



TILLICUM MOUNTAIN GOLD-SILVER PROJECT
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INTRODUCTION

The Tillicum Mountain gold-silver property lies approximately 13 kilometres east of Burton and 30 kilometres south of Nakusp in southeastern British Columbia (Fig. 5). Publications relevant to this area include those by Cairnes (1934), Little (1960), Hyndman (1968), Parrish (1981), Kwong and Addie (1982), Roberts and McClintock (1984), McClintock and Roberts (1984), and Kwong (this volume).

Current exploration was initiated in 1980 after visible gold was discovered in the area by two local prospectors, Elaine and Arnold Gustafson. In 1982 Esperanza Explorations Ltd. and La Teko Resources Ltd. concluded a joint venture agreement to assess the property; a 1.5-million dollar exploration program of soil sampling, trenching, and drilling was completed in 1983. Seven prominent gold-bearing, skarn-like zones were outlined, namely the Heino-Money, East Ridge, Jenny, 950, Grizzly, South Slope, and Ridge Road zones. In addition, extensive silver geochemical soil anomalies were discovered in the vicinity of the defunct Silver Queen mine and over the 'Silver Jack' zone on Arnies Flats, approximately 2 kilometres southeast and 1.5 kilometres southwest of Tillicum Mountain respectively (Fig. 5). The 1983 drill program on the Heino-Money zone, situated 200 metres north of Tillicum Mountain, outlined a 1 to 7-metre-thick gold-bearing skarn horizon with a strike length of 150 metres and a depth of 60 metres. This zone currently comprises a 36 000-tonne orebody grading 20.5 grams gold per tonne (Roberts and McClintock, 1984).

During 1984, work by Esperanza Explorations Ltd. included driving a 60-metre adit into the upper part of the Heino-Money zone for both exploration and bulk sampling purposes. In addition, approximately 4 kilometres of new roads were constructed to the Silver Queen mine and Silver Jack areas, and the collapsed Silver Queen mine adit was reopened, sampled, and mapped by company geologists. Twelve drill holes were put down in the Silver Queen mine area, and the Silver Jack zone (Fig. 5) was trenched and mapped.

During the summer of 1984, the Geological Branch of the British Columbia Ministry of Energy, Mines and Petroleum Resources, in cooperation with Esperanza Explorations Ltd., completed a three-week geological mapping

