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GEOLOGICAL, GEOCHEMICAL AND GEOPHYSICAL REPORT

ON THE

NAKINILERAK LAKE PROPERTY
NAK 1 - 5 MINERAL CLAIMS

Babine Lake Area
Omineca Mining Division
British Columbia

NTS: 93M/8E,8W
55°17' North 126°14' West

OWNER: LORNE B. WARREN

AUTHOR: N.C. CARTER, Ph.D. P.Eng.

DATE: May 5,1994

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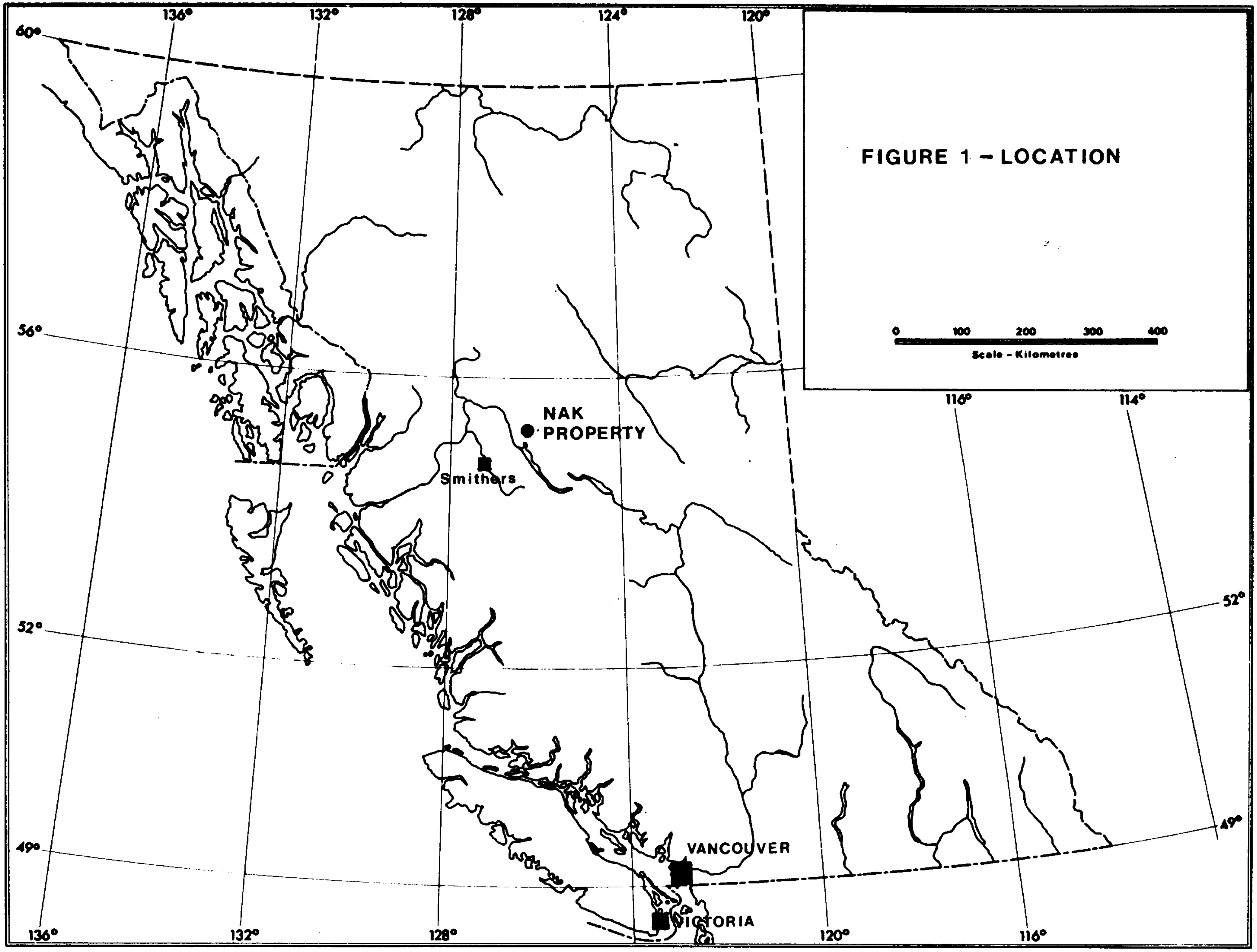


FIGURE 1 – LOCATION
0
100
200
300
400
Scale - Kilometres
NAK PROPERTY
Smithers
VANCOUVER
VICTORIA
60°
56°
52°
49°
136°
132°
128°
124°
120°
116°
114°

INTRODUCTION

Location and Access

The NAK 1 - 5 mineral claims are situated immediately east of Nakinilerak Lake 80 km northeast of Smithers in west-central British Columbia (Figure 1). The geographic centre of the property is at latitude 55°17' North and longitude 126°14' West in NTS map-areas 93M/8E and 8W.

Nakinilerak Lake is 30 km north of Bell Copper mine on Babine Lake (Figure 2). Access to the NAK 1 - 5 mineral claims is currently by helicopter. Active logging roads along the east side of Babine Lake provide access to Morrison Lake from which a 20 year old, 15 km bulldozer road extends through the central part of the present property (Figure 2). Recent logging roads in the Hautete Creek Valley extend to within 3 km of the present claims.

Mineral Property

The Nakinilerak Lake property consists of five 4-post mineral claims (94 units) in the Omineca Mining Division which are recorded in the name of Lorne B. Warren of Smithers. The claims are shown on Figure 3 and details are as follows:

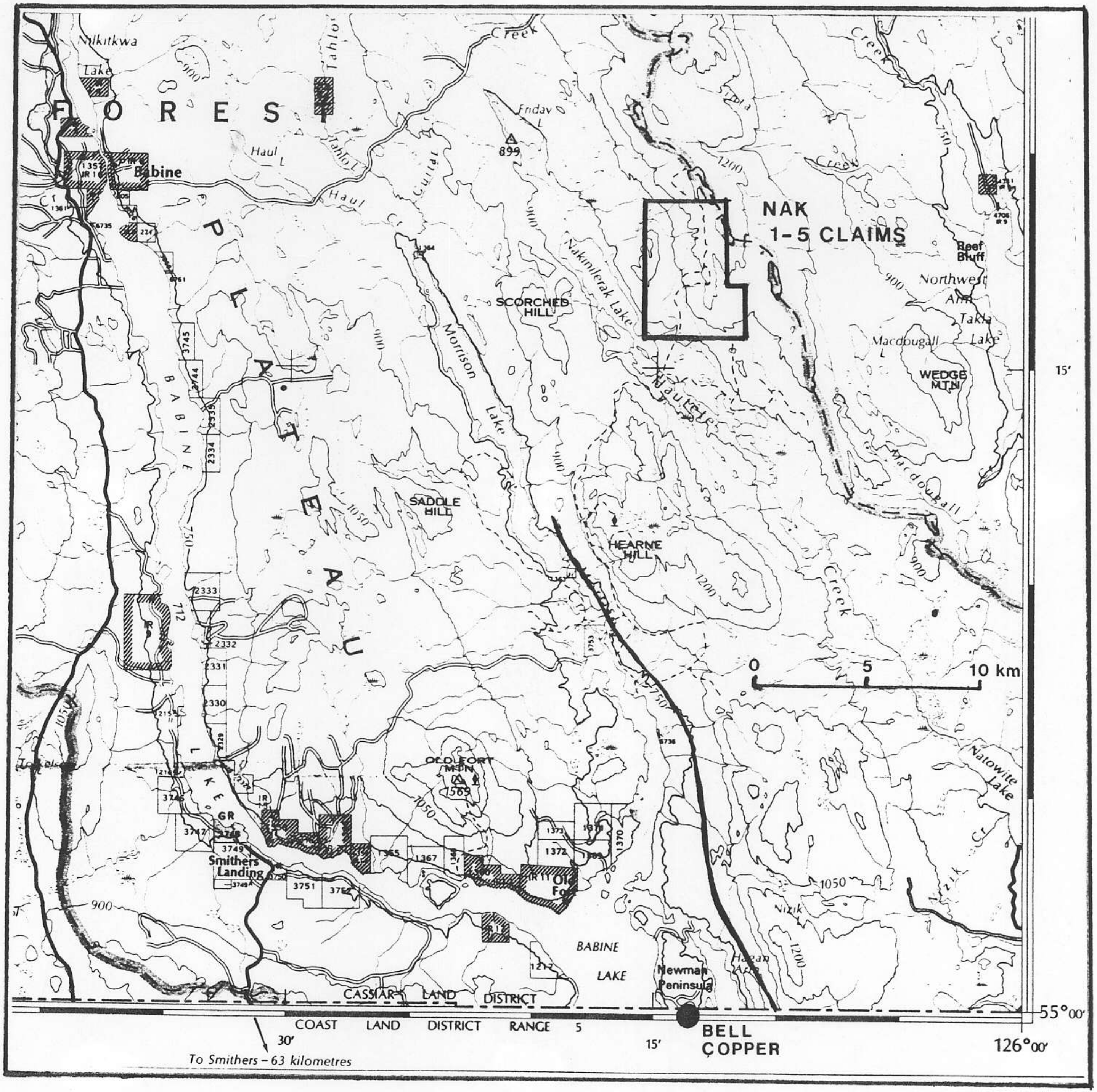


FIGURE 2 - LOCATION - NAK PROPERTY

Claim Name	Units	Record Number	Date of Record
NAK 1	20	307617	February 10/92
NAK 2	20	307618	February 7/92
NAK 3	20	307619	February 11/92
NAK 4	14	308552	April 9/92
NAK 5	20	308553	April 9/92

History

Original claims were staked in the area by Noranda Exploration Company, Limited following the detection of anomalous copper values in stream sediments northeast of Nakinilerak Lake in 1964. Over the next six years, Noranda completed airborne and surface geophysical programs, soil geochemistry, geological mapping and alteration studies, limited bulldozer trenching and 1835 metres of diamond drilling in 28 holes. Geological, geochemical and geophysical surveys were completed by Noranda on the Sno claim group, southeast of the main property, in 1971. This area is included in the southern part of the present NAK claims.

The northern part of the present property includes most of the original Lynn property which was investigated by Ducanex Resources in the early 1970's. In addition to geochemical and geophysical surveys, 480 metres of diamond drilling was completed in eight holes.

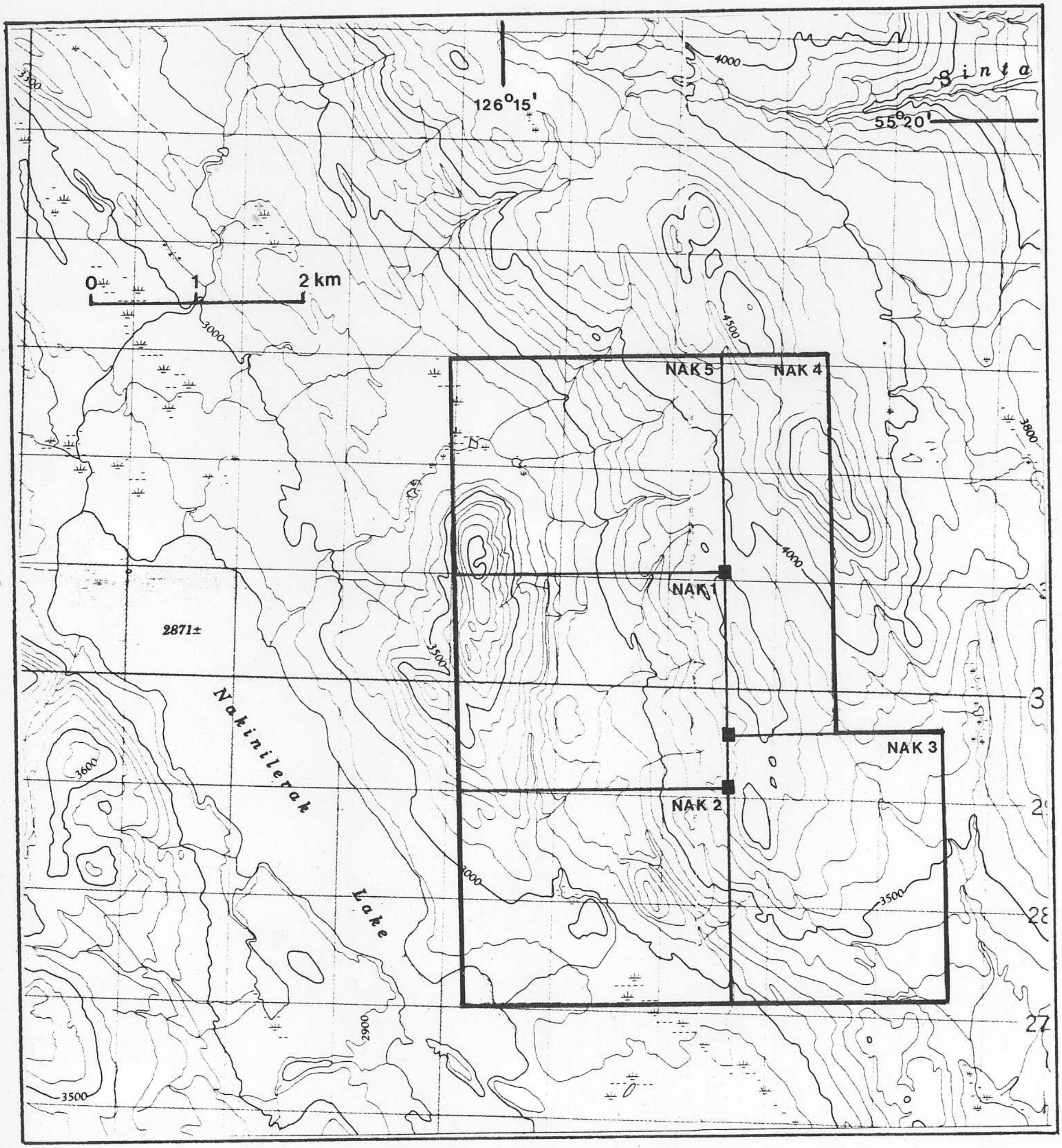


FIGURE 3 - NAK MINERAL CLAIMS

Present Status

The NAK 1 - 5 mineral claims were located by Lorne B. Warren in February and April of 1992.

An option agreement for the purposes of conducting further exploration work on the NAK claims was negotiated with Tri-Alpha Investments Ltd. in mid-1992. Two additional mineral claims were located in June of 1992 and work included some grid construction on the NAK 1 mineral claim in early 1993 following which the property was returned to the owner.

This report incorporates results of an airborne geophysical survey conducted on behalf of Noranda Exploration Company, Limited by Aerodat Limited over the central part of the NAK claim block February 25,1993 and results of petrographic and lithogeochemical work on samples collected from the property in July and October of 1993 by J.L. Oliver of Teck Exploration Ltd.

Airborne survey results and petrographic - lithogeochemical information have been made available to the property owner and author of this report through the auspices of Noranda Exploration Company, Limited and Teck Exploration Ltd.

The author has examined and reported on the area of the present mineral claims on a number of previous occasions (Carter,1967,1972,1976).

GEOLOGY AND MINERALIZATION

Physical Setting

The northern Babine Lake area is within the Nechako Plateau, a physiographic subdivision of the Interior Plateau.

Nakinilerak Lake, at an elevation of 875 metres abobe sea level, is immediately east of the drainage divide between the Fraser River and Babine - Skeena River watersheds.

The NAK mineral claims cover an area of moderate relief featuring a central broad valley with mean elevations of about 1000 metres and which is flanked on the east and west by ridges with maximum elevations of 1200 and 1400 metres respectively (Figure 3).

Glacial deposits of gravel, sand and clay cover much of the area, and good bedrock exposures are limited to ridges and some creek valleys.

Regional Geological Setting

The northern Babine Lake area, within Stikinia terrane of the Intermontane tectonic belt, is underlain primarily by Mesozoic volcanic and sedimentary rocks of the Jurassic Hazelton Group. Younger sequences include sedimentary and lesser volcanic rocks ranging in age from late Jurassic to early Tertiary. The layered rocks are intruded by granitic rocks of several ages including Lower Jurassic Topley intrusions, Omineca intrusions of early Cretaceous age, late Cretaceous rhyolite and granodiorite porphyries (Bulkley intrusions) and Babine intrusions of early Tertiary (Eocene) age.

Porphyry copper mineralization in the Babine Lake area is well documented and is associated with three ages of intrusive activity (Figure 1). The most significant are the Eocene Babine intrusions which occur as small stocks and dyke swarms and host more than a dozen known porphyry copper deposits and occurrences including the former Granisle mine and Noranda's currently producing Bell Copper mine.

These deposits have a significant gold content in addition to copper grades in the 0.45 - 0.70% range. Production to date from the Granisle and Bell operations is as follows:

	Period	Tons Milled	Cu(tons)	Au(oz)	Ag(oz)
Granisle	1966-1982	57,498,131	236,225	148,000	1,906,000
Bell	1972-1991	83,816,398	329,150	405,100	1,244,232

Remaining reserves in the Bell open pit at the end of 1991 were reported to be 1.4 million tons grading 0.70% copper and 0.011 oz/ton gold. Not included were some 20 years of reserves grading close to 0.45% copper plus gold values immediately northeast of the present open pit. Reserves for the Morrison property, also owned by Noranda, have been variously reported as being 45 - 90 million tons grading 0.42% copper and 0.01 oz/ton gold.

Copper mineralization at these and other prospects is related to biotite-feldspar porphyry phases of the Babine intrusions. This distinctive rock type ranges in composition from quartz diorite to granodiorite and is a crowded porphyry with 2 to 3 mm phenocrysts of plagioclase and biotite. Multiple intrusion is a common feature with the earliest intrusive phase at some deposits and prospects represented by fine-grained, equigranular quartz diorite and/or quartz monzonite. Pre-, inter- and post-mineral biotite-feldspar porphyry phases and intrusive breccias have been recognized at many of the better mineralized properties.

Hydrothermal alteration zones associated with Babine porphyries include a central potassic zone, represented by abundant secondary biotite, gradational outward to a quartz-sericite-pyrite zone which in turn is enveloped by a propylitic zone.

Copper mineralization consists of chalcopyrite and lesser bornite which occur primarily in northeast and northwest striking, vertically dipping, quartz-filled fractures ranging in width from 1 to 5 mm. Better grades are developed at or near contacts between intrusive phases and marginal volcanic and sedimentary rocks. Pyrite haloes, containing 5-10% pyrite, extend outward for at least 300 metres from zones of copper mineralization.

Property Geology, Geophysics, Geochemistry and Mineralization

Geology - The Nakinilerak Lake property is underlain by a northwest trending, east dipping sequence of andesite flows and fragmental rocks and argillaceous and cherty sediments which are part of the Hazelton Group of Jurassic age (Figure 4). Conglomerates and sandstones bordering Nakinilerak Lake may be part of a younger sequence.

The volcanics and sediments are intruded by small monzonite - diorite stocks of probable early Cretaceous age and by stocks, sills and dykes of Babine porphyries of Eocene age. The largest of these is a 1500 x 1200 metre stock in the central property area (Figure 4) which is made up of several intrusive phases including fine-grained quartz diorite and quartz monzonite and several varieties of biotite (hornblende)-feldspar porphyry.

Intrusive contacts are not well defined and numerous dykes and sills cut layered rocks several hundred metres south and west of the main stock and near the property north boundary. Similar intrusive rocks underlie much of the ridge near the western claim boundary.

