13		.085			
210	"	Local white carb. veins	Hematite common	"	"	12		.137			
220	"	Sheeted zone, Qz veinlets @ 65°		"	"	11		.134			
230	"	Local grey Qz stockworks		"	"	10		.117			
240	"	Secondary, fine-grained biotite yields mottles 221-247	Hi. cp.	"	"	09		.696			
250	"	.247 end dyke	Hi cp + covellite	"	"	08		.123			
260	"	Bx 247-287 Qz-sericite rock, throughout	Hi. cp - continues	"	81	07		.155			
270	"	Ang. frags. up to 6 cm Grey Qz flooded matrix		5	"	06		.018			
280	"	Generally very light grey frags, sericitized (BFP?). Some vuggy carb. Few 1-1 cm grey Qz veins, 10°-30°		"	"	05		.199			
290	"	DYKE 287-348.5, light olive grey		3	"	04		.142			
300	"	Very fine-grained Few vuggy carb. veins + calcite xls		"	71	03		.118			

noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-11

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
300				to	MIF						
310	100	DYKE (continued)	Pyrite continue	3	71	02		.159			
320	"	Altered. All I can say	Local hem. & Magnetite	"	"	01		.163			
330	"	with certainty is that this is a Qz-sericite		"	"	79600		.137			
340	"	rock of igneous derivation!		"	"	99		.154			
350	"	.348.5. Sharp basal contact - 75°	Py + calcite	"	"	98		.142			
360	"	Bx to end of hole	very minor cp.	5	81	97		.013			
370	"	light grey to very light grey Frags. gen. 10 cm or less; ang. to		"	"	96		.218			
380	95	rounded. Qz matrix sericitized & silicified		"	"	95		.011			
387	100	May include very alt. BFP. Local gouge. Vugs + calcite xls		"	"	79594		.014			
(397)	"	DRILLERS MARKED END		"	"	79924					
		AT 387' & THAT SHOULD BE CORRECT, MY LOG									
		RUNS 10' AHEAD									
		BECAUSE OF TWO CHIPS									
		MARKED 107'									

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Collared JUNE 25	Completed JUNE 26	Core Size N	Logged by A. LORSA	Project No	Date 9 July 1986

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 1 of 3
Lat. 16250N	Elev. 2180	Dip -90°	Lat. 16230.28	Elev. 2188.57	Dip 90°	Hole No.
Dep. 21135E	Depth 360'	Bearing	Dep. 21127.32	Depth 368'	Bearing	86-12

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
0				UP TO	MIF CODE						
20	/	CASING									
30	98	Qz-Seri. Zone TUFF ? (Qz-sericite rock)	Pyrite & chalcopyrite	5	? 31	79210		.390			
40	100	Qz-seri alt. throughout. Original rock type often in doubt	throughout hole Frac. fill. & diss.	"	"	09		.280			
50	"	Bx 34-46 indistinct Highly sericitized, chalky	Qz veins common. Modest Qz stockworks	"	81	08		.251			
60	"	May include alt. BFP light grey to orange grey	Good — " 3mm Max. Py>>Cp @ 45°	"	31	07		.285			
70	"	colour changing to med. dark grey by 70'. Darker colour may	Red + spec. hem. veinlets	"	"	06		.300			
80	"	indicate secondary biotite.	Mod. stockworks. Py + Cp	"	"	05		.360			
90	"	Lighter again: light to orange grey to ± pink locally. Qz-Seri.		"	"	04		.270			
100	"	Tuff? locally brecciated	Grey Qz + Cp + spec. + Py Local tourmaline?	"	"	03		.276			
110	"	Good Qz stockworks. Some vuggy Qz veins. Some ± rose Qz	Qz-Py-Cp-spec. Frac. fill. >> diss.	10	"	02		.353			
120	"	Orange grey alt. (seri + limonite) Highly sericitized	Py > Cp	"	"	01		.372			
130	"	Orange grey > dive green		5	"	79200		.255			
140	"	Local carbonate veins		"	"	99		.265			
150	"	Modest Qz stockworks		"	"	98		.259			
160	"	.159 - alt. BFP? Dyke? 14 cm	Spec., few frac. fill. plus diss. in grey Qz	"	"	97		.230			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 2 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-12

