ASB

010455

THE GEOLOGY OF CRAIGMONT MINES

To be presented at the Annual Meeting of the Canadian Institute of Mining and Metallurgy, Vancouver, B.C.

24 APRIL, 1968.

By

J.F. Bristow

ABSTRACT

The Geology of Craigmont Mines

This paper gives a brief account of the history and development of the Craigmont property. It compares the local and regional geological environments emphasizing the anomalous nature of the local setting.

The fundamental mine structure appears to be a series of drag folds on the north limb of a large anticlinal fold. Where this structure lies within the thermal aureole of the Guichon batholith calc silicate skarn alteration is developed and is closely associated with pyrometasomatic copper iron replacement orebodies.

Purpose

The purpose of the following paper is to bring the mining community up to date on the current geological hypotheses at Craigmont Mines. It is hoped that the paper will augment the ideas put forward in a previous paper entitled "Geology of Craigmont Mines", written by C.C. Rennie, W.S. Pentland and C.C. Sheng.

Introduction

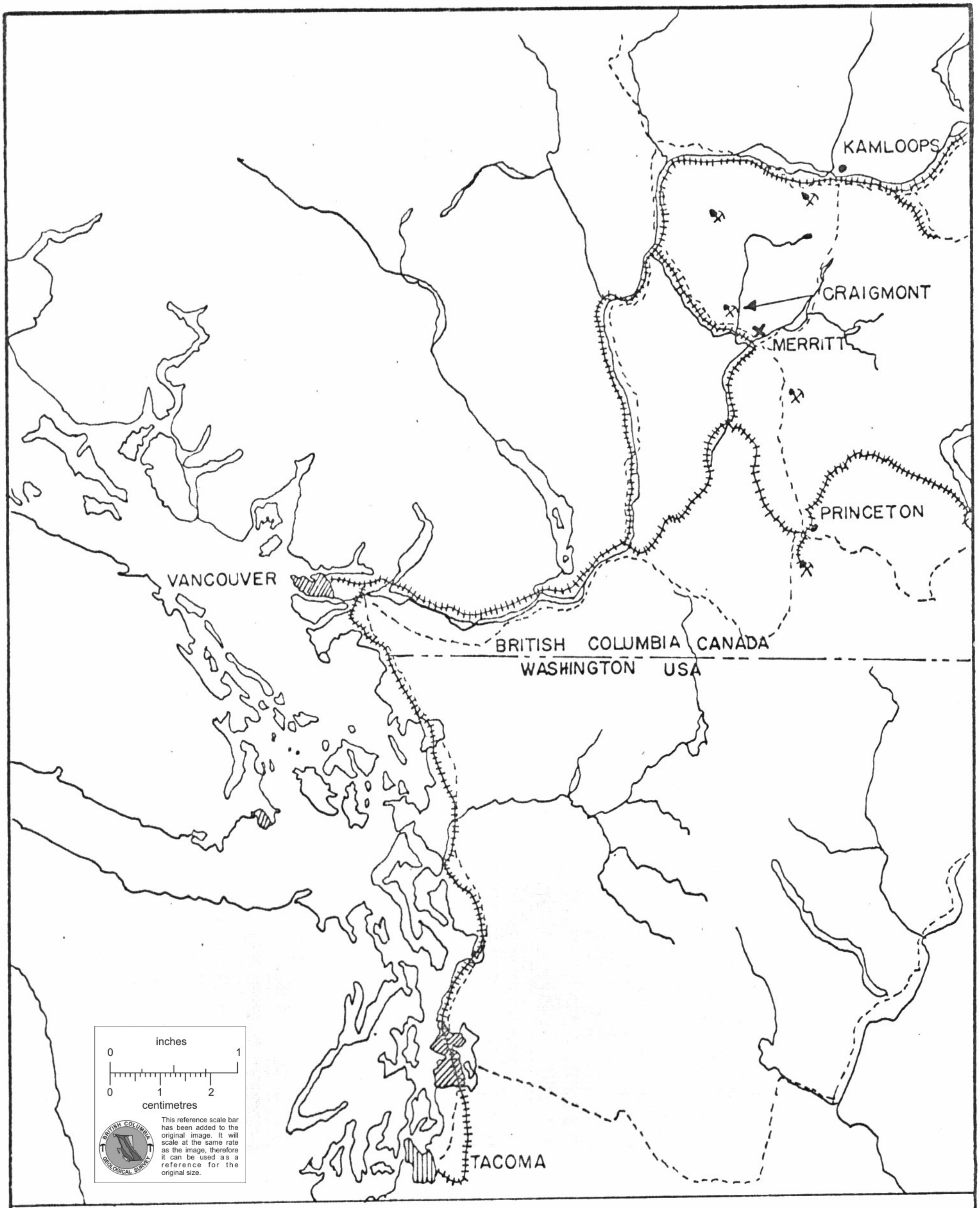
The Craigmont property is situated in south-central British Columbia, Canada, approximately ten miles north-west of the town of Merritt and about two hundred and forty miles by road north east of Vancouver at latitude 50° 12' 28" north, and longitude 120° 54' 48" west. (Figure 1) Access to the property is by paved road which connects with No. 8 highway at Lower Nicola and the Canadian Pacific Railway at Coyle.

