Similco
887632

Tom Schroeter

INTRODUCTION

The Copper Mountain mine is located immediately east of the Similkameen River, some 10 miles south of Princeton, British Columbia, and approximately 20 miles north of the United States border. Copper was first discovered in the area in 1884, and has been mined intermittently from 1900 to 1957, with a total production to date of some 34 million tons of ore having a gross value of approximately 321 million dollars in copper, gold, and silver. All the above production has come from the Copper Mountain mine, but renewed interest in the area has led to the outlining of at least three more large zones of copper mineralization, one of which, the Ingerbelle, lies west of the Similkameen River and in part underlies the Hope Princeton highway. The other two zones are located on Copper Mountain, and are centered on two old open pits. These deposits, which at present are being prepared for production by open-pit methods, are estimated to include a total of 76 million tons of ore averaging 0.53 per cent copper and small but significant values of gold and silver.

Systematic and comprehensive geological work in the area was first undertaken by Dolmage (1934) and later by Rice (1947), Fahrni (1951, 1962, 1966), and Montgomery (1967). A detailed study of the Copper Mountain area, of which this paper is one aspect, was done in 1968 and 1969 by Preto of the British Columbia Department of Mines and Petroleum Resources. In 1967 Sinclair and White obtained the first radiometric ages from the Copper Mountain area, laying the base for the present study.

GENERAL GEOLOGY OF THE COPPER MOUNTAIN AREA

The oldest rocks in the area are part of the Upper Triassic Wolf Creek Formation of the Nicola Group. These include volcanic and sedimentary rocks which generally display a very mild degree of metamorphism and deformation except in the immediate vicinity of intrusive bodies. A number of quartz-poor calc-alkalic plutons, collectively known as the Copper Mountain intrusions (Montgomery, 1967) cut the Nicola rocks and are spatially and genetically related to the ore deposits. The largest, the Copper Mountain stock, is a concentrically differentiated intrusion, elliptical in plan and approximately 6.5 square miles in area. Its long axis is approximately 6 miles and strikes north 60 degrees west. This stock ranges in composition from diorite at its outer edge, through monzonite to syenite and perthosite pegmatite* at the core (Montgomery, 1967). Two smaller satellites, the Smelter Lakes and Voigt stocks, to the north and northeast respectively show no differentiation, but are similar in composition to the outer phase of the Copper Mountain stock. A complex of intrusive rocks ranging in composition from diorite to syenite, and generally porphyritic, occurs mainly north

*Perthosite pegmatite contains about 97 per cent perthite with minor amounts of leucoxene or sphene, quartz, and fine-grained colourless micas.

of Copper Mountain, extending from Wolf Creek to a major northerly trending fault that lies west of the Hope-Princeton highway. These rocks, known as the Lost Horse intrusions, show widespread albitization, saussuritization, and pink feldspar alteration that can be intense. They do not occur as a continuous mass, but as a complex of dykes, sills, and irregular bodies that display variable and complicated contact relationships with rocks of the Wolf Creek Formation. Because of their complexity the Lost Horse intrusions could only be divided into two groups: One composed of irregular bodies of variable size and shape; the other of well-defined dykes of biotite-latite porphyry or biotite-pyroxene microsyenite porphyry that cut the older Lost Horse rocks. The Lost Horse intrusions are believed to be genetically related to the Copper Mountain stock, and in fact to be late phases of the stock, although contact relationships are nowhere clearly displayed in the field. They are also closely related to the orebodies spatially and, it is believed, genetically.

To the northeast of Copper Mountain, diorite of the Voigt stock and older volcanic rocks are cut by a body of younger quartz monzonite that was named Verde Creek granite by Dolmage (1934) and believed by Rice (1947) to be correlative with the Otter intrusions of Upper Cretaceous or younger age. This pluton and older rocks are cut by several northerly trending dykes of felsite, quartz feldspar, and feldspar porphyry which are the eastern continuation of the "mine dykes" swarm of Copper Mountain.

All of the above intrusive, volcanic, and sedimentary rocks are cut and unconformably overlain by intrusive, volcanic, and sedimentary rocks of the Princeton Group of Middle Eocene age.

Both at Copper Mountain and at Ingerbelle faulting and fracturing are very intense and prominent. Major faults trend north 80 to 90 degrees east, north 35 degrees east, north 20 degrees east, and north 45 degrees west, and are important structural controls to mineralization. At Ingerbelle, a regional post-mineral normal fault that trends northerly and dips 60 degrees west cuts off the orebody to the west, and further south truncates the western part of the Copper Mountain stock.