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au
60				upto	MIF				
170	100	Qz-Sericite rock = Tuff?	Py more abundant than Cp & continuing	5	31	96		.272	
180	"	.179 grey Qz vein 3cm subparallel		"	"	95		.189	
190	"		Local hematite	"	"	94		.426	
200	"	Locally dark grey green, spotted. Biotitized - (secondary)	Py > Cp	"	"	93		.392	
210	"	fine-grained bio.; some altered to chlorite (?)	Cp > Py in Qz veins	"	"	92		.190	
220	"	•213 colour lighter - Much more Qz BFP starts. Qz stock. + flooding	Red hem. Py > Cp	"	41	91		.205	
230	"	•230 - sericitized plag. obvious No bio. Med. light grey to	"	10	"	90		.476	
240	"	light brownish grey.		5	"	89		.410	
250	"	Bx ± 249 - 285	Py > Cp ± 3% diss., rest in frac.	"	"	88		.335	
260	"	indistinct, sericitized grey Qz matrix	Sulphide frac. cut matrix	"	81	87		.207	
270	"	Ang. BFP(?) frags. to 8 cm Chalky		"	"	86		.246	
280	"	Few large Qz vein Moderate stockworks (Qz)		"	"	85		.178	
290	"	•285 Bx end.	Frac. controlled - (Qz) Mi. matrix diss.	"	"	84		.263	
300	"	BFP (?) Few white carb. veins		"	41	83		.310	
310	"	Bx start 305. Vague 50° top contact		"	"	82		.240	

noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 3 of 3
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-12

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au	
310				To	H I F					
320	100	Bx - generally vague silicified & sericitized	Py > mi. Cp	10	81	81		.328		
330		Locally chalky	Local red hem.	"	"	80		.400		
340		.232 . 2 cm Qz vein @ 25° Many tiny Qz fractures		5	"	79		.420		
350		Frags. up to 3 cm	Cp > Py (?)	"	"	78		.260		
360		Gen. colour: light brownish grey Qz flooding	Py > Cp	"	"	77		.187		
368		Frags. to 10 cm - prob. alt. BFP	"	"	"	79176		.178		
END		Includes grey Qz vein frags.								

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Collared June 13	Completed June 14	Core Size N	Logged by A. LORSA	Project No	Date 21/6/86
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 1 of 5
Lat. 15552 N	Elev. 2460'	Dip -55°	Lat. 15852.15	Elev. 2454.29	Dip 60°
Dep. 21250 E	Depth 680'	Bearing Due North	Dep. 21251.44	Depth 677'	Bearing N 1-02-59 E

Hole No. 86-13

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est Grade~~	Sample No.	Lt.	% Cu	OPT Au		
0				up to	MIF code						
-20	/	CASING									
30	80	BFP(?) Highly sericitized & sil.	Pyrite is main sulphide Cp local.	5	41?	79348		·061			
40	100	Original rock type uncertain	More frac. fill. than diss.	"	"	47		·057			
50	"	Qz is grey throughout Locally rock is well	Qz veins + py cut by	"	"	46		·050			
60	"	fract., Qz filling.	± 1mm py veins (massive)	"	"	45		·075			
70	"	Colour is greyish orange to	Local. diss. bem.	"	"	44		·087			
80	"	med. light grey to orange grey.		"	"	43		·103			
90	"	(Orange = limonite in sericite, see petrographic report 5-92)	Py + Cp + mi chalcocite	"	"	42		·228			
100	"			"	"	41		·115			
110	"			"	"	40		·221			
120	"	Only a few Qz veins.	·110-115 Sulphide-bearing grey Qz vein ∥ parallel.	10	"	39		·180			
130				5	"	38		·179			
140				"	"	37		·180			
150				"	"	36		·163			
160				3	"	35		·093			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
					Sheet 2 of 5

FIELD COORDINATES			SURVEYED COORDINATES			Hole No.
Lat.	Elev.	Dip	Lat.	Elev.	Dip	86-13
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
160 - 170	100	BFP (?) Qz-sericite rock	Py	to 3	H I F AI ?	34		.096			
180	"	continues		"	"	33		.092			
190	95	orange grey to light grey		"	"	32		.072			
200	100			"	"	31		.091			
210	"			"	"	30		.061			
220	"			"	"	29		.095			
230	"	Calcite rare		"	"	28		.073			
240	"			"	"	27		.101			
250	98	.249 Fault gouge	.248-245 Py-Qz vein ‖ parallel to core	"	"	26		.098			
260	"	.255-257 Fault - crushed	Mi. cp.	"	"	25		.161			
270	"	Few Qz + sulphide veins	cp in frac. fill. & diss.	"	"	24		.141			
280	"	.277 1.5 cm gouge @ 45°	Mi. hem. frac. fill.	"	"	23		.058			
290	"		Bluish Qz vein + cp	"	"	22		.045			
300	"	.294 - 5 cm breccia dyke	Hem. frac. filling	"	"	21		.066			
310	"	@ 45°. Post mineral slickensides	common	"	"	20		.127			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by		Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES			Sheet 3 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-13