The mine is located on the eastern slope of Promontory Hill. Moderate local relief ranges from 1850 elevation at the Nicola River, 2400 elevation at the plant site, 4400 elevation at the west end of the Open Pit area to 5600 elevation at the top of Promontory Hill. Climate and vegetation are characteristic of the semi-arid "dry belt" of British Columbia. Since records have been kept at the plant site the average rainfall has been approximately 14 inches per year.

History

The history of the Craigmont Company is short and dates back to 1951 when it was incorporated following the re-organization of Pinecrest Gold Mines Limited. It follows that the written history of the present Craigmont orebodies are also short, although the Eric showing, situated one mile to the east of the present Open Pit, was diamond drilled and trenched during or before 1935.

In 1954, the fourteen key mineral claims which form the core of the present property were acquired. Prior to 1957, most of the geological and geophysical work was concentrated in the vicinity of Jackson Lake on the Payston showing approximately a mile north-west of



MAP SHOWING THE LOCATION OF CRAIGMONT

Fig I

the present Open Pit. Much of the initial work consisted of the investigation and evaluation of magnetic anomalies of low magnetic intensity similar to the anomalies obtained on the Bethlehem property in the Highland Valley area 20 miles to the north. It is interesting to note that the anomaly obtained above the Craigmont No. 1 orebody was one of high magnetic intensity. The strength of this anomaly was as high as 14,000 gammas above background. By the fall of 1957, diamond drilling on the magnetic anomaly in the driftcovered area immediately above the present No. 1 orebody indicated that an extensive zone of copper mineralization existed. By mid 1958 the results of diamond drill hole No. 15 suggested that an orebody of substantial proportions was being delineated. This drill hole passed through the centre of the No. 1 orebody intersecting approximately 640 feet of continuous mineralization which averaged better than 4.0% copper.

Canadian Exploration Limited directed and financed exploration from November 1957 to July 1958 when underground development was undertaken by an operating group, Birkett Creek Mine Operators Limited. This group, formed by Canadian Exploration Limited, Noranda Mines Limited and Peerless Oil and Gas Company, was dissolved in 1960 and the same interests are presently operating the mine as Craigmont Mines Limited.

Development

Development of the underground as of 1 January 1968, totalled 83,300 feet of drifts, ramps and crosscuts, 26,900 feet of raises and 1,250 feet of internal shafts. Surface diamond drilling to date total 45,400 feet and underground diamond drilling total 338,400 feet.

From the commencement of operations March 1961, to March 1967, the bulk of the ore handled in the concentrator was obtained from the Open Pit. Upon completion of the pit in March 1967, just over 87,000,000 tons of ore and waste had been removed. I believe this tonnage is comparable to the tonnage moved by the South Saskatchewan Dam Project.

During the mining of the Open Pit 5,700,000 tons of low grade and 834,000 tons of high grade ore was stockpiled. The low grade material is currently being blended with the underground ore as required by the concentrator.

The Underground production is obtained using a sub-level caving mining method.

