THE GEOLOGIC SETTING AND ENVIRONMENT OF ORE DEPOSITION AT THE MINDAMAR MINE, STIRLING, RICHMOND COUNTY, NOVA SCOTIA

by

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ABSTRACT

The Mindamar Mine exploited a group of lenticular bodies of sulphides that occurred within a persistent, wide, and steep shear zone. The mineralization consists of extremely fine-grained pyrite and sphalerite with minor amounts of chalcopyrite, galena and tennantite. The host rocks for the deposit have been correlated, on lithologic similarities, to the Bourinot Group of Middle Cambrian age.

The genesis of the deposit, as well as the relative ages of the host rocks and mineralization, have been a matter of controversy. This study was undertaken to clarify the geologic setting, geologic history, and environment of base metal deposition at the Mindamar Mine.

The geometry of the rock-types at the mine was interpreted from diamond drill core found abandoned on the mine property. Descriptive drill logs of a previous program, and mine plans of the early workings were re-interpreted and their data was incorporated into a new interpretation for the deposit, using a new nomenclature for the rock-types. This nomenclature was established from specimens collected from the drill core, outcrops and from the mine dumps.

The bulk of the ore occurred within a northeast-striking, westward facing, steeply dipping rock sequence which consists of felsic to mafic lava flows, pyroclastic rocks and related volcaniclastic and chemical sedimentary rocks all of which were intruded by mafic sills and dykes. The ore-zone, comprised of a quartz-carbonate rock, massive sulphides, and siliceous siltstones, is stratigraphically controlled, occurring between two chemically distinct volcanic piles, with felsic flows predominating in the footwall, and intermediate tuffs in the hangingwall. The most important concentrations of sulphides occur stratigraphically above the quartz-carbonate within the siltstones. Graded beds and sedimentary layering are present in both the massive banded sulphides and the siltstones.

Superimposed shearing and carbonatization (calcite) processes have modified the primary textures in all lithologies, including the ore and the intrusions which transect it. The introduction of calcite into sheared rocks of all lithologies is not related to the processes that formed the quartz-carbonate rock of the ore-zone.

The ore-zone at the Mindamar Mine was deposited subaqueously as a result of volcanic-related hydrothermal processes, rather than by a younger replacement mechanism. The deposit is interpreted to be a distal-type of the volcanic-exhalative-sedimentary model, analogous to the geologic situation responsible for some of the Kuroko deposits in Japan.

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CHAPTER 1

INTRODUCTION

1. General

The Mindamar Mine, active until 1956, exploited a base metal deposit at Stirling, Richmond County, Nova Scotia. The orebody has been described (Richardson, 1953; Watson, 1954) as a group of irregularly-shaped lenses of sulphides in a quartz-carbonate envelope occurring within a persistent, wide, steeply-dipping shear zone. This shear zone cuts altered volcanic rocks of the Middle Cambrian (?) Bourinot Group.

The mineralization consists of extremely fine-grained pyrite and sphalerite with minor chalcopyrite, galena, and tennantite in a gangue composed of dolomite, quartz, magnesite, sericite, talc and chlorite (Watson, 1954).

Total production for the mine was approximately one million tons of ore averaging 6.4% Zn, 1.5% Pb, 0.74% Cu with Ag and Au contents of 2.2 and 0.03 oz per ton respectively (Messervey, 1965).

2. Purpose and Scope

The Mindamar Mine has long been known to exploration companies as a past-producer, unique to an area where considerable exploration programs have failed to uncover other significant mineralization.

Until recently, the deposit was interpreted as an epigenetic replacement-type within a shear zone (Richardson, 1953; Watson, 1954). During the last four years, several authors (Poole, 1974; Ruitenberg, 1976; Lydon, 1977) have speculated on a syngenetic origin for the Mindamar orebodies, but there has been no adequate documentation of evidence to support either view.

The objective of this study is to determine the geologic setting, geologic history and environment of base metal deposition at the Mindamar Mine. This is achieved by integrating pre-existing data with new stratigraphical, sedimentological, mineralogical, geochemical and structural data obtained during the course of this study. This should enable the deposit to be incorporated into a metallogenic model for Nova Scotia (Zentilli, 1977).

From the writers first visit to the mine, it was evident that previous authors used a nomenclature different from this authors for the rock-types observable in the mine dumps. It was decided, therefore, that a major task of the thesis would be to construct a three-dimensional interpretation for the deposit using a new, more detailed lithologic nomenclature. Data for the construction (Figure 4, in pocket) came from the following:

1. limited outcrops
2. drill core from 19 diamond drill holes logged by the writer. The logs appear in Appendix I.

3. re-interpretation of descriptive drill logs from 34 holes drilled in the 1950's by Mindamar Metals Corp. Ltd.
4. re-interpretation of mine plans of British Metals (Can.) Ltd. from the vicinity of Number 1 shaft. These plans conveniently filled in the space where drill information was not available.

3. Geography

The Mindamar Mine is situated at Stirling, a small village in the eastern end of Richmond County, Cape Breton, Nova Scotia, approximately 72 kilometres southwest of Sydney and 65 kilometres northeast of St. Peters (Figure 1). Access is by a combination of paved highways and good secondary gravel roads. The coordinates for the mine are latitude 45°44'N, longitude 60°25'W and the surrounding area is shown on National Topographic Series map sheets 11F/16B and 11F/9C.

Topographically, the area around Stirling is within the Atlantic watershed of the Mira Hills. The relief is low and the region is dotted with lakes, ponds, bogs, and streams with falls and stillwaters draining into the Atlantic Ocean. Bedrock exposure is sparse, generally found only in stream beds and on lake shores, but there are a few large low-lying areas of flatland with outcrops. Between the streams are rolling, thickly wooded hills averaging 30 metres above the neighboring streams. These hills are heterogeneous glacial till deposits and are composed of rounded pebbles and boulders in a matrix of sand and clay. The boulders commonly reflect the underlying

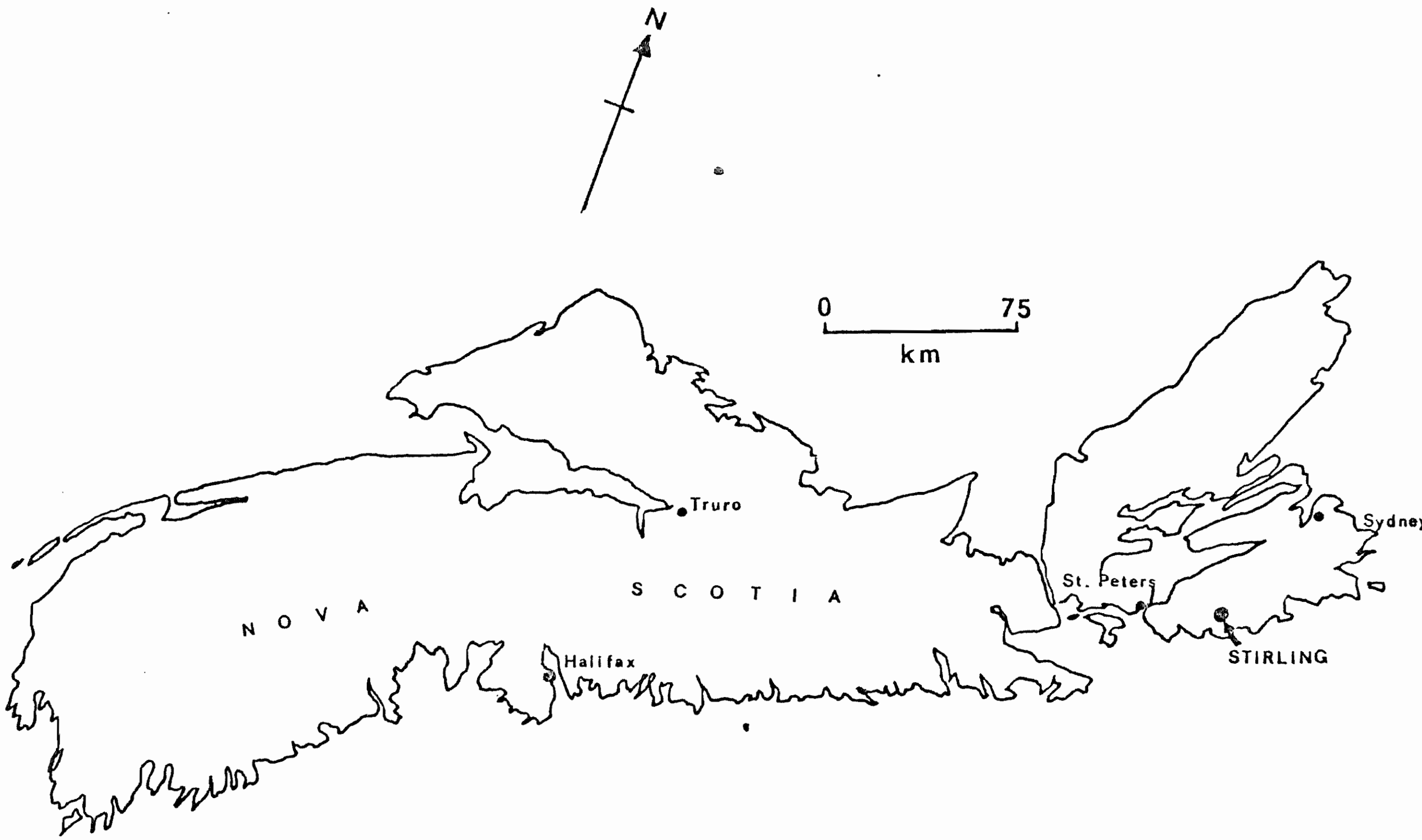

Figure 1. Location map.

lithologies, a fact which is especially noticeable in areas underlain by granites and diorites (Weeks, 1924). Glacial striae in southeast Cape Breton indicate southerly to southeasterly directions of ice movement.

At the mine site, glacial till forms a 15 metre thick cover which restricts outcrops to the edge of a 'glory hole' where mine workings broke through to the surface, and to a drainage ditch 80 metres west of the 'glory hole' (Figure 4, in pocket). Diamond drill and topographic data indicate minor bedrock relief.

4. Mining History

Mineralization was discovered at Stirling during the 1890's in what is now called Copper Brook, a small stream which traverses the mine site. The prospect was regarded as a copper deposit, and a small pit, which yielded discouraging results, was opened in 1904.

During the fall of 1915, Barytes Ltd. investigated the showing for zinc. Trenching revealed complex fine-grained Zn-Pb-Cu mineralization which could not be processed economically by metallurgical techniques available at that time.

Exploration by trenching, stripping of overburden, and diamond drilling, was conducted during World War I and up to 1924, by several companies hoping to develop a zinc producer. All results were disappointing.

American Cyanamid Co. Ltd. acquired the property in 1925, sank a two-compartment shaft to the '400 foot level' (130 metres) and conducted a small amount of crosscutting and drifting. Again, results were unsatisfactory and operations were suspended.

In the spring of 1927, the property was acquired by British Metals (Can.) Ltd. which operated under a subsidiary, Stirling Mines Ltd. The shaft was deepened to 240 metres (630 feet) and a new development program was completed. A 250 tpd mill was installed; its capacity was increased to 300 tpd in 1930. Low metal prices forced the mine to close between December 1931 and October 1935. With the resumption of operations in 1935, 3,400 metres of development and 8,200 metres of diamond drilling were completed before operations were suspended in February 1938. Stirling Mines Ltd. milled 196,479 tons of ore which averaged 10% Zn, 2.3% Pb, 1.0% Cu and with Ag and Au contents of 2.5 and 0.04 oz per ton respectively.

The mineral rights to the property were obtained by Mindamar Metals Corp. in 1949, who dewatered the workings with the aid of the Mobile Mining Plant of the Nova Scotia Department of Mines and carried out an underground development program consisting of sampling and diamond drilling. Under an agreement with Mindamar Metals, Dome Explorations (Can.) Ltd. assumed management of the mine in 1951, and made the site ready for production by installing a 500 tpd mill. The workings were rehabilitated, and a new 4-compartment shaft was sunk to 357 metres. Production totalling 863,115 tons of ore averaging 5.5% Zn, 1.3% Pb and 0.7% Cu came from the old mine area and from a new ore zone discovered north of the existing workings. Operations were suspended in April 1956 with the exhaustion of known ore reserves. This was coincident with an abrupt increase in the talc content within the ore-zone below the '1000 foot level' (325 metres) which discouraged exploration at depth.

Keltic Mining Corp. Ltd. held the mineral rights to the ground from 1965 to 1967, conducted electro-magnetic, induced polarization, and ground magnetometer geophysical surveys over the mine area, and drilled 22 holes within the limits of the old workings. After obtaining negative results, Keltic optioned the property from 1968 to 1969 to Penarroya Ltd., who conducted a geological mapping program, a geochemical survey and a diamond drill program of three holes, testing for a southern extension of the ore-zone. Nothing of significance was found, and the lease reverted to Keltic.

The exploration rights around the mine area are presently held by Cominco Ltd. who staked the ground in 1972 after Keltic's lease was allowed to lapse.

5. Previous Studies

According to Hutchinson (1952) the first mention of the geology of the area was by R. Brown (1845) who recognized the presence of pre-Carboniferous slates in the Mira valley. Sir Wm. Dawson (1855) classified these rocks as Devonian or Upper Silurian and mentioned the existence of "syenite and porphyry".

The first systematic mapping of the area was conducted by H. Fletcher (1878) who distinguished the Cambrian beds from both the overyling Carboniferous strata and the underlying George River Group. He put all the volcanic and intrusive rocks together with the George River rocks into a pre-Silurian Group. To the Cambrian sedimentary rocks, together with those of the Kelvin Glen Group and Middle River Formation, he ascribed on the evidence of fossils, a Lower Silurian age following the nomenclature of the day.

G. F. Matthew (1903) began a study of Fletcher's 'Lower Silurian' strata and ascribed a Cambrian age to them on newer evidence from fossils. By inference, he gave a Precambrian age to the George River Group.

D. D. Cairnes (1917) published the first description of the Stirling ore deposit, in which he interpreted the ores tc be metasomatic replacements of the host "andesitic" volcanic rocks. Subsequent workers (Hayes, 1919; Weeks, 1924, Alcock, 1930) supplemented Cairnes observations and commented on the character of the deposit, concurring with a replacement genesis.

Numerous authors have written private reports on the deposit, but the most concise and accurate was that of W. F. James and

B. S. W. Büffam (1937), written for British Metals Corporation Ltd. This descriptive report was based on underground mapping, and is accompanied by several mine plans and sections.

R. D. Hutchinson (1952) added much detailed stratigraphic and paleontologic information to the area in his study of trilobite faunas within sedimentary rocks of southeast Cape Breton and he developed the stratigraphic nomenclature for the region (Chapter 2).

The general geology of southeast Cape Breton was mapped by L. J. Weeks during the period from 1944-1954. In his report, Weeks (1954) correlated the volcanic and sedimentary rocks in the vicinity of Stirling with the Bourinot Group (Hutchinson, 1952) of Middle Cambrian Age.

Richardson (1953) wrote a brief summary on the deposit, noting that the shear zone close to the ore body was related to the mechanism responsible for concentrating the metals.

R. D. Watson (1954, 1957, 1959) summarized pre-existing data on the deposit and supplemented them with the first description of thin sections of the host and ore lithologies. He discussed the relationships between the ore and nearby igneous dykes, and commented on the mode of emplacement for the sulphides. He interpreted the ore as sulphide replacements of felsic volcanic and sedimentary rocks, with the timing of mineralization synchronous with a deformational event responsible for the regional foliation and metamorphism in the Bourinot

Group of the Mira-L' Ardoise belt.

A detailed petrographic examination of rocks from the Bourinot Group in the Mira-L'Ardoise belt was conducted by J. T. Wilband as part of an M.Sc. thesis at the University of New Brunswick. He noted different volcanic lithologies, with a full range of compositions extending from rhyolite to basalt, interbedded with volcaniclastic sedimentary rocks (Wilband, 1962, 1963).

Helmstaedt and Tella (1973) in dealing with the tectonic development of southeast Cape Breton Island from the Hadrynian to the Tournasian, conducted chemical analyses on samples from the Bourinot Group volcanic rocks on the Boisdale Peninsula for comparison with another volcanic sequence, the Fourchu Group of Hadrynian age. Their work indicated a calc-alkaline affinity for the Bourinot volcanic rocks.

Poole (1974) suggested, on a re-appraisal of existing data combined with recent concepts on ore genesis for this type of mineralization, that the Mindamar deposit is a syngenetic, volcanogenic-type (White, 1969; Hutchinson, 1973) with superimposed tectonic, metamorphic and hydrothermal effects. This view is shared by recent workers of Appalachian metallogeny (Ruitenberg, 1976; Zentilli, 1977; Lydon, 1977).

6. Methods

Field work for the thesis was conducted during the summer and fall of 1977 and consisted of:

1. mapping of, and specimen collection from, surface exposures around the mine area.
2. collecting representative specimens from the mine dumps, and
3. salvaging, logging of, and specimen collection from, approximately 3,200 metres of core (19 holes) drilled by Keltic Mining Corp. Ltd. in 1965-66 and Penarroya Ltd. in 1969.

The majority of the drilling had been conducted across the ore-zone at various intervals along its strike for a distance of 1.3 kilometres. It was possible to correlate rock-types exposed on the surface and in the mine dumps with rock-types observed in the drill core.

Having established an acceptable lithologic nomenclature for the rock units from the drill core, descriptive drill logs of 30 holes drilled by Mindamar Metals Corp. Ltd. in the 1950's (Nova Scotia Department of Mines assessment files) and mine plans of British Metals (Can.) Ltd. were re-interpreted. This allowed the geometry of the ore and enclosing rock units to be determined for the bedrock surface and the first four mine levels. The enclosed maps (Figures 5 and 6, in pocket) and sections (Figures 7 and 8; Appendix II) are the result of this compilation. Appendix (I) contains the drill logs made by the writer.

Specimens were selected from representative rock-types within the drill core for thin sections, polished thin sections and whole rock analyses. Polished thin sections and slabs of ore specimens came mainly from the mine dumps, which afforded a more representative suite of ore grade material than did the drill core. In total, 55 thin sections, 15 polished thin sections and 15 slabs were studied. Whole rock analyses were performed on 48 specimens with Pb, Zn, Cu, Mn determinations for some of them.

7. Organization of this Thesis

As an introduction to the problem, the general geology of the Bourinot Group is summarized in Chapter 2, based mainly on the works of Hutchinson (1952) and Weeks (1954). The geology at the Mindamar Mine is described in Chapter 3, incorporating new and pre-existing data. The relationships between host rocks, ore, intrusions, alteration, structure and metamorphism are described. An interpretation of the base metal deposition, which, in the writers opinion, is compatible with the observed and developed data, follows in Chapter 4 with a discussion of a proposed model. Conclusions are drawn in the final chapter.

CHAPTER 2

GEOLOGY OF THE BOURINOT GROUP

1. General Statement

The possibility exists that the Mindamar ore-bodies represent a syngenetic concentration within the volcanic-sedimentary rocks known as the Bourinot Group, and not a mineralized, relatively young, fault structure. This possibility necessitates an attempt be made to understand the distribution, extent, lithology and age of this rock unit in southeast Cape Breton Island. This chapter also serves to point out the uncertainties in age and correlation of these economically significant rocks.

The rocks of southeast Cape Breton are part of the Avalon Platform (Poole, 1967); Avalon Belt (Rodgers, 1972) or Avalon Zone (Williams *et al.*, 1974) stretching along the southeast margin of the northern Appalachians from the Avalon peninsula of southeastern Newfoundland into Nova Scotia, New Brunswick and eastern Massachusetts (Helmstaedt and Tella, 1973). Segments of this belt are characterized by late Precambrian (Hadrynian) volcanic and intrusive rocks overlain by Cambrian strata, containing an Atlantic-type trilobite fauna (Hutchinson, 1952). The Hadrynian rocks have been affected by the Avalonian orogeny (Lilly, 1966; Hughes, 1970; Rodgers, 1972) or Ganderian orogeny (Kennedy, 1976).

The name Bourinot was proposed by Hutchinson (1952) for an assemblage of volcanic-sedimentary rocks which outcrop on the Boisdale peninsula between East Bay and St. Andrews Channel of Bras d'Or Lake in Cape Breton (Figure 2). On the evidence of fossils, these rocks form the lower part of the Cambrian system in this area. The unfossiliferous volcanic-sedimentary rocks, called the Mira-L'Ardoise Belt (Weeks, 1954), which contain the Mindamar ore-bodies, have been correlated with the Bourinot Group solely on the basis of lithologic similarities (Weeks, 1954). The present writer considers this to be a tentative correlation and prefers to refer to these rocks as Middle Cambrian (?). The distribution of the Bourinot Group is shown in Figure 2.

2. Boisdale Peninsula

On the Boisdale peninsula the rocks of the Bourinot Group occur in two major northeast-trending belts and a third, narrow belt completely enclosed by granitic rocks northwest of Castle Bay. The largest belt, which outcrops from Eskasoni in the southwest to Georges River in the northeast (Figure 2) is the subject of the following discussion.

At Long Island, the Bourinot rocks are underlain by the Precambrian George River Group. At this locality, there appears to be a slight angular discordance, but at most locales, the contact is obscured by granitic intrusions (Hutchinson, 1952). The upper contact

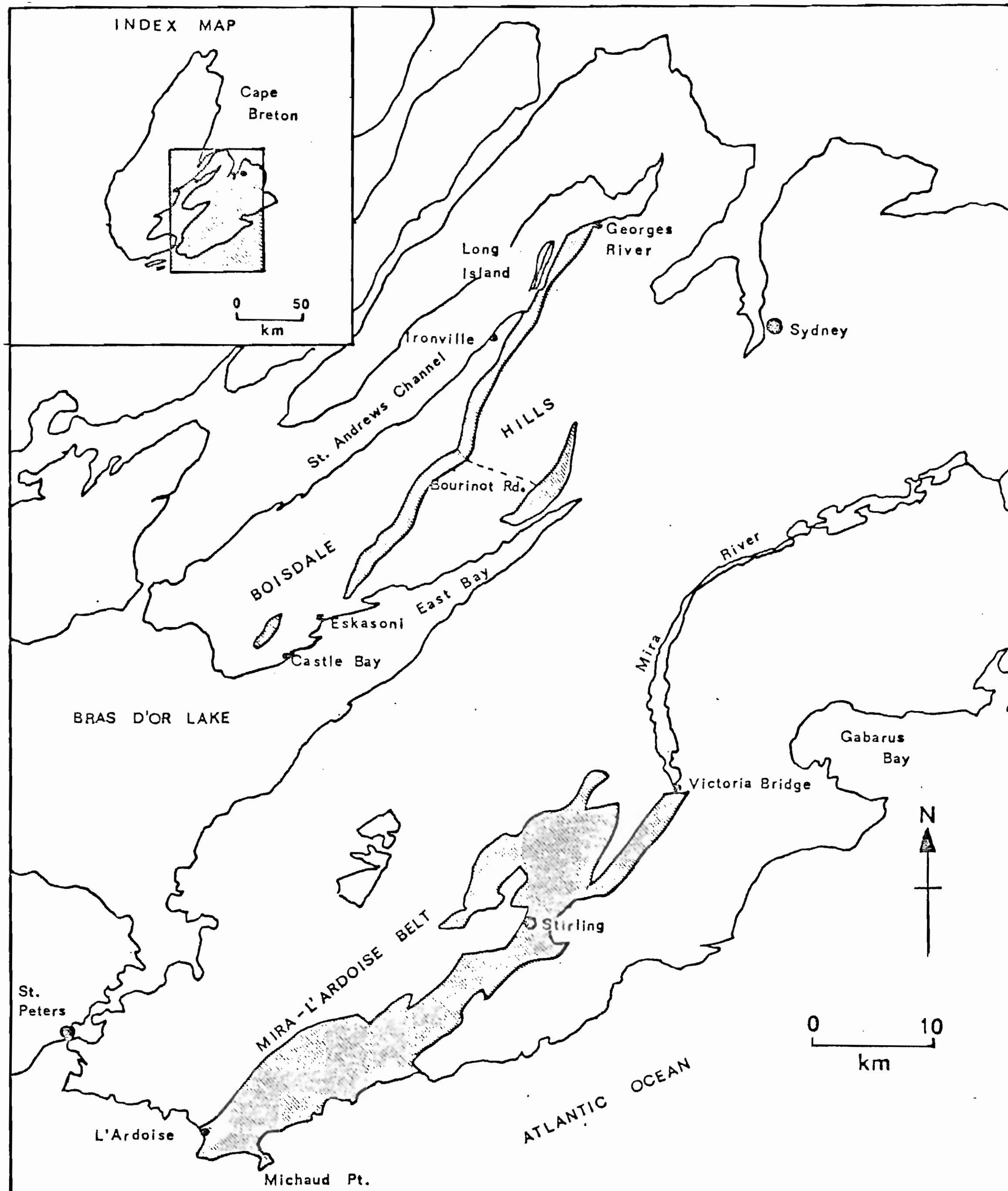

Figure 2. Distribution of the Bourinot Group in southeast Cape Breton Island.

of the Bourinot Group is everywhere marked by a sharp lithologic break which makes identification easy. Along the MacLeod Brook valley near Ironville, the Bourinot Group is in part disconformably overlain by shales and quartzite of the Middle Cambrian McMullin Formation (Hutchinson, 1952; Table 1).

Southwest of the Bourinot Road (Figure 2), the Bourinot Group has been subdivided into three formations, namely the Eskasoni, Dugald, and Gregwa Formations. This subdivision can only be recognized as far as the Bourinot Road, northeast of which, all rocks are mapped as one unit, the Bourinot Group (Hutchinson, 1952).

The lowermost Eskasoni Formation consists mainly of basaltic lava flows and agglomerates interbedded with tuffaceous shales. These volcanic rocks are overlain by the sedimentary sequence of the Dugald Formation which consists of quartzitic and silty tuffaceous shales. In the upper part of this formation, Matthew (1903, p. 176) and Hutchinson (1952) found trilobite fragments of the *Paradoxides oelandicus* fauna corresponding in age to the European Middle Cambrian. The Gregwa Formation overlies the Dugald and consists mainly of agglomerates and amydaloidal flows of basalts, andesites and spilites (Weeks, 1954) of calc-alkaline affinity (Helmstaedt and Tella, 1973).

Within the area, there is a considerable range in thickness of the Bourinot Group. It reaches a maximum, estimated from discontinuous outcrops, of at least 610 metres at the Bourinot Road and thins rapidly to the northeast and southwest.

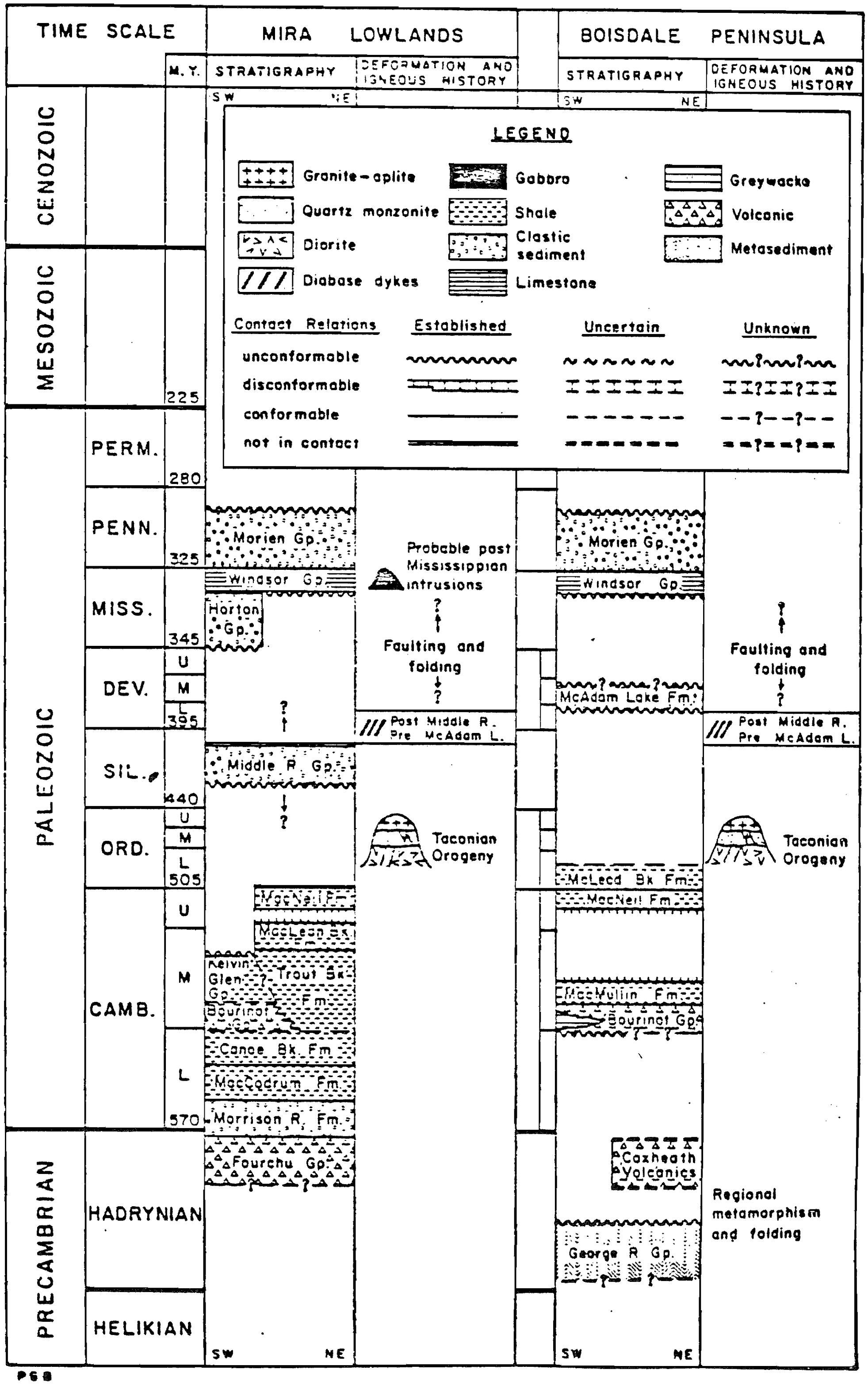

Table 1. Stratigraphic and plutonic history of southeast Cape Breton Island (after O'Reilly, 1977).

All along the northwestern border of this Cambrian belt, the rocks of the Bourinot Group strike between N 30°E and N 60°E and dip very steeply or vertically with tops facing southeast. On the southeast edge of the belt, rocks strike about N 40°E, dip 60° to the northwest and are right side up.

3. The Mira - L'Ardoise Belt

The largest area of Cambrian (?) strata on Cape Breton Island lies to the southeast of Bras d'Or Lake within a belt some 40 kilometres long by 6 kilometres wide, extending from 2 kilometres west of Victoria Bridge to Michaud Point and L'Ardoise (Figure 2). The rocks lie in one broad syncline and, to a considerable degree, are cut by granitic intrusions or overlain by younger rocks (Weeks, 1954). This syncline, called the Mira Valley syncline (Weeks, 1954) begins close to Mira Bay, and extends along the valley of the Mira River to L'Ardoise, where it is covered by younger and older rocks of the L'Ardoise thrust block.

The Bourinot Group is underlain on the southeast, and partly on the northwest limbs of the syncline by the Lower Cambrian clastic sedimentary rocks of the Morrison River, McCodrum and Canoe Brook Formations, which in turn are underlain by the Fourchu Group volcanic rocks of Hadrynian age (Figure 3; Table 1).

Hutchinson (1952) and Weeks (1954) determined that in the Mira-L'Ardoise belt, the red sandstones and conglomerates of the Morrison

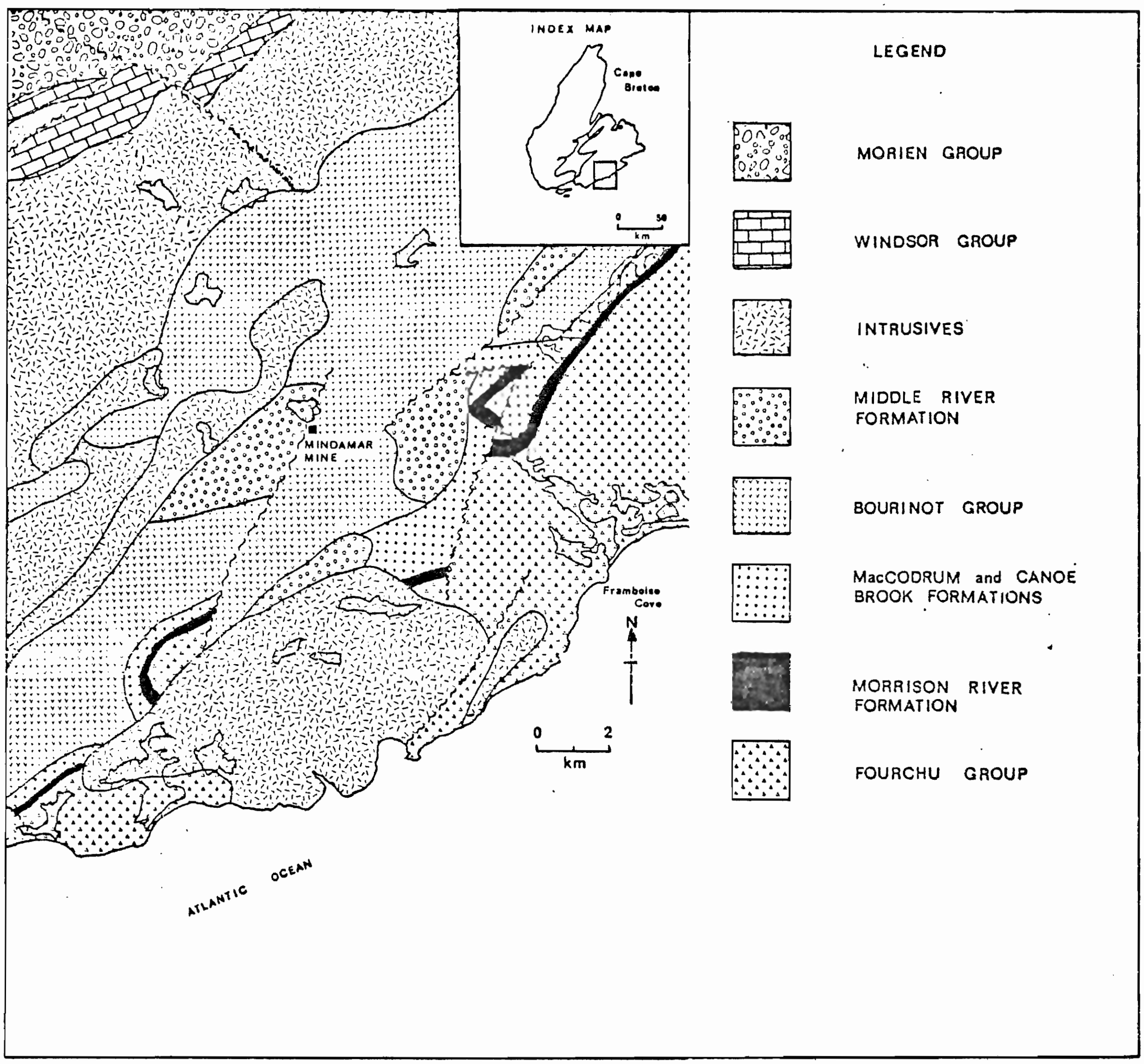

Figure 3. General geology of southeast Cape Breton Island (modified after Weeks, 1954).

River Formation are conformable on the reddish volcanic breccia of the Fourchu Group. This is in contrast to the unconformable relationships on the Boisdale Peninsula (Table 1). Hutchinson ascribes an Early Cambrian age to the Morrison River Formation but Weeks is of the opinion that the Fourchu Group and the Morrison River Formation form a depositional sequence that somewhere in its succession crosses the arbitrary boundary line separating the Paleozoic from the Proterozoic.

Conformably overlying the Morrison River Formation is the MacCodrum Formation consisting of shales and siltstones of Early Cambrian age, based on the trilobite, Strenuella strenua (Hutchinson, 1952). A sequence of soft, red and green mottled claystones of the Canoe Brook Formation conformably overlies the MacCodrum Formation, but exposures are very poor.

Structurally, the Bourinot Group overlies the Canoe Brook Formation but obscure contact relationships with rocks above and below, combined with a lack of fossils, casts some doubt on the assigned Middle Cambrian age (Poole, 1972, Helmstaedt and Tella, 1973, in pers. comm. with R. D. Hutchinson). Suspicion must therefore be raised on the correlation of volcanic rocks on the Boisdale Peninsula with those in the Mira-L'Ardoise belt.

Elsewhere in the Mira-L'Ardoise belt, the Trout Brook Formation, composed of grey to black shales (Weeks, 1954) and volcanic rocks (Chatterjee, 1977) conformably overlies the Canoe Brook Formation and as such, is considered correlative in its lower part with the Bourinot Group (Weeks, 1954). West of the Mira River, conglomerates, sandstones and siltstones of the Kelvin Glen Group supposedly overlie the Bourinot Group. These unfossiliferous rocks of Middle Cambrian (?) age (Weeks, 1954) have obscure contact relationships with other Cambrian rocks to the north and east.

Overlying the Trout Brook Formation are the quartzitic siltstones and shales of the McLean Brook Formation, followed by the McNeil Formation. The latter, composed of black shale with calcareous concretions, is the youngest Cambrian formation in the area.

Within the Mira-L'Ardoise belt, arkosic rocks of the Middle River Formation of Siluro-Devonian age, are fault bounded by and/or unconformable with the Bourinot Group.

Granitic intrusions cut Cambrian strata in the Mira-L'Ardoise belt and all rocks previously mentioned have been unconformably overlain by the Horton and Windsor Groups of Mississippian age. A summary of the stratigraphic and plutonic history of southeast Cape Breton is given in Table 1.

The most common lithologies within the Mira-L'Ardoise belt are altered lavas and pyroclastics of basaltic to rhyolitic composition, chemical sediments and associated sub-volcanic intrusions. Of almost equal importance are thick successions of more or less graded sequences of clastic material, mainly reworked volcanic debris. The thickness of the Bourinot Group is uncertain, due to a lack of continuous exposure, but Weeks (1954) estimates a minimum thickness of 150 metres. The Group has a wide areal extent, and the strata are folded and faulted locally.

The Bourinot Group has been regionally metamorphosed to the lower greenschist facies with alteration mineral assemblages of chlorite, sericite and epidote. The structural trend parallels the major northeasterly trend developed within pre-Devonian rocks of southeast Cape Breton. The rocks have been folded into a series of anticlines and synclines, and a northeast-trending fracture cleavage or schistosity is locally well developed. Accompanying the development of this foliation has been the introduction of calcite into all foliated rocks; the carbonate content increases with the degree of schistosity. The calcite is associated with chlorite and epidote in the mafic rocks; with sericite and chlorite in the more felsic varieties.

4. Summary

This chapter has described the general geology and distribution of the Bourinot Group, and serves to point out the uncertainties in the correlation of the unfossiliferous rocks of the Mira-L'Ardoise belt with those on the Boisdale Peninsula.

Until such time as new fossil evidence is found, or definite contact relationships are established with adjacent formations of known ages, the rocks of the Bourinot Group in the Mira-L'Ardoise belt cannot be dated with certainty.

CHAPTER 3

GEOLOGY AT THE MINDAMAR MINE

1. General

The ore from the Mindamar Mine occurred within a shear-zone, the strike of which parallels the bedding of a northeast-striking, steeply dipping rock sequence. The rocks at the mine have been termed the 'Mine Series', and the shear zone, the 'Mine Shear' (Richardson, 1953). The mineralization has been described as sulphide 'veins' (Richardson, 1953), 'lenses' (Watson, 1954) or 'folded structures within an anticline' (Messervey, 1965) that occurred within an envelope of a distinct quartz-carbonate rock.

2. Map Units and their Distribution

As a result of this study, the 'Mine Series' has been subdivided, for presentation purposes, into six map-units. Each map-unit occupies a distinct stratigraphic position and is characterized by a dominant lithology accompanied by one or more subordinate rock-types. The selected map-units of felsic flows, quartz-carbonate rock, massive sulphides, siliceous siltstones and graywackes, intermediate tuffs and tuff breccias, and intrusions were categorized on combinations of mineralogy, textures, geochemistry and mode of occurrence. Their distribution is best illustrated on the mine plans (Figures 5 and 6, in pocket) and sections (Figures 7 and 8; Appendix II) of the writer.

Previous workers interpreted the ore to be sulphide replacements occurring in an alteration zone within a sequence of westward-facing volcanic and sedimentary rocks. For reasons discussed later, this writer considers the 'altered rocks' and the ore to be part of the primary stratigraphy. From the mine plans, it is apparent that the sulphides occurred within and between two other map-units, the quartz-carbonate rock and the overlying siltstones and graywackes. These three rock-units have been designated the ore-zone by the writer. Rocks east and west of the ore-zone comprise the 'stratigraphic' footwall and hangingwall respectively.

3. Descriptions

A The Footwall Rocks

The stratigraphic footwall rocks are dominated by massive felsic flows with minor pyroclastics and siltstones, all of which are underlain to the east, beyond the coverage of Figures 5 and 6, by intermediate flows and tuffs.

a. Felsic Flows

A large volume of rocks within the 'Mine Series' are considered to be felsic lava flows. Chemically, the rocks are siliceous (SiO_2 > 66%) with a large proportion of specimens analyzed being relatively enriched in Na_2O (Tables 2, 3, 4) when compared to average

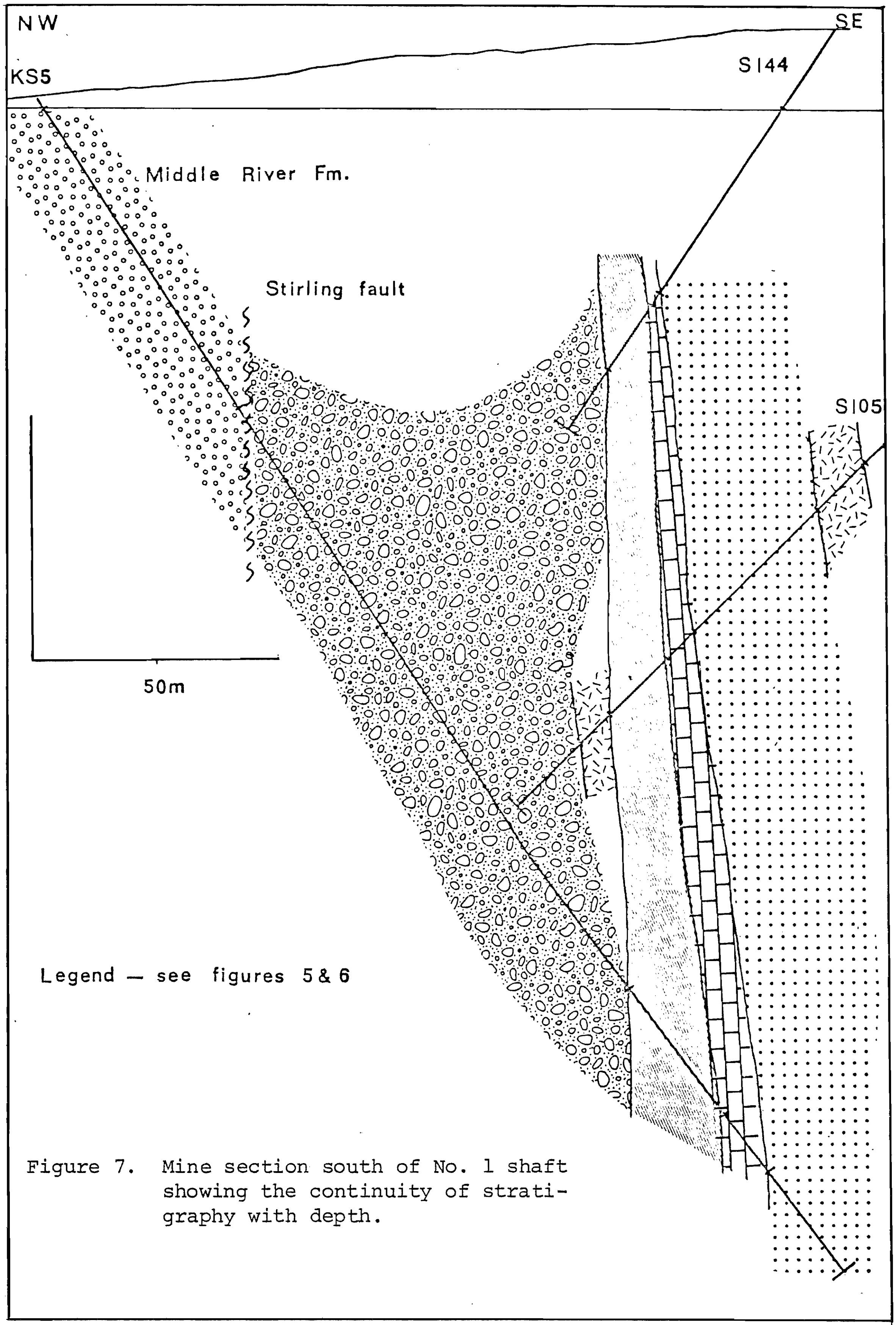

Figure 7. Mine section south of No. 1 shaft showing the continuity of stratigraphy with depth.

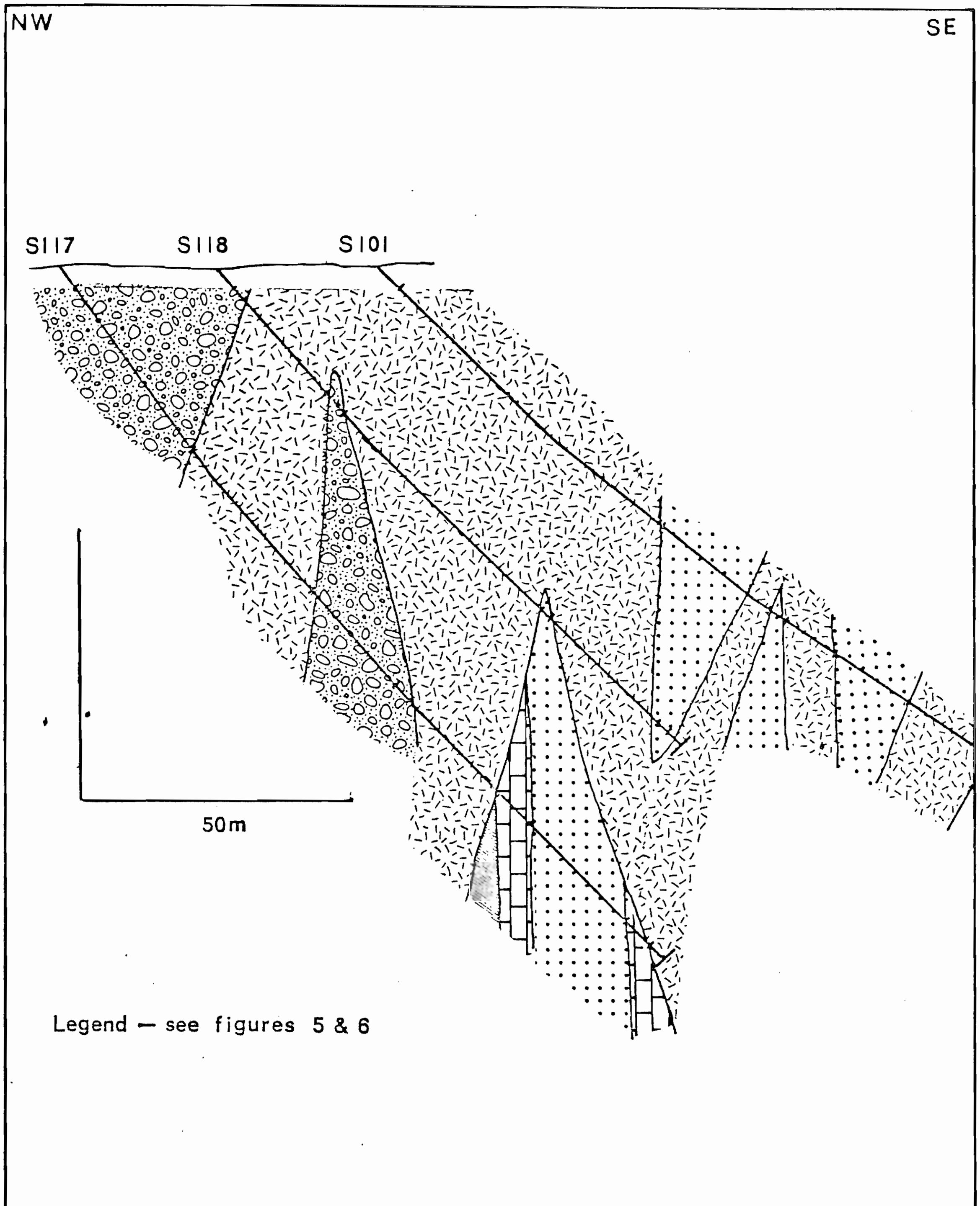

Figure 8. Mine section north of No. 2 shaft illustrating the large volume of intrusive material.