Copper deposits have long been know around the entire periphery of the Copper Mountain stock; but the economic ones to date have been found only on the northeast side of the stock, mostly in the narrow zone of altered and intensely faulted and fractured Nicola rocks which are bound to the south by the main stock and to the north by an almost continuous mass of Lost Horse intrusive rocks. At Copper Mountain most of the early production was from orebodies close to the stock contact, in which the principal ore mineral was bornite. The size and grade of orebodies was largely controlled by the presence and intensity of the so-called "ore fractures," a set of northeast trending fractures and pegmatite veins oriented almost at right angles to the stock contact. Away from the contact, however, large amounts of ore have been and will be produced in which chalcopyrite is the principal ore mineral. These zones do not appear to be so directly dependent on the northeast fractures as on other favourable structural and alteration conditions and on the presence or proximity of Lost Horse rocks.

POTASSIUM-ARGON DATES

The work of Sinclair and White (1968) was confined to the Copper Mountain stock and to a pegmatite-sulphide veinlet close to the stock contact. It indicated a mean age of 193 ± 7 million years for both the stock and the copper mineralization and hence supported the suggestion based on field evidence that the orebodies are genetically related to the Copper Mountain stock.

The present work continues and enlarges that of Sinclair and White, by determining the radiometric age of biotite from the Smelter Lakes and Voigt stocks, the Lost Horse intrusive rocks, and the Verde Creek quartz monzonite.

Adequately large samples of fresh, unaltered rock were collected to produced a concentrate of clean biotite sufficient for argon and for quadruplicate potassium analyses. In the case of sample VP-69KA-1 this meant taking a sample of approximately 100 pounds, although in most other cases samples of 25 to 50 pounds were adequate. Biotite concentrates were obtained in the laboratory of the British Columbia Department of Mines and Petroleum Resources by crushing, grinding, screening heavy mineral separation, and by floating the biotite off in a water column. Biotite concentrates submitted for analysis were 95 to 98 per cent pure by visual estimate and in most cases contained negligible amounts of chlorite. Potassium analyses were done in triplicate or in quadruplicate with a flame photometer, and argon analyses were obtained by using a MS-10 mass spectrometer. All analytical work and calculations were done by J. E. Harakal at the potassium-argon laboratory of the University of British Columbia Department of Geology.

The analytical data and apparent ages of the samples are given in Table 1.

DISCUSSION OF RESULTS

Eight of the nine apparent ages obtained from two biotites each of the Smelter Lakes and Voigt stocks, from four biotites of Lost Horse rocks, and from one of a sulphide-bearing pegmatite vein are identical within the limits of experimental error. Their average is 195 ± 8 million years, which is in very close agreement with the results obtained by Sinclair and White (1968). The ninth of these ages, that from sample VP-69KA-6 of the Voigt stock is slightly lower at 181 ± 7 million years. A possible reason for this discrepancy is that the biotite from this sample is considerably chloritized and markedly poikilitic in habit. Another possible, though unlikely, reason is that differential loss of argon has been caused by the proximity of an unexposed "mine dyke," several of which are found in the area.

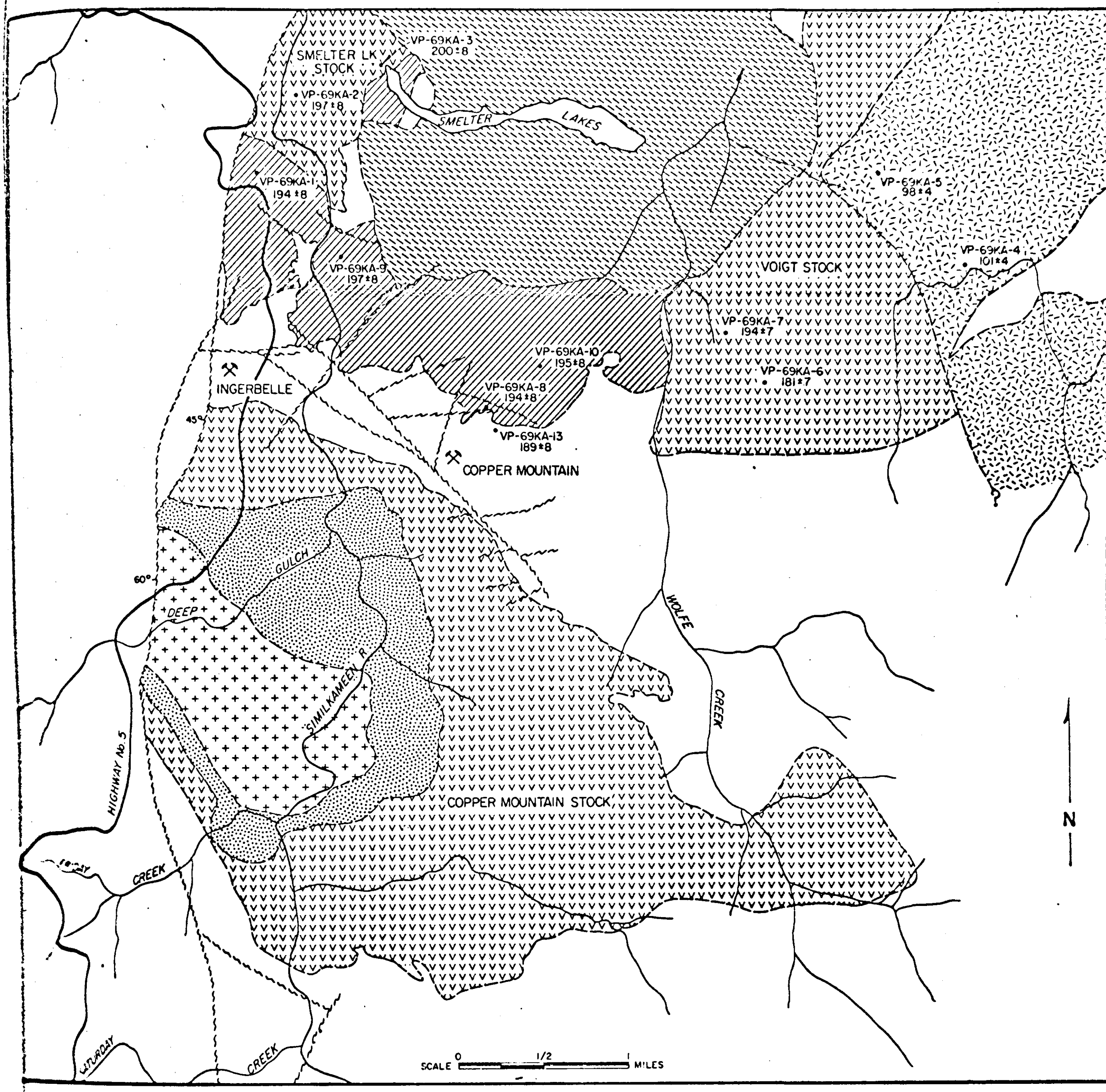
The two apparent ages from biotite of the Verde Creek quartz monzonite body yield an average age of 99.5±4 million years, which according to the Kulp (1961) time scale corresponds to the earliest Upper Cretaceous. From the above, the following conclusions can be drawn:

1. The apparent radiometric age of Lost Horse rocks is indistinguishable from that of the Copper Mountain, Smelter Lakes, and Voigt stocks. These rocks, which were regarded by Dolmage (1934) as probably somewhat older than the three stocks are related to them in time and, as Montgomery (1967) suggests, in origin. Their composition, texture, structural setting, commonly altered state, and relationship to zones of alteration and of mineralization in Nicola rocks indicate that they were probably emplaced at a relatively late stage under conditions of prevailing and widespread hydrothermal alteration. No difference can be detected between the apparent age of dykes and that of somewhat older Lost Horse rocks which they cut.

2. The Smelter Lakes and Voigt stocks have apparent radiometric ages that are indistinguishable from those of the Copper Mountain stock obtained by Sinclair and White (1968). This is in agreement with field evidence that they are satellites of the main stock and owe their lack of differentiation either to their smaller size or level of exposure, or both.

3. The apparent radiometric age of all the Copper Mountain intrusions and of the associated mineralization, according to Kulp's time scale, is Upper Triassic, the same age as the Nicola rocks which they cut, as determined from fossil evidence. The above, together with the type, texture, and structural setting of some of the Lost Horse rocks makes one wonder whether some of the Lost Horse dykes were not feeders to Nicola flows higher in the volcanic pile that surrounds the Copper Mountain intrusions at the present level of erosion. This would imply a fairly rapid change from the mesozonal environment in which the three stocks were emplaced, to an epizonal or even sub-volcanic environment in which some of the Lost Horse phases may have been emplaced, thus necessitating a fairly rapid erosion of overlying strata. A similar situation is suggested by Northcote (1969) for the Guichon Creek batholith, another mineralized differentiated intrusion which cuts Nicola rocks and has an apparent age of 200±5 million years (White, et al., 1967).

4. The apparent age of 99.5±4 million years obtained from biotite of the Verde Creek body, which is cut by the eastern continuation of the "mine dykes" swarm, contradicts the suggestion put forth by Sinclair and White (1968) that these dykes may have an age of 150 million years. It is believed that the dykes are of Upper Cretaceous or Tertiary age and may be genetically related to a period of widespread



GENERAL GEOLOGY OF THE COPPER MOUNTAIN AREA
BRITISH COLUMBIA

PRINCETON GROUP	MONZONITE
VERDE CREEK QTZ. MONZ.	DIORITE
LOST HORSE INTRUSION	NICOLA GROUP
PERTHOSITE PEGMATITE	VP-69AK-1 194±8 SAMPLE LOCATION AND AGE IN M.Y