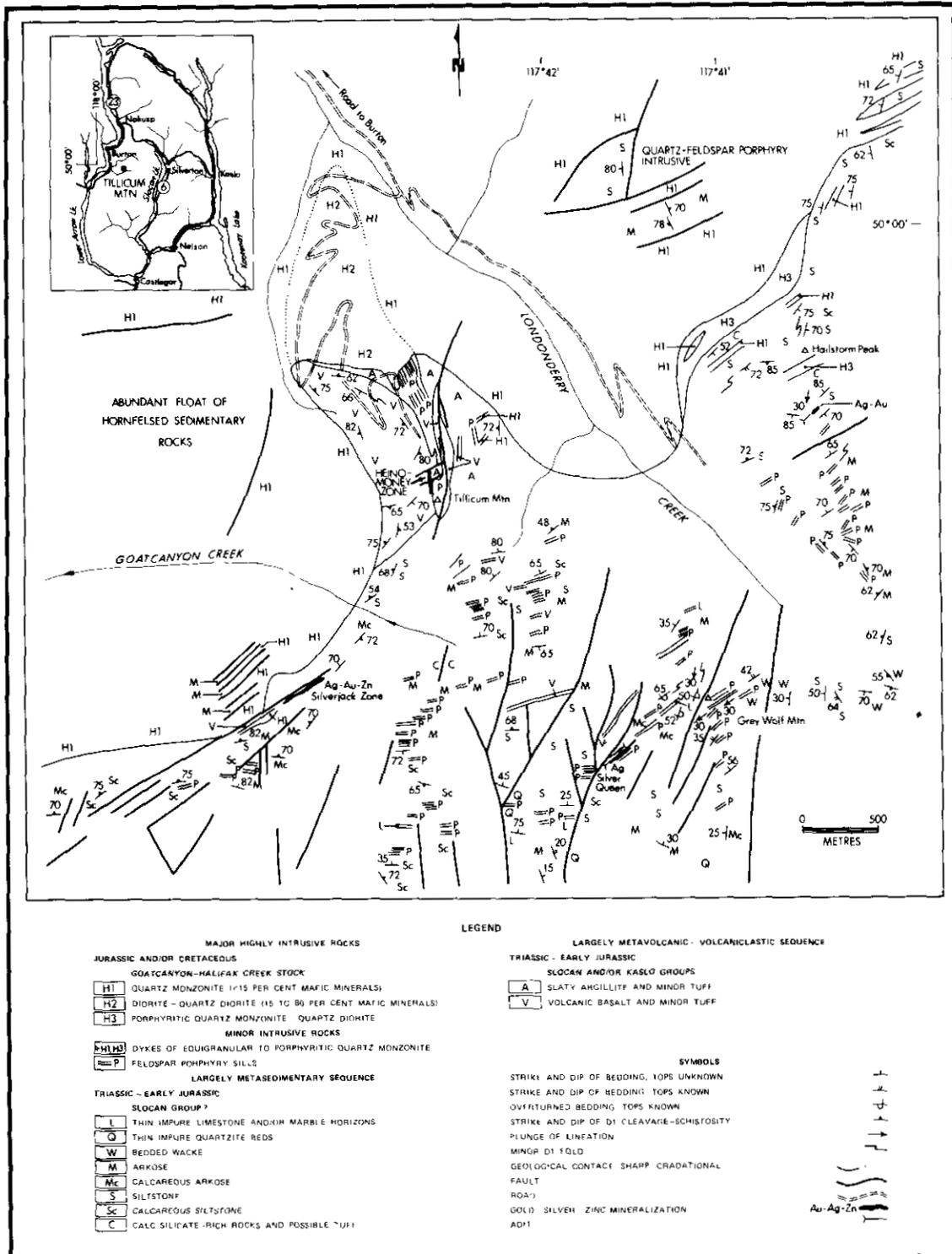


Figure 5. Simplified geology of the Tiliicum-Grey Wolf Mountains area.

and sampling program in the area. This work involved mapping, at 1:5000 scale, a 25-square kilometre area in the Tillicum Mountain-Grey Wolf Mountain-Hailstorm Peak area (Fig. 5). Two drill holes intersecting the gold-rich Heino-Money zone (hole TM 82-16) and the silver-rich Silver Queen mine zone (hole SQ 84-10) were systematically sampled. These core samples will be analysed for their major and trace element contents to determine whether any element zoning patterns or enrichment halos are associated with the mineralization. In addition, a suite of unmineralized mafic metavolcanic rocks and economically important feldspar porphyry sills were sampled; these will be subjected to whole rock analysis. Samples of some impure limestone beds in the Silver Queen mine vicinity will be analysed for microfossils.

REGIONAL GEOLOGY

The rocks hosting gold-silver mineralization in the Tillicum Mountain area lie within the easterly trending Nemo Lakes belt (Parrish, 1981), a 5-kilometre-wide roof pendant largely comprising a sequence of metasedimentary and metavolcanic rocks. To the north and west (Fig. 5), the belt is intruded by the Goatcanyon-Halifax Creeks stock of Jurassic and/or Cretaceous age (Hyndman, 1968), while to the south it is invaded by the Nemo Lakes quartz monzonite stock of Eocene age (Parrish, 1981). The Goatcanyon-Halifax Creeks stock is also largely of quartz monzonite composition (Hyndman, 1968); however, near Tillicum Mountain contamination by mafic volcanic rocks of the belt resulted in the local formation of hybrid quartz diorite and mafic diorite zones within the stock.

Supracrustal rocks of the Nemo Lake belt in the Tillicum Mountain-Grey Wolf Mountain-Hailstorm Peak area (Fig. 5) are dominated by metamorphosed siltstone, calcareous siltstone, arkose, and wacke, with lesser amounts of mafic volcanic rock, tuff, argillite, and some impure carbonate layers