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GEOLOGY OF AN AREA INCLUDING NORTHAIR MINES' CALLAGHAN CREEK PROPERTY

by

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and

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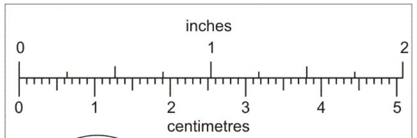
INTRODUCTION

Northair Mine's Callaghan Creek property is about 85 k north of Vancouver on the western side of Mt. Sproat, 8 k north by gravel road from highway 99. General geology of the area has been outlined most recently by Miller and Sinclair (1978). During the 1978 field season a more detailed study was undertaken of some aspects of the geology in the immediate vicinity of the mineral deposits. This was done as a continuation of a project initiated at U.B.C. through the B.C. Ministry of Mines and Petroleum Resources and continued with the support of Northair Mines Ltd. and the National Research Council of Canada. We particularly thank Mr. M.P. Dickson, Mine Manager, and Mr. Wayne Ash, Mine Engineer, for their interest and encouragement. Dr. N.A. Carter's interest and enthusiasm for the study has been an important factor in its success.

GENERAL GEOLOGY

A detailed geological map of a small area including Northair Mine is given in figure 1. Principle rock units are numbered after Miller and Sinclair (1978) and have been subdivided further where possible. All Mesozoic pyroclastic units strike northerly or northwesterly and are near vertical with tops facing easterly wherever such determinations could be made, mostly outside the area of figure 1. A number of samples were crushed, ground and fused to produce glass beads for refractive index measurements. These measurements can be correlted roughly with composition (e.g. Mathews, 1951; Church, 1975) and results, shown graphically in figure 2, indicate the predominance of rhyodacitic to andesitic compositions for the pyroclastic units (Units 3 to 5 inclusive). The Coast Plutonic Complex is represented in the map area by a diorite (unit 6b). Descriptions of these units follow.



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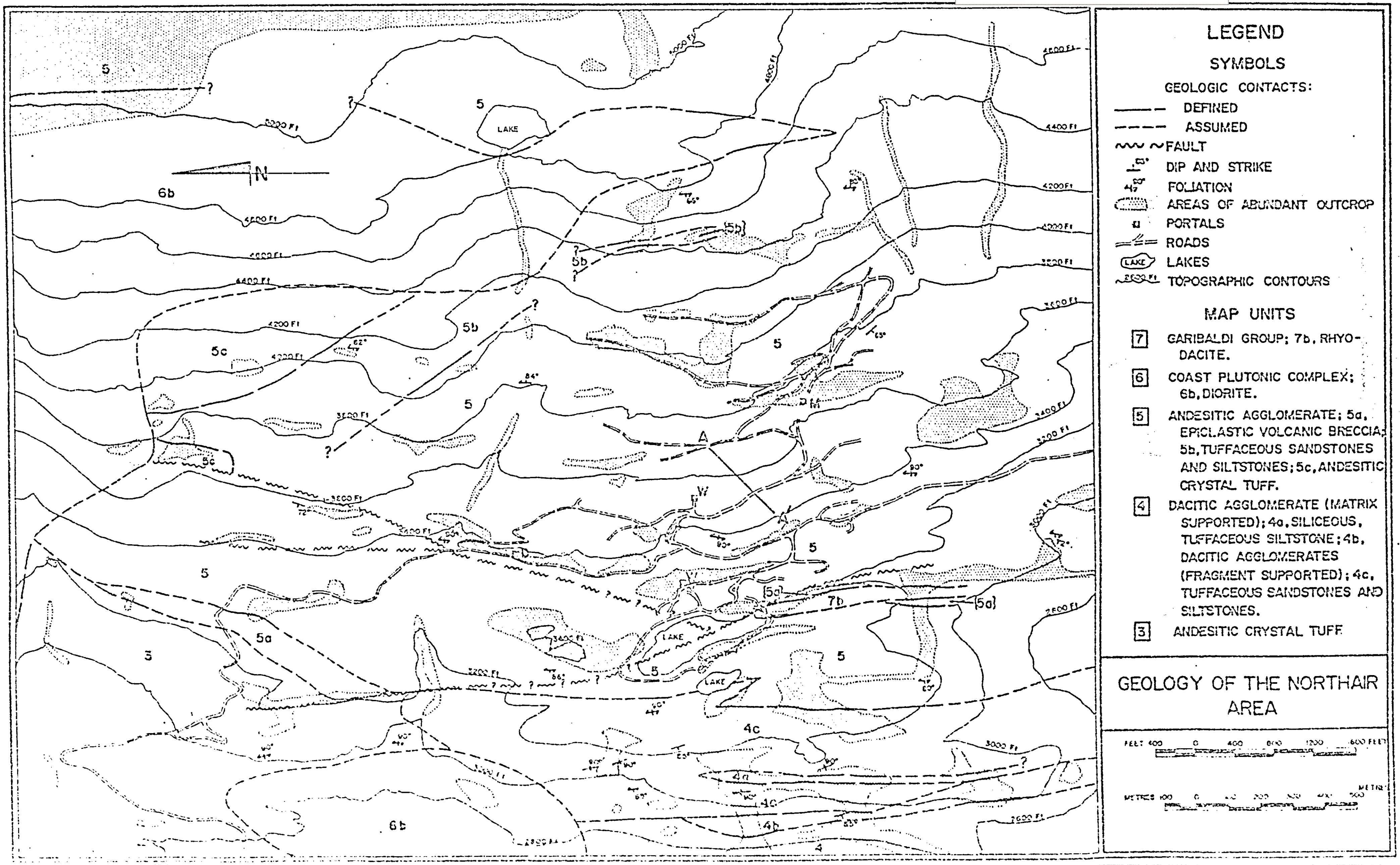