The central porphyry stock is situated near the intersection of northwest and northeast faults, a structural setting similar to other porphyry intrusions in the area.

Geophysics - Magnetite is a common constituent of the intrusive rocks and to a lesser extent, the volcanic sequences. Airborne magnetic highs are situated marginal to intrusions. Surface surveys indicate three areas of high magnetic response (+1500 gammas) including an arcuate zone along the southeast margin of the central porphyry stock, a circular area coincident with known porphyry dykes along the property north boundary and a northwest trending linear zone in the southern property area which is probably a reflection of magnetite in volcanic rocks.

Areas of high or anomalous IP response are arranged in a subcircular pattern marginal to the central porphyry stock. These anomalous areas include chargeabilities of between 10 and 30 msec and resistivities of 150 ohm-ft. or less.

Geochemistry - Geochemical signatures for the property area are shown on Figure 6. Anomalous copper values in stream sediments extend to Nakinilerak Lake and a number of copper anomalies in soils are distributed throughout the property area. Relatively high background values of between 50 and 100 ppm copper are the norm and better values (up to 1000 ppm Cu) occur in the marginal areas of the central porphyry stock.

Overburden depths range from zero to as much as 50

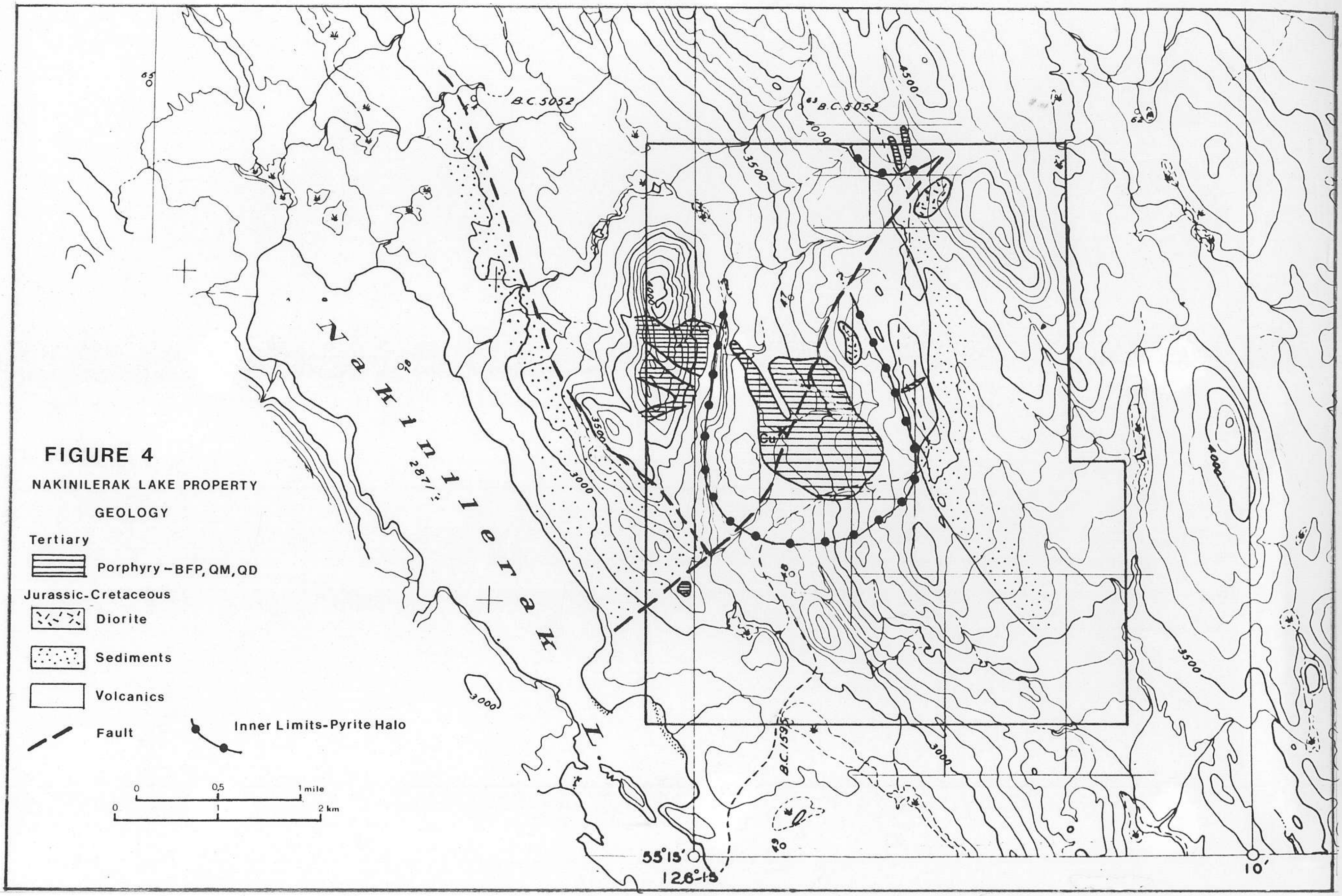


FIGURE 4
NAKINILERAK LAKE PROPERTY
GEOLOGY
Tertiary
Porphyry – BFP, QM, QD
Jurassic-Cretaceous
Diorite
Sediments
Volcanics
Fault
Inner Limits-Pyrite Halo
0
0.5
1 mile
0
1
2 km
Nakinilerak L.
2871'±
B.C. 5052
B.C. 5052
B.C. 1595
Cu
4500
4000
3500
3000
55°15'
126°15'
10'

metres within the area drilled. Average overburden depths in areas of anomalous soil geochemistry are 3 - 10 metres.

Mineralization - The principal copper showing is situated in the western part of the main stock (Figure 4). Chalcopyrite, pyrite and minor bornite occur as disseminations in bleached feldspar porphyry and in 2-4 mm northeast and northwest trending, vertical quartz veinlets in biotite (hornblende)-feldpsar porphyry and fine-grained quartz diorite. A grab sample from this locality assayed 0.35% copper (Carter,1967).

Copper mineralization in fractures and quartz veinlets has also been noted along the ridge east of the stock and in areas marginal to the south and west stock contacts.

The property has been partially tested by 28 widely spaced drill holes of which 15 contained sections grading more than 0.15% copper. Two holes contained 3 metre sections grading more than 1% copper, reflecting the presence of 1 - 2.5 cm wide quartz-chalcopyrite veins. Analyses for gold, carried out for the first six short X-Ray holes only, indicated two 3 metre sections in one hole grading 1 and 2 grams/tonne respectively. Molybdenum values were found to be generally in the 0.005% range.

Drill logs indicate that the better copper grades are hosted by sheared and brecciated biotite (hornblende)-

feldspar porphyry with abundant sericite alteration. Multiple phases of intrusion are evident and intrusive breccias were noted in two holes. A relatively fresh, leucocratic, possible post-mineral porphyry phase occupies the upper part of hole 15 which contains an average 0.57% copper between hole depths of 64 and 82 metres.

Copper mineralization noted in drill core invariably is contained in quartz-filled fractures which are parallel to core surfaces. Late porphyry phases noted probably occur as steeply dipping dykes. These features suggest that vertical holes in this environment do not provide a proper sample.

Better copper grades obtained by drilling to date are developed along the southwest margin of the main porphyry stock and are contained in a zone that is open to the south and west.

Hydrothermal alteration within the area drilled includes locally abundant secondary biotite within the porphyry. A peripheral quartz-sericite-pyrite zone is represented by a pyrite halo which is well developed marginal to the central porphyry stock (Figure 4). Between 3 and 10% fracture filling and disseminated pyrite occurs in volcanic and sedimentary rocks both along the ridge east of the main stock and over a broad area to the south. Abundant pyrite has also been noted in intrusive rocks underlying the ridge near the western property boundary.

1993 AIRBORNE GEOPHYSICAL SURVEY

A combined helicopter-borne magnetometer, electromagnetic and VLF-EM survey, undertaken by Aerodat Limited February 25,1993, covered a 6 square km area in the central part of the NAK claim block. Data was retrieved for four east-west flight lines at 500 metre spacings for a total coverage of 16 line-kilometres (Figure 5 - note that no data was recorded for flight line 20050).

Survey procedures, equipment specifications, comments re data presentation and interpretation are contained in a report by R.W. Woolham, P.Eng. which is included in this report as Appendix I.

Survey results for flight lines 20010, 20020, 20030 and 20041 (Figure 5) are shown as flight line profiles (Figures 6A, 6B, 6C and 6D respectively) and the author's comments re interpretation are as follows:

Magnetic Survey - The high amplitude semi-circular anomaly referred to by Woolham reflects the biotite-feldspar porphyry stock underlying much of the NAK 1 mineral claim. A northerly trending magnetic high, extending from the eastern margin of the semi-circular magnetic feature, is probably due to an older, more magnetic hornblende diorite flanking the

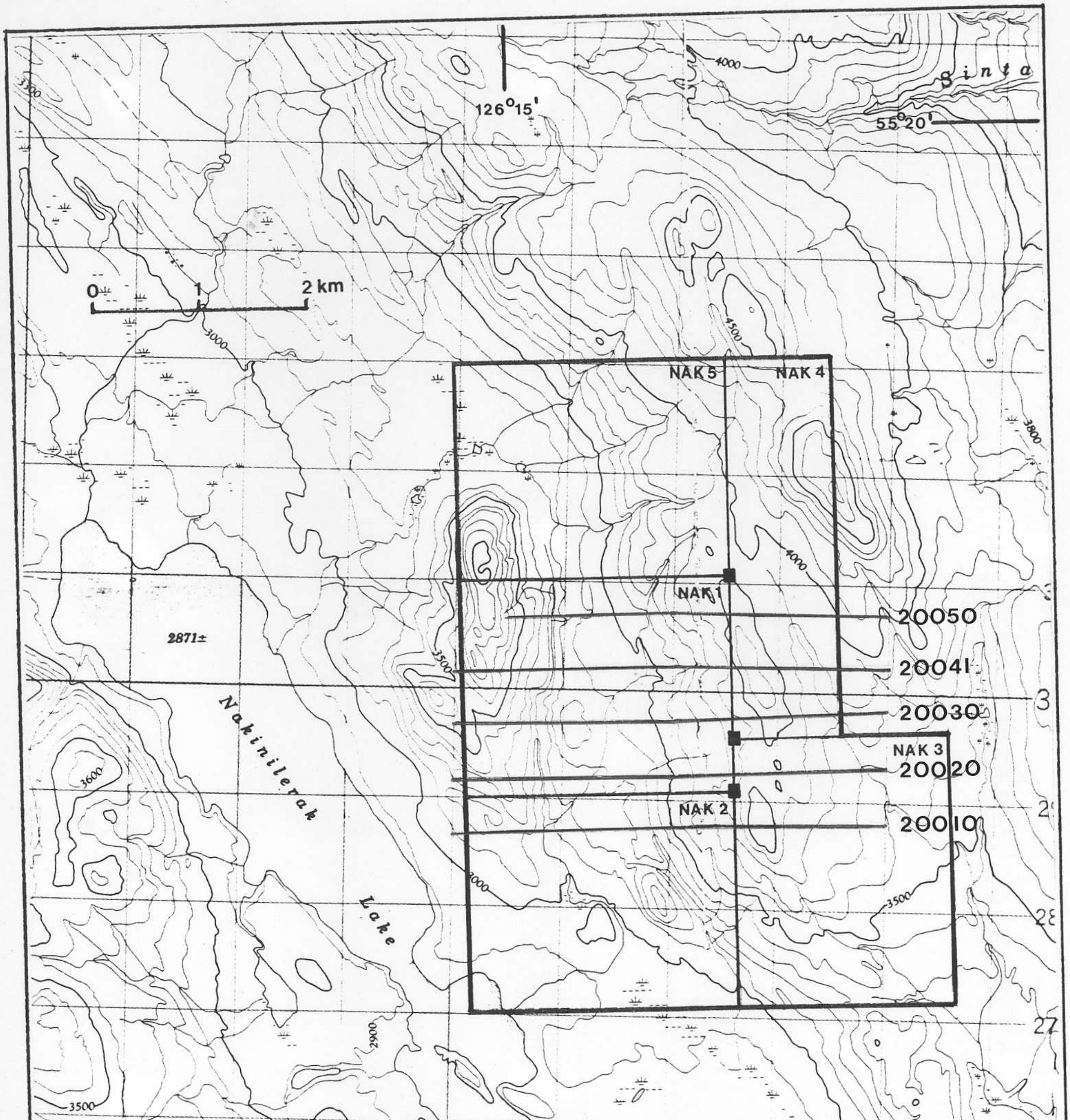


FIGURE 5 - FLIGHT LINES-AIRBORNE SURVEY

BFP stock on the northeast.

The cause of an area of apparent higher magnetic susceptibility northwest of the BFP stock may reflect other porphyry intrusions.

Electromagnetic and VLF-EM Surveys - Woolham's report (Appendix I) notes that no significant conductors were detected by either the VLF-EM or conventional electromagnetic surveys.

Calculations of apparent resistivity show two areas of lower resistivity bordering the eastern and southwestern margins of the BFP stock. These features are roughly correlative with previous surface IP surveys.

PETROGRAPHIC AND LITHOGEOCHEMICAL STUDIES

A number of surface and drill core samples were collected from the NAK mineral claims by J.L. Oliver, P.Geo., of Teck Exploration Ltd. in 1993. Locations of most of these samples are shown on Figure 7; four samples of AQ-size drill core, for which hole numbers could not be identified, were also collected.

Thin sections were prepared for 12 of the samples collected and major elements and base precious metal values were determined for 13 samples by Eco-Tech Laboratories of Kamloops.

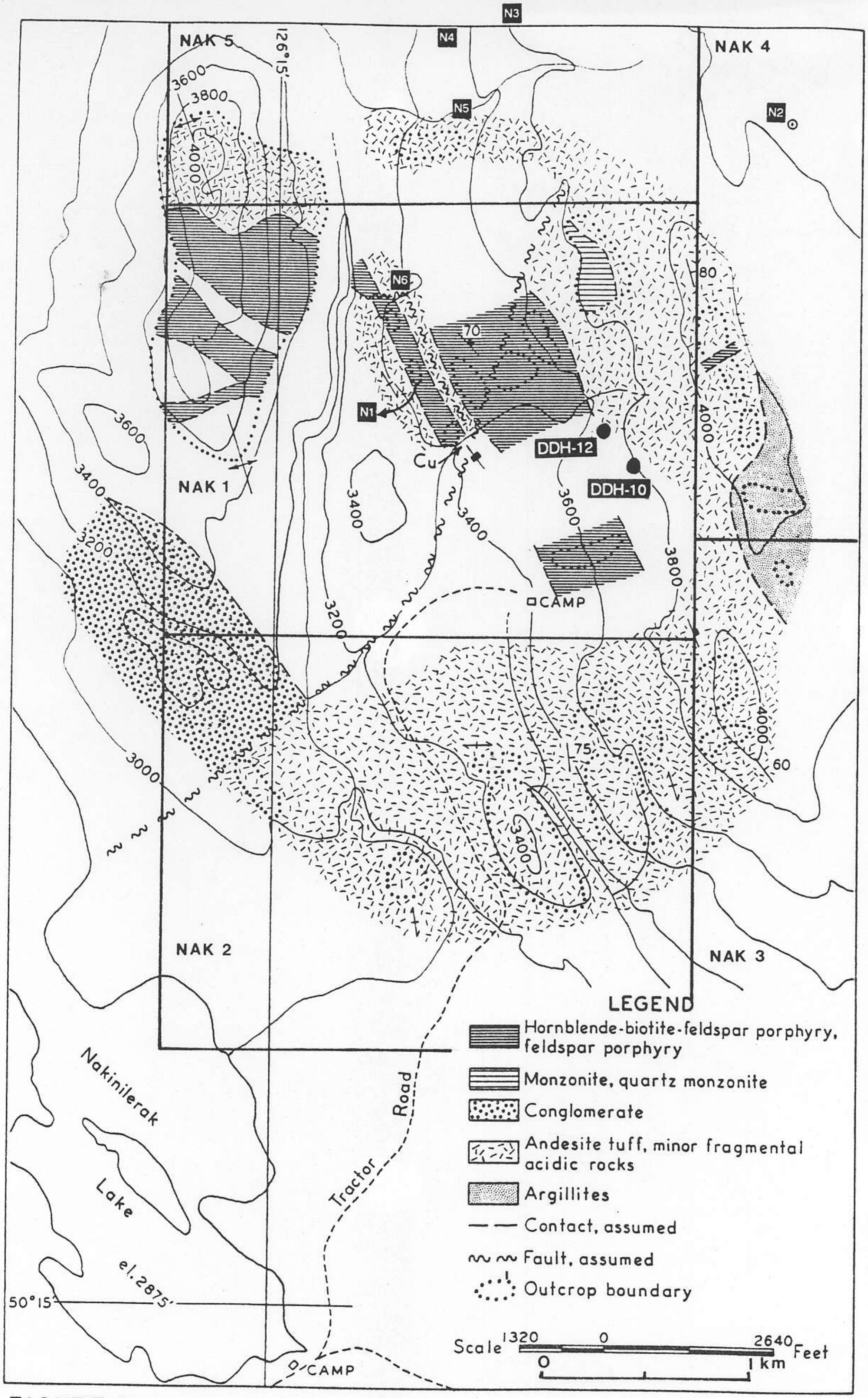


FIGURE 7
NAKINILERAK LAKE : SAMPLE LOCATIONS

General comments and observations of 12 thin sections plus analytical results, plots of major elements, base and precious metal values and general comments on same, all by J.L. Oliver, P.Geo., are included with this report as Appendix II.

A synthesis of Oliver's comments is as follows:

Petrographic Study - At least four distinct phases of intrusive activity are evident on the NAK mineral claims including an older hornblende diorite, two mineralized biotite-feldspar porphyry (BFP) phases, and a late or post-mineral BFP.

Four alteration styles were identified from the thin sections examined. These include potassic alteration in the form of secondary biotite, later quartz-chlorite-calcite + pyrite, sericite-quartz alteration in drill hole 10 (Figure 7) which is marginal to the porphyry system associated with the BFP stock and a distal hematite-sericite alteration.

The intensity, colour and distribution of secondary biotite in thin sections examined from the NAK property compare favourably with the secondary biotite observed within the zone of better copper mineralization at the nearby Morrison deposit. Based on this study, there is also evidence that more than one mineralized intrusive complex may exist within the NAK mineral claims.

Lithogeochemical Study - Major element ratios for 13 whole rock samples collected from the NAK property confirm the calc-alkaline character of the BFP phase and are similar to published whole rock data for other porphyry prospects in the Babine Lake area.

Base and precious metal ratios indicate a positive correlation between zinc and gold contents suggesting that better gold values might be expected on the periphery of the main porphyry copper system.

Plots of various metal ratios are generally similar to other Babine porphyries (Appendix II).

CONCLUSIONS AND RECOMMENDATIONS

Results of recent airborne geophysical surveys of the NAK mineral claims are in general agreement with geophysical signatures obtained from previous surface surveys.

Petrographic studies indicate that secondary biotite, representative of potassic alteration, is of similar intensity and quality to that observed within zones of better grade copper mineralization at the Morrison deposit. Alteration mineral assemblages noted in the samples studied suggest that more than one porphyry system may be present on the NAK mineral claims.

Analytical results of 13 samples confirm the presence of low gold values within the NAK porphyry system.