$\lambda_B = 4.72 \times 10^{-10}\ yr^{-1}$

$K^{40}/K = 1.181 \times 10^{-4}$

Tom Schroeter

Ingerbelle

By V. A. G. Preto

LOCATION: (49° 120° S.W.) On Highway No. 3, 13 miles south of Princeton.
CLAIMS: Sixty-six Crown-granted and recorded mineral claims.
ACCESS: Via Highway No. 3.
OWNER: Ingerbelle Mines Limited, P.O. Box 520, Princeton.
METALS: Copper (molybdenum, gold).
WORK DONE: Sixteen men were employed by the company and 40 by contractor for 12 months; supervision by J. McCue. Detailed geological mapping, ground magnetometer, induced polarization, and soil geochemical surveys over the whole property, one adit totalling 3,722 feet; 97,900 feet of BQ-size diamond drilling in 224 surface holes; 30,500 feet of AQ-size diamond drilling in 104 underground holes; 51,500 feet of 2-inch-diameter percussion drilling in 200 holes.
REFERENCES: *Minister of Mines, B.C.*, Ann. Repts., 1966, pp. 177–178; 1967, pp. 181–182; *Geol. Surv., Canada,* Mem. 171, 1934; Montgomery, J. H., 1967, "Petrology, Structure and Origin of the Copper Mountain Intrusions near Princeton, British Columbia," unpublished Ph.D. thesis, *U.B.C.*
DESCRIPTION:

The extensive work which was commenced on the Ingerbelle property in 1966 continued in 1968 and culminated with the completion of the exploratory underground workings and of a major surface and underground drilling programme. This work, accompanied by further surface and underground mapping, has led to the following simplified understanding of the geology of the property.

Most of the known copper mineralization of economic interest occurs in a block of intensely altered volcanic rocks of the Nicola Group which are cut by a host of dykes and sills of dioritic and monzonitic composition. This block of rocks, designated as the Ingerbelle block, is centred on the Ingersoll Belle (Lot 234) and La Reine (Lot 233) claims and is bounded to the north by a diorite-monzonite-syenite complex which begins approximately at line 16,000 N (*see* Fig. 24), and to the west by a sharp north-by-northeast trending fault which dips steeply to the west and brings virtually unmetamorphosed argillite and siltstone of the Nicola Group in contact with the highly altered Ingerbelle rocks. At the west end of section 14,660 N, a concealed north-trending fault has been discovered by drilling. This fault is probably a subsidiary of the main boundary fault immediately to the west. It dips to the west at 40 degrees and brings unmetamorphosed and unmineralized volcanic greywacke, siltstone, argillite, and conglomerate in contact with highly altered and sparsely mineralized intrusive and volcanic rocks. To the south the boundary of the Ingerbelle block is marked by the Copper Mountain stock. The eastern boundary is marked by the Honeysuckle break, a fracture and fault zone which trends northeasterly and dips steeply. Although this break marks a sudden change in the attitude and lithology of the Nicola rocks, copper mineralization continues sporadically to the east of it on the west side of Copper Mountain and may be traced, though with many interruptions and irregularities, to those areas to the east which either were sites of former mining operations or are presently under intense examination.

A major east-trending fault, locally known as the Gully Fault, cuts the Ingerbelle block (*see* Fig. 24 and section 13,800 E) in two markedly different parts. The northern part consists almost entirely of intensely altered volcanic and intrusive rocks, the original lithology of which at best can be deciphered only with great difficulty. The most common types of alteration found in these rocks are intense albitization, pink feldspathization, and scapolitization, accompanied by abundant and widespread development of epidote, biotite, pyroxene, and sphene. Within these highly altered rocks, however, a few lenses of fine-grained bedded material indicate gentle northeasterly dips.

To the south of the Gully Fault the volcanic rocks consist of a pile of brownish to greenish massive and fragmental andesite (*see* Fig. 24) at least 800 feet thick. On Figures 25 and 26 these rocks are designated as unit 2 and are characterized in their upper part by an excellent marker horizon of delicately laminated metasiltstone and (or) tuff which is designated as unit 3 (*see* Plate III). In sections 14,660 N and 13,800 E it ranges from 70 to 100 feet in thickness and has been intersected by virtually every hole drilled south of the Gully Fault and west of Highway No. 3. The thickness of the unit is greatest to the southwest and decreases gradually to the northeast. The locus of unit 3 in each drill-hole and the core-bedding angles both indicate that the layer dips gently to the northeast. Thinly laminated tuffaceous layers and (or) lenses found at several other places within the andesitic rocks above and below unit 3 also indicate the same general attitude. The deepest drill-holes of sections 14,660 N and 13,800 E indicate that some 600 feet below unit 3 the fragmental andesite of unit 2 changes rather sharply into massive finely porphyritic dark brownish-grey andesite.

Gentle northeasterly dips of the Nicola rocks in the Ingerbelle block are found within a very short distance of the Copper Mountain stock contact, immediately east of Highway No. 3. To the east of the Honeysuckle break, however, the lithology changes abruptly and the strata trend northwesterly and dip vertically or steeply to the northeast for a distance of more than 1,200 feet directly away from the intrusive contact. This may mean either that there has been considerable movement of the strata along the Honeysuckle break or that the Nicola rocks were folded along northwesterly trending axes and then faulted in a northeasterly direction prior to the intrusion of the stock. The second alternative is presently favoured because of other indications of pre-intrusion folding of Nicola rocks to the south, in the vicinity of Saturday Creek.

