GEOLOGY OF AN AREA INCLUDING NORTHAIR MINES LTD.'S CALLAGHAN CREEK PROPERTY (92J/3W)

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INTRODUCTION

Northair Mines Ltd.'s Callaghan Creek property is about 85 kilometres north of Vancouver on the western side of Mount Sproat, 8 kilometres 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 the University of British Columbia through the British Columbia 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. C. 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 on Figure 32. Principal 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, mainly outside the area of Figure 32. A number of samples were crushed, ground, and fused to produce glass beads for refractive index measurements. These measurements can be correlated roughly with compositions (for example, Mathews, 1951; Church, 1975) and results, shown graphically on Figure 33, 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.

Lithologic Descriptions

Unit 3 — Andesitic crystal tuff has an aphanitic, dark grey matrix surrounding clasts of zoned, subhedral plagioclase and lesser hornblende. Clasts make up about 20 per cent of the rock, and some are up to 1 centimetre in length. The clasts are broken crystals that commonly show a crude alignment (bedding). Andesitic crystal tuff fragments up to 6 centimetres in diameter are present in small amounts in the lower part of this unit. These fragments are generally spherical and subrounded, with clasts of broken phenocrysts of plagioclase and hornblende making up 40 per cent of the fragment.

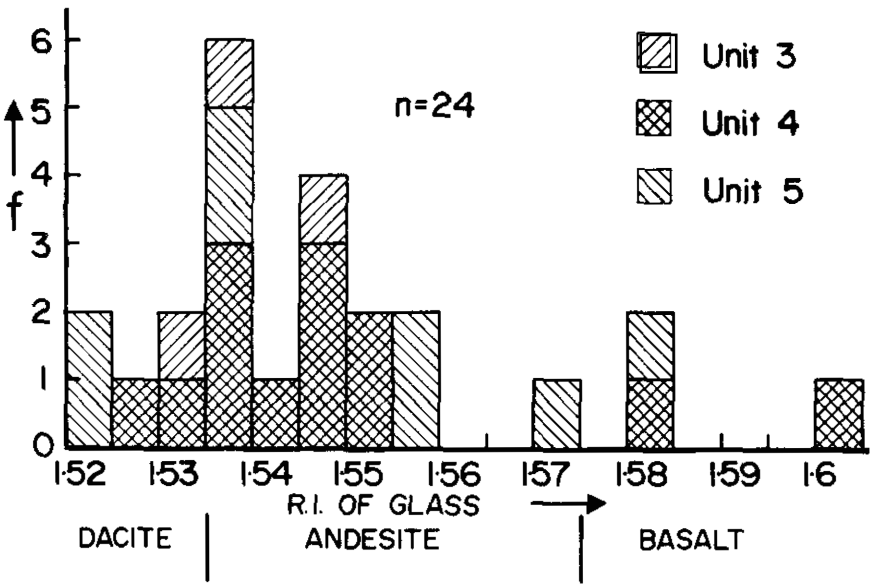

Figure 33. Histogram of refractive index measurements for fused glass beads obtained from crushed powders of hand specimens of units 3, 4, and 5.