	FELSIC VOLCANIC ROCKS										INTERMEDIATE TUFFS			SILICEOUS SILTSTONES		
	BN479	BN539	BN542-1	BN559	BN585	BN466*	BN480*	BN483*	BN517*	BN528*	BN471*	BN522*	BN476	BN560	BN569	BN536
SiO_2	74.88	71.92	74.93	75.43	76.74	71.18	72.78	70.92	81.97	78.49	47.92	51.29	27.31	69.56	76.57	26.88
Al_2O_3	10.39	12.91	11.64	10.85	9.04	11.67	10.52	10.12	7.69	10.00	14.96	16.56	8.16	9.24	10.48	10.96
Fe_2O_3	2.47	4.38	3.52	1.66	1.80	.60	.33	.73	.15	.04	1.16	1.96	6.59	7.74	2.55	8.10
FeO						2.37	3.07	1.20	.35	1.02	8.09	6.81				
MgO	.64	1.20	.68	2.36	.53	4.31	2.92	1.99	.44	.90	7.90	6.88	9.36	.62	.55	11.30
CaO	2.13	2.01	1.80	1.74	3.37	1.34	1.76	4.26	2.86	2.01	5.79	2.88	25.88	2.93	2.01	15.66
Na_2O	4.34	2.68	3.95	3.27	4.51	.56	3.11	.18	3.05	4.37	1.93	1.96	.39	3.10	2.49	1.89
K_2O	.41	1.97	1.09	.87	.02	2.14	.60	2.99	.21	.68	.99	2.54	.13	.74	1.89	1.62
TiO_2	.18	.20	.22	.24	.17	.21	.17	.20	.14	.20	.86	1.22	.33	.41	.27	.66
MnO						.22	.09	.09	.07	.04	.09	.06				
P_2O_5						.11	.02	.02	.01	.02	.07	.43				
CO_2						1.77	2.49	3.43	2.69	1.68	2.97	2.01				
H_2O^+						4.99	2.43	2.12	.88	.78	5.83	4.90				
H_2O^-						.23	.08	.19	.21	.11	.08	.18				
LoI	2.49	2.68	1.92	2.71	2.13								23.74	2.15	1.79	24.22
TOTAL	97.93	99.95	99.75	99.13	98.31	99.58	100.37	98.44	101.62	100.34	98.64	99.68	101.89	96.49	98.60	101.29
Cu(ppm)	6	4	3	5	12								46	64	44	55
Pb	<3	3	<3	<3	8								3	48	6	4
Zn	67	94	85	30	37								36	84	44	50
Mn	580	890	374	330	556								1240	540	365	1730

BN490* - Dalhousie Geology Department Lab.

BN476 - Cominco Lab - Vancouver

TABLE 2. Whole rock geochemistry of the footwall rocks.

values for rhyolites (Carmichael *et al.*, 1974).

In hand specimen, the felsic flows are grey, buff to purplish, or light to dark green depending on the chlorite content. In thin section, the flows consist of a massive, fine-grained siliceous matrix of up to 80 percent cryptocrystalline quartz, occasionally with 10 percent phenocrysts of ellipsoidal quartz 'eyes' and feldspar grains (Plate la). Within the felsic flows, chloritized mafic rocks occur as inclusions having sharp contacts.

Quartz phenocrysts occur as anhedral 'eyes' which are commonly rimmed by an unknown, extremely fine-grained mineral, or corroded by the matrix material. Locally, the quartz grains have been fractured, recrystallized with a preferred orientation in the foliation plane, or strained - as evidenced by undulose extinction in the grains. Remnants of feldspar phenocrysts are subhedral to anhedral and have undergone extensive sericitation, leaving pseudomorphs with relic polysynthetic twinning. Like quartz, the feldspar grains have a preferred orientation in the foliation plane and show corrosion by the matrix. Calcite is present as isolated blebs within the matrix and in crosscutting veinlets associated with quartz. Calcite is also commonly abundant near altered feldspars. Chlorite is present in oriented fractures but also as lepidoblastic* growths near altered feldspars and aggregates of calcite grains.

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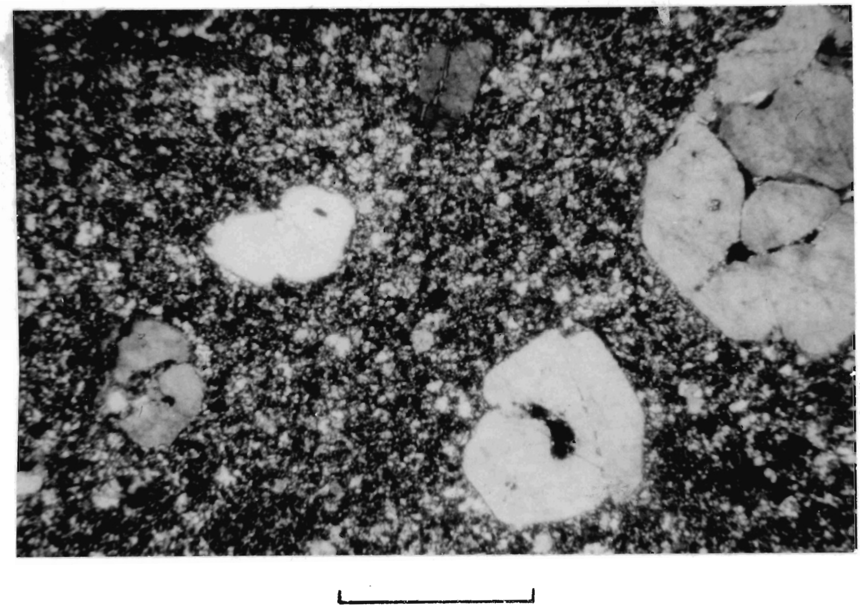
* Lepidoblastic - a term applied to that type of flaky schistosity due to an abundance of minerals like micas and chlorites with a general parallel arrangement.



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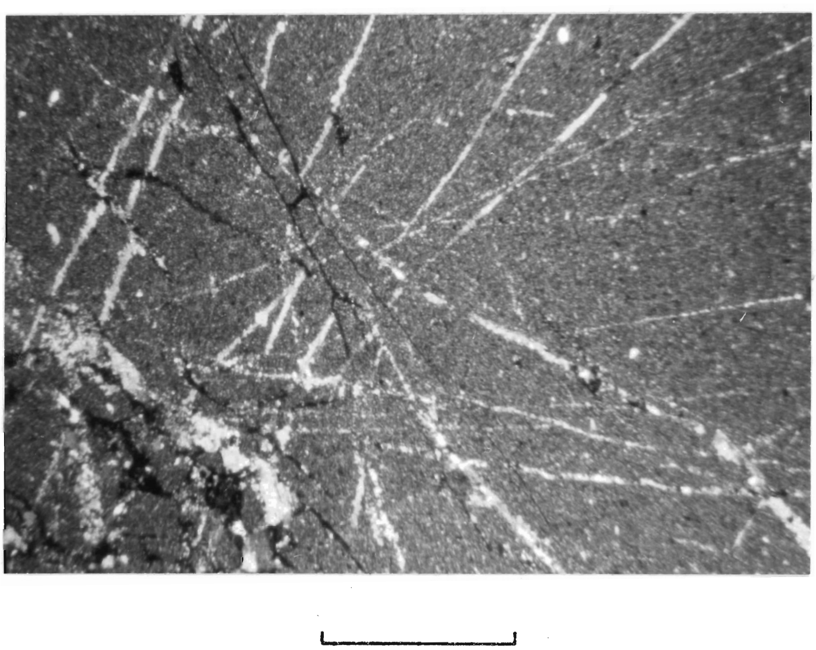
a. Photomicrograph of a rhyolite flow exhibiting quartz and feldspar phenocrysts within a quartz-sericite matrix (x-nicols).



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b. Photomicrograph of a fractured rhyolite exhibiting a random orientation of fractures that have been infilled with calcite (x-nicols).

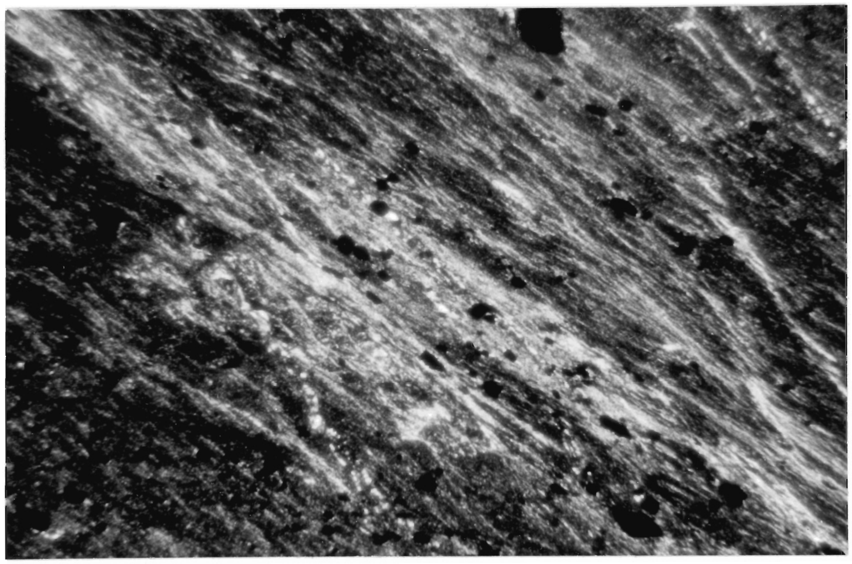
PLATE 1

Some of the felsic flows have been subjected to intense fracturing. Where the fracturing is less intense, the distribution and orientation of the fractures is random (Plate 1b); however, as the intensity increases, the fractures become closely-spaced in parallel arrangement imparting to the rock a fracture cleavage (Plate 2a). The cleavage direction coincides with the direction of the foliation within the mine area. Drill hole KSL (Appendix I) contains a grey, massive rhyolite which grades progressively from a rock with minor, randomly oriented fractures into an extensively sheared quartz-sericite schist. Commonly accompanying the shearing has been the introduction of calcite (carbonatization) which has transformed the initial rhyolite into a quartz-calcite-sericite schist. The majority of the felsic flows have resisted shearing and carbonatization, but thin tuffaceous layers, commonly interbedded with the competent felsic flows, are usually extensively deformed and altered.

Interbedded with the rhyolites are narrow zones (10 to 30 cm thick) of thinly laminated siltstones. Chemically, the rhyolites and siltstones are similar (Table 2). Descriptions of the siltstones occur in a subsequent section.

b. Intermediate - Mafic Flows

Flows of mafic composition (SiO_2 45 to 52 percent) occur in the footwall east of the rhyolites, off the limits of Figures 5 and 6. These rocks are dark to medium green in color, locally amygdaloidal



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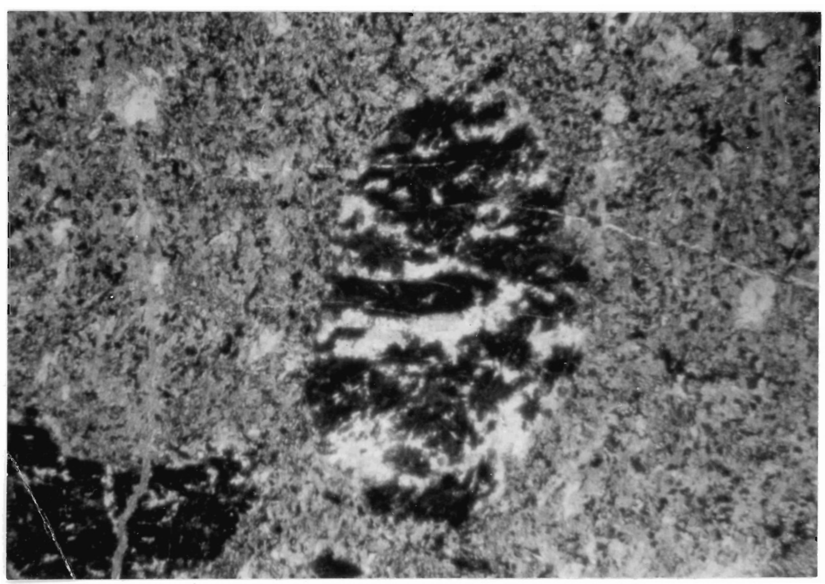
a. Photomicrograph of an extensively deformed rhyolite flow exhibiting a strong fracture cleavage. The rhyolite has been transformed into a quartz-sericite-calcite schist (x-nicols).



1 mm

b. Photomicrograph of a mafic flow with altered amygdales. (x-nicols)

PLATE 2

(Plate 2b) and contain up to 20 percent feldspar phenocrysts in an aphanitic to medium-grained feldspathic and chloritic matrix. The matrix accounts for approximately 50 percent of the rock.

Feldspars, occurring as phenocrysts or as part of the matrix, have been extensively replaced by sericite, leucoxene, clays and calcite, but relic polysynthetic and Carlsbad twinning have been preserved. Boundaries of the altered feldspars are distinct, but locally show corrosion by the matrix. Chlorite, pleochroic in shades of green with a brownish and Berlin blue extinction under crossed nicols, occurs as lepidoblastic aggregates. Calcite is present as widespread, fine-grained, crystalline masses within the matrix and in veinlets associated with quartz. The calcite content tends to increase with the intensity of the foliation. Calcite also forms pressure shadows to the larger feldspar and magnetite grains. Amphibole and/or pyroxene is seen in thin section in accessory amounts as microcrystalline grains that are closely associated with aggregates of chlorite. Up to 10 percent magnetite is present and locally has been oxidized to hematite.

Sheared mafic flows have been altered to chlorite-calcite schists which commonly exhibit cataclastic textures. Feldspar phenocrysts have been comminuted and the crystal fragments (1 mm size) occur as subangular aggregates or as grains redistributed with a preferred orientation in the foliation plane.

B. The Ore-Zone

The ore-zone at the Mindamar Mine consists of three principal zones: 1. a quartz-carbonate rock with minor altered tuffs, siltstones and sulphides, commonly in mineable concentrations; 2. massive sulphides with minor quartz-carbonate, tuffs and siltstones and 3. siltstones Generally, the entire ore-zone is mineralized to some degree but zones completely barren of sulphides are present. The quartz-carbonate occurs in contact with the footwall rhyolites and is overlain by the majority of the sulphides and the siltstones.

a. The Quartz-Carbonate Rock

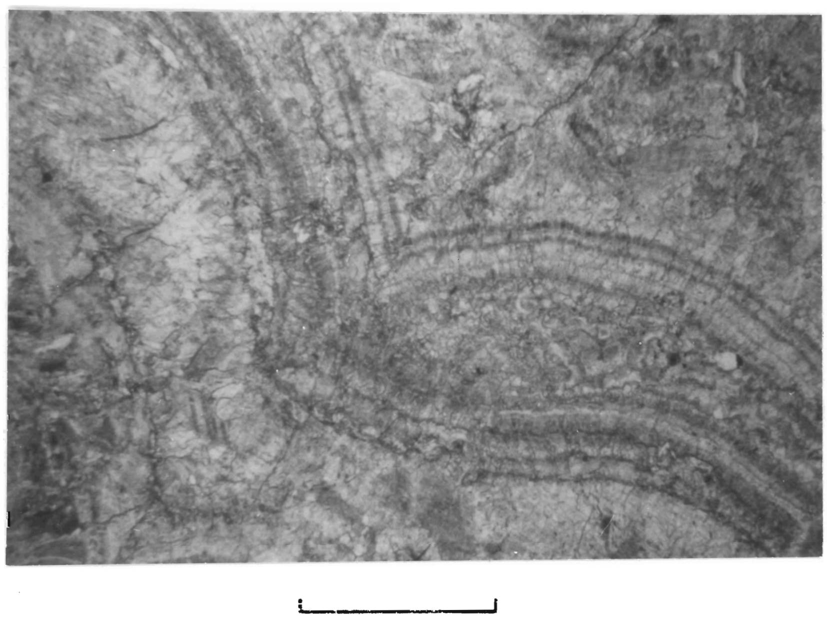
Three large lenticular quartz-carbonate bodies have been described by Richardson (1953) within the 'Mine Series'. The main central body is 304 metres long, 45 metres wide and is truncated at the surface. The northern body is 250 metres long, 25 metres wide, comes within 60 metres of the surface and is more continuous than the central zone. Diamond drilling to the south of No. 1 shaft encountered another quartz-carbonate body which comes to within 135 metres of the surface. The depth and geometry of the bottoms of all three zones are unknown. In between the three quartz-carbonate bodies, the 'Mine Series' consists of siltstones, altered volcanic rocks and intrusions. At the south end of the mine, occur a few, well mineralized, podiform quartz-carbonate lenses, up to a few metres long (J. MacPherson, pers. comm.). With the available drill information, the writer could not distinguish the three zones of Richardson or the podiform lenses.

The quartz-carbonate rock consists of an aphanitic to medium-grained, mottled mass of crystalline carbonates and quartz. In order of decreasing abundance, the minerals are dolomite, magnesite, quartz, sericite, talc, chlorite, barite, albite and alunite (Watson, 1954). Of these, only barite and alunite were not identified by the writer.

Dolomite and magnesite, verified by x-ray diffraction, form approximately one half of the entire ore-zone and occur together as medium to fine-grained, white to buff colored crystalline masses. In thin section, the bulk of the carbonate is a brownish color in plane polarized light, fine-grained and massive. Another form of dolomite, considered by the writer to have been recrystallized, is medium to coarse-grained and white in plane polarized light. Fine-grained quartz is ubiquitous in the carbonates.

Locally, the carbonates have been extensively fractured and re-cemented repeatedly; a distinct crustified layering developed within the cement (Plate 3a). Elsewhere, this layering is also seen in a colloform texture (Plate 3b) with the layers having an appearance similar to growth rings within a geode. Etching of sections of colloform layers revealed dolomite layers predominating in some cases, magnesite in others, and alternating layers of both in a few (Watson, 1954). A fine-grained layer of pyrite commonly occurs in the earliest-formed colloform 'growth ring'. Occurring in one specimen with a well-developed colloform texture are concentrically layered spheres having a core of dark brown material and outer layers of radially

a. Crustified layering within the clasts of a quartz-carbonate breccia.



1 mm

b. Photomicrograph of the colloform texture within the quartz-carbonate rock (plane-polarized light).

PLATE 3

arranged carbonate crystals. These spheres closely resemble oolites and occur in clusters (Plate 4a).

James and Buffam (1937) noted an irregular 'crenulated' banding within the carbonates; the orientation of the banding parallels the laminations in the siltstones. This, they believed, was evidence for the original rock having been bedded. These crenulations probably represent stylolites a texture observed in the drill core.

Other parts of the quartz-carbonate rock are composed of practically 80 to 100 percent fine-grained quartz. The quartz is massive, crystalline, grey and dense. In thin section, the rock is similar in texture to the rhyolite flows and has undergone extensive brecciation, with the fractures infilled by dolomite. Most of the quartz grains exhibit undulose extinction, as well as corrosion and dissolution along grain boundaries. Angular clasts of carbonate and sulphides, commonly elongated in the foliation plane, occur within the zones of abundant quartz.

Both sericite and chlorite occur in elongated lenses as lepidoblastic aggregates sporadically distributed throughout the quartz-carbonate rock, but can also form the major components of distinct layers within it.

Talc, confirmed by x-ray diffraction, occurs in much the same manner as sericite and commonly, the grain size of both minerals is too fine to distinguish them optically. Generally, the talc has random growth orientations, but in areas that have been sheared, talc has grown with a preferred orientation imparting a strong foliation to the rock. Talc also forms a matrix for angular carbonate clasts or occurs as discontinuous lenses in sulphides. The talc content of the ore-zone ranges from negligible to 100 percent but averages about 5 percent. An abrupt increase in the talc content with depth (J. MacPherson, pers. comm.) discouraged the mine operators from exploring and developing the deeper levels of the mine.

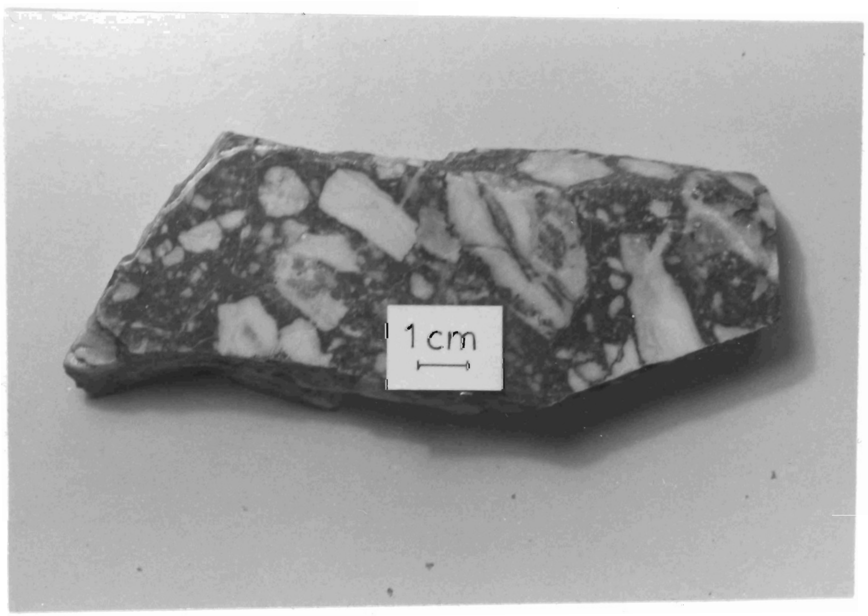
Barite has been described (Watson, 1954) as having two modes of occurrence: 1) forming clusters of anhedral grains in colloform dolomite/magnesite layers that locally have recrystallized and have been replaced by talc, and 2) barite is present along with quartz, clinochlore, carbonate, albite, pyrite, and chalcopyrite in veinlets that cut a few of the local intrusions.

Within the quartz-carbonate rock, minor concentrations of sulphides occur as ubiquitous disseminations, isolated blebs, clasts or in massive layers 1 to 2 mm thick. The latter layers commonly are interstitial to, or draped around, carbonate fragments. In drill hole KSM (Appendix I) there is a repetition four times of layers, 10 to 20 cm thick, containing carbonate fragments within a sulphide-rich matrix (Plate 4b).

The quartz-carbonate contains what James and Buffam (1937) called 'inclusions of volcanic rocks' the dimensions of which range

1 mm

a. Photomicrograph of the quartz-carbonate rock exhibiting concentrically-zoned spheres - oolites? (x-nicols)



b. Angular carbonate fragments within a sulphide-rich matrix.

PLATE 4

from a few centimetres to large tabular bodies, 9 metres thick, extending over an area of 70 by 45 metres. The largest of these inclusions, found on the '100 foot level', begins approximately 15 metres southeast of No. 1 shaft and extends northeasterly for a distance of 65 metres. This block is 10 metres thick and extends vertically for 45 metres (James and Buffam, 1937). Weeks (1924) noted alternating layers of sulphides with 'greenstones' and 'schists' in some of the early development trenches. Early workers interpreted these inclusions to be areas where the volcanic rocks resisted replacement. In drill hole KSA (Appendix I) four separate layers of altered tuffs alternate with layers of quartz-carbonate. Contacts of the quartz-carbonate with the tuffs are abrupt and, commonly, thin laminae of sulphides in the quartz-carbonate parallel the contact. Locally, the contacts have been sheared.

The 'inclusions' or tuffs are light green in color and contain stretched lithic and/or crystal fragments (1 to 2 mm in size) in a dolomite-sericite-chlorite matrix. Crystalline quartz and dolomite, the major components of the tuffs, occur as discrete anhedral grains or as aggregates of grains with chlorite occupying the interstices. Pseudomorphs of clays or leucoxene have completely replaced feldspars and elongated clasts of volcanic rocks up to 3 or 4 mm in their long direction have been chloritized. A notable feature within these tuffs is the presence of angular clasts of quartz-carbonate. The chemistry of the tuffs is given in Table 3.

	QUARTZ CARBONATE		SILICEOUS SILTSTONES					ORE ZONE TUFFS						
	BN626	BN627	BN591	BN573	BN587	BN465	BN635	BN593	BN576	BN624	BN625	BN619	BN599	BN600
SiO_2	35.99	24.20	70.16	74.72	64.96	66.62	67.97	40.23	48.93	75.49	75.62	47.96	54.07	69.06
Al_2O_3	5.76	3.39	11.11	9.03	10.72	13.01	11.76	15.78	13.37	12.49	10.48	14.72	9.37	14.14
Fe_2O_3	7.30	2.37	5.03	4.44	8.96	6.60	7.17	9.35	9.04	1.39	1.71	13.60	5.51	3.97
FeO														
MgO	12.51	17.54	1.21	.85	1.32	1.01	1.17	23.54	10.84	3.94	4.80	4.12	16.02	4.68
CaO	13.88	21.27	3.07	3.58	3.84	3.23	2.40	.33	4.10	.13	.14	6.04	2.16	.43
Na_2O	.24	.29	2.22	.78	1.05	2.85	2.53	.02	.17	.19	.14	2.19	.11	.09
K_2O	.82	.42	1.73	1.79	2.17	1.28	1.42	.01	1.64	2.27	1.63	1.21	.00	3.51
TiO_2	.19	.05	.58	.44	.39	.58	.57	.85	.66	.25	.20	2.26	.22	.52
MnO														
P_2O_5														
CO_2														
H_2O^+														
H_2O^-														
LoI	15.59	31.88	2.53	3.50	3.03	3.33	1.89	8.75	9.96	2.56	2.76	6.20	6.35	3.23
TOTAL	92.21	101.41	97.64	99.13	96.44	98.51	96.88	98.86	98.71	98.71	97.48	99.30	93.81	99.63
Cu(ppm)	94	10	26	2	64	44	100	147	25	2	5	37	290	10
Pb	130	3	7	<3	22	4	7	12	<3	4	<3	3	760	14
Zn	1450	37	125	60	168	153	580	580	224	66	202	108	3460	126
Mn	2600	1900	455	600	560	490	620	270	1200	25	169	940	2040	285

BN480* - Dalhousie Geology Department Lab BN476 - Cominco Lab. - Vancouver

TABLE 3. Whole rock geochemistry of the ore-zone rocks.

Exposed at the 'glory hole' (Figure 9), and in holes KSA and KSO (Appendix I), altered tuffs occur within the quartz-carbonate. The tuffs are greyish-green in color, aphanitic, and strongly foliated. Elongated pseudomorphs of sericite and talc after feldspars and/or lithic clasts are present. Pyrite grains have been comminuted, with the fragments distributed along the foliation plane. Locally, the deformation was so intense that the tuffs were transformed into talc-sericite schists, obliterating all clues to their primary origin. Eastward and immediately adjacent to these altered tuffs at the glory hole, the quartz-carbonate rock (Table 3, samples BN626 and BN627) consists of a rusty weathering, grey, massive, dense rock composed predominantly of crystalline dolomite with discrete subrounded grains and aggregates of fine-grained quartz. Pyrite, sphalerite and chalcopyrite are present as fine-grained disseminations. A moderate foliation is defined by the presence of lepidoblastic sericite.

Also occurring within the quartz-carbonate are siliceous silt-stones exhibiting fine laminae containing graded bedding. The graded beds indicate tops to the west. The strike of the siltstones and the altered tuffs is conformable with bedding attitudes measured in the footwall and hangingwall rocks.

b. Massive Sulphides

The most important zones of massive sulphides occur as lenses distributed along the northwest side of the ore-zone (James and Buffam,

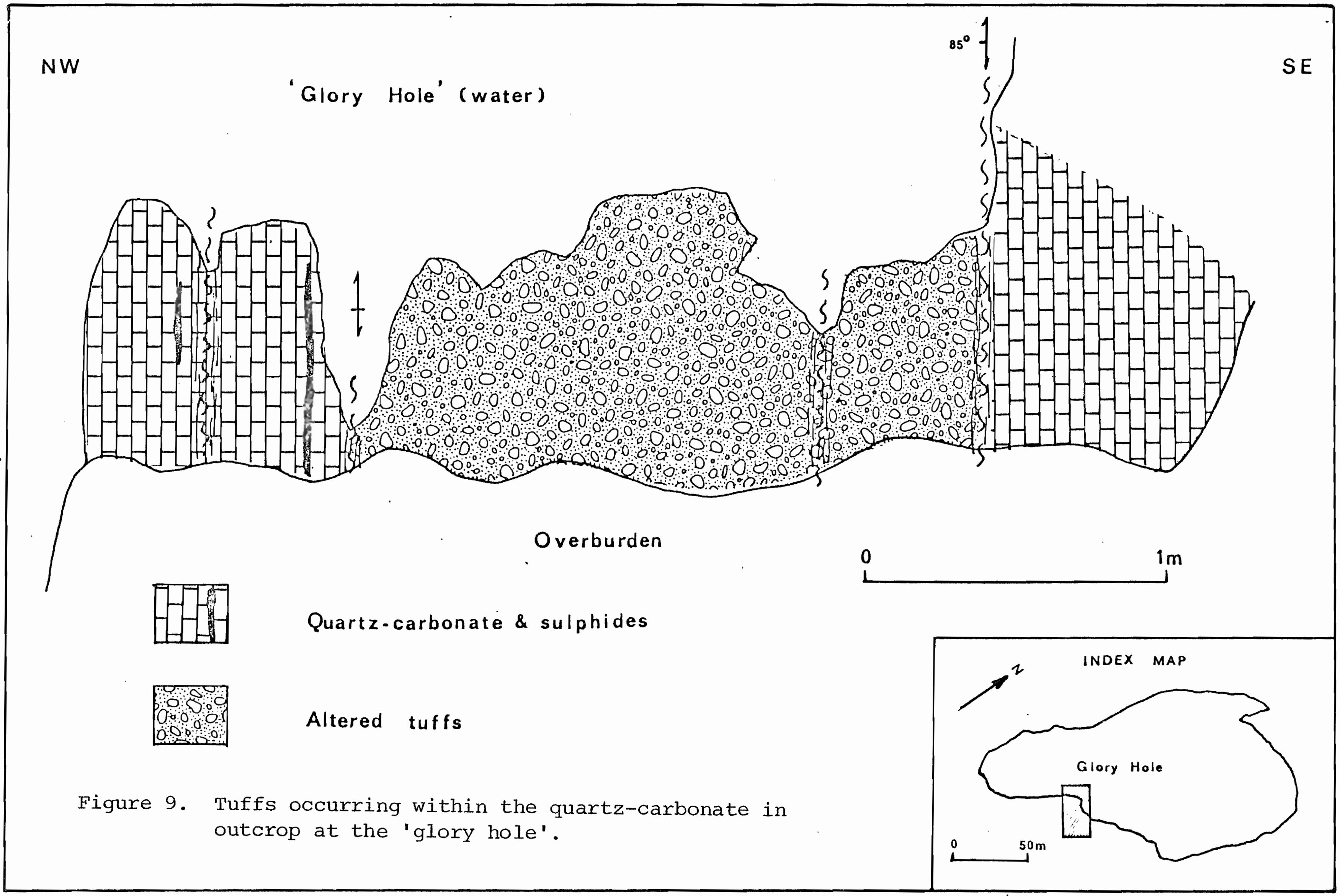


Figure 9. Tuffs occurring within the quartz-carbonate in outcrop at the 'glory hole'.

1937). The larger and higher grade lenses occurred within the siltstones or between and along the contact of the 'quartz-carbonate' with the siltstones. Within the central 'quartz-carbonate' body, the sulphide lenses ranged in length from 12 to 120 metres and were up to 18 metres wide (Richardson, 1953).

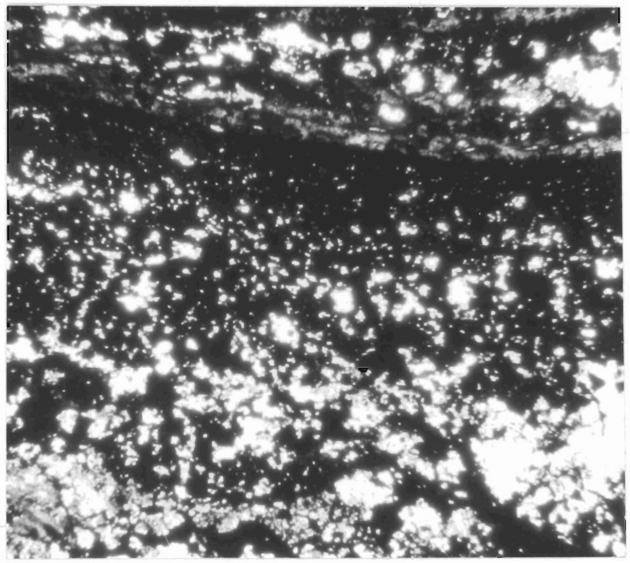
As a rule, the footwall and hangingwall boundaries of the higher grade lenses were abrupt; adjacent to these lenses, however, some pyritic mineralization usually occurred (Weeks, 1924). The lenses terminated laterally by a gradual decrease in the quantity of ore minerals accompanied by an increase in pyrite and commonly, also by a decrease in the dip of the lens. Also, the lenses terminated against younger cross-fractures (Richardson, 1953) and intrusions (Figures 5 and 6, in pocket; Watson, 1954).

Small concentrations of sulphides have been found within the adjacent volcanic rocks (James and Buffam, 1937). This feature was observed in a specimen collected from the mine dumps in which pyrite-rich bands with sphalerite are interlayered with layers of chloritic tuffs. The sphalerite occurs interstitially to fine-grained pyrite, chlorite, sericite and dolomite.

The sulphides within the ore-zone consist of idiomorphic pyrite with allotriomorphic sphalerite, galena, chalcopyrite and tennantite, arranged in order of decreasing abundance.

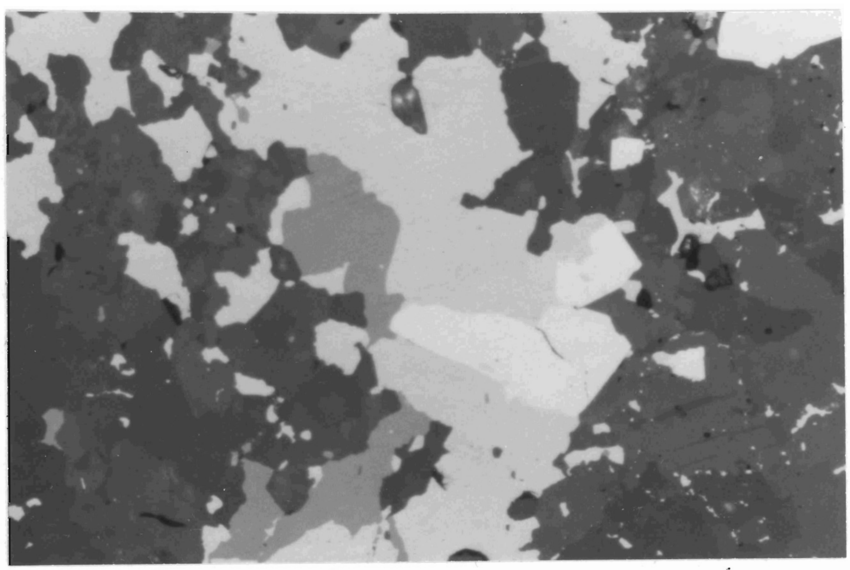
A pronounced banding within the massive sulphides is well developed and has several characteristics. In hand specimen, the bands show continuous 1 to 3 mm thick layers that have abrupt contacts with the overlying and underlying bands. In thin section, these abrupt contacts are still very much in evidence, and the banding is seen to be a manifestation of changes in the relative abundance and grain size of the various components. In one specimen, a gradation is seen in the bands from almost massive sphalerite with minor quartz-carbonate to a reverse in their relative contents. A mineral abundant in one band may be entirely absent in an adjacent band. Within an individual band that contains both sulphides and gangue minerals, the sulphides usually occur towards the bottom of the layer where quartz is coarser-grained (2 mm). Towards the top of the band, the sulphide content decreases as does the grain size of the quartz. At the Mindamar Mine, the banding in the sulphides is aligned parallel to the sedimentary layering that occurs in the adjacent siltstones. The thickness and extent of individual sulphide bands and of laminae within the siltstones are comparable.

Pyrite occurs as ubiquitous fine-grained disseminations throughout the massive sulphides or occurs as the dominant component in distinct, sharply-bounded layers. Within these layers, pyrite is distributed with respect to grain size and concentration (Plate 5a). The pyrite ranges from extremely fine-grained to 2 mm, and is euhedral to anhedral with rounded and angular grain boundaries. Commonly, the pyrite has been granulated into fragments that have been distributed into lenses



1 mm

a. Photomicrograph from a banded, massive sulphide specimen (Plate 6b) showing the distribution of quartz and pyrite with respect to grain size and concentration (x-nicols).



1 mm

b. Photomicrograph of relationships between the major sulphide minerals. Sphalerite (dark grey) accounts for the majority of sulphides with chalcopyrite (medium dark grey) and galena (white) forming inclusions within and rims on pyrite (light grey). Gangue is represented by the darkest grey material. (reflected light)

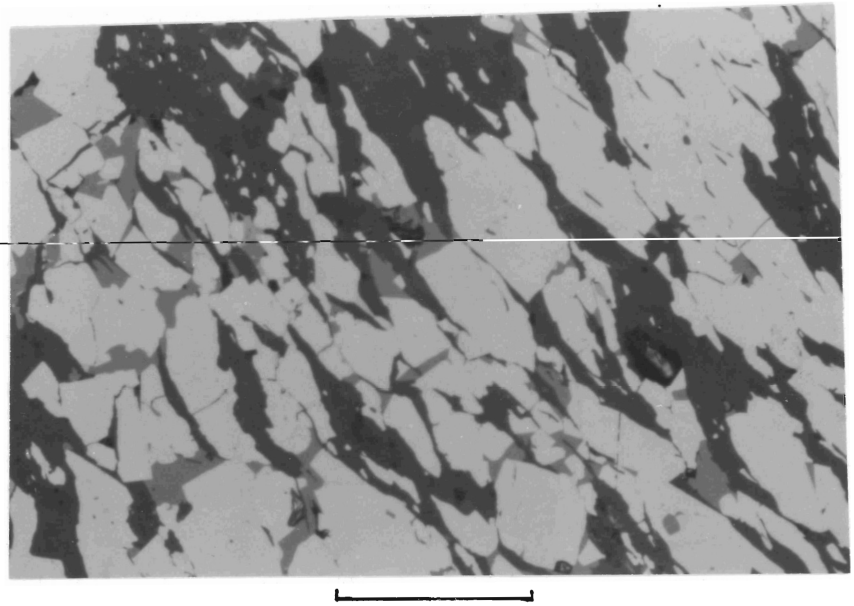
PLATE 5

along the foliation planes. Most pyrite grains have been fractured to some extent and are locally recemented by sphalerite, galena and chalcopyrite. Other layers of pyrite have compaction texturew with stylolites occurring along grain boundaries. Many pyrite cubes have cores of sphalerite, while the fractured pyrites have embayments and inclusions of sphalerite and galena. Other pyrite grains are elongated in the foliation plane. Chalcopyrite and/or galena both vein and rim pyrite grains.

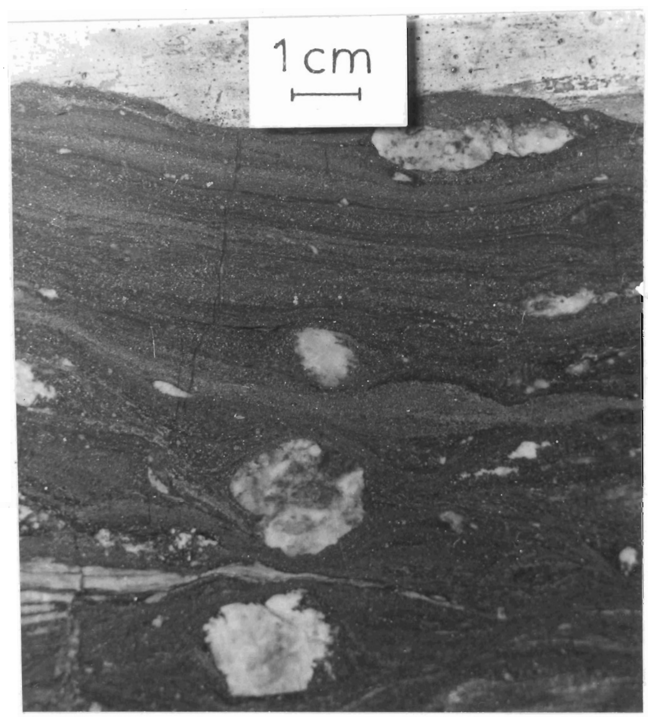
Allotriomorphic sphalerite is the next abundant sulphide after pyrite, and is concentrated in layers or lenses that parallel or cross the foliation. Although the lenses of sphalerite are elongated, the individual grains have an equigranular crystalline texture. Watson (1954) etched some sphalerite and found no strained grains, only undeformed twin lamellae, possibly indicating annealing. Sphalerite also occurs as interstitial material in zones dominated by quartz-carbonate or pyrite. Zones of massive sphalerite contain inclusions of galena, chalcopyrite and tennantite.

Chalcopyrite, galena and tennantite exhibit mutual relationships and occur as 1) randomly-oriented interstitial infillings to pyrite, sphalerite or quartz-carbonate (Plate 5b), 2) inclusions in or coatings on pyrite and sphalerite grains, 3) a cement to aggregates of pyrite grains, or as 4) discrete grains. These three sulphides occur as inclusions or embayments within each other, possibly suggesting contemporaneity in crystallization. Tennantite is closely associated with galena, occurring as inclusions within and coatings around it. The coatings of tennantite are in turn, commonly veined or rimmed by chalcopyrite. Chalcopyrite also forms veinlets that cut the fine-grained banded ore, and occurs at the margins of the mafic intrusions (Watson, 1954). In general, the chalcopyrite (less than 1 mm) is finer grained than the sphalerite and galena, and appears to have been the last sulphide to crystallize, filling in the last available interstices within the rock.

Structurally, a modification of the banding has taken place in the sulphides where the rock has been subjected to the shearing stresses so prevalent within the host rocks. The bands have become wispy lenses (Plate 6a), adjoining others or pinching out completely. The brittle minerals, quartz and pyrite, have undergone extensive fracturing, with the fragments distributed in lenses parallel to the foliation. The 'softer' minerals, sphalerite, chalcopyrite, galena and carbonates, 'flowed' or crystallized in response to the stresses, and have formed distinct lenses parallel to the foliation. Subangular clasts of quartz-carbonate occur within the massive sulphides (Plate 6b). These clasts have been stretched in the plane of foliation and deflect the banding, imparting an augen texture to the rock. Larger pyrite crystals occasionally have pressure shadows of quartz and sulphides in the foliation plane. Layers with abundant sericite, chlorite and talc are strongly foliated.



a. Photomicrograph of deformed sulphides showing the elongation of pyrite grains (light grey), wispy lenses of sphalerite (dark grey) and subsequent infilling by chalcopyrite (medium grey). (reflected light)



b. Subangular clasts of quartz-carbonate rock within massive banded sulphides.

PLATE 6

Evidence of folding is locally visible in one massive sulphide specimen collected from the mine dumps (Plate 7a and 7b). The folding is seemingly the result of shearing processes as the foliation parallels the fold axis. Differential movements along the various shear planes have resulted in an interfingering texture of the individual bands, parallel to the axis and foliation. Within this sample, pyrite has undergone extensive fracturing and subsequent corrosion by other sulphides. An interesting aspect of this sample is that the banding within the sulphides does not parallel the foliation, a feature which is discussed in a subsequent section.

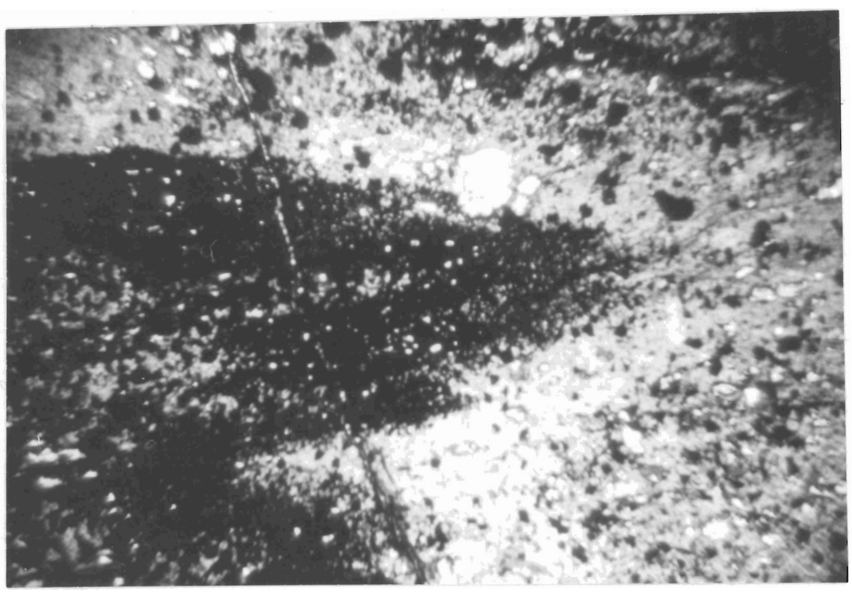
In this thesis, sulphides have been treated as rocks, in the same manner as the host volcanic rocks and later intrusions. It is apparent that the same metamorphic and deformational processes affected all lithologies.

c. Siliceous Siltstones

From the drill core, it is evident that siliceous siltstones occur in the footwall and hangingwall. Their major occurrence, however, is in the ore-zone adjacent to the hangingwall rocks (Figures 5 and 6, in pocket). In the footwall, the siltstones are interbedded with the massive felsic flows, possibly marking the end of an eruptive cycle. Chemically, the footwall siltstones are similar to the rhyolites (Table 2) but they have higher contents of Cu, Pb, Zn, and Mn. Within the ore-zone, the siltstones are felsic in composition also and

1 cm

a. Photomicrograph of a fold within the massive sulphides. The banding does not follow the foliation, but has been displaced by it (plane-polarized light).



1 mm

b. Photomicrograph of the above fold at a higher magnification (plane-polarized light).

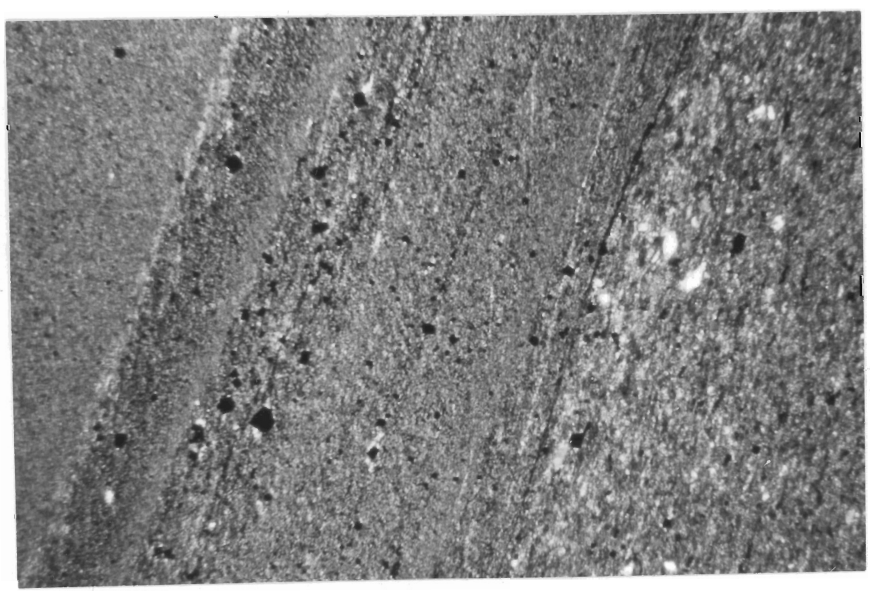
PLATE 7

similar in texture to those in the footwall, but contain considerably more dolomite, chert and sulphides. Generally, the siltstones are too fine-grained for an adequate determination of mineralogy; where coarser laminae exist, however, the minerals are an intimate mixture of fine-grained quartz, sericite, dolomite, chlorite, talc and sulphides.