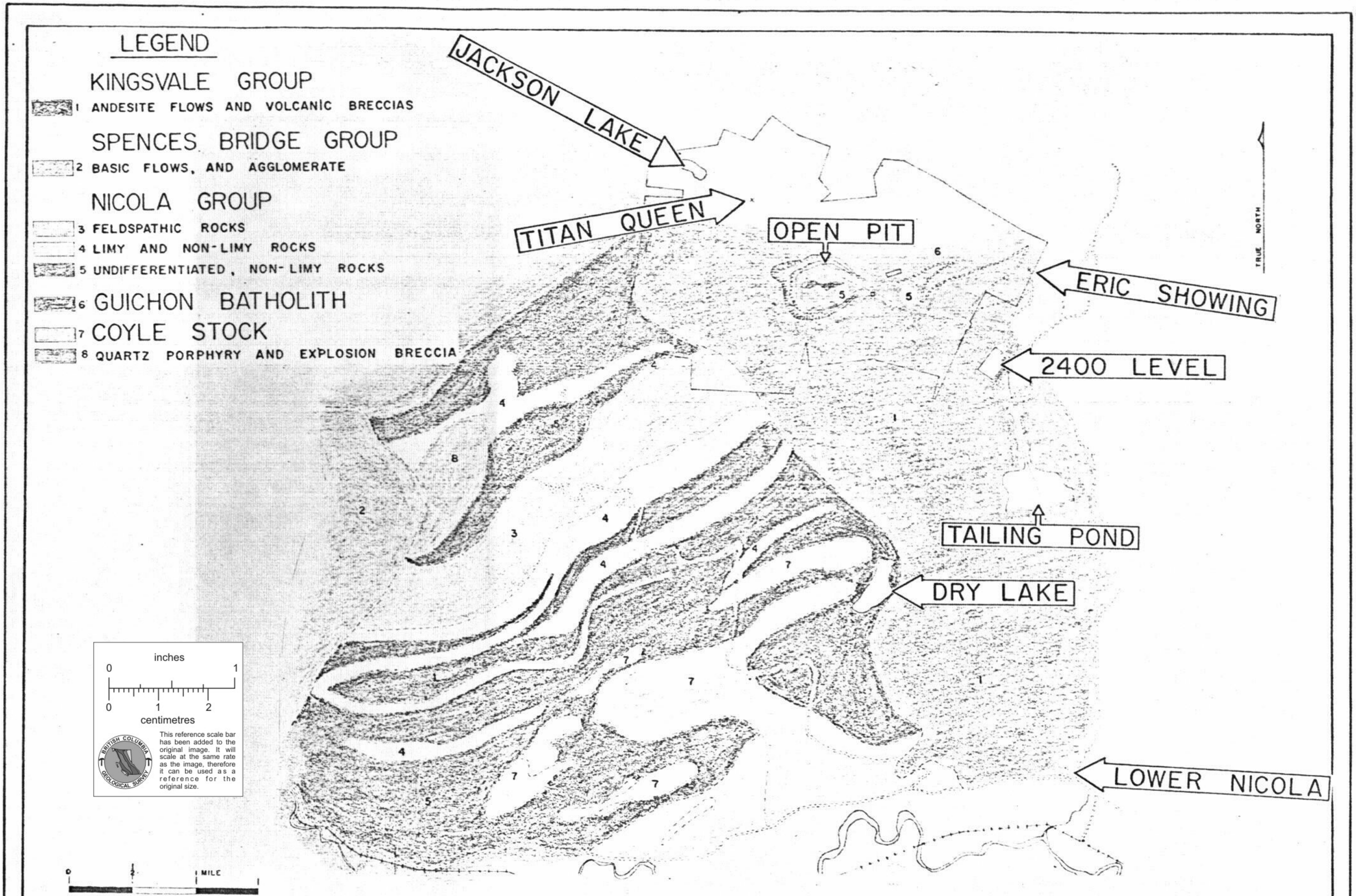
Regional Geological Setting

The Merritt area is situated in a broad copper metallogenic province that extends from Lake Chelan in Washington State through Copper Mountain, Princeton, Aspen Grove, Highland Valley and apparently terminates north of Kamloops Lake. Throughout the belt, Jurassic intrusive bodies of granodiorite, quartz diorite and diorite intrude the Upper Triassic rocks of the Nicola series. One of the largest of these intrusives is the Guichon batholith which extends from just north of Craigmont, north to Cache Creek which includes the Highland Valley, and west from Guichon Creek to the Thompson River. In general, the long axis of this intrusive is semiconcordant with the strike of the surrounding sediments. It appears to be multi-staged, variable in composition and possibly concentrically zoned.

Regionally, the Nicola series consists mainly of coarse volcanic and clastic rocks with interbedded flows. Sedimentary horizons which consist of grits, limestones and greywackes, make up approximately 20% of the series. Major structures in the Nicola series have a regional strike of approximately N 20° W.

Local Geological Setting

Structurally, the area at the south end of the Guichon batholith in the vicinity of Promontory Hill is anomalous and complex. (Figure 2). In general, the Nicola rocks in this area strike east-west and dip steeply to the south (70°S). This area is intersected by a number of north-westerly trending regional faults with apparent lateral movements of up to 1,200 feet and as yet of unknown vertical movements. Part of the east slope of Promontory Hill is covered by agglomerates and flows of the Lower Cretaceous Kingsvale group. These dip approximately 15° to the south. They lie unconformably on the Nicola series and are up to 600 feet thick. The south-west flank of Promontory Hill is partially covered by Volcanic rocks of Lower Cretaceous age. Spences Bridge group rocks are unconformably overlain by rocks of the Kingsvale group.