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
310-320	100	BFP? Qz - Seri. rock	Py	to 3	HIF 41?	19		.146			
330	"	Probably an igneous rock originally. Grey orange to grey	QV + diss. spec. + Py	"	"	18		.225			
340	"			"	"	17		.124			
350	"		Hem. may reach 10%.	"	"	16		.243			
360	"	Light coloured frags. e.g. 3 cm suggest Bx or lapilli tuff.		"	"	15		.200			
370	"		Py + cp.	"	"	14		.182			
380	"			"	"	13		.256			
390	"	.386-387 FAULT	.382-386 Qz-sulphide vein parallel to core.	5	"	12		.441			
400	"	Local dol. & calcite veins	.393-395 — " —	"	"	11		.436			
410	90	BFP More greys than above		"	41	10		.173			
420	"	Local Qz stockworks		"	"	09		.280			
430	"	Bx - BFP (or pyroclastic?)		"	81	08		.281			
440	"	"	Py-cp diss. > frac. fill. Hematite > sulphide	3	"	07		.208			
450	"	.445 Bx dyke. 1.5 cm wide	Dyke: up to 10% diss. py	"	"	06		.179			
460	"	@ 45° Ang. to rounded, cream coloured to light grey frags.		"	"	05		.178			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 4 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-13

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
460-		•460 Bx - Qz + sulphide filling.			MIF						
470	100	•466 Bx zone. Colour change grad. to dark greenish grey.	Py. Local hem. frac.	3	81	04		.185			
480	"	Local Qz stockworks		.5	41?	03		.252			
490	"	•488 Bx dyke @ 45° - 5 cm wide BFP? Hematitized, silicified, seri	Hem., diss. + frac. fill. to 10°	"	"	02		.215			
500	"			"	"	01		.252			
510	"	•504 Bx dyke @ 30° - 1.5 cm •506 FAULT	Dyke: ± 3% diss. sulphide in matrix	"	"	79300		.284			
520	"	•509 Colour change: dark grey green to greenish black (2nd bio.?)		"	"	99		.273			
530	"	— lighter again - to light grey Bx (?) Highly altered	vuggy carb. veins •529-536 cp-bearing Qz	"	81?	98		.251			
540	"	• 519 - 540 orange grey to grey Orange predominate	vein parallel to core	"	"	97		.366			
550	"	• 541 change to med. light grey + lighter Bx(?) continues. Q-Seri.	Local Qz stockworks Py + cp diss. to 5%	10	"	96		.539			
560	"	•558 - start dark green grey		"	"	95		.383			
570	"	TUFF (?) fine-grained	Cp. frac. + diss. + red hem., Locally magnetic	5	31?	94		.332			
580	"	•572 BFP @ 55°. Med. dark grey Feld. average ± 3mm	py + cp	"	41	93		.233			
590	"	Biotite: "fresh" to sericitized Locally rock is chalky (seri.)	Few large Qz. veins with	"	"	92		.268			
600	"	•587-622 bio. mostly altered.	cp + specularite.	"	"	91		.343			
610	"			"	"	90		.278			

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Collared	Completed	Core Size	Logged by	Project No	Date

FIELD COORDINATES			SURVEYED COORDINATES			Sheet 5 of 5
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-13

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
10 -				+0	41F						
620	100	BFP continues		5	41	89		.239			
630	"	Feld. averages 3mm, up to 5mm & occupies ± 40% of rock	.620-621.5 Qz-sulphide vein cuts core @ 10°	"	"	88		.155			
640	"	.645-654 darker; fresh biotite	Cp + Py	"	"	87		.245			
650	99	Local epidote	Weak Qz stockwork	"	"	86		.087			
660	100	.654 - 30° contact with		"	"	85		.096			
670	"	bleached BFP (bio. ± gou)		"	"	84		.113			
677 END	"			"	"	79283		.142			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared June 11	Completed June 13	Core Size N	Logged by A. LORSA		Project No	Date 16/6/86
FIELD COORDINATES			SURVEYED COORDINATES			Sheet 1 of 4
Lat. 16055 N	Elev. 2460'	Dip -50°	Lat. 16056.85	Elev. 2456.49	Dip 56°	Hole No. 86-14
Dep. 20740 E	Depth 560'	Bearing N 40° E	Dep. 20741.09	Depth 557'	Bearing N 40-00-00 E	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au		
0				UP TO	MIF CODE						
10		CASING									
20	100%	ANDESITE TUFF	Pyrite: diss. & frac. fill.	.3	31	79055		.039			
30	"	includes lapilli & blocks. largest frag. noted: 80mm	with quartz – ubiquitous	"		54		.042			
40	"	Locally brecciated: grey quartz	Hematite & Magnetite ± 1%	"		53		.031			
50	"	Alteration: chlorite + epidote		"		52		.026			
60	"	varies: moderate to strong quartz-calcite-pyrite veins		"		51		.030			
70	"	Colour: dark to light green	pyrite ≤ 1mm	"		50		.038			
80	"		poikilitic py in fractures general	3		49		.044			
90	90%		Hematite + magnetite diss. & fracture fillings (2mm local) ≤ 5%	1		48		.044			
100	100			2		47		.053			
110	"	Tuff clasts ≤ 50mm	Hem. local veins ≤ 3mm dia. Quartz-py veins ≤ 30mm	2		46		.048			
120	"			4		45		.053			
130	"	clasts ≤ 60mm	Pyrite: diss. & frac. fill.	"		44		.043			
140	"	Dark green	Disseminated: ± 2% Mag, incl. frac. fill ≤ 2mm	3		43		.036			
150	"		Hematite: dark, powdery	3		42		.054			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size N	Logged by A. LLORCA	Project No	Date 16/6/86
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 2 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No. 86-14
Dep.	Depth	Bearing	Dep.	Depth	Bearing	