The volcanic rocks in the Ingerbelle block are cut by a host of medium- to fine-grained porphyritic dykes and sills which probably range in composition from diorite to monzonite and occasionally perhaps syenite. The vagueness in classifying these intrusives is due to the fact that most are so strongly altered that even by an extensive petrographic study their composition can at best only be estimated. Moreover, the alteration of andesite of unit 2 and of some of the dioritic intrusives is such that in some cases it cannot be said with any degree of certainty what rock one is dealing with. It seems, however, that one of the characteristics of the intrusive rocks of units 6 and 7 is the presence of generally well-formed crystals of clear apatite ranging from less than 1 to 3 millimetres in diameter. These crystals are very obvious in thin-section and can generally be easily identified in the hand specimen with the aid of a pocket magnifier. All the intrusives also contain conspicuous phenocrysts of augitic pyroxene, but these may be variously altered to amphibole, epidote, and chlorite, depending on the condition the rock is in.

Types of alteration which have affected all rocks with the exception of units 5, 8, and part of 7 involve extensive saussuritization and the formation of biotite, sphene, chlorite, pyroxene, pink feldspar, and scapolite. Of these types of alteration, scapolization is one of the latest (*see* Plate IV). Scapolite may occur as large irregular crystals which poikilitically enclose earlier minerals, or as distinct veins which cut through all other alteration minerals with the exception of pink potash feldspar veinlets and late carbonate veinlets. The relative age of scapolitization and sulphide mineralization is as yet not well understood. In some instances the scapolite appears to be later than the bulk of the sulphides, but in others discontinuous chalcopyrite and pyrite veinlets and patches appear to cut through scapolite veinlets. Alteration by pink feldspar occurred in two distinct stages. In the first there was wholesale replacement of the rock by salmon pink sodic plagioclase, which in turn was strongly sericitized, veined by scapolite, and finally veined and partly replaced by pink potash feldspar (*see* Plate IV). Veinlets and disseminations of fine-grained pyrite, chalcopyrite, and molybdenite are in turn cut by later veins of coarsely crystalline pyrite and bright-green epidote.

Apart from the main faults which have been briefly mentioned earlier, all rock units of the Ingerbelle block are cut by innumerable generally steeply dipping fractures, a large part of which trend in northwesterly and northeasterly directions.

Sulphide mineralization may be found in any of units 1, 2, 3, 4, 6, 7, or 8, and on a small scale its distribution is controlled by steeply dipping fractures and alteration zones. On a larger scale, however, most sulphides are found in the lower and central portions of unit 2, below unit 3. Within this area, rocks of unit 6 are also generally better mineralized than elsewhere. Very strongly pink feldspathized or intensely scapolitized rocks generally are not a good host to mineralization, most of which is found in less intensely altered rocks.

T

LOCATION: (49° 120° S.W.) Two miles southwest of Kennedy Mountain, on the southeast side of Whipsaw Creek adjoining the property of Ingerbelle Mines Limited.

CLAIMS: T 1 to 22.

ACCESS: Fifteen miles by road south from Princeton.

OWNER: Anchor Mines Ltd., 1111, 409 Granville Street, Vancouver 2; A. P. Fawley, consultant.

METAL: Copper.

WORK DONE: An induced polarization survey was made of the 22-claim group.

REFERENCES: *Minister of Mines, B.C.*, Ann. Rept., 1967, p. 178; Assessment Report No. 1774.

Whip, Saw

By V. A. G. Preto

LOCATION: (49° 120° S.W.) On the north side of Whipsaw Creek, approximately 8 miles upstream from the bridge on Highway No. 3.

CLAIMS: Twenty-eight recorded claims comprising the Whip, Saw, Axe, and Pick groups.

ACCESS: Twenty-one miles south from Princeton via Highway No. 3 and the Whipsaw Creek road.

OWNER: Texas Gulf Sulphur Company.

OPERATOR: Amax Exploration, Inc., 601, 535 Thurlow Street, Vancouver 5.

METALS: Copper, molybdenum.

WORK DONE: Over the whole claim block. Eight men were employed by the company and two by contractor for a period of two months. Work was supervised by D. K. Mustard, geologist for Amax Exploration, Inc. A geological survey and a soil and silt geochemical survey for copper and molybdenum were carried out over the whole claim block. Eight trenches totalling 4,200 feet were bulldozed and some access roads built.

REFERENCES: Assessment Reports Nos. 314, 362, 409, and 561.

DESCRIPTION:

The property is located along, and immediately east of, the contact between Eagle granodiorite and rocks of the Nicola Group. In this region the contact

OWNER: SIMILKAMEEN MINING COMPANY, LIMITED, P.O. Box 520, Princeton.

METALS: Copper (molybdenum, gold).