GEOLOGY OF PROMONTORY HILLS AREA

Fig 2

The lack of Nicola outcrop and the absence of marker horizons in the Nicola series hampers us considerably in resolving the structural complexities on Promontory Hill. In the immediate mine area, the greywackes in the Nicola group have been hornfelsed. The sediments immediately adjacent to the batholith can be best described as hornfelsed quartzofeldspathic greywackes. They are biotite-bearing and often have a dioritic texture. Immediately south of the hornfelsed greywacke, a copper-magnesium-iron-silica metasomatic zone (skarn) was developed and is considered to be the down dip continuation of the mine limestone. (Figure 3). The bulk of the ore at Craigmont is found in this skarn zone. South of the skarn zone, a series of greywacke, argillites, cherts and medium grained greywackes are separated from fine grained massive andesitic rocks by a regional east-west trending fault zone.

Structures

It is the writer's belief that one of the first and fundamental structures developed in the mine area was the anticlinal fold structure outlined by diamond drilling on section 7415. A number of drag folds have been developed on the north side of this structure. (Figure 4). In general, these plunge steeply to the east at from 60° to 70°. In some sections of the mine they have caused a local widening of the skarn zone.

The structural picture is further complicated by the fact that the anticlinal fold structure is cut-off on the west by a north-westerly trending regional fault and on the south by an east-westerly trending regional fault. Therefore, all of the Craigmont orebodies occur within a block bounded on the north and east by the Guichon batholith and on the south and west by faults.

Alteration

Apparent thermal zoning is evident in many sections of the mine, and is especially well demonstrated on section 7615. Near the top of this section the favourable mine limestone has been altered to a marble. Further down the section and hence closer to the batholith it has been altered to a massive actinolite skarn. It is this actinolite skarn which is our most favourable host rock.

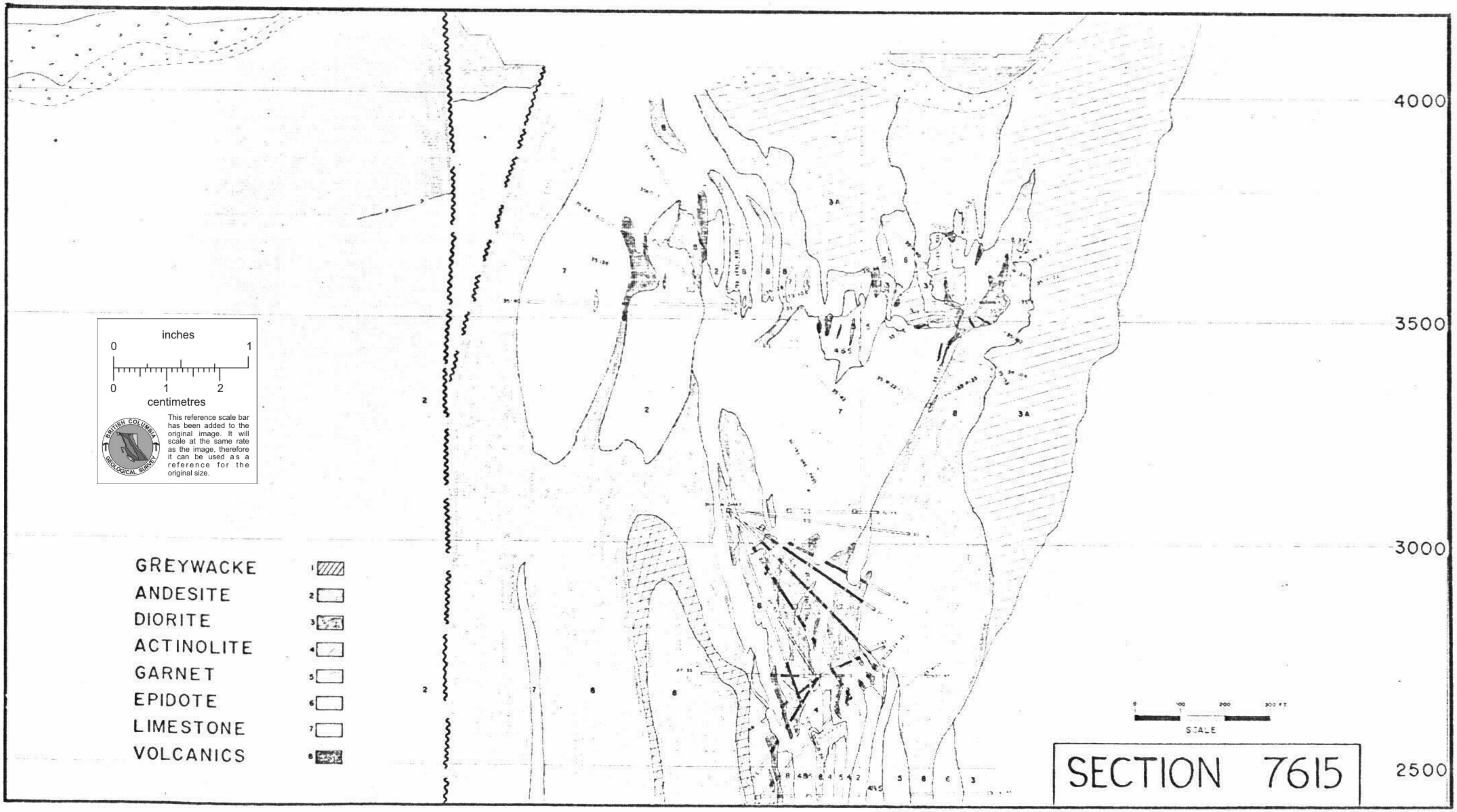
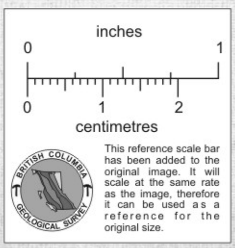