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	CODE (~~Est. Grade~~)	Sample No.	Lt.	% Cu	OPT Au		
160	100	Explosion Bx ? Locally brecciated, Q-seri-calcite	Pyrite: diss. &	3	31	41		.074			
170	"	Zones of bleaching & sericite	fracture filling with quartz			40		.055			
180	90	Local white calcite veins, e.g. 10mm	Frac. average 3/ft ?	3		39		.046			
190	70	colour: light grey to orange-grey	Major fractures 0°, i.e. parallel to core.	3		38		.029			
200	100	Medium dark green chloritization locally predominant	Local magnetite	4		37		.077			
210	"	Dark green		3		36		.045			
220	"	local red hematite alteration	Some pyrite-quartz veins	3		35		.052			
230	"		open into vugs, Q. xls. Grey to clear quartz cuts hem.	3		34		.070			
240	"	Frac. /ft. Average 3 ± (py) clasts ≤ 35mm	Major py frac. 0-30° to core. Pyrite + mag. + hematite	3		33		.044			
250	"	Chloritized. Bleaching along veins	Few pyrite veins ≤ 2mm plus diss. py.	2		32		.048			
260	"	Colour gen. dark green				31		.051			
270	"	Clasts ≤ 60mm	Pyrite + hematite + mag. veins cut by pyrite veins	2		30		.049			
280	"	277.5 alt. increase: Med. grey to pinkish		3		29		.044			
290	"	Local dark green. Light grey		"		28		.051			
300	"		Unidentified. Blue green mineral + pyrite in fractures.	3	↓	27		.054			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 3 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-14

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au
300-				to	KIF				
310	100	Tuff. Highly seri. & sil. colour: light grey	Py. Mi. Hem. frac. fill. cont in [illegible]	3%	31	26		.064	
320	"	Qz veins + py; ave. 4/ft. Qz microfractures numerous	Vuggy Qz veins + Py + earthy hem.	4	"	25		.070	
330	"	Local Islands of chloritized tuff Medium grey	Local diss. spec. + py	3	"	24		.070	
340	"	Minor calcite		"	"	23		.077	
350	"	.345 start dark grey Local Qz stockworks		"	"	22		.091	
360	"	Locally brecciated. Grey Qz fill.		5	"	21		.064	
370	"	Med. grey to pinkish grey		"	"	20		.132	
380	"	Locally shattered with Qz flooding		"	"	19		.138	
390	"		Py veins up to 5mm	"	"	18		.056	
400	"	Vuggy calcite veins with ± 3mm XLS		"	"	17		.137	
410	"	Light grey to light olive grey	Larger Qz-Py veins @10°	"	"	16		.123	
420	"			"	"	15		.132	
430	"	Grey Qz + py veins @ 20°		2	"	14		.144	
440	"	.435-437 BFP dyke @ 20°	.438 sulphide mylonite Local cp (?)	4	"	13		.096	
450	"	Feld. av. 3mm, up to 5mm bio. sericitized.		3	"	12		.070	

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			SURVEYED COORDINATES		Sheet 4 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-14

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est Grade	Sample No.	Lt.	% Cu	OPT Au	
				to	HIF					
450-466	100	Tuff (?) sericitized ± sil. to end	Py & mi CP general	4	31	11		.098		
470	"	carbonate present	Local hem.	"	"	10		.137		
480	"	Hair Qz veins @ 35°		"	"	09		.080		
490	"	Orange to green grey		"	"	08		.093		
500	"	•496 · Colour change: dark grey green		3	"	07		.088		
510	"	•496-513 chloritized : " —		"	"	06		.117		
520	"	Alt. increase: yellowish grey to grey to orange grey	Qz flooding	"	"	05		.157		
530	"	Qz Stockworks		"	"	04		.124		
540	"			5	"	03		.165		
550	"	orange grey to med. grey sericite - Qz rock		"	"	02		.160		
557	"	white calcite vein, 1.5 cm @ 20°		"	"	79001		.111		
END										