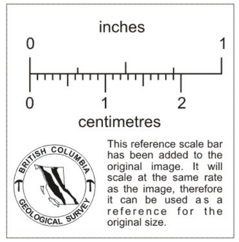
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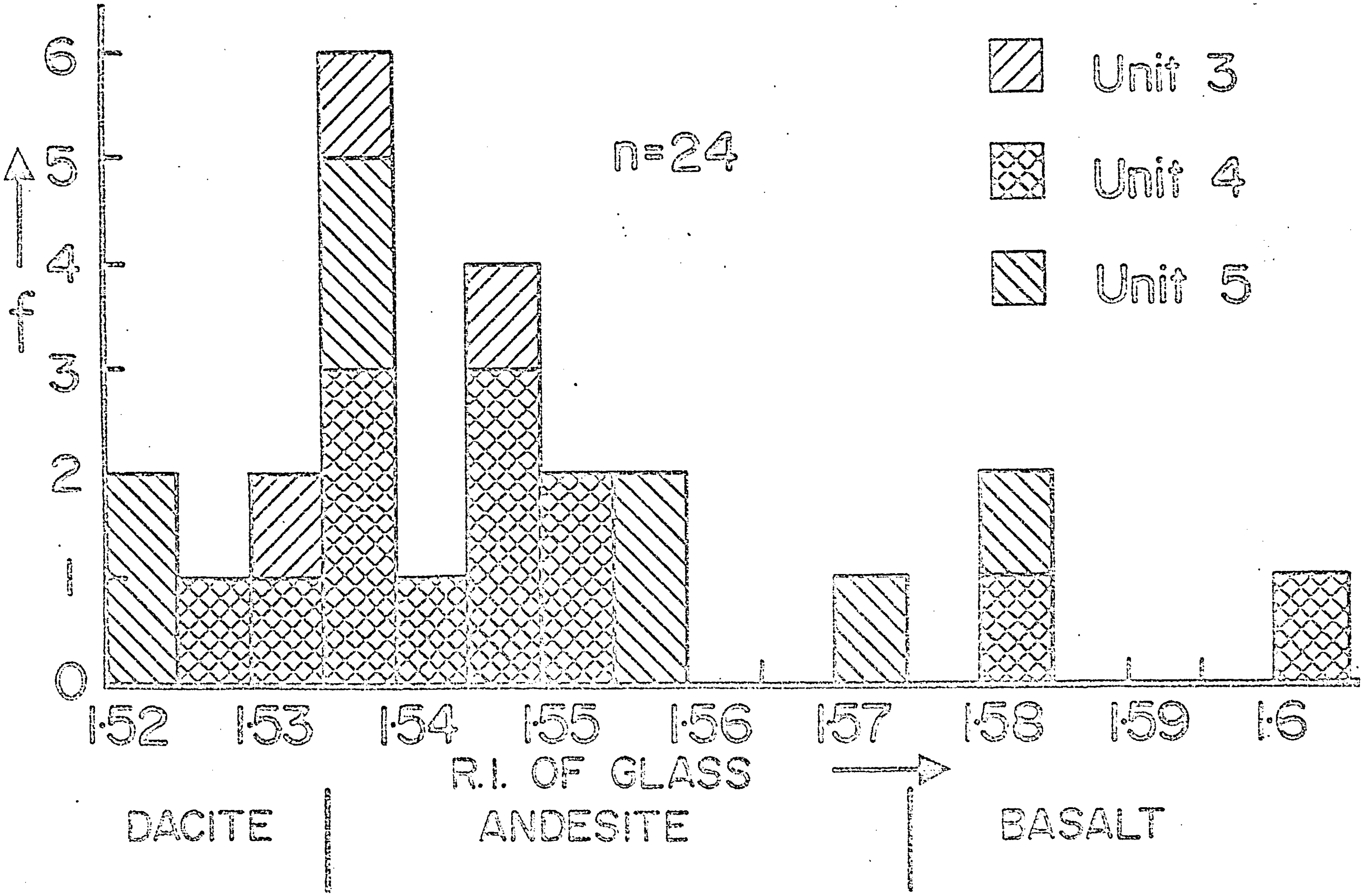
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R.I. OF GLASS
DACITE
ANDESITE
BASALT