4000
3500
3000
2500
inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA GEOLOGICAL SURVEY
GREYWACKE 1
ANDESITE 2
DIORITE 3
ACTINOLITE 4
GARNET 5
EPIDOTE 6
LIMESTONE 7
VOLCANICS 8
SCALE
SECTION 7615

Fig 3.


inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA
GEOLOGICAL SURVEY

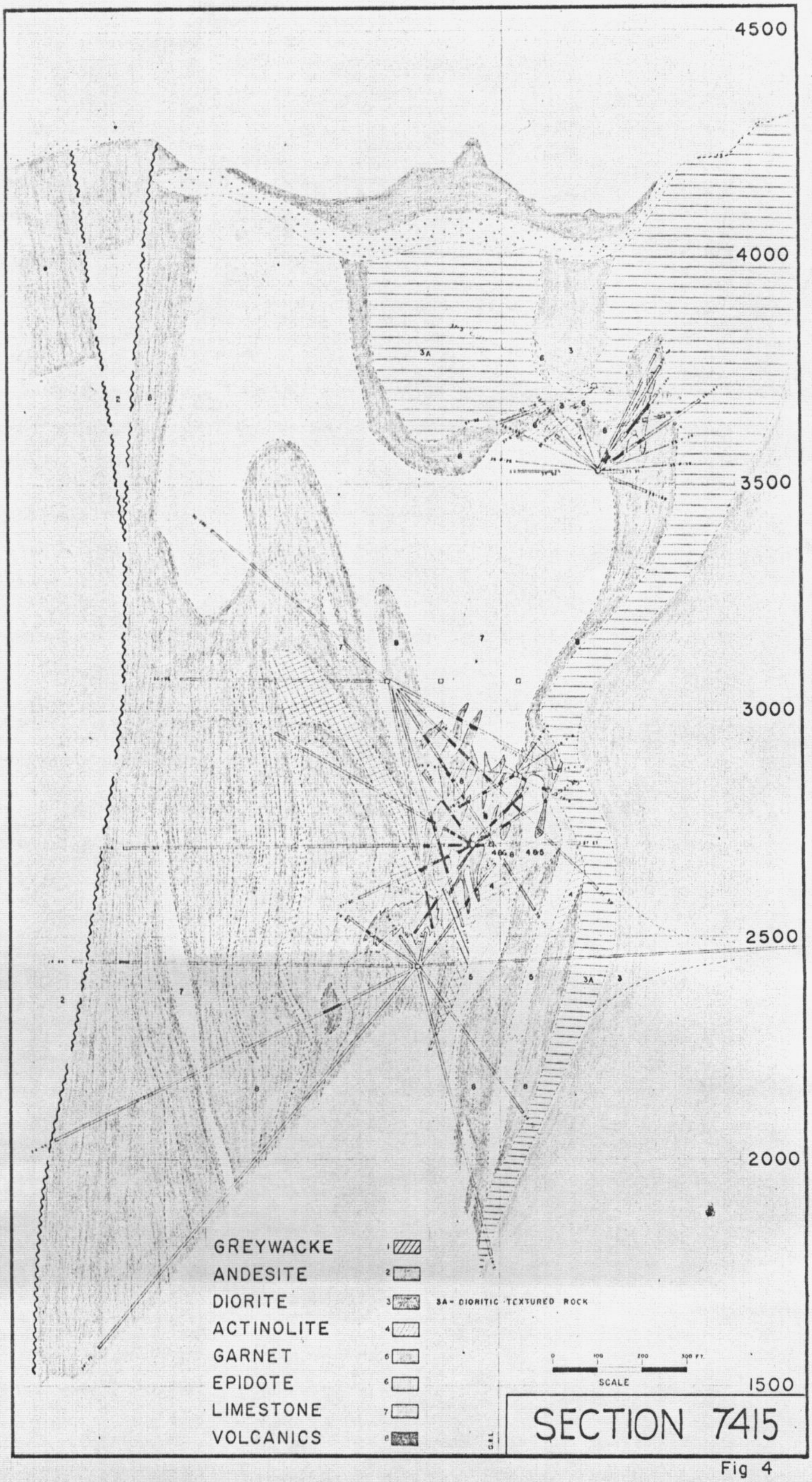

4500
4000
3500
3000
2500
2000
1500
3A
485
GREYWACKE 1
ANDESITE 2
DIORITE 3
3A - DIORITIC TEXTURED ROCK
ACTINOLITE 4
GARNET 5
EPIDOTE 6
LIMESTONE 7
VOLCANICS 8
0 100 200 300 FT.
SCALE
SECTION 7415