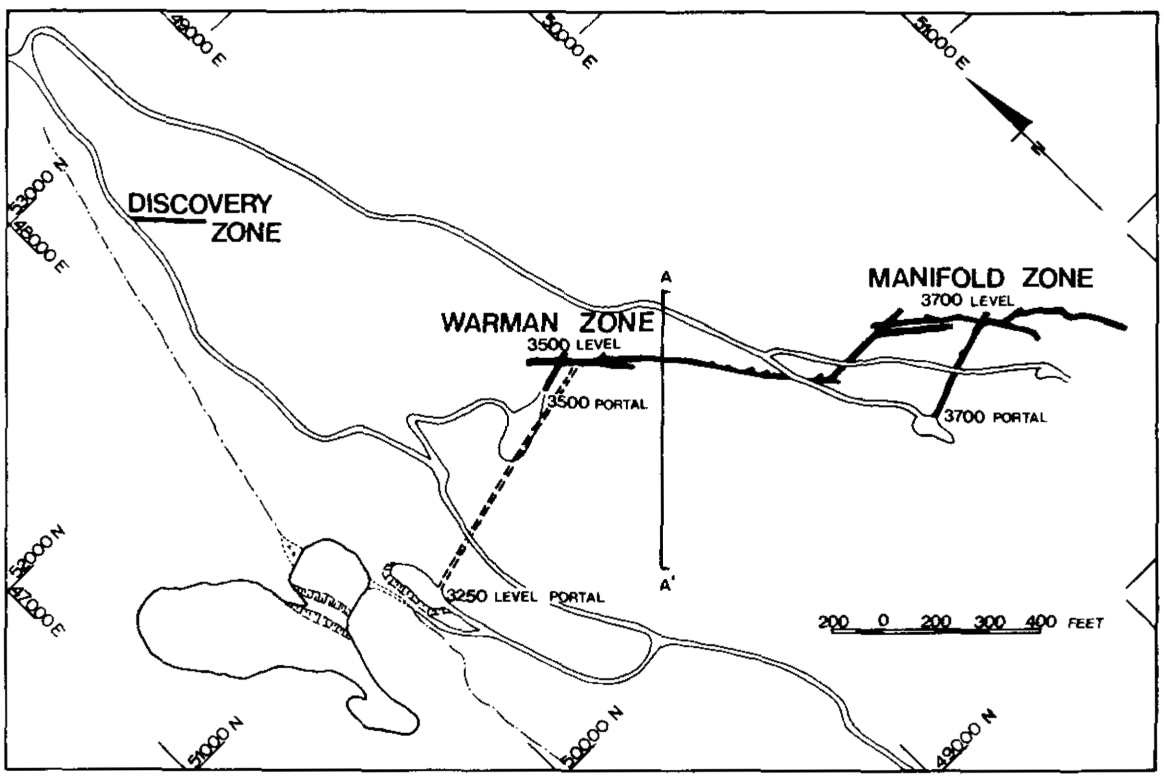

Figure 34. Generalized plan of underground haulage levels showing relative locations of three principal ore zones. A–A[1] is location of the cross-section of Figure 35 (modified from Dickson and McLeod, 1975).

Unit 4 — Dacitic agglomerate (matrix supported) has a fine-grained, medium grey-green, tuffaceous matrix which contains three fragment types including dacite, rhyodacite, and andesite in decreasing order of abundance. Fragments are subangular and elongate and range up to 30 centimetres in diameter with an average of about 6 centimetres. Matrix varies from 20 to 70 per cent but averages about 50 per cent. Graded bedding and crossbedding 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 10 per cent and 4b is fragment supported. Tuffaceous sandstones and siltstones (unit 4c) are dark grey, siliceous siltstones to pale grey, tuffaceous sandstones interbedded on varying scales, from 1 centimetre to 50 metres, and together comprise a layer about 35 metres thick.

Unit 5 — 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 70 centimetres in diameter (average about 4 centimetres). Matrix varies from 20 to 95 per cent with an average of about 40 per cent. 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 3 centimetres but range up to 30 centimetres. Matrix varies from 90 to 5 per cent and averages about 15 per cent. Tuffaceous sandstones and siltstones (unit 5b) vary between pale to medium grey siltstones and coarse-grained sandstones. Graded bedding and crossbedding were observed throughout this unit. Andesitic crystal tuff (unit 5c) has an aphanitic, dark grey matrix surrounding broken phenocrysts of zoned, subhedral plagioclase. The plagioclase laths are up to 1 centimetre in length.

Unit 6b — Diorite is fine to medium grained and pale to medium grey-green with an equigranular texture. Mineral composition is about 45 per cent plagioclase, 25 per cent chlorite, 14 per cent epidote, 8 per cent quartz, and the remainder accessory minerals.

MINERAL DEPOSITS

Three ore zones are known on the Callaghan Creek property of Northair Mines which are, from north to south, the Discovery, Warman, and Manifold zones (Fig. 34). All zones are tabular in form, strike about north 40 degrees west and have near vertical dips. Average thicknesses are about 1.8, 2.4, and 5.1 metres 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.