LITHOLOGIC DESCRIPTIONS

Unit 3: Andesitic crystal tuff

Andesitic crystal tuff has an aphanitic, dark grey matrix surrounding clasts of zoned, subhedral plagioclase and less abundant hornblende. Clasts make up about twenty percent of the rock, and some are up to one centimetre in length. The clasts are broken crystals that commonly show a crude alignment (bedding). Andesitic crystal tuff fragments up to 6 cm in diameter are present in small amounts in the lower part of this unit. These fragments are generally spherical and sub-rounded, with clasts of broken phenocrysts of plagioclase and hornblende making up forty percent of the fragment.

Unit 4: Dacitic agglomerate (matrix-supported).

Dacitic agglomerate has a fine grained, medium grey-green, tuffaceous matrix which contains three fragment types, in decreasing order of abundance; dacite, rhyodacite, and andesite. Fragments are sub-angular and elongate and range up to thirty centimetres in diameter (average about six centimetres). Matrix varies from twenty to seventy percent but averages about fifty percent. Graded bedding and cross-bedding were observed in the basal part of the unit and indicate tops facing east. Siliceous siltstone (Unit 4a) is dark grey with a very fine grained, uniform texture and contains trace amounts of finely disseminated pyrite. Dacitic agglomerate - fragment supported (Unit 4b) is similar to the general description of unit 4 except that the matrix is consistently about ten percent and 4b is fragment-supported. Tuffaceous sandstones and siltstone (Unit 4c) are dark gray, siliceous siltstones to pale gray, tuffaceous sandstones interbedded on varying scales, from one centimetre to fifty metres, and together comprise a layer about 35 m thick.

Unit 5: Andesitic agglomerate

Andesitic agglomerate has a fine grained, dark green tuffaceous matrix which surrounds six different fragment types. These are, in order of decreasing abundance; andesite, andesitic tuff, dacite, tuffaceous sandstones, dacitic tuff and jasper. Fragments range from well rounded to sub angular, commonly are ovoid in general shape, and are up to seventy centimetres in diameter (average about four centimetres). Matrix varies from twenty to ninety-five percent with an average of about forty percent. Epiclastic volcanic breccia (Unit 5a) has a very fine grained, black matrix surrounding four different coarse fragment types, which are, in decreasing order of abundance; andesite equigranular tuff, dacite and siliceous siltstone. The fragments are angular to subangular and elongate in shape with an average diameter of three centimetres but range up to thirty centimetres. Matrix varies from ninety to five percent and averages about fifteen percent. Tuffaceous sandstones and siltstones (Unit 5b) vary between pale to medium gray, siltstones and coarse grained sandstones. Graded bedding and cross-bedding were observed throughout this unit. Andesitic crystal tuff (Unit 5c) has an aphanitic, dark gray matrix surrounding broken phenocrysts of zoned, subhedral plagioclase. The plagioclase laths are up to 1 centimetre in length.