Fig 4

The ideal zoning picture would be for this actinolite skarn to grade into epidote and garnet at depth. In a general way this holds true, although there is also a lateral zoning along the strike. This zoning is spatially coincident with a large diorite dyke which occupies one or more of the previously mentioned steeply plunging fold structures.

Within the hornfelsed zone, actinolite and biotite are the most common alteration minerals present. Potassium feldspar introduction may or may not be present in both the limy and non-limy rocks, although in the limy rocks it is confined to siliceous fragments or thin siliceous bands.

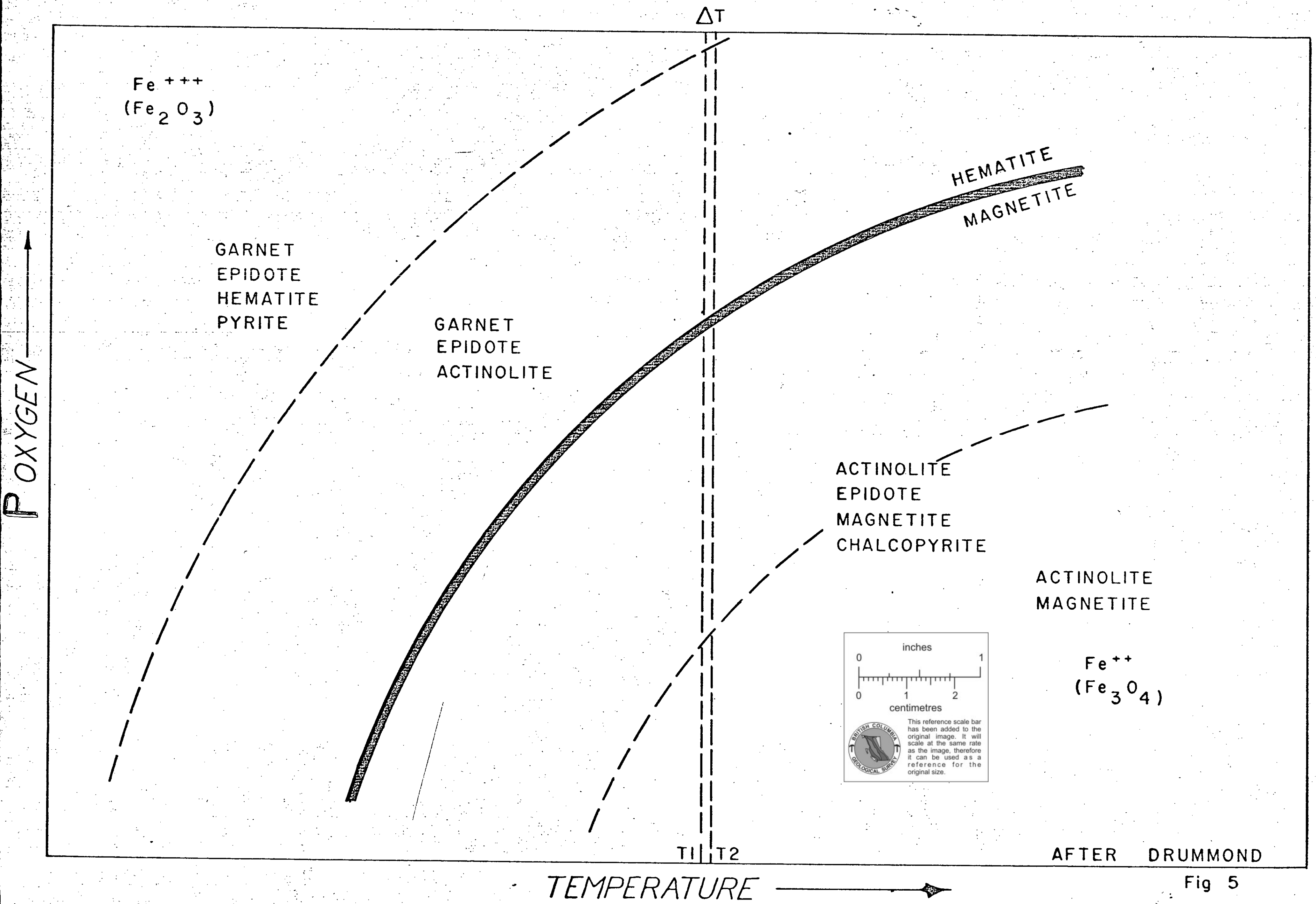
At the eastern end of the mine where the favourable skarn zone is enveloped on three sides by diorite, there appears to be little evidence of thermal zoning. Recent studies have suggested that the silicate mineralogy within the skarn assemblage may best be explained by variation of the partial pressure of oxygen under near isothermal conditions. (Figure 5). This diagram demonstrates that even though the temperature gradient (ΔT) across the favourable zone may be quite small, a complete range of skarn minerals may occur if changes in the partial pressure of oxygen occurred during metasomatism.