The present NAK claims include a porphyry copper environment which is typical of the Babine Lake area of west-central British Columbia. Copper mineralization is associated with distinctive biotite-(hornblende)-feldspar (BFP) porphyries of Eocene age which are identical to the intrusions hosting mineralization at Bell Copper, Granisle and ten other known deposits and occurrences in the general area.

Previous work in the central part of the present property has identified copper mineralization over a 1000 x 600 metre area near the western margin of a large BFP stock. Copper grades encountered in limited drilling of this area ranged from 0.15 to 1.14%. Onl;y a few analyses for gold were undertaken; assays for two samples yielded 1 - 2 grams/tonne.

The NAK mineral claims include the most areally extensive hydrothermal alteration zone known in the Babine Lake area. As indicated by recent petrographic studies, more than one porphyry copper system may be present within this large alteration zone.

COST STATEMENT

Airborne Geophysical Survey	
February 25,1993	
- 16 line km @ $74.00/line km	$1,185.00
Petrographic and Lithogeochemical Studies	
Field Work - J.L. Oliver,	
July, October, 1993 - 1.5 days @ $365/day	$547.50
Helicopter Support	$800.00
Field supplies	$40.00
Thin section preparation	$449.00
Sample analyses	$574.59
Computer plots	$243.43
Colour reproductions	$100.00
Petrographic analysis and interpretation -	
J.L. Oliver - 5 days @ $365/day	$1,825.00
Report Preparation	
N.C. Carter - 2.5 days @ $500/day	$1,250.00
Word processing, drafting, duplicating	$220.48
TOTAL EXPENDITURES	**$7,235.00**

REFERENCES

B.C. Ministry of Energy Mines and Petroleum Resources: Assessment Reports 1198, 3311, 3531

Carter, N.C.(1967): DA,AK in B.C. Minister of Mines Annual Report 1966, pp.95-97

------------(1973): Geology of the Northern Babine Lake Area, B.C. Department of Mines and Petroleum Resources Preliminary Map No.12

------------(1976): Regional Setting of Porphyry Deposits in West-Central British Columbia in Porphyry Deposits of the Canadian Cordillera, CIM Special Volume 15,pp.227-238

AUTHOR'S QUALIFICATIONS

I, NICHOLAS C. CARTER, of 1410 Wende Road, Victoria, British Columbia, do hereby certify that:

1. I am a Consulting Geologist, registered with the Association of Professional Engineers and Geoscientists of British Columbia since 1966.

2. I am a graduate of the University of New Brunswick with B.Sc.(1960), Michigan Technoligical University with M.S.(1962) and the University of British Columbia with Ph.D.(1974).

3. I have practised my profession in eastern and western Canada and in parts of the United States for more than 25 years.

4. The foregoing report is based partly on my background knowledge of the Babine Lake area and on a review and synthesis of reports on a 1993 airborne geophysical survey by R.W. Woolham, P.Eng. and a 1993 petrographic - lithogeochemical study by J.L. Oliver, P.Geo.

N.C. Carter, Ph.D. P.Eng.

Victoria, B.C.
May 5,1994

APPENDIX I

AIRBORNE GEOPHYSICAL SURVEY

APPENDIX II

PETROGRAPHIC AND LITHOGEOCHEMICAL STUDY

I. Assessment of Petrographic Relationships: Surface Outcrop and Drillcore from Nakinilerak Lake.

The data of these thin sections suggests the following:

1. At least four intrusive phases are found on the Nakinilerak Lake property. These include one post-mineral biotite feldspar-porphyry, two phases of syn-mineral biotite feldspar porphyry and one pre or syn-mineral hornblende diorite phase.

2. Four alteration forms are recorded by these sections:

i. Early potassic alteration is well defined by disseminated biotite. Hydrothermal biotite is often finely disseminated throughout the matrix of biotite feldspar porphyry rocks. Most of the disseminated hydrothermal biotite is not associated with secondary potassium feldspar. Small amounts of some secondary potassium feldspar is present within small sulphide rich veins and veinlets.

ii. Quartz-chlorite-calcite and pyrite alteration assemblages, contained in the rock matrix and in individual veins, post-dates most of the potassic alteration and the development of copper sulphides. This assemblage is usually stronger than potassic alteration. This may suggest that many of these exposures have been selected from spatially overlapping and probably slightly distal sites, either laterally or vertically, to the potential mineralized core of this system. Several photomicrographs display distinct crosscutting relations between iron and copper dominant sulphide phases and between potassium and quartz-chlorite-calcite alteration assemblages.

The spatial relationships between alteration patterns may solely indicate the diachronous relationship between later quartz-chlorite-calcite and early potassic alteration systems. It is possible, that a stronger potassic core does not exist, that there is no vertical or lateral zonation and the superposition of alteration styles is a function only of variations in time and not of variations in space.

iii. A sericite - quartz alteration assemblage was identified in a few samples, most particularly in one rock sample, DDH 10-231. This alteration form was not well developed. From these samples, the impression is gained that at Nakinilerak Lake, the transition from Chlorite-Quartz-Calcite-Pyrite to secondary biotite is quite abrupt.

iv. Iron-carbonate, hematite +/- sericite mineral assemblages define the most distal alteration forms found on this property. In addition to being spatially separate, some of this rock alteration appears to be preferentially localized to specific dyke phases. These probably repressnt younger dykes.

3. There is evidence to suggest that more than a single mineralized intrusive complex exists on this property. The area of past drilling may represent one of these centres. Some of the rock alteration effects suggest that a separate mineralized zone is developing to the west of the main occurrence area. A second intrusive centre may flank the eastern side of the south trending valley and drainage system in the west-central portions of this property.

4. The feldspar composition of unaltered BFP at Nakinilerak Lake, An 40-50, corresponds closely to the published information on these intrusions. Similarly, the percentage of free quartz is usually less than 2-3% and primary potassic feldspars are quite rare.

5. The relationships that Carson and Jambor (1974) develop between the intensity, color and distribution of secondary biotite with copper grade may not apply to Nakinilerak Lake. Petrographic characteristics of secondary biotite from the 0.45% Cu cut-off at Morrison Lake was compared with the secondary biotite from the 0.1% Cu contour at Nakinilerak Lake. Although the sample size is limited, there does not seem to be significant differences in the optical characteristics of the two biotite populations.

6. The overall concentration of sulphides at this locale is quite low and dominated by pyrite. Net sulphide concentrations of 3% would be quite high. This system will either never evolve into a productive copper-gold porphyry system or we are sitting on the flanks of one. It is disconcerting that the whole rock values for zinc are typically less than 50 ppm. Flanking distal zinc zones at Granisle are typically above 200 ppm with the main ore zones carrying less than 50 ppm zinc.

7. When chalcopyrite and bornite are best developed, pyrite is much weaker. A ratio of 2:1, copper to iron sulphides, may accurately describe higher grade copper zones. This suggests that some of the best copper targets on this property will have very subtle geophysical signatures.

8. Much of the calcite in these samples is confined to vein and veinlet margins. HCl responses from carbonates locked in the matrix of these samples are produced only with hot acid. This suggests that there is some partitioning between the two carbonate

phases. Carson and Jambor (1974) suggest that iron carbonates are well developed at Bell and Granisle, in peripheral alteration zones, and weakly developed at Nakinilerak Lake. Some of the Nakinilerak Lake samples might suggest otherwise.

II. Assessment of Major and Minor Element Relations: Surface Outcrop and Drillcore from Nakinilerak Lake.

In interpreting these major and trace element plots two data sources are used: (1) 12 whole rock samples collected from the Nakinilerak Lake area and (2) comparison with published and additional unpublished data on other porphyry copper gold occurrences in the Babine Lake area. The following comments are relevant to this data:

Major Element Ratios:

1. The mobility of selected trace elements may be rapidly determined on these graphs. The positive slope and positive intercept, on a best fit by eye regression line, on a P205 vs TiO2 plot suggests that TiO2 is relatively conserved. A similar relationship is seen on a TiO2 vs total iron plot. The presence of conserved and immobile trace elements would permit a quantitative analysis of rock alteration effects on this property.

2. Ternary plots of these data demonstrate that all of the samples selected from this locale have a calc-alkaline petrogenesis. The relatively flat slope, by eye, of total alkalies versus silica, again suggests a calc-alkaline parentage for these rocks.

3. Although these rocks have a calc-alkaline parentage they do exhibit modest alkalic affinities. For those BFP samples which are least altered, the relationship between potassium and silica suggest a chemical affinity with high K - andesites bordering on the field of toscanites. Enhanced gold contents are commonly associated with alkalic copper-gold systems worldwide.

4. Two drillcore samples have been profoundly depleted in alkalies, sample numbers 10-107 and 12-270. These effects are well demonstrated on both total alkali or separate sodium, potassium versus silica plots. The petrographic relations confirm that in both samples all sodic feldspars have been completely replaced by sericite. Profound alkali depletion is the exception rather than the norm.

5. Major element distribution patterns for Nakinilerak Lake compare closely with the major element distribution patterns for 8 to 10 other past producers or occurrences in this district.

Base and Precious Metals Relations

Three points can be made regarding linkages to base and precious metals in the Nakinilerak Lake rock samples. On these figures Nakinilerak Lake samples are plotted as solid symbols and the results of 32 samples from other occurrences in this area are shown as open squares.

1. The strongest positive correlation exists between zinc and gold. This suggests that gold contents are zoned similarly to base metals and enhanced on the periphery to these porphyry systems.

2. The strongest antithetic relationship exists between gold and molybdenum.

3. The relationship between gold and copper is weakly positive for rock samples excluding those selected from Nakinilerak Lake. This may suggest that central core of the Nakinilerak system, where both gold and copper should be enhanced, has not been represented in these samples.

The petrographic and whole rock data opens some exploration opportunities and raises concerns about other areas of this property. The area most intensely worked during the initial evaluation of Nakinilerak Lake may not end up being the best target. Careful assessment of this very large alteration zone, in its entirety, may be required prior to initiating detailed technical or drilling programs.

Photomicrographs:

Scale Criteria

Magnification	Field (photograph long axis)
25X	5.25 mm +/- 0.25mm
50X	2.625 mm +/- 0.125 mm
100X	1.312 mm +/- 0.0625 mm
400X	0.328 mm +/- 0.0156 mm

Sample Number N1

Location: Nak Lake traverse, central property area, due east of the main creek and valley drainage.

Hand Sample

Rock Type: Ankeritic Feldspar Porphyry - Ankeritic Diorite

Alteration: This intrusive rock has been moderately carbonitized. Carbonate replacement, of mafic mineral phases, has been through the assemblage calcite-ankerite-hematite. Plagioclase has been very lightly sericitized.

Oxide and Sulphide Phases: Hematite is disseminated across the rock matrix at moderate 1-2% levels. Pyrite is present in trace amounts primarily associated with ankerite.

Structural Features: There are no significant primary or secondary structural features present in this hand sample.

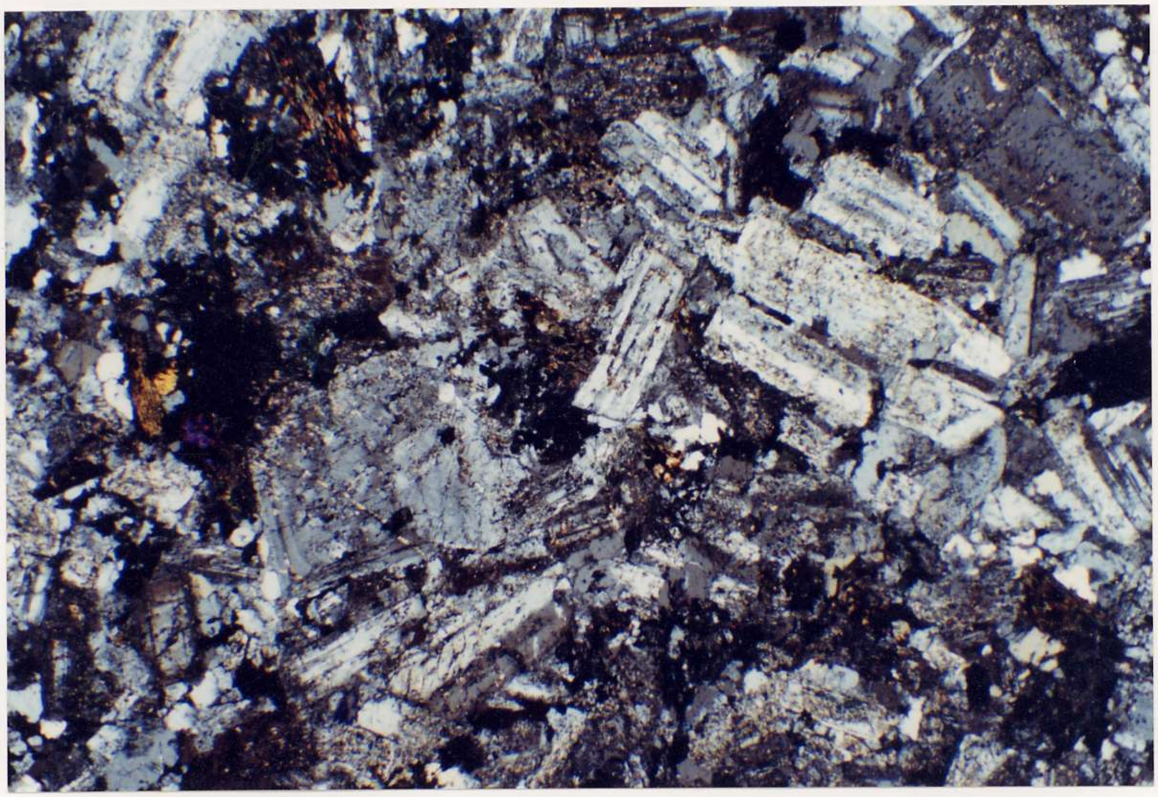
Thin Section

In thin section, this rock appears as a crowded plagioclase rich hornblende diorite. The rock does have a small percentage of free quartz, but it lies below that of a quartz diorite. It did not contain primary biotite. Calcite, chlorite and minor sericite are the principle alteration features. Alteration is not veinlet controlled.

Approximate mineral abundances are:

Chlorite 12% (after hornblende)
Plagioclase 62-64% (An 40)
Clinopyroxene 3-4%
Hematite 1%
Pyrite 2%
Sericite 4-6%
Quartz 4-5%
Calcite +/- iron carbonate 6-8%

Plate 1. 25X Transmitted Light - Crossed Polars. General textural features are shown on this photomicrograph. The style and form of rock alteration is suggestive of regional metamorphic assemblages.



Sample Number N2

Location: The sample is located on the extreme north-eastern limits of the property, distal to any known intrusive contacts.

<u>Hand Sample</u>

Rock Type: Mafic Flow.

Alteration: Primary phenocrysts in this rock have been strongly corroded and replaced by epidote-calcite and hematite. This mineral assemblage loosely resembles distal propylitic alteration. However, it may reflect lower greenschist regional metamorphic mineral stabilities. The occasional pyrite-epidote-calcite veinlet suggests that these mineral assemblages are hydrothermal in origin and not related to the regional metamorphic field.

Oxide and Sulphide Phases: Hematite is present, 10-15%, as uniform disseminations and aggregates across the rock matrix. Pyrite, <0.25%, is restricted to the margins and envelopes of weakly developed microfractures.

Structural Features: The sample has no penetrative rock fabrics. Brittle microfractures are weakly developed in this hand specimen.

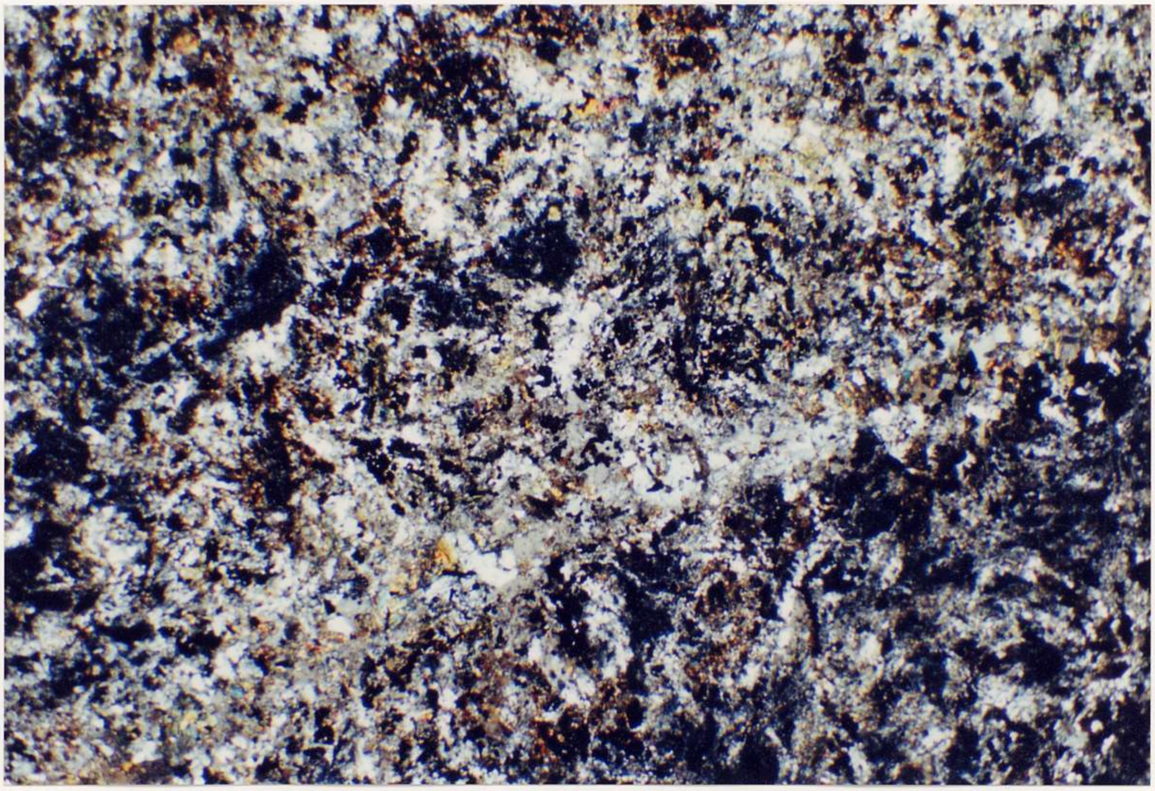
Thin Section

The hydrothermal origin of rock alteration is confirmed in this thin section. The rock protolith is difficult to identify. A weakly porphyritic, feldspar and clinopyroxene, mafic volcanic rock is a likely parent.

Approximate mineral abundances are:

Hematite-goethite (partially replaces clinopyroxene) 8-9%
Magnetite 3-4%
Pyrite 1%
Biotite (secondary) 6-8%
Chlorite (secondary, after hornblende) 10%
Hornblende (primary) 1-3%
Plagioclase 55%
Calcite (may partially replace clinopyroxene) 4-5%
Sericite 7-9%

Plate 2. 25X Transmitted Light, Crossed Polars. The abundant hematite in the rock matrix and the dark black pseudomorphs, relict clinopyroxene, are significant features in this rock. Pyrite is largely constrained to small veinlets, one of which cuts across the lower half of this photomicrograph.



Sample Number N3

Location: North-central diorite-volcanic contact.

Hand Sample

Rock Type: Medium Grained Melano Hornblende Diorite.

Alteration: Rock alteration in this sample is extremely light. Matrix calcite is absent and epidote is limited to irregularly disseminated aggregates. Amphiboles are generally intact.