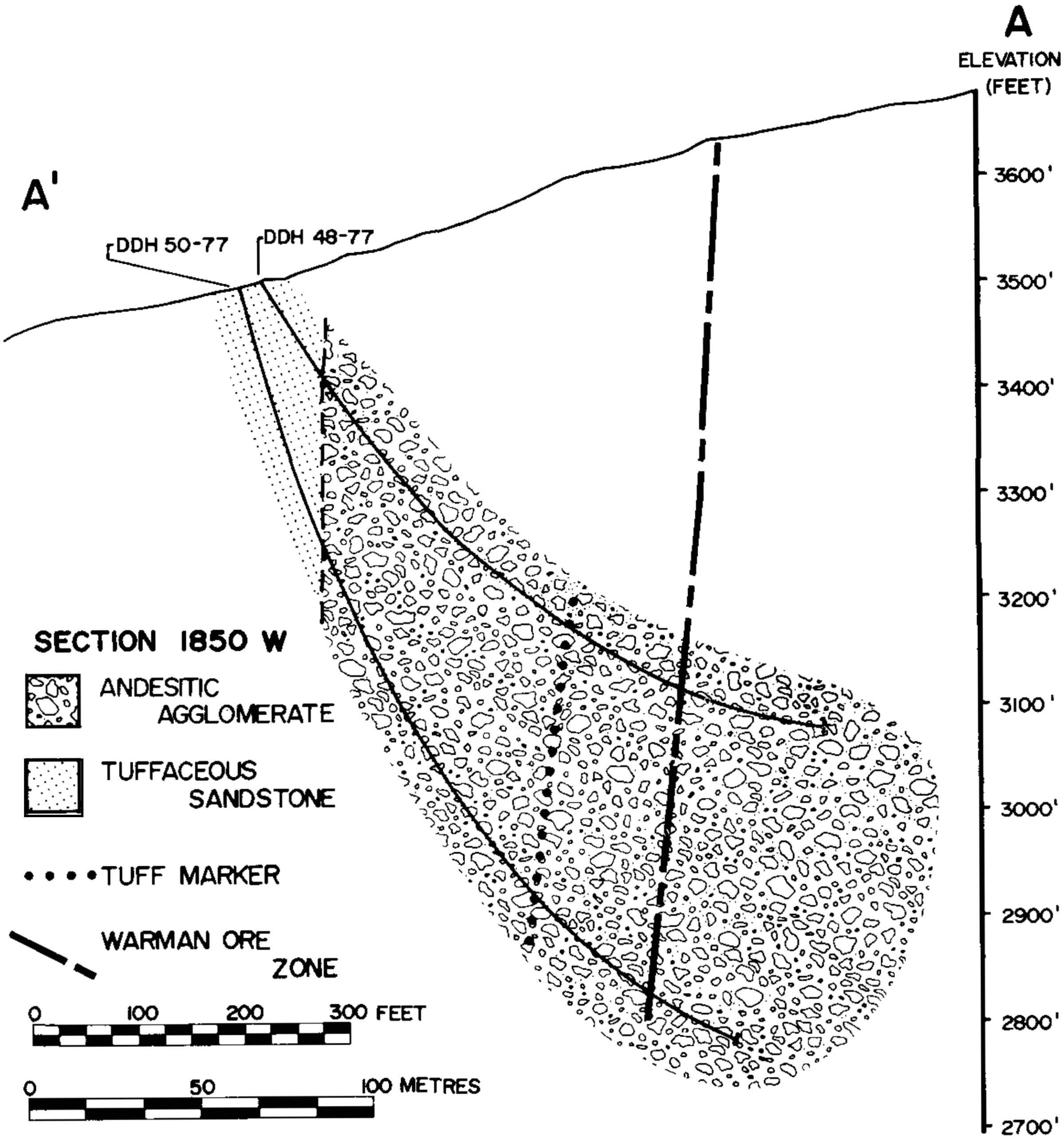

Figure 35. 1850 cross-section perpendicular to Warman zone showing parallelism of lithologic contacts and the Warman zone whose thickness is shown to correct scale.

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 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.