On a weathered surface the siltstones consist of 1 mm to 1 cm thick laminae containing a rusty weathering zone which gradually changes to a buff-colored zone devoid of rust (Plate 8a). This sequence is repetitive and extends over a thickness of more than 2 metres in drill hole KS3 (Appendix I). The rusty layers are attributable to fine-grained pyrite and traces of sphalerite and chalcopyrite.

Bedding is expressed by changes in the relative abundance and grain size of the components within individual laminae. The laminae have abrupt contacts with adjacent laminae above and below. Graded bedding (Plate 8b) is expressed by coarser grains of quartz and pyrite (commonly framboidal), gradually diminishing in size and content into very fine-grained quartz or dolomite, accompanied by a concommitant increase in the sericite content. These relationships indicate that the beds are westward facing. Abrupt contacts occur at the base of pyrite-rich layers, with a gradual decrease in the pyrite content towards the top of the layer (Plate 9a). Other laminae with abundant pyrite show no apparent grading (Plate 9b). Some laminae consist of crystocrystalline quartz/

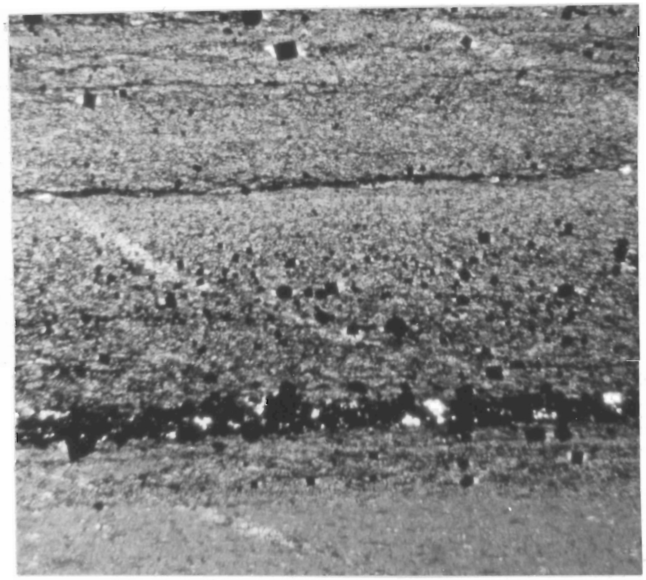
a. Weathered surface of a siliceous siltstone exhibiting cyclic laminae. Darker laminae have weathered a rust-color.



1 mm

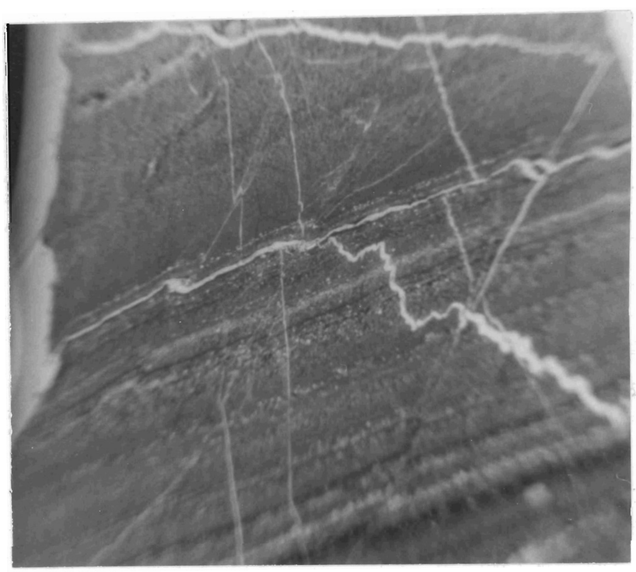
b. Photomicrograph of laminae exhibiting graded bedding within a siliceous siltstone (x-nicols).

PLATE 8



1 mm

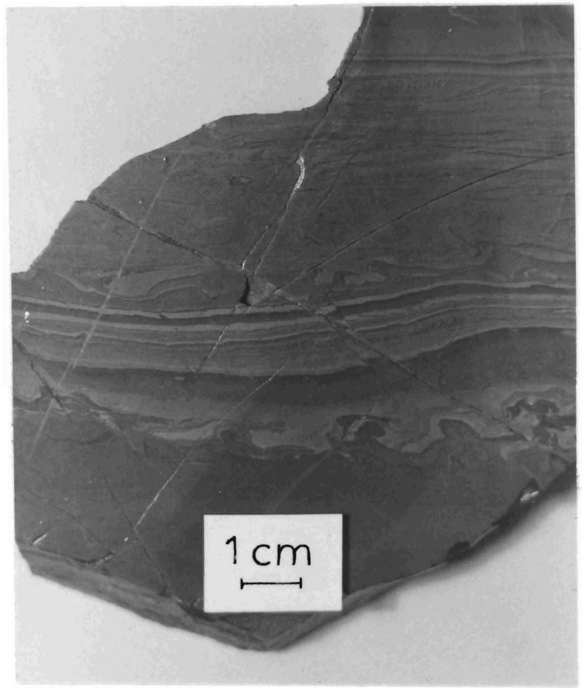
a. Photomicrograph of a siliceous siltstone which shows the relationship between pyrite and the laminae (x-nicols).



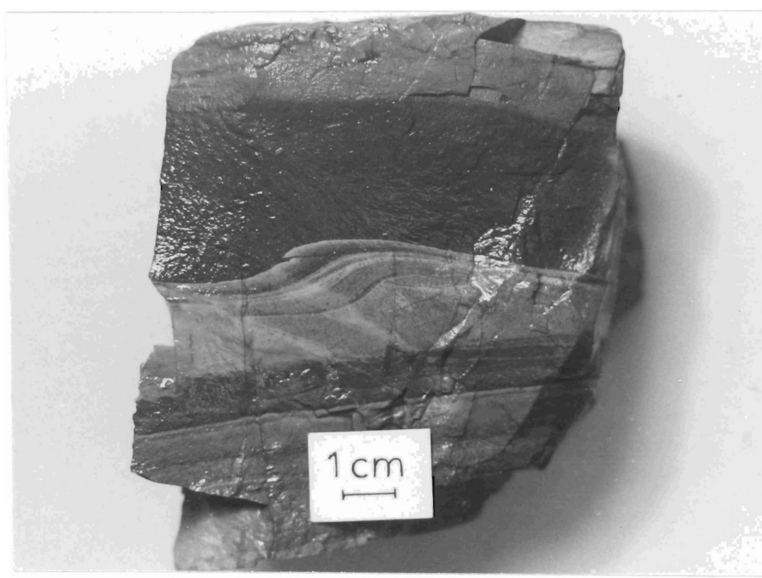
1 cm

b. Photomicrograph of a siliceous siltstone which contains 35 percent of very fine-grained pyrite (plane-polarized light).

PLATE 9



a. Soft sediment deformation and slump structures within a siliceous siltstone.



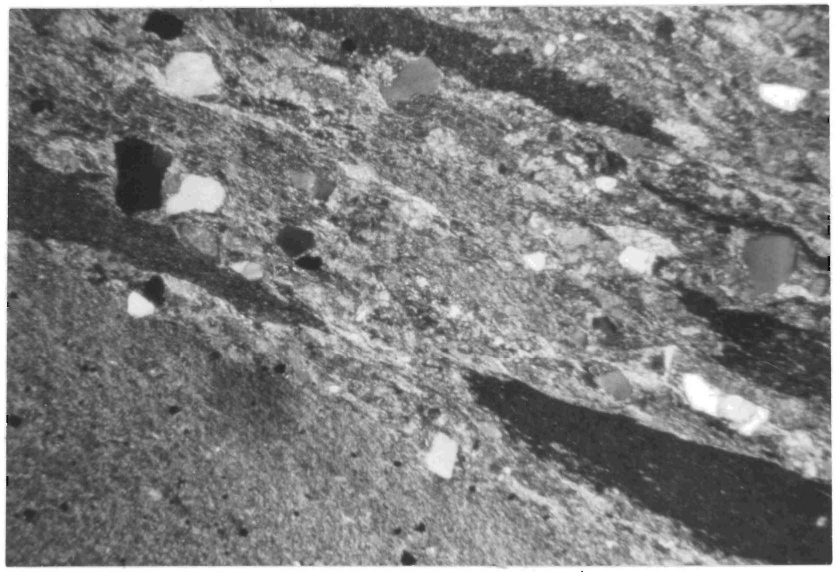
b. Ripple marks within the siliceous siltstones. Darker layers have weathered a rust color.

PLATE 10

sericite layers which grade into crystalline dolomite layers. Thin chloritic tuffaceous material containing crystal and lithic fragments (1 to 2 mm in size) are commonly interbedded with the siltstones.

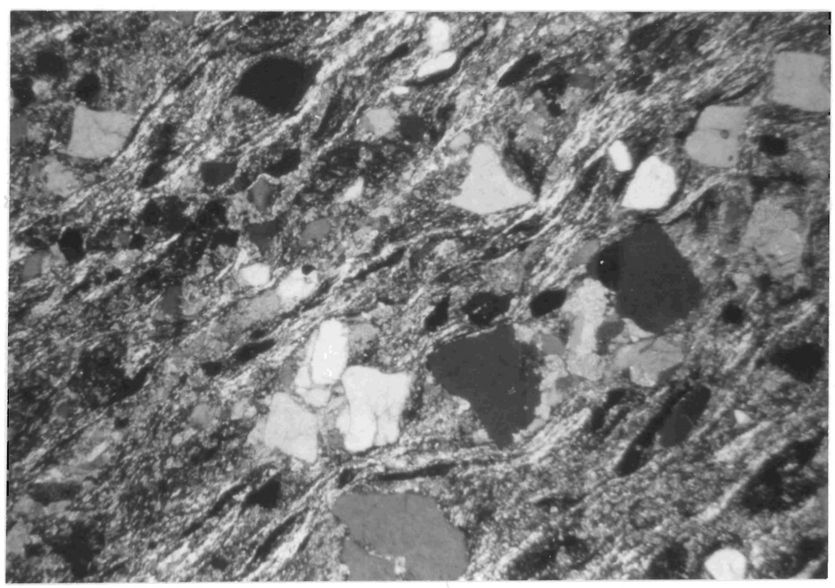
Other sedimentary structures exist within the siltstones but are not widespread. Soft sediment deformation and slump structures, (Plate 10a) and ripple marks (Plate 10b) occur but are rare in the dump material. The siltstones provide the clasts for a conglomerate (Plate 11a) developed within the hangingwall tuffs at the contact between the two lithologies.

Structurally, the siltstones exhibit relatively little deformation in contrast to the adjacent tuffs. They are weakly to moderately foliated in response to lepidoblastic growths of sericite, talc and chlorite. Locally where deformation was more intense the rock was transformed into a calcite-sericite schist, usually with the foliation paralleling the sedimentary laminae or intersecting it at very shallow angles. Where bedding/foliation relationships are not parallel within the siltstones, the pyrite distribution follows the bedding. On the second level, south of No. 1 shaft, the schistosity cuts the bedding at a high angle on the crest of a small fold within the siltstones (Watson, 1954). The pyrite in the sparsely mineralized rock is concentrated mainly in the lower parts of the graded laminae, not along the foliation planes. Within the foliation plane, quartz pressure shadows occur on some of the larger pyrite grains. Elsewhere small localized faults have displaced the sedimentary laminae, with



1 mm

a. Photomicrograph of the contact between the siliceous siltstones and the hangingwall tuffs exhibiting imbricated fragments of the siltstone within the tuffs (sharpstone conglomerate) (x-nicols).



1mm

b. Photomicrograph of a foliated crystal tuff from the hangingwall rocks (x-nicols).

PLATE 11

displacements measured in centimeters.

Watson (1954) noted that the siltstones were changed by dynamothermal metamorphism to sericite schists and that these 'schists' contained the major ore-bodies at the Mindamar Mine.

C The Hangingwall Rocks

The hangingwall rocks are dominated by intermediate tuffs and tuff breccias although intermediate to felsic flows and sedimentary rocks are present.

a. Tuffs and Tuff Breccias

The predominant lithologies within the hangingwall are intermediate pyroclastic rocks consisting of crystal to lithic tuffs (Plate 11b). A striking character of the tuffs is the uniformity in grain size of both the crystal and lithic clasts (1 to 2 mm) which seldom reach lapilli size. The coarsest pyroclastic rocks encountered were lapilli tuffs and tuff breccias in drill holes KS3 and KS5 (Appendix I). Commonly, chloritic layers 1 to 3 mm thick are interbedded with the coarser tuffs, as are massive aphanitic layers, possibly representing flows.

Chemically, the pyroclastics are intermediate in composition (SiO_2 52 to 66 percent) and are quite variable in content of the other major oxides (Table 4). Fundamentally, all of these rocks have

	FELSIC FLOWS	INTERMEDIATE PYROCLASTIC ROCKS								SILICEOUS SILTSTONES		MAFIC INTRUSIONS
	BN607	BN459	BN462	BN464	BN489	BN611	BN490	BN492*	BN605	BN554	BN566	BN542
SiO_2	72.69	59.16	63.68	61.28	55.85	54.06	56.47	55.66	67.30	69.51	88.36	48.88
Al_2O_3	10.99	14.34	14.80	12.94	14.66	15.14	15.45	14.71	14.70	12.56	4.55	15.03
Fe_2O_3	3.42	8.76	5.23	6.13	8.38	8.27	7.76	5.78	3.78	5.85	1.26	1.83
FeO								2.79				2.51
MgO	1.19	2.74	2.05	2.50	3.61	4.84	3.53	3.10	2.17	.81	.62	2.90
CaO	3.52	3.52	3.50	6.09	6.81	5.20	5.00	7.22	2.06	1.74	.89	3.84
Na_2O	.08	3.85	2.39	2.86	2.81	3.40	2.51	2.93	3.56	1.89	.90	4.59
K_2O	2.99	.68	2.26	1.18	.83	1.40	2.28	.99	1.92	2.66	.60	2.71
TiO_2	.47	.73	1.18	.63	.63	1.12	.78	.69	.48	.52	.07	.88
MnO								.15				.10
P_2O_5								.13				.45
CO_2								2.89				3.37
H_2O^+								3.35				2.03
H_2O^-								.22				.18
LoI	3.01	4.61	3.41	5.54	5.97	5.65	6.23		1.82	2.62	.71	
TOTAL	98.36	98.39	98.50	99.15	99.55	99.08	100.01	100.63	97.79	98.16	97.96	99.51
Cu(ppm)	36	20	12	25	26	15	3		4	86	18	
Pb	<3	<3	<3	<3	<3	<3	<3		<3	15	10	
Zn	85	92	65	67	80	126	92		56	110	28	
Mn	460	890	478	810	1160	680	770		366	293	100	

BN480* - Dalhousie Geology Department Lab.

BN476 - Cominco Lab. - Vancouver

TABLE 4. Whole rock geochemistry of the hangingwall rocks and intrusions.

similar characteristics in hand specimen, but have subtle differences in their mineralogy, degree of alteration and grain size. Generally, the tuffs consist of quartz, feldspar crystal fragments, shards, pumice fragments and lithic clasts in different percentages. The matrix material is light to medium green, aphanitic and consists of chlorite, sericite, calcite and leucoxene.

Quartz crystal fragments (1 to 2 mm) are sub-rounded to sub-angular, generally strained, and occasionally show corrosion along grain boundaries. They occur as individual grains or as comminuted aggregates of orginally larger grains, and there is a tendency for their long directions to be aligned parallel to the foliation.

Feldspar crystal fragments are white to pinkish in hand specimen, but in thin section, are seen to consist of pseudomorphs with different degrees of sericitization (> 75 percent replacement). Both relic polysynthetic and Carlsbad twinning are preserved in these pseudomorphs. In tuffs that have been strongly sheared, the feldspars have been fractured, commonly to the point of total annihilation by mechanical deformation and sericitization processes. As with quartz, there is a tendency for the long directions of feldspar grains to be aligned in the foliation plane.

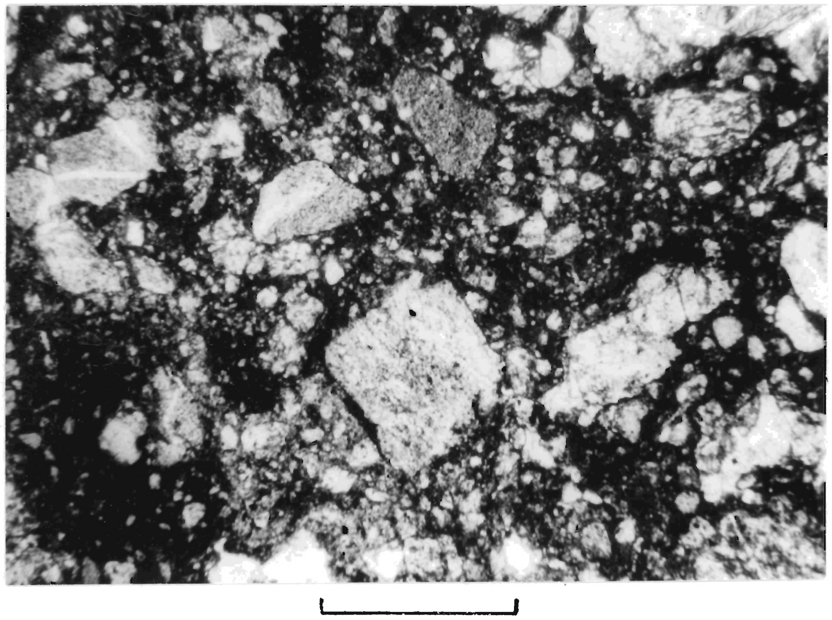
Sericite and chlorite with both brown and Berlin blue extinction colors, occur as lepidoblastic growths imparting a moderate to strong foliation within the pyroclastics. Chlorite is also present as aggregates in interstitial openings.

Crystalline calcite is a major component of the matrix. The calcite content increases with the degree of shearing. Where carbonatization and shearing have been intense a banding has developed within the tuffs characterized by chlorite-rich bands alternating with calcite-rich bands.

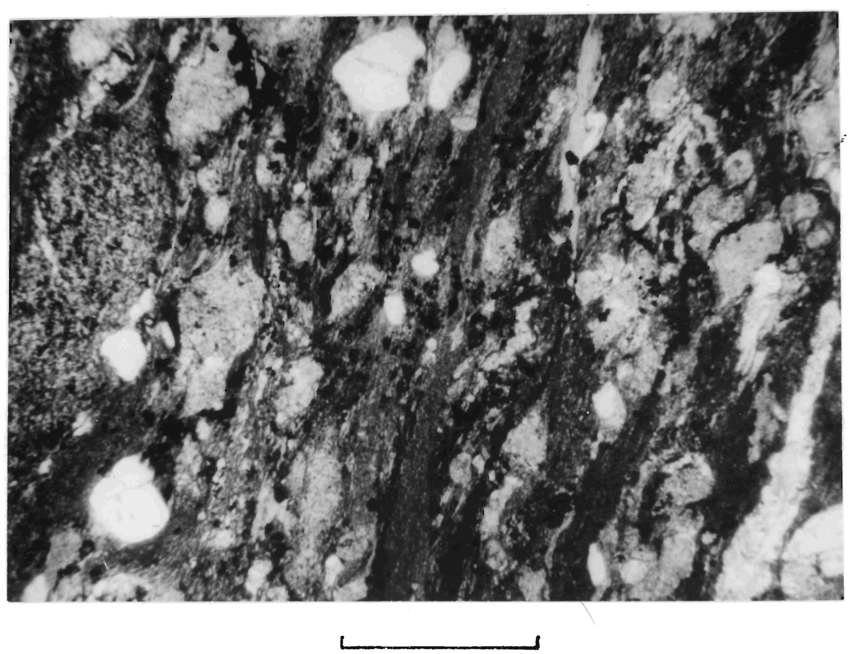
Amphibole and/or pyroxene consists of fine-grained, subrounded grains occurring in accessory amounts within the matrix. They have second order interference colors and two cleavages intersecting at 90° or larger.

Pyrite is a ubiquitous component of the pyroclastic rocks occurring as fine disseminations and comminuted grains that exhibit redistribution along foliation planes. Trace amounts of sphalerite and hematite were noted.

Lithic fragments, subrounded to subangular in shape, compose a large percentage of some tuffs. These fragments, elongated in the foliation plane, are usually altered to sericite, chlorite, leucoxene and clays. Rocks containing large proportions of lithic clasts have been termed tuff breccias (Plate 12a). The majority of the lithic material has been derived from intermediate and felsic volcanic rocks, but flattened chloritic shards (Plate 12b) and pumice fragments (Plate 13a) also occur. Angular fragments of chert, dolomite, and sulphides are seen in pyroclastics west of the ore zone.

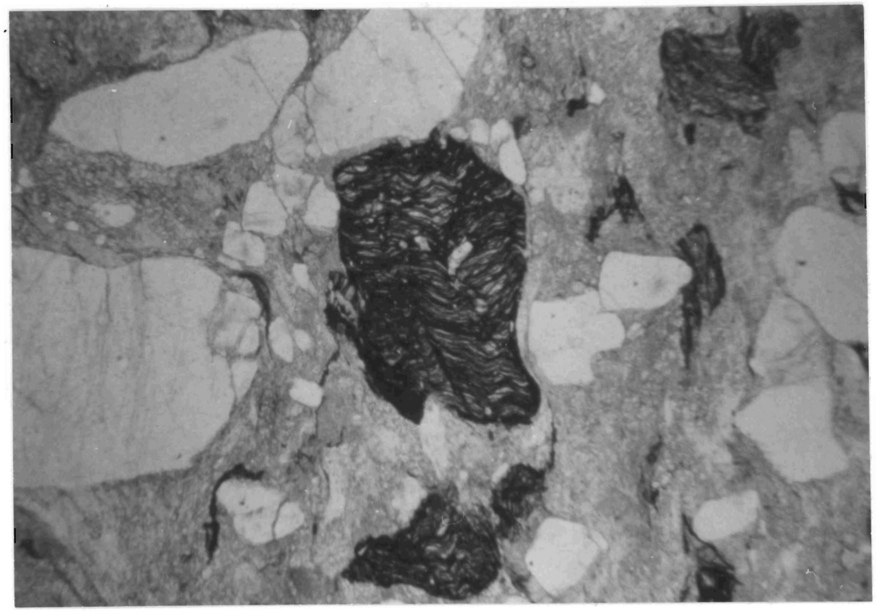


a. Photomicrograph of a lithic tuff breccia from the hangingwall rocks (x-nicols).



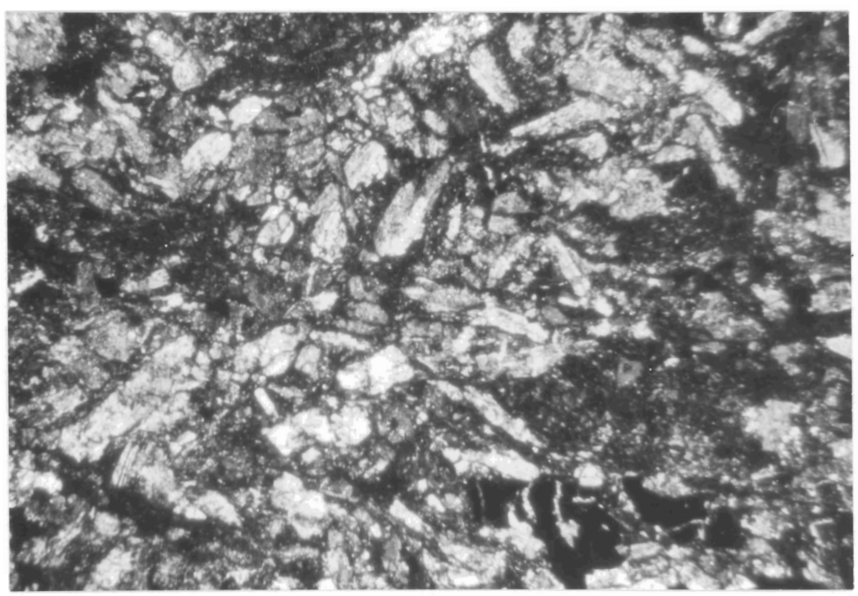
b. Photomicrograph of the hangingwall tuffs exhibiting stretched chlorite shards (x-nicols).

PLATE 12



1 mm

a. Photomicrograph of the hangingwall tuffs showing undeformed pumice fragments (plane-polarized light).



1 mm

b. Photomicrograph of a mafic intrusion exhibiting altered laths of feldspar (x-nicols).

PLATE 13

The sulphide fragments consist of an aggregate of subangular pyrite grains within a siliceous sericitic matrix, which is sitting within the matrix of the tuff.

Graded bedding is visible in the pyroclastic rocks. The coarsest layers contain abundant quartz and feldspar grains, in grain to grain contact, within a sericite-chlorite matrix. As the grain size of the quartz and feldspars decreases upward, their abundance diminishes so that the grains are floating in the matrix. As the grain size continues to decrease, leucoxene and clays become the dominant components of the matrix. Other beds contain subrounded to subangular pyrite, occurring in thin laminae parallel to the bedding. Pyrite occurs as aggregates or as discrete grains that generally, are restricted to individual laminae, a feature that is distinct from the textures of the fractured pyrite described previously. Where the bedding is seen, the foliation parallels it or cuts it at shallow angles.

Structurally, the pyroclastics are moderately to strongly foliated and have undergone differing degrees of shearing and carbonatization (Table 4) obliterating primary textures. In one specimen (drill hole KSL, BN 614) - the foliation, defined by lepidoblastic minerals, elongated aggregates of leucoxene, and bands of calcite, has been kinked. The alignment of the long directions of quartz and feldspar crystal fragments commonly indicates a rotation of the grains, forming an augen texture deflecting the foliation. These grains commonly have pressure shadows of quartz or calcite. The degree of fracturing within the quartz, feldspars, and pyrite, combined with the rotation of grains and a strong foliation, points to mechanical deformation. Later quartz/calcite veinlets cross-cut these structures.

A minor proportion of the hangingwall is composed of felsic flows and siltstones similar to those already described.

D Intrusions

Within the mine, rocks of the footwall, hangingwall and ore-zone have been intruded by mafic rocks which account for at least 30 percent of the entire 'Mine Series' (Richardson, 1953) (Figures 5 and 6, in pocket). The volume and distribution of the intrusions have been a misleading aspect in previous interpretations of the ore body where very few intrusions were represented. In the mine dumps, mafic rocks do not account for any appreciable amounts of material, but within the drill core they are by far the most voluminous lithology, often making up 50 percent of the entire intersection. In the mine plans (Figures 5 and 6) it is clear that the volume of intrusive material decreases with depth, thus making the deeper levels more amenable to mining. The upper levels in the northern part of the mine were uneconomical for production due to the large volume (over 30 percent) of intrusive material.

The major intrusions are sill-like in nature, being parallel or subparallel to the foliation and bedding (Figures 5 and 6). The sills have attitudes from vertical to near horizontal and thickness up to 22 metres (Watson, 1954). Smaller crosscutting dykes accompany the sills and have similar attitudes. An intrusion exposed on the northwest side of the 'glory-hole' dips southerly at 45° and can be traced from the surface to below the '200 foot level'. The dip length is over 90 metres and the average thickness is 4.5 metres (James and Buffam, 1937). Generally, the intrusions are very irregular in form, pinching and swelling laterally and vertically; locally, they have been offset by younger shears (Figures 5 and 6).

The intrusions are mafic in composition (SiO_2 45 to 52 percent) (Table 4) and consist of a dark to medium-green chloritic matrix in which occasionally are lath-shaped feldspar phenocrysts up to 1 mm long (Plate 13b). These phenocrysts have been altered to saussurite, epidote and leucoxene. Within some of the intrusions, a well-developed ophitic texture occurs. Pyrite and magnetite are ubiquitous, locally accounting for as much as 10 percent of the rock. Xenoliths of chert were observed within the intrusions in drill hole KSH (Appendix I).

The intrusions are moderately to strongly foliated, with lepidoblastic chlorite. This chlorite gives a streakiness to the rock and is deflected around feldspar phenocrysts. The intrusions have been extensively sheared and show numerous slickensided shear planes within them. Accompanying the shearing has been the extensive introduction of calcite. Most of the contacts of the intrusions with the country rock are strongly sheared and carbonatized ($\leqslant$75% by volume) with the degree of foliation and carbonatization decreasing away from the contacts. The central zones of the intrusions are generally massive, porphyritic, weakly foliated and slightly carbonatized. Quartz-calcite veinlets cut the dykes and sills, causing a saussurite-epidote alteration at the contacts.

From the observations of the writer and Watson (1954), it is concluded that the intrusions transect the quartz-carbonate and sulphide lithologies and that the intrusions are therefore post-mineralization. The intrusions have chilled margins against the ore lenses they cut, and contain sparse sulphides, although Watson (1954) noted local veinlets of calcite, containing chalcopyrite and pyrite, within the dykes and sills. The fact that the intrusions, which are sheared and carbonatized, transect the ore-zone indicates that the shearing and carbonatization processes were younger than the intrusions which in turn are younger than the mineralization. Xenoliths of chert, quartz-carbonate and tuffs are interpreted from the drill core to occur in the intrusions.

E Structure

Bedding within rocks of the 'Mine Series' strikes northeasterly, and dips vertically or steeply to the east. This attitude is parallel to the strike and dip of the ore-zone and the banding within the massive sulphides. The average strike of the ore-zone is N 30°E, and the dip is 80 to 85°SE (James and Buffam, 1937). Graded bedding within the siltstones and pyroclastic rocks indicates that the beds are westward facing, thus putting the rocks of the 'Mine Series' on the western limb of a slightly overturned anticline.

The major structure within the 'Mine Series' is the 'Mine Shear' which has a width of approximately 100 metres and an attitude which roughly parallels the bedding. The 'Mine Shear' has been traced underground for approximately 1,520 metres along strike, and to a depth of 350 metres (Watson, 1957). It has been the formation of this shear that has been responsible for the carbonatization and the foliation within rocks of the 'Mine Series'. Evidence offered by the striations, grooves and parasitic folds on the fault planes indicates that the southeast side moved down and to the southwest (James and Buffam, 1937), and that the deformation textures described previously are the result of translation. In the northeastern part of the 'Mine Shear', minute crinkles in the foliation within the tuffs produce a lineation plunging steeply to the northeast (Watson, 1957).

Post-ore faults are numerous (Watson, 1957) with two distinct sets closely related to the individual lenses of ore. These faults are thought to cause a thinning of the quartz-carbonate laterally and at depth (James and Buffam, 1937). The more important of the two sets of faults occur on the northwest side of the ore-zone on the '300 and 400 foot levels' in the vicinity of the No. 1 shaft. These faults strike N 5°E and dip 70° to the SE, cut the ore-zone at small angles, and therefore cause an apparent thinning of the ore-zone at depth.

The second set of faults is represented by a NW dipping fault which occurs at the hangingwall contact in the old '209 stope'. The strike is parallel to the ore-zone and the dip is 45° to the NW. Movement along this fault is considered by James and Buffam (1937) to account for the narrowing of the ore-zone towards the surface.

A third type of secondary fault has been interpreted from the diamond drill compilation to cut across the ore-zone at higher angles than those described above, causing apparent horizontal displacements in the order of 15 to 30 metres. Near the southwest end of the mine, a mineralized zone was displaced 60 metres to the east by predominantly strike-slip movement along a fault striking N 60°D and dipping 60°SE (Watson, 1957). Later faults are probably responsible for the repetition of the ore zone in hole KSA (Appendix I). These faults have commonly brecciated the quartz-carbonate, and some carbonate grains have bent twin lamellae (Watson, 1954).

A major fracture in southeast Cape Breton, the Stirling Fault (Figure 3), noted by Weeks (1954), lies slightly west of the Mine. This fault, intersected in hole KS5, consists of a highly fractured zone, 1.5 metres thick which brings the relatively undeformed rocks of the Middle River Group into contact with the deformed rocks of the Bourinot Group. The fault-zone is extensively mylonitized, and contains fresh gouge. The fault surface may dip rather steeply to the southeast (Watson, 1957) and may truncate the Mine Shear (Richardson, 1953).

CHAPTER 4

THE ENVIRONMENT OF BASE METAL DEPOSITION AT THE MINDAMAR MINE

1. Syngenesis vs. Epigenesis

Two basic concepts for the genesis of the deposit at Stirling have been advocated: 1) an epigenetic shear zone replacement model (Cairnes, 1917; Weeks, 1924; Richardson, 1953; Watson, 1954) and 2) a syngenetic volcanic-exhalative sedimentary model (Poole, 1974; Ruitenberg, 1976; Lydon, 1977).

The mechanism for metal concentration in both models involves a hydrothermal system, but the timing of mineralization relative to the deposition of the host rocks is the vital difference between them. By the nature of these models, each calls for differing origins for the hydrothermal solutions and the metals (White, 1969; Hutchinson, 1973; Sangster, 1972; Sato, 1977).

The ore-bodies at the Mindamar Mine were described by early workers as lenses sitting within an envelope of a quartz-carbonate 'gangue' and they considered that the shear zone (The Mine Shear) provided a channel and a site for ore deposition. Watson (1957) advocated that the deposits were formed in the following overlapping stages as the shearing was taking place.

1. deposition of some fine-grained pyrite and sphalerite by replacement of sericite schists (sheared siltstones).

2. deposition of most of the dolomite and magnesite and some of the quartz, partly in fractures and partly by replacement.

3. deposition of most of the galena, chalcopyrite and tennantite with some pyrite and sphalerite, both in the carbonates and in the pyrite-sphalerite ore formed in 1. above.

Watson recognized that movement occurred on the shear during and after the mineralization, on the evidence of:

1. brecciated and mineralized schist (siliceous siltstones).

2. quartz-carbonates displaying repeated brecciation and recementation.

3. meta-diabase dykes with sheared and carbonatized margins cutting the quartz-carbonate and ore.

His evidence for the fine-grained sulphide ore having formed by replacement of the sericite schists (sheared siltstones) was:

1. relics of schist within the ore,

2. well-defined thin layers in the ore similar in thickness to the laminae of the siltstones and to the relic laminae of the schist.

The replacement model was enhanced by the presence of: 1) inclusions, within the quartz-carbonate, of volcanic rocks that were considered to have resisted replacement, and 2) sheared and carbonatized siltstones, intrusions, and flow rocks in the footwall and hangingwall. This carbonatization, however, introduced unmineralized calcite into the sheared rocks in contrast to the mineralized dolomite of the quartz-carbonate.

Relationships in the mafic intrusions indicate that shearing and the accompanying introduction of calcite are younger than the intrusions, which transect the 'quartz-carbonate' and the ore. It is therefore suggested that the two carbonates are the result of different processes that occurred at different times. The origin of the calcite is unknown, but an alternate hypothesis is given in a subsequent section for the formation of the quartz-carbonate rock. It is this writer's opinion that an epigenetic shear zone replacement mechanism is untenable for this deposit and cannot adequately explain all the observed and interpreted data.

Based on the distribution, contact relationships and internal characteristics of the map-units, these lithologies are considered to be interbedded, deposited one on top of the other. This feature favours the syngenetic volcanic-exhalative sedimentary model and subsequent discussions serve to justify this interpretation.

2. Discussion

A Stratigraphy

The character, distribution, and continuity of the ore-zone relative to the footwall and hangingwall rocks suggest that the ore-zone is interbedded within those rocks. The ore-zone lies between two chemically and texturally different volcanic piles; there are massive felsic flows with minor pyroclastics in the footwall, and intermediate pyroclastics predominate the hangingwall (Figures 5, 6 and 10). The footwall contact was observed in a number of diamond drill holes to be sheared; in other holes where it is not sheared, however, the contact appears conformable to the bedding attitudes in the adjacent footwall siltstones. The strike of the ore-zone rocks is parallel to the general strike of bedding attitudes in other rock-types of the 'Mine Series'.

An interesting observation is the distribution of angular fragments within each lithology. The footwall rhyolites contain xenoliths of the underlying mafic flows. The quartz-carbonate contains fragments of sulphides, quartz-carbonate and footwall rhyolite and the altered tuffs contain angular inclusions of quartz carbonate. The massive sulphides contain clasts of quartz-carbonate and sulphides, whereas the siltstones have fragments of sulphides and rhyolite. The hangingwall tuffs and tuff breccias contain fragments of siltstone, rhyolite, quartz-carbonate and sulphides. These relationships indicate that as each lithology was being deposited, fragments of the underlying units were being eroded elsewhere and incorporated into the newer beds. The distribution of clasts indicates that the stratigraphy is facing westward.

B <u>Subaqueous Deposition</u>

The rocks of the 'Mine Series' are considered to have been deposited in a subaqueous environment of unknown depth. Evidence for

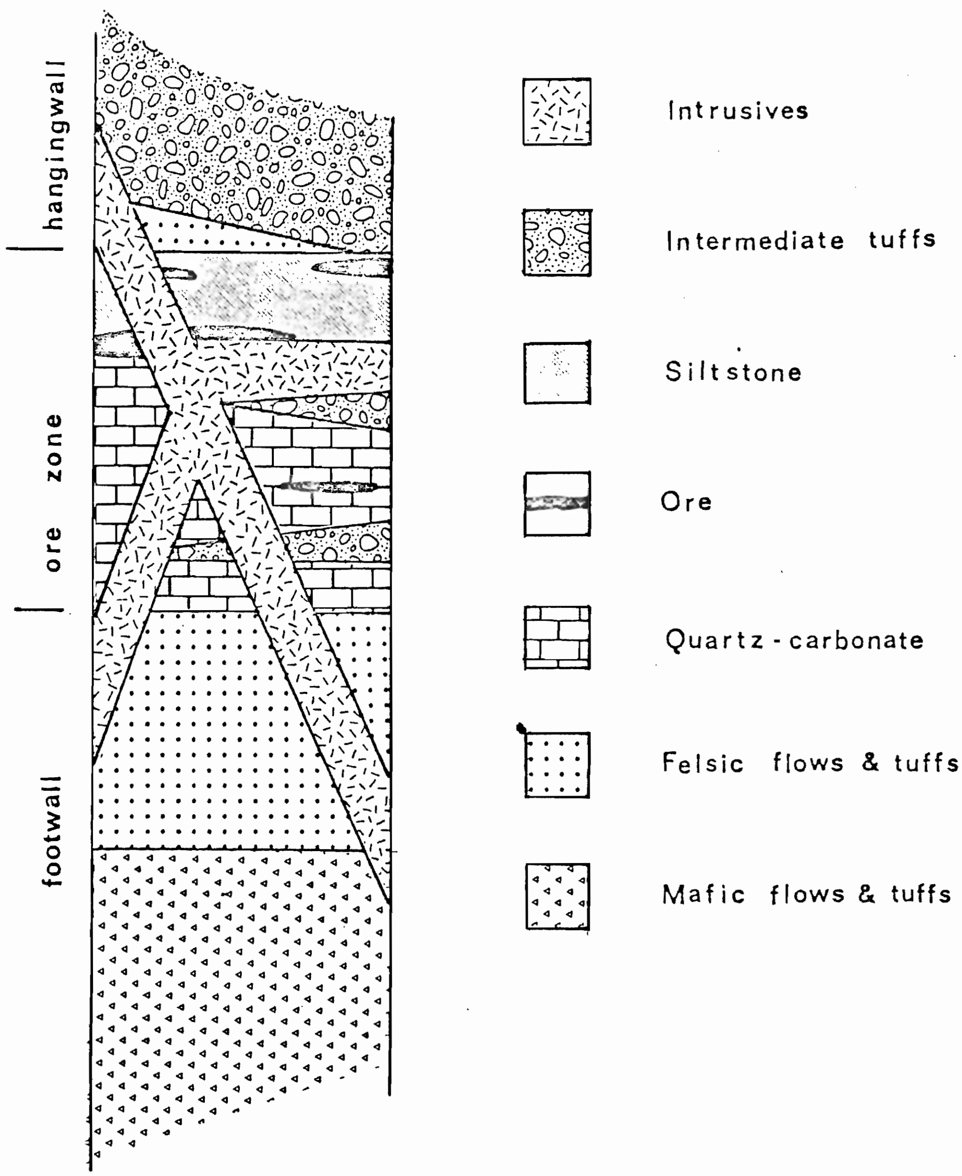


Figure 10. Schematic drawing of the stratigraphic column at and in the vicinity of the Mindamar Mine.

subaqueous deposition of the rocks lies in the thinly-laminated, commonly-graded, beds (Plates 8a and 8b) within the siltstones of the ore-zone, footwall and hangingwall. The nature of this very thin and continuous lamination (commonly less than 1 mm) suggests that the water was non-turbulent and that circulation was restricted. Slump and soft-sediment deformation textures (Plate 10a) are more indicative of subaqueous rather than subaerial deposition. The abundance of carbonate suggests a mildly alkaline environment, similar to that of seawater.

C <u>The Quartz-Carbonate Rock</u>

Evidence for the quartz-carbonate being bedded is given in drill hole KSM (Appendix I) where a relatively unsheared 8-metre intersection of quartz-carbonate contains four separate layers, each having angular quartz-carbonate fragments in a sulphide-rich matrix (Plate 4b). Each layer is interpreted as a weak mineralizing pulse and the carbonate fragments possibly are the result of volcanic-related explosions.

Other indications of bedding are suggested by the tabular bodies of pyroclastic rocks within the quartz-carbonate that have their long directions parallel to the strike of the bedding in the siltstones. A repetition of tuffaceous layers in the quartz-carbonate of drill hole KSA (Appendix I) is interpreted as bedding. The crenulated banding noted by James and Buffam (1937) may also be a reflection of bedding; they might represent stylolites that developed along the bedding planes, a feature characteristic in deformed carbonate rocks

(Bathurst, 1975).

D Tuffs and Tuff Breccias

Crystal and lithic fragments of the tuffs and tuff breccias were described in a previous section as being of a uniform grain size, generally 1 to 2 mm, over a thickness in excess of 10 metres. These pyroclastics are not well bedded but do contain layers with graded beds.

A portion of the contact of the hangingwall pyroclastics with the underlying siltstones is considered to be represented in Plate (11a). where an imbricated, angular conglomerate has been developed with clasts of siltstone sitting within a tuffaceous matrix. This type of conglomerate is commonly referred to as a sharpstone conglomerate and suggests movement of the layer being deposited over the underlying lithology. Sharpstone conglomerates are formed by the penecontemporaneous erosion or disruption of the underlying stratum and consist of angular to subangular flat fragments of shale, mudstone or micritic limestone in a sandy matrix (Conybeare and Crook, 1968).

It is suggested that the hangingwall tuffs are the result of slumping and/or turbidity currents off a volcanic dome and that textural and sedimentary features (Ross and Smith, 1961) are indicative of ash flow deposits. The interpretation that the underlying siltstones were deposited subaqueously, implies similar conditions of deposition for the ash flows.

Typically, ash flows consist of welded, distorted and stretched pumice fragments (Plate 13a), compacted shards (Plate 12b), ash, volcanic dust and lithic fragments (Plate 12a). Ash flows are usually thick units (greater than 1 metre), non-sorted and non-bedded. There is generally a wide range in size and relative amounts of constituents and sorting may be present at the distal ends of the flows. Ash flows commonly incorporate rubble near the base, of different sorts of terrain over which the flows travel. A more detailed description of ash flows is given in (Ross and Smith, 1961).

The tuffs that occur within the quartz-carbonate might represent debris from an ash flow that mixed with the hydrothermally derived materials as they were being ponded down topographic slope from their origins. These tuffs contain angular inclusions of quartz-carbonate.

E Structure

The 'Mine Shear' affected each lithology of the 'Mine Series' in a slightly different manner. The degree of deformation was dependent on the competencies of the rock-types, in turn dependent on mineral composition and texture. The harder, more competent, rhyolites had a tendency to fracture, whereas, the incompetent tuffs were strongly foliated and carbonatized. Lepidoblastic growths of chlorite, sericite and talc, combined the presence of comminuted quartz, feldspar and pyrite grains indicate cataclastic as well as penetrative deformation.

Where deformation was intense, the original textures in the volcanic and intrusive rocks were obliterated, but, the degree of deformation ranges from weak to strong, so that locally, some primary textures have been preserved.

F Metamorphism and Deformation of Sulphides

Problems have been generated in the interpretation of the nature and genesis of the sulphide ores, because metamorphism usually has obliterated primary textures, wholly or in part (Vokes, 1969). For the purpose of description, metamorphic fabrics can be considered from two main points of view: 1) those due to deformation, and 2) those due to recrystallization or annealing. In nature, both processes usually have been active either simultaneously or at different times during the metamorphism/deformation so that one process may modify or destroy the textures generated by the other. Because of the relative ease with which sulphides deform and anneal, compared to silicates, the resultant fabric is commonly very difficult to interpret (Vokes, 1969). The effects depend upon the relative brittleness and plasticity of the minerals at different conditons of temperature and pressure.

Within the Mindamar ores, the more plastic sulphides (sphalerite, chalcopyrite, galena and tennantite) were subjected to flow under stress conditions that produced directed banded fabrics. Recrystallization and annealing of these sulphides probably destroyed other expected deformation textures of distorted cleavages and twins.

Mobilization of these sulphides is shown by the way they 'fill' in between or corrode the fragments of granulated, harder sulphides (pyrite) and silicate minerals. The textures thus produced resemble those often interpreted as implying an age difference between 'older' shattered sulphides and the 'younger' infilling sulphides, and Watson (1957) so interpreted the textures in the Mindamar ores.

As in other lithologies of the 'Mine Series', the degree of deformation in the sulphides ranges from weak to strong. If preserved, primary textures might be expected in the lesser deformed areas. In the siliceous siltstones, pyrite was described as following the bedding planes where the bedding and foliation planes are not parallel. Within an individual lamina, pyrite is graded in size and concentration, with more grains of a larger size occurring at the base of the layer and so suggesting a sedimentary affiliation. The same relationships of pyrite occur in the lesser deformed sulphides. The scale of banding in the sulphides is similar to the scale of the laminae in the siltstones where the two lithologies occur adjacent to one another.

One feature characteristic of most massive sulphide deposits in volcanic-sedimentary terrains is the mineral banding. This banding is an expression of alternating types and concentrations of different mineral components. Vokes (1969) states that in most massive sulphide deposits, the sulphides were present in their respective layers in the ore prior to any deformation, and that the actual distance of movement of the sulphide was very small. In deposits of low metamorphic grade, the cause of the banding can be related to sedimentary processes involving variation in the type and relative amounts of components added to the floor of the basin of deposition (Watanabe, 1974; Ito et al., 1974; Bignell et al., 1975).

Although the ores at the Mindamar Mine are metamorphosed, the banding is aligned with the sedimentary layering occurring in the adjacent siltstones. Evidence that the sulphides did not move very far during metamorphism may be given in the textural relationships shown in Plate 7 . In this specimen where the foliation crosses the sulphide banding at steep angles, the chalcopyrite and sphalerite rich bands do not follow the foliation; a feature one might expect if the banding were attributable to deformation. This, combined with the interpretation that some of the pyrite has a sedimentary affiliation in some of the relatively undeformed samples of sulphides, strongly suggests that the banding in the Mindamar ores is relic sedimentary layering.

This writer considers the volcanic-exhalative-sedimentary model (Stanton, 1959; Anderson, 1969; White, 1968; Hutchinson, 1973) to be the most likely type for the generation of the Mindamar ores. This model is discussed in the next section; it is followed by the interpretation for the environment of base metal at the Mindamar Mine.

3. The Volcanic-Exhalative-Sedimentary Model

In recent years, highly saline, metal-rich brines have been observed generating base metal deposits of ore grade in basins on the floor of the Red Sea (Degens and Ross, 1969). Dense brines with even higher metal contents have been discovered in deep drill holes penetrating several kilometres under the Salton Sea geothermal area of California (White, 1968). Strongly acid waters discharged at the surface in volcanic environments can carry large amounts of iron and manganese, and smaller but significant amounts of other metals (Ferguson and Lambert, 1972; Taylor, 1974). A common characteristic of the above is that they occur in areas that are geothermally active, a feature often related, but not necessarily, to igneous activity.