Oxide and Sulphide Phases: Pyrite, 1%, is present as disseminated aggregates and knots across the rock matrix. It does not have a strong vein or fracture control.

Structural Features: Early ductile shear veinlets are present in this rock. These vein forms likely predate mineralization in this area.

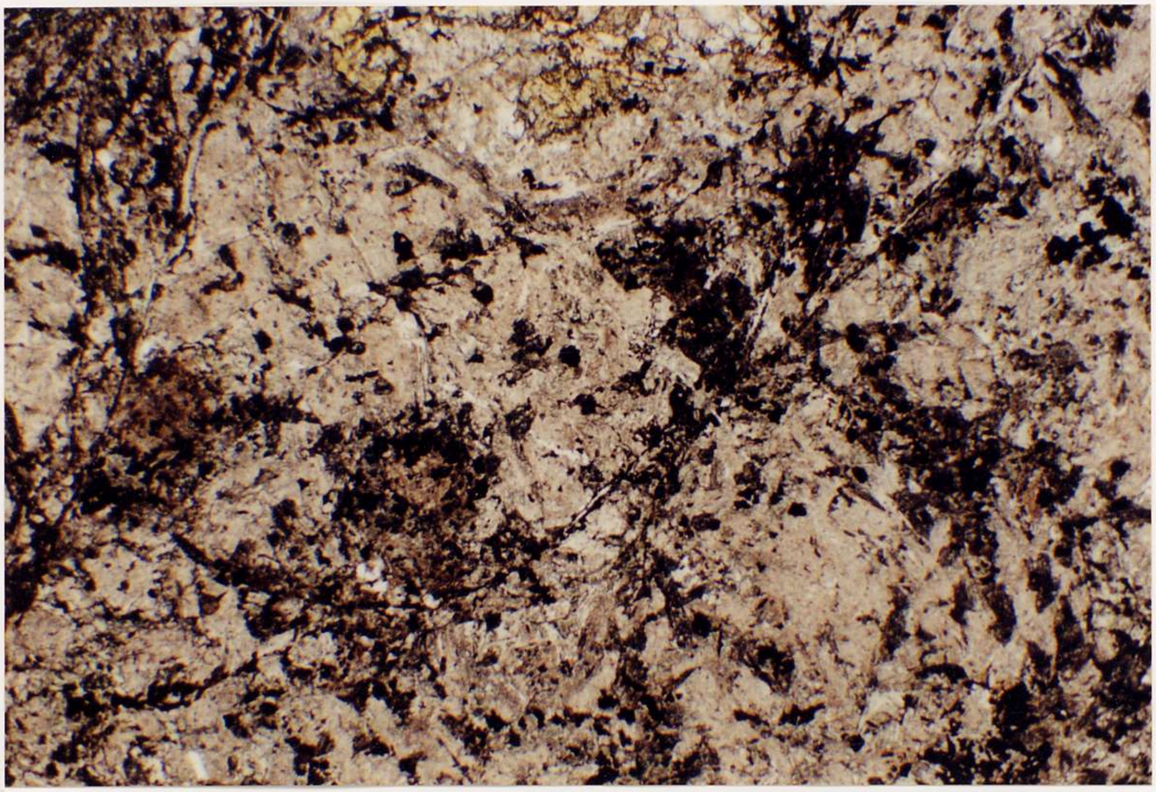
Thin Section

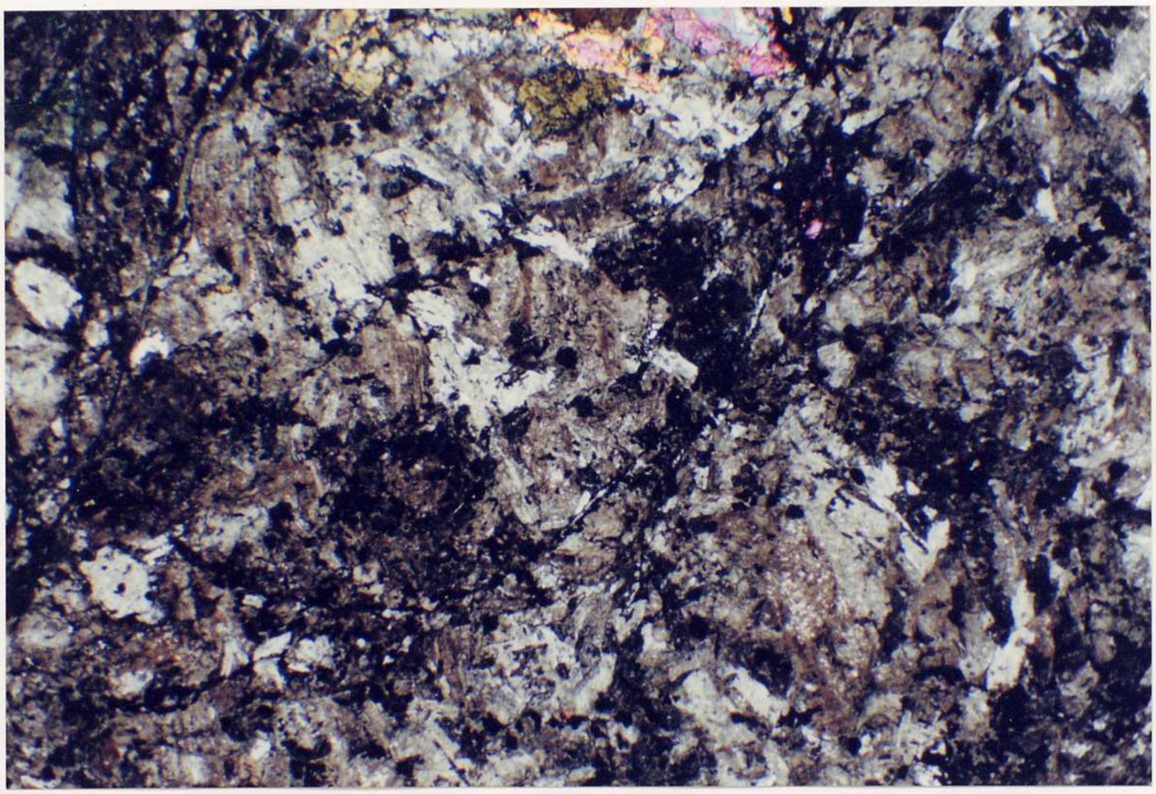
The thin section of this sample clearly indicates that the overall level of alteration has been grossly underestimated by the hand sample. All amphiboles have been replaced by an iron poor chlorite. The only primary mafic minerals are pyroxenes. Sericitization of feldspars and moderate to strong development of matrix carbonate destroys many primary rock features. The rock protolith was originally a hornblende diorite. Ductile shear structures likely pre-date regional metamorphism.

Approximate mineral abundances are:

Sphene trace
Clinopyroxene 2-3%
Chlorite (replaces hornblende) 25%
Plagioclase 55%
Sericite 3-5%
Pyrite 0.5%, rims clinopyroxene
Hematite 5-6%
Zoisite 1%
Iron-magnesium carbonates 5%

Plate 3 and 4. 25X Transmitted Light, Plane and Crossed Polars. A brittle ductile fracture is shown cutting the left hand corner of these plates. An aggregate of plagioclase, zoisite and pyrite is shown on the upper centre of the field of view.





Sample Number N5

Location: The north-south trending ridge due east of main creek drainage.

Hand Sample

Rock Type: Ankeritic Hornblende Diorite

Alteration: All mafic phases have been replaced by orange carbonates. Most of these have been pseudomorphed after hornblende. A few, 2-4%, of the orange pseudomorphs are larger and may represent ankerite replacing biotite. Feldspars have been replaced by light green sericite.

Oxide and Sulphide Phases: Traces of pyrite remain in this highly oxidized sample. Hematite is not present.

Structural Features: There are no significant fractures or brittle failures. This rock has a weak primary hornblende flow foliation.

Thin Section

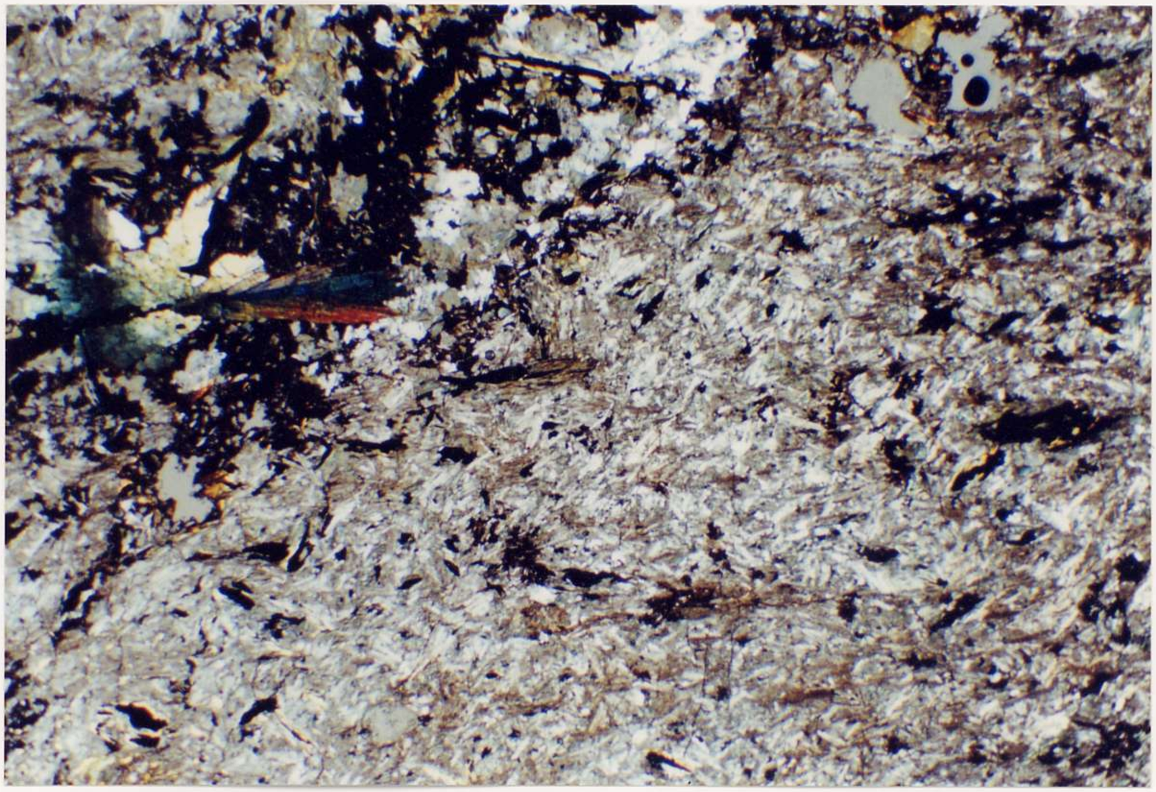
The rock matrix is composed of crowded small feldspar microliths. The sample has been selected from a strongly altered extrusive volcanic rock. This locale may be close to a significant structural zone. Many of the feldspar lathes and chlorites display partial development of a crenulation cleavage.

This sample could represent the pyritic fringe to the main mineralized zone at Nakinilerak Lake.

Approximate mineral abundances are:

Chlorite (replaces hornblende) 20%
Brown opaques, after ankerite?, 12-14%
Plagioclase 55%
Epidote, after clinopyroxene, 3-5%
Hematite 3-4%
Goethite 1-2%
Pyrite 1%
Sericite (partially replaces plagioclase) 6-8%
Quartz 1-2%

Plate 5. 25X Transmitted Light, Crossed Polars. Radiating lathes of epidote cut residual iron carbonates. The fine grained nature of the plagioclase in the rock matrix, and its weak crenulation cleavage, is well demonstrated in this photograph.



Sample Number N6

Location: Due east of central drainage, northwest of the abandoned Nak Lake drill camp.

<u>Hand Sample</u>

Rock Type: Carbonitized Biotite Feldspar Porphyry

Alteration: Orange brown iron carbonates have selectively replaced most of the feldspar phenocrysts within this rock. Matrix feldspar has been largely replaced by calcium carbonate. Mafic phases, principally biotite and hornblende have been moderately chloritized. Biotite may be preferentially sulphidized by both chalcopyrite and biotite.

Oxide and Sulphide Phases: Pyrite (1.5%) and chalcopyrite (0.25%) are uniformly disseminated across the rock matrix. The distribution of these sulphides is not controlled by stockworks or microfractures. They are replacements of mafic minerals.

Structural Features: The sample is non-foliated and does not display any brittle or ductile features.

Thin Section

The thin section of this sample suggests that it is a chloritized and carbonitized biotite feldspar porphyry. All primary biotite has been replaced by chlorite. There is no secondary biotite in this sample. Amphiboles have also been replaced by chlorite. This sample has a relatively fine grained matrix and is likely to have been emplaced at shallow crustal levels.

Approximate mineral abundances are:

Brown semi-opaques, after ankerite, 5%
Chlorite, after biotite, 6-8%
Chlorite, after hornblende, 10%
Sericite, partially replaces plagioclase, 15-17%
Quartz 6-7%
Plagioclase 50%
Chalcopyrite 0.5%
Pyrite 0.75%
Hematite 1%
Goethite 1%

Plate 6. Reflected Light, 50X. Both chalcopyrite and pyrite in this thin section replaces either biotite or hornblende.

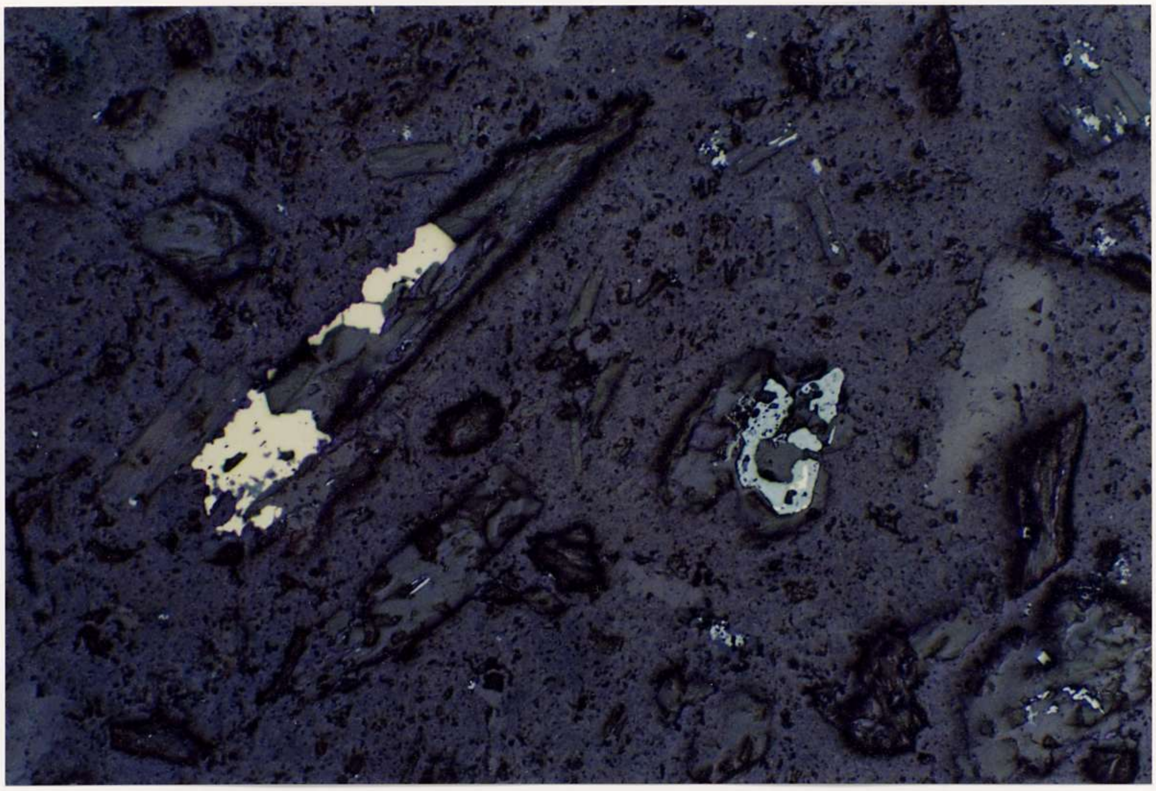
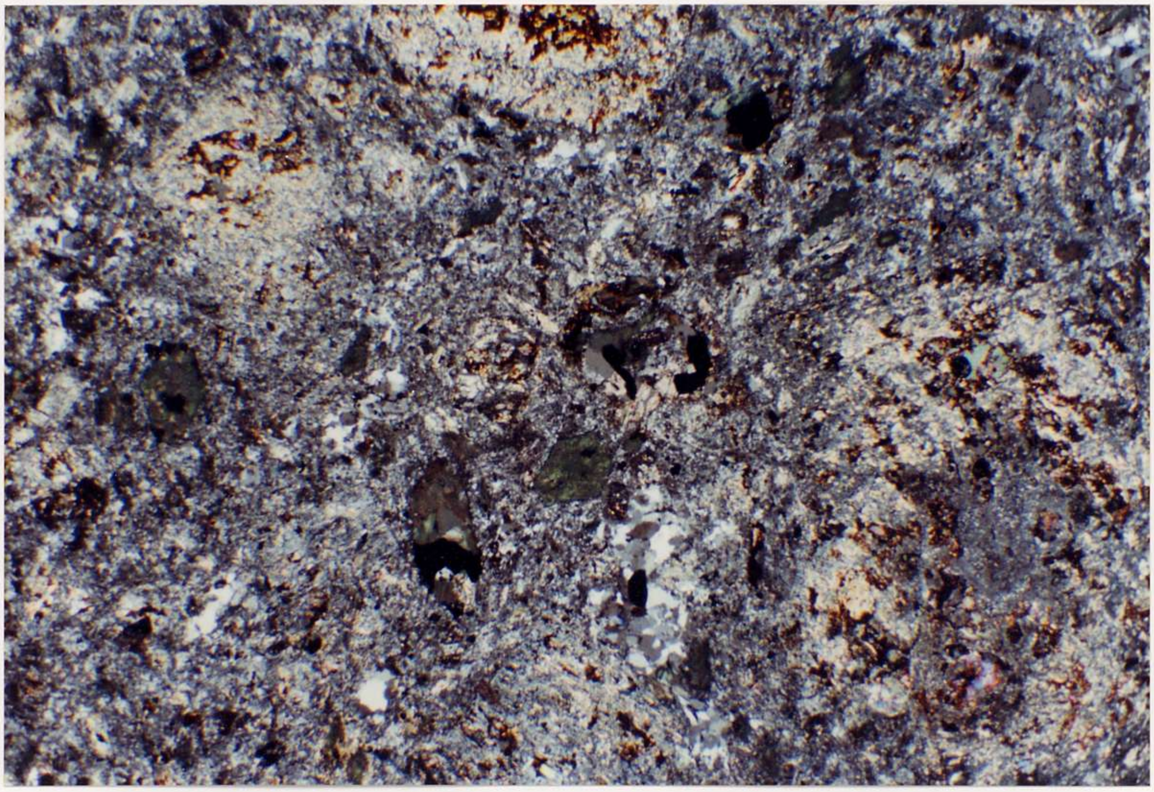


Plate 7. Transmitted Light, Crossed Polars, 25X. Pseudomorphs of biotite, completely replaced by chlorite, are present near the centre of the field in this photomicrograph.



Sample Number NK U1

Location: Indeterminent footage in an abandoned AQ borehole, main drill camp.