Orebodies

In detail, the orebodies at Craigmont are quite irregular, although their axial planes parallel the limy horizon. The bulk of the ore thus lies between walls of greywacke and andesite and is confined to the limy zone.

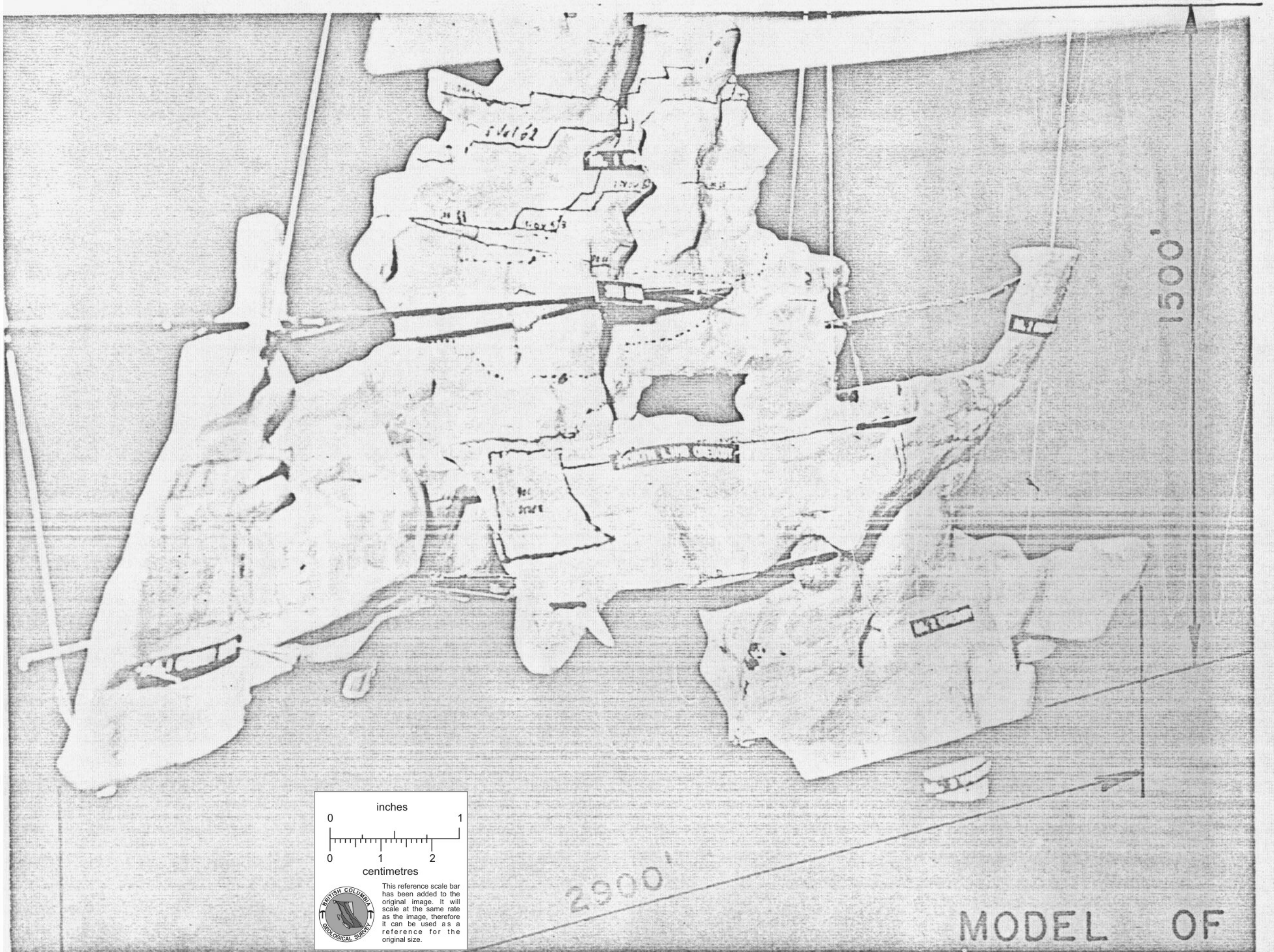
Semi-continuous ore is found over a horizontal strike length of 3,100 feet and a vertical height of 1,800 feet. (Figure 6).