With the publication of two notable volumes (Tatsumi, 1970; Ishihara *et al.*, 1974), Japanese geologists have revealed the extent of their excellent studies and descriptions of volcanic-related, subaqueously deposited ore deposits in Japan. A Kuroko deposit (Figure 11) is a "stratabound polymetallic mineral deposit genetically related to submarine, acid volcanic activity of Neogene Tertiary age in Japan" (Matsukuma and Horikoshi, 1970). The unmetamorphosed nature of these ores, together with their excellent documentation has led to the unofficial acceptance of these deposits as the 'type deposits' for volcanogenic sulphide ores (e.g. Sangster, 1972). Table 5 compares the important characteristics of the Kuroko deposits with the Mindamar deposit, and points out the many similarities.

The hydrothermal fluids, according to the volcanic-exhalative-sedimentary model, either originate from 1) oxygenated, slightly alkaline seawater containing Na, Mg, SO_4 and Cl ions, percolating

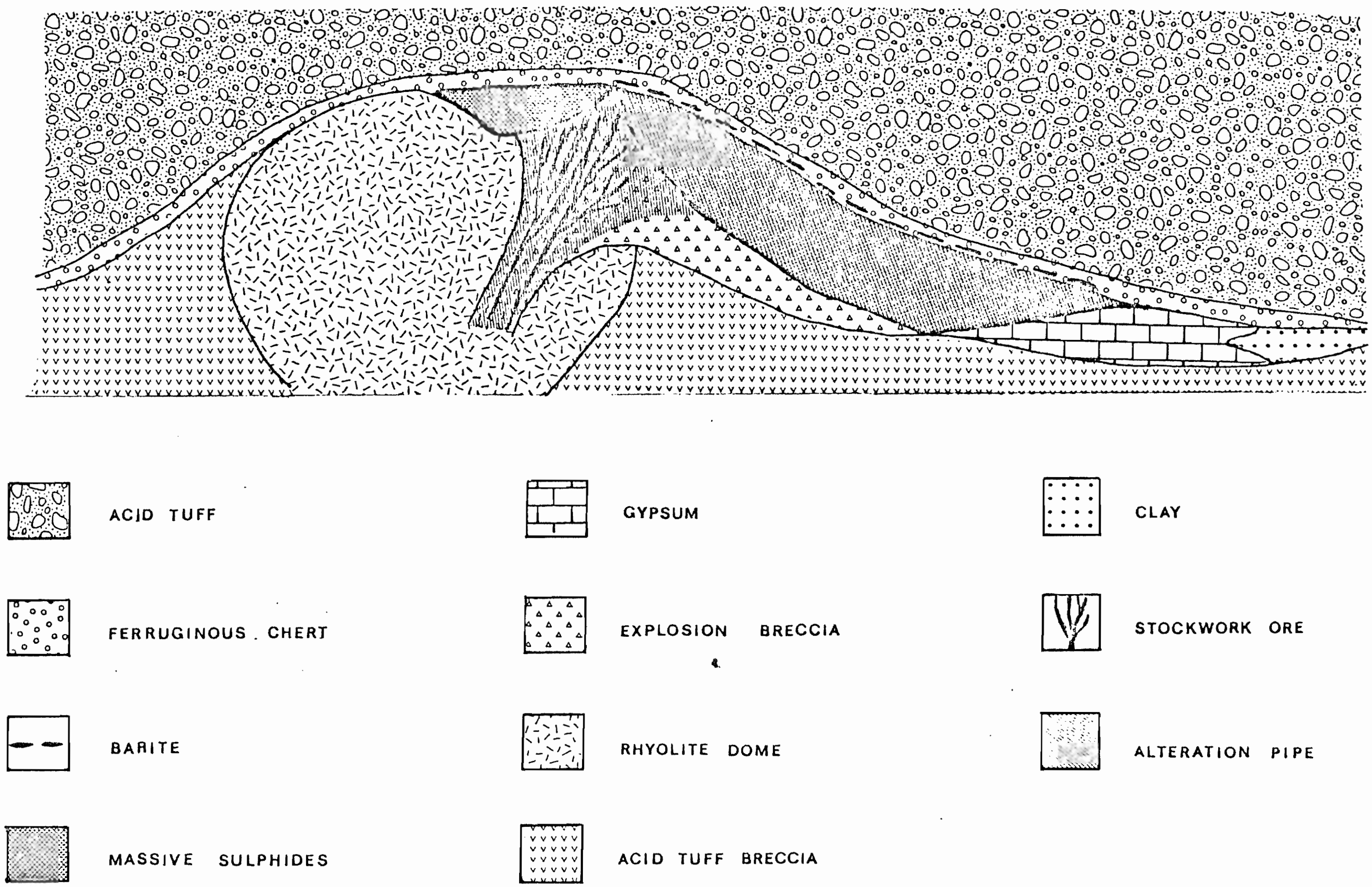


Figure 11. Schematic cross-section of a typical Kuroko deposit (modified after Sato, 1974).

	KUROKO DEPOSITS - JAPAN		MINDAMAR MINE
Geologic Setting	submarine volcanic-sedimentary; zeolite facies regional metamorphism		submarine volcanic-sedimentary; greenschist facies metamorphism
Timing of Mineralization	waning stages of a felsic period of volcanism		waning stages of a felsic period of volcanism
Mineralization	Zn-Cu-Pb-Ag-Au		Zn-Pb-Cu-Ag-Au
Metal Distribution	Fe-Cu base	Zn-Pb top	insufficient data
Zonation (top to bottom)	tuffites barite sulphides gypsum/anhydrite rhyolite		tuffites massive sulphides quartz-carbonate-talc rhyolite
Character of the tuffite	laminated ferruginous cherts		laminated, siliceous, ferruginous and calcareous mudstones and siltstones
Gangue minerals	gypsum, anhydrite, barite, chert, minor carbonate (dolomite)		quartz, dolomite, talc, sericite, chlorite
Sedimentary structures in sulphides	graded beds, slump structures, imbricated sharpstones, transport breccias, facies changes, banding		graded beds (?) banding
Footwall alteration	quartz, sericite, clays, chlorite (silicification)		not recognized
Metal ratios		Similar	

TABLE 5. Comparison of characteristics of Kuroko-type deposits with the Mindamar Mine.

through porous and permeable volcanic rocks, becoming heated with depth to form a reduced, more acid Na-Ca-Cl brine capable of leaching metals from volcanic rocks (Ferguson and Lambert, 1972; Andrews and Fyfe, 1976), or 2) from fluids formed at the late stage in the fractionation of silicate magmas and containing water, sulphur, salts and metals of magmatic origin (Sato, 1977). This has developed into a conflict over the role of volcanism, either as the provider of vast amounts of primary magmatic fluids enriched in metals, or as a feature capable of heating, circulating and acidifying seawater.

Regardless of the source, the hydrothermal solutions reach the surface of the earth in a subaqueous environment in response to geothermal gradients within a subterranean convection cell. These solutions precipitate their load in water in response to changing conditions involving a complex interplay of many factors such as adiabatic expansion of the solution, changes in temperature and Eh/pH conditions as a result of dilution, mixing with seawater, and hydrothermal rock alteration (Helgeson, 1964; Barnes and Czamanske, 1967; Toulmin and Clark, 1967). The behaviour of the ore fluids and the actual concentrating mechanism to form ores in the submarine environment will be significantly affected by the following (Andrews and Fyfe, 1976):

a) density of ore fluids relative to that of seawater

b) organic activity in the immediate environment

c) local topography and current motion

d) chemistry of seawater

Sato (1972) pointed out that the physical behaviour of the ascending ore fluid when discharged into seawater will be dependent on its temperature and salinity conditions, that is, its density relative to seawater. If the solution is less dense than seawater, it will float upwards and eventually experience dilution. If by some mechanism, metals are released during this process, they may accumulate in colloidal suspension, eventually to settle out in the vicinity of the discharge area, or in the presence of bottom currents, they may be dispersed over a wide area of the ocean floor (Andrews and Fyfe, 1976). If the hydrothermal solution is highly saline and of a relatively low temperature, the brine will be heavier than normal seawater, and will collect in depressions on the sea floor forming distal ores (Figure 12) (Large, 1977). If topographic conditions allow the metals to concentrate above the feeder vent, a proximal deposit (Large, 1977) will form directly above the altered and often mineralized zone of the feeder vent (Sato, 1977). Table 6 compares features of proximal and distal ores. By the nature of this process, the ores may be deposited on inclined surfaces. The resultant unconsolidated ores might then be reworked by submarine slides or turbidity currents triggered by explosive activity continuing throughout the ore-forming stage (Spence, 1975), with the development of fragmented transported ore (Sato, 1972; Thurlow *et al.*, 1977).

Most metal-rich hydrothermal emanations active today, such as those observed in the Salton Sea, the Red Sea, and the Cheleton

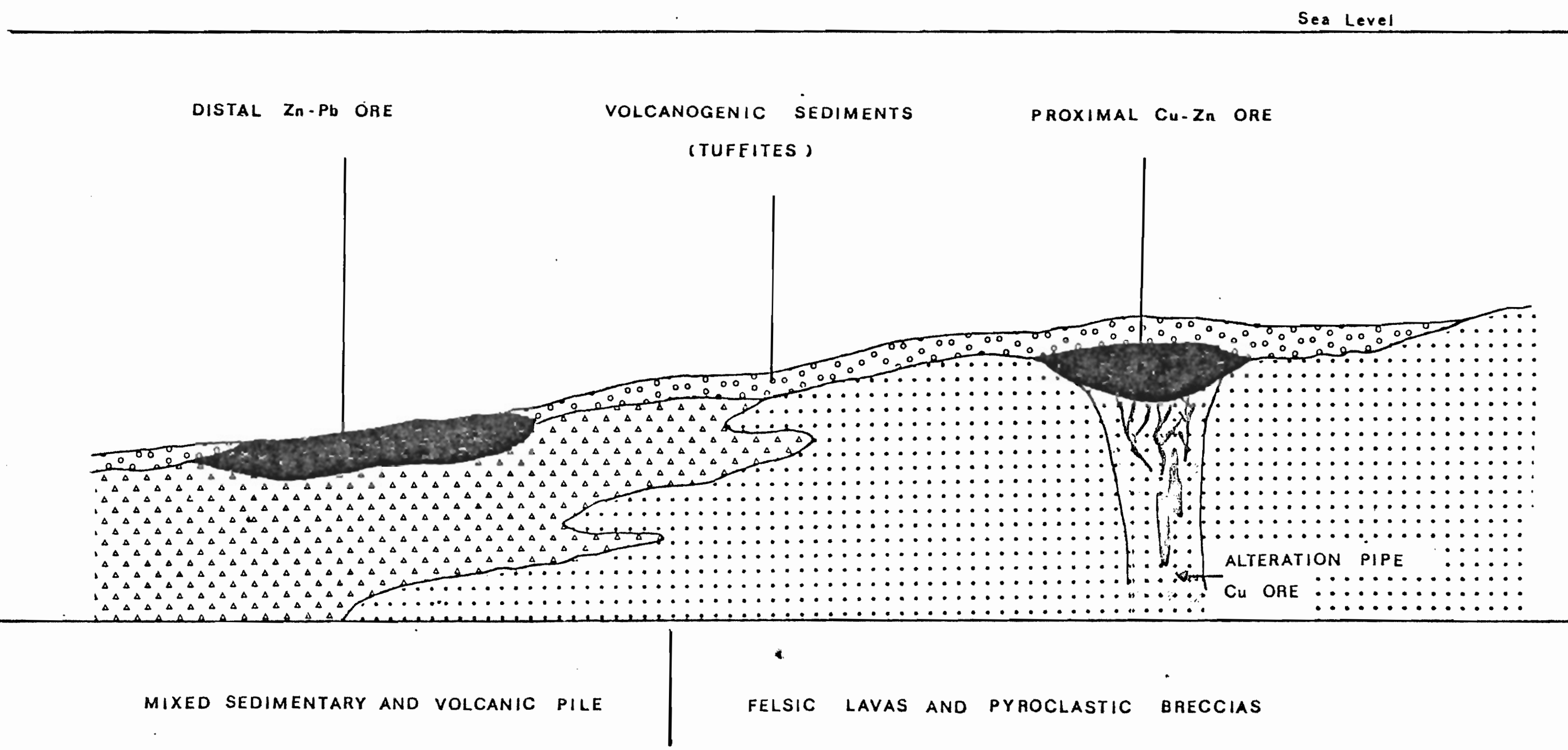


Figure 12. Schematic diagram of the geological setting of proximal and distal ores and their relationship to siltstones (chemical sediments) (modified after Large, 1977).

	PROXIMAL ORES	DISTAL ORES
METAL CONTENT	Cu-rich (with Au); Zn may be present in economic quantities. Pb generally low.	Pb-Zn rich; Cu poor
ALTERATION	Underlain by a distinct alteration zone (pipe).	No distinct footwall alteration zones.
IRON SULPHIDES AND OXIDES*	Pyrite and pyrrhotite dominant sulphides. Magnetite often in footwall.	Pyrite dominant, pyrrhotite absent. Magnetite may be in hangingwall.
FORM	Pipe-like or mushroom shaped, generally massive and crosscutting. Banding only in hangingwall.	Well banded, stratiform, and blanket-shaped.
ZONING	Good zoning. Cu is concentrated toward footwall. Zn/Cu ratio increases upward. Pb occurs in hangingwall of lode.	Generally lack distinct metal zoning.
VOLCANIC SETTING	Toward the top of a pile of massive pyroclastic, fragmental volcanic, and flow rocks.	Within a mixed sedimentary-volcanic pile.
SULPHUR ISOTOPES	$\delta^{34}S$ values of Archean types range from +2 to -2‰. Phanerozoic ores exhibit distinct decrease in $\delta^{34}S$ from stratigraphic footwall to hangingwall.	$\delta^{34}S$ values are either variable and erratic, or show a distinct increase from footwall to hangingwall.

* These differences may be destroyed by high-grade metamorphism.

TABLE 6. Differences between proximal and distal ores (Large, 1977).

Penninsula are chloride-rich and sulphide-poor (Ellis, 1969) in accord with Helgeson's (1964, 1969) conclusions. Andrews and Fyfe (1976) suggest therefore that transport of any significant quantity of metal by circulating hydrothermal solutions involves chloride, rather than sulphide complexing. Upon discharge onto the ocean floor, these chloride-rich, sulphide-poor ore fluids would gain immediate access to an infinitely large reservoir of oxidized sulphur. It is reasonable to assume that massive sulphide formation and subsequent deposition on the sea floor involves the reduction of seawater sulphate to sulphide by the action of inorganic and/or organic processes in the immediate area of hydrothermal discharge (Andrews and Fyfe, 1976). Evidence suggests that sulphate-reducing bacteria can produce sufficient quantities of H_2S (Fyfe, 1977) to precipitate metals in large amounts, as is considered the case for sulphide precipitation in brine pools of the Red Sea (White, 1968; Bischoff, 1969). There is, however, little evidence to suggest that sulphate-reducing bacteria were important in the precipitation of the Kuroko ores (Sato, 1973). Detailed structural studies of some massive sulphide bodies suggest that under certain conditions, hydrothermal solutions discharging onto the ocean floor are able to produce their own reducing environments. The stratigraphic features exhibited by the Kuroko massive sulphide ores of Japan demonstrate this process. Those deposits characteristically exhibit the following sequence from the base up (Figure 11):

1) gypsum-anhydrite beds

2) massive sulphide ore

3) barite beds

4) ferruginous quartz beds (hematite and chert)

In order to explain this sequence, Andrews and Fyfe (1976) envisage the advance of metal-rich hydrothermal fluids into a topographically restricted area of the ocean floor where bottom current activity is at a minimum. The solubility of $CaSO_4$ decreases with increasing temperature so that initial heating of seawater in the immediate vicinity of discharge results in precipitation of anhydrite directly from seawater. The process will be greatly enhanced if the hydrothermal fluids are rich in Ca^{2+}. Continued discharge of the reduced hydrothermal fluid results in a flushing out of most of the oxidizing species and the gradual establishment of a reducing environment (Andrews and Fyfe, 1976).

Ore-bodies of this type are frequently overlain by, or pass stratigraphically along strike into, a laminated chert-rich sediment containing minor amounts of pyrite (Large, 1977). These sediments, which are generally enriched in sphalerite for some distance from the ore-body (Sakrison, 1966), are locally termed cherty tuffs or tuffites and are considered by Ridler (1971) and Hutchinson et al. (1971) to be chemical precipitates of predominantly volcanic origin. Ridler and Shilts (1973) refer to these rocks as exhalites. The siliceous siltstones of the 'Mine Series' are interpreted to be the equivalent of these rocks at the Mindamar Mine.

Ridge (1974) points out that the formation of massive sulphide deposits on the sea floor can only be achieved if there is sufficient water depth to prevent the hydrothermal solution from boiling as it moves up through the volcanic pile and onto the sea floor. Based on fluid inclusion studies, Sato (1977) found that the major part of the Kuroko deposits formed at temperatures of 200-250°C. According to Haas (1971), at least 500 metres of water are required to prevent a 1 M NaCl solution at 275° from boiling on the sea floor. For lesser water depths, the solution would boil before reaching the sea floor and deposits much of its sulphide content, and some of its salt content, to form subsurface deposits of replacement or fissure-filling type (Ridge, 1974). Geological evidence from amygdaloidal lavas at Buchans (Thurlow et al., 1975) suggests water depths considerably less than 500 metres, possibly indicating that the deposit formed at temperatures lower than 250°C and/or from solutions with a particularly high NaCl content (Large, 1977).

Notable Canadian deposits whose genesis is attributed to variations of this model are Buchans, Nfld. (Thurlow et al., 1975), Kidd Creek, Ontario (Walker et al., 1975); Noranda Camp, Quebec (Gilmore, 1965; Goodwin, 1965; Fisher, 1974), Bathurst Camp, New Brunswick (Luff, 1977) and the Mattagami Camp, Quebec (Sharpe, 1965; Large, 1977) to mention a few.

From the above discussion, it can be seen that the formation of an ore body by this method results from the combination of a number of physical and chemical parameters, and that if any one condition is lacking, the chance of a deposit forming is greatly reduced. A number of conflicts occur over the origins of the fluids and metals, transport mechanisms, and controls on precipitation of sulphides, but it is beyond the scope of this thesis to discuss and evaluate each hypothesis.

4. The Environment of Base Metal Deposition at the Mindamar Mine

The ore-zone at the Mindamar Mine marks the late-stages of a volcanic cycle which deposited an unknown thickness of mafic flows, pyroclastic and felsic volcanic rocks which make up the footwall of the deposit. The ores were deposited as a result of hydrothermal solutions enriched in metals derived from either seawater or magmatic sources, emanating onto the sea floor and precipitating metals in response to changes in physical and chemical conditions. Poor circulation allowed the denser precipitates to sink in the seawater and accumulate in basinal depressions near the vent area, rather than to be dispersed over a wider area by currents. The three quartz-carbonate lenses mentioned in Chapter 3 might represent separate topographic depressions in which the dense brine material was allowed to collect.

At the mine, an absence of a recognizable alteration zone beneath the ore-zone, corresponding to a hydrothermal vent, indicates that the ore-bodies formed away from the vent, presumably down any topographic slope. The hydrothermal vent may or may not correspond to the volcanic vent. At present there is insufficient evidence to determine where each vent is/was in relation to the ore-zone. Studies by Sangster (1972), Fox (1977) and Lajoie (1977) have shown that the coarsest pyroclastic rocks of an area are generally nearest to the volcanic vent. At Stirling, the coarsest pyroclastic rocks encountered were tuff breccias occurring at depth, south of No. 1 shaft, but evidence is too limited and inconclusive to imply a southerly direction to the volcanic vent. Large (1977) points out that metal zonation given by Zn/Cu ratios, is present in a number of volcanic-related deposits and that these ratios increase away from the hydrothermal vent. Ratio calculations from extensive assay data for portions of the mine, revealed no obvious zonation, although Cu contents of the ores were reported to be noticeably higher at depth in the northern area of the mine (J. MacPherson, pers. comm.).

The sequence of events that resulted in the features and relationships described in Chapter 3 are summarized below:

1. Deposition of the footwall volcanic rocks ended with the extrusion of voluminous felsic flows and pyroclastic rocks. Lulls in the volcanism are marked by finely-laminated siltstones interbedded with the rhyolites.

2. Hydrothermal activity was generated during the waning stages of the felsic volcanism and the resulting brines emanated from a vent, mixed with seawater, and precipitated mineral phases which sank within the seawater to be deposited upon the footwall rocks.

3. The dense, reduced brines initially precipitated dolomite, magnesite and quartz under oxidizing conditions of seawater, and these minerals along with brine, flowed down topographic slope, infilling depressions on the sea floor. As the volume of brine reaching the rock-seawater interface increased, an aureole of reducing conditions was established around the vent. This allowed the metals to be precipitated as sulphides and they were deposited on top of the quartz-carbonate. The presence of sulphide lenses within the quartz-carbonate might be explained by variations in flows rates of the brine emanating from the vent allowing oxidizing conditions to be re-established periodically.

4. Explosive activity near the vent brecciated the footwall rocks and the earlier-formed quartz-carbonate and sulphides and incorporated the fragments into younger ore-zone layers. This explosive activity triggered submarine slides of tuffaceous material that had accumulated near the volcanic vent. These tuffs flowed down slope as turbidites and mixed with the hydrothermal brines and precipitates. Steam explosions occurred simultaneously and caused the repeated brecciation and cementation of the 'quartz-carbonate' as well as brecciation in other lithologies.

5. As the hydrothermal activity diminished in intensity, siltstones were deposited on top of, and in between, sulphide 'pools' as fine-grained, less-dense material in suspension began settling out of the seawater. Periodic rejuvenation of hydrothermal

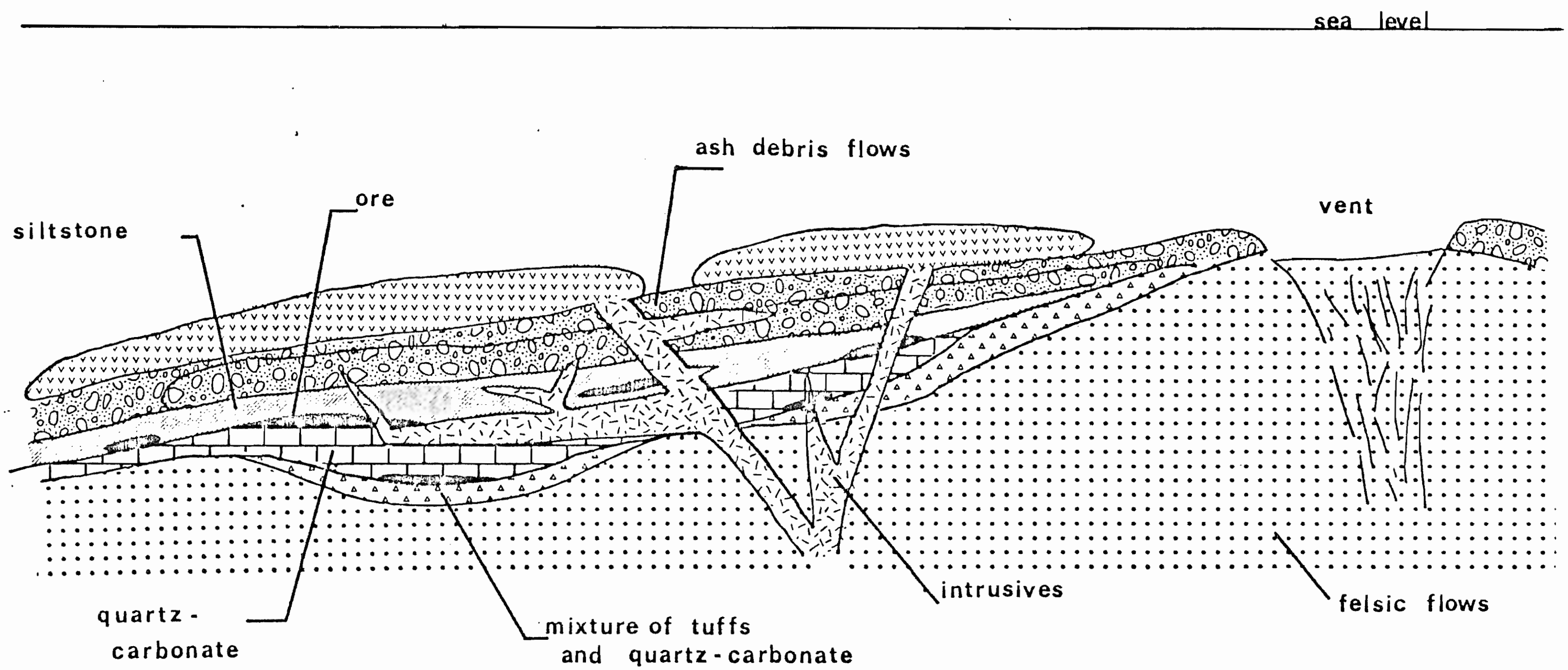


Figure 13. Schematic diagram illustrating the geologic setting at the Mindamar Mine.

activity continued, developing successive laminae of siltstone and lenses of sulphides.

6. Volcanic activity became active once again, extruding large volumes of tuffaceous material which was deposited as pyroclastic flows down slope on top of the siltstones and brine 'pools'. Volcanic explosions at or near the vent incorporated clasts of underlying lithologies into the tuffs and tuff breccias.

7. Younger mafic rocks intruded the above lithologies, transecting the ore-lenses.

8. Later folding, faulting, shearing and carbonatization processes were superimposed on all rocks, including the intrusions.

Figure 13 depicts schematically the geological setting at the Mindamar Mine at the time of ore deposition. The deposit falls under the distal classification of Large (1977) (Figure 12; Table 6).

CHAPTER 5

SUMMARY

1. Conclusions

a) The ores at the Mindamar Mine were concentrated as a result of syngenetic hydrothermal processes that were operative during the deposition of the volcanic-sedimentary rocks of the Bourinot Group.

b) The epigenetic shear-zone replacement model advocated for the deposit by previous workers is untenable as it does not adequately explain all the observed features within the lithologies at the mine.

c) The ore-zone sits conformably within a volcanic-sedimentary sequence, between predominantly felsic lavas in the footwall and intermediate pyroclastics in the hangingwall.

d) Attitudes measured within the tuffs and siliceous siltstones indicate that the rocks of the mine series occur on the western limb of a slightly overturned anticline, with tops facing westward.

e) All rocks, including the ores and the intrusions that transect them, have been regionally metamorphosed to the greenschist facies and subjected locally to cataclastic deformation with accompanying carbonatization. The degree of deformation differs from weak to strong.

f) Younger cross-faults have displaced the ore-zone and intrusions.

g) The massive sulphides are considered to exhibit relic sedimentary-related textures, similar to sedimentary textures occurring within the adjacent siltstones.

h) The hangingwall tuffs contain fragments of quartz-carbonate, sulphides and siltstones, which dates the mineralization as pre-hangingwall deposition.

i) Finely laminated siltstones with graded beds and slumps are indicative of a subaqueous environment of deposition for the rocks at the mine.

j) The deposit is considered a distal-type, generated by hydrothermal processes similar to those now operative in the Red Sea, following the model for the formation of Kuroko-type deposits in Japan.

k) The assignment of a Middle Cambrian age for rocks of the Bourinot Group in the Mira-L'Ardoise belt is considered reasonable but tentative and until such time as these rocks are dated with certainty, the deposit cannot be accurately incorporated into a metallogenic framework for Nova Scotia and the Appalachians.

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APPENDIX I

Diamond Drill Logs

Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property	STIRLING	District	Maritimes	Hole No.	KA-1
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.	130°	Logged by	C. Miller
Objective				% Recov.		Date	September, 1977

Claim: Stirling; T Brg.: 130°; Collar Dip: 080°; Elev.: ; Length: 1180 feet.; Hole No.: KA-1; Sheet 1 of 5

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 13.0	OVERBURDEN			
13.0 - 30.0	MISSING CORE			
30.0 - 57.5	MAFIC INTRUSIVE/FLOW			
	– dark green, massive, fine-grained to aphanitic, weakly foliated 40° to core axis. Minor 1mm size dark (amphibole, chlorite?) phenocrysts 5% locally. Fractured with infilling of calcite veinlets. Sample @ 56.0.	BN 512		
57.5 - 75.0	SHEAR ZONE/INTERMEDIATE FLOW			
	– light green, chloritic, sericitic, extensively sheared and foliated. Weakly carbonatized. Drillers had to cement 3 times in this section. Carbonate stringers are present.			
75.0 - 130.0	MAFIC/INTERMEDIATE FLOWS			
	– dark to medium green, ranges from fine-grained, aphanitic to medium grained. Chloritic with 30% visible feldspar locally. Amygdaloidal from 99.5-100.5 with calcite infilling. Sample @ 100.0. Smaller amygdales occur elsewhere. Shear planes have hematite stains. Magnetite present 5%. Rock is locally sheared and fractured. Calcite stringers present.	BN 513		
130.0 - 477.0	MASSIVE RHYOLITE FLOWS/BRECCIAS			
	– white, buff, green, purplish in color, massive, fine-grained to aphanitic. Very siliceous, difficult to scratch. Sheared extensively with chlorite and sericite development on the shear			

211-9437

Drill Hole Record

Scale
Colour Plot & Dips

Cominco

Property		District		Hole No.	KA-1		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.		Logged by	
Objective				% Recov.		Date	

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KA-1 | Sheet 2 of 5

Footage From – To	Description	Sample No.	Length	Analysis
	planes. Volcanic breccias appear to be present but are not cospicuous. Sample @ 239.0.	BN 514		
	Other breccias are tectonic and are restricted in .5-1 foot widths. Sample @ 226.0	BN 515		
	Sample @ 166.0 - massive cream colored rhyolite	BN 516		
	Sample @ 307.0 - purplish massive rhyolite	BN 517		
	Sample @ 418.5 - greenish rhyolite	BN 518		
	Calcite stringers are present. Drillers had to cement 175-180, 194, 313, 360-365. Other			
	volcanic breccias occur 315-320, 355-360.			
477.0 - 487.5	MAFIC INTRUSIVE			
	- dark green, massive, chloritic, faintly foliated with calcite stringers, fine-grained.			
487.5 - 495.5	MASSIVE RHYOLITE			
	- a distinct pink, massive, fine-grained to aphanitic matrix with quartz phenocrysts 10%, 1-2mm			
	size. Siliceous. Sample @ 493.5. Possible Intrusive?	BN 519		
495.5 - 501.5	MASSIVE RHYOLITE - similar to the greenish type (BN 518) from 130-477.0.			
501.5 - 503.0	MISSING CORE			
503.0 - 524.0	RHYOLITE FLOW			
	- pink to buff, massive, fractured appearance, very siliceous with minor fragmental material.			
	Sheared with sericite developed on shear planes.			

211-0437

Scale
Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KA-1			
Commenced	Location	Tests at	Hor. Comp.		
Completed	Core Size	Corr. Dip	Vert. Comp.		
Co-ordinates		True Brg.	Logged by		
Objective		% Recov.	Date		

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KA-1 | Sheet 3 of 5

Footage From – To	Description	Sample No.	Length	Analysis
524.0 - 539.5	SHEAR ZONE			
	- mafic rock, chloritic, strongly foliated injected with quartz and carbonate veins, parallel to the foliation 30^{o} to core axis. Fractured and very schistose. Sample @ 531.5.	BN 520		
539.5 - 551.0	SHEARED INTERMEDIATE FLOW/TUFF			
	- continuation of the above shear but in a different rock. Foliated 30^{o} to core axis but is not as intensely deformed as above. Quartz and carbonate has been injected. Locally the rock has been fractured.			
551.0 - 576.5	RHYODACITE FLOW/TUFFS			
	- buff to white, locally foliated 30^{o} to core axis. Contains chlorite-rich zones giving the rock a light/dark banding in the foliation plane. Carbonate and secondary quartz have been intruded and are also in the foliation plane. Sample 570.5.	BN 521		
576.5 - 582.0	FELSIC INTRUSIVE			
	- light green, aphanitic, massive matrix with 1mm size mafic phenocrysts. Calcite stringers present. The rock has been fractured.			
582.0 - 805.0	INTERMEDIATE TUFFS AND FLOWS			
	- light to medium green, foliated to massive. The flows are considered massive, poorly foliated, equigranular or porphyritic, chloritic and veined by calcite stringers. Carbonatized is moderate. The tuffs are lighter in color, sometimes visible clastic material			

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Scale :

Colour Plot & Dips

Drill Hole Record

Cominco

Property		District		Hole No.	KA-1		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.		Logged by	
Objective				% Recov.		Date	

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KA-1 | Sheet 4 of 5

Footage From – To	Description	Sample No.	Length	Analysis
	is recognizable. They are generally strongly foliated and extensively carbonatized,			
	accounting for the lighter color. The carbonatized cores are often banded in the plane of			
	foliation 30° to core axis.			
	Sample @ 777.5 – Msv. Dacitic Flow	BN 522		
	Sample @ 792.5 – Dacitic tuffs	BN 523		
	Locally, the foliation has been kinked into 2 folds. Minor units appear to be fragmental			
	with 3cm size clasts 785-788, 802.5			
805.0 – 887.5	MAFIC FLOWS/INTRUSIVES			
	– dark green, massive, locally porphyritic. 1-2mm size feldspar phenocrysts (10%). Chloritic,			
	weakly sheared. Carbonatized. Foliation 40° to core axis. Veined by calcite veins and			
	stringers. Sample @ 856.0.	BN 524		
887.5 – 894.0	FELSIC INTRUSIVE –			
	– buff to pinkish, massive, very siliceous. Cut by calcite veinlets.			
894.0 – 1023.5	MAFIC PYROCLASTICS/FLOWS			
	– dark to medium green, strongly foliated and extensively carbonatized. Alternate chlorite/			
	carbonate zones give the rock a banding in the plane of foliation. Veined by calcite stringers.			
	Foliation deformed -2 folds. Sample @ 933.5.	BN 525		

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property		District		Hole No.	KA-1
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg.	Logged by
Objective				% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KA-1 | Sheet 5 of 5

Footage From – To	Description	Sample No.	Length	Analysis
1023.5 - 1180.0	RHYOLITE FLOWS/BRECCIAS			
	- buff to pink massive, fractured, siliceous with fragmental material locally. Sample @ 1030.5	BN 526		
	Intruded by felsic dyke (1066.0-1079.0)			
	Intruded by mafic dykes (1051.0-1055.5), (1113.0-1125.0)			
	Numerous sections of lost core from 1080 to 1180.0			
	Calcite stringers present			
	Sample @ 1102.5	BN 527		
1180.0	END OF HOLE			

211-0437

Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property	STIRLING	District	Maritimes	Hole No.	KA2
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg. 100°	Logged by C. Miller
Objective				% Recov.	Date September, 1977

Claim: Stirling | T Brg.: 100° | Collar Dip: 065° | Elev.: | Length: 660 feet | Hole No.: KA2 | Sheet: 1 of 4

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 27.0	OVERBURDEN			
27.0 - 49.0	RHYOLITE FLOW			
	- light green, massive, aphanitic. Minor chlorite. Very siliceous. Sheared and fractured 32.0-49.0. Sample @ 31.0.	BN 528		
49.0 - 127.0	MAFIC FLOWS/PYROCLASTICS			
	- dark green, chloritic moderate foliation ~30° to core axis. Locally porphyritic with 1-3mm size epidotized feldspar phenocrysts 10%. A banding is apparent in above sections, suggestive of tuffs. Msssive flow units predominate. Calcite stringers are present as well as longer carbonate veins. Small streaks of black green chlorite are also present locally. Hematite staining often occurs on shear surfaces. Sample @ 110.0. May contain amygdales. The rock has been substantially carbonatized.	BN 529		
127.0 - 130.0	SYENITIC INTRUSIVE			
	- buff to brown, aphanitic siliceous matrix with 1mm size mfaic (amphibole) phenocrysts.			
130.0 - 154.0	MAFIC FLOWS			
	- similar to (49.0-127.0). Like the section above, this unit has been fractured and sheared.			
154.0 - 158.0	SYENITIC INTRUSIVE			
	- similar to 127.0-130.0. Xenoliths of the mafic rock are present, as well as alteration on the			

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211-8437

Drill Hole Record

Cominco

Property	District	Hole No. KA2	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Sheet 2 of 4 — Hole No. KA2

Footage From – To	Description	Sample No.	Length
	contacts. The intrusive contains chilled contacts.		
158.0 – 285.0	INTERMEDIATE FLOWS & PYROCLASTICS		
	– light to medium green massive and porphyritic flows interbedded with lithic and crystal pyroclastic units. Sample @ 208.0. Bedding ~30° to core axis, parallel to foliation. Some flows appear to have amygdales that have been stretched in the plane of foliation. Quartz eyes <5% are also seen locally. The rock has been substantially carbonatized and calcite stringers occur. Breccia fragments (lithic tuff?) occur @ 208.0. (BN 530).	BN 530	
285.0 – 291.0	FELSIC INTRUSIVE		
	– pinkish, massive, aphanitic, very siliceous. Fractured appearance.		
291.0 – 318.5	INTERMEDIATE FLOWS/PYROCLASTICS		
	– similar to 158.0-285.0. Extensively carbonatized with a banded appearance in the foliation plane.		
318.5 – 340.0	RHYOLITE BRECCIA		
	– white, buff to light green, fragmental rhyolite in a chloritic, finer clastic matrix. Portions of this section are massive, resembling flows. Other portions contain higher chlorite content. Thin tuffaceous units may also be present. Thin siliceous units occur from 326.0-327.0 with 2-3% diss. pyrite. They may possibly be exhaltes. Parts of this section are massive, white and change gently into darker green units. These could be		

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. KA2

Analysis

211-0437

• Scale

Colour Plot. & Dips

Drill Hole Record

COMINCO

Property	District	Hole No. KA2		Sheet 3 of 4
Commenced	Location	Tests at	Hor. Comp.	
Completed	Core Size	Corr. Dip	Vert. Comp.	
Co-ordinates		True Brg.	Logged by	
Objective		% Recov.	Date	Claim / T Brg. / Collar Dip / Elev. / Length / Hole No. KA2

Footage From – To	Description	Sample No.	Length	Analysis
	intrusives (darker units) that have become blended with the rhyolite in subsequent tectonic events. The breccia is considered volcanic. Sample @ 320.0. The massive white units could also be tuffaceous zones?	BN 531		
340.0 - 446.0	RHYODACITIC FLOWS/PYROCLASTICS			
	- light green, strongly foliated, generally fine-grained and equigranular. The rock seemingly has been silicified. White to buff colored zones gently change into lighter green units. The rocks are siliceous, especially in the lighter zones. The lighter zones are also banded with more chloritic zones. Carbonate is minor except for calcite stringers. Within this section are darker green rocks that have been extensively carbonatized. The entire section has been sheared and sericite is abundant on shear planes. The rock may be interpreted as a sheared rhyodacite with metamorphic recrystallization or a silicified intermediate volcanic. Samples @ 382.0; 367.0. Since the silicified zones are local and not widespread, they could also be related to a nearby intrusive since the gradation from light to dark is usually symetrical. Saml qtz veins are also present with minor silicification on the contacts. Sample @ 438.0. Calcite stringers.	BN 532 BN 533 BN 534		
446.0 - 490.0	MAFIC INTRUSIVE			
	- dark green, massive, weakly foliated with 15% feldspar phenocrysts. 1-3mm size. Magnetite occurs 20%. Hematite staining occurs on shear planes near carbonate intrusive and around magnetite grains.			

211-0437

Drill Hole Record

Cominco

Property	District	Hole No. KA2	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KA2 | Sheet 4 of 4

Footage From – To	Description	Sample No.	Length	Analysis
490.0 - 650.0	INTERMEDIATE FLOWS/PYROCLASTICS			
	- light green, strongly foliated, sericitized, chloritized and extensively carbonatized.			
	Silicification has occurred near felsic intrusives. The rock locally has a banded appearance			
	while other parts are massive. A large percentage of the banding is from quartz/chlorite			
	zones. Silicification is widespread. Silicified zones have not been carbonatized.			
	The foliation is approx. 45° to core axis. This section has been severely sheared, injected			
	with siliceous intrusions which have silicified the adjacent rocks. Sample @ 503.0	BN535		
	" 531.0	BN536		
	" 582.0	BN537		
650.0	END OF HOLE			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Cape Breton N.S.	Hole No.	KSA
Commenced		Location	Mine Property	Tests at	
Completed		Core Size		Corr. Dip	80°
Co-ordinates				True Brg.	130°
Objective				% Recov.	

Hor. Comp.
Vert. Comp.
Logged by C. Miller
Date June 26, 1977

Claim Stirling | T Brg. 130° | Collar Dip 080° | Elev. | Length 775 feet. | Hole No. KSA | Sheet 1 of 16

Footage From – To	Description	Sample No.	Length	Analysis
0.0 - 5.5	OVERBURDEN			
5.5 - 25.0	DIORITE			
	- the rock is a medium, greyish green in color, massive, fine-grained composed predominantly of feldspars, altered to sussanite and epidote especially near quartz and carbonate veins. Chlorite is the other main rock constituent occuring as streaks around the coarser feldspars. This alignment accounts for the weak to moderate foliation which is nearly parallel to the core axis. Magnetite makes up 1-3% and shows lemotite staining around the grain rims. Numerous quartz and calcite veins cut the core at shallow angles. Their average thickness is 1/8" to 3/4". The diorite shows a stronger alteration adjacent to those veins (saussanite, epidote). Blebs of pyrite are often seen scattered randomly in the rock as well as in the veins. Numerous slicken sided shears are evident, also cutting the core at shallow angles, and are not filled with any vein material. Carbonate also occurs in the rock intersections, which gives the rock a weak to violent acid reaction.			
	5.5 Shear dip 06°			
	17.0 Carbonate vein dip 30°			
	22.0 Carbonate vein dip 05°			
	23.5 Foliation dip 15°			
25.0 - 50.0	DIORITIC			
	- similar to the above, medium greyish green, massive, fine-grained with chlorite occurring as steaks giving a foliation to the rock.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property		District		Hole No. KSA	
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg.	Logged by
Objective				% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 2 of 6

Footage From	To	Description	Sample No.	Length	Analysis
		Randomly oriented hair-like fractures are filled with quartz and carbonate. Near some of			
		the longer veins which cut the core at shallow angles, blebs of pyrite are distributed			
		along the foliation planes. Elsewhere, disseminations of pyrite and magnetite occur			
		throughout. Feldspars are saussanitized and epidotized. Fine-grained books of a mica-like			
		mineral are randomly distributed and do not align with the foliation. The majority of the			
		rock contains interstitial carbonate (acid reaction) away from the vein material.			
		27.0 Foliation dip 010°			
		44.0 Shear dip 010°			
		48.5 Carbonate vein dip 010°			
50.0 -	72.0	DIORITE			
		- as described above. Magnetite <1%. Numerous hairlike veins and shallow dipping shears to			
		core axis.			
		50.0 Foliation dip 010°			
		58.0 Shear dip 010°			
		70.0 Shear dip 015°			
72.0 -	74.5	FELDSPATHIC DYKE (VEIN)			
		- buff to pinkish, aphanitic (feldspar?) can be scratched. The contacts are intrusive with			
		xenoliths of the diorite in the dyke. (73.0-73.6 is diorite again). This may be a large			
		inclusion, or there are two separate dykes. The dyke itself appears to have been fractured,			
		and carbonate often provides the matrix between fragments. The diorite on either side of			

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Drill Hole Record

Cominco

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 3 of 16

Scale

Colour Plot & Dips

Footage From – To	Description	Sample No.	Length	Analysis
	the dyke are strongly foliated. No sulphides occur in the dyke. The contacts dip @ 10^o. The foliation parallels this dip. A pinkish, "streaky" alteration parallels the foliations in the diorite.			
74.5 – 100.0	DIORITE			
	– essentially the same as the previous sections. A bit more variation in grain size and color are seen. In places, the rock becomes a dark green, and this area randomly distributed carbonate "pods" and veinlets occur (87.0-88.0). The rock is strongly foliated, especially near shears. This foliation varies in dip from <5 to 15^o to the core axis. Pyrite blebs and disseminations still occur but make up $<1\%$ of the rock.			
	Shear 79.0 @ 10^o as in Foliation			
	Shear 90.5 @ 10^o as in Foliation			
100.0 – 114.3	DIORITE			
	– once again, the rock is basically the same as described above with minor textural differences. The chlorite "streaking" is very much evident. This segment of the core is more extensively sheared with numerous fractures dipping approx. 10^o. Between 104.0 and 11.0 the rock has been fractured and sheared with carbonate and quartz filling the openings. Magnetite is also abundant in thick veins.			
114.3 – 123.0	SYENITIC DYKE			
	– contacts are unclear but seems to be in the order of 45^o to the core axis.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 9 of 9

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA

Footage From – To	Description	Sample No.	Length	Analysis
	The rock is fresh looking, massive, buff colored to pink with mafic phenocrysts of hornblende in an aphanitic matrix. No foliation exists. The freshness and lack of foliation suggests this dyke is very late in the sequence. Hairlike carbonate veinlets cut the dyke at various angles.			
123.0 - 150.0	DIORITE - similar to sections logged previously, dark greyish green, darker locally with chlorite streaks of aligning in the plane of foliation. Feldspar still appears to make up the bulk of the rock. A pinkish unidentified alteration mineral occurs throughout (5%) and is aligned with the foliation. Carbonate veinlets cut the core at various angles. Shearing is still very much in evidence, cutting the core at shallow angles -0^{o} to 15^{o}. The foliation parallels these fractures. Disseminated and blebs of pyrite make up $<1\%$.			
150.0 - 173.0	DIORITE - similar to above except certain sections have been strongly sheared, mylonitizing the rock into a gouge which has subsequently been recemented. See - (150.5-151.5), (162.3), (164.4). In areas of these shears, randomly oriented carbonate veins infill the fractures presumably resulting from the shearing. Carbonate also occurs in the "gouge", but is minor to the prevalent epidotization. Small fragments can be seen in the gouge. Between these sheared sections, the diorite has the same character as described in previous sections. The shears cut the core at angles between $10-15^{o}$. Hematite staining occurs on some of the shear planes. The diorite contains some interstitial carbonate. Sample @ 158.5.	BN 581		120

211-9437

Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 9/7 5

Footage From – To	Description	Sample No.	Length	Analysis
173.0 – 175.0	QUARTZ/CARBONATE/SULPHIDE			
	– the contact is abrupt with angle relationships unclear. The white, to buff carbonate is massive, aphanitic and fragmental. The sulphides occupy approx. 15% near the contact and occur as lenses and laminations between fragments of the "carbonate". The rocks is soft, and has a "churned" appearance. Small carbonate veinlets randomly cut the core at various angles (devoid of sulphides).			
175.0 – 225.0	QUARTZ-CARBONATE/SULPHIDES			
	– the carbonate (dolomite) is white, cream colored to yellowish, massive, soft and does not react with acid. Interspersed throughout the carbonate is talc, which is a very pale green and has the "soapy" feel. Within the carbonate, there seems to have been a later infilling of vug-like features with a whiter carbonate which also does not readily fiss. The rock is foliated as evidenced by the sulphides and the talc. The sulphides occur sporadically as fine disseminations (cubs of pyrite) isolated bleb like features, and in layers of fine grain banded sulphides. Pyrite is the most abundant sulphide with galena and sphalerite also seen. The banding in the sulphides gives evidence of a foliation which cuts the core axis at unconsistent angles (varys from parallel to core axis to almost right angles to it). Some sulphide layers appear to be draped around "pods" (fragments?) of carbonate, giving a churned "flow" like look to the rock. Where talc is abundant, foliation is most evident cutting the core axis at shallow angles. Within the carbonate, there is fine-grained black mineral(?) which is unevenly distributed as lenses, and isolated patches. The sulphides are also unevenly distributed with most of the section barren or near so of sulphides.			