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 fieldwork 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 metres 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' (Fig. 35), the location of which is indicated on Figure 32 and 34. The immediate footwall of the Warman zone is a 113-metre-thick layer of andesitic agglomerate which consists of a fine-grained tuffaceous matrix containing 70 per cent large fragments as in the general description of unit 5. About 34 metres below the Warman zone is a 0.3 to 4.6-metre, 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 centimetres in diameter. The contact between the tuffaceous sandstone and the andesitic agglomerate is gradational over about 1.5 metres. 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 zone, but the marker cannot be traced because of lack of both outcrop and other appropriately located drill holes. Nevertheless, this occurrence indicates that the stratigraphy immediately southwest of and parallel to the Warman zone extends over a total distance of at least 500 metres. 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 hundreds of metres, it is common in underground workings to see sulphide layers from a few millimetres to a few centimetres thick that parallel alternating layers of carbonate, quartz, and, locally, silicates, over distance of centimetres to metres. 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, 1977; 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 Discovery 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 or 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, particuarly 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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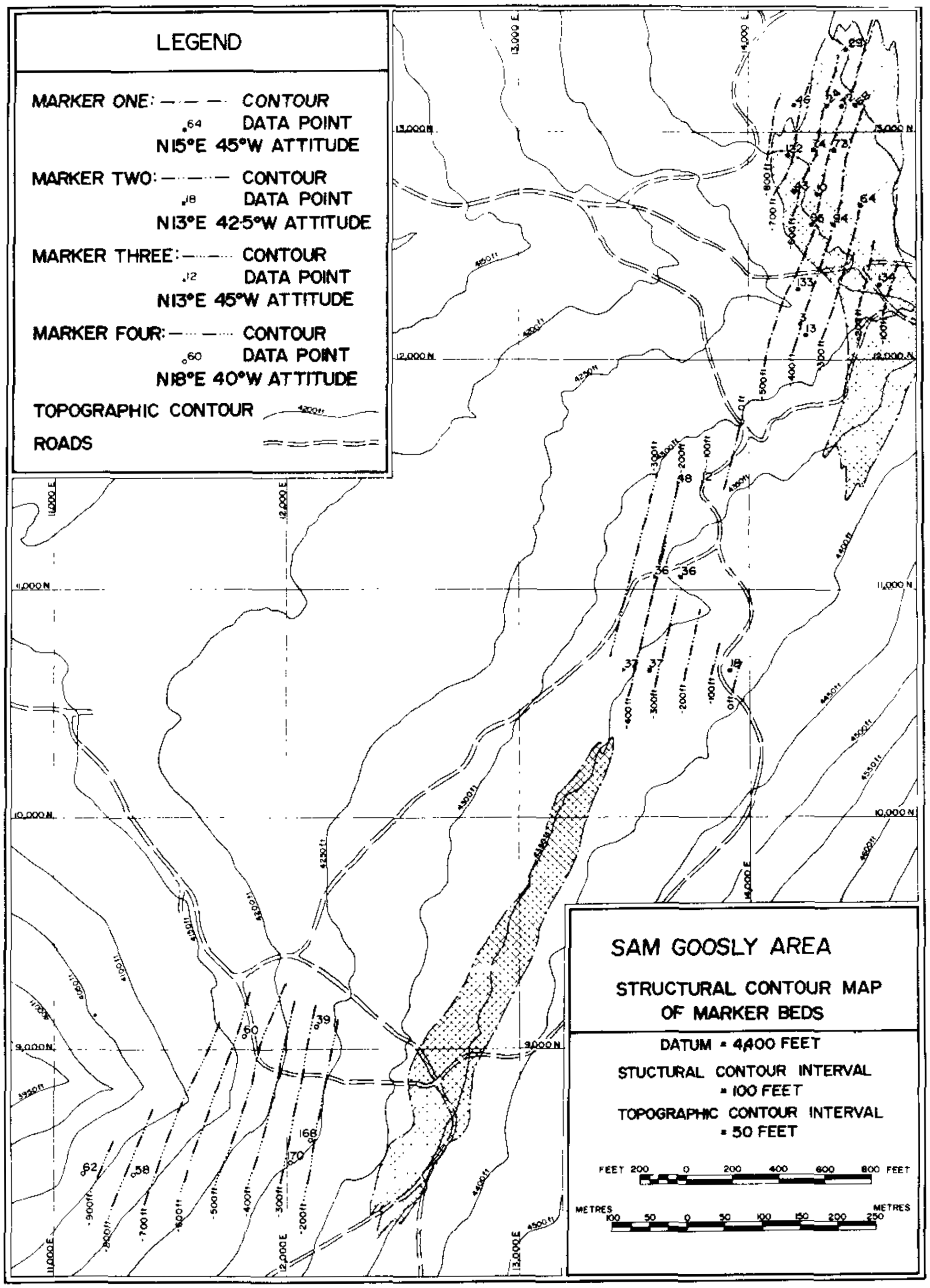

Figure 36. Map of area including the Sam Goosly Cu–Ag deposit, showing structure contours on the tops of four marker beds in the ore-bearing pyroclastic unit. The reference grid used by Equity Mining Corp. is shown, as are vertical projections of drill hole intersections with the various marker beds. Patterned areas are approximate outlines of ore zones on the 4400-foot level: the Main zone on the north and the Southern Tail zone on the south.