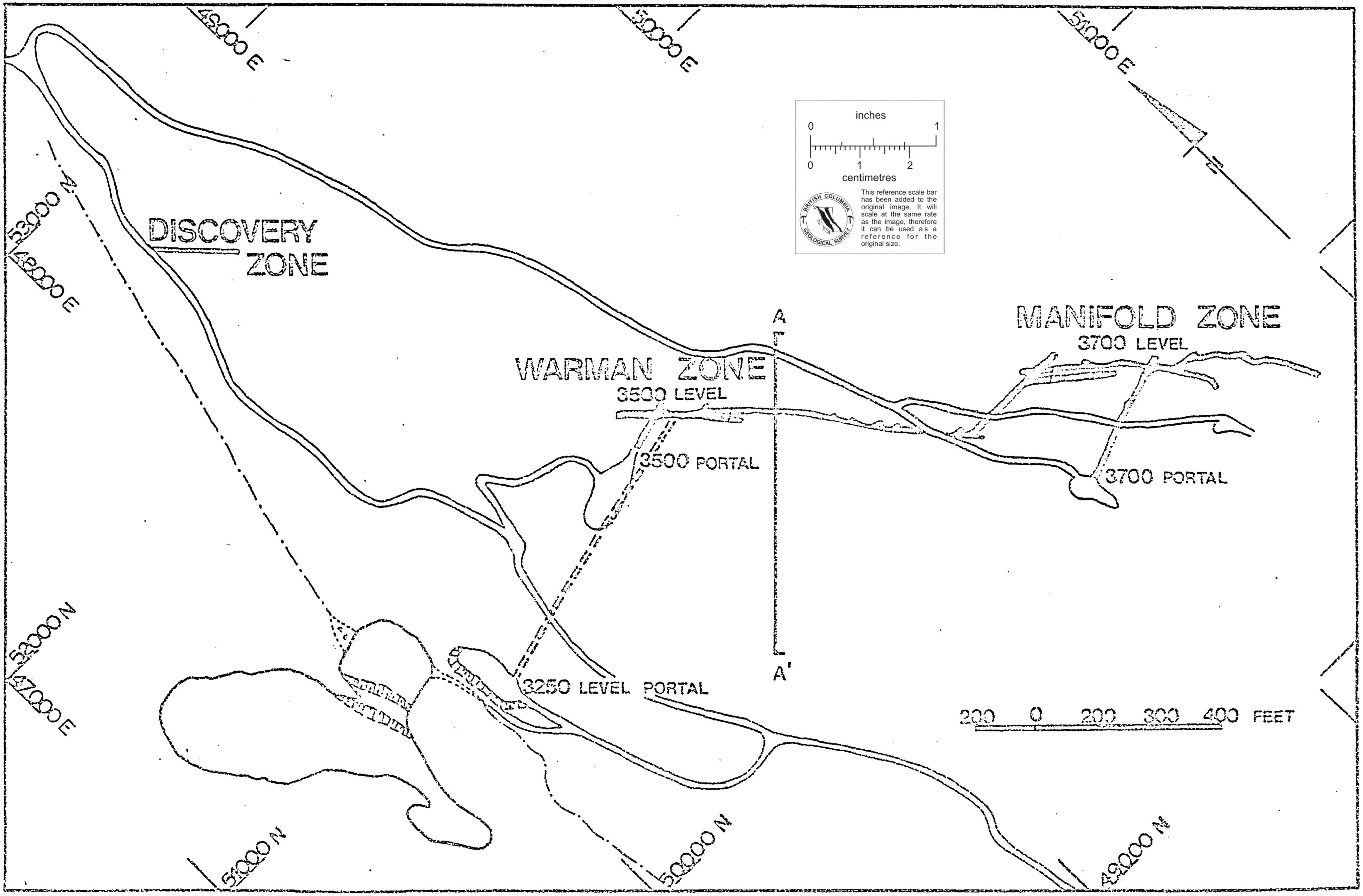
Unit 6b: Diorite

Diorite is fine to medium grained and pale to medium gray-green with an equigranular texture. Mineral composition is about 45% plagioclase, 25% chlorite, 14% epidote, 8% quartz and the remainder accessory minerals.