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Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 9/16

Footage From – To	Description	Sample No.	Length	Analysis
	An estimate would give 5% sulphides (mostly pyrite) from this section. Sample @ 223.5	BN 583		
	Sample @ 185.0	BN 582		
225.0 - 375.0	MISSING CORE			
375.0 - 381.5	RHYODACITIC FLOW (TUFF?)			
	- the rock is grey to dark grey, aphanitic, massive and fairly hard. Interstitial carbonate is evidenced by a moderate acid reaction. It is extensively sheared, some of which have been healed. A weak foliation nearly parallels the core axis. There is a faint suggestion of lamination but this has all but been obliterated by the shearing and foliation. Approx. 3-5% finely disseminated pyrite occurs throughout in a random fashion. Portions of the rock are greenish grey in areas where qtz veining and shearing are more abundant. The coloration is probably due to increased chlorite and epidote content. Another possible consideration is an Intermediate Intrusive which has been silicified? Numerous shears at 377.0 dip $<10^{\circ}$ to core axis. The foliation is also $<10^{\circ}$.			
381.5 - 386.0	RHYODACITIC CRYSTAL TUFF			
	- the contact with the above unit is abrupt and jagged, with slices of ore penetrating the other. The contact has obviously been modified by the very evident late shearing and fracturing. The rock is a light green, aphanitic, streaky matrix of chlorite and epidote predominantly, and is peppered with saussanite alteration. Coarser grains (feldspars?) deflect the foliation, but they themselves, are stretched and flattened in this plane.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property		District		Hole No.	KSA
Commenced		Location		Tests at		Hor. Comp.
Completed		Core Size		Corr. Dip		Vert. Comp.
Co-ordinates				True Brg.		Logged by
Objective				% Recov.		Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 7 of 16

Footage From – To	Description	Sample No.	Length	Analysis
	Because of the severe stretching and alteration in a fine matrix (with stretched phenocrysts/ fragments) this rock has been interpreted to be a tuff. There is a moderate reaction with acid. Carbonate also vans the rock. The lower contact has been very extensively sheared into a chloritic schist. The schistosity cuts the core axis at 25°. Sample @ 387.0.	BN 584		
386.0 – 396.0	SILICIFIED ZONE (Msv RHYOLITE)			
	– it is difficult to determine what the original rock might have been but now it is a grey to greyish block, aphanitic, very hard. It has undergone extensive fracturing, with silica forming a matrix around the fragments. In the more intense zones of shearing, a laminated texture has resulted (as at 386.6) with cubes of pyrite disseminated in and along the plane of shearing (<10° to core axis). The fragmental and shearing nature (as opposed to sedimentary) of the lamination can readily be seen. Some of the fractures contain talc on the sheared surfaces. Minor chlorite and epidote alteration can be seen. Sulphide content < 5%.			
396.0 – 398.5	GROUND CORE			
398.5 – 425.0	SILICIFIED ZONE (Msv RHYOLITE)			
	– similar to the above. Banding is again present and at 420.0 has a sedimentary look with thin, continuous (1-2mm) laminae with sulphide layers. A strong shear, however, parallels the banding (<10° to core axis), but which came first? Again the rock is extensively fractured with poor core recovery in certain zones. Inclusions of an altered mafic rock occur at (405.5 and 417.0). Contact are abrupt, very shpar.t Ore contact at 405.5 cuts the core axis at 10°. Sulphides, 2%. Sample @ 402.0	BN 585		123

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 8 of 16

Footage From - To	Description	Sample No.	Length	Analysis
425.0 - 430.7	SILICIFIED ZONE (Msv. RHYOLITE)			
	- similar to the above, with fracturing again very much in evidence due to the brittle nature of the rock. Carbonate occurs and gives a moderate to strong acid reaction. Carbonate veins also cut the core at various angles. There are also numerous chloritic stringers in some of the fractures. Sulphides <1%. (Sample @ 426.0).	BN 586		
430.7 - 450.5	DIORITE DYKE			
	- texturally this rock is not dissimilar from the silicified rock, but silica is noteably less abundant making the rock easy to scratch. The upper contact with the siliceous zone is sharp with fragments of the diorite in the siliceous rock. The diorite is thinly laminated with interlayers of pyrite at this contact cutting the core axis at $\sim 10^{o}$. Once again a shear parallels this layering. The diorite itself is medium green, fine-grained to aphanitic, massive and fractured. Many of the fractures have been re-healed, and altered but "ghost" fragments can still be seen. The rock has been chloritized which is aligned as a foliation paralleling the numerous shears which cut the core axis at shallow angles. There is little or no evidence for a pyroclastic origin for this work and the thin laminations are still thought at this time to be the result of shearing.			
450.5 - 457.5	CHERTY LAMINATED SILTSTONE (EXHALITE?)			
	- this rock is in a sheared contact with the above diorite. This shear cuts the core axis $<10^{o}$. The rock itself is whitish to grey, thinly laminated with 5-10% sulphides (mostly pyrite) which also occur as thin laminations. It is siliceous and also has a moderate reaction with acid.			

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Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. KSA	Sheet 9 of 16

Footage From - To	Description	Sample No.	Length	Analysis
	The laminations which parallels the foliation cuts the core axis parallel to the sheared contact of <10°. The extensiveness of these thin laminations which vary from 1mm to 1cm in thickness over 7ft. suggest that these laminations are a sedimentary origin but this cannot be confirmed. There is a suggestion of graded bedding in some of the thicker sulphide laminations which give tops toward the collar or westwards in this case. From 455-456, the rock becomes massive, grey and aphanitic containing <1% sulphides. At the lower contact, the laminations reappear. This zone (455-456) is interpreted to be an Intermediate Intrusive. Sample @ 452.0.	BN 587		
457.5 - 458.0	TALCOSE, ALTERED SHEAR ZONE			
	- carbonate and quartz veins and pod-like features form a matrix around inclusions of an altered mafic rock. Shear planes in this zone often contain talc. Chlorite and epidote are abundant. The shear cuts the core axis at <10°.			
458.0 - 473.6	RHYODACITIC TUFF			
	- the rock has a yellowish green, streaky, (due to extensive chlorite and epidote alteration) aphanitic to fine-grained matrix, with 5% quartz eye phenocrysts. Foliation is moderate cutting the core axis at approx. 10°. Dark green aggregates of chlorite often give the rock a spotted appearance. Quartz and carbonate veinlets cut the core at various angles. Shearing is very much in evidence cutting the core axis at ~10°. The quartz eye often are spheroid, fractured, and have an alteration rim around them. Saussanite alteration also dots the matrix. Sulphides <1%. Some of the quartz eyes and (feldspars?) have been			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 10 of 16

Footage From – To	Description	Sample No.	Length	Analysis
	stretched in the plane of foliation. Sample @ 468.0.	BN 588		
473.6 - 475.0	RHYOLITE FLOW - white with orange tinges, very siliceous, fractured appearance with xenoliths of a mafic rock which subsequently has been completely chloritized. The contact is sheared at 10° to core axis. A parallelism (banding) in the veins also has this attitude. Minor pyrite occurs, 1%.			
475.0 - 484.5	SILICIFIED (RHYOLITE?) ZONE - greyish, aphanitic, massive dense rock, extensively fractured and containing inclusions of chloritized mafics. The rock has a weak foliation semi-parallel to the core axis, and contains a fair percentage of carbonate - moderate to strong acid reaction. A shear at 478.5 had a "talcy" feel to the shear surfaces and cuts the core axis at approx. 05°. The brittle nature and intense fracturing have made core recovery difficult. Sample @ 481.5.	BN 589		
484.5 - 495.0	RHYODACITIC TUFF (EXHALITE?) - greyish, whitish and of green, this rock is finely laminated (1mm to 1cm in thickness) with varying colors for each laminae. Finely disseminated sulphides (pyrite) also occur as laminations. Some laminae are cherty - white, aphanitic, extremely hard. Carbonate also is evident. The laminae cut the core axis at approx 10-15°. Seemingly interbedded with this unit are fine-grained, mafic horizons which have undergone extensive shearing, obliterating primary textures.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 11 of 16

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. KSA

Footage From – To	Description	Sample No.	Length	Analysis
	These units may be tuffaceous horizons or intrusive dykes. Contact relations are unclear but seem to parallel the laminae in ore instance at 488.5. Other contacts suggest an intrusion.			
495.0 - 505.8	(INTRUSIVE?)			
	- the rock is a medium green, aphanitic to fine-grained, massive and easily scratched. It has been sheared, fractured and chloritized in the process making it difficult to assess its genesis			
505.8 - 516.5	RHYODACITIC TUFF (EXHALITE?)			
	- this rock is thinly laminated and a concordancy with the above rock-type suggests bedding relationships, hence a flow genesis. As before, this rock type is greyish green to grey. Finely laminated with sulphides making up 5-10% of the rock. The rock is dense, foliated parallel to the laminations which cuts the core axis at approx 10^{o}. There has been extensive shearing along this plane. The abrupt contacts at the base of the sulphide layers, and a seemingly gradational thinning to the top of the layer suggests a sedimentary origin, and tops to the collar (west). Sericite alteration can be seen on the shear surfaces.			
	Sample @ 506.0.	BN 590		
516.6 - 527.0	TALC-SERICITE SCHIST (DACITE TUFF?)			
	- a light green, to buff, aphanitic matrix is dotted with aggregates of chlorite (often fragments, phenocrysts?).			

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Drill Hole Record

Cominco

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Scale
Colour Plot & Dips

Sheet 12 of 16 | Hole No. KSA | Length | Elev. | Collar Dip | T Brg. | Claim

Footage From – To	Description	Sample No.	Length	Analysis
	This rock has been extensively sheared, chloritized, epidotized and sericitized making this rock essentially a Talc-Sericite Schist. Sections not broken up during drilling reveal thin laminations with suiphides similar to the above interlayered with barren talcose zones.			
527.0 – 528.0	SILICIFIED ZONE (RHYOLITE)			
	- this very hard, siliceous zone is aphanitic, massive and contains epidotized inclusions of the neighbouring rock.			
528.0 – 575.0	TALC-SERICITE SCHIST (DACITIC TUFF?)			
	- for the most part, the rock is a yellowish to greyish green, talcose, sericitized and schistose. Parts are laminated, others laminated with sulphides, and massive looking. Numerous shears parallel or nearly parallel the lamination. Some of the laminae are composed of cherty material. Thickness of the laminae vary from 1mm to 5mm. The schistosity is now cutting the core at approx 20^{o} suggesting that the hole is deviating from its original dip - or the attitudes are changing. Occasional layers containing aggregates of chlorite occur as at 538.8 which appear to be tuffaceous horizons (lithic tuffs?). Some horizons have (phenocrysts/fragments?) which have been stretched in the plane of foliation as at 573.9. Sample @ 541.0. (Ground core 551.0-553.7). (Sample @ 571.5).	BN 591 BN 592		
576.0 – 580.0	GROUND CORE - no recovery			

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Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 13 of 16

Footage From - To	Description	Sample No.	Length	Analysis
580.0 - 601.0	QUARTZ/CARBONATE			
	– cream colored, buff to white carbonate (dolomite-no acid reaction) with lenses, laminations and pods of sulphides (pyrite and sphalerite?) which cut the core at various angles. From 505-595, the rock is well foliated and very talcose. The foliation cuts the core axis at ~20°. The "carbonate" rock is made up of a number of "healed" fractures, and is often vuggy. Sulphides make up approx. 10-15% of the section.			
601.0 - 602.0	DACITE TUFF			
	– two possible explanations can be put forward for this rock. 1) sheard tuff, 2) sheared intrusive. The implications of 1) would give new light to the mechanism of carbonate implacement. The rock is light green, well foliated with a sericitic and chloritic matrix in which there are elongated shard-like features which look like stretched lithic fragments. Fine-grained feldspar (and qtz?) grains can also be seen in the matrix. The foliation is approx. 20-25° to the core axis, and has been cut by a shear paralleling the axis. Broken core has deliterated contact relations. Sample @ 601.0.	BN 593		
602.0 - 606.5	QUARTZ-CARBONATE-SULPHIDES – similar to the above Qtz-Carb Zone.			
606.5 - 607.2	DACITE TUFF			
	– this rock is almost identical to the above tuffaceous rock. This small unit contains a large inclusion (1.5" wide) of the carbonate rock. The contact with this inclusion are very sharp and partly rimmed by sulphides. Smaller carbonate inclusions also occur. A tuffaceous			

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Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Property	District	Hole No. KSA	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSA | Sheet 14 of 16

Footage From - To	Description	Sample No.	Length	Analysis
	origin for this rock is more apparent than in the above. Fragmental material is more abundant and contrasts well with the altered matrix. The alteration consists of talc and sericite with some chlorite and epidote.			
607.2 - 637.0	QUARTZ-CARBONATE-SULPHIDES			
	- similar to previous zones of this type. Two small tuffaceous horizons occur at 626.2 and at 631.2. The ore extensively sheared and altered (talc-sericite). Sample @ 619.5.	BN 594		
637.0 - 643.0	DACITE TUFF			
	- light green, fine-grained to aphanitic, matrix with elongated lithic fragments. The contact with the Qtz-carbonate has been preserved. It is abrupt and cuts the core axis at 30°. Thin laminae of sulphides parallel this contact. A thin chloritized (talcose) layer which "looks" tuffaceous parallels both and is interlayered with the "carbonate". The Dacite proper then begins. The lithic fragments are a darker green. Shears cut the core parallel to the axis. Blebs, cube and disseminations of pyrite occur sporadically throughout. Sample @ 643.0.	BN 595		
643.0 - 663.0	QUARTZ-CARBONATE-SULPHIDES			
	- similar to previous zones. Sulphides content is low (1%) from 643.0 to 654.0. From 654.0 sulphide make up approx 3-5% of the rock (predom. pyrite). Parts of this section contain inclusions of the tuffaceous material.			

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211-9437

Drill Hole Record

COMINCO

Scale
Colour Plot & Dips

Property | District | Hole No. KSA
Commenced | Location | Tests at | Hor. Comp.
Completed | Core Size | Corr. Dip | Vert. Comp.
Co-ordinates | True Brg. | Logged by
Objective | % Recov. | Date

Sheet 15 of 16 | Hole No. KSA | Claim | T Brg. | Collar Dip | Elev. | Length

Footage From – To	Description	Sample No.	Length	Analysis
663.0 - 667.0	DACITE TUFF			
	- the contact is abrupt but seemingly a bedding contact. A fine streaky layer .5 inches thick is sitting directly on the carbonate interpreted to be a possible fine ash layer. The tuff then becomes thicker with lithic fragments of 1-2mm size. stretched in the plane of foliation. The contact cuts the core axis at approx 30°. The lower contact has been modified by a shear which nearly parallels the core axis. An inclusion of carbonate seemingly is sitting in the tuff, elongated in the shear plane (Sample @ 665.0).	BN 596		
667.0 - 704.0	QUARTZ-CARBONATE (SULPHIDES)			
	- similar to previous zones - nearly barren of sulphides <1%.			
704.0 - 705.0	MAFIC DYKE			
	- dark green, fine-grained, fresh looking made up of feldspar and mafic minerals. Not sheared or foliated. Very late in the stratigraphy. Contacts are unclear due to fracturing in the carbonate from drilling.			
705.0 - 747.5	QUARTZ-CARBONATE			
	- as before, talcose churned appearance. Sulphides 1%. From 729.0-747.5, core recovery was very poor, and a massive brown looking material appears to be cement. Sample @ 747.0	BN 597		
	Sample @ 721.5.	BN 598		

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No.	KSA		
Commenced	Location	Tests at		Hor. Comp.	
Completed	Core Size	Corr. Dip		Vert. Comp.	
Co-ordinates		True Brg.		Logged by	
Objective		% Recov.		Date	

Sheet 16/16

Hole No. KSA

Footage From	To	Description	Sample No.	Length	Claim	T Brg.	Collar Dip	Elev.	Length
747.5	775.0	TALC-SERICITE (DACITE TUFF)							
		– the rock is a light green, extremely soft and brittle, schistose and moisture from being outside has reduced most of the rock to a crumbly moss. The brown, massive zone (cement) is abundant. The foliation is approx. 30^{o} to the core axis. The rock has a fractured appearance and may be a large fault zone. Pyrite cubes make up 1-2% of the rock. Sample @ 773.5	BN 599						
		END OF HOLE							

Analysis

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211-9437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Maritimes	Hole No.	KSB
Commenced		Location		Tests at	
Completed		Core Size		Corr. Dip	
Co-ordinates				True Brg.	130°
Objective				% Recov.	

Hor. Comp.
Vert. Comp.
Logged by C. Miller
Date August, 1977

Claim Stirling
T Brg. 130°
Collar Dip 080°
Elev.
Length 467 feet
Hole No. KSB
Sheet 1/3

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 5.0	OVERBURDEN			
5.0 – 21.0	DIORITIC INTRUSIVE			
	- dark to medium green, chloritic, massive with occasional feldspar phenocrysts of 1mm size. The rock is slightly magnetic owing to ~5% magnetite often with hematitic rims. Chlorite is streaky in the plane of foliation < 20° to core axis. Minor sulphides (pyrite) 1-2% as disseminations. Erratic carbonate veinlets cut the core at various attitudes.			
21.0 – 26.0	QUARTZ-CARBONATE SULPHIDES			
	- whitish to buff colored, predominantly carbonate, strong acid reaction. The rock appears laminated, but I think this is a foliation affect. Irregular lenses of sulphides occur also in the foliation plane. Pyrite predominates but visible sphalerite was also seen. Minor galena is evident < 1%. Part of the "lamination" is made up of chloritic zones. Since the majority of the qtz-carbonate seen previously did not react violently with acid, this zone is probably recrystallized material resulting from metamorphism.			
26.0 – 29.0	SYENITIC INTRUSIVE			
	- massive, pinkish to buff colored aphanitic matrix with amphibole phenocrysts up to 2mm size, giving the rock an spotted appearance. Upper and lower contacts in the adjoining rocks has undergone contact metamorphism. This intrusive is part the tectonic event responsible for the regional foliation in the Bourinot.			

211-0437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSB	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Sheet 2 of 3

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSB

Footage From	To	Description	Sample No.	Length	Analysis
29.0 -	43.5	ALTERED DACITIC TUFF			
		- light to dark green, chloritic, sericitic, and often talcose on shear planes. The rock is strongly foliated ~25° to core axis and has a laminated appearance in this plane. Distinct pyroclasts could not be identified, but small elongated saussanites and epidotes are considered metamorphosed clasts of lithic or feldspathic material. Portions may be rhyodacitic evidenced by the quartz content when scratched. For the most part, the rock is soft, and has a streaky, often spotty look. Sulphide (pyrite) made up <1%.	BS 571		
43.5 -	47.5	RHYOLITE FLOW (FLOW BRECCIA?)			
		- grey to greyish green in color, extremely siliceous and massive for the most part. The rock looks fractured (primary/secondary?). In the past, this was called CHERT as it may well be. The chlorite content, especially near the upper contact is suggestive of inclusions at a flow contact. Sericite and talc occur on sheared surfaces. Sulphides make up 2-4$ as very fine disseminations, mostly pyrite.			
47.5 -	50.0	DACITE FLOW/PYROCLASTIC			
		- dark green, chloritic with feldspar phenocrysts making up 10% of the rock. Saussanite and epidote and possibly sericite alteration abound in specific areas giving the rock a lamination. It is not known whether is this often a primary lamination. There are also small clasts of "epidote" often feldspars. Because of the strong shearing and subsequent alteration, a definite genesis is difficult. Sulphides make up <1%. Sample @ 48.5	BN 572		

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811-0437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSB	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSB | Sheet 3 of 3

Footage From - To	Description	Sample No.	Length	Analysis
50.0 - 175.0	MISSING			
175.0 - 200.0	MAFIC INTRUSIVE-DIORITIC			
	- dark green, massive with a weak foliation. Chloritic, with feldspar phenocrysts up to 2mm size. Magnetite with hematitic halos make up 1-2%. Carbonate veinlets cut the rock at various angles.			
200.0 - 250.0	MISSING			
250.0 - 275.0	MAFIC INTRUSIVE-DIOIRITIC - similar to above			
275.0 - 466.5	MISSING CORE			
466.5	END OF HOLE			

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211-0437

Scale

Core Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Maritimes	Hole No.	KSC		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.	130^{o}	Logged by	C. Miller
Objective				% Recov.		Date	August, 1977

Claim: Stirling | T Brg.: 130^{o} | Collar Dip: 080^{o} | Elev.: | Length: 444 feet | Hole No.: KSC | Sheet 1 of 3

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 14.0	OVERBURDEN			
14.0 - 50.0	MISSING CORE			
50.0 - 59.5	RHYOLITE FLOW			
	- grey to greyish green, massive, fractured, aphanitic. The rock is very siliceous, difficult to scratch. There is a weak foliation developed where chlorite and sericite are more abundant (30^{o} to core axis). Fine disseminated pyrite occurs occasionaly in these foliated zones.			
59.5 - 152.0	MAFIC INTRUSIVE-DIORITIC			
	- dark to medium green, moderately foliated and sheared, locally feldspar porphyritic 1mm in an aphanitic matrix. Chlorite is abundant, growing in the plane of foliation (30^{o} to c. axis). Epidole is also common as is saussanite which occurs as elongated streaks. Shearing is widespread, often transforming the rock into a chlorite schist. Quartz carbonate veins often cut the rock altering the adjacent rocks. (99.0, 101.0). Magnetite occurs locally, up to 10%. Hematite staining often surrounds the magnetite and also occurs on shear plane surfaces. Disseminated pyrite occurs locally.			
152.0 - 159.0	SYENITIC INTRUSIVE			
	- pink to buff coloured, massive, not foliated, feldspathic matrix with 1-2mm size amphibole phenocrysts.			

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Drill Hole Record

COMINCO

Scale
Collar Plot & Dips

Sheet 2 of 3

Hole No. KSC

Property	District	Hole No. KSC	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSC

Footage From - To	Description	Sample No.	Length	Analysis
159.0 - 197.5	MAFIC INTRUSIVE-DIORITIC			
	- similar to (59.5-152.0). Saussanite and epidote are more abundant. Also, showing has been more intense, with the rock being extensively fractured. The foliation is very strong ~30° to core axis. Carbonate stringers cut the core at various attitudes.			
197.5 - 373.0	QUARTZ-CARBONATE-TALC-SULPHIDES			
	- buff, to white, often yellowish or greenish. Carbonate predominate (dolomite) with very little visible quartz. Talc occurs but is not widespread. It is usually restricted to narrow zones, or as fragmental material on a sulphide matrix. (Sample @ 228.5). Sulphides make up 10-15%	BN 448		
	and are fairly evenly distributed. Narrow zones are almost massive but the bulk of them are as fine disseminations or blebs. Pyrite is the main sulphide. Minor sphalerite and a finely disseminated blue black sulphide is also seen. (Covellite, galena?). Calcite stringers cut the core at various angles. The rock is foliated most evidenced in talcose zones, and in the sulphides ~30° to axis. Barren zones, as at 202.0 contain mostly quartz. The rock is extensively sheared and fractured. Zones where sulphides are nearly massive, have clasts of carbonate material. MAFIC INTRUSIVE - 347.5-348.0. Medium green, chloritic, aphanitic.			
	Sample @ 353.0.	BN 568		
373.0 - 375.0	RHYOLITE FLOW			
	- greyish, aphanitic, massive, very siliceous. Flow banded. The rock is fractured and contains inclusions of mafic (chloritic) material. The contact with the above is not obviously abrupt, and looks conformable, however this is not clear. Finely disseminated sulphides 1-5% are			

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Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Property	District	Hole No. KSC	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSC | Sheet 3 of 3

Footage From	To	Description	Sample No.	Length	Analysis
		evenly distributed. Also, sulphides, mainly pyrite occur in hairlike fractures.			
375.0	391.0	MAFIC INTRUSIVE-DIORITIC			
		- dark to medium green, chloritic, fine-grained with a strong foliation ~30° to core axis. The rock is fairly uniform throughout, and has been sheared and fracturing kinking is evident @ 383.0. Calcite stringers cut the core at various angles.			
391.0	444.0	RHYOLITE FLOW			
		- similar to (373.0-375.0), grey to greyish green in color, massive, aphanitic, siliceous. The rock is very hard but zones are softer and can be scratched. The rock has been fractured, and has a weak foliation. Banding occurs at various spots (391.0, 414.0). Some of it may be a flow banding while others look like they are graded, being exhalative in origin. Finely disseminated sulphides (pyrite) <5% are widespread. Sulphides also occur in fractures, and they are laminated in the plane of foliation. Portions of the rock appear dacitic and maybe similar to the rock outcropping on the east side of the glory hole. Certain zones as at 438.5 contain considerable amounts 10-15%. Finely disseminated, laminated sulphides (pyrite?). Sheared surfaces are often sericitic and slightly talcose. Sample @ 423.5.	BN 569		
		Sample @ 431.0	BN 570		
444.0		END OF HOLE			

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property STIRLING		District Maritimes		Hole No. KSD			
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg. 130^o		Logged by C. Miller	
Objective				% Recov.		Date August, 1977	

Claim: Stirling | T Brg.: 130^o | Collar Dip: 080^o | Elev. | Length: 399 ft. | Hole No.: KSD | Sheet: 1/4

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 1.5	OVERBURDEN			
1.5 – 3.0	DACITE TUFF			
	– light green, sericitic, chloritic, foliated 20^o to core axis. The bulk of the rock is chloritic but minor feldspar and possible qtz. occur (2%). Saussanite dots the rock giving it a spotty look.			
3.0 – 5.0	MUD SEAM – Missing Core			
5.0 – 6.5	EXHALITE (CHERT)			
	– light grey to buff coloured, very siliceous and fractured (healed). Some lamination believed to be primary is preserved. Some of the laminae are rusty. These zones react with acid showing the carbonate content. Sulphides are negligible.			
6.5 – 9.0	MAFIC INTRUSIVE (DIORITIC)			
	– medium green, chloritic, massive, with a weak foliation. Could also be an extrusive. Contacts not seen due to poor core recovery.			
9.0 – 13.0	EXHALITE (CHERT)			
	– light grey to buff depending upon relative amounts of carbonate and chert. Highly fractured (healed) but primary lamination is often preserved. Due to the brecciation, this lamination cuts the core axis at various angles. Calcite stringers cut the core at various angles. Sulphides are negligible.			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property	District	Hole No. KSD
Commenced	Location	Tests at
Completed	Core Size	Corr. Dip
Co-ordinates		True Brg.
Objective		% Recov.

Hor. Comp.	
Vert. Comp.	
Logged by	
Date	

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. KSD	Sheet 2 of 4

Footage From – To	Description	Sample No.	Length
13.0 – 18.5	MAFIC INTRUSIVE-DIORITIC		
	– medium green, massive, chloritic with a weak foliation. Minor phenocrysts of feldspar 2%. Minor sulphides 1%. Near the upper contact occur what appear to be altered xenoliths. They are a light green (epidote) and are in sharp contrast the host rock.		
18.5 – 25.0	EXHALITE INTERBEDDED WITH RHYODACITIC TUFFS		
	– the core is very blocky so contact relationships are obscure. The exhalite zones are light grey, to buff (chert, carbonate), finely laminated and barren of sulphides. They often have been fractured. The tuffs are chloritic, light green, and often talcy and sericite. Altered lithic clasts are interpreted as well as "augen" quartz eyes which often account for 20% locally. Other tuffaceous looking horizons are devoid of qtz eyes. The tuffs are strongly foliated, approx 20° to the core axis. Sulphides are negligible in the tuffs.		
	Sample @ 23.0	BN 573	
25.0 – 250.0	MISSING CORE		
250.0 – 301.5	DACITIC/RHYODACITIC TUFFS INTERBEDDED WITH EXHALITE (Rhyolite flows)		
	– this continuous section is mainly made up of greyish green felsic tuffs of varying composition. The tuffs are often finely laminated believed primary, and contain elict, stretched pumice shards. Qtz and feldspar crystal fragments are often seen. Locally, the tuffaceous rocks are more massive and homogeneous. Within the primarily tuffaceous section occur zones of a grey to buff exhalite, which is finely laminated and extremely cherty.		

Analysis

Drill Hole Record

Cominco

Sheet 3 of 4

Property	District	Hole No. KSD	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSD

Footage From – To	Description	Sample No.	Length	Analysis
	Both laminations in the tuffs and exhalite cut the core axis at approx. 35°. Sulphides are rarely seen. Calcite veinlets cut the core axis at various angles often, the tuffaceous looking zones are siliceous suggesting a mixing of two compoents from the same or different sources. Sample @ 276.0. Sample @ 297.5	BN 574 BN 575		
301.5 - 305.5	MUD SEAM - MISSING CORE			
305.5 - 307.5	RHYODACITIC TUFFS WITH EXHALITE - core recovery is very poor. The small pieces of core show similar rock types to the above from (250.0 - 301.5)			
307.5 - 309.0	MUD SEAM - MISSING CORE			
309.0 - 350.0	QUARTZ-CARBONATE, SULPHIDES - white to mean colour, extensively brecciated, sheared. Talc is abundant making the rock extremely delicate. Talc rich zones are very frissile. The top of the unit from 309.0-315.0 contains 10% sulphides occupying a matrix of carbonate clasts (samples 310.6) This could be a primary texture! Sulphides occur sporadiocally throughout and are often laminated in the plan of foliation -35° to core axis. The bulk of the mineralization is pyrite and sphalerite. Locally, sphalerite is almost massive. Chalcopyrite and galena are notably absent suggesting that if mineral zoning is evident, the Zn-pyrite zone is suggestive of the top of the deposit.	BN 447		

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Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Sheet 4 of 4

Property	District	Hole No. KSD	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. SKD

Footage From	To	Description	Sample No.	Length	Analysis
		Much of the quartz carbonate has been brecciated, but later healed. Fragments are much in evidence. Talc has grown in the foliation plane. Portions of this section are devoid of sulphides. An overall average for the section would give 10% sulphides. Pyrite probably predominates over sphalerite. The sphalerite is very fine grained and a light, honey-yellow in color.			
350.0	399.0	MISSING CORE			
399.0		END OF HOLE			

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Drill Hole Record

Scale
Colour Plot & Dips

COMINCO

Property STIRLING		District Maritimes		Hole No. KSE	
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg. 130°	Logged by C. Miller
Objective				% Recov.	Date August, 1977

Claim: Stirling | T Brg.: 130° | Collar Dip: 060° | Elev.: | Length: 514 feet | Hole No.: KSE | Sheet 1 of 4

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 16.0	OVERBURDEN			
16.0 – 20.0	GROUND CORE, NO RECOVERY			
20.0 – 75.0	MISSING CORE			
75.0 – 106.5	INTERMEDIATE/INTRUSIVE?			
	– dark to medium green, moderately foliated, chlorite is extensively developed. The rock is massive, substantially sheared, with carbonate developed in the shear plane (foliation plane). Calcite also cuts the core at various angles. It is slightly lighter in color than most of the intrusive rocks and has negligible magnetite. Disseminated sulphides make up 1%.			
106.5 – 212.0	DACITIC FLOW/PYROCLASTIC			
	– light green, carbonatized. Strongly sheared and foliated. Chlorite is abundant with minor epidote and sericite. Certain parts have fragmental looking material, stretched in the plane of foliation. Carbonate is abundant, mostly in the plane of foliation. The foliation is 45-50° to the core axis. Sulphides are negligible.			
121.0 – 137.0	CARBONATIZED, CHLORITE, SERICITE SCHIST-INTERMEDIATE FLOW/PYROCLASTIC?			
	– similar to 106.5-121.0 except the carbonate alteration is much more stronger developed giving the rock a whitish green color locally. The rock is extensively sheared and foliated. Hair-like carbonate stringers also cut the core at various angles. This zone is also talcose.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSE	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSE | Sheet 2 of 4

Footage From	To	Description	Sample No.	Length	Analysis
		Where carbonate is less developed, the rock looks intermediate in composition. Sample 128.5	BN 556		
137.0	150.0	INTERMEDIATE FLOW			
		- medium green, less foliated than above. Carbonate not as well developed, although carbonate rich zones do occur. Portions of this section are massive, poorly foliated, with calcite stringers cutting them. The foliation is 40-60^{o} to the core axis. The unit could probably be lumped with the above zone 121.0-137.0. Sample 139.5	BN 557		
150.0	155.0	PORPHYRITIC FLOW/INTRUSIVE?			
		- dark to medium green, chloritic matrix with saussanitized and fresh feldspar phenocrysts 1-3mm, randomly oriented. Some of the phenocrysts are shaped giving the rock an aphitic texture. Qtz-carbonate veinlets are responsible for epidote alteration near their contacts. Magnetite, with hematite staining is also evident. Sample 151.5.	BN558		
155.0	178.0	INTERMEDIATE INTRUSIVE			
		- dark to medium green, fine-grained matrix with 1mm size saussanitized feldspar? phenocrysts. The phenocrysts are obviously smaller than in the above unit. Chlorite is widespread, but the rock is not strongly foliated. Carbonate stringers cut the core at various angles. Missing core - 172.0-174.0 , 176.0-178.0.			
178.0	285.0	RHYOLITE FLOW			
		- greyish, massive, fine-grained to aphanitic, minor qtz-eyes 1%. Very siliceous. For the most			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Sheet 3 of 4

Property	District	Hole No. KSE	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSE

Footage From – To	Description	Sample No.	Length	Analysis
	part, the rock is very hard, but there are zones where it is rhyodacitic and possibly dacitic. In these area, the rock is more greenish with a higher chlorite content. A moderate foliation is developed where chlorite is abundant, cutting the core axis at 60°. Quartz caronate veins, and calcite stringers are intruded. Disseminated pyrite makes up 1% of the rock. Portions of this section are fractured. It may be that some of these fractured zones are rhyolite breccias modified in the shearing. This could not be ascertained in the core.			
	Missing core 247.0-249.0. Sample 252.5	BN559		
285.0 - 375.0	MISSING CORE			
375.0 - 400.0	RHYOLITE FLOW (INTERBEDDED WITH MAFIC TUFFS & EXHALITES)			
	- greenish grey, fine-grained to aphanitic, generally massive, siliceous. Parts appear laminated in the plane of foliation which parallels shear plane 30° to core axis. Chlorite occurs, giving the rock its green color. Parts of the rock are very siliceous looking like a grey-blue chert. Calcite veinlets cut the core randomly. Sericite occurs and can best be seen on the shear planes.			
400.0 - 425.0	MISSING CORE			
425.0 - 467.0	RHYOLITIC/RHYODACITIC FLOW			
	- similar to 375.0-400.0. Parts of the rock are finely laminated. These appear to be siliceous (cherty) horizons interlaminated with chloritic units interpreted to be fine ash or tuffs.			

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Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Sheet 4 of 4

Property	District	Hole No. KSE	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSE

Footage From - To	Description	Sample No.	Length	Analysis
	At 444.0-445.0, alkali feldspar occurs in a gneissic looking rock. This is probably a sheared intrusive. Most of this section has been extensively sheared. Calcite stringers occur but are not abundant. Sample 436.0. Exhalitive units.	BN560		
467.0 - 475.0	PYROCLASTIC, RHYOLITE - brownish grey, fine-grained, feldspathic and chloritic matrix, with qtz and alkali feldspar phenocrysts. 1-2mm size"shards" are stretched in the plane of foliation. The phenocrysts vary from 2-10mm and are sub-rounded. The bulk of the matrix looks pyroclastic, so this rock might be a lithic tuff. Sample 472.0	BN561		
475.0 - 514.0	MISSING CORE			
514.0	END OF HOLE			

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Drill Hole Record

Scale

Colour Plot & Dips -

Cominco

Property STIRLING	District MARITIMES	Hole No. KSF	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg. 130^{o}	Logged by C. Miller
Objective		% Recov.	Date August 1977

Claim: STIRLING | T Brg.: 130^{o} | Collar Dip: 080^{o} | Elev.: | Length: 375 feet | Hole No.: KSF | Sheet 1

Footage From	To	Description	Sample No.	Length	Analysis
0	15.5	OVERBURDEN			
15.5	25.0	MISSING CORE			
25.0	56.0	DACITE/RHYODACITIC TUFFS - grey, green, chloritic, sericitic, generally aphanitic to fine grained, often finely laminated. The laminae are made up of alternating bands of a chlorite tuff and a grey chert (exhalite?). The rock has been strongly sheared and foliated 20^{o} to the core axis. Carbonate only occurs in hair-like fractures.			
		Sample 34.0.	BN554		
56.0	65.0	SYENITIC INTRUSIVE - buff to pinkish, feldspathic, massive matrix with 1-2 mm size amphibole phenocrysts. No foliation is developed.			
65.0	82.0	DACITE/RHYODACITIC TUFFS - similar (25.0 - 56.0) Certain zones are more massive and siliceous suggestive of rhyo-dacitic flows interbedded with the tuffs. One such unit extends from 65.0 to 71.5. At 71.5, the rock is again finely laminated to 80.0 with massive patches. This entire section is made up of thin alternating beds of massive and laminated felsic volcanics (flows & Pyroclastics?)			
82.0	92.0	DACITE LITHIC TUFF - dark to medium green, fine grained, foliated 30^{o} to core axis. Chlorite growths in this plane. Numerous black-green shreds also aligned in the foliation,			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	MARITIMES	Hole No.	KSF con't		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.		Logged by	
Objective				% Recov.		Date	

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.	Sheet
STIRLING					KSF	2

Footage From	To	Description	Sample No.	Length	Analysis					
82.0	92.0	interpreted to be stretched lithic fragments. There also could be stretched quartz and								
	con't	feldspar fragments; may possible be an intrusive; calcite veinlets are abundant; Sample								
		88.5	BN555							
92.0	100.0	RHYOLITE FLOW - grey, often pinkish tinges, massive, aphanitic, very siliceous; portions								
		are laminated in the plane of foliation. The rock appears to have been fractured								
		(healed); the pinkish colour is believed due to alkali feldspar.								
100.0	125.0	MISSING CORE								
125.0	200.0	MAFIC INTRUSIVE - dark to medium green, fine grained, abundant chlorite in the foliation								
		plane 30^{o} to core axis; yellowish saussarite "streaks" often feldspar; magnetite								
		present 5% locally; calcite veinlets cut the core at various angles.								
200.0	225.0	MISSING CORE								
225.0	244.0	MAFIC INTRUSIVE - similar to (125.0 - 200.0)								
244.0	251.0	RHYOLITE BRECCIA - greyish to buff coloured, aphanitic, siliceous fragments in a finer,								
		chloritic to sericitic matrix, greener in colour; whole fragments seen in the core								

Drill Hole Record

Cominco

Scale

Colour Plot, & Dips

Property STIRLING	District	Hole No. KSF con't	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSF | Sheet 3

Footage From	To	Description	Sample No.	Length	Analysis
		range from 1 mm to 1.5 cm in size; minor sulphides occur in the matrix 1%.			
		(Sample @ 249.0)	BN 449		
251.0	262.0	RHYOLITE FLOW - greyish, aphanitic, massive, very siliceous, often veined by calcite stringers locally, the rock is buff coloured.			
262.0	275.0	INTERMEDIATE/FELSIC TUFFS - The rock varys from light to dark green, is fine grained to aphanitic, moderately foliated with chlorite in this plane; parts have what appear to be stretched lithic fragments, while others have crystal fragments; the foliation makes it difficult to interpret this rock calcite stringers are abundant.			
275.0	325.0	MISSING CORE			
325.0	350.0	RHYODACITE FLOW - greyish green, fine grained, foliated 30° to core axis, generally massive with rhyolitic (very siliceous) patches; there may be thin laminae of pryoclastic material interbedded with chert @ 328.5; other narrow pyroclastic units may exist, especially from 343.0 - 344.5 where a crystal tuff is interpreted; the rock is strongly sheared, with feldspar crystal fragments at various stages of stretching; some are faint streaks in the otherwise chloritic matrix (sample @ 344.0); from 344.5 - the rock is again a rhyodacitic flow.	BN 450		

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Drill Hole Record

COMINCO

Scale

Colour Plot & Dips

Property STIRLING	District	Hole No. KSF con't	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. KSF	Sheet 4

Footage From	To	Description	Sample No.	Length	Analysis
350.0	375.0	MISSING CORE			
375.0		END OF HOLE			

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property STIRLING	District Cape Breton	Hole No. KSG			
Commenced	Location	Tests at	Hor. Comp.		
Completed	Core Size	Corr. Dip	Vert. Comp.		
Co-ordinates		True Brg. 130^{o}	Logged by C. Miller		
Objective		% Recov.	Date July 11, 1977		

Claim: Stirling | T Brg.: 130^{o} | Collar Dip: 080^{o} | Elev. | Length: 378 feet | Hole No. | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 9.0	OVERBURDEN – NO CORE			
9.0 – 58.5	MAFIC INTRUSIVE (DIORITE)			
	– the rock is dark to medium green predominantly composed of feldspar and chloritized mafic minerals. It varys from a massive, fine-grained variety to a porphyritic one with saussanitized feldspars as the phenocryst. These phenocrysts have a yellowish look and are elongated in the plane of foliation. The abundant chlorite gives a "streakiness" to the rock, also in the foliation plane. The foliation is well developed and parallels numerous shears. Magnetite is an important constituent making up 15-20% of the rock. Hematite staining occurs around the magnetite and on some of the shear plane surfaces. Minor sulphides are distributed throughout (<1%) as disseminations and blebs (mostly pyrite). Carbonate stringers are abundant, cutting the core axis at varying angles. Some stringers parallel the foliation. In the vicinity of these stringers, the mafic rock is slightly epidotized. Minor qtz veins also cut the core. Foliation 15.0' – 30^{o} to core axis.			
58.5 – 61.0	SYENITE INTRUSIVE			
	– buff brown, aphanitic (predominantly feldspar matrix) with 1-2mm size phenocrysts of pyroxene (or hornblende) which make up approx. 10% of the rock. Contacts are abrupt cutting the core axis at approx. 30^{o}.			
61.0 – 68.0	MAFIC INTRUSIVE (DIORITE)			
	– similar to the above. This portion is porphyritic with the saussanitized feldspar phenocrysts			

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Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Property	District	Hole No. KSG	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSG | Sheet 2 of 7

Footage From – To	Description	Sample No.	Length	Analysis
	(yellowish) in a strongly foliated chloritized matrix. The foliation is approx. 30° to core axis. Magnetite occurs but in lesser amounts than above. Sulphide content has increased to 2-3%. Carbonate stringers still abound and qtz veins with mafic and magnetite inclusions occur near the contact at 68.0'.			
68.0 – 69.0	SYENITIC INTRUSIVE – as described previously (58.5-61.0).			
69.0 – 125.0	MAFIC INTRUSIVE (DIORITE) – similar to that described from (8.0-58.5) and (61.0-68.0). The magnetite content has increased again to approx. 10%. Porphyritic zones occur locally. The foliation still cuts the core at approx 30° (Sample @ 72.5). Sample @ 107.0.	BN 542 BN 543	-2	
125.0 – 150.0	MISSING CORE			
150.0 – 164.0	MAFIC INTRUSIVE (DIORITE) – similar to above (8.0-58.5) (61.0-68.0) and (69.0-125.0) in appearance, but the rock is more extensively sheared and foliated near the contact with the qtz-carbonate zone at 164.0. The shear planes vary from 0 to 25° to the core axis. The foliation averages 20-25° to the core axis. Carbonate and quartz stringers are still abundant with unconsistent orientations.			

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Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Property	District	Hole No. KSG	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSG | Sheet 3 of 7

Footage From – To	Description	Sample No.	Length	Analysis
164.0 - 173.2	QUARTZ-CARBONATE-SULPHIDES			
	- the contact with the above mafic intrusive is abrupt and brecciated. The qtz-carbonate rock is fractured with mafic material infilling the matrix, definitely doting the dykes as post qtz-carbonate and pre-shearing. The rock is white to yellowish to buff in color depending upon the relative proportions of carbonate and quartz. The rock has a massive, often brecciated, churned appearance. Sulphides make up approx. 15% of the rock and occurs as lenses and laminations. Pyrite is the predominant sulphide with minor sphalerite and galena seen. The mineralization is inconsistent with most of the zone being barren. The laminated sulphides appear to parallel the foliation measured previously, cutting the core axis at approx. 20°. (Sample @ 167.0).	BN 544		
173.2 - 181.0	MAFIC INTRUSIVE (DIORITE)			
	- similar to the mafic zone from (150.0-164.0). The rock is dark green, occasionally porphyritic with elongated saussanitized (epidotized) feldspars. Chlorite is widespread giving a "streakiness" in the plane of foliation (approx 20° to core axis). Sulphide content has increased especially in carbonate veins which cut the dyke. The sulphides are predominantly pyrite and also occur as "veinlets" paralleling the foliation. This zone is extensively sheared.			
181.0 - 231.3	QUARTZ/CARBONATE-SULPHIDES			
	- similar to the zone from (164.0-173.2). Once again the rock has a fractured and churned appearance, but the foliation is becoming more evident especially near zones where sulphide			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSG	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
	content is high. The foliation can be seen where the sulphides are thinly laminated around carbonate inclusions, or where a later carbonate remobilization product (talcose) forms a matrix for carbonate inclusions (fragments) in the plane of foliation which is approx. 20° to the core axis. It appears that during the shearing which produced the foliation, the qtz-carbonate zone was flowing and fracturing in response to the stress. Remobilization of sulphides and carbonate/talc filled in the matrices normal to the stress. The sulphide content increases to approx. 20% from (210-225.0). Proportions of visible sphalerite also increase but cannot be estimated. Galena is negligible and chalcopyrite seems to be absent. Portions of this zone from 220.-225 appear tuffaceous, but is probably a feature of the shearing. Sample @ 186.5	BN 545		
	" 222.5	BN 546		
	" 212.0	BN 547		
231.3 - 236.0	MAFIC INTRUSIVE (DIORITE)			
	- the contact is very abrupt and nearly parallels the core axis. The carbonate has been brecciated with mafic material infilling around the fragments. The dyke is a medium green, massive to slightly porphyritic (feldspars) in a fine grained to aphanitic matrix. It is sheared and foliated approx. 20° to the core axis. The lower contact is also near parallel to the core axis and the mafic rock is fragmental.			
236.0 - 237.7	QUARTZ/CARBONATE-SULPHIDES - as described from (181.0-231.3).			