<u>**Hand Sample**</u>

Rock Type: Carbonitized Biotite Feldspar Porphyry (BFP)

Alteration: This BFP rock has been only very lightly altered. Most of the fine grained biotite in the rock mass is primary in origin as are the coarser euhedral biotite phenocrysts. The rock matrix contains 4-5% calcite and amphiboles have been lightly sericitized. No other alteration is present in this rock.

Oxide and Sulphide Phases: Sulphide and oxide phases are absent in this sample.

Structural Features: Matrix biotite shows a weak primary igneous flow foliation. There are no other penetrative or non-penetrative rock fabrics.

Thin Section

The thin section is representative of a very fresh biotite feldspar porphyry rock. None of the biotite in the rock is secondary.

Approximate mineral abundances are:

Hematite <0.5%
Magnetite 0.5%
Calcite 3-4%
Plagioclase An 45-50, 65-68%
Quartz 3-4%
Orthoclase 1-2%
Biotite 15-18%
Sericite 2-3%
Apatite 1-2%

Plate 8. 25X Transmitted Light, Crossed Polars. This BFP rock represents a late post-mineral phase. It has not been affected by any significant form of hydrothermal alteration.

Sample Number NK-U2

Location: Indeterminent footage in abandoned AQ core, main camp area.

Hand Sample

Rock Type: Leuco Quartz Feldspar Biotite Porphyry

Alteration: Potassic microveinlets are cored by dark brown to black secondary biotite. All primary mafic minerals have been altered to chlorite +/- carbonate. No primary hornblende or biotite is left in this sample. Plagioclase has remained relatively intact. Albite twins are still obvious in thin section, although patches of sericite +/- albite do appear to be present. The rock matrix is weakly carbonitized.

Oxide and Sulphide Phases: These veinlets may carry traces of chalcopyrite and pyrite. Hematite is disseminated at low levels across the rock matrix.

Structural Features: Brittle veins and veinlets are well developed. No penetrative rock fabrics are present.

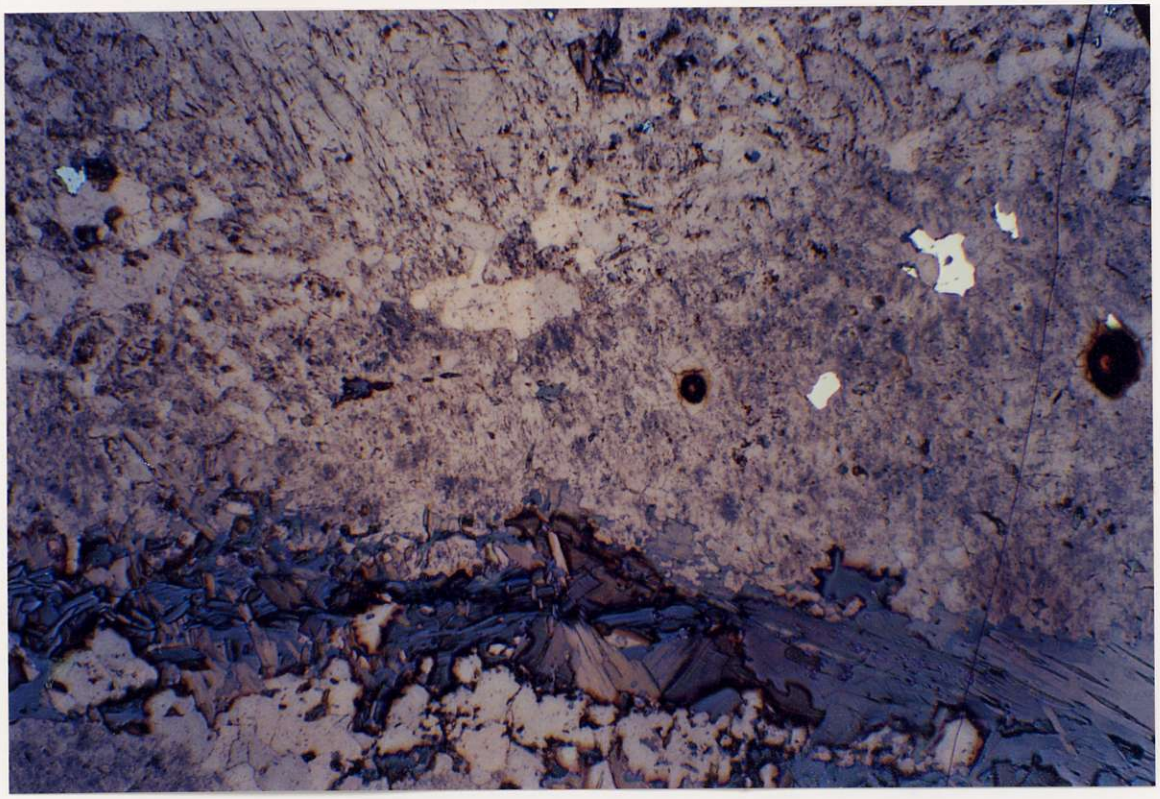
Thin Section

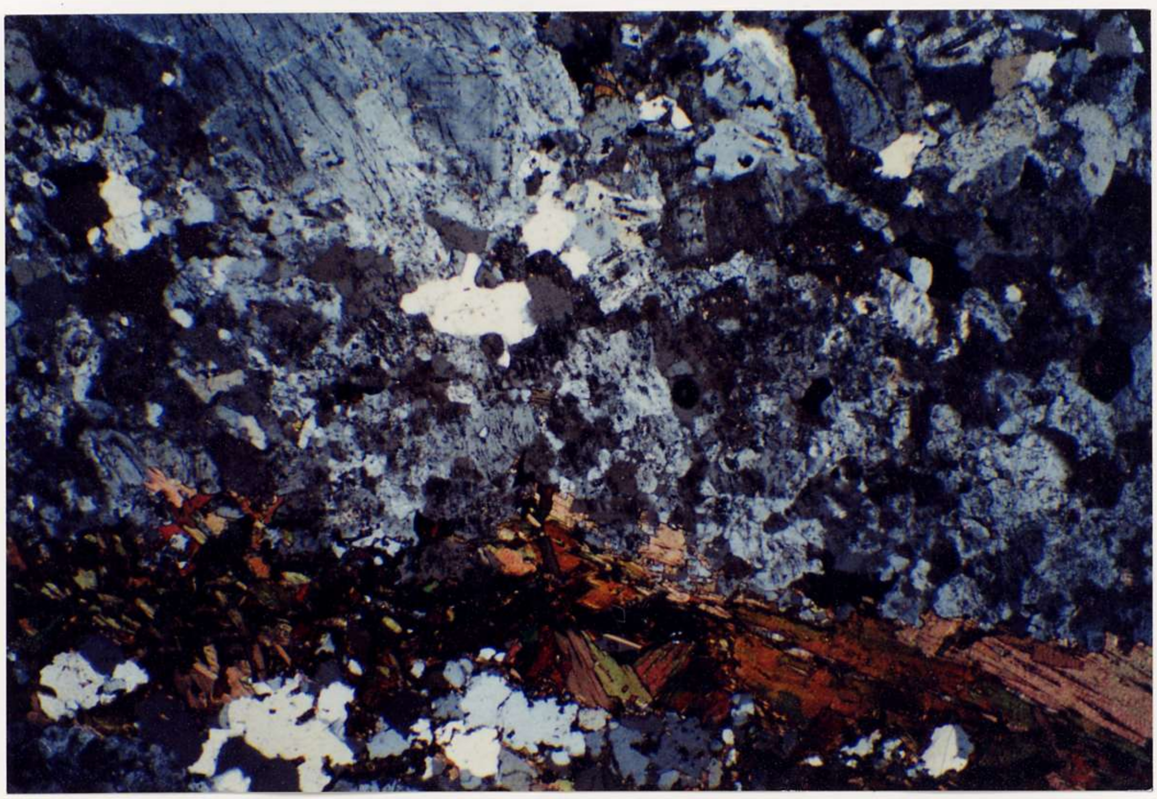
This thin section contains a significant amount of secondary biotite. It is distributed throughout the rock matrix and may replace hornblende and primary biotite. Secondary biotite is often enveloped by calcite. Feldspars have been weakly sericitized.

Approximate mineral abundances are:

Plagioclase 55%
Quartz primary 6%
Quartz secondary 8-10%
Biotite primary 3-5%
Biotite secondary 10-12%
Calcite 4-5%
Orthoclase secondary 3-4%
Pyrite 0.5%
Chalcopyrite < 0.25%
Apatite trace
Sericite 3-5%
Magnetite 1%

Plate 9 and 10. 25X Reflected and Transmitted Light, Crossed Polars. A potassic veinlet cuts across a lightly altered biotite feldspar porphyry. The veinlet is cored by hydrothermal biotite and is enveloped by orthoclase. Small amounts of chalcopyrite and pyrite are associated with the potassic selvedge to this vein.





Sample Number NK U4

Location: Unidentified borehole and footage, abandoned AQ core Nak Lake camp area.

Hand Sample

Rock Type: Chloritized Hornblende Diorite

Alteration: This sample has been affected by (1) strong carbonitization of the rock matrix and by (2) moderate chloritization of mafic minerals. Chlorite is also present in the interiors and as selvedges to early microveinlets and brittle fractures. Weakly developed silica-calcite veins post-date matrix carbonitization.

Oxide and Sulphide Phases: Molybdenum rosettes (0.5%) and traces of chalcopyrite are associated with silica-caloite veins. These minerals are not disseminated in the rock matrix.

Structural Features: A weak tectonic, or primary, foliation produces partial alignment of chloritized amphiboles. This feature is vaguely reminiscent of older intrusions, for example Topely intrusions. Veinlets to 1.0 cm., in diameter, post-date and cut early chloritized microfractures.

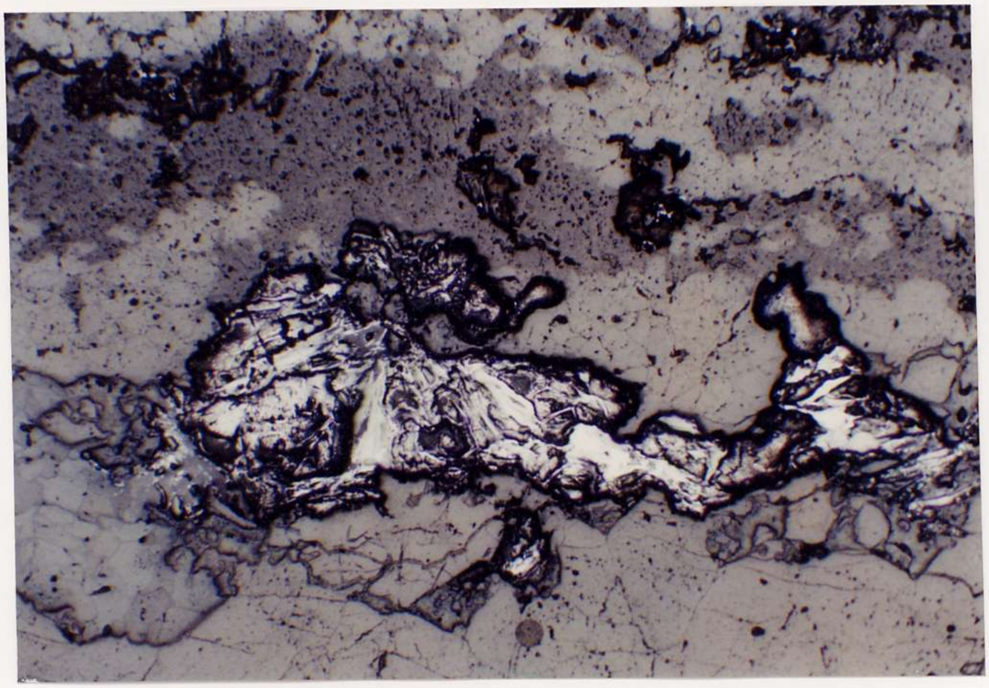
Thin Section

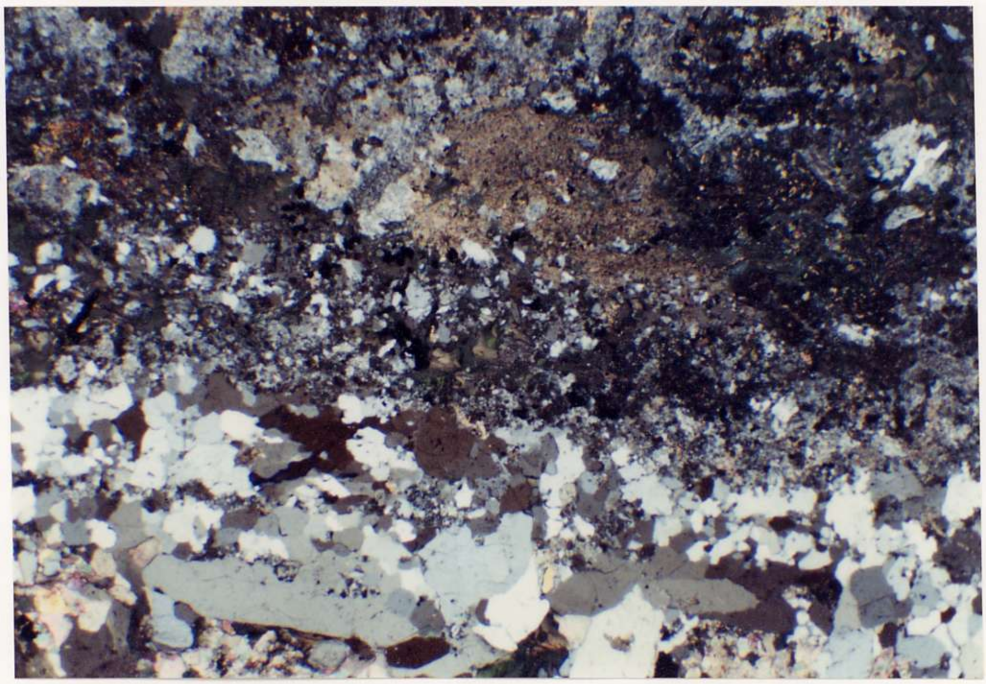
In thin section, the rock is dominated by moderately to strongly sericitized feldspars and by abundant chlorite. There is no secondary biotite or secondary feldspar. The rock matrix has also been strongly altered by quartz and calcite. Molybdenum and traces of chalcopyrite are found internal to 1.0 cm wide quartz-calcite veins. Small amounts of hematite are disseminated throughout the rock matrix. There are no biotite pseudomorphs. It is unlikely that this rock, in it's unaltered state, would have been a biotite feldspar porphyry.

Approximate mineral abundances are:

Chlorite (replaces hornblende) 15-18%
Sericite (replaces plagioclase) 22-25%
Plagioclase 25-30%
Calcite 15-17%
Quartz (secondary) 15%
Molybdenum <0.25%
Hematite 0.5%
Chalcopyrite tr
Sphalerite tr
Rutile 0.5%

Plate 11 and 12. 25X Reflected and Transmitted Light. Molybdenum aggregates are constrained by quartz calcite veins, Plate 11. Contact relations between quartz-calcite-chlorite veins and the host diorite are shown on Plate 12.





Sample Number DDH 10-107

Hand Sample

Rock Type: Ankeritic Feldspar Porphyry - Ankeritic Diorite. This rock appears to have no free quartz.

Alteration: The rock has been pervasively sericitized and carbonitized. Abundant plagioclase feldspar, within the rock matrix, has been strongly sericitized. All mafic mineral phases have been replaced by ankerite. Carbonitization may post-date the development of sericite. Some previously sericitized feldspar is replaced by iron carbonate.

Oxide and Sulphide Phases: Very finely disseminated pyrite (0.5%) and hematite (1.0%) are the sole oxide and sulphide phases.

Structural Features: No penetrative rock fabrics. Brittle microfractures are weakly developed.

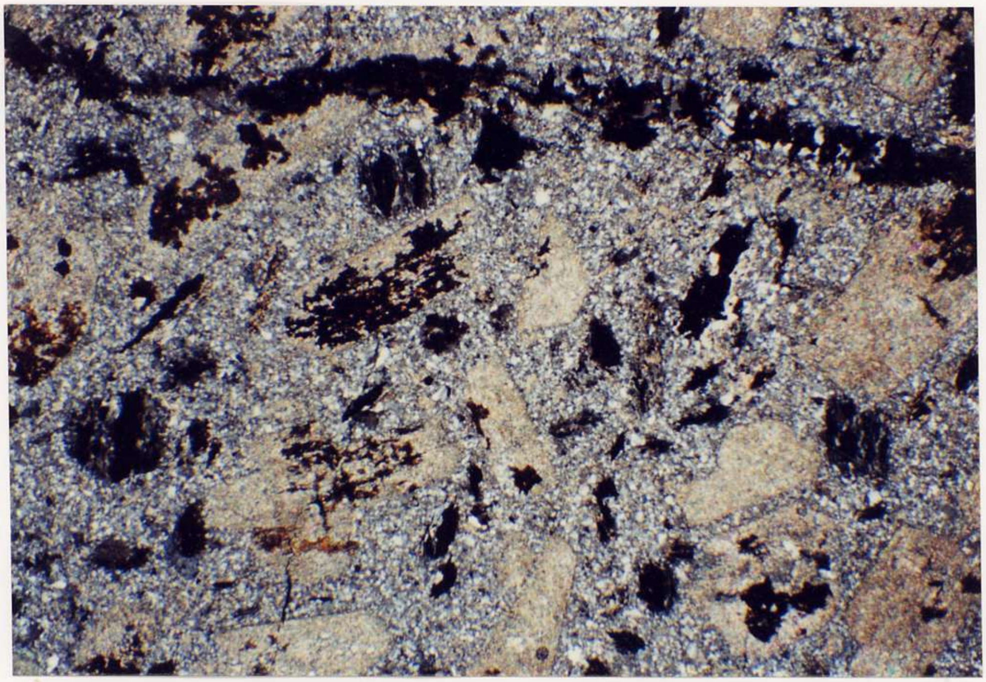
Thin Section

Although this rock has been pervasively altered, primary textures are preserved. The rock protolith was a crowded feldspar +/- biotite porphyry. All feldspars have been completely replaced by sericite. Ankeritization postdates and overprints the development of sericite. The rock matrix has been strongly replaced by secondary quartz. There may be secondary potassic feldspar embayed within the very fine grained quartz of the rock matrix.

Approximate mineral abundances are:

Sericite, replaces plagioclase, 40%
Quartz, secondary, 30%
Brown semi-opaques and iron carbonates 20%
Zoisite 1%
Zircon tr
Pyrite 0.5%
Hematite 1.0%
Orthoclase, secondary, 5-10% ?

Plate 13. 25X Transmitted Light Crossed Polars. The strongly porphyritic nature of this rock has been retained under relatively strong sericitization. A primary biotite phenocryst has been replaced by iron carbonates and is visible on the extreme left central portion of this photomicrograph.



Sample No. DDH 10-231

<u>Hand Sample</u>

Rock Type: Melano Quartz Biotite Porphyry. Pervasive rock alteration makes recognition of the original rock type difficult.

Alteration: This sample contains two overprinting rock alteration forms. It has been strongly potassically altered. This alteration form is represented primarily by secondary biotite. Greater than 30% of the rock mass appears to be secondary biotite.

Early potassic alteration has been overprinted by late carbonitization and the development of stockwork pyrite-ankerite-quartz and calcite microveinlets.

Oxide and Sulphide Phases: 4-5% pyrite is hosted by stockworks (4%) and is disseminated throughout the rock matrix (1%). Magnetite, in trace amounts, is found associated with pyritic microveinlets.