The ore occurs in five orebodies, four of these are interconnected namely: the No. 1, No. 2, No. 2 wing and north limb. The orebody which occurs separately is the No. 3. This is a very small orebody and is unique in that it is composed entirely of chalcopyrite filled fractures in a crackled chert. Individual orebodies may vary in width from 10 to 350 feet and in height from 20 to 1,500 feet.



ΔT
Fe +++
(Fe2 O3)
GARNET
EPIDOTE
HEMATITE
PYRITE
GARNET
EPIDOTE
ACTINOLITE
HEMATITE
MAGNETITE
ACTINOLITE
EPIDOTE
MAGNETITE
CHALCOPYRITE
ACTINOLITE
MAGNETITE
Fe ++
(Fe3 O4)
T1
T2
AFTER DRUMMOND
P OXYGEN
TEMPERATURE
inches
0
1
0
1
2
centimetres
This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.
BRITISH COLUMBIA
GEOLOGICAL SURVEY

Fig 5



MODEL OF

CRAIGMONT ORE BODY

(LOOKING SOUTH WEST)

Mineralogy

The metallic mineralogy at Craigmont is quite simple. Chalcopyrite is our main copper bearing mineral. Polished briquettes of concentrate reveal minor bornite, although hand specimens containing bornite are a rarity.

In the No. 1 orebody, mineralization occurred in two stages: in the first stage magnetite and chalcopyrite were deposited during formation of the actinolite skarn at the east end of the mine skarn zone. The second stage was a predominantly specularite -- chalcopyrite fracture filling or veining phase which accounted for the bulk of the ore at the west end of the No. 1 orebody. In the central portion of the No. 1 orebody the two stages of mineralization were superimposed. This accounts for the higher than average mine grade values encountered in surface diamond drill hole No. 15: 4.40% copper as compared to 1.76 copper which is the mine average.

In general, supergene copper minerals are confined to a narrow zone immediately below a buried land surface -- namely the top of the Nicola series. Age of this surface was considered to be Lower Cretaceous but recent work on plant spores from the erosion surface suggest an age of early to middle Eocene. Only in the west end of the No. 1 and wing orebodies do these minerals persist to depth down a series of intersecting shear zones. In this area native copper and steel blue chalcocite have been identified in limonitic stained fault zones 1,000 feet below surface.

The principle minerals occurring in the skarn zone are magnetite, specular haematite, actinolite, epidote, garnet, pyrite and minor diopside. Magnetite and haematite account for approximately 25% by weight of the orebody. The actinolite is usually fine grained in texture and dark green in color. Pistachio green epidote is common throughout the mine. The grossularite-andradite garnet range in color from reddish-brown to yellowish-green. Zones of heavy garnet seldom contain economic copper mineralization. Generally speaking, heavy garnet indicates close proximity to diorite intrusives.

Pyrite is generally confined to areas of heavy garnet although it is quite common as subhedral grains in most of the wall rocks.

Ore Controls

The probable ore controls at Craigmont are as follows:

(a) favourable host rock
(b) folding of the host rock
(c) brecciation of the host rock
(d) optimum distance from the batholith of the host rock

Distance from the batholith is an important factor as all known orebodies lie within the thermal aureole of the batholith.

The batholith developed the favourable structures during its emplacement. The deposition of the mineralization was probably slightly later than the emplacement of this Lower Jurassic intrusive. The intrusive also appears to be the most logical source of copper mineralization.

Type of Deposit

In conclusion the evidence indicates that the Craigmont orebodies are pyrometasomatic replacement deposits occurring within the thermal aureole of the Guichon batholith.

Acknowledgements

The writer is grateful to Mr. R.E. Hallbauer, Manager, Craigmont Mines Limited, for permission to publish this paper and also to the staff for their cooperation and assistance. Special mention is due to Dr. A.D. Drummond, Research Geologist, Placer Development Limited and to Mr. C.C. Rennie, Project Supervisor, Canex Aerial Exploration Limited, for their criticism and advice. I would also like to thank Mr. A. Mosley, Geology Draughtsman, for his assistance.

References

1. Annual Report, (1960), Minister of Mines and Petroleum Resources.
2. Drummond, A.D., 1965; Mineralogical and Chemical study of Craigmont Mines, Merritt, B.C., PhD thesis (unpublished).
3. Financial Post Survey of Mines, 1967, pp. 80.
4. Rennie, C.C., Pentland, W.S. and Sheng, C.C., (1961), Geology of Craigmont Mine: Canadian Mining and Metallurgy Bulletin V.54, pp. 297-301.