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Drill Hole Record

COMINCO

Property	District	Hole No. KSG	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Sheet 5 of 7 — Hole No. KSG

Claim | T Brg. | Collar Dip | Elev. | Length

Scale

Colour Plot & Dips

Footage From – To	Description	Sample No.	Length	Analysis
237.7 – 241.2	MAFIC INTRUSIVE (DIORITE) – similar to that between 231.3-236.0			
241.2 – 245.0	QUARTZ/CARBONATE-SULPHIDES – as described from (181.0-231.3)			
245.0 – 245.8	MAFIC INTRUSIVE – interpretation of this zone is difficult due to the extensive shearing that has taken place. It is a greyish green, strongly foliated marked by chlorite streakiness. There appears to be some crystal fragments, but again, these could be phenocrysts. The rock could also be the Dacitic Tuff which has undergone shearing. Contact relationships are unclear. Shear planes are talcose and the rock has been sericitized.			
245.8 – 246.4	QUARTZ/CARBONATE-SULPHIDES – as described from (181.0-231.3). The contacts are unclear but look intrusive.			
246.4 – 250.2	MAFIC INTRUSIVE (DACITE TUFF?) – (as described from 245.0-245.8). Parts of the core have a fragmental appearance with the fragments aligned in the foliation plane which cuts the core axis at approx. 20°.			
250.2 – 344.2	MAFIC INTRUSIVE-GABBROIC – the contact with the above intrusive is sheared, and the two rock types are distinct. It is partly for this reason that the above units may be tuffs. This rock varys in color from medium green to dark green, depending on the chlorite content. The rock is massive, fine-			

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSG	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Sheet 7 of 9

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No. KSG

Footage From – To	Description	Sample No.	Length	Analysis
	grained, often porphyritic (feldspar phenocrysts) and is weakly to strongly foliated. Most of the phenocrysts are aligned in the plane of foliation which is now approx. 30° to the core axis. Portions of the rock have been carbonatized with discontinuous carbonate stringers in the plane of foliation. Thicker (1-2cm), seemingly more continuous carbonate veinlets cut the core at various angles. Sulphide content of the mafic rock is <1% with the occasional bleb or dissemination of pyrite (and possible chalcopyrite). Magnetite is present (5%) locally and often has a hematite staining which gives the rock a red spottiness.			
344.2 - 348.8	MAFIC INTRUSIVE?!			
	- this is a rock, difficult to interpret genetically. Appearance-wise it is a schistose rock composed of a light and dark banding. The light areas are predominantly carbonate with minor quartz and the dark bands are chlorite. Most of the bands are thin, 3-5mm and within the light zones, the carbonate has been fractured. The strong foliation is suggestive of a shear zone but there are two explanations for the mafic material. It is derived from the mafic intrusive and the two became mylonitized in the shearing, or the mafic material is primary in the form of ash which settled out in the carbonate, which also has been mylonitized. Either way, the Quartz Carbonate Forms the bulk of this zone (Sample @ 346.0'). This is a carbonate injected MI - not qtz-carb.	BN 548		
348.8 - 350.0	MAFIC INTRUSIVE - as described from (250.2-344.2)			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property		District		Hole No.	KSG		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.		Logged by	
Objective				% Recov.		Date	

Claim | T Brg. | Collar Dip | Elev. | Length

Footage From – To	Description	Sample No.	Length	Analysis
350.0 - 358.0	MYLONITIZED MAFIC INTRUSIVE (CARBONATIZED)			
	- as described (344.2-348.8). The lower contact is abrupt, but the mafic material in the quartz-carbonate is similar to the mafic rock at the contact. The foliation cuts the core axis at approx. 30°. Sample @ 355.5	BN 549		
358.0 - 364.0	MAFIC INTRUSIVE - as described from (250.2-344.2)			
364.0 - 366.3	MYLONITIZED CARBONATIZED MAFIC INTR.			
	- as described from (344.2-348.8). Shear zones within the MI with introduction of carbonate.			
366.3 - 378.0	MAFIC INTRUSIVE			
	- as described from (250.2-344.2). Dark green in color, massive and weakly foliated. Carbonate occurs as isolated patches and as veinlets. Magnetite makes up 10% of the rock.			
378.0	END OF HOLE			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property STIRLING	District Maritimes	Hole No. KSH			
Commenced	Location	Tests at	Hor. Comp.		
Completed	Core Size	Corr. Dip	Vert. Comp.		
Co-ordinates		True Brg.	Logged by C. Miller		
Objective		% Recov.	Date		

Claim Stirling | T Brg. 130° | Collar Dip 080° | Elev. | Length 277.0 ft. | Hole No. KSH | Sheet 1/4

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 6.0	OVERBURDEN			
6.0 – 50.0	MISSING CORE			
50.0 – 70.5	MAFIC INTRUSIVE-DIORITIC, – dark green, massive, moderately foliated with feldspar phenocryst 1mm size in a predominantly chloritic matrix. Magnetite with hematite can make up to 15% of the rock. Near a quartz carbonate vein @ 62.0. the intrusive has been altered – feldspars to saussurite giving the rock a yellow spotty appearance. The foliation cuts the core axis of approximately 30°. Calcite stringers randomly cut the core.			
70.5 – 79.5	DACITE TUFF – the rock is light green, soft and banded in the plane of foliation –30° to core axis. The rock is slightly talcose and sericitic. For the most part it is aphanitic and could be called a sericite schist.			
74.5 – 84.0	RHYOLITE FLOW – modified by subsequent shearing the rock is foliated. The feldspars have a pinkish tinge, while the quartz is white to grey. The rock has been fractured subsequent to its deposition. Chlorite occurs in randomly oriented fractures and in the plane of foliation.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 2 of 4

Property	District	Hole No. KSH	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSH

Footage From - To	Description	Sample No.	Length	Analysis
84.0 - 100.0	DACITIC TUFFS			
	- light green, soft, laminated in the plane of foliation. The pyroclastic nature is seen where stretched lithic and crystal fragments occur in a chloritic matrix. Fine and coarser layers are seen implying that bedding near parallels the foliation. Quartz eye are seen in some layers, others are aphanitic, sericitic and often talcose. Minor sulphides occur -<1%.			
	Sample @ 94.0	DN 565		
100.0 - 125.0	MISSING CORE			
125.0 - 195.0	MAFIC INTRUSIVE - DIORITIC			
	- dark green, chloritic foliated ~35° to core axis. Saussanite often stretched gives the rock a spotty look, probably often feldspar phenocrysts. Parts of this section are massive. Magnetite can make up 10% locally. Quartz carbonate veins cut the core axis at various angles. The largest vein is 5cm wide, most are 1-5mm. Epidole is also common near the veining. The qtz-carbonate veins occur in the plane of foliation implying deposition before the final stages of whatever caused the foliation. These veins are possible remobilized products from the qtz-carbonate gangue material.			
195.0 - 209.5	RHYOLITE (ALTERED)			
	- this rock is predominantly quartz and carbonate but looks different than most other zones of this kind. It is often schistose, aphanitic where carbonate predominates. The rock is strongly foliated -30° to core axis. Sericite occurs on shear surfaces in the foliation			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSH	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSH | Sheet 3 of 4

Footage From – To	Description	Sample No.	Length	Analysis
	plane. Interpreted as the qtz-carbonate that has been severely mylonitized and recrystallized.			
	Sulphides are negligible. From 209.0-209.6 the rock is cherty, grey, aphanitic.			
209.5 – 220.0	MAFIC INTRUSIVE-DIORITIC			
	- Similar to 125.0 - 195.0			
220.0 – 225.0	RHYOLITE			
	- grey, aphanitic, massive, extremely siliceous. The rock has undergone some fracturing			
	and contains some inclusions of an intermediate rock.	BN 566		
	Sample @ 221.0			
225.0 – 250.0	MISSING CORE			
250.0 – 252.0	RHYOLITE			
	- similar to 220.0 - 225.0			
252.0 – 266.0	MAFIC INTRUSIVE - (DIORITIC)			
	- the rock is intermediate to mafic in composition, medium green, sheared in its upper and lower			
	zones, and porphyritic in its core. Xendiths of chert are also seen, especially at 264.0			
	near the lower contact where the rock almost appears to be a breccia. The rock is strongly			
	foliated ~30° to core axis. Carbonate veins cut the core at various angles.			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSH	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.	Sheet
Stirling	130°	080°		277.0 ft.	KSH	4 of 4

Footage From – To	Description	Sample No.	Length	Analysis
266.0 - 275.0	RHYOLITE			
	- grey, thinly laminated, very siliceous, aphanitic. Laminations of chert are separated by 1mm thick yellowish weathering laminae thought to be talc and sericite. Sulphides <1%	BW 567		
	Sample @ 274.0			
275.0 - 277.0	MISSING CORE - END OF HOLE			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Maritimes	Hole No.	KSJ		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.	130°	Logged by	C. Miller
Objective				% Recov.		Date	August, 1977

Claim: Stirling | T Brg.: 130° | Collar Dip: 080° | Elev.: | Length: 315.5 feet | Hole No.: KSJ | Sheet 1 of 3

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 4.0	OVERBURDEN			
4.0 – 42.0	RHYOLITE FLOW			
	– pale green, buff, to light brown in color, generally massive, aphanitic and moderate to very hard and siliceous. Portions of the section are rhyodacitic. Moderate foliation ~30° to core axis. Rock is sericite, possibly talcosic (minor) and chlorite is usually developed locally. 1-2mm thick sulphide stringers occasionally lie in the foliation plane where extensive shearing has occurred (pyrite). Calcite occurs as hairlike cris-crossing veinlets.			
42.0 – 72.0	MAFIC INTRUSIVE/FLOW			
	– dark green, fine-grained, chloritic matrix with saussanite spots (yellowish) often feldspar phenocrysts 1-2mm size (10%). The porphyritic texture extends from 42.0-52.0 before the rock becomes massive and equigranular. The rock is moderately foliated ~30° to core axis. Minor epidote is also developed. <1% diss. pyrite. Calcite stringers randomly cut the core. The saussanite spots are stretched in the vicinity of shear zones.			
72.0 – 87.5	TALC/SERICITE SCHIST (SHEARED RHYODACITIC TUFF OR FLOW)			
	– light green to dark green, often grey and brown depending upon percentages of components. The rock is basically quartz rich with carbonate which has been extensively sheared and fractured, mylonitizing the rock, metamorphising the fines to talc and sericite with some chlorite. Disseminated pyrite occurs in the foliation planes ~30° to core axis. Fragments of carbonate are also seen 1cm size. Calcite veinlets are present. Sample @ 83.5	BN 550		

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Scale -

Colour Plot & Dips

Drill Hole Record

Cominco

Property | District | Hole No. KSJ | Sheet

Commenced | Location | Tests at | Hor. Comp.

Completed | Core Size | Corr. Dip | Vert. Comp.

Co-ordinates | True Brg. | Logged by

Objective | % Recov. | Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No.

Footage From - To	Description	Sample No.	Length	Analysis
87.5 - 104.5	MAFIC INTRUSIVE/FLOW			
	- dark to medium green, chloritic, moderately foliated matrix with 1mm spots of saussanite. For the most part, the rock is equigranular, fine-grained. The rock has been altered (bleached) to epidote in the vicinity of shear zones. Calcite stringers are present. Magnetite with hematite staining occurs up to 10% locally. Hematite coatings also occur on shear plane surfaces.			
104.5 - 160.0	QUARTZ/SERICITE SCHIST - RHYODACITIC CRYSTAL TUFF - RHYOLITE FLOWS			
	- light greenish, well banded in the plane of foliation ~30° to core axis, very schistose. There is the suggestion of quartz eyes, that have been stretched in the shearing. Quartz is abundant 30-40%, sericite, 10-20%, feldspar 20%, talc and chlorite 20%. Becuase rhyolites seen previously tend to fracture, rather than form schists, this rock is interpreted to be a felsic tuff, with the finer tuffaceous matrix being responsible for its susceptibility to shearing. Sulphides, pyrite occur as stringers parallel to the foliation (Sample @ 103.5).	BN 451		
	From 125.0-136.0 - the rock becomes more chloritic, possibly being a more mafic tuffaceous unit. It is strongly banded and schistose. From 136.0-160.0, the rock once again becomes siliceous with a marked increase in talc and sericite, giving shear planes a soapy feel. Parts of this section are massive, weakly foliated and very siliceous. These may be flow units, but then maximum thickness is generally 1-2 feet. Sulphides (pyrite) occur as fine disseminations (1-2%) randomly distributed and along the foliation. Near the end of this section, the rock once again looks tuffaceous. A small intermediate lamporphyre occur from 144.0-144.5 Sample @ 142.0.	BN 551		

211-5437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSJ	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet 3 of 3

Footage From - To	Description	Sample No.	Length	Analysis
160.0 - 230.0	MAFIC INTRUSIVE/FLOW			
	- dark green, equigranular, chloritic with 1mm size saussanite spots locally. The rock is massive and weakly foliated. Magnetite is disseminated 10%. Calcite stringers cut the core at various angles. Epidote alteration is evident near shears. <1% diss. pyrite. Sample 200.0.	BN 552		
230.0 - 243.5	CARBONATE/CHLORITE SCHIST			
	- light green to white alterating bands depending upon calcite/chlorite content. Highly sheared, considered to be part of the mafic unit above (160-230.0) into which carbonate has been introduced during the shearing and subsequent metamorphism. A violent reaction occurs throughout the entire rock when acid is applied. Late calcite stringers cut the core. Sample @ 241.0.	BN 553		
243.5 - 315.5	MAFIC INTRUSIVE/FLOW			
	- generally dark green, equigranular with 1mm size saussanite spots. Magnetite occurs making up 5% of the rock. Locally, but on a smaller scale to the above (230.0-243.5), the rock is strongly foliated, light green in color, and contains sericite/talc alteration. Carbonate is a minor component, generally as hairlike veinlets infilling fractures. These lighter zones are considered shear zones within the mafic body although usually it is a different looking rock. Contacts are generally gradual, and the mafic unit occurs on either side of these zones. Quartz may also be a component in these shear zones.			
315.5	END OF HOLE			

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211-0437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Maritimes	Hole No.	KSK		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.	310^{o}	Logged by	C. Miller
Objective				% Recov.		Date	September, 1977

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.	Sheet
Stirling	310^{o}	060^{o}		480.0 feet	KSK	1 of 2

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 8.5	OVERBURDEN			
8.5 - 24.0	RHYOLITE BRECCIA			
	- light green, aphanitic, siliceous angular fragments in a green aphanitic siliceous matrix.			
	Fragments vary in size from 2mm to 3cm. Sample @ 10.0.	BN 538		
24.0 - 27.5	MISSING CORE			
27.5 - 30.0	MAFIC INTRUSIVE			
	- medium green, massive, chloritic with 1mm feldspars. Hematite staining on shear surfaces.			
30.0 - 55.0	MISSING CORE			
55.0 - 147.5	RHYOLITE FLOW			
	- green to greyish green, massive, aphanitic with qtz/feldspar phenocrysts locally (1-2mm size).			
	Very siliceous, often fractured appearance. May contain fragmental material locally.			
	Sample @ 123.0.	BN 539		
147.5 - 186.5	PORPHYRITIC MAFIC INTRUSIVE			
	- dark to medium green, fine-grained chloritic matrix, massive, weak foliation with 20% 1-3mm			
	size. Feldspar phenocrysts often both shaped. Sample @ 176.0	BN 540		

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211-9437

Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Property		District		Hole No. KSK	
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg.	Logged by
Objective				% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSK | Sheet 2 of 2

Footage From - To	Description	Sample No.	Length	Analysis
186.5 - 245.0	RHYOLITE FLOW - similar to 55.0-147.5			
245.0 - 255.0	INTERMEDIATE INTRUSIVE			
	- medium green, fine-grained, massive, equigranular chloritic with calcite stringers. 1mm size feldspars. Sample @ 230.0	BN 541		
255.0 - 330.0	MISSING CORE			
330.0 - 403.0	MAFIC INTRUSIVE			
	- dark to medium green, massive, chloritic matrix. Varys from massive (similar to 245.0-255.0) to porphyritic (similar to 147.5-186.5). Porphyritic zones have 20% 1-2mm size feldspar phenocrysts. Calcite stringers present.			
403.0 - 429.5	PORPHYRITIC RHYOLITE			
	- purplish grey to buff, massive, aphanitic, siliceous matrix with 5-10% pink feldspars and quartz phenocrysts. Sample @ 414.5. Some of the phenocrysts have been stretched ~40° to core axis. Small mafic lamporphyres intrude locally.	BN 542-1		
429.5 - 474.0	PORPHYRITIC MAFIC INTRUSIVE - similar to (147.5-186.5) and parts of (330.0-403.0)			
474.0 - 480.0	PORPHYRITIC RHYOLITE - similar to (403.0-429.5)			
480.0	END OF HOLE			

211-8437

Scale

Colour Phot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Nova Scotia	Hole No.	KSL
Commenced		Location		Tests at	
Completed		Core Size		Corr. Dip	
Co-ordinates				True Brg.	130°
Objective				% Recov.	

Hor. Comp.

Vert. Comp.

Logged by J. Collins

Date July, 1977

Claim: Stirling | T Brg.: 130° | Collar Dip: 072° | Elev.: | Length: 6390 ft. | Hole No.: KSL | Sheet 1 of 4

Footage From – To	Description	Sample No.	Length	Analysis
0 - 10.0	OVERBURDEN			
10.0 - 41.5	DACITIC TUFF			
	- light greenish grey, foliated, calcareous tuff - foliation approx. 30-90° to core axis, sericitic, chloritic. Contains qtz and feldspar "eyes", 1-2mm (20%). Probable stretched lapilli (~1-4mm) and other pyroclastic material. (Sericite and chlorite approx 20%). Lower contact - sharp - 45° to core axis. (Sample @ 27.0)	BN 601		
41.5 - 103.0	MASSIVE TO POORLY FOLIATED, MEDIUM GREY MAFIC FLOW OR INTRUSIVE?			
	- medium grained, equigranular mixture of qtz 10%, feldspar, 40-50% chlorite, sericite (muscovite?) erratic while carbonate veins (calcite) - 2-5% of section generally <3mm thick (Sample @ 47.0)	BN 602		
	98.0 Fault - 4 inch slicker sided gauge zone (Sample @ 84.5)	BN 603		
137.0 - 141.0	MEDIUM GREEN, FINE GRAINED LAMPROPHYRE (DACITIC)			
157.0 - 160.0	FINE GRAINED TO APHANITIC, MEDIUM GREY LAMPROPHYRE			
103.0 - 166.5	COARSE GRAINED, MEDIUM GREY, SDS PORPHYRITIC RHYS-DACITE			
	- grain size, 1-4mm, with subhedral grains, qtz/feldspar in a sericitic, chloritic matrix (20-40% qtz) (20-50% feldspar) (5-15% mafics). Massive to poorly foliated 45° to core	BN 604		
	axis. Up to 5% calcite (Sample @ 105.0) (Sample @ 133.0)	BN 605		

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Drill Hole Record

COMINCO

Scale

Colour Plot & Dips

Property		District		Hole No. KSL	
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg.	Logged by
Objective				% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSL | Sheet 2 of 4

Footage From – To	Description	Sample No.	Length	Analysis
166.5 - 167.5	MISSING CORE			
167.5 - 247.0	MODERATELY TO THINLY BANDED, CHLORITE CHERT ROCK			
	- ranges from thinly banded chlorite medium green to thinly banded chert (medium grey to brown). Interlaminated chert and chlorite. Avg 40° to core axis with local disruptions 0-45° to core axis			
	Missing Core -(176.5-177.0) (177.5-179.0) (180.0-181.5) (186.0-186.5) (Sample @ 174.0)	BN 606		
	(202.0-202.5) (205.0-208.0) (235.0-236.5) (Sample @ 230.5)	BN 607		
	Banding at 40-45° to core axis, contorted locally			
	186.0-208.0 Brecciated and disrupted section with chert fragments from 3mm to 4cm in a chloritic matrix. Disrupted banding @ 0-40° to core axis. Some lapilli or chert banding sections. Probable shear fault zone. (Sample @ 198.0)	BN 608		
	Chert content 10-30%. Mainly quartz/sericite			
247.0 - 278.0	MEDIUM GREEN, MEDIUM GREY LAMPROPHYRE DYKE			
	- with some sections of pinkish chert (baked) 5%. Considerable fracturing and disruption by intrusive. (Sample @ 268.5)	BN 609		
273.0 - 274.5	MISSING CORE			
278.0 - 299.0	LIGHT GREY, GREENISH GREY, BROWNISH GREY CHERT			
	- with lensy banding. Bands .5cm -1cm thick (20% chlorite locally). Bedding angle 45-50°			

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211-8437

Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property	District	Hole No. KSL	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSL | Sheet 3 of 4

Footage From – To	Description	Sample No.	Length	Analysis
	to core axis.			
	Missing core (280.5-282.0) (283.0-284.5)			
	Some lamprophyre (<5% section) material. Up to 5% very finely divided pyrite.			
	This rock is probably an exhalite (Sample @ 285.0)	BN 610		
299.0 – 36.50	FOLIATED DYKE ROCK (MASSIVE LOCALLY)			
	– green, fine-grained lamprophyre with considerable carbonate veining. Much fracturing. (301.5)	BN 611		
	Local medium grey sections. Dyke becomes coarser down section with foliation angle (324.0)	BN 612		
	approaching 85°. The lower 20' has a diabase texture. Contains tuffaceous horizons (356.5)	BN 613		
365.0 – 377.0	THINLY BANDED, CALCAREOUS, CHLORITE RICH TUFF,			
	– banding of mafic minerals 75-80° to core axis. Rock contains from 30-70% chlorite, 20-40%			
	calcite. Medium grained feldspar and qtz eyes, traces sphalerite locally (Sample 372.0)	BN614		
377.0 – 398.0	WHITE QUARTZ-CARBONATE SULPHIDE ROCK			
	– mottled, to poorly banded with sulphides concentrated along styolitic partings. Pyrite			
	from 0-40% locally. Traces of sphalerite, galena, chalcopyrite. First 5' chert – siliceous.	BN615	(377.5')	
	Sample 381.0 – further down – carbonate content increases	BN616		
	385.0-387.0 Dyke Rock Lower contact a 398 – barren qtz carb/sulphides			
	387.0-388.0 Missing Core Dyke Rock – sample 398.5	BN617		

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211-9437

Drill Hole Record

COMINCO

Scale

Colour Plot & Dips

Property	District	Hole No. KSL	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
398.0 – 535.0	PROBABLE DACITIC FLOW (conformable contact with above) (Sample @ 423.5)	BN619		
	– medium fine-grained, medium grey/green, relatively massive, lower 35' becoming coarser grained (diabase) (Sample 477.5)	BN620		
535.0 – 578.0	RHYOLITE			
	– well foliated to thinly bedded in upper part of section at 50-60° to core axis. Medium greenish grey, more chloritic than overlying section. Lower sections become coarser, diabasic but not as much so as the above (Sample @ 547.5)	BN621		
578.0 – 623.5	WELL BANDED TUFF			
	– intermediate light greenish grey, 1-5mm thick bands @ 25-55° to core axis. Lacks qtz/feldspars eyes – very fine-grained			
	600.5-604.0 Dark green, medium green. Diabasic Dyke. Sample @ 583.5	BN622		
623.5 – 635.0	SYENITIC DYKE – pinkish, porphyritic			
635.0 – 639.0	MISSING CORE			
639.0	END OF HOLE			

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Drill Hole Record

1965 KELTIC DRILLING

Cominco

Scale

Colour Plot & Dips

Property	STIRLING	District	MARITIMES	Hole No.	KSM
Commenced		Location		Tests at	
Completed		Core Size		Corr. Dip	
Co-ordinates				True Brg.	
Objective				% Recov.	

Hor. Comp.

Vert. Comp.

Logged by

Date

Claim Stirling

T Brg. 130°

Collar Dip 080°

Elev.

Length 389.0 ft.

Hole No.

Sheet

Footage From	To	Description	Sample No.	Length	Analysis
0.0	15.0	OVERBURDEN			
15.0	25.0	MAFIC INTRUSIVE - medium green; moderately foliated 25° to core axis; chlorite is abundant aligned in the plane of foliation, but is deflected by coarser grains (probably feldspar and/or quartz; the chlorite gives a streakiness to the rock; calcite stringers cut the core at various angles.			
25.0	50.0	MISSING CORE			
50.0	100.0	MAFIC INTRUSIVE (DIORITIC) - dark green, massive to weakly foliated; locally the rock may be slightly porphyritic, but is generally equigranular with chlorite in the foliation plane. Magnetite makes up 10% locally and has hematite staining on grain rims and shear plane surfaces. Randomly distributed calcite stringers occur.			
100.0	150.0	MISSING CORE			
150.0	171.5	QUARTZ-CARBONATE - (TALCOSE) - whitish to grey in colour, very soft, containing inclusion of dacitic rocks; talc rich zones occur making the rock very soft; the talc splits along a foliation 30° to core axis. Sulphides are notably very minot - 1% except at the lower contact where they are a nearly massive matrix to qtz-carbonate fragments;			

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property STIRLING	District MARITIMES	Hole No. KSM	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim STIRLING | T Brg. 130° | Collar Dip 080° | Elev. | Length 390.0 feet | Hole No. KSM | Sheet

Footage From	To	Description	Sample No.	Length	Analysis
		The sulphide is almost exclusively pyrite and is very finely disseminated from 165.0 - 167.0; the quartz-carbonate-talc is again barren; from 167.0 - 168.0, sulphides again occur as carbonate fragments in a massive pyrite matrix; (sample @ 167.0) 168.0 - 171.5 is again barren, talcose quartz carbonate	BN 446		
171.5	176.5	DACITE LITHIC TUFF - light green, chloritic with stretched chloritized lithic fragments aligned in the plane of foliation (sample @ 174.5). The foliation on a bedding is approximately 35° to core axis; contact relationships are obscure, but it appears to be interbedded with the quartz carbonate; the pyroclastic nature of the rock is quite evident; the upper contact is finely ground which may suggest a shear zone; Sample 175.0'.	BN 445 BN 576		
176.5	200.0	QUARTZ-CARBONATE-TALC-SULPHIDES - similar to above from 150.0 - 171.5; finely disseminated sulphides are more widespread but never more than a few percent except in very restricted zones such as at 184.0 and 192.5 where there are narrow zones of massive pyrite with carbonate fragments; this feature has been repeated 4 times and are considered pulses in the mineralizing process; portions of this section are almost entirely made up of talc.			

211-5437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSM	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.	Sheet

Footage From To	Description	Sample No.	Length	Analysis
200.0 - 265.0	QUARTZ-CARBONATE-TALC-SULPHIDES - similar to 176.0 - 200.0 but from 202.0 - 250.0 the carbonate content is gretaly reduced, with quartz making up the majority of the rock, with talc and 2% pyrite. The quartz is white to grey, massive and has a mottled, chained look. Portions are definetly fractured but have subsequently healed in a carbonate matrix. Sulphides occur as widely distributed disseminations (pyrite cubes) and as thin (1-2mm) massive sulphide laminations in the quartz carbonate. The siliceous zones look very similar to those in other holes which had been called chert or possibly rhyolite. Portions of the rock from 250.0 - 265.0 contain chloritic zones which may suggest that tuffaceous material was mixed with the quartz carbonate during the time of deposition. Carbonate content also increases from 250.0 - 265.0 looking more like the "normal" quartz carbonate rock. Sample @ 242.0	BN 577		
265.0 - 285.0	SYENITIC INTRUSIVE - massive, pinkish to buff colour, feldspathic matrix with 1-2mm size amphibole and feldspar phenocrysts. This rock is relatively fresh and is not foliated. Sample @ 275.5	BN 578		
285.0 - 300.0	QUARTZ-CARBONATE-TALC-SULPHIDES - similar to above from 200.0 - 265.0. Quartz is still relatively abundant 90%, carbonate 40%, talc 10%, others 10%. Sulphides are very patchy 5%. The rock is very mottled, and deformed from shearing. Sample @ 295.0	BN 579		
300.0 - 375.0	MISSING CORE			

211 6437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 4 of 4

Property	District	Hole No. KSM	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSM

Footage From To	Description	Sample No.	Length	Analysis
375.0 - 384.0	QUARTZ-CARBONATE-TALC-SULPHIDES - similar to 200.0 - 265.0 and 285.0 - 300.0			
384.0 - 389.0	EXHALITE-CHERT - massive, grey, aphanitic, chert which is brecciated and possibly sheared within and seemingly occurring as fracture emplaced xenoliths are a light green, dacitic tuffaceous looking rock. These tuffaceous units at times elsewhere in the section look interbedded with the chert. The "tuffs" could also be intrusive features.			
	Sample @ 386.0	BN580		
389.0	END OF HOLE			

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211-0437

Drill Hole Record

Scale
Colour Plot & Dips

COMINCO

Property	STIRLING	District	Nova Scotia	Hole No.	KSN		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.	050°	Logged by	C. Miller
Objective				% Recov.		Date	

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.	Sheet
Stirling	050°	080°		318.0 ft.	KSN	1 of 5

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 44.0	OVERBURDEN			
44.0 – 55.5	MAFIC INTRUSIVE/FLOW – dark to medium green, massive predominantly equigranular but some feldspar and quartz eyes occur locally (5%) moderately foliated cutting the core axis @ 35-40. Chlorite ~30% occurs as streaks around the granular material. Minor saussanite 5% gives a local spottiness. Carbonate veinlets cut the core at erratic angles. Magnetite with hematitic staining makes up 20% of rock. Pyrite 2%.			
55.5 – 58.5	MYLONITIZED DACITIC TUFF – strongly foliated ~30° to core axis, light greenish grey streaky rock. Streakiness caused by abundant chlorite, sericite. Carbonate also abundant 10-15% and appears as bands and augen shaped "clasts?" stretched by the foliation. Epidote locally abundant in plane of foliation, as are sulphides, pyrite (3%). The lower foot (57.5-58.5) has been silicified and fractured. The zone of silicification is fragmental silica in a siliceous matrix. Parts of the matrix have been epidotized and chloritized. Sample @ 56.5	BN 562		
58.5 – 76.0	MAFIC INTRUSIVE/FLOW – similar to above, dark medium green, massive with chlorite streaks in foliation plane. Magnetite 10-20%. Carbonate veinlets cut core at erratic angles. Blebs of pyrite 1-3%.			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property	District	Hole No. KSN	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSN | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
76.0 – 80.0	MASSIVE RHYOLITE – mottled fractured, grey to buff coloured chert. Carbonate veinlets cut the core axis at erratic angles.			
80.0 – 117.0	MYLONITIZED, SILICIFIED RHYODACITIC TUFF – extremely strongly foliated, light green siliceous aphanitic matrix with fragmental material (pyroclastic or tectonic origin?) up to 2-3mm. The rock is slightly talcose and sericitic in the foliation plane which cuts the core at 30°. Parts of the section is the massive chert like rock described above, which has a fragmental appearance. Could be exhalative type chert bands interbedded with tuffs. During tectonism, chert features, and tuffs become strongly foliated. The tuffaceous horizons are strongly calcareous. Carbonate veinlets predominantly parallel the foliation but a few cut the core erratically. Parts of the tuff horizons are very chloritic, giving the rock a darker green color. Sulphides (pyrite) make up ~5% of the section, occuring as elongate blebs in the foliation plane, and random disseminations. The lower contact is approx. 60° to core axis with the upper part composed of massive white quartz interbanded with pyrite. Sample @ 86.5	BN 563		
117.0 – 130.0	MAFIC/INTERMEDIATE TUFF/INTRUSIVE – difficult rock to interpret. Generally, it is similar in colour and alteration to the mafic units above except in this section, the rock is strongly foliated, mottled and contorted, fractured and silicified locally. Feldspars and epidotized lenses may be tectonic fragments (cataclastic) or of pyroclastic origin. Large fragments of siliceous (chert) material occur			

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Drill Hole Record

Cominco

Property	District	Hole No. KSN	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSN | Sheet 3 of 5

Footage From – To	Description	Sample No.	Length	Analysis
	occasionally. Saussanite alteration gives portions of the section a spottiness (yellowish). The strong foliation varys from 0 to 70° and can have a appearance. Carbonate stringers cut the core at erratic angles. Chlorite is abundant 85%.			
	124.5-125.5 Pink quartz feldspar porphyritic dyke. (inclusions in the above)			
	128.5-130.0 Pink quartz feldspar porphyritic dyke. These dykes may be flows or pyroclastics. The mafic rock between the two dykes contains xenoliths dating the qtz-felds as pre-mafic.			
130.0 - 233.5	MAFIC/INTERMEDIATE FLOW/INTRUSIVE			
	- moderately to strongly foliated locally, dark to medium green. Foliation 40° to core axis. <1 mm size grains of feldspar (possible quartz) in a chloritic streaky matrix (50%) with yellowish saussanite spots. Locally, patches of angular carbonate as well as stringers. The entire rock is strongly calcareous. Parts of the section show a catoclastic fracturing and subsequent healing of the fracture with new minerals - chlorite growing in the plane of stress - paralleling the foliation. Non magnetic. From 150-233.5, the rock becomes massive with a very weak foliation. Magnetite reappears making up 15-20%. Numerous shear planes have a hematite staining as do the magnetite disseminations. Carbonate veinlets, stringers and isolated patches . The massive zone is fine grained, equigranular seemingly made up of 40-50% feldspars and 30-40% mafic. Locally saussanite alteration gives the rock a yellowish spottiness.			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Sheet 4 of 5

Hole No. KSN

Property	District	Hole No. KSN	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Footage From - To	Description	Sample No.	Length	Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.
233.5 - 249.0	QUARTZ CARBONATE-SULPHIDES								
	- both contacts are unclear but appear to be sheared with a cataclastic mixing of both rock types. The upper contact is extremely talcose, but the talc content continues throughout this section making up 20-25% of the rock. Sulphides make up 10-15% occurring as bands paralleling the foliation 40° to core axis. Sulphides are mostly pyrite, but sphalerite, galena and covellite also occur. The rock has been mylonitized with large fragments 1-2cm maximum in a fine talcose, sulphide rich matrix. The rock is mottled and churned.								
249.0 - 275.0	MAFIC FLOW/INTRUSIVE								
	- dark to medium green, massive, fine-grained, weakly foliated. Slightly magnetic with ~10% magnetite with hematite staining locally. This staining also occurs on shear planes. The rock is calcareous in the matrix as well as in carbonate stringers and isolated blebs like patches.								
275.0 - 300.0	Lost Core								
300.0 - 320.0	QUARTZ CARBONATE/SULPHIDES								
	- extremely talcose and sericitic from 300.0-307.0. 307.0-318.5 (approx) poor recovery. Massive sulphides, sphalerite galena, chalcopyrite, covellite, finely banded parallel to the foliation approx 40° to core axis. The sphalerite is honey yellow and has a sugary texture. The chalcopyrite is more bleb like with the remaining sulphides very fine grained. Carbonate stringers and veinlets cut the sulphides at erratic angles. Sample 318.0	BN 564							

211-9437

Drill Hole Record

Scale

Colour Plot & Dips

0

Cominco

Property		District		Hole No.	KSN		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.		Logged by	
Objective				% Recov.		Date	

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSN | Sheet 5 of 5

Footage From	To	Description	Sample No.	Length	Analysis
		318.5-320.0 poor core recovery, a few chips of the quartz carbonate zone as well as a few chips of the quartz eye, strongly foliated chloritic rock which is so abundant in the dump material.			
	320.0	END OF HOLE			

911-0417

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	Maritimes	Hole No.	SKO		
Commenced		Location		Tests at		Hor. Comp.	
Completed		Core Size		Corr. Dip		Vert. Comp.	
Co-ordinates				True Brg.	050°	Logged by	C. Miller
Objective				% Recov.		Date	August, 1977

Claim: Stirling
T Brg.: 050°
Collar Dip: 085°
Elev.:
Length: 395.0 feet.
Hole No.: KSO
Sheet 1 of 2

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 35.0	OVERBURDEN			
35.0 – 50.0	MISSING CORE			
50.0 – 53.0	RHYOLITE FLOW			
	– grey to buff, massive very siliceous. Has a fractured appearance. Sericite developed on shear planes. Minor epidotization and pyrite.			
53.0 – 270.0	MAFIC INTRUSIVE/FLOW			
	– massive, dark green chloritic matrix, equigranular feldspars and mafics. Weakly foliated with numerous shear surfaces. Finely disseminated magnetite makes up 10-15% locally. Hemolite staining occurs on most shear planes. There is very little change throughout this section. Minor sulphides 1%. Calcite stringers are abundant.			
270.0 – 321.0	QUARTZ/CARBONATE/TALC/SULPHIDES			
	– buff to white and greenish, mottled, chained and often fractured appearance. Talc and sericite developed in the plane of foliation around coarser qtz carbonate interval. Sulphides are almost absent making up <1%. Talc is the predominant component making up 50% of the rock especially from 275.0 – 321.0. The rock is strongly sheared.			
321.0 – 343.0	QUARTZ, SERICITE, TALC SCHIST – FELSIC TUFFS?			
	– light green, strongly foliated ~30° to core axis, the majority of the rock has been sheared,			

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Drill Hole Record

Cominco

Property	District	Hole No. KSO	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSO | Sheet 2 of 2

Footage From – To	Description	Sample No.	Length	Analysis
	with the development of sericite, talc and chlorite in the plane of foliation. Clastic material may have been stretched in this plane giving the rock a "streaky" appearance. The "streaky" mineral is whitish. Some zones are banded and may be remnants of a primary bedding (324.0). Carbonate is noteably absent, or it is of a type that does not react with acid.	BN 600		
	Sample @ 327.5			
343.0 – 375.0	MAFIC INTRUSIVE/FLOW			
	– dark green, massive, veined by qtz carbonate veins and calcite veinlets similar to 53.0 – 270.0			
375.0 – 395.0	MISSING CORE			
395.0	END OF HOLE			

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Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Property STIRLING | District Maritimes | Hole No. KSQ

Commenced | Location | Tests at | Hor. Comp.

Completed | Core Size | Corr. Dip | Vert. Comp.

Co-ordinates | True Brg. 050° | Logged by C. Miller

Objective | % Recov. | Date September, 1977

Claim Stirling | T Brg. 050° | Collar Dip 080° | Elev. | Length 387.0 feet | Hole No. | Sheet /

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 47.5	OVERBURDEN			
47.5 - 60.0	INTERMEDIATE TUFFS			
	- light green, chloritic, sericitic, strongly foliated ~45° to core axis. The rock has been extensively fractured. Coarser clastic material (phenocrysts?) are stretched in the foliation plane. From 47.5-50.0, the rock appears to have been brecciated. This unit has been extensively carbonatized. Sample @ 56.0. Calcite stringers present.	BN 505		
60.0 - 63.0	RHYOLITE			
	- light green, massive, fractured appearance. Very siliceous. Chlorite and sericite alteration. Extensively fractured. Sample @ 62.5	BN506		
63.0 - 70.0	QUARTZ CARBONATE SULPHIDES			
	- buff to white carbonate with zones of laminated sulphides with quartz and carbonate. The sulphides (almost massive locally) are finely disseminated (mostly pyrite but sphalerite is suspected). The laminations are ~30° to core axis. Like the above units, this rock has been sheared and fractured. Sample @ 67.0.	BN507		
70.0 - 95.0	MISSING CORE			
95.0 - 116.0	RHYOLITE FLOW/TUFFS			
	- light green, siliceous, massive with a fractured appearance with thin tuffaceous units showing			

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Drill Hole Record

Scale
Colour Plot & Dips

COMINCO

Property	District	Hole No. KSQ	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSQ | Sheet 2 of 3

Footage From – To	Description	Sample No.	Length	Analysis
	a strong foliation and carbonatization. The foliation cuts the core axis at ~30°. From 111.0-112.0, above the tuffs occurs a siliceous unit with 10% diss. pyrite. It has been fractured and sheared. This could possibly be EXHALITE. Sample @ 111.5. This section is intruded by 1' thick mafic lamprophyres.	BN 508		
116.0 - 362.0	MAFIC INTRUSIVE			
	- dark to medium green, generally massive, but often is foliated locally ~30° to core axis. Chloritic. Fine-grained often aphanitic but medium-grained porphyritic zones are present. Quartz carbonate vein (shear zone?) extends from 172.5-175.0. Other smaller calcite veins cut the core randomly - infilling fractures. The majority of the rock has not been carbonatized, nor is it strongly foliated. Minor epidote alteration occurs adjacent to the larger veins. Portions of this section could be flows, but it is very difficult to tell. Since quartz carbonate zones occur at either end, and within, the entire section is considered intrusive. Sample @ 195.0. Sample @ 326.0. Magnetite is present <10% as fine disseminations. Calcite stringers.	BN 509, BN 510		
362.0 - 387.0	QUARTZ/CARBONATE - SULPHIDES			
	- white to buff quartz carbonate, mottled, fractured and sheared. Sulphides are concentrated in narrow zones and consist of laminations in the plane of foliation, surrounding stretched quartz carbonate fragments. There are at least two sulphide rich zones where they constitute 10-20% of the rock. The sulphide zones are generally <1 foot. The bulk of the qtz carbonate has <5% to barren sulphides. Sample @ 377.0.	BN511		

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211-9437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KSQ	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSQ | Sheet 3 of 3

Footage From	To	Description	Sample No.	Length	Analysis
387.0		END OF HOLE - The hole actually ends at 404.0. From 387.0-403.0. the hole intersected a drift in the mine. From 403.0-404.0 the hole drilled a mine timber. This is noted in keltic logs, and is present in the core box.			

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211-0437

Drill Hole Record

Cominco

Scale

Contour Plot & Dips

Property	STIRLING	District	Maritimes	Hole No.	KSQ
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg.	Logged by
Objective				% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 35.0	OVERBURDEN			
35.0 - 42.0	RHYOLITE FLOW - grey, massive, fractured appearance, aphanitic, very siliceous and hard. Lamprophyre (mafic) intrude at 39.0-41.0. Sericitic alteration occurs on shear plane. Calcite stringers are evident.			
42.0 - 103.5	MAFIC INTRUSIVE/FLOW - dark green massive, fine-grained, equigranular and chloritic. Weakly foliated with calcite veinlets. The rock is very uniform throughout. Finely disseminated magnetitic makes up 10% of the rock. The rock has been substantially carbonatized, reaching very strongly to acid.			
103.5 - 147.0	CHLORITIC, CARBONATIZED, SHEAR ZONE - extremely foliated in contrast to the massive rock above, light green, to white, schistose, chloritic, sericitic and banded. The bands are chloritic zones interbanded with quartz-carbonate. The carbonate has been brecciated and often sits in a sulphide matrix. This can be interpreted as a shear zone within the mafic unit, into which the carbonate has been injected, or it represents a xenolith within the mafic intrusive that has been subsequently sheared and mylonitized. Magnetitic is also present in the matrix for the carbonate fragments. Sample @ 146.5. The foliation appears 30° to core axis. Other carbonate fragments up to 3cm (Sample @ 107.0). sit in a chloritic and talcose matrix, adjacent to lithic looking breccia fragments. Portions of this section are definitely sheared mafic intrusive similar to the massive units above and below, except more foliated.	BN 452 BN 453		

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Scale

Contour Plot & Dips

Drill Hole Record

Cominco

Property | District | Hole No. KSQ

Commenced | Location | Tests at | Hor. Comp.

Completed | Core Size | Corr. Dip | Vert. Comp.

Co-ordinates | True Brg. | Logged by

Objective | % Recov. | Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KSQ | Sheet 2 of 2

Footage From	To	Description	Sample No.	Length	Analysis
147.0	287.0	MAFIC INTRUSIVE/FLOW – dark green, chloritic, weakly foliated ~35° to core axis. Massive, equigranular, 10% magnetite and calcite stringers cutting the core at various angles. Hematite occurs on shear plane surfaces. Similar to (42.0-103.5). From 215.5-218.0 occurs another carbonate filled shear zone, white with streaks of chlorite and lithic material, stretched in the plane of foliation ~35° to core axis. Talc and sericite may also be present in the schistose zone.			
287.0	328.0	QUARTZ/CARBONATE/TALC/SULPHIDES – white, buff to light green. Predominantly quartz talc and sericite with carbonate. Mottled, often fractured and fragmental appearance. Chlorite is also a minor component growing in the plane of foliation with talc and sericite. Sulphides make up a very minor part 1-3%, and occur in narrow restricted zones. The bulk of this section is barren. Pyrite is the predominant sulphide with possible? sphalerite.			
328.0		END OF HOLE			

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property STIRLING	District Maritimes	Hole No. KST	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip 050^o	Vert. Comp.
Co-ordinates		True Brg.	Logged by C. Miller
Objective		% Recov.	Date September, 1977

Claim Stirling | T Brg. 050^o | Collar Dip 55^o | Elev. | Length 512' | Hole No. KST | Sheet 1 of 4

Footage From – To	Description	Sample No.	Length	Analysis
0.0 - 55.0	OVERBURDEN			
55.0 - 75.0	MISSING CORE			
75.0 - 101.5	INTERMEDIATE TUFFS/FLOWS			
	- light to medium green, strong to moderately foliation, chloritic, often sericitic in the plan of foliation $\sim 45^o$ to core axis. The rock is generally massive, equigranular but does contain units with what appear to be stretched phenocrysts or crystal fragments. Strongly foliated zones have a banded appearance in the plane of foliation, and have been highly carbonatized. The lesser foliated more massive zones have also been carbonatized, but to a lesser degree. Veinlets of quartz and calcite cuc the core at random angles. Portions appear rhyodacitic. Massive unit 75.0-88.5. Foliated unit 88.5-101.5. Sample @ 98.5 Contact with below is 45^o to core axis.	BN 494		
101.5 - 118.5	INTERMEDIATE FLOW			
	- light to medium green, medium grained, massive, weakly foliated. Equigranular equal proportions of altered mafics and feldspar. Chloritic, sericitic. Moderate carbonitization Calcite stringers present. Sample @ 106.5	BN 495		
118.5 - 135.0	INTERMEDIATE TUFFS			
	- light to medium green, chloritic, carbonitized, strongly foliated and banded. Similar to 88.5-101.5 Bedding relationships $\sim 45^o$ to core axis			

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property		District		Hole No.	KST
Commenced		Location		Tests at		Hor. Comp.
Completed		Core Size		Corr. Dip		Vert. Comp.
Co-ordinates				True Brg.		Logged by
Objective				% Recov.		Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KST | Sheet 2 of 4

Footage From – To	Description	Sample No.	Length	Analysis					
135.0 - 208.5	INTERMEDIATE FLOWS WITH THIN TUFF UNITS								
	- similar to (101.5-118.5) light to medium green, massive, weakly foliated, chloritic,								
	minor sericite. Weakly carbonitized. Calcite stringers present. Bedding relationships								
	40-60° to core axis. Local thin porphyritic units, and thin pyroclastic units.								
	Sample @ 159.0. Massive and generally equigranular.	BN 496							
208.5 - 213.5	FELSIC INTRUSIVE								
	- pinkish to brownish buff coloured, fine grained, siliceous/feldspathic matrix with 1-3mm size								
	pinkish feldspar phenocrysts and 1-2mm size mafic (amphibole?) phenocrysts. Sample @ 211.0.								
	The contact are chilled, fine grained resembling the syenitic intrusives logged previously.	BN 497							
	The thicker intrusives have feldspar phenocrysts while the thiner lamprophyries contain								
	only 1mm size amphibole phenocrysts.								
213.5 - 288.0	RHYODACITE FLOWS AND TUFFS								
	- similar to (101.5-188.5) (135.0-208.5). The rock is slightly coarser than the above units								
	and contains 10% quartz. The rock is harder than the above units. Massive, equigranular,								
	medium grained. Chloritic and sericitic. The rock is poorly foliated and weakly	BN 498							
	carbonitized. Calcite stringers are present. Sample @ 271.0								
288.0 - 312.0	INTERMEDIATE TUFFS								
	- similar to (118.5-135.0) light grain, strongly foliated, weakly carbonitized. Faint banding,								
	fine grained, chloritic, sericitic. Foliation is ~45° to core axis.								

Drill Hole Record

COMINCO

Property	District	Hole No. KST	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Scale | Colour Plot & Dips | 0

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
	Local zones have carbonate rich bands with chlorite rich zones in the plane of foliation.			
	Rock is fractured from 306.0-309.0.			
312.0 - 320.0	RHYOLITE BRECCIA			
	- poorly consolidated, gritty matrix with 1-2cm size fragments of rhyolitic material.			
	Indications are that it is probably a volcanic breccia that has been sheared. Sample @ 314.0.			
	Sulphide rich fragments are present. From 317.0-320.0, the rock is more massive.	BN 499		
320.0 - 329.0	MAFIC INTRUSIVE			
	- dark to medium green, chloritic, massive with 2% feldspar phenocrysts locally. Pods and			
	stringers of calcite have been intruded. The rock contains a weak foliation.			
329.0 - 350.0	RHYOLITE BRECCIA			
	- similar to (312.0-320.0). Rhyolitic. Mafic and chert looking, angular fragments in a finer			
	chloritic but fragmental matrix. Could be volcanic or tectonic feature. Sample @ 349.0.			
	This unit has been intruded by two .5' mafic lamprophyries. Finely disseminated pyrite	BN 500		
	occurs in both the matrix and fragments 2-4%.			
350.0 - 357.5	RHYODACITE CRYSTAL TUFF			
	- medium green, fine grained, chloritic and sericitic matrix with 30-40% quartz/feldspar crystal			
	fragments. Massive, equigranular. Clasts 1-2mm. The lower contact is finer and somewhat altered			
	and sheared. This contact is interpreted to be intrusive.			