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Collared JUNE 23	Completed JUNE 24	Core Size N	Logged by A. L'ORSA		Project No	Date 29/6/1986
FIELD COORDINATES			**SURVEYED COORDINATES**			Sheet 1 of 4
Lat. 16250N	Elev. 2060'	Dip -50°	Lat. 16234.44	Elev. 2058.87	Dip 54°	Hole No.
Dep. 21440E	Depth 560'	Bearing DUE NORTH	Dep. 21441.07	Depth 567'	Bearing N 2-21-13 E	86-15

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	~~Est.~~ Grade	Sample No.	Lt.	% Cu	OPT Au		
0-20	/	CASING - NO MARKER		UP TO	MIF CODE						
30	80	BRECCIA (Bx) to 40'	Pyrite is main sulphide	5	81	79593		.143			
40	100	light brown grey to med. dk grey Frags: BFP > Qz vein & fine-grained	throughout hole chalcopyrite occurs	"	"	92		.304			
50	"	• 42' Fault gouge 10 cm BFP - sericite & Qz	locally. Hem, minor, in frac. fill.	3	41	91		.174			
60	"	Obvious feldspars - seri. sericitized bio. visible	Py & Cp; frac. fills	"	"	90		.201			
70	"	• 64' transition to black biotite & darker; locally dark greenish grey	diss ← includes fine-grained secondary biotite.	"	"	89		.117			
80	"	Feld. ± 2mm, up to 7mm occupy 30-40% of rock	Cp > Py locally	"	"	88		.116			
90	"	Qz is grey throughout hole. This applies to all '86 holes		"	"	87		.194			
100	"	• 92 end black biotite. 3 cm Qz vein + crackle fill. @ 15°		"	"	86		.299			
110	"	Rounded to angular Bx 99 - ±115. Frags. BFP & f.g. rocks		"	81	85		.339			
120	"	Sharp top contact @ 85° Lower cont. to altered to pick	Good Qz stockworks locally	"	"	84		.610			
130	"	BFP - (?) - unrecognizable, Seri - Qz		"	41	83		.466			
140	"	Light grey to brown grey BFP - 139 - feldspars visible. No bio	Py + Cp + Qz frac. fill.	5	"	82		.488			
150	"			"	"	81		.386			
160	/	BFP recognizable only locally		"	"	80		.710			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 2 of 4
Lat.	Elev.	Dip	Lat. / Elev. / Dip		Hole No.
Dep.	Depth	Bearing	Dep. / Depth / Bearing		86-15

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
60				to	HIF						
170	100	BFP. light grey. Seri-Qz	Py > Cp	5	41	79		.963			
180	"	Alteration so intense in much of section that	Frac. fill. & diss.	"	"	78		.901			
190	"	rock only locally recognizable. Good Qz stockworks &	Local hematite	"	"	77		.606			
200	"	Qz flooding. Few white carbonate veins	MoS_2, min., + Py-Cp-Qz Sulphide: diss. > frac. fill	"	"	76		.534			
210		.203 - feld. obvious	Py - Massive frac. fill. to 5 mm + Vugs & calcite	"	"	75		.512			
220		Moderate Qz veining		"	"	74		.394			
230		locally chalky		"	"	73		.538			
240		.237-242 no visible feldspars		"	"	72		.535			
250				"	"	71		.334			
260				"	"	70		.296			
270		Qz veins not abundant		"	"	69		.331			
280		sericitized biotite visible		"	"	68		.396			
290		Local black biotite Light grey to Olive grey		3	"	67		.218			
300		.297 - 1 cm carb. vein @ 35° Seri. > Qz		"	"	66		.128			
310			.308 Mass. Py vein, 5 mm @ 40°	"	"	65		.183			

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noranda MINES LIMITED BELL COPPER DIVISION

Collared	Completed	Core Size	Logged by	Project No	Date
					Sheet 3 of 4

FIELD COORDINATES			SURVEYED COORDINATES			
Lat.	Elev.	Dip	Lat.	Elev.	Dip	Hole No.
Dep.	Depth	Bearing	Dep.	Depth	Bearing	86-15

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
310 - 320	100	BFP light grey to orange grey	Pyrite continues	to 3	MI.F 41	64		.224			
330	"	Feld. "ghosts" & sericitized bio. visible	cp may be present,	"	"	63		.208			
340	"	Qz frac. not abundant. e.g. ± 1 frac. @ 2mm / ft.	but I did not spot it.	"	"	62		.135			
350	"	Local calcite frac. fill. sub-parallel to core.		"	"	61		.221			
360	"			"	"	60		.240			
370	"			"	"	59		.211			
380	"	.375 Dyke, 13 cm @ 60° light olive green		"	"	58		.250			
390	"	.385' 3 cm Bx, Qz vein frags. Rx flour		"	"	57		.273			
400	"	.408' Bx dyke, 2.5 cm @ 45° Rounded BFP frags. in a		"	"	56		.252			
410	"	rock flour matrix; Qz + Seri.		"	"	55		.133			
420		Qz veins increasing in no. BFP mi. green tourmaline?		"	"	54		.185			
430		Med. light grey to olive grey Bx 437-448 very light grey	Py, mass. 1.5 cm vein @ 80°	"	"	53		.385			
440		to yellowish grey. Lower contact very alt.	Few Qz stockworks	"	81	52		.032			
450		& hard to pick BFP + Qz vein frags. Rx flour matrix		"	81	51		.012			
460		BFP	1 cm mass. Py vein @ 30°	5	41	50		.306			

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Collared	Completed	Core Size	Logged by	Project No	Date
FIELD COORDINATES			**SURVEYED COORDINATES**		Sheet 4 of 4
Lat.	Elev.	Dip	Lat.	Elev.	Dip
Dep.	Depth	Bearing	Dep.	Depth	Bearing

Hole No. 86-15

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est M.I.F	Sample No.	Lt.	% Cu	OPT Au		
460 – 470	100	•462 Bx 5 cm @ 30° BFP. Frags BFP & Qz in rock flour	•Py most abundant cp local	3	41	49		.366			
480	"	Qz veins, 1 mm thick or thicker ± 4/ft. @ 45° or less	•467 & 475 vugs + calcite	"	"	48		.372			
490	"		& cp crystals	"	"	47		.466			
500	"	•494-497 intense silicification •497 Bx 16 cm, ang. alt. BFP frags.		5	"	46		.531			
510	"	Qz stockworks BFP - med. dark grey		"	"	45		.671			
520	"	Feldspars obvious •517 post mineral fault @ 55°	carbonate	"	"	44		.541			
530		Med. dark grey (silic.) to light olive grey		"	"	43		.541			
540		•531-535 Qz flooding + vugs –	& sulphides	"	"	42		.641			
550		sericitized bio. visible	Mi. hem. + cp in Qz vein	"	"	41		.379			
560		•548-563 several zones of dark		"	"	40		.547			
567		silicification + sulphides		"	"	79539		.584			
END											

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Collared JUNE 29	Completed JUNE 29	Core Size N	Logged by A. LORSA	Project No	Date 10 July 198
FIELD COORDINATES			**SURVEYED COORDINATES**			Sheet 1 of 1
Lat. 17175N	Elev. 2180'	Dip -60°	Lat. 17170.14	Elev. 2186.30	Dip 60°	Hole No.
Dep. 21170E	Depth 560'	Bearing DUE SOUTH	Dep. 21169.93	Depth 132	Bearing S 0-07-26 W	86-16

Footage	Rec'y	Rock Type/Alteration	Mineralization	% Sulp.	Est. Grade	Sample No.	Lt.	% Cu	OPT Au		
0	%										
10	0	Casing	Pyrite dominant sulphide	UP TO	MIF CODE						
20	70	Probably altered BFP (?) Quartz-sericite rock, Local bx	throughout. Chalcopy. generally present	5	41	79462		.355			
30	100	Strong grey quartz stockworks. Minor green tourmaline (?), Carb. vns	Frac. fillings > disseminations. Bornite, mi., with cp + py	"	"	61		.380			
40	90	Silic. > seri., but variable. Light orange grey to med. grey	assoc. with dolomite vein	10	"	60		.485			
50	100	• 47' - ±7mm bx dyke @ 65° • 50.51' ±20cm —"— 55°	Local red hem. + spec. in gy Qz.	5	"	59		.565			
60	"	Frags. ang. to subrounded. Few Qz vein frags. Alt. BFP frags. Grey	± 3% diss. py + cp in bx matrix.	"	"	58		.487			
70	"	Qz matrix, & small rock frags. BFP obvious. Feld. ± 1mm = ± 15%		"	"	57		.366			
80	"	Colour locally greyish green	Spec. + red hem. locally common	"	"	56		.386			
90	"	• 84-104 strong silicification.	Local py frac. fill. to 5mm	"	"	55		.325			
100	"	Good stockworks. Silica flooding		"	"	54		.286			
110	"	Med. lght to med. grey to end. • 108-127 Strong silicification		"	"	53		.348			
120	"	• 115 end of slight rust in frac.	9mm white calcite vein @ 65° Py dominant. Mi. cp + covellite	"	"	52		.445			
130	"	Local white carbonate veins		10	"	51		.636			
132	"			5	"	79451					
END		Drill stopped at fault									

APPENDIX IV

DRILL HOLE LOG SUMMARY

SUMMARIES OF DIAMOND DRILL HOLES 86-1 to 86-16. July 1986.