WORK DONE: Five men were employed by the company for 12 months and 20 by contractors for nine months. Work was done by and under the supervision of T. N. Macauley and R. Pyper, company geologists. Diamond drilling totalled 8,514 feet in 15 holes of BQ size. Percussion drilling consisted of 3,467 feet in 12 holes of 4⅞-inch diameter and 72,358 feet in 220 holes of 2-inch diameter. Some bulldozer trenching and geological mapping at a scale of 1 inch equals 100 feet was also done.

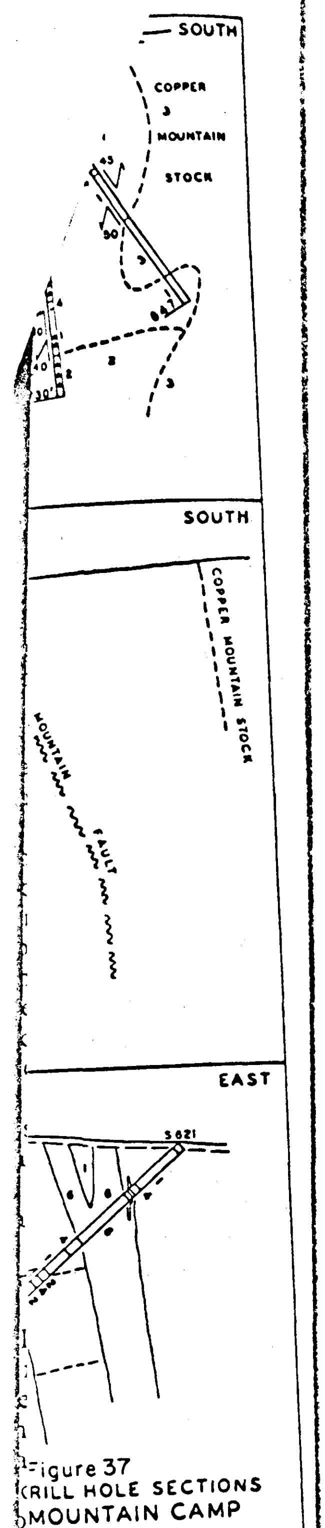
REFERENCES: *Minister of Mines, B.C.*, Ann. Repts., 1967, pp. 178–180; 1968, p. 206; *Geol. Surv., Canada*, Mem. 171, 1934; Montgomery, J. H., 1967, Petrology, Structure and Origin of the Copper Mountain Intrusions near Princeton, British Columbia, unpublished Ph.D. thesis, *U.B.C.*; Fahrni, K. C., 1951, Geology of Copper Mountain, *Cdn. Min. and Met. Bull.*, Vol. 44.

DESCRIPTION:

The drilling and trenching programme which had been commenced in 1966 by The Granby Mining Company Limited was continued and extended by the Newmont Mining Corporation of Canada Limited, following the purchase of the Granby holdings in 1967, and was carried to completion in 1969.

The programme was successful in outlining two areas of economic grade copper mineralization, and also produced much information which greatly helps in the understanding of the geology of Copper Mountain. The areas of copper mineralization are centred on Pit No. 1 and Pit No. 2 (*see* Fig. 36) and thus are known as the Pit 1 and Pit 2 zones. These two zones are roughly rectangular in plan, with the longer dimension oriented in an east-west direction. Their approximate maximum plan dimensions, respectively, are 2,400 by 900 feet and 3,400 by 1,000 feet. Of the two, the Pit 2 zone has by far the more irregular outline. A third zone of mineralization, roughly comparable in size to the Pit 1 zone, is known to occur in the glory-hole area between Pit 5 and the contact of the Copper Mountain stock to the southwest. This zone, though extensive, is still inadequately known as to its exact shape and grade, and is at present considered only as a possible orebody. The boundaries of the Pit 1 and Pit 2 zones, as crudely outlined above, are arbitrary vertical assay boundaries and merely encompass volumes of ground which are mostly of economic grade. Copper mineralization extends far beyond these boundaries and is in fact widespread on Copper Mountain, but, at present, nowhere else in the camp is it known to occur in sufficient amount and grade to be economic.

Figures 36 and 37 give a generalized and greatly simplified picture of the geology of Copper Mountain. A zone of volcanic rocks of the Nicola Group extends in a northwesterly direction from Wolf Creek to the Similkameen River and beyond, and is confined to the southwest by the Copper Mountain stock and to the north by a complex of intrusive rocks which forms part of the Lost Horse intrusions. Both volcanic and intrusive rocks are cut by a swarm of northerly trending felsitic dykes, known as the Mine dykes. These dykes appear to be more numerous in the immediate vicinity of the Copper Mountain mine. This, however, is largely an erroneous impression, because the ground near the mine workings has been explored in much greater detail than elsewhere, and the dykes do not have a prominent surface expression. In fact, dykes identical in composition and trend to the Mine dykes have been found several miles east and southeast of Copper Mountain, but not for any appreciable distance to the west of it.



igure 37
RILL HOLE SECTIONS
MOUNTAIN CAMP

Sedimentary and volcanic rocks of the Princeton Group overlie unconformably all the intrusive and volcanic rocks mentioned above. On Copper Mountain, a narrow trough of boulder conglomerate, less than 100 feet thick, follows the course of the Tremblay fault from the Copper Mountain fault northward to the Ada fault. The conglomerate contains boulders of altered and mineralized intrusive and volcanic rocks, but is itself not mineralized. This rock unit is very poorly exposed, and although it is almost certainly not cut by the Tremblay, Pit, and Ada faults, these important structures are shown on Figure 36 as crossing it, solely for purposes of clarity. The conglomerate, however, appears to stop against the Copper Mountain fault, suggesting some late movement along this structure. Similarly, volcanic rocks of the Princeton Group are cut by the northeast trending Honeysuckle Break on the No. 15 Fractional claim (Lot 1598).