MINERAL DEPOSITS

Three ore zones are known on the Callaghan Creek property of Northair Mines, from north to south, the Discovery, Warman and Manifold zones (figure 3). All zones are tabular in form, strike about N40°W and have near vertical dips. Average thicknesses are about 6, 8 and 17 feet respectively from south to north. Ore grades differ progressively from zone to zone. In general the southern (Manifold) zone is high in precious metals and low in base metals. The converse is true for the Discovery zone and the Warman zone is intermediate in character. Similarly, the form of mineralization varies from south to north. In the south (Manifold) zone sulphides are disseminated or thickly layered in a siliceous carbonate layer and in the north (Discovery) zone sulphides are layered and locally massive in form. Again the Warman zone is intermediate in character.

The three zones appear to represent faulted segments of a single mineral-rich sheet. Such an interpretation is apparent underground between the ends of the Warman and Manifold zones where small faulted segments of the ore have been identified. A much more complex fault zone exists between the Warman and Discovery zones. This "single sheet" hypothesis is supported by the gradational characteristics of the ore if all three zones are reconstructed to a single body. Characteristics of both the Discovery and Manifold zones extend to the respective adjacent parts of the Warman zone.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BRITISH COLUMBIA GEOLOGICAL SURVEY
DISCOVERY ZONE
WARMAN ZONE
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3500 PORTAL
MANIFOLD ZONE
3700 LEVEL
3700 PORTAL
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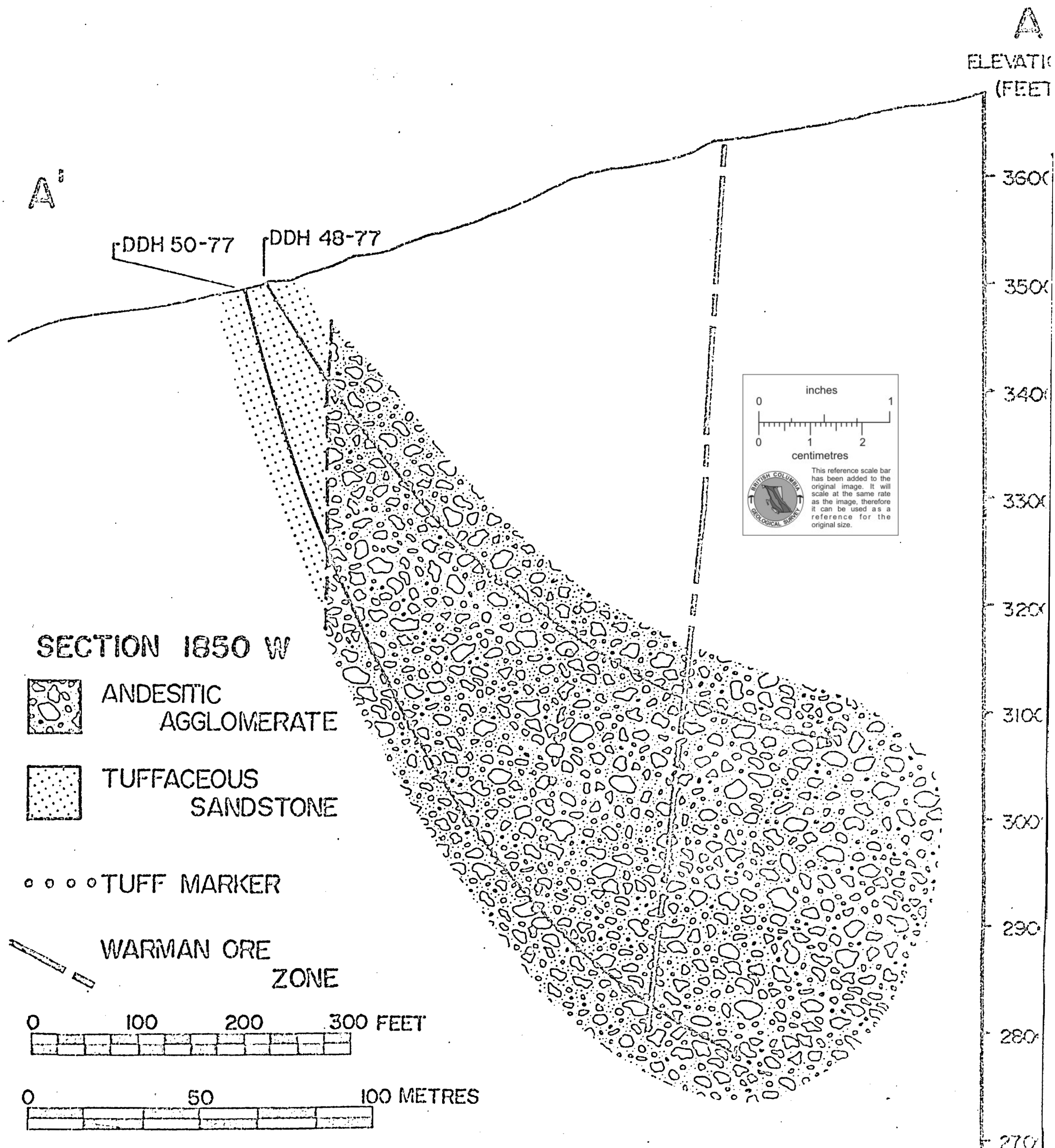
A'
3250 LEVEL PORTAL
200 0 200 300 400 FEET