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Drill Hole Record

Cominco

Property	District	Hole No. KST	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
	Epidote alteration is present at this contact. Sample @ 335.0. Calcite stringers present.	BN 501		
357.5 – 412.0	MAFIC INTRUSIVE			
	– dark green, massive, poorly foliated. Equigranular, fine grained. Chloritic matrix with feldspar 20%. Magnetite occurs as fine disseminations 10%. Foliation when recognized cuts the core axis @~45°. Sample @ 301.0.	BN 502		
412.0 – 415.0	SYENITIC INTRUSIVE – similar to 208.5-213.5			
415.0 – 430.0	MAFIC INTRUSIVE – similar to 357.5-412.0. Calcite stringers are abundant on both segments.			
430.0 – 437.5	SYENITIC INTRUSIVE – SIMILAR TO 208.5-213.5 and 412.0-415.0.			
437.5 – 512.0	MAFIC INTRUSIVE			
	– similar to (357.5-412.0) (415.0-430.0). From 445.0-450.0, the mafic units may have been intruded by thiner lamprophyries causing epidotization on the contacts. Sample @ 447.5.	BN 503		
	Calcite stringers are present. Sample @ 497.0 is of the mafic intrusive.	BN 504		
512.0	END OF HOLE			

Scale

Colour Plot & Dips

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	STIRLING	District	MARITIMES	Hole No.	KS3				
Commenced		Location	South Mine Property	Tests at	250'	500'	750'	1000'	Hor. Comp.
Completed		Core Size	BQ	Corr. Dip	60^o	55^o	60^o	52^o	Vert. Comp.
Co-ordinates				True Brg.		308^o			Logged by C. Miller
Objective				% Recov.					Date August, 1977

Claim Stirling | T Brg. 308^o | Collar Dip 65^o | Elev. | Length 1102 feet. | Hole No. KS3 | Sheet 1/7

Footage From - To	Description	Sample No.	Length	Analysis
0.0 - 35.0	OVERBURDEN			
35.0 - 40.5	RHYODACITE CRYSTAL TUFF			
	- light green, chloritic and sericit matrix, strongly foliated 35^o to core axis with stretched quartz and feldspar crystal fragments in the plane of foliation. Extensively carbonatized and also cut by later calcite stringers. Sample @37.0.	BN 470		
40.5 - 112.5	INTERMEDIATE TUFFS AND FLOWS			
	- thick sequence of light green, chloritic and sericitic rocks extensively carbonatized, violent acid reaction. Varys from fine-grained to aphanitic to a strongly foliated matrix with stretched clastic material, mostly feldspars. Foliation 35^o to core axis. Carbonate stringers are present. Portions of this sequence are probably porphyritic flows, with phenocrysts stretched in the plane of foliation. As a rule, the flow looking units are darker, and less foliated. They may also be intrusives. Sample @ 76.0. Some sections contain which appear to be clasts of carbonate. Sample @ 91.5. Also present locally are dark green chlorite streaks in the lighter matrix.	BN 471 BN 472		
112.5 - 128.5	RHYODACITE TUFFS			
	- light green, massive, moderate foliation with extensive carbonatization. The rock is siliceous, but can be scratched. Portions appear to be brecciated. These may well be agglomerate but it is difficult to determine from the core. However, the clasts do not appear angular, but are stretched in the plane of Foliation. Sample @ 123.0.	BN 473		

211-9437

Drill Hole Record

Cominco

Property	District	Hole No. KS3	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Scale

Colour Plot & Dips

Footage From – To	Description	Sample No.	Length	Analysis
	The lower contact is very siliceous and massive but is still carbonatized.Within this are thin 1-3mm lenses of crystal tuff.			
128.5 - 170.0	INTERMEDIATE TUFFS AND FLOWS			
	- similar to (40.5 - 112.5) medium green, chloritic, sericitic, fine-grained with coarser stretched feldspar locally (1-2mm size). Extensively carbonatized with a banded appearance (chlorite rich/carbonate rich zones). Calcite stringers cut the core at various attitudes. Chlorite streaks are present locally and may represent stretched lithic material (pumice shards). Sample @ 162.0. From 171-185.0 the rock is extensively sheared roughly parallel to the core axis. The foliation parallels this structure.	BN 474		
176.0 - 185.0	MAFIC INTRUSIVE			
	- dark green, blackish, massive, extensively fractured and sheared. Hematite staining on shear planes. Porphyritic with 20% 1-2mm size feldspar phenocrysts.Veined by calcite stringers. This shear, probably represents the Stirling Fault.			
185.0 - 197.5	FELSIC INTRUSIVE			
	- pink, feldspathic, massive matrix with subrounded clasts, often of pebble size. Calcite stringers occur.			
197.5 - 209.0	MAFIC INTRUSIVE/FELSIC INTER			
	- similar to (176.0-185.0) dark green, blackish, massive, extensively fractured and carbonate			

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Sheet 3 of 7

Property	District	Hole No. KS3	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS3

Footage From – To	Description	Sample No.	Length	Analysis
	injected. Contains an felsic inclusion 204.5-205.5			
209.0 - 311.5	INTERMEDIATE TUFFS/FLOWS			
	- similar to (40.5-112.5) (128.5-170.0). Light green chloritic, sericitic, extensively carbonatized with a banded appearance locally, the rock can look tuffaceous or like a more massive, less foliated and carbonatized flow. These units could also be intrusives (Sample @ 232.5). Sample @ 277.0 is representative of the section. Some portions have been epidotized where carbonate veining has occurred. Kink folds can be seen in the foliation. The foliation is now 70-80^{o} to the core axis.	BN 475 BN 476		
311.5 - 313.5	MISSING CORE			
313.5 - 315.5	INTERMEDIATE FLOW/INTRUSIVE			
	- dark green, moderately foliated, stretched feldspar phenocrysts chloritic, carbonatized and veined by calcite stringers.			
315.5 - 318.5	MISSING CORE			
318.5 - 322.0	INTERMEDIATE TUFFS/FLOWS - similar to (40.5-112.5) (128.5-170.0) (209.0-311.5)			
322.0 - 334.0	RHYODACITIC LITHIC TUFF/FLOW BRECCIA?			
	- light green, chloritic, epidotized, carbonatized with dark green clastic material stretched			

Scale

Colour Plot & Dips

Drill Hole Record

COMINCO

Property	District	Hole No. KS3	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. | Sheet

Footage From – To	Description	Sample No.	Length	Analysis
	in the plane of foliation 80^{o} to core axis. Sample @ 326.5. Other portions are more massive	BN 477		
	and dense suggestive of a felsic flow with the fragmental units on either side.			
334.0 - 343.0	INTERMEDIATE TUFFS/FLOWS			
	- similar to (40.5-112.5) (128.5-170.0) (209.0-311.5) (318.5-322.0). Extensively carbonatized			
	in the plane of foliation, and with later calcite veinlets, banded appearance.			
343.0 - 348.5	RHYODACITE FLOW			
	- light green, massive, locally minor feldspar phenocrysts stretched in the foliation plane.			
	Carbonatized, epidotized near qt-carbonate veins. Siliceous, with local rhyolitic zones.			
	Calcite stringers present.			
348.5 - 354.0	FELSIC INTRUSIVE			
	- massive, non foliated, reddish brown siliceous aphanitic matrix with 10-15% quartz feldspar			
	phenocrysts. Calcite stringers present. Sample @ 351.5.	BN 478		
354.0 - 363.0	MASSIVE PORPHYRITIC RHYOLITE			
	- purplish to buff colored, aphanitic massive siliceous matrix with 20% quartz feldspar			
	phenocrysts. Calcite stringers present. Upper and lower contacts have been altered by the			
	felsic intrusives - epidotization. Sample @ 356.5.	BN 479		
363.0 - 385.5	FELSIC INTRUSIVE - similar to (348.5-354.0)			

211-0437

Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Property	District	Hole No. KS3	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Sheet 5 of 7

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS3

Footage From - To	Description	Sample No.	Length	Analysis
385.5 - 641.0	MASSIVE RHYOLITE FLOWS			
	- multiple flow units ranging from dark green, light green, buff and purplish. Most are massive, aphanitic to fine-grained and very siliceous. They have been fractured with calcite infillings. Locally, they may be porphyritic with qtz/feldspar phenocrysts. Portions may also be breccias, but the homogenous nature of the rock made this difficult to determine with certainty. Widespread carbonitization is notably absent as is a foliation. However, thin zones, possibly tuffs have a foliation and have been carbonitized. Samples @ 402.5	BN 480		
	477.5	BN 481		
	521.0	BN 482		
	633.0	BN 483		
641.0 - 655.0	MAFIC INTRUSIVE			
	- dark green, extensively sheared and fractured. Foliated and injected with carbonate veins and stringers. Chloritic. Possible stretched phenocrysts of feldspar.			
655.0 - 660.0	RHYOLITE TUFF			
	- buff to pinkish rhyolite fragments up to 3-4cm in a sericitic, chloritic matrix. The matrix is often siliceous. Portions of the rock are poorly consolidated. Other are more massive showing quartz eyes and pumice shards. Sample @ 659.0. The breccia is considered a later tectonic feature.	BN 484		

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Drill Hole Record

Cominco

Scale

Colour Plot & Dips

Property	District	Hole No. KS3	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS3 | Sheet 6 of 7

Footage From – To	Description	Sample No.	Length	Analysis
66.0 – 684.0	SHEAR ZONE/QUARTZ-CARBONATE			
	– highly fractured zone which includes the lower contact of the rhyolite above, the quartz carbonate and the intermediate rocks below. Basically this unit consists of 1-3cm size fragments of the above units in a chlorite, sericite, talc matrix. The rock is poorly consolidated and contains gouge. One small fragment was chert like with sulphides – EXHALITE. There is <2% disseminated sulphides in the Quartz Carbonate Zone (pyrite). Rhyolite also occurs below the quartz carbonate for approx 3 feet. Sample @ 668.6	BN 485		
	" 677.5	BN 486		
684.0 – 698.0	INTERMEDIATE INTRUSIVE/FLOW			
	– medium green, massive, equigranular, equal proportions of mafics and feldspars. Calcite stringers present.			
698.0 – 1048.0	INTERMEDIATE FLOWS AND TUFFS			
	– light green, chloritic, sericitic, moderately carbonatized in the plane of foliation. Generally massive, equigranular, fine-grained with local aphanitic zones. Thin tuffaceous units are interbedded. Sample @ 733.0. Bedding is ~45^{o} to core axis. Locally the rock may	BN 487		
	be rhyodacitic. Weak foliation 70^{o} to core axis. Carbonatization increases from top to bottom. From 800' on, the rock often has a banded appearance where carbonate content is high. The carbonatization is widespread in the strongly foliated zones, which corresponds to the	BN 488		
	thicker tuffaceous units. Minor breccias are present. Sample @ 826.5	BN 489		
	Bedding contact 95^{o} to core axis. Sample @ 891.5	BN 490		
	Dacite flow Sample @ 949.0			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 7 of 7

Property	District	Hole No. KS3	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS3

Footage From	To	Description	Sample No.	Length	Analysis
		Foliated Carbonatized Tuff. Sample @ 938.5	BN 491		
		Tuff Bx. Sample @ 1037.5	BN 492		
		The foliation is approx. 50° to core axis.			
1048.0	1102.0	DACITE TUFF BRECCIA			
		- Light green, chloritic, epidotized, sericitic matrix made up of fine tuffaceous material with			
		angular lithic fragments of dacite, rhyolite, and chert with sulphides. Thin massive			
		porphyritic intrusive units interspersed. Fragments range from 3mm to 3cm size. Could also			
		be sulphide fragments. Sample @ 1077. This section has been split by Penarroya.	BN 493		
		Hematite staining on shear planes. Calcite stringers present.			
1102.0		END OF HOLE			

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Drill Hole Record

COMINCO

Property	STIRLING	District	Maritimes	Hole No.	KS4
Commenced		Location	South Mine Property	Tests at	Hor. Comp.
Completed		Core Size	NQ	Corr. Dip	Vert. Comp.
Co-ordinates				True Brg. 308°	Logged by C. Miller
Objective				% Recov.	Date August, 1977

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.	Sheet
Stirling	308°	65°		129'		

Footage From – To	Description	Sample No.	Length	Analysis
0.0 – 15.0	OVERBURDEN			
15.0 – 27.5	INTERMEDIATE CRYSTAL TUFF			
	– light to dark green, fine-grained chloritic matrix, well foliated 35° to core axis with feldspar crystal fragments 1-2mm size making up 40% of the rock. These clasts are stretched in the plane of foliation. This unit may also be interpreted as a porphyritic flow or intrusive. Sample @ 19.0. Extensively carbonatized, violent acid reaction.	BN 467		
27.5 – 51.0	INTERMEDIATE TUFFS			
	– light green, fine-grained to aphanitic, faintly banded, light and dark. Extremely carbonatized 30% which gives the rock its light color. Foliation parallels banding @ ~35° to core axis. Some coarser units <1mm size. Sample @ 44.0.	BN 468		
51.0 – 54.5	INTERMEDIATE CRYSTAL TUFF – similar to (15.0-27.5) could also be a Porphyritic Flow.			
54.5 – 85.0	INTERMEDIATE TUFFS			
	– light green, strongly foliated, banded, extensively carbonatized and sheared. Very similar to (27.5-51.0).			
85.0 – 129.0	INTERMEDIATE FLOWS			
	– medium green, strongly foliated chloritic and sericitic matrix with 1-2mm feldspar phenocrysts			

211-0137

Scale

Colour Plot & L.P.

Drill Hole Record

COMINCO

Property	District	Hole No. KS4				Sheet
Commenced	Location	Tests at	Hor. Comp.			
Completed	Core Size	Corr. Dip	Vert. Comp.			
Co-ordinates		True Brg.	Logged by			
Objective		% Recov.	Date	Claim / T Brg. / Collar Dip / Elev. / Length		Hole No.

Footage From	To	Description	Sample No.	Length	Analysis
		stretched in the plane of foliation. Lighter coloured tuffaceous units are interbedded.			
		Contacts reveal at best 2 flow units - contact @ 100.5. Extensively carbonatized and cut			
		by the ubiquitous calcite stringers. A carbonate vein extdnds from 124.0-125.0.			
		Sample @ 101.0	BN 469		
129.0		END OF HOLE			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property STIRLING	District Maritimes	Hole No. KS5			
Commenced	Location South Mine Property	Tests at 100'	500'	750'	Hor. Comp.
Completed	Core Size BQ	Corr. Dip 58^o	57^o	53^o	Vert. Comp.
Co-ordinates		True Brg.			Logged by C. Miller
Objective		% Recov.			Date August, 1977

Claim Stirling | T Brg. 126^o | Collar Dip 58^o | Elev. | Length 941 ft. | Hole No. | Sheet /

Footage From – To	Description	Sample No.	Length	Analysis
0 – 8.0	OVERBURDEN			
8.0 – 12.5	ARKOSE/IMPURE QUARTZITE			
	- qtz rich matrix with clasts of alkali feldspar up to 1.3mm			
12.5 – 60.5	MAFIC INTRUSIVE/FLOW			
	- dark green, chloritic, massive, of chlorite and phenocrysts of feldspar 1-2mm size. Veined by calcite stringers. Portions are dark green, white others are lighter and coarser grained. Contact with above is seemingly chilled. Epidote on stringers - magnetite.			
60.5 – 67.5	ARKOSE/IMPURE QUARTZITE			
	- similar to (8.0-12.5) - veined by calcite stringers randomly distributed and oriented			
67.5 – 72.0	MAFIC INTRUSIVE			
	- dark green, chloritic matrix with feldspar phenocrysts up to 3mm size. Some of the phenocrysts have been epidotized. Calcite stringers. Chilled contacts. Hematitic on shear planes.			
72.0 – 79.0	ARKOSE/IMPURE QUARTZITE			
	- similar to (8.0-12.5) and (60.5-67.5) shear zone @ 79.0 fracturing the arkose. Gauge produced is stained by hematite. Rock gets coglomeratic from 77.0-79.0			

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Drill Hole Record

Scale

Colour Plot & Dips

Cominco

Property	District	Hole No. KS5	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS5 | Sheet 2 of 8

Footage From - To	Description	Sample No.	Length	Analysis
79.0 - 83.5	MAFIC INTRUSIVE - similar to above			
83.5 - 37.5	ARKOSE/IMPURE QUARTZITE			
87.5 - 90.5	MAFIC INTRUSIVE			
90.5 - 99.0	ARKOSE/CONGLOMERATE	BN 454		
	- lithic, rounded pebbles up to 3-4cm size. (Sample @ 98.0)			
99.0 - 105.5	MAFIC INTRUSIVE - (Sample @ 104.0)	BN 455		
105.5 - 125.0	ARKOSE/IMPURE QUARTZ/CONGLOMERATE - similar to above units			
125.0 - 126.5	MAFIC INTRUSIVE			
126.5 - 128.0	ARKOSE/IMPURE QUARTZITE			
128.0 - 147.5	MAFIC INTRUSIVE			
147.5 - 150.5	ARKOSE/IMPURE QUARTZITE			
150.5 - 154.0	MAFIC INTRUSIVE			

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Drill Hole Record

Scale

Colour Plot & Dips

COMINCO

Sheet 3 of 8

Property		District		Hole No. KS5	
Commenced		Location		Tests at	Hor. Comp.
Completed		Core Size		Corr. Dip	Vert. Comp.
Co-ordinates				True Brg.	Logged by
Objective				% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS5

Footage From – To	Description	Sample No.	Length	Analysis
154.0 – 156.0	ARKOSE/IMPURE QUARTZITE – epidotized			
156.0 – 161.0	MAFIC INTRUSIVE			
161.0 – 164.5	ARKOSE/IMPURE QUARTZITE			
	– contacts are often fractured and altered, usually to epidote			
164.5 – 174.5	MAFIC INTRUSIVE			
174.5 – 176.0	ARKOSE/IMPURE QUARTZITE – severely altered			
176.0 – 192.5	MAFIC INTRUSIVE			
	– when intrusive is thicker, rock is more porphyritic. Feldspar phenocrysts 30% up to 4mm in size. Chloritic matrix. Massive, non-foliated			
192.5 – 241.0	ARKOSE/SAMPLE QUARTZITE			
241.0 – 246.0	SHEAR ZONE CONTACT OF MIDDLE RIVER WITH BOURINOT			
	– fractured, mylonitized zone, gauge, with fragments of both groups of rocks. Middle River Rocks are massive, fresh looking, non-foliated above the contact. The Bourinot rocks are strongly foliated and metamorphosed.			

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Drill Hole Record

Cominco

Property	District	Hole No. KS5	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Sheet 8 of 8

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS5

Footage From – To	Description	Sample No.	Length	Analysis
246.0 - 260.0	MAFIC INTRUSIVE/FLOW			
	- dark green, strongly foliated and deformed, all original textures			
	Brecciated appearance locally. Fruther away from the shear zone, the rock is more massive,			
	and aphanitic to fine-grained. Looks like a flow			
260.0 - 262.0	FELSIC INTRUSIVE			
	- deep pink clolour, qtz and feldspar (alkali) predominant			
262.0 - 275.5	DACITE FLOW			
	- similar to 246.0-260.0 - light green, chloritic, sericitic, fine-grained to aphanitic			
	foliated 45° to core axis. Quartz eyes <2%, often stretched. (Sample @ 273.5)	BN 456		
275.5 - 277.0	FELSIC INTRUSIVE - similar to 260.0-262.0			
277.0 - 283.5	INTERMEDIATE TUFF BRECCIA			
	- light green, strongly foliated with fragments up to 2-3cm size. Stretched in the plane of			
	foliation ~45° to core axis. (Sample @ 278.0)	BN 457		
283.5 - 289.5	RHYCDACITIC LITHIC TUFF			
	- dark green chloritic matrix 20% with lithic and qtz feldspar fragments making up the bulk			
	of the rock. Clasts are mostly angular although some are subrounded. Contacts are			
	and slightly epidotized, so an intrusive cannot be ruled out. (Sample @ 286.0)	BN 458		

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211-8437

Drill Hole Record

Scale

Colour Plot & Clps

COMINCO

Property	District	Hole No. KS5	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS5 | Sheet 5 of 8

Footage From To	Description	Sample No.	Length	Analysis
289.5 - 371.5	DACITIC TUFFS			
	- thick sequence of light green, strongly foliated, chloritized and sericitized tuffs.			
	Foliation is 50^{o} to core axis. Rocks have an apparent banding on the foliation. Coarser			
	zones represent coarser tuffs. More massive, less foliated zones may be flows. Calcite			
	occurs in the foliation plane, and as randomly oriented stringers. Some kinking of the			
	foliation has taken place. Other portions appear to have lithic fragments, but the rock			
	is too strongly deformed to say whether its a breccia. (Sample @ 333.0)	BN 459		
371.5 - 374.5	FELSIC INTRUSIVE			
	- pinkish to buff, medium grained, siliceous. Massive, non-foliated			
374.5 - 392.5	DACITIC TUFFS			
	- similar to above (289.5-371.5) light green, carbonatized, strongly foliated with remnant			
	lithic and crystal fragments. Chloritized and sericitized.			
392.5 - 401.5	RHYODACITE FLOW			
	- light grey to buff, massive, siliceous, somewhat fractured with epidote forming in fractures.			
	Two felsic lamprophyries (pink with amphibole phenocrysts) occur in this section.	BN 460		
	(Sample @ 405.0)			
401.5 - 438.0	DACITE TUFFS			
	- similar to (374.5-392.5) light green, carbonatized. Foliated 45^{o} to core axis, chlorite and			
	sericite. Some horizons are massive and fine grained, others coarser with lithic and crystal			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 87 9

Property	District	Hole No. KS5	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS5

Footage From - To	Description	Sample No.	Length	Analysis
	fragments. There are some thinly laminated units similar to the exhalite, except more clastic looking and devoid of carbonates or sulphides - ash! Other narrow portions look like tuffs or tuff breccias with lithic clasts up to 2cm size.			
438.0 - 442.0	INTERMEDIATE TUFF BRECCIA - dark green chloritic matrix with clasts and fragments of feldspar quartz and lithic material. Matrix 60%. Clasts 40%. (Sample @ 442.0)	BN461		
442.0 - 519.0	INTERMEDIATE TUFFS - thick sequence of interbedded (bedding ~38° to core axis) of fine-grained tuffs, crystal and lithic tuffs, often of lapilli size. Grain size may range from aphanitic to medium-grained, and lithic clasts up tc 2cm may be present locally. The rocks are moderately foliated and sericitized, chloritized. Graded beds give top towards collar (Sample @ 518.5)	BN 462		
519.0 - 585.0	INTERMEDIATE TUFFS - interbedded lithic tuffs of lapilli size fragments with crystal tuffs of lapilli size and finer. Graded beds indicate tops towards the collar. Some units are fine-grained to aphanitic. Calcite stringers are present			
585.0 - 608.0	RHYODACITIC CRYSTAL TUFFS - dark green, fine-grained chloritic matrix with crystal and lithic fragments often of lapilli size. The clasts are predominantly of feldspar (pink, white/and quartz. Chert			

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Drill Hole Record

Scale
Colour Plot & Dips

Property	District	Hole No. KS5	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim | T Brg. | Collar Dip | Elev. | Length | Hole No. KS5 | Sheet 7 of 8

Footage From – To	Description	Sample No.	Length	Analysis
	fragments were also seen. (Sample @ 591.0)	BN 463		
608.0 – 711.0	INTERMEDIATE TUFFS			
	- interbedded lithic and crystal tuffs similar to (519.0-585.0) with coarser and finer horizons, some with clasts >2cm. The majority of the clasts are feldspar, qtz and pumice shards stretched in the foliation plane ~35° to core axis. (Sample @ 681.0)	BN 464		
711.0 – 715.0	SHEAR ZONE			
	- very siliceous fragments - rhyolitic in a dark green chloritic matrix. Also in this zone, dark green mafic intrusives have been emplaced.			
715.0 – 716.0	INTERMEDIATE TUFF - similar to (608.0-711.0)			
716.0 – 775.0	EXHALITE			
	- massive chert to finely bedded chert/carbonate intruded by mafic dykes. Graded beds give tops towards the collar. Finely disseminated sulphides <2%. Calcite stringers are present. Locally the rock has been fractured. (Sample @ 748.0)	BN 465		
775.0 – 900.0	MISSING CORE - believed taken for assay since the Qtz Carbonate zone was intersected in this zone from ( ).			

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Scale

Colour Plot & Dips

Drill Hole Record

Cominco

Sheet 8 of 8

Hole No. KS5

Property	District	Hole No. KS5	
Commenced	Location	Tests at	Hor. Comp.
Completed	Core Size	Corr. Dip	Vert. Comp.
Co-ordinates		True Brg.	Logged by
Objective		% Recov.	Date

Claim	T Brg.	Collar Dip	Elev.	Length	Hole No.
					KS5

Footage From – To	Description	Sample No.	Length	Analysis
900.0 - 941.0	MASSIVE RHYOLITE FLOW			
	- light to dark green, chloritic, massive, very siliceous and hard. Minor quartz feldspar phenocrysts. Veined by quartz and calcite. Sheared locally with sericite developed on shear planes. (Sample @ 933.0)	BN 466		
941.0	END OF HOLE			

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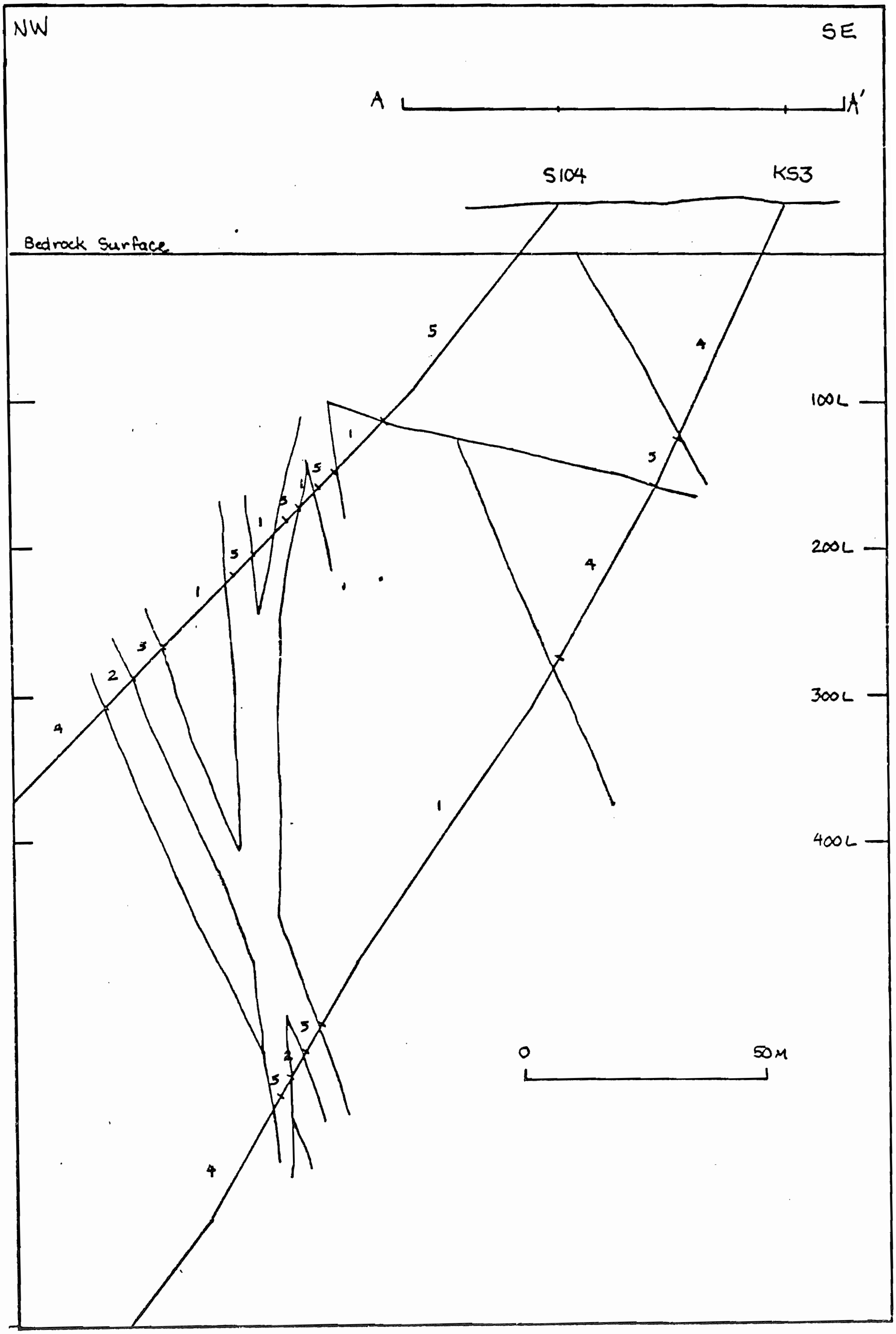
APPENDIX II

Interpreted Mine Sections

LEGEND

1. Rhyolite
2. Quartz-carbonate and sulphides
3. Siliceous siltstone and sulphides
4. Intermediate pyroclastics
5. Mafic Intrusions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KS3
Bedrock Surface
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100L
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400L
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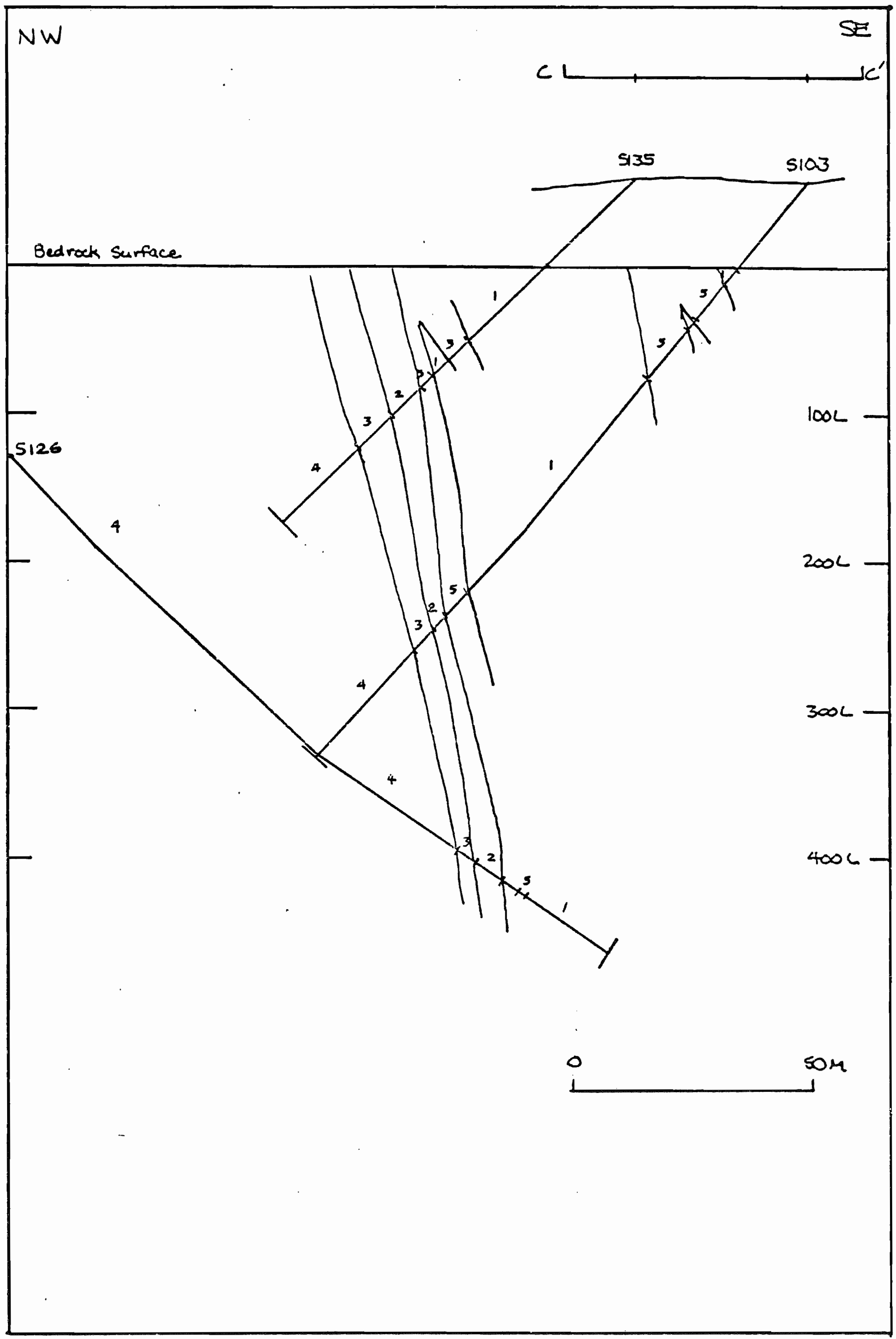
50M
4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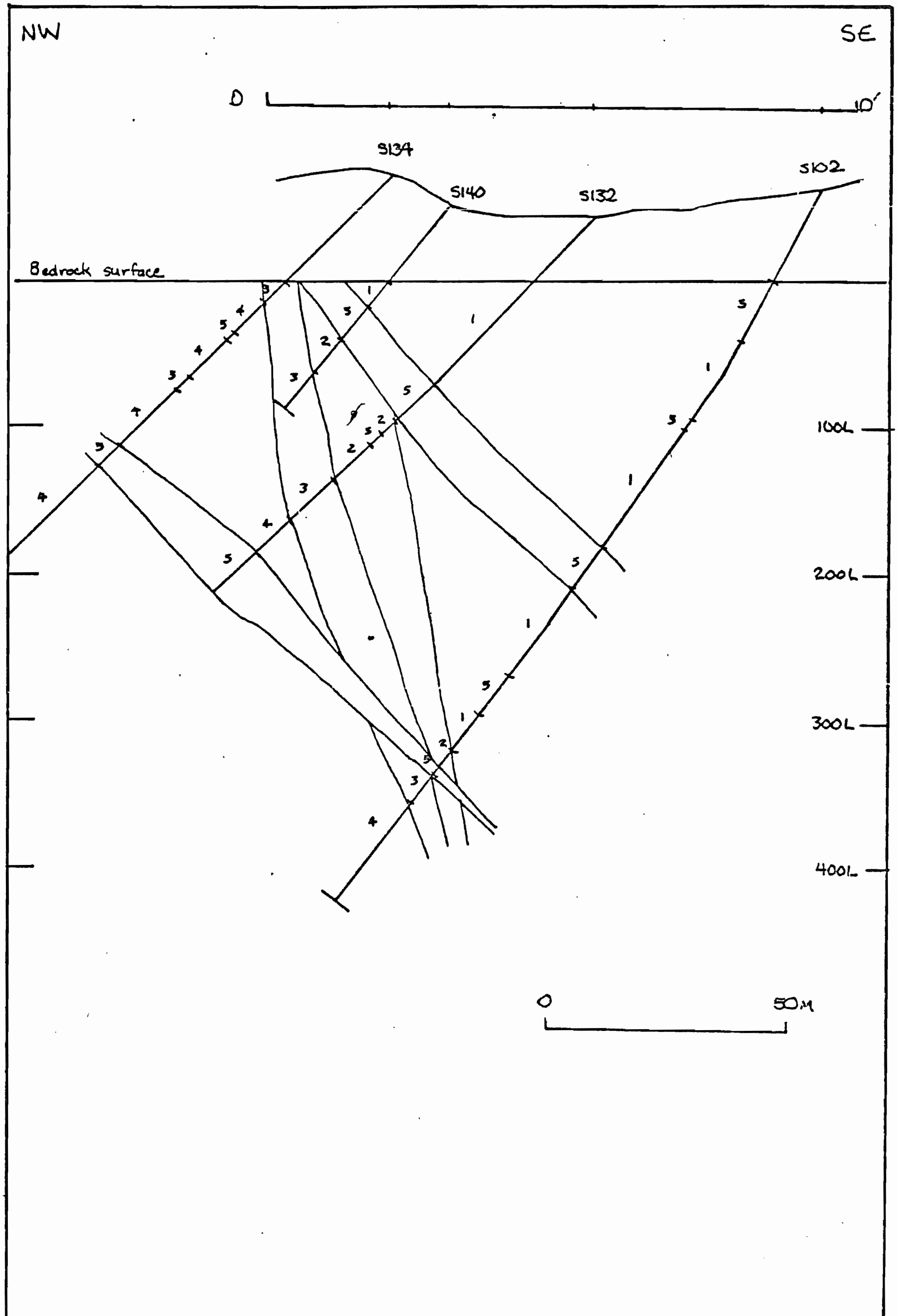
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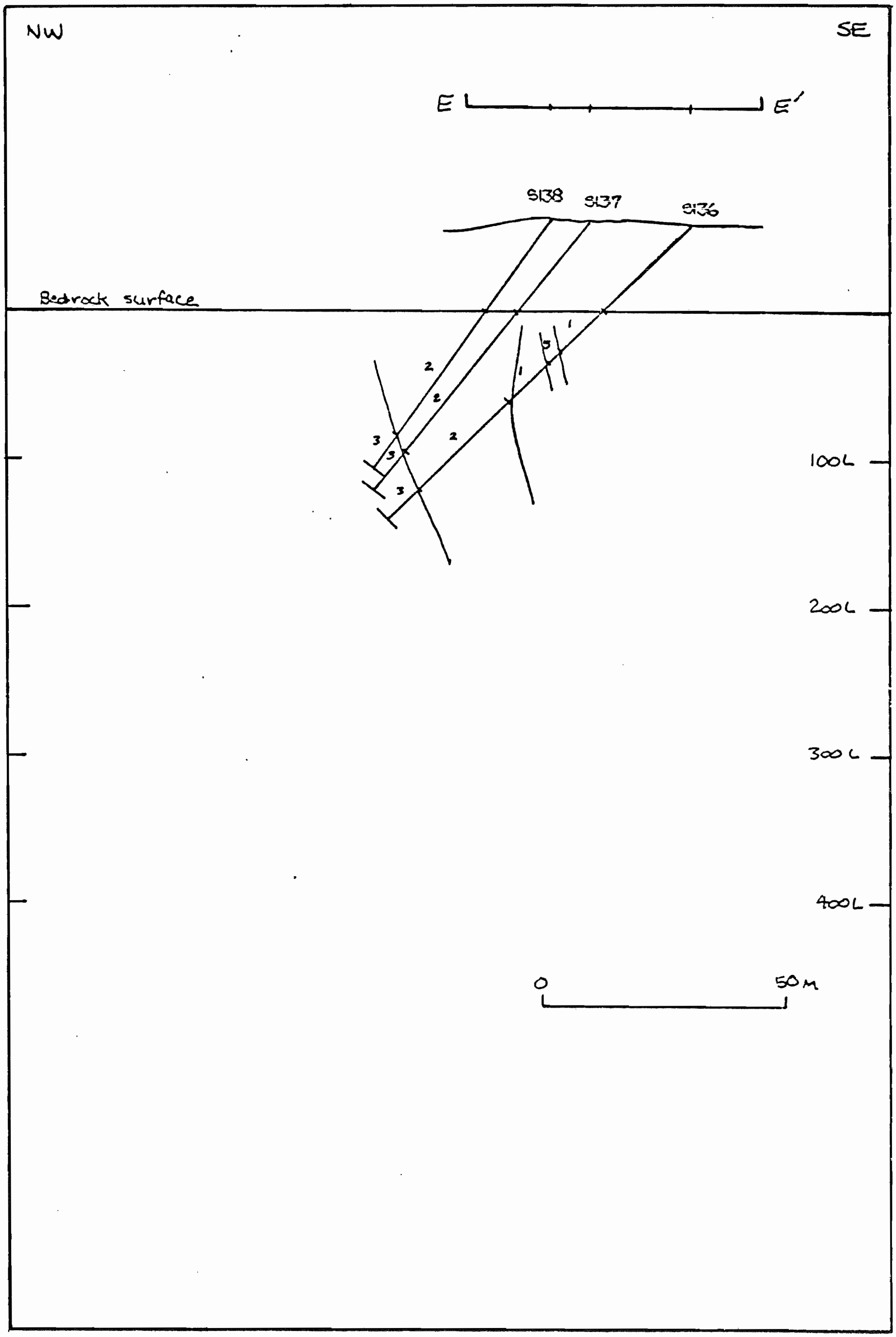
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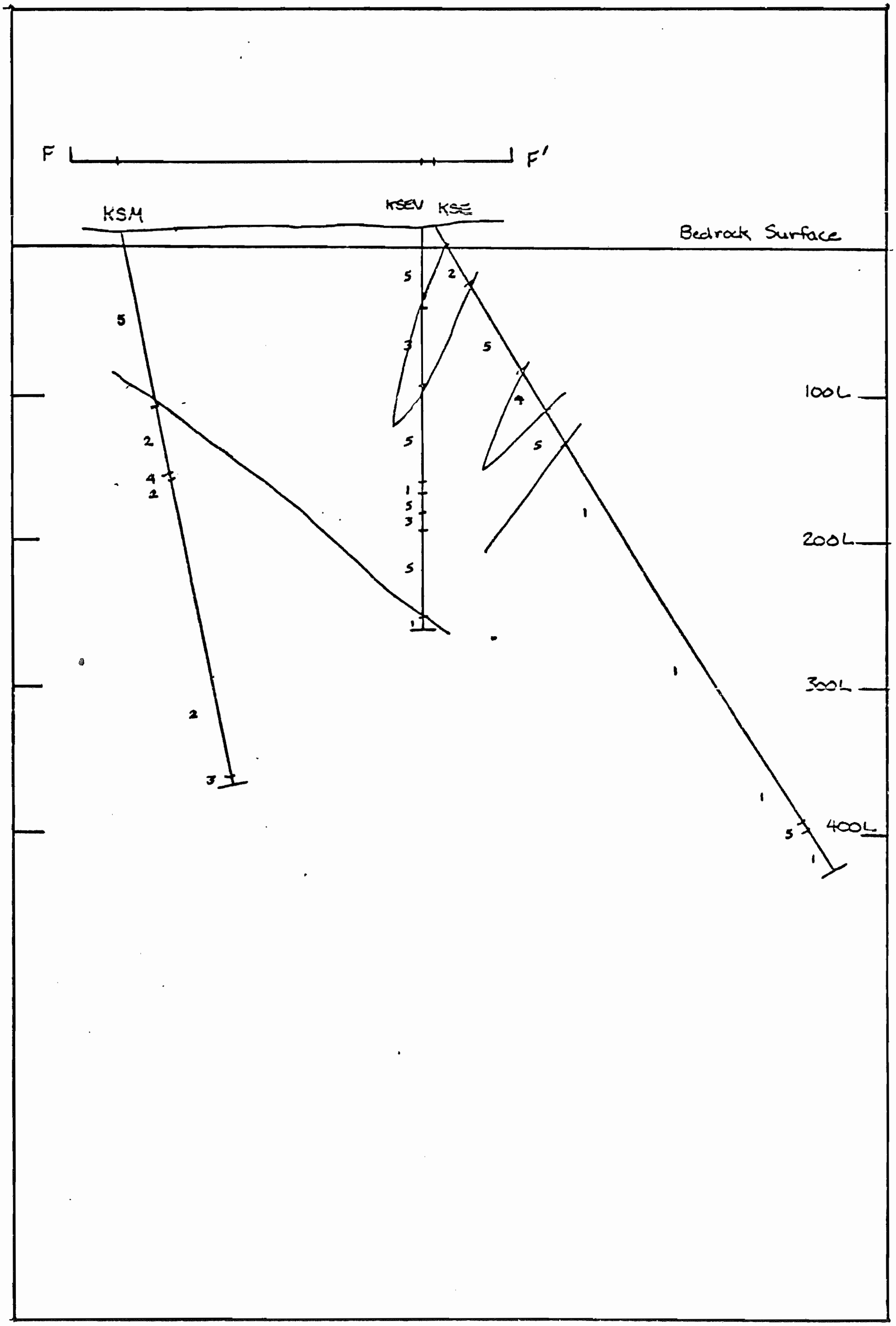
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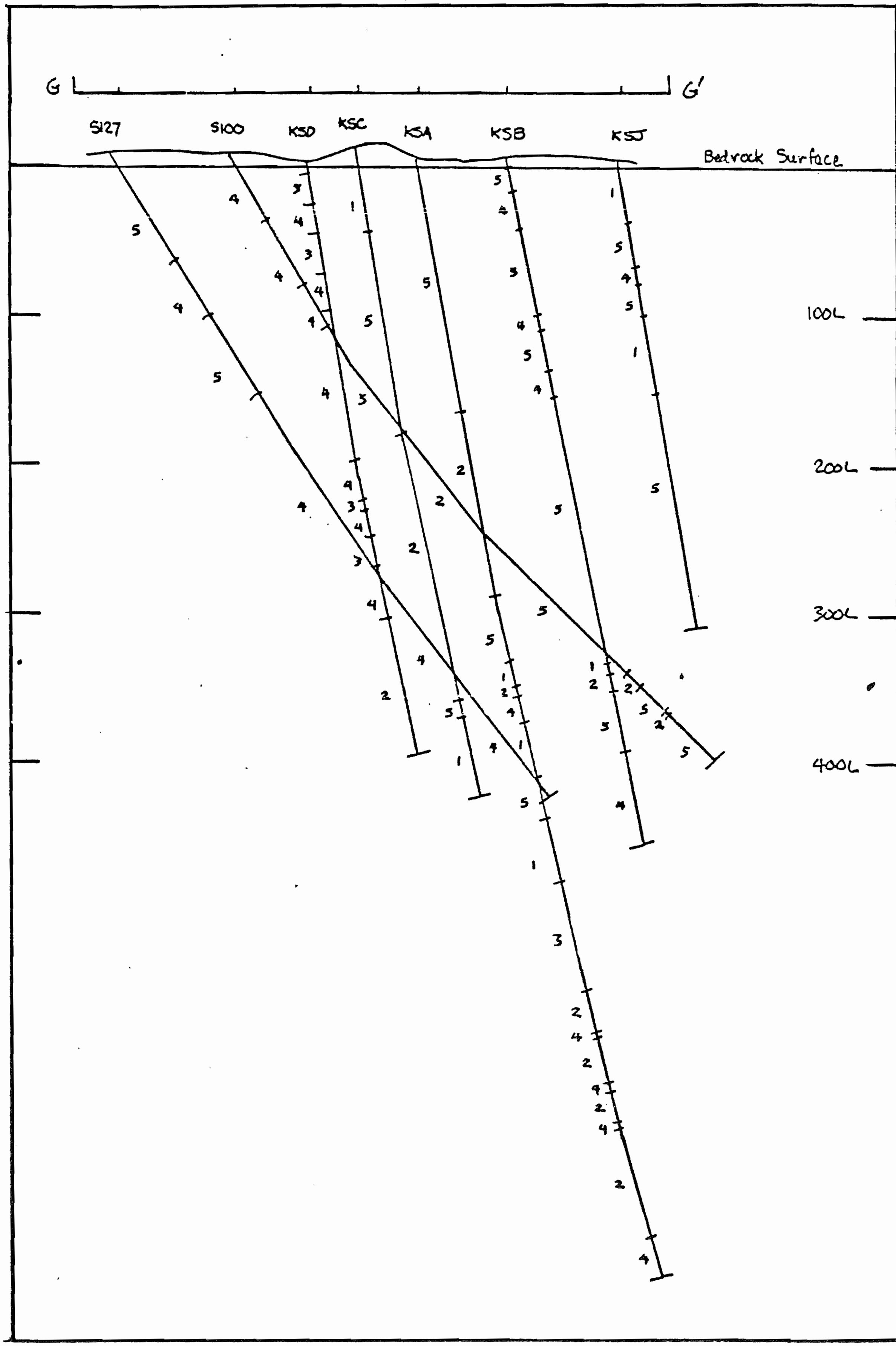
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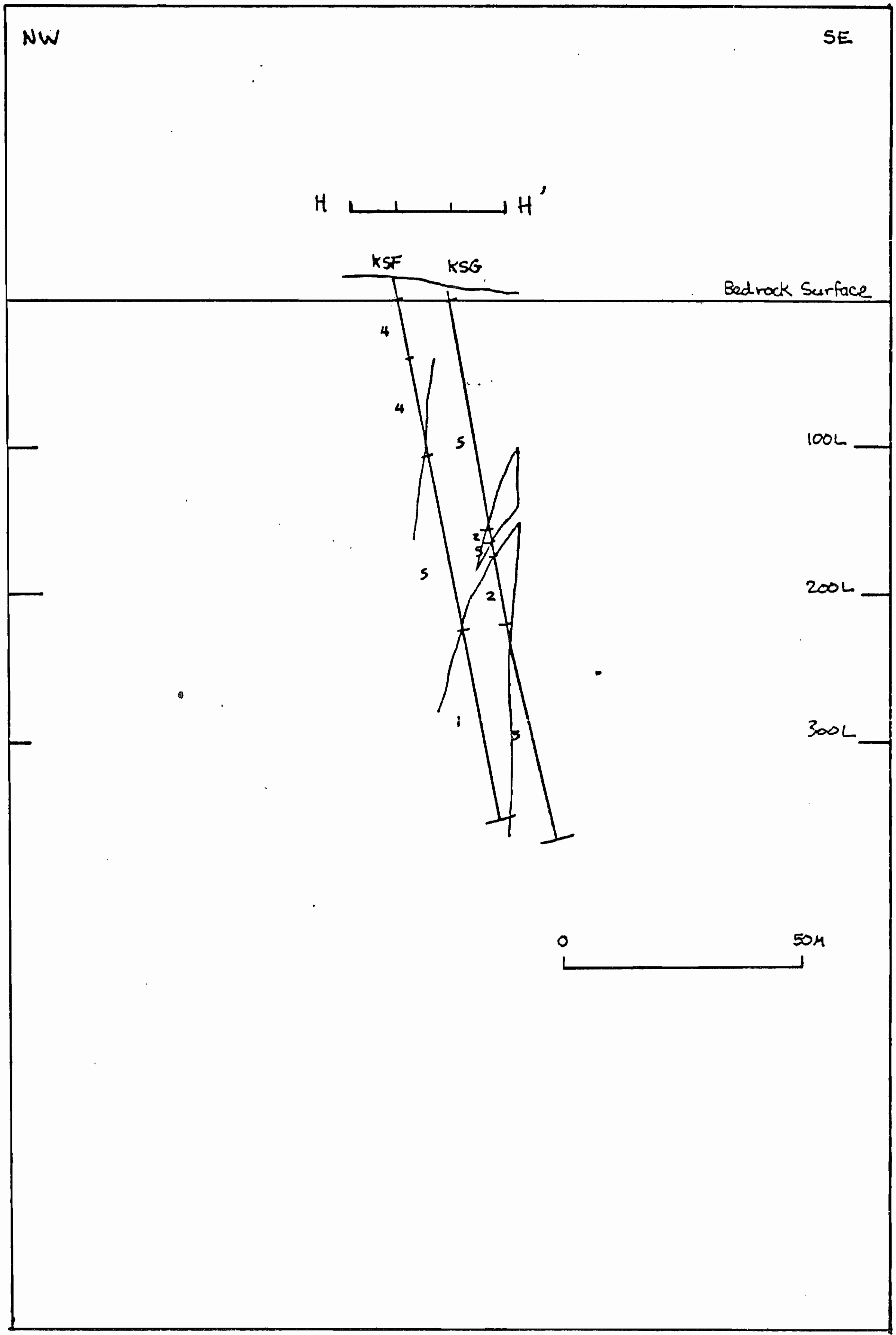
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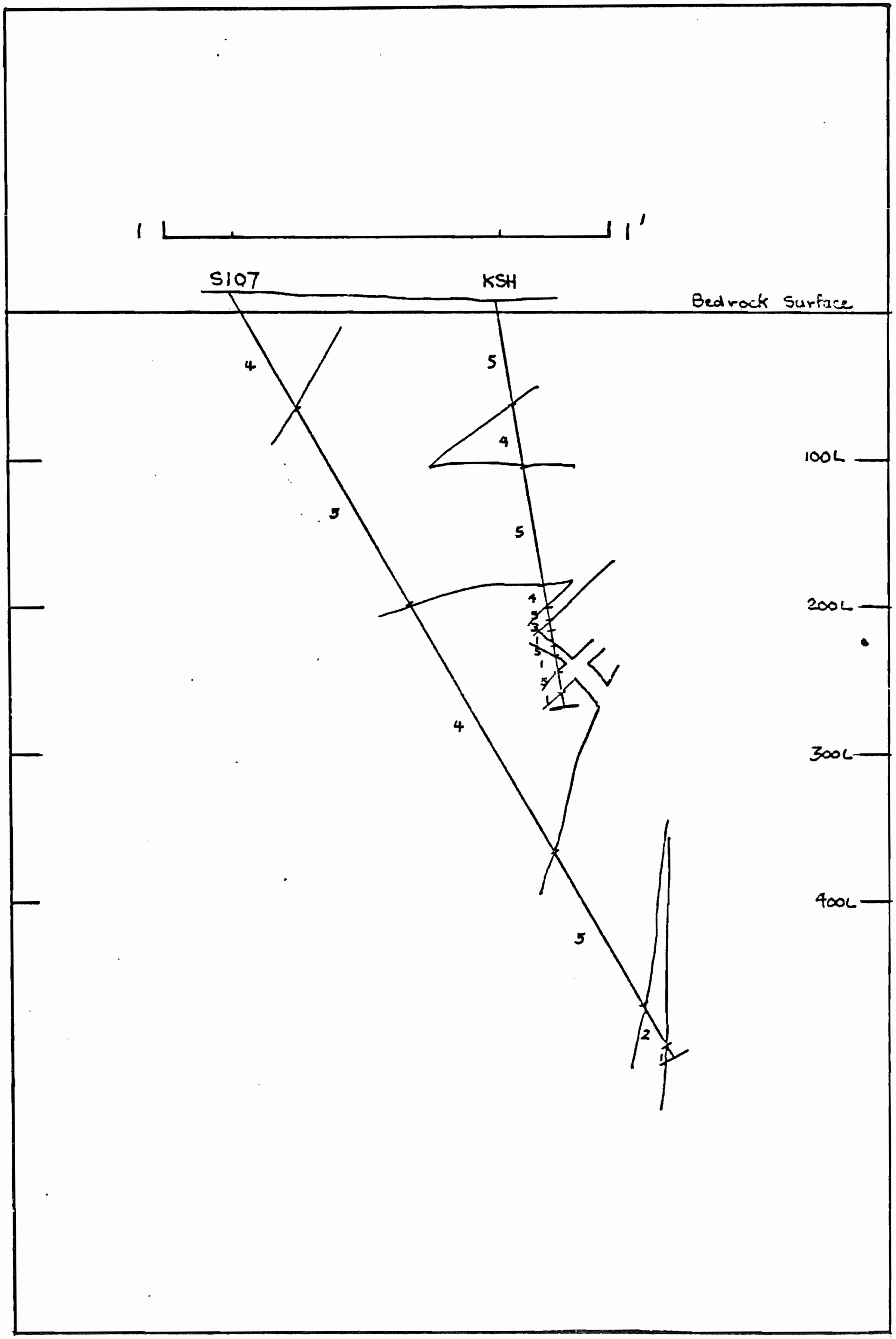