Although most of the Nicola volcanic rocks on Copper Mountain are structureless massive flows and breccias, at least two units of generally well-bedded tuff and (or) volcanic siltstone exist and, through drilling and underground development work, their extent is sufficiently known to outline the structure of the Nicola rocks on Copper Mountain. The two marker beds, designated as unit 2 on Figure 37, are approximately 100 and 300 feet thick, are separated by some 300 to 400 feet of massive and fragmental volcanics, and resemble very closely unit 3 of Ingerbelle (Ann. Rept., 1968, pp. 208–212). They indicate that most of Copper Mountain is underlain by gently to moderately dipping strata in their original upright position. Exceptions to this rule are found in at least two places: (1) On the Triangle Fractional claim a small fault-bounded area of generally massive rocks contains a thin, well-bedded marker unit which shows that the strata are here nearly vertical, trend northwestward, and face northeast (*see* Fig. 36). These rocks are considered to be part of a tilted fault block, shown on Figure 36. (2) In the area bounded by the Copper Mountain fault, the contact of the Copper Mountain stock, the northerly trending dyke 4a (*see* Fig. 36) and the Honeysuckle Break, a sequence of thinly laminated schistose metasiltstone, tuff, and volcanic breccia strikes parallel to the intrusive contact and dips steeply to the northeast. These rocks have a well-marked mineral lineation which plunges gently to the east-southeast, and is made easily recognizable by an appreciable amount of widespread metamorphic biotite. Secondary pyroxene becomes a major metamorphic mineral very close to the intrusive contacts, and the rock is slightly less schistose. The schistosity, however, is here paralleled by a light-grey to nearly white alteration banding which continues to the southeast beyond dyke 4a, truncating the bedding where it dips gently to the northeast. West of dyke 4a, the schistosity parallels the general compositional layering of the rocks. It appears that dyke 4a probably follows an older northerly trending fault, and thus the area west of it probably is bound on three sides by faults and on the fourth side by the Copper Mountain stock. The rocks in this area are thus either part of a tilted fault block or are the limb of a faulted northwesterly trending fold which pre-dated the emplacement of the Copper Mountain stock.

As shown on Figure 36, a great number of faults cut intrusive and volcanic rocks on Copper Mountain. Of these, the largest ones have been given a name, and show the general pattern of fracturing. However, innumerable smaller faults, shears, and fractures are found on Copper Mountain, especially in the central part of the area. Northwesterly trending structures such as the Copper Mountain fault and fractures parallel to it, or northeasterly trending faults and fractures such as the Mine Breaks and the ore fractures, have been known and referred to for a long time (Fahrni, 1951). Recent work, however, has brought into focus the existence and importance of more northerly trending faults such as the Tremblay fault, which is almost entirely concealed by the Tertiary conglomerate, and of easterly trending faults such as the Pit and Ada faults, which have similarly trending structures as their counterpart at Ingerbelle, west of the Similkameen River. It would appear that easterly trending faults, such as the Ada and Pit faults, are at least in part older than northerly or northwesterly trending structures as they are either cut by them or stop against them.

It is believed that all faults mentioned above and, to a lesser extent, subsidiary structures parallel to them originated before the main period of mineralization and played an important part as ore controls, probably acting as avenues along which much of the ore-bearing solutions moved. This is suggested by the prominence of the long-known northeasterly trending "ore-fractures" in some parts of the camp, by the fact that all of the major faults run through or along the edges of orebodies (*see* Fig. 36) at least for a good part of their course, and by the fact that structures such as the Pit and Copper Mountain faults have definite "tails" of copper mineralization, albeit not economical, leading out along them from known orebodies. Most of the best known mineralization on Copper Mountain occurs in the central part of the area shown on Figure 36, where all the above-mentioned faults are strongest, best developed, and intersect one another.