Origin of the Northair mineral deposits recently has been the subject of controversy with the two general extreme points of view being (1) a vein hypothesis, and (2) a volcanic exhalative origin followed by partial mobilization accompanying plutonism. We will not consider all the arguments for genesis in this discussion, but some results of the 1978 field work have a direct bearing on the problem . One of the main points used in the past as indicative of an epigenetic nature to the ore zones has been the apparently diverse orientations of bedding and the tabular ore zones. The northwesterly trend of the ore zones has been contrasted with the northerly regional trend of bedding measured hundreds of meters to the west and south of the ore zones. Extrapolation of these bedding orientations into the area of ore deposits has led to the suggestion of transgressive geometry for the ore shoots and therefore an epigenetic origin.

Detailed examination of core from 12 exploratory drill holes to the southwest of the Warman zone has established a local detailed stratigraphy that extends the length of, and parallels, the Warman ore zone. An example is shown in cross section A-A' of figure 2, the location of which is indicated in figures 1 and 3. The immediate footwall of the Warman zone is a 370-foot (113 m) thick layer of andesitic agglomerate which consists of a fine grained tuffaceous matrix containing 70 percent large fragments as in the general description of Unit 5. About 110 feet (34 m) below the Warman zone is a one to fifteen-foot (0.3 to 4.6 m), fine-grained tuffaceous marker layer that locally is disrupted into fragments. Below the andesitic agglomerate layer is a pale grey to green tuffaceous sandstone unit that contains rare subrounded fragments up to 3 cm in diameter. The contact between the tuffaceous sandstone and the andesitic agglomerate is gradational over about 5 feet (1.5 m). A similar andesitic agglomerate containing a thin tuff marker has been observed in a single diamond drill hole on the southwest side of the Discovery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ANDESITIC AGGLOMERATE
TUFFACEOUS SANDSTONE
TUFF MARKER
WARMAN ORE ZONE
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GEOLOGICAL SURVEY

zone, but the marker cannot be traced because of lack of both outcrop and other appropriately located drill holes. Never-the-less, this occurrence indicates that the stratigraphy immediately southwest of and parallel to the Warman zone extends over a total distance of least 500 meters. As yet we have not been able to check the presence of a comparable stratigraphy to the southwest of the Manifold zone because of the deteriorated condition of boxes of drill core from exploration holes drilled several years ago. However, we note the parallelism of so-called alteration zones mapped in one cross-section of the Manifold zone by Little (1974) and suggest the possibility that in reality these zones which parallel bedding defined above, represent original compositional differences rather than superimposed alteration zones.