Structural Features: Anastomosing and sheeted pyritic microveinlets are common. The intrusive rock does not have any other internal fabrics.

Thin Section

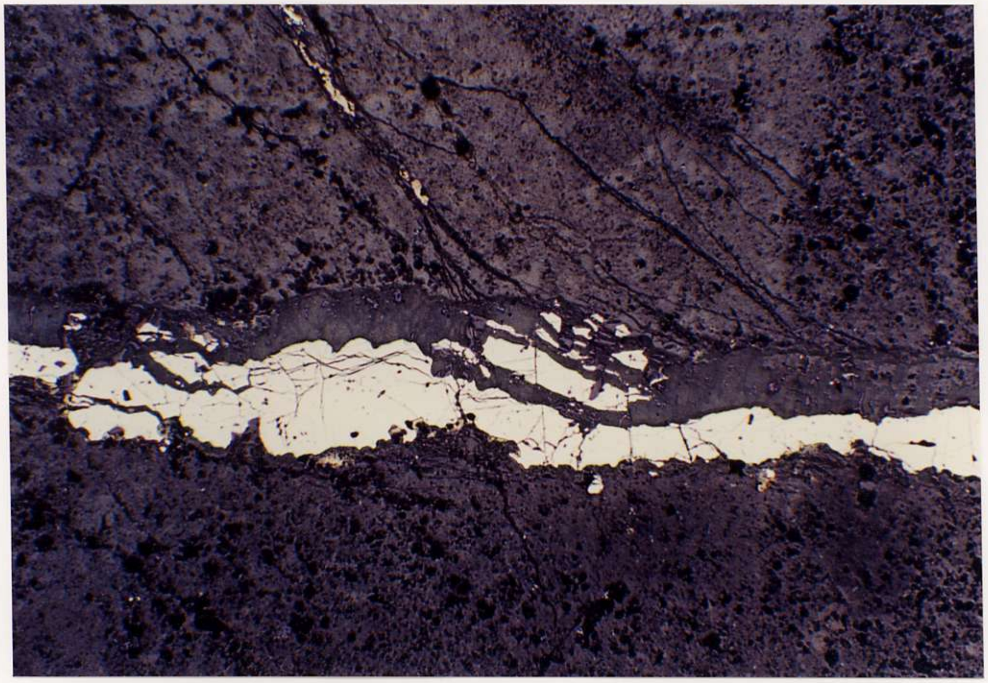
Portions of this thin section have undergone strong, and texturally disruptive, rock alteration. In limited areas of the slide the rock protolith may conclusively be identified as a feldspar +/- biotite porphyry. Rock alteration is dominated by secondary quartz, sericite and abundant fine grained hydrothermal biotite. The coler of the seoondary biotite is medium brown in plane polarized light. It compares closely with the hydrothermal biotite noted at Morrison Lake, but is somewhat finer grained.

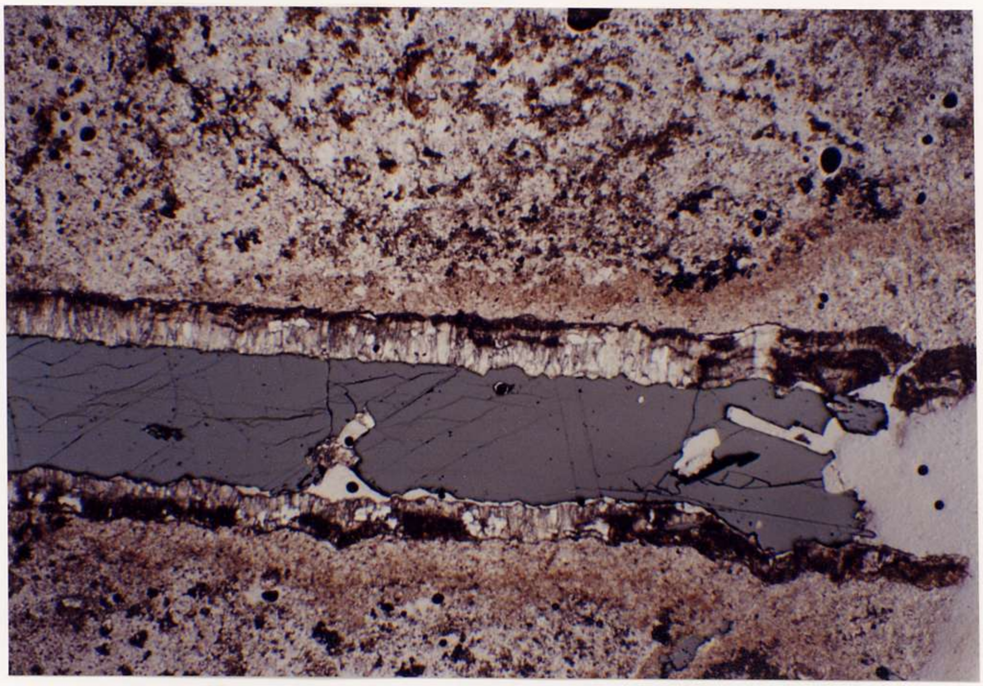
Pyrite, chalcopyrite and bornite are hosted by quartz rich sheeted veinlets and disseminated throughout the rock matrix. Pyrite is dominant in sheeted veins. Chalcopyrite and bornite are typically disseminated and lack a vein association. Pyritic veins post-date the development of secondary biotite.

Approximate mineral abundances are:

Biotite, secondary, 15-18%
Quartz, secondary, 30%
Albite, secondary, 5%
Orthoclase, secondary, 5%?
Sericite, secondary, 10-12%
Pyrite 3%
Chalcopyrite 0.5%
Bornite <0.25%
Hematite tr
Goethite <0.25%
Plagioclase 28-30%
Apatite tr
Calcite 2-3%
Brown semi-opaques 1%
Magnetite 0.25-0.5%
Rutile tr

Plate 14 and 15. Transmitted and Reflected Light, 25X. Discordant relations between early chalcopyrite veinlets and later pyrite veinlets are shown on Plate 14. Crosscutting relationships between early matrix potassic alteration and vein related sericitization are shown under plane polarized light in Plate 15.





Sample Number DDH 12-102

Hand Sample

Rock Type: Melano Quartz Biotite Porphyry

Alteration: Two alteration forms are present in this rock sample. The rock matrix has been strongly potassically altered. This alteration form is represented by secondary biotite. Early potassic alteration is overprinted by calcite-ankerite-quartz-chlorite-pyrite veins. Weak evidence suggests some brown hydrothermal biotite is forming weakly restrained selvedges to these quartz-carbonate veins.

Oxide and Sulphide Phases: Disseminated and stockwork controlled pyrite (2%), hematite <0.5%.

Structural Features: Stockwork microveinlets common. No penetrative rock fabrics.

Thin Section

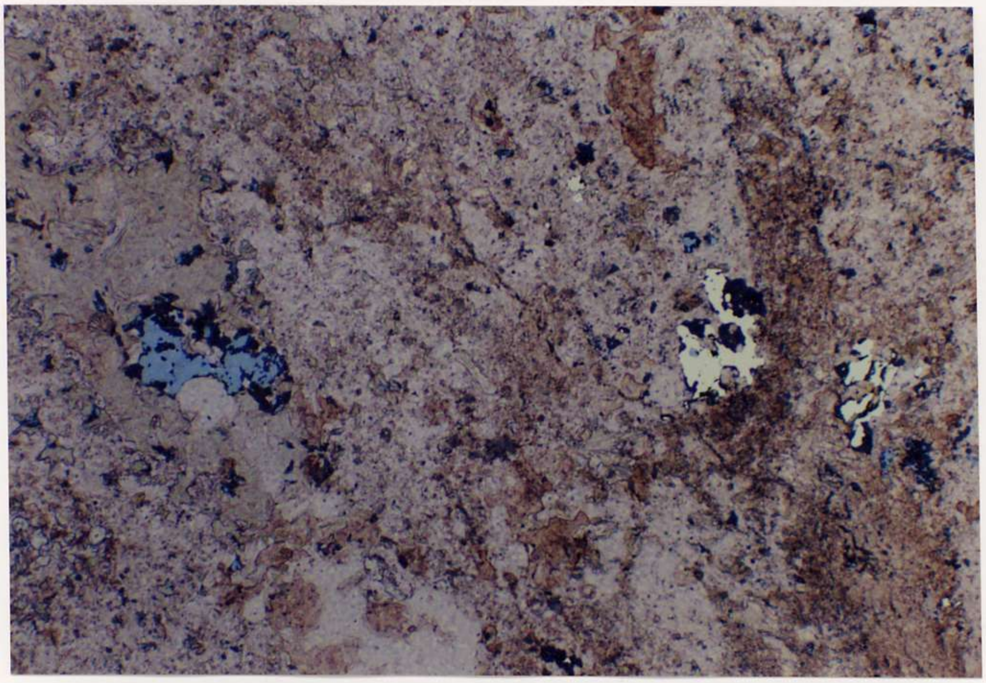
In thin section, secondary biotite is present in this sample. It tends to be very fine grained and only moderate to weak in its intensity. Much of the rock alteration is texturally destructive and consists of a combination of strong chloritization, hematization and quartz injection. The development of sericite, biotite and calcite are subordinate alteration forms.

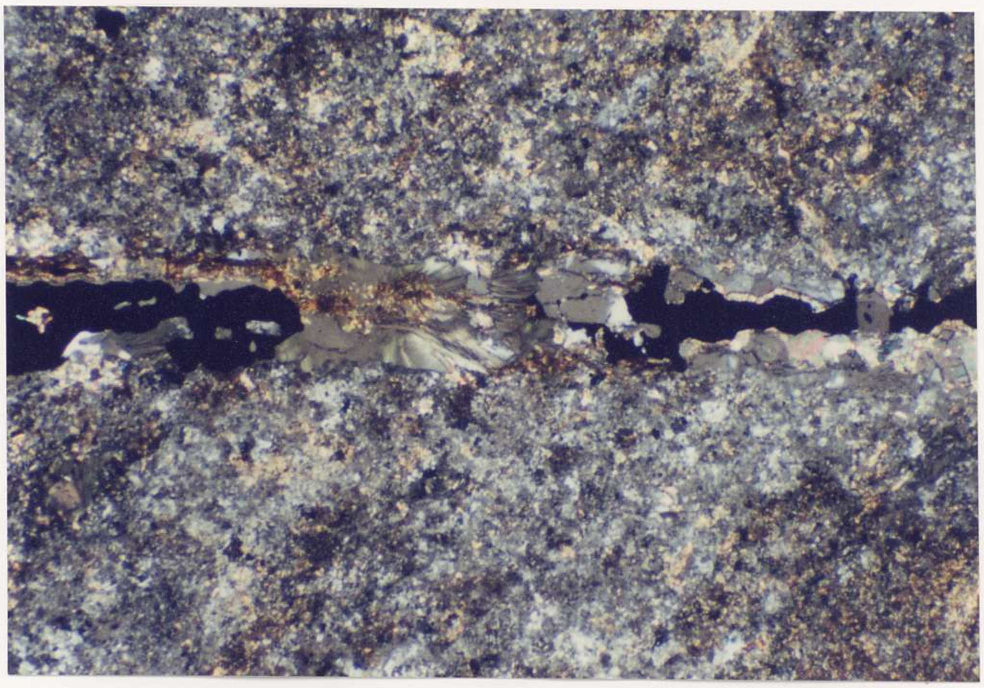
The rock is strongly feldspar porphyritic. All primary mafic phases have been destroyed by alteration processes. Most of the pyrite +/- chalcopyrite veinlets in this sample post-date the development of secondary biotite and are more typically associated with a quartz-sericite-chlorite mineral assemblage. Traces of sphalerite may also be associated with these veins.

Approximate modal abundances are:

Hematite, after mafics, 3-4%
Magnetite, 5-6%
Pyrite 2%
Chalcopyrite 0.25%
Sphalerite trace
Plagioclase 25%
Sericite, replaces plagioclase, 15%
Quartz, secondary, 10-11%
Quartz, primary, 2-3%
Biotite, secondary, 5-7%
Chlorite 7-9%
Calcite 8-10%
Sphene trace

Plate 16 (100X) and 17 (25X). Reflected and Transmitted Light. Both sphalerite, left field and chalcopyrite aggregates, right field, are visible on Plate 16. Both sulphide minerals have a strong association with quartz-chlorite veinlets. Chalcopyrite and pyrite are again shown sharing a common vein system, which has a chlorite-quartz gangue mineralogy, Plate 17 .





Sample Number DDH 12-240

Hand Sample

Rock Type: Medium Grained Quartz-Biotite-Feldspar Porphyry

Alteration: This sample is effectively unaltered. It may represent a late phase post-mineral biotite feldspar porphyry. Very slight matrix carbonate is the only significant alteration. This does not appear to be hydrothermal in origin. Unlike the other BFP samples, biotite in this sample is primary. Twin planes are preserved in plagioclase phenocrysts. Hornblende phenocrysts have been slightly chloritized.

Oxide and Sulphide Phases. Hematite (0.5%) as a primary oxide phase.

Structural Features: No primary or secondary structural features are present in this medium grained non-foliated intrusive.

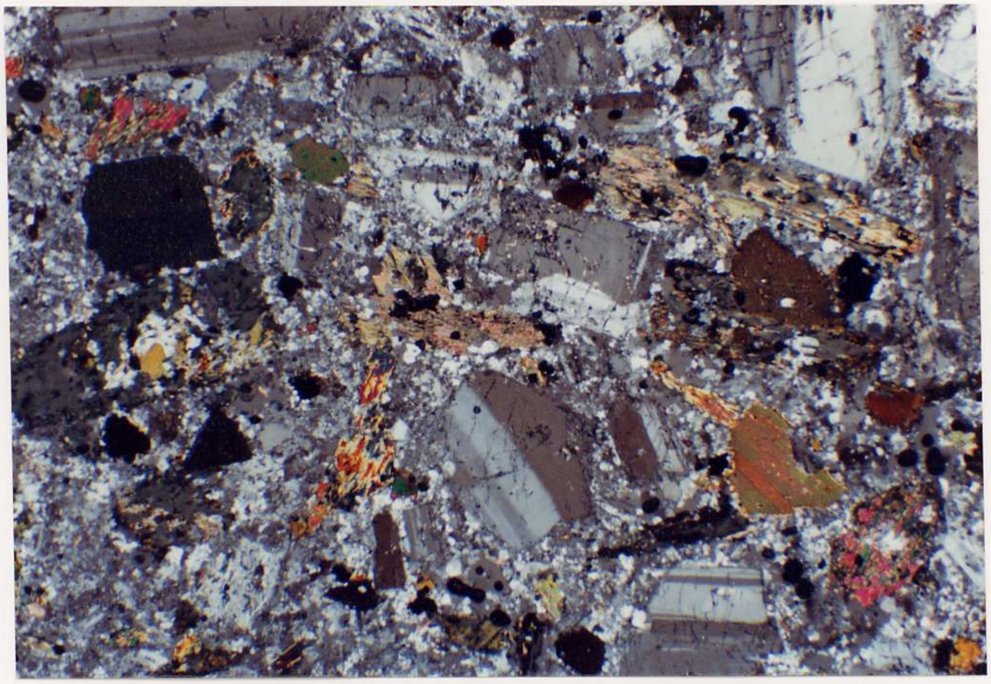
Thin Section

This biotite feldspar porphyry rock has experienced very limited rock alteration. The rock matrix has been very lightly altered by calcite. Hornblende phenocrysts are either intact or have been very lightly chloritized. Primary biotite is unaltered. Magnetite and hematite are the sole oxide phases.

Approximate modal analysis:

Biotite 8-10%
Hornblende 6-8%
Chlorite, after hornblende, 3-4%
Plagioclase, An 40, 55-60%
Quartz 6-7%
Orthoclase 4-5%
Sericite, after feldspar, 5-6%
Calcite 2-3%
Magnetite 2%
Hematite 0.5%

Plate 18. 25X Transmitted Light - Crossed Polars. The intact form of all phenocrysts is easily identifiable in this thin section.



Sample Number DDH 12-270

Hand Sample

Rock Type: Ankeritic Feldspar Porphyry - Ankeritic Diorite

Alteration: The hand sample is light creamy-buff in color. All mafic minerals in the rock matrix have been replaced by iron carbonate and hematite. Matrix feldspars have been slightly sericitized or albitized. No primary feldspar twin planes are visible.

Oxide and Sulphide Phases: Finely disseminated hematite, 0.5%; and trace amounts of disseminated pyrite are the principle sulphide and oxide phases in this sample.

Structural Features: Brittle microfractures, locally with open space textures, are weakly developed.

Thin Section

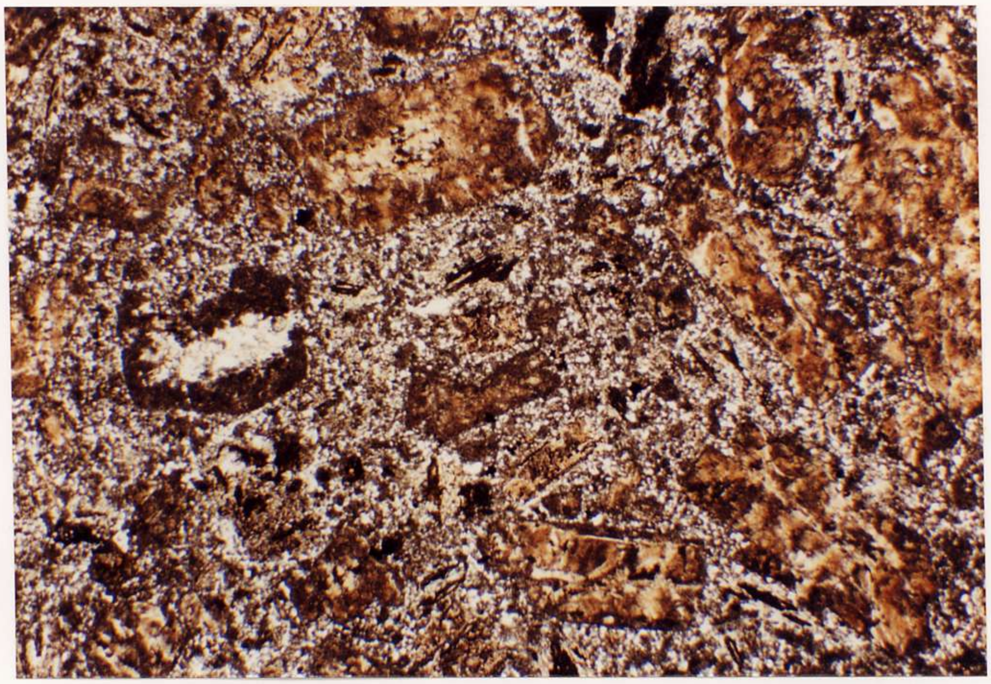
The rock sample has been pervasively carbonitized. Iron carbonates and brown opaques have replaced all of the coarse grained phenocryst phases. The rock matrix has been replaced by quartz. Quartz is also present as small veinlets. The form of the pseudomorphs suggests the original rock type was a biotite feldspar porphyry.

Pyrite is weakly disseminated throughout the rock matrix and is sometimes associated with small quartz sericite veins.