Another factor that is believed to have played an important role in the localization of copper mineralization at Copper Mountain are rocks of the Lost Horse intrusions. This complex of intrusive rocks, all of them quartz poor, medium- to rather fine-grained and porphyritic, includes phases that range in composition from diorite to syenite, and show a great variation in amount of alteration. Lost Horse type rocks are known to occur from Wolf Creek west to the Boundary fault at Ingerbelle, and are most abundant in the northern part of this area (*see* Fig. 36 and Fig. 24, Ann. Rept., 1968). The complexity of rock types and alteration, and the lack of adequate exposures are such that only two main subdivisions can be made in the Lost Horse intrusions. One group, encompassing by far the larger amount of rocks, includes all those, altered or not, which do not form obvious dykes. The other group, consisting mostly of biotite-latite porphyry and of biotite-pyroxene microsyenite porphyry, includes rocks which are generally fresh and which cut older Lost Horse rocks as well-defined dykes up to 100 feet wide. Copper mineralization may occur in both groups, but is found to be best and most common in the older rocks. All Lost Horse rocks, whether fresh or extensively albitized, mineralized, or barren, have as a distinguishing characteristic the presence of disseminated, tiny, distinct phenocrysts of apatite which may be seen either with the naked eye or by using a good pocket magnifier.

For the following reasons it is suggested that rocks of the Lost Horse intrusions played a more direct role in the localization of copper mineralization than rocks of the Copper Mountain stock.

1. Lost Horse type rocks both at Copper Mountain and at Ingerbelle occur within or very close to orebodies and at many places form excellent ore.
2. Orebodies such as the one at Pit 2 crudely follow the contact between Lost Horse and Nicola rocks and include rocks of both units. At the north end of Pit 2 a body of intrusive breccia, roughly circular in plan and apparently forming a pipe-like body which plunges steeply to the north, contains as fragments almost exclusively Lost Horse rocks, and has excellent chalcopyrite-magnetite mineralization both in the matrix and in some of the fragments.
3. At Ingerbelle, and, but less obviously, at Copper Mountain albitization and hornfelsing of Nicola rocks is stronger close to Lost Horse rocks, and, if occurring in the right amount, appears to be a factor conducive to copper mineralization.

4. Although Nicola rocks, rock alteration, and faults similar to those present at Copper Mountain and Ingerbelle are found at other places along the periphery of the Copper Mountain stock, Lost Horse rocks are not present nor is copper mineralization of comparable extent and intensity to that of the Copper Mountain-Ingerbelle area.

The bornite-chalcopyrite fracture-filling type of mineralization that formed most of the ore mined in earlier years at Copper Mountain gives way rapidly to chalcopyrite-pyrite mineralization northeast of the Copper Mountain fault. Although in some places sulphide minerals are so finely distributed in the rock as to appear disseminated, in fact the greatest part if not all of the sulphides occur as fillings or coatings of fractures, which range in thickness from a few hundredths of a millimetre to several inches or, as in some rare cases, 2 or 3 feet. Copper mineralization as it is known today is not confined to or preferentially found in any particular rock type. In a favourable area good ore is found in all rock types, with massive intrusive and volcanic rocks or coarse fragmental rocks being as well mineralized as fine-grained tuff or volcanic sediments.

T (No. 273, Fig. 34)

LOCATION: Lat. 49° 19.5′ Long. 120° 36.5′ (92H/7E)
Two miles southwest of Kennedy Mountain, on the southeast side of Whipsaw Creek, adjoining the property of Ingerbelle Mines Limited.
CLAIMS: T 1 to 22.
OWNER: ANCHOR MINES LTD., 807, 409 Granville Street, Vancouver 2.
METAL: Copper.
WORK DONE: Three holes totalling 750 feet were diamond drilled.
REFERENCE: *Minister of Mines, B.C.*, Ann. Rept., 1968, p. 212.

AXE (No. 309, Fig. 34)

LOCATION: Lat. 49° 20′ Long. 120° 35′ (92H/7E)
Adjacent to and northwest of Highway No. 3, 14 miles south of Princeton.
CLAIMS: AXE 1 to 16.
ACCESS: Via Highway No. 3.
OWNER: NORANDA EXPLORATION COMPANY, LIMITED, 1050 Davie Street, Vancouver 5.
WORK DONE: Induced polarization survey.
REFERENCES: Assessment Reports Nos. 1745 and 2125.

JILL, TOW, JJJ (No. 364, Fig. 34)

LOCATION: Lat. 49° 18.1′–20′ Long. 120° 34.7′–37.6′ (92H/7E)
Between Whipsaw and Deep Gulch Creeks, 11½ miles south-southwest of Princeton.
CLAIMS: JILL 1 to 6, 3 Fraction, 8 to 25, 27, 29, 31, 33, 35, 37, 39; TOW 2, 4, 9 to 19; JJJ 1 to 12, including 72 claims in all.
ACCESS: By road, 12 miles south from Princeton.
OPERATOR: SCURRY-RAINBOW OIL LIMITED, 539 Eighth Avenue S.W., Calgary 2, Alta.
METAL: Copper.
WORK DONE: Geology mapped, 20 line-miles of ground magnetometer survey run, and 1,500 feet of diamond drilling done.
REFERENCES: Assessment Reports Nos. 948, 1601, and 2243.
DESCRIPTION: Disseminated sulphides in brecciated volcanic rock.