In addition to recognition of a parallelism between ore zones and bedding on a scale of 100's of metres, it is common in underground workings to see sulphide layers from a few millimeters to a few centimeters thick that parallel alternating layers of carbonate, quartz, and locally, silicates, over distance of centimeters to meters. These layered sulphides are part of a highly deformed (folded and fractured) interlayered sequence that is cut by veins of coarse-grained calcite with or without quartz and/or sulphides. In places these form a myriad of sulphide-bearing veinlets of post deformation age, superposed in places on layered sulphides that appear to represent vestiges of a pre-deformational mineralizing event. It was this obvious finely layered aspect, apparent underground locally in all ore zones, that originally led us to suggest an early "volcanogenic" stage in the development of the ore zones. (Miller and Sinclair, 1978; Miller et al, 1978).

In idealized form the model that we propose is a distal volcanogenic or exhalative model in which a local marine basin formed during a hiatus in explosive rhyodacitic to andesitic volcanism. Ore fluids were fed to the water-sediment interface from a pipe zone, not now known, to contribute base and precious metals to the basin of chemical sedimentation. Further explosive volcanism followed. The deposit was deformed and metamorphosed to greenschist facies during subsequent emplacement of Coast plutonic rocks and it was late in this interval that post-deformational, sulphide-bearing carbonate and/or quartz veinlets formed by mobilization of originally syngenetic material. Similar veinlets removed from known mineral zones are free of sulphides. The deposit was later disrupted by northerly trending faults, many with significant strike-slip components. One of these faults truncates the Discovery zone on the west.

CONCLUSIONS

Detailed mapping in the vicinity of the Northair ore deposits has led to the establishment of a fairly detailed stratigraphy within the pyroclastic sequence that contains the ores. Bedding has been shown to be parallel to the Warman Zone and probably to the Disovery zone as well. Re-examination of the Manifold zone is required.

The weight of available evidence indicates a complex origin for the Northair deposits. Their close association with a thick pyroclastic sequence of rhyodacitic to andesitic composition is well established as is the layered nature of the ores and the parallelism of this layering with bedding in the enclosing pyroclastic rocks. These features as well as the more detailed association with common exhalite products such as layered chert and carbonate would appear to necessitate some genetic relationship of ore to volcanism. However, superimposed on this "volcanogenic" exhalite are the obviously later effects, the veinlets that crosscut deformed layered sulphides. It seems unreasonable to require that metals in these veinlets be derived elsewhere, particularly because similar veinlets elsewhere in the pendant do not contain sulphides. Consequently, we attribute these sulphide-bearing veinlets to local remobilization during metamorphism that accompanied intrusion of the adjacent Coast Plutonic Complex.

The model proposed here has important implications regarding exploration of other roof pendants and septae in the Coast Plutonic Complex. Sulphide-bearing veinlets appear to require a metal-rich source, that in some cases could be a bedded volcanogenic concentration. This possibility is in accord with the general principle enunciated by Sinclair et al, (1978) regarding the importance of metal occurrences as an important factor in mineral exploration and resource evaluation.

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CAPTIONS

Figure 1:

Detailed geological map of a part of Callaghan Creek pendant including mineral deposits of Northair Mines Ltd. Portals to the main deposits are labelled M - Manifold Zone, W - Warman Zone, and D - Discovery Zone. A-A^1 is the location of a cross-section through the Warman Zone, shown in figure 4.

Figure 2:

Histogram of refractive index measurements for fused glass beads obtained from crushed powders of hand specimens of Units 3, 4 and 5.

Figure 3:

Generalized plan of underground haulage levels showing relative locations of 3 principal ore zones. A-A$'$ is location of the cross-section of figure 4 (modified from Dickson and McLeod, 1975).

Figure 4:

1850 Cross-section perpendicular to Warman zone showing parallelism of lithologic contacts and the Warman zone whose thickness is shown to correct scale.