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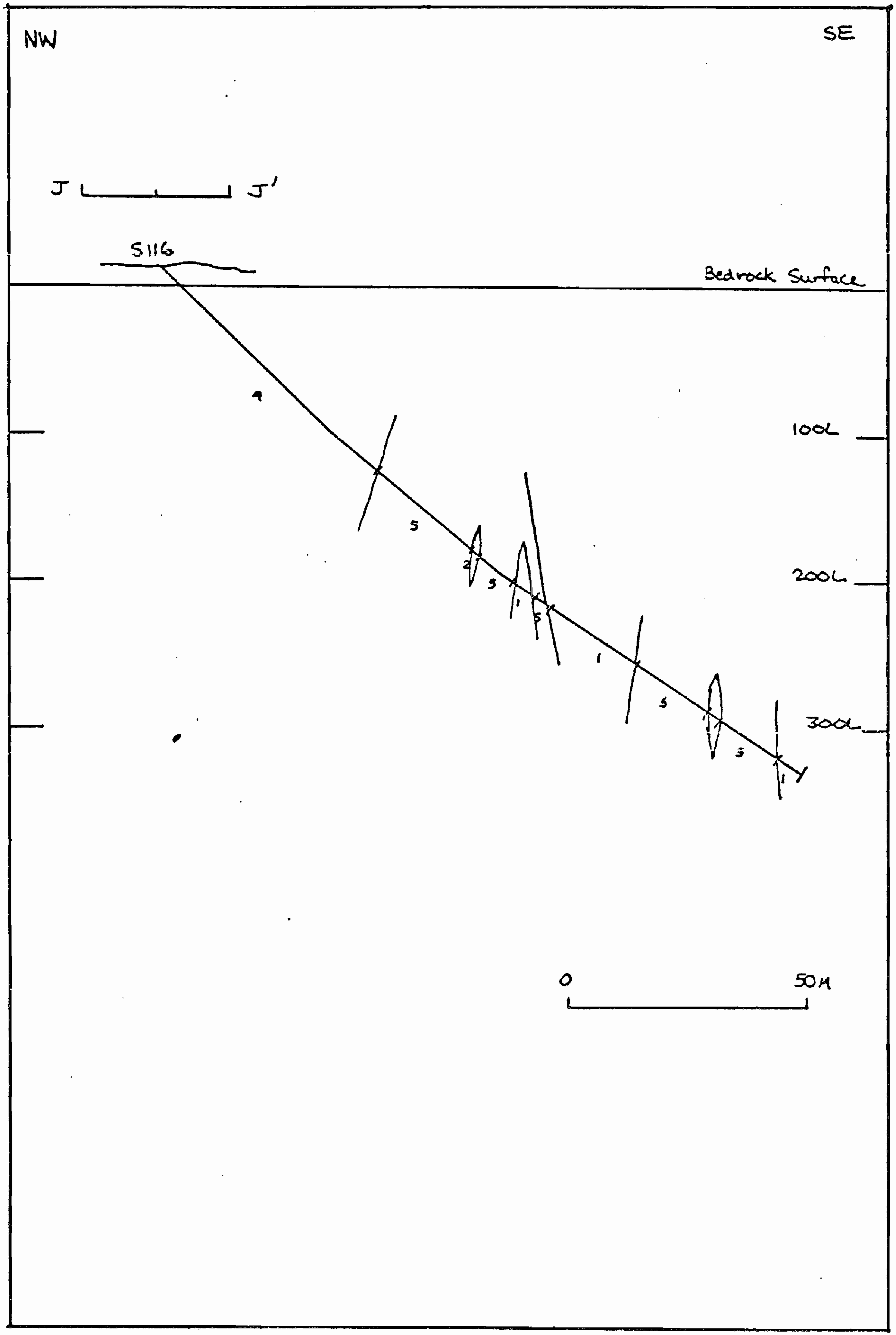
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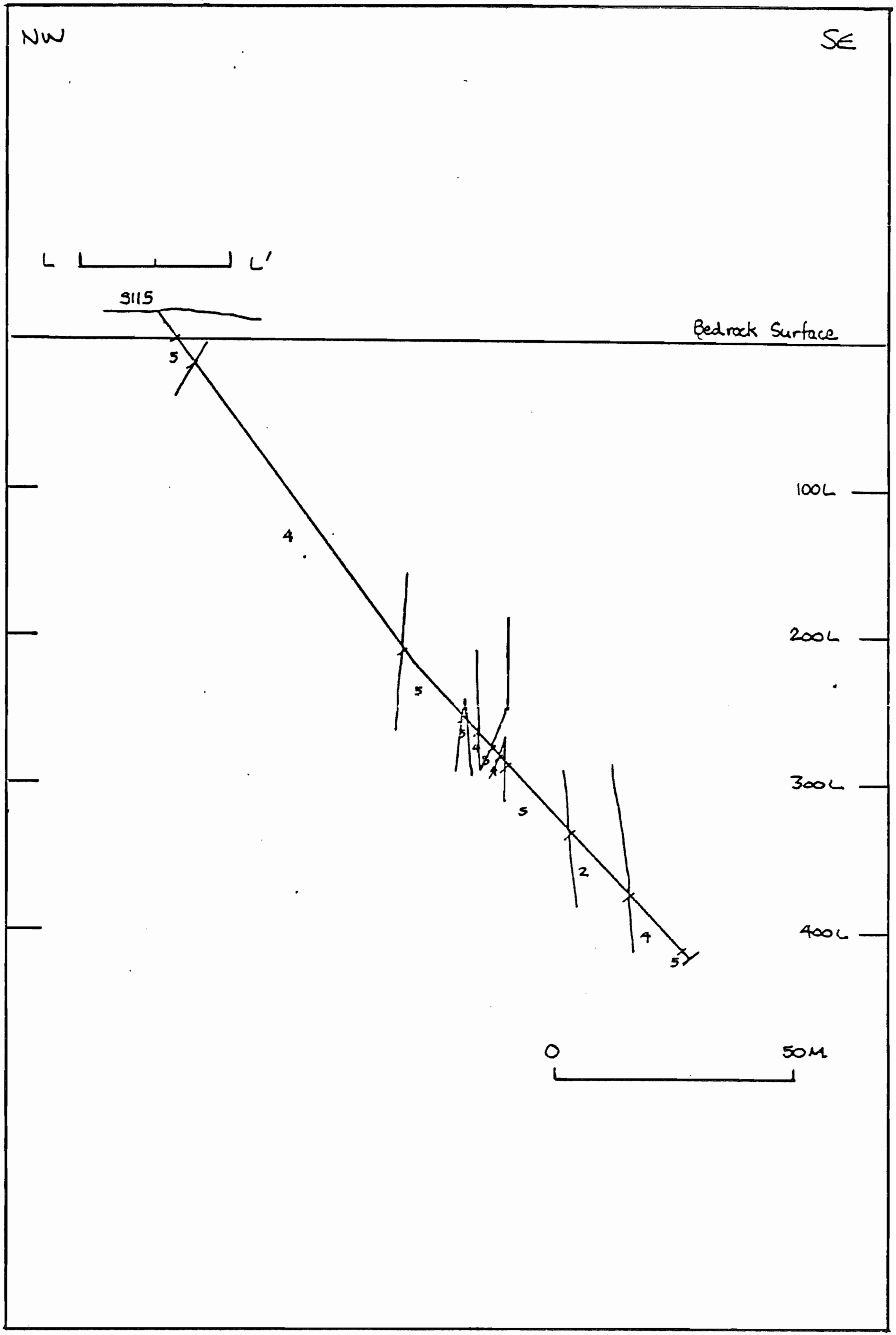
50M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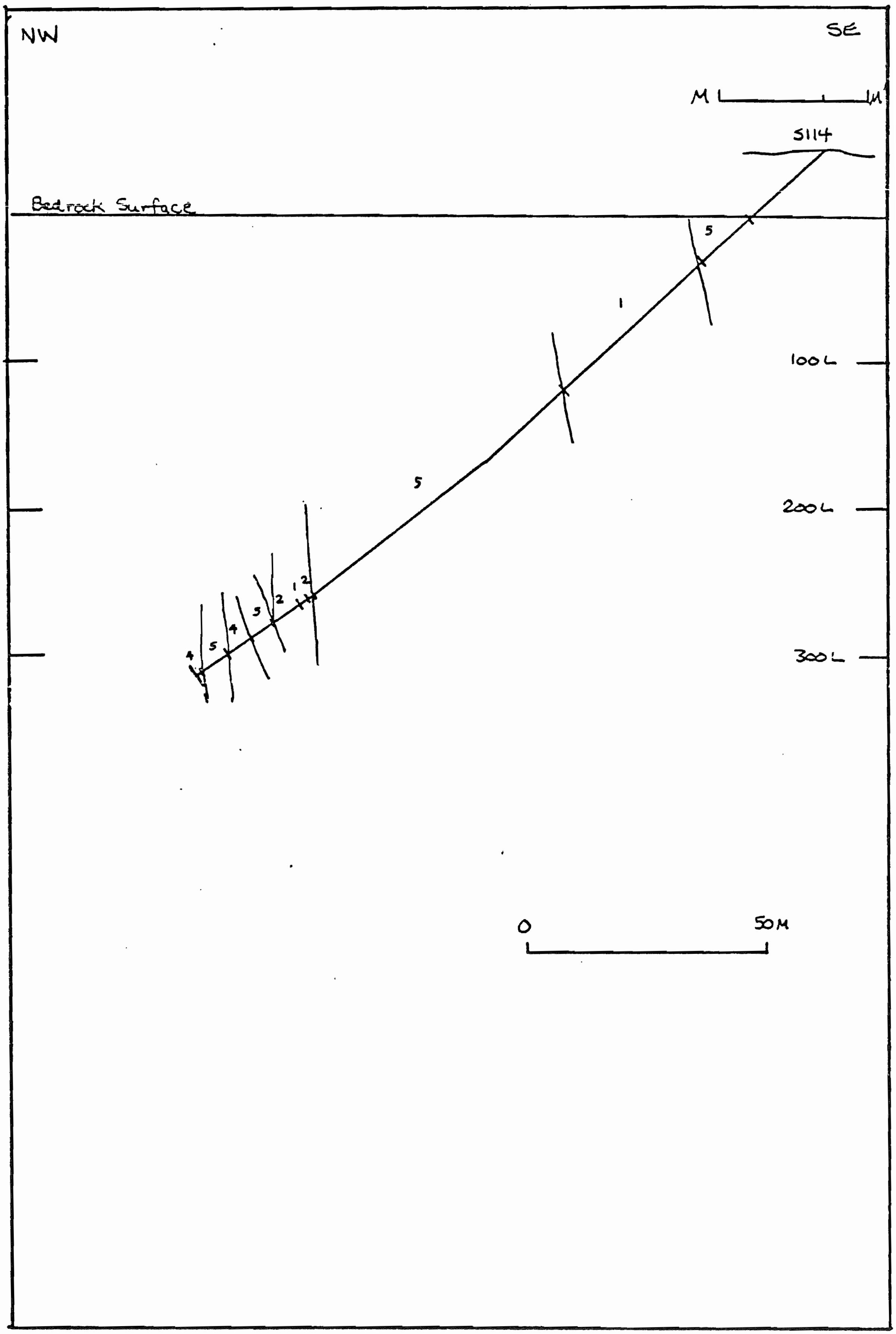
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Bedrock Surface
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200L
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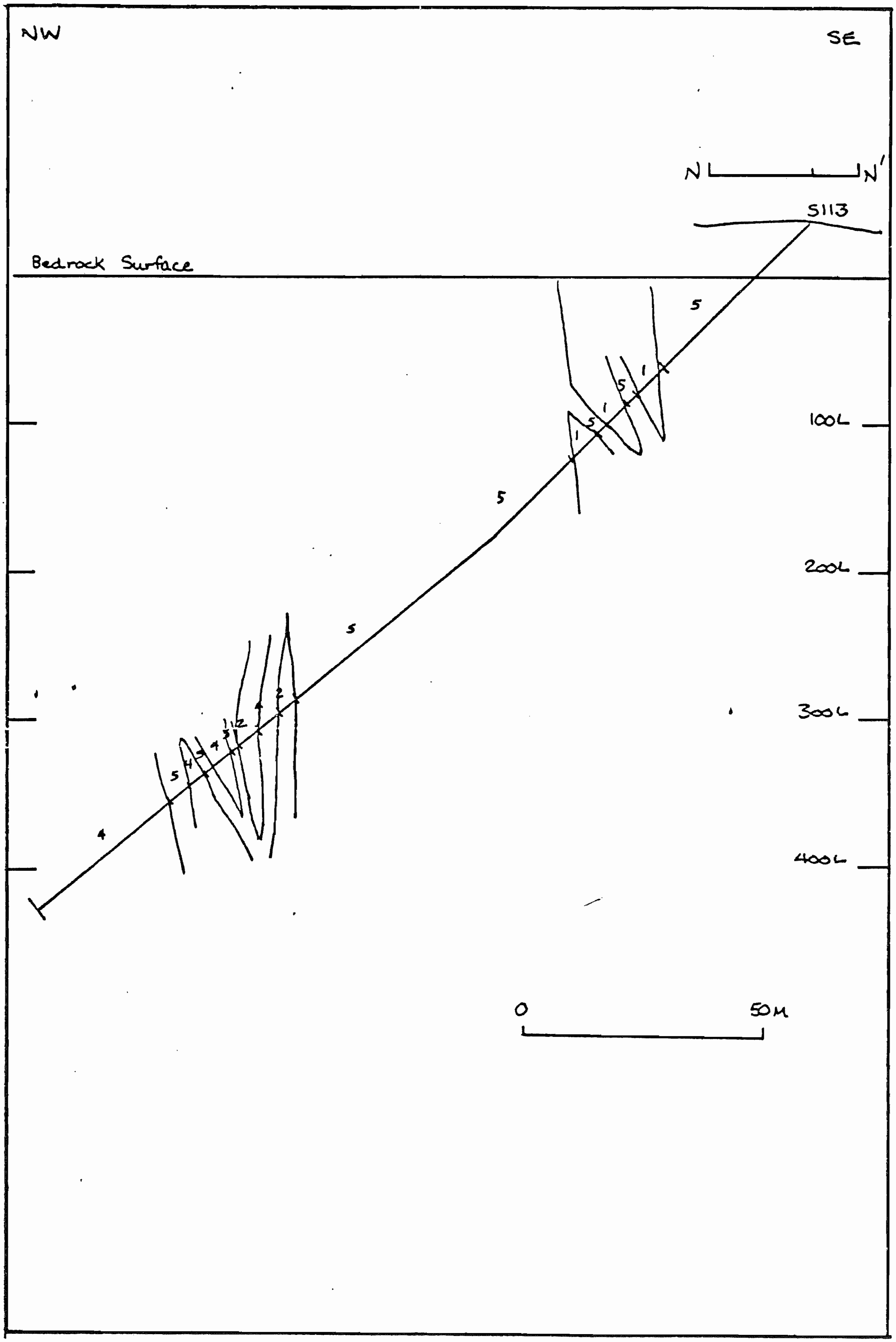
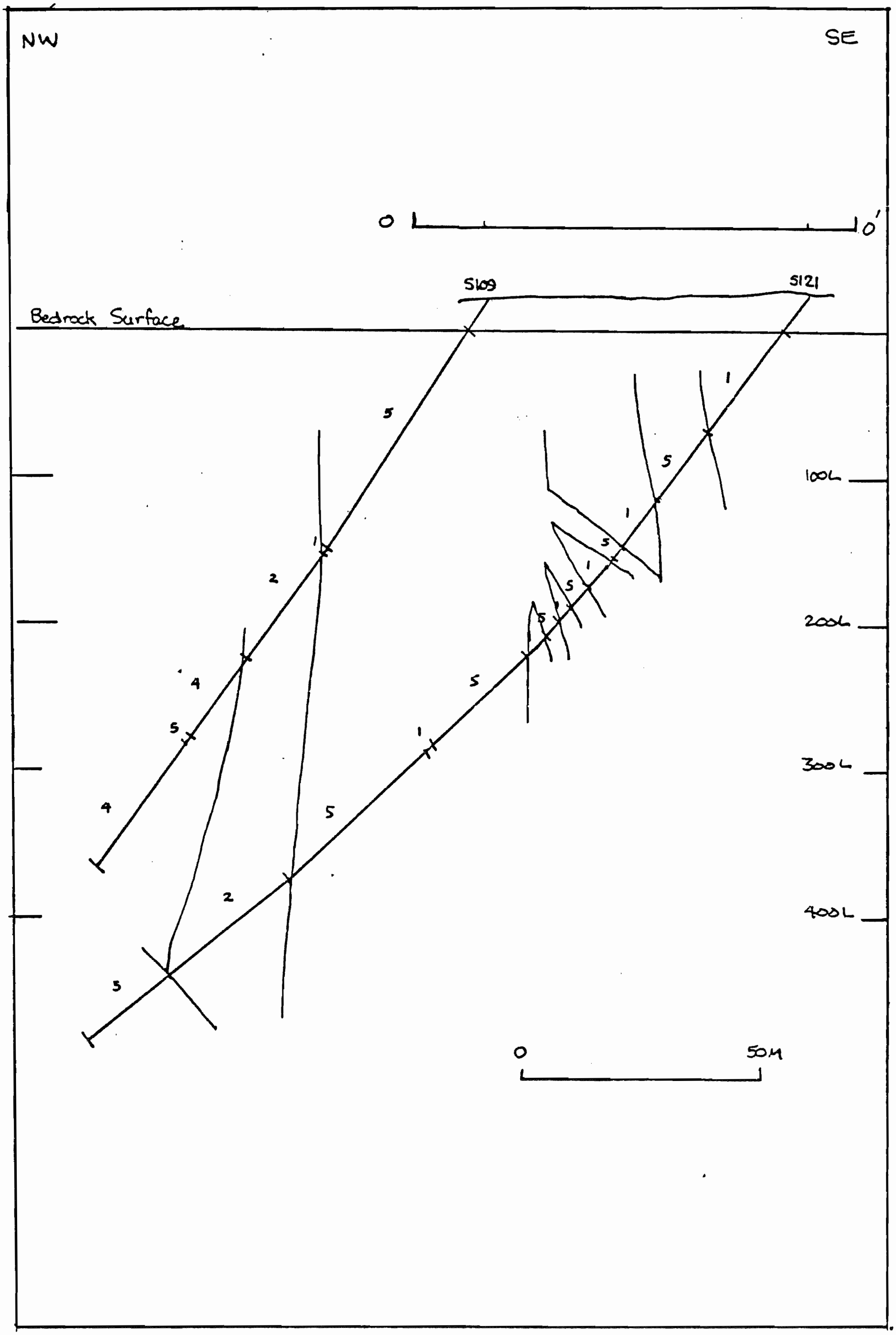
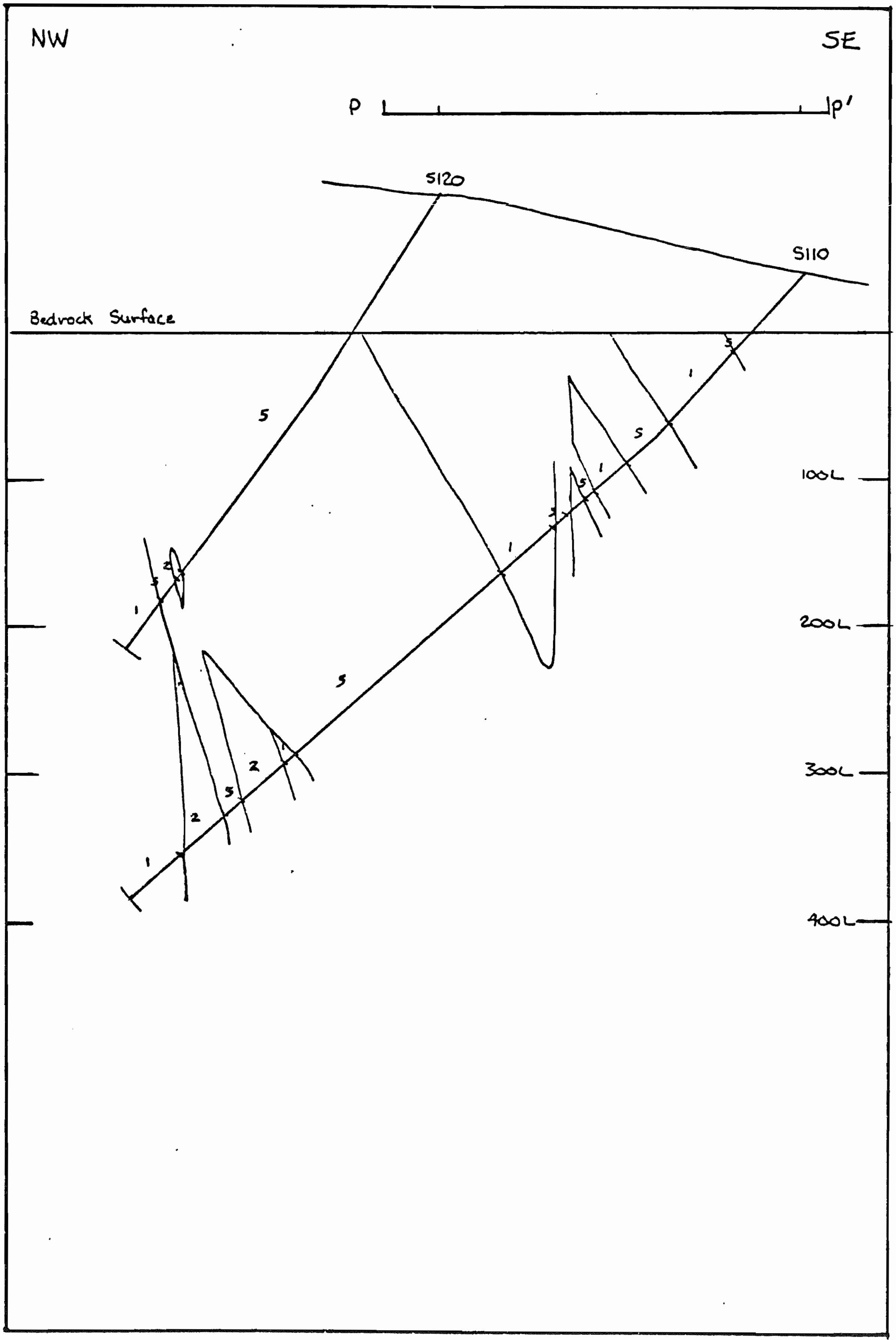
300L
0
50M


NW
SE
N
N'
S113
Bedrock Surface
5
100L
200L
300L
400L
0
50M


NW
SE
0
10'
S109
S121
Bedrock Surface
5
1
2
4
5
4
1
5
1
5
1
5
5
5
1
5
2
5
100L
200L
300L
400L
0
50M


NW
SE
P
P'
S120
S110
Bedrock Surface
100L
200L
300L
400L

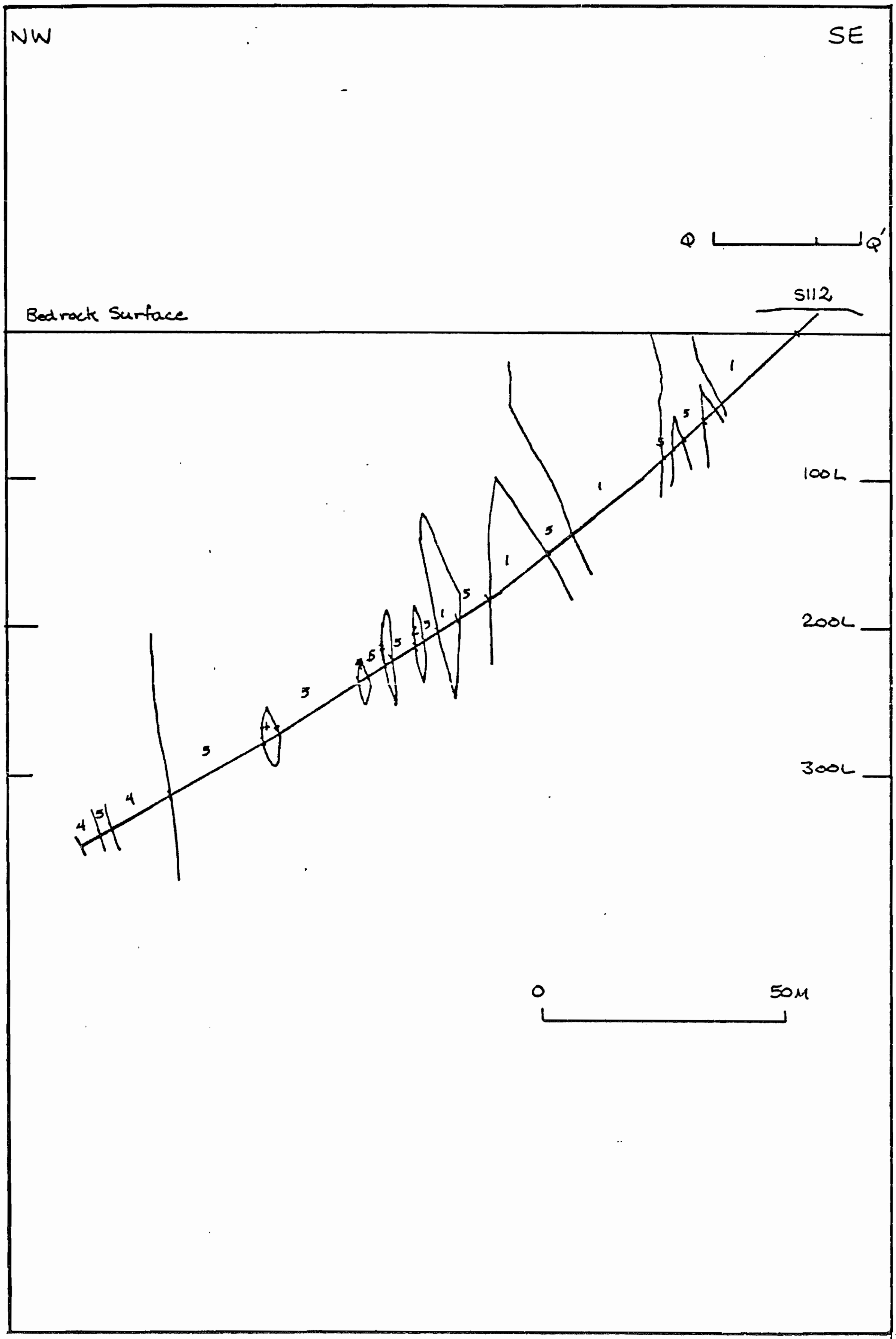
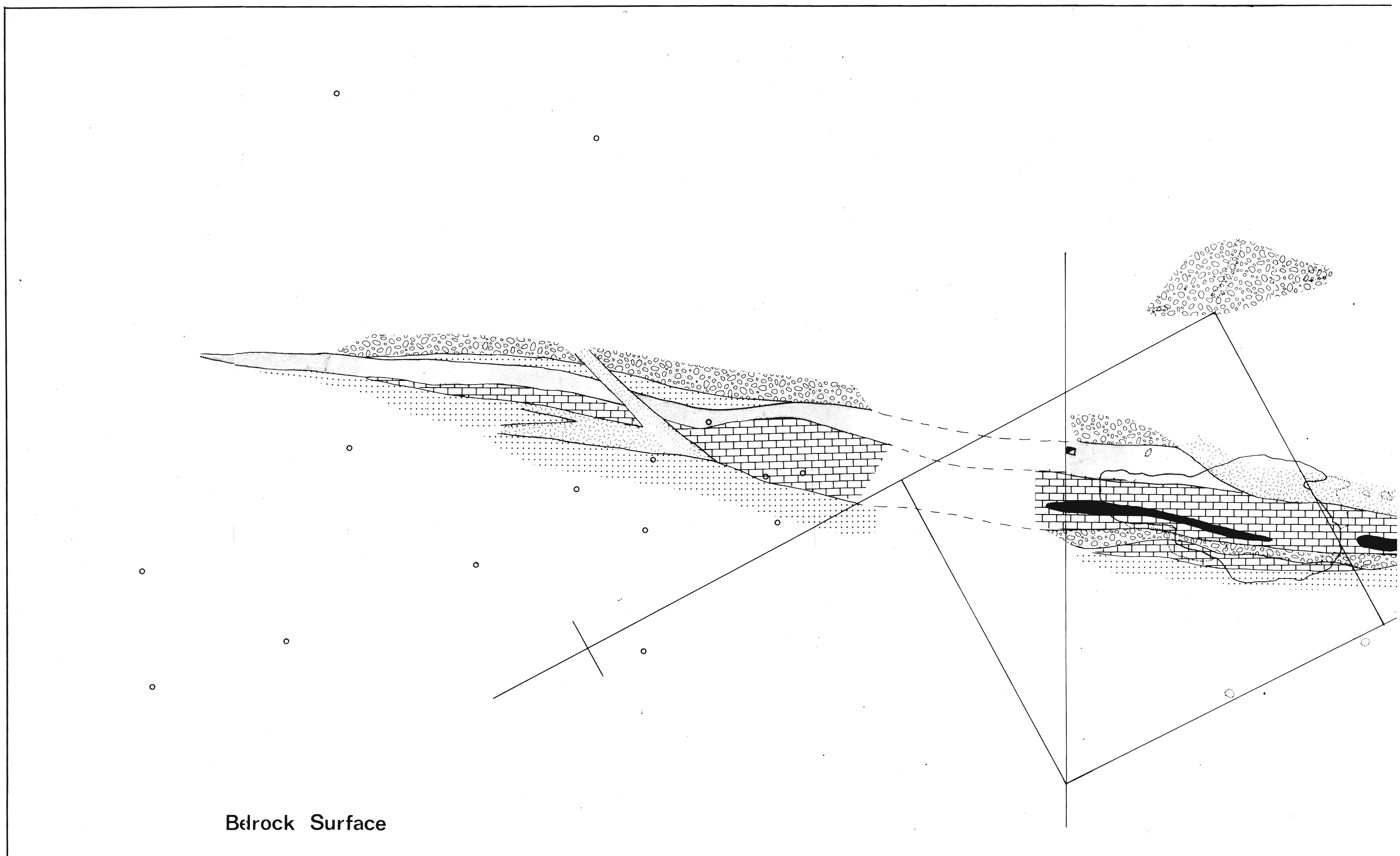
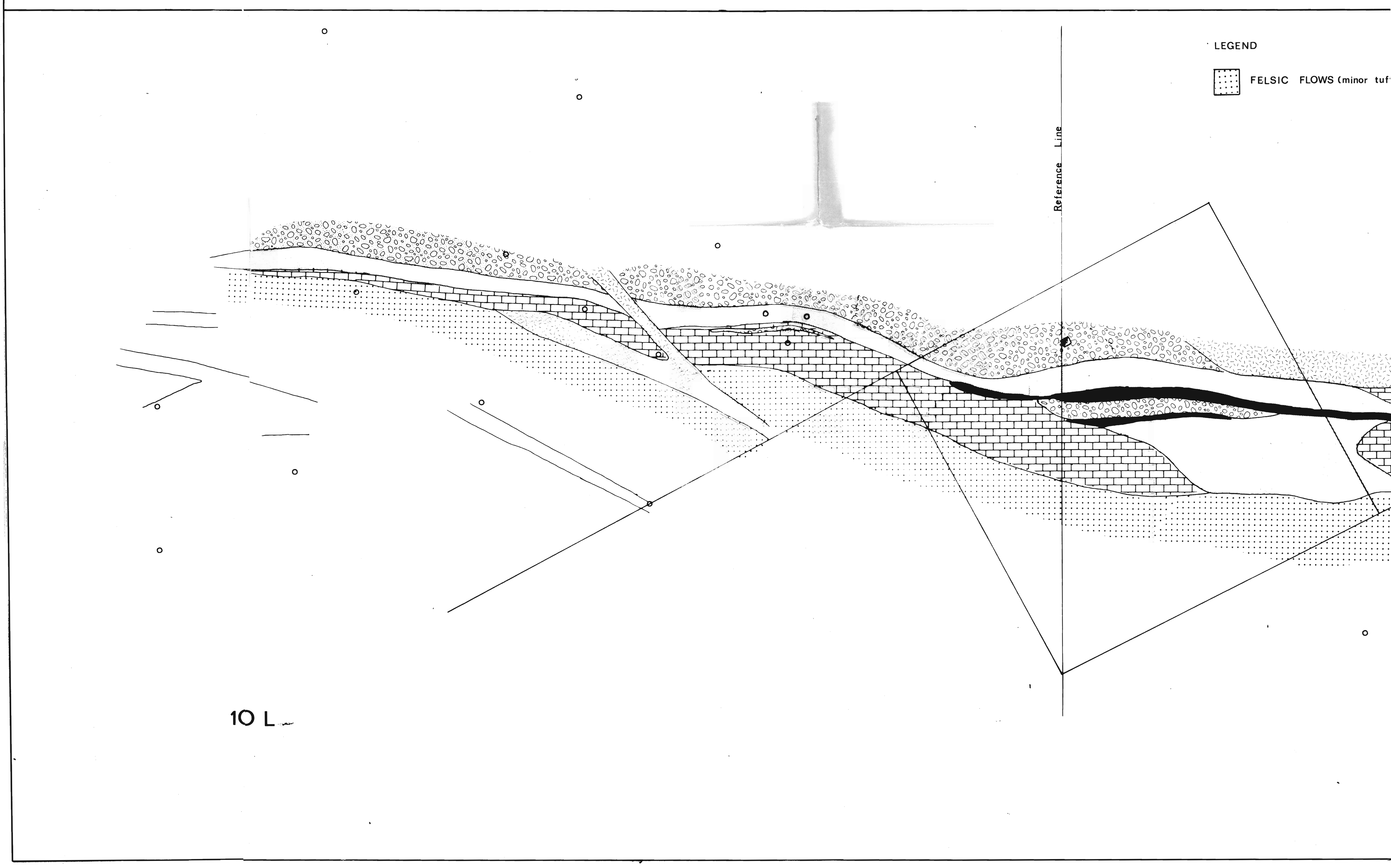

NW
SE
Q
Q'
S112
Bedrock Surface
100L
200L
300L
0
50M

FIGURE 4

MINDAMAR MINE

SURFACE PLAN AND DIAMOND DRILL HOLE LOCATIONS


Bdrock Surface


LEGEND
FELSIC FLOWS (minor tuf
Reference Line
10 L

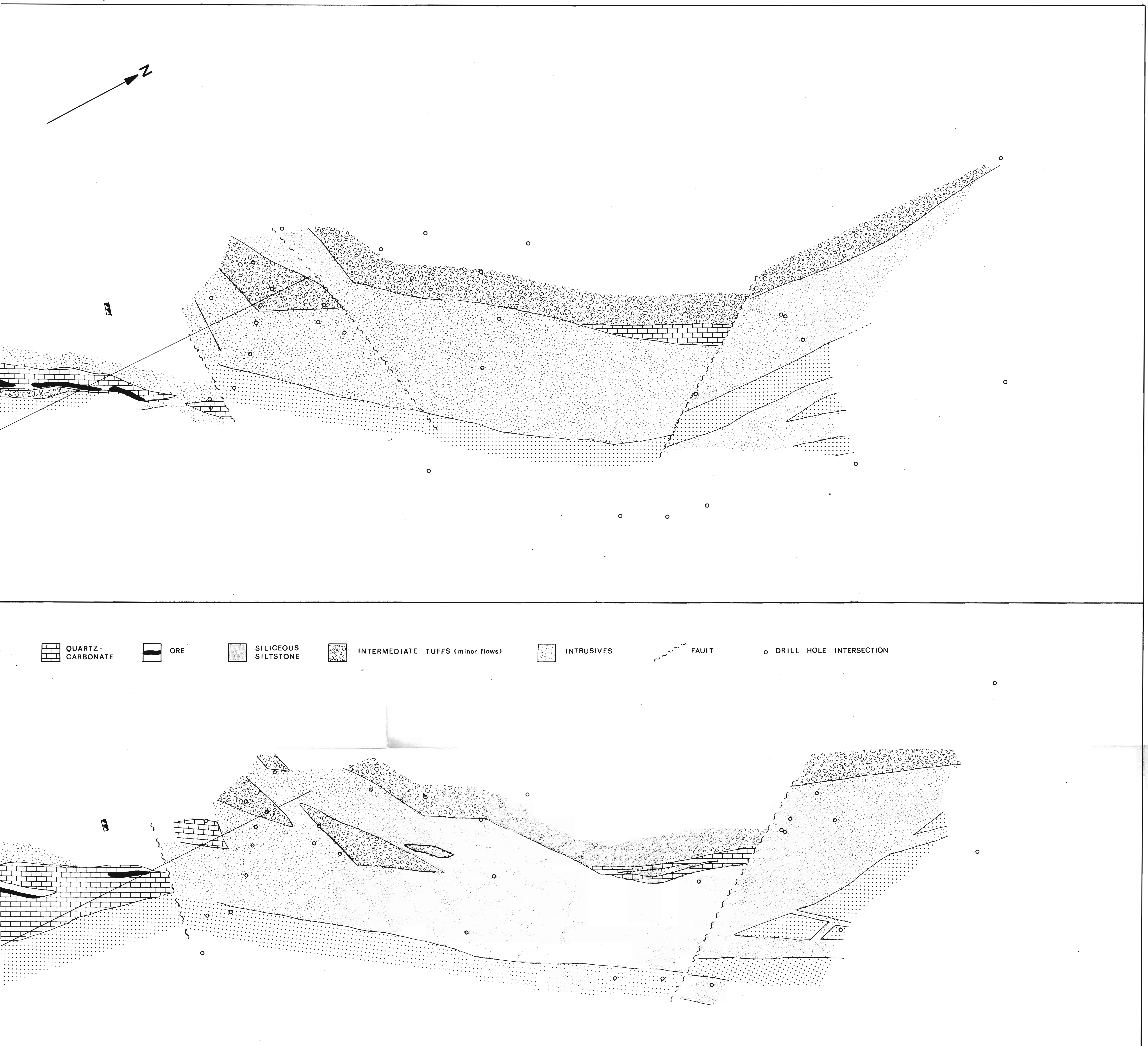


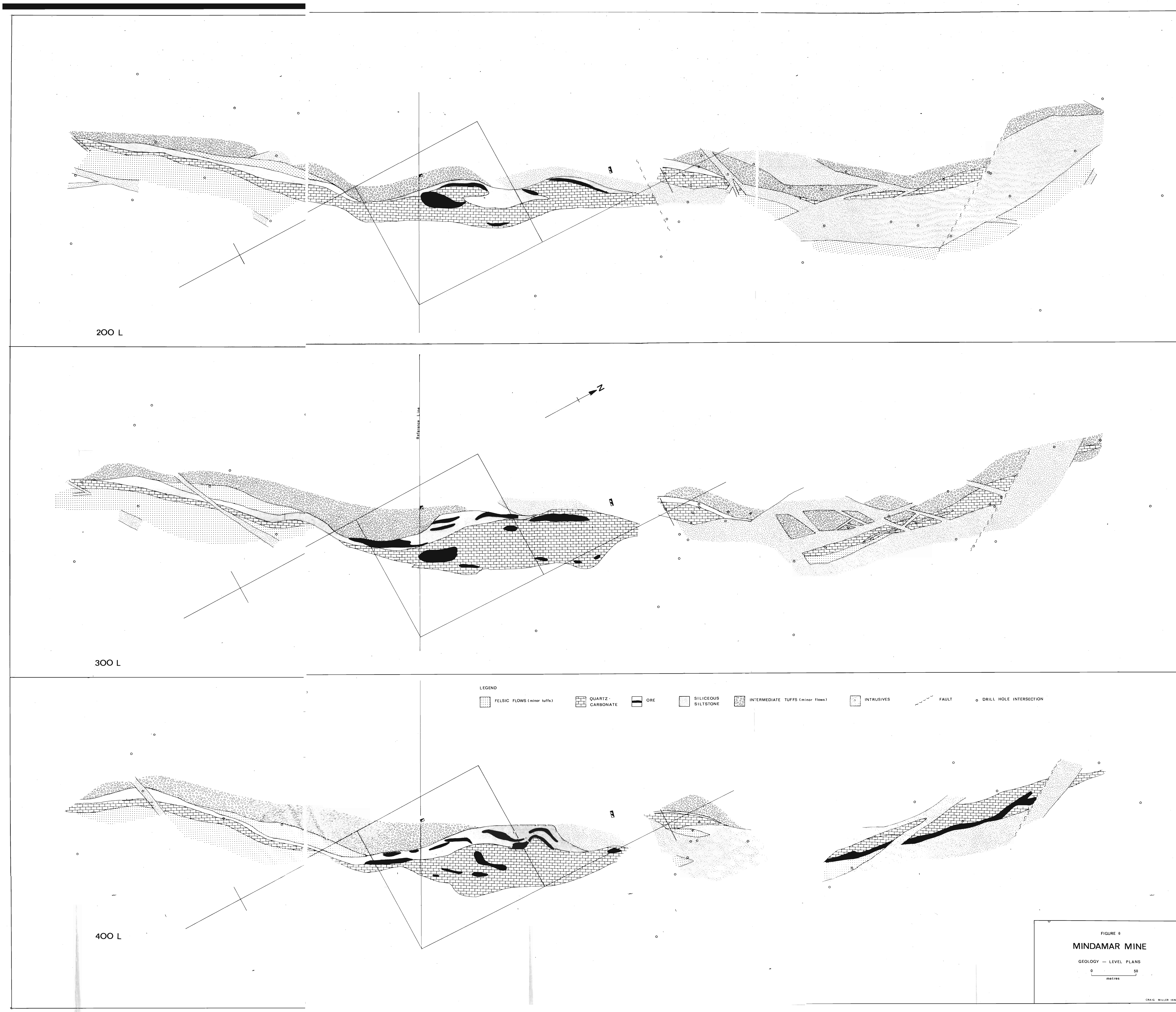
FIGURE 5

MINDAMAR MINE

GEOLOGY — LEVEL PLANS

0 50
metres

CRAIG MILLER 1978


200 L
300 L
400 L
N
Reference Line
LEGEND
FELSIC FLOWS (minor tuffs)
QUARTZ-CARBONATE
ORE
SILICEOUS SILTSTONE
INTERMEDIATE TUFFS (minor flows)
INTRUSIVES
FAULT
DRILL HOLE INTERSECTION
FIGURE 6
MINDAMAR MINE
GEOLOGY — LEVEL PLANS
0
50
metres
CRAIG MILLER 1978