Approximate mineral abundances are:

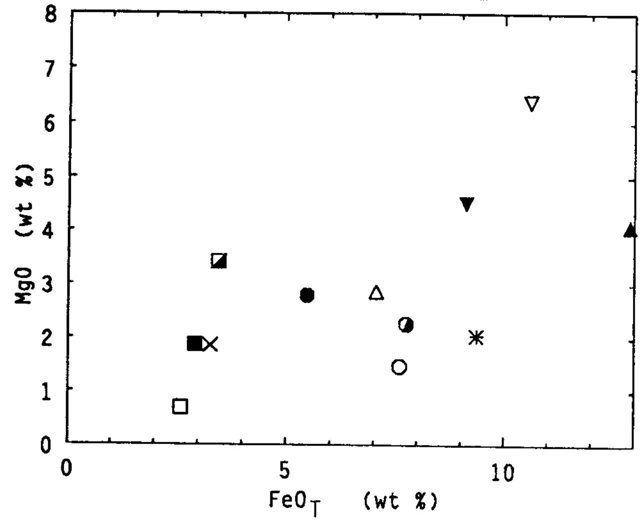
Sericite 2-3%
Quartz, secondary, 15-18%
Brown semi-opaques and iron carbonates 70-75%
Calcite 3-4%
Pyrite 1-2%
Hematite 0.5%

Plate 19. 25X Transmitted Light, Plane Polarized. Pervasive carbonitization, buff semi-opaques, is the principle feature on this thin section. This relatively strong alteration form has been texturally retentive.

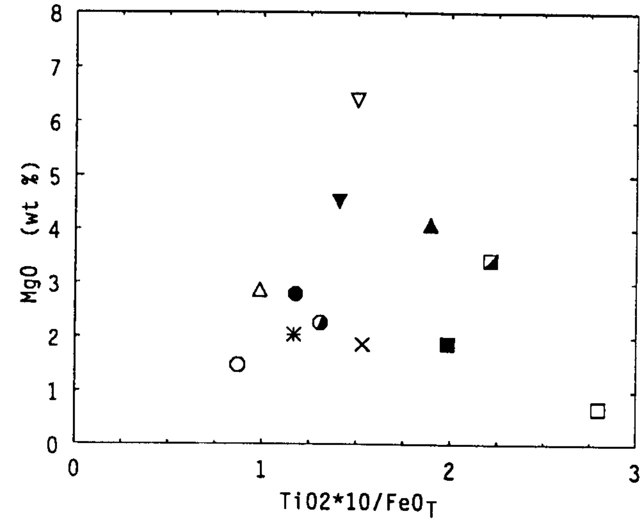


MAJOR ELEMENT RELATIONS:

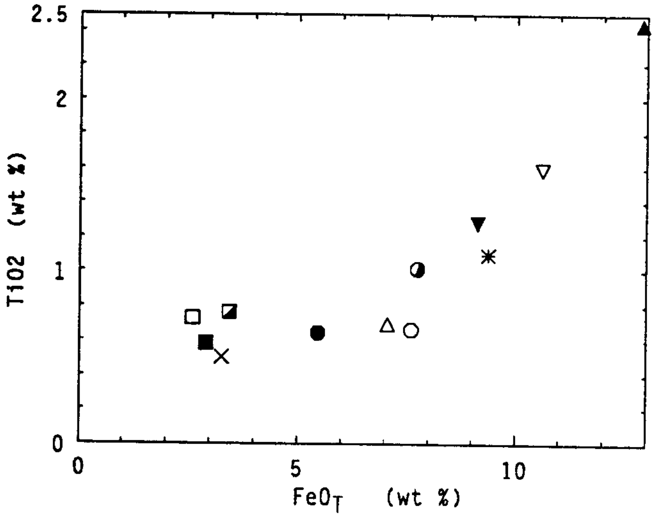
MgO vs FeO_T



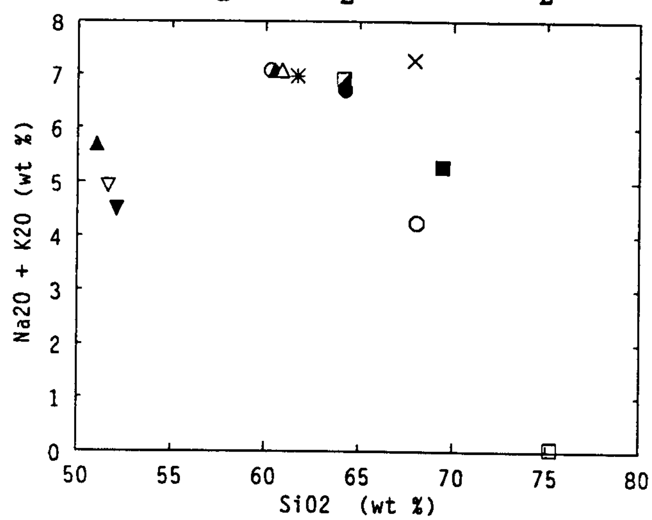
MgO vs 10 X TiO_2 /FeO_T



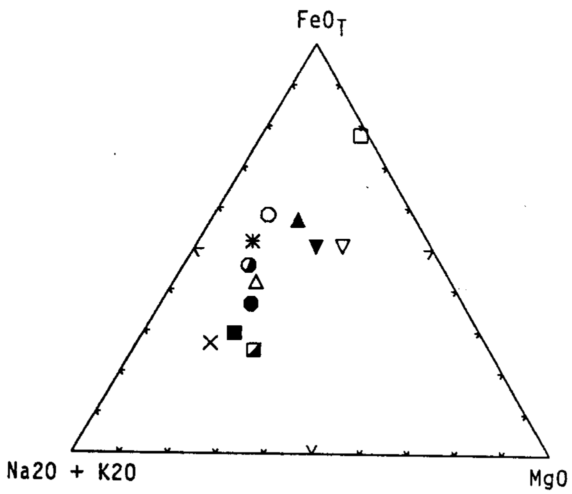
TiO_2 vs FeO_T

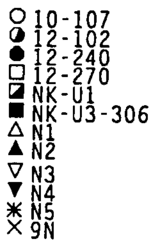


$Na_2O + K_2O$ vs SiO_2



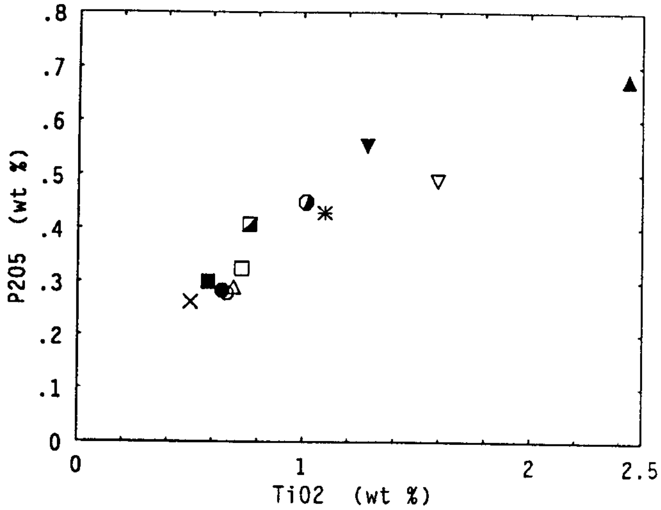
$Na_2O + K_2O$ vs FeO_T vs MgO



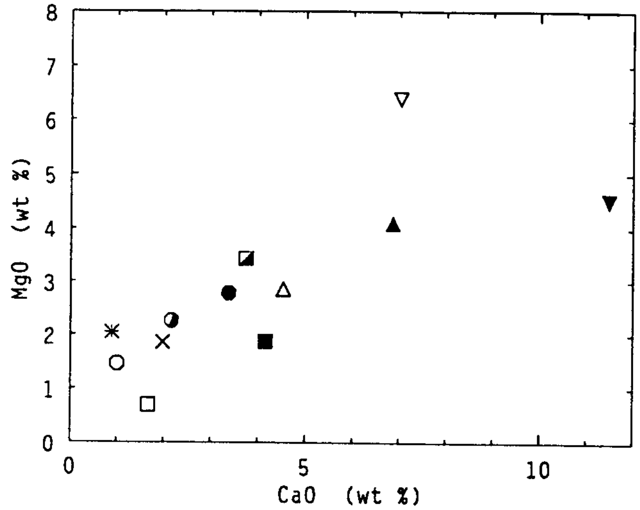


MAJOR ELEMENT RELATIONS

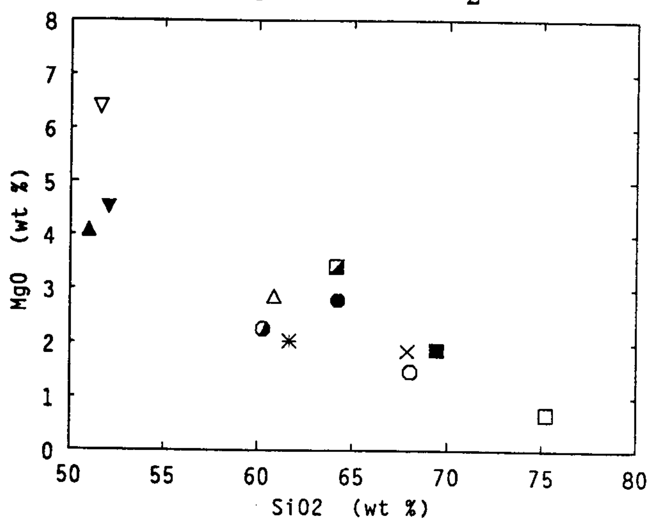
P_2O_5 vs TiO_2



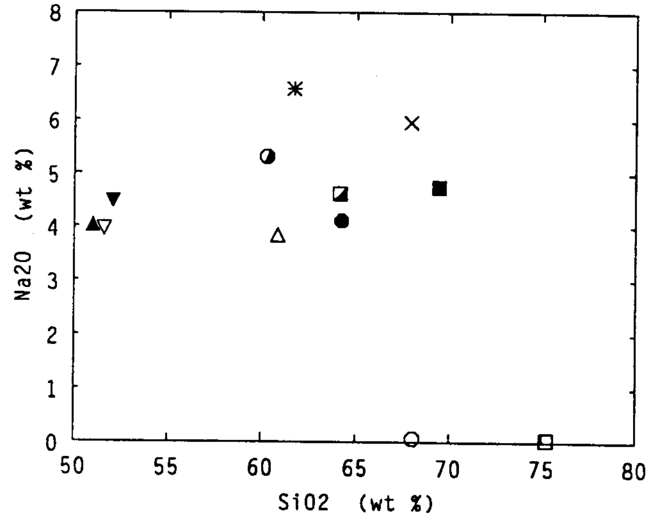
MgO vs CaO



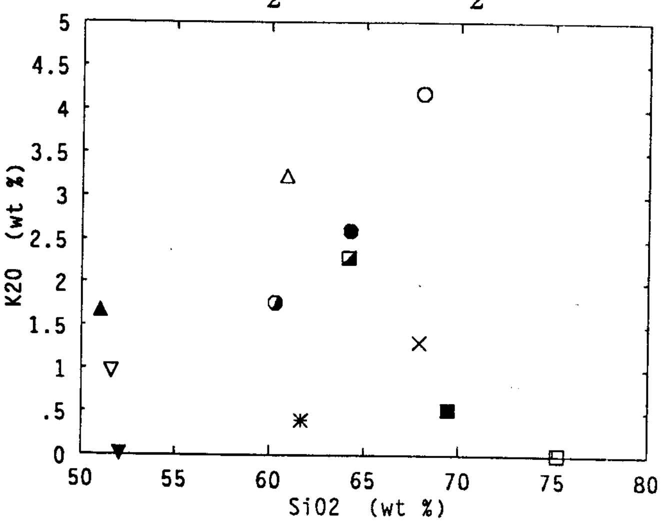
MgO vs SiO_2



Na_2O vs SiO_2



K_2O vs SiO_2



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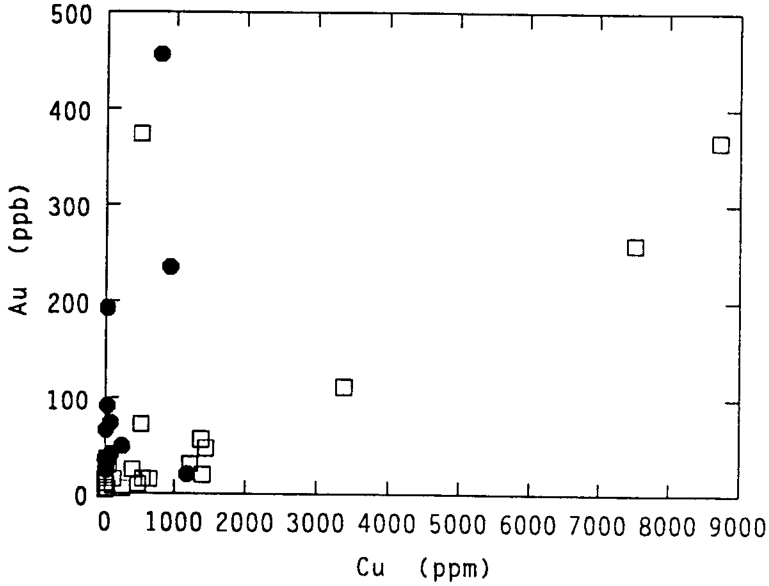
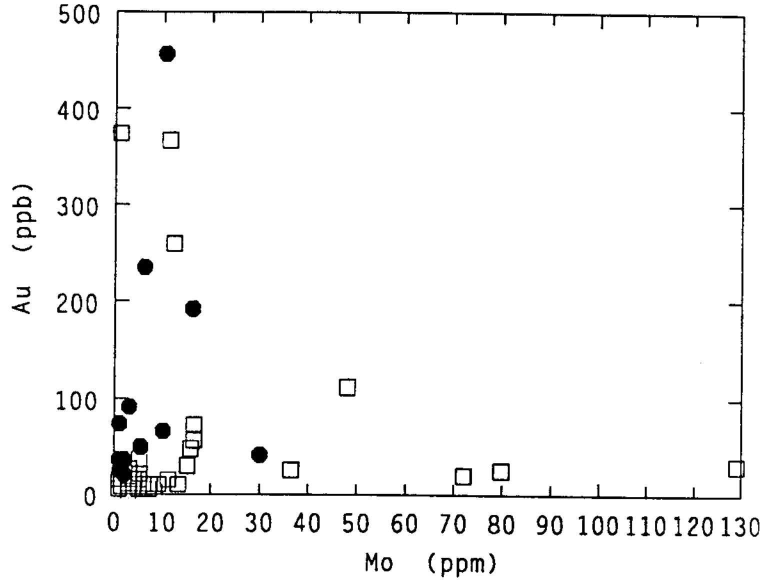
BASE & PRECIOUS METAL RELATIONS:

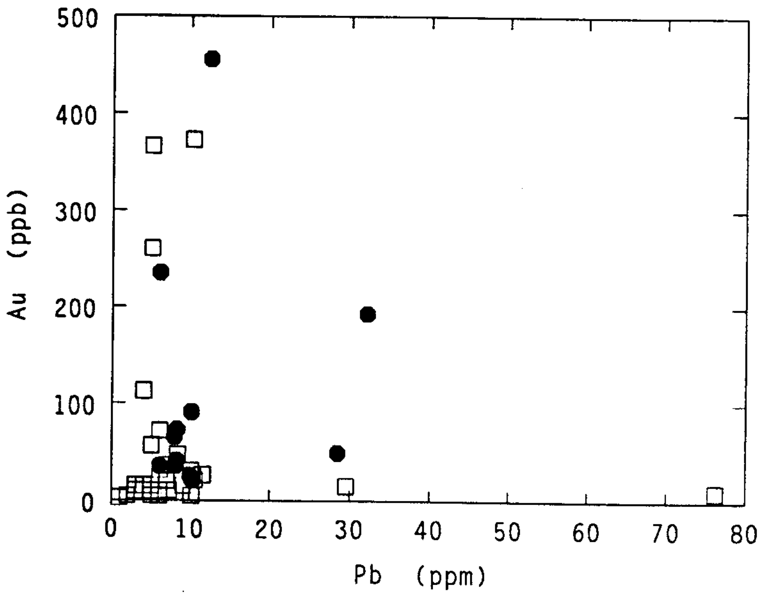
Au vs Cu



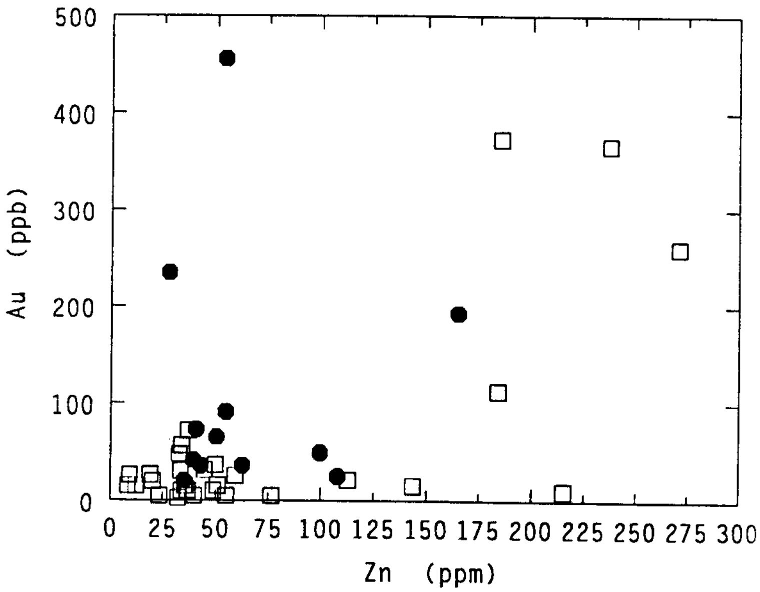
Au vs Mo



Au vs Pb



Au vs Zn



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● 9N

REPORT ON A
COMBINED HELICOPTER-BORNE
MAGNETIC, ELECTROMAGNETIC
AND VLF-EM SURVEY
NAK BLOCK
PROVINCE OF BRITISH COLUMBIA
NTS 93 M/1,8

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MARCH 18, 1993

J9321NK

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Consulting Geophysicist

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2. VERTICAL MAGNETIC GRADIENT; with superimposed contours, flight lines and EM anomaly symbols.

RESISTIVITY

3A. APPARENT RESISTIVITY; calculated for the 800 Hz data with superimposed contours, flight lines and EM anomaly symbols.

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5C. HEM OFFSET PROFILES; 32,000 Hz data with flight lines and EM anomaly symbols.

REPORT ON A
COMBINED HELICOPTER-BORNE
MAGNETIC, ELECTROMAGNETIC
AND VLF-EM SURVEY
NAK BLOCK
PROVINCE OF BRITISH COLUMBIA

1. INTRODUCTION

This report describes an airborne geophysical survey carried out on behalf of Noranda Exploration Company, Limited by Aerodat Limited under a contract dated February 11, 1993. Principal geophysical sensors included a five frequency electromagnetic system, a high sensitivity cesium vapour magnetometer and a two frequency VLF-EM system. Ancillary equipment included a colour video tracking camera, a Global Positioning System for navigation, a radar altimeter, a power line monitor and a base station magnetometer.

The survey was carried out over a small blocks totalling about 6 sq. km. located approximately 85 km east northeast of Hazelton, B.C. Total survey coverage was approximately 15 line kilometres. The Aerodat Job Number is J9321.

This report describes the survey, the data processing, data presentation and interpretation of the geophysical results. Electromagnetic anomalies have been identified and appear on selected map products as EM anomaly symbols with interpreted source characteristics. Conductive areas of interest are indicated on an interpretation map with designation number or letter. Prominent structural features interpreted from the magnetic results are also indicated. Recommendations concerning areas with favourable geophysical characteristics are made with reference to this compilation/interpretation map.