86-1 Upper section of hole is in chloritized tuffs cut by BFP dykes. Below 172 ft. sericitized and silicified BFP predominates. Explosion and probable tectonic breccias occur in both rock types. Pyrite is the dominant sulphide mineral, accompanied generally by chalcopyrite. Hematite is present. Small amounts of molybdenite were noted at the bottom of the hole associated with strong chalcopyrite mineralization and quartz.

86-2 Altered BFP occurs throughout the hole, interrupted by several breccia zones. The rock is generally well fractured with lots of quartz. Alteration is mainly sericite-quartz but some darker coloured sections may represent fine-grained biotitization. I cannot tell megascopically without petrographic support. Pyrite and chalcopyrite are present throughout the hole in fracture fillings and disseminations. Minor disseminated molybdenite was noted at 128ft. and 487ft. Hematite is present from about 120 ft. to end of hole. Magnetite is rarely present.

86-3 Chloritized tuffs, silicic in part, were intersected to 60 ft., from which point the drill cored very altered (sericitized and silicified) BFP to end of hole. Silicification increases in lower sections of hole where local zones of pervasive silicification were encountered, but not to the extent of nearby 86-1 at lower depths. Pyrite and chalcopyrite occur in fracture fillings and disseminations throughout. Bornite (?) is finely disseminated at 251 ft. Hematite was noted from about 150 ft. to EOH.

86-4 BFP throughout the hole; silicified,sericitized and locally biotitized. Hydrothermal biotite particularly noted at 234-291 ft. and 317-355 ft. Breccia zones occur in sections 100-138 ft. and 164-226 ft., with much quartz. Pyrite and chalcopyrite are present in fracture fillings and disseminations. Minor molybdenite was noted at 347 ft. Magnetite appears to be associated with biotitization in a general way. It may be useful to check old magnetometer maps as an aid in determining zoning.

<u>86-5</u> The hole was collared in highly sericitized and silicified tuffs (?) and this alteration and rock type generally continued throughout. A thin section was prepared from a sample collected at 92 ft. and a petrographic report is attached to the drill log. Breccia dykes (explosion breccias) were intersected in the 550 ft.-570 ft. area and include altered probable BFP fragments. Pyrite is the most abundant sulphide mineral. Chalcopyrite occurs locally. Small amounts of hematite and magnetite were found.

<u>86-6</u> Generally highly sericitized and silicified rocks extend to the bottom of the hole. Most are probably igneous rocks but alteration is too intense for megascopic identification. There is BFP at the bottom of the hole, but it is not certain that this occurrence represents the main intrusion. A probable BFP dyke was cored at 295.5-297 ft. A highly altered breccia zone was intersected from the collar of the hole to about 65 ft. Explosion breccia dykes with BFP fragments were noted at 132-136.5 ft. and 258 ft. Pyrite is common throughout. Small amounts of chalcopyrite were noted below 200 ft.

<u>86-7</u> BFP all the way down the hole. Alteration varies from quartz-sericite (0-240') to biotite (240-340') and back to qz-seri. A dyke and explosion breccia complex was cut between 55 and 115 ft. Pyrite is the most abundant sulphide mineral by far. Small amounts of chalcopyrite were noted locally. Hematite is present in places.

<u>86-8</u> This hole completely in BFP. Alteration includes sericite, quartz and biotite with local gypsum. A dyke and explosion breccia complex was intersected 39-67 ft. The breccia includes rounded to angular fragments of altered BFP, quartz veins and quartz-sericite rock. Pyrite is the dominant sulphide mineral throughout, but chalcopyrite and local bornite are present. There is a marked increase in sulphides below the dyke-breccia complex.

<u>86-9</u> This hole is probably in BFP all the way, but alteration is so intense between 237 ft and 488 ft that I cannot identify the original rock. Alteration is quartz and sericite. The explosion breccias of nearby holes were not identified, but they could be in the highly altered 237-488 ft section. Sulphides occur throughout the hole. Pyrite generally predominates but chalcopyrite is locally dominant (e.g. 320-330 ft).

<u>86-10</u> The hole was drilled in altered BFP of the quartz-sericite zone. There is much intense sericitization. Explosion breccia-dyke complex 286-320 ft and smaller breccia zones below. Pyrite is the main sulphide mineral. Chalcopyrite is present and minor bornite was noted.

<u>86-11</u> This hole was drilled entirely in a breccia and dyke complex, mainly in the quartz-sericite alteration zone. Hydrothermal biotite is present in places (e.g. 221-247 ft), indicating that this hole also cut some potassic zone rocks. This hole may have penetrated a major breccia pipe to which breccias found in nearby holes are related. Pyrite is the major sulphide mineral. Chalcopyrite occurs locally.

<u>86-12</u> Highly sericitized and silicified rocks were encountered throughout the hole. The upper part of the hole may be in altered tuffs, but alteration is too intense for megascopic identification. BFP starts at 220 ft, but from about 249 ft to end of hole breccias predominate. Breccia fragments include highly altered probable BFP. Pyrite is the main sulphide, but chalcopyrite is also present.

86-13 This hole was collared in quartz-sericite rock that could be BFP or could be a tuff sequence or could be a bit of both. The rock is cut by a few thin explosion breccia dykes that cross the core at 45°. There are also extensive breccias, many of which are vague, in the 430-550 ft section. Some of these breccias may be quartz-filled shattered zones rather than explosion breccias. Obvious BFP was intersected at 572 ft and continued to end of the hole. Pyrite is the principal sulphide mineral here, but chalcopyrite is relatively abundant locally. There is more hematite in this hole than in any other of this series.

86-14 The hole is generally in the chlorite-carbonate zone from the collar to about 277 ft where the transition to the quartz-sericite zone occurs. Below 277 ft quartz and sericite are dominant, but local chlorite-carbonate alteration was encountered below 500 ft. Pyrite is the most abundant sulphide mineral by far. Magnetite is common in upper sections of the hole and hematite is found throughout.

86-15 The entire hole is in sericitized, silicified and locally biotitized BFP, cut by several zones of explosion breccias. Hematite is generally present. Pyrite is the dominant sulphide mineral, accompanied by local chalcopyrite. Minor molybdenite was noted at 198 ft.

86-16 This hole intersected quartz-sericite zone BFP. However, the quartz-sericite rock in upper sections of the hole is too altered for positive identification. Silicification is strong in places. Pyrite is the main sulphide mineral, but chalcopyrite is generally also present. Bornite was noted at 30 ft. Two breccia dykes, up to 20 cm wide, occur in this hole. The rock is slightly oxidized (minor rust in fractures) down to 115 ft.

A. L'O

Anthony L'Orsa, Geologist

APPENDIX V

GEOLOGIST'S QUALIFICATIONS STATEMENT

CERTIFICATE

I, Anthony T. L'Orsa, of Smithers, British Columbia, hereby certify that:

1. I am a consulting geologist with business address at R.R.2, S.57, C.23, Adams Road, Smithers, B.C., VOJ 2NO.

2. I was born in and raised near Smithers, B.C.

3. I am a graduate of Tulane University, New Orleans, La., U.S.A., with the degrees of B.Sc. (1961) and M.Sc (1964) in geology.

4. I have practised my profession in mineral exploration since 1962 in western Canada, Australia and Mexico.

5. I am a Fellow in good standing of the Geological Association of Canada and a member of the Society for Geology Applied to Mineral Deposits.

6. I logged diamond drill holes 86-1 through 86-16 at the Bell mine during June and July 1986.

A. L'Orsa

Anthony L'Orsa, Geologist

Hagan Arm
N.T.S. 93M/1E
N.T.S. 93L/16E
HS 15 M.C.
HS 16 M.C.
VIEW 1 Fraction M.C.
Rum Island
Rum Bay
Newman Peninsula
Wolverton Bay
M 134
M 135
TAILINGS IMPOUNDMENT AREA
North Dump
Explosives Magazine
CG 27 M.C.
CG 26 M.C.
CG 25 M.C.
CG 24 M.C.
CG 23 M.C.
CG 21 M.C.
CG 19 M.C.
CG 17 M.C.
CG 15
CG 5 M.C.
CG 4 M.C.
CG 3 M.C.
CG 2 M.C.
CG 1 M.C.
126° 14' W (est)
55° 00' N (est)
Newman Island
Babine Lake
GEOLOGICAL BRANCH ASSESSMENT REPORT
15,711
LEGEND:
D.D. Holes in Grant Application 86-5
D.D. Hole outside Application 86-9
Mineral Lease Boundaries
Located Claim Boundaries
Scale: 1 in. = 500 ft.
0 500 1000 1500 2000
maclaren FOREST PRODUCTS INC.
BABINE MINING DIVISION
BELL MINE
General Location Plan Showing Diamond Drill Hole Collars and Mineral Lease and Claim Boundaries for:
ACCELERATED MINE EXPLORATION PROGRAM - Number 10963 M21
SCALE: 1" = 500'
DATE 870121
DRAWN:
DRWG. No. 2