2. SURVEY AREA

The survey area is located about 85 km east northeast of Hazelton northeast of Babine Lake. Topography is shown on the 1:50,000 scale NTS map sheet 93 M/8. Local relief is rugged. Elevations range from 3,000 to over 4,000 above mean sea level.

The survey area is shown in the attached index map which includes local topography and latitude - longitude coordinates. This index map also appears on all black line map products. The flight line directions and line spacings respectively were east-west and 500 m.

3. SURVEY PROCEDURES

The survey was flown on February 25, 1993. Principal personnel are listed in Appendix IV. A total of one survey flight was required to complete the project.

The aircraft ground speed was maintained at approximately 60 knots (30 metres per second). The nominal EM sensor height was 30 metres (100 feet), consistent with the safety of the aircraft and crew.

A global positioning system (GPS) consisting of a Trimble TANS GPS receiver plus the Polycorder data logger. Differential GPS data is processed in the field on a PC using software supplied by Trimble. One system is installed in the survey helicopter. This involves mounting the receiver antenna on the tail boom. A second system was used as the base station.

The UTM coordinates of survey area corners were taken from the published NTS maps. These coordinates are used to program the navigation system. A test flight was used to confirm that area coverage would be as required.

Thereafter the traverse lines are flown under the guidance of the navigation system. The operator also enters manual fiducials over prominent topographic features as seen on a topographic map. Survey lines which show excessive deviation were re-flown.

The magnetic tie lines were flown using visual navigation in areas of low topographic and magnetic relief. Aircraft position was taken from the navigation system.

Calibration lines are flown at the start, middle (if required) and end of every survey flight. These lines are flown outside of ground effects to record electromagnetic zero levels.

4. DELIVERABLES

The colour maps are delivered in four copies. The colour maps are rolled and delivered in map tube(s).

A full list of all map types is given at the beginning of this report. A summary is given following:

MAP NO.	DESCRIPTION
	COLOUR
1	Total Field Magnetics
2	Vertical Magnetic Gradient
3A	Apparent Resistivity Contours - 800 Hz
3B	Apparent Resistivity Contours - 935 Hz
3C	Apparent Resistivity Contours - 4,175 Hz
3D	Apparent Resistivity Contours - 4,600 Hz
3E	Apparent Resistivity Contours - 32,000 Hz
4	VLF-EM Total Field
5A	HEM Offset Profiles - 800 Hz and 935 Hz
5B	HEM Offset Profiles - 4,175 Hz and 4,600 Hz
5C	HEM Offset Profiles - 32,000 Hz

5. AIRCRAFT AND EQUIPMENT

5.1 Aircraft

A ASTAR helicopter, piloted by G. Suthern owned and operated by Executive Helicopters Ltd, was used for the survey. A. Sweet of Geonex Aerodat acted as navigator and equipment operator. Installation of the geophysical and ancillary equipment was carried out by Aerodat. The survey aircraft was flown at a mean terrain clearance of 60 metres (200 feet).

5.2 Electromagnetic System

The electromagnetic system was an Aerodat 5 frequency system. Two vertical coaxial coil pairs were operated at 935 Hz and 4,600 Hz and three horizontal coplanar coil pairs at 800 Hz 4,175 Hz and 32 kHz. The transmitter-receiver separation was 7 metres. Inphase and quadrature signals were measured simultaneously for the 5 frequencies with a time constant of 0.1 seconds. The HEM bird was towed 30 metres (100 feet) below the helicopter.

5.3 VLF-EM System

The VLF-EM System was a Herz Totem 2A. This instrument measures the total field and vertical quadrature components of two selected frequencies. The sensor was towed in a bird 10 metres below the helicopter.

VLF transmitters are designated "Line" and "Ortho". The line station is that which is in a direction from the survey area which is ideally normal to the flight line direction. This is the VLF station most often used because of optimal coupling with near vertical conductors running perpendicular to the flight line direction . The ortho station is ideally 90 degrees in azimuth away from the line station.

The transmitters used were:

NLK, Jim Creek, Washington broadcasting at 24.8 kHz. (ortho)

NSS, Annapolis, Maryland broadcasting at 21.4 kHz. (line)

5.4 Magnetometer

The magnetometer employed was a Scintrex H8 cesium, optically pumped magnetometer sensor. The sensitivity of this instrument is 0.001 nanoTesla at a 0.2 second sampling rate. The sensor was towed in a bird 15 metres (50 feet) below the helicopter (45 metres (150 feet) above the ground).

5.5 Ancillary Systems

Base Station Magnetometer

An IFG-2 proton precession magnetometer was operated at the base of operations (Babine Lake Lodge) to record diurnal variations of the earth's magnetic field. The clock of the base station was synchronized with that of the airborne system to facilitate later correlation. Recording resolution was 1 nT. The update rate was 4 seconds.

External magnetic field variations were recorded on a 3" wide paper chart and in digital form. The analog record shows the magnetic field trace plotted on a grid. Each division of the grid (0.25") is equivalent to 1 minute (chart speed) or 5 nT (vertical sensitivity). The date, time and current total field magnetic value are printed every 10 minutes.

Radar Altimeter

A King KRA-10 radar altimeter was used to record terrain clearance. The output from the instrument is a linear function of altitude. The radar altimeter is checked after installation using a line marked off at intervals of 100, 150, 200 and 245 ft. A heavy weight is tied onto one end of the line. The helicopter moves up over the weight and the operator notes the radar altimeter reading at the 100, 150, 200 and 250 foot marks.

Tracking Camera

A Panasonic colour video camera was used to record flight path on VHS video tape. The camera was operated in continuous mode. The flight number, 24 hour clock time (to .01 second), and manual fiducial number are encoded on the video tape.

Global Positioning System (GPS)

The Global Positioning System is a U.S. Department of Defense program which will provide world-wide, 24 hour, all weather position determination capability . GPS consists of three segments:

- a constellation of satellites
- ground stations which control the satellites
- a receiver

The receiver takes in coded data from satellites in view and there after works out the range to each satellite. The coded data must therefore include the instantaneous position of the satellite relative to some agreed earth-fixed coordinate system.

The final satellite constellation will consist of 24 satellites with a proportion of the satellites acting as standby spares.

Analog Recorder

A RMS dot matrix recorder was used to display the data during the survey. Record contents are as follows:

Label	Contents	Scale
MAGF	Total Field Magnetics, Fine	2.5 nT/mm
MAGC	Total Field Magnetics, Course	25 nT/mm
VLT	VLF-EM, Total Field, Line Station	2.5% / mm
VLQ	VLF-EM, Vert. Quadrature, Line Station	2.5% / mm
VOT	VLF-EM, Total Field, Ortho Station	2.5% / mm
VOQ	VLF-EM, Vert. Quadrature, Ortho Station	2.5% / mm
CXI1	935 Hz, Coaxial, Inphase	2.5 ppm/mm
CXQ1	935 Hz, Coaxial, Quadrature	2.5 ppm/mm
CXI2	4,600 Hz, Coaxial, Inphase	2.5 ppm/mm
CXQ2	4,600 Hz, Coaxial, Quadrature	2.5 ppm/mm
CPI1	800 Hz, Coplanar, Inphase	10 ppm/mm
CPQ1	800 Hz, Coplanar, Quadrature	10 ppm/mm
CPI2	4,175 Hz, Coplanar, Inphase	10 ppm/mm
CPQ2	4,175 Hz, Coplanar, Quadrature	10 ppm/mm

CPI3	32,000 Hz, Coplanar, Inphase	20 ppm/mm
CPQ3	32,000 Hz, Coplanar, Quadrature	20 ppm/mm
RALT	Radar Altimeter	10ft/mm
PWRL	60 Hz Power Line Monitor	-

Data is recorded with positive - up, negative - down. This does not apply to the VLF data as seen on the analog records which is inverted.

The analog zero of the radar altimeter is 5 cm from the top of the analog record. A helicopter terrain clearance of 60 m (200 feet) should therefore be seen some 3 cm from the top of the analog record.

Chart speed is 2 mm/second. The 24 hour clock time is printed every 20 seconds. The total magnetic field value is printed every 30 seconds. The ranges from the radar navigation system are printed every minute.

Vertical lines crossing the record are operator activated manual fiducial markers. The start of any survey line is identified by two closely spaced manual fiducials. The end of any survey line is identified by three closely spaced manual fiducials. Manual fiducials are numbered in order. Every tenth manual fiducial is indicated by its number, printed at the bottom of the record.

Calibration sequences are located at the start and end of each flight and at intermediate times where needed.

Digital Recorder

A DGR-33 data system recorded the digital survey data on magnetic media. Contents and update rates were as follows:

DATA TYPE	RECORDING INTERVAL	RECORDING RESOLUTION
Magnetometer	0.2 s	0.001 nT
VLF-EM (4 Channels)	0.2 s	0.03%
HEM (8 Channels)	0.1 s	
coaxial		0.03 ppm
coplanar-800 Hz/4,175 Hz		0.06 ppm
coplanar -32 kHz		0.125 ppm
Position (2 Channels)	0.2 s	0.1 m
Altimeter	0.2 s	0.05 m
Power Line Monitor	0.2 s	-
Manual Fiducial		
Clock Time		

6. DATA PROCESSING AND PRESENTATION

6.1 Base Map

The base map is taken from a photographic enlargement of the NTS topographic maps. A UTM reference grid (grid lines usually every kilometre) and the survey area boundary were added. After registration of the flight path to the topographic base map, topographic detail and the survey boundary are digitized. This digital image of the base map is used as the base for the colour and shadow maps.

6.2 Flight Path Map

Global Positioning System

The GPS receiver takes in coded data from satellites in view and there after works out the range to each satellite. The coded data must therefore include the instantaneous position of the satellite relative to some agreed earth-fixed coordinate system.

A further calculation using ranges to a number of satellites gives the position of the receiver in that coordinate system (eg. UTM, lat/long.). The elevation of the receiver is given with respect to a model ellipsoidal earth.

Normally the receiver must see 4 satellites for a full positional determination (3 space coordinates and time). If the elevation is know in advance, only 3 satellites are needed. These are termed 3D and 2D solutions.

The position of the receiver is updated every second. The accuracy of any 1 second position determination is described by the Circular Error Probability (CEP) . 95% of all position determinations will fall with a circle of a certain radius. If the horizontal position accuracy is 25 m CEP for example, 95% of all trials will fall within a circle of 25 m radius centred on the mean. The system may be degraded for civilian use and the autonomous accuracy is then 100 m CEP. This situation is called selective availability (SA). Much of this error (due to principally to satellite position/time errors and atmospheric delays) can be removed using two GPS receivers operating simultaneously. One receiver acting as the base station, is located at a known position. The second remote receiver is in the unknown position. Differential corrections determined for the base station may then be applied to the remote station. Differential positions are accurate to 5 m CEP (for a one second sample). Averaging will reduce this error further.

Flight Path

The flight path is drawn using linear interpolation between x,y positions from the navigation system. These positions are updated every second (or about 1.5 mm at a scale of 1:20,000). These positions are expressed as UTM eastings (x) and UTM northings (y).

Occasional dropouts occur when the optimum number of satellites are not available for the GPS to make accurate positional determinations. Interpolation is used to cover short flight path gaps. The navigator's flight path and/or the flight path recovered from the video tape may be stitched in to cover larger gaps. Such gaps may be recognized by the distinct straight line character of the flight path.

The manual fiducials are shown as a small circle and labelled by fiducial number. The 24 hour clock time is shown as a small square, plotted every 30 seconds. Small tick marks are plotted every 2 seconds. Larger tick marks are plotted every 10 seconds. The line and flight numbers are given at the start and end of each survey line.

The flight path map is merged with the base map by matching UTM coordinates from the base maps and the flight path record. The match is confirmed by checking the position of prominent topographic features as recorded by manual fiducial marks or as seen on the flight path video record.

6.3 Electromagnetic Survey Data

The electromagnetic data were recorded digitally at a sample rate of 10 per second with a time constant of 0.1 seconds. A two stage digital filtering process was carried out to reject major sferic events and to reduce system noise.

Local sferic activity can produce sharp, large amplitude events that cannot be removed by conventional filtering procedures. Smoothing or stacking will reduce their amplitude but leave a broader residual response that can be confused with geological phenomena. To avoid this possibility, a computer algorithm searches out and rejects the major sferic events. The signal to noise ratio was further enhanced by the application of a low pass digital filter. This filter has zero phase shift which prevents any lag or peak displacement from occurring, and it suppresses only variations with a wavelength less than about 0.25 seconds. This low effective time constant gives minimal profile distortion.

Following the filtering process, a base level correction was made using EM zero levels determined during high altitude calibration sequences. The correction applied is a linear function of time that ensures the corrected amplitude of the various inphase and quadrature components is zero when no conductive or permeable source is present. The filtered and levelled data were used in the determination of apparent resistivity (see below).

6.4 Total Field Magnetics

The aeromagnetic data were corrected for diurnal variations by adjustment with the recorded base station magnetic values. No corrections for regional variations were applied. The corrected profile data were interpolated on to a regular grid using an Akima spline technique. The grid provided the basis for threading the presented contours. The minimum contour interval is 5 nT. A grid cell size of 25 m was used.

6.5 Vertical Magnetic Gradient

The vertical magnetic gradient was calculated from the gridded total field magnetic data. The calculation is based on a 17 x 17 point convolution in the space domain. The results are contoured using a minimum contour interval of 0.2 nT/m. Grid cell sizes are the same as those used in processing the total field data.

6.6 Apparent Resistivity

The apparent resistivity is calculated by assuming a 200 metre thick conductive layer over resistive bedrock. The computer determines the resistivity that would be consistent with the sensor elevation and recorded inphase and quadrature response amplitudes at the selected frequency. The apparent resistivity profile data was re-interpolated onto a regular grid at a 25 metres true scale interval using an Akima spline technique and contoured using logarithmically arranged contour intervals. The minimum contour interval is 0.1 log(ohm.m).

The highest measurable resistivity is approximately equal to the transmitter frequency. The lower limit on apparent resistivity is rarely reached.

6.7 VLF-EM

The VLF Total Field data from the Line Station is levelled such that a response of less than 0% is seen in non-anomalous regions. The corrected profile data are interpolated onto a regular grid using an Akima spline technique. The grid provided the basis for threading the presented contours. The minimum contour interval is 1%. Grid cell size is 25 m.

7. INTERPRETATION

7.1 Regional Geology

The survey area is located within the Intermontane Belt on the Skeena Arch. The belt is composed principally of eugeosynclinal volcanic and clastic rocks of Late Palaeozoic, Triassic and Jurassic age. Deformation consists of moderate folding, transcurrent boundary faults, thrusting and normal faulting.

7.2 Magnetic Interpretation

The total field magnetic responses reflect major changes in the magnetite content of the underlying rock units. The amplitude of the magnetic responses relative to the regional background help to assist in identifying specific magnetic and non-magnetic units related to, for example, mafic flows or tuffs, mafic to ultramafic intrusives, felsic intrusives, felsic volcanics and/or sediments etc. Obviously, several geological sources can produce the same magnetic response. These ambiguities can be reduced considerably if basic geological information on the area is available to the geophysical interpreter.

In addition to amplitude variations, magnetic patterns related to the geometry of the particular rock unit also help in determining the probable source of the magnetic response. For instance, long narrow magnetic linears usually reflect mafic tuff/flow horizons or intrusive dyke structures while semi-circular features with complex magnetic amplitudes may be produced by local plug-like intrusive sources such as pegmatites, carbonatites or kimberlites.

The calculated vertical magnetic gradient assists considerably in mapping weaker magnetic linears that are partially masked by nearby higher amplitude magnetic features. The broad zones of higher magnetic amplitude, however, are severely attenuated in the vertical magnetic gradient results. These higher amplitude zones reflect rock units having magnetic susceptibility signatures. For this reason both the total and gradient magnetie data sets must be evaluated.

Theoretically the zero contour of the magnetic gradient map marks the contacts or limits of large magnetic sources. This applies to wide sources, greater than 50 metres, having simple slab geometries and shallow depth.(See discussion in Appendix I) Thus the gradient map also aids in the more accurate delineation of contacts between differing magnetic rock units.

The cross cutting structures, shown on the interpretation map as faults, are based on interruptions and discontinuities in the magnetic trends. Generally, sharp folding of magnetic units will produce a magnetic pattern indistinguishable from a fault break. Thus these structures have been designated as fold/fault features.

7.3 Magnetic Survey Results and Conclusions

To facilitate the following discussion of the magnetic results it is suggested that the interpretation map be compared with the total field and vertical gradient magnetic eolour contour maps either as overlays or side by side.

An interpretation map for this block is not warranted because of the limited geophysical coverage. Obviously a particular geological environment is being tested for its geophysical response or the survey covers a small claim block.
The block contains a high amplitude local semi-circular anomaly which is adjacent to a more regional north south linear to the east. There are no significant conductive responses associated with the magnetic responses in this block.

7.4 Electromagnetic Anomaly Selection/Interpretation

Usually two sets of stacked colour coded profile maps of one coaxial and one coplanar inphase and quadrature responses are used to select conductive anomalies of interest. Selection of anomalies is based on conductivity as indicated by the inphase to quadrature ratios of the 935 Hz, and/or 4,600 Hz coaxial data, anomaly shape, and anomaly profile characteristics relative to coaxial and corresponding coplanar responses (see discussion and figure in Appendix I). It is difficult to differentiate between responses associated with the edge effects of flat lying conductors and actual poor conductivity bedrock conductors on the edge of or overlain by flat lying conductors. Poor conductivity bedrock conductors having low dips will also exhibit responses that may be interpreted as surficial overburden conductors. In such cases, where the source of the conductive response appears to be ambiguous, the anomaly is still selected for plotting. In some situations the conductive response has line to line continuity and some magnetic association thus providing possible evidence that the response is related to an actual bedrock source.

The calculation of the depth to the conductive source and its conductivity is based on the 935 Hz data using a thin vertical sheet model. The amplitude of the inphase and quadrature responses are used for the calculations which are automatically determined by computer. These data are listed in Appendix II and the depth and conductivity values are shown with each plotted anomaly. Further detailed discussion and illustration of the determination of these values is contained in Appendix I.

The selected anomalies are automatically categorized according to their conductivity and amplitude. The calculation of the conductivity of low amplitude anomalies can be very inaccurate. Therefore, anomalies having amplitudes below a certain level and/or low conductivity value are given a zero rating with the category increasing for increasing conductivity values that are statistically reliable.

7.5 VLF Electromagnetic Survey

This high frequency type of survey, utilizing fixed government communication transmitter stations, tends to detect long strike length and/or surficial poor conductivity sources such as swamps, creeks and rivers. Conductors that are optimum coupled with the primary field will usually predominate over those with other strike directions. In some instances anomalies will be produced by variations in topographic relief. This appears to be the case for this survey where most of the VLF anomalies are associated with topographic highs.

7.6 Electromagnetic Survey Results and Conclusions

No significant conductors were noted on the Nak block.

8. RECOMMENDATIONS

Local geological information or the ore target model for the survey area was not made available to the author. This is a small survey area containing a local magnetic anomaly but no significant conductive responses. The significance of the geophysical results is best assessed by Noranda personnel with more intimate geological knowledge of the area.

Respectfully submitted,

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for

AERODAT LIMITED

J9321

March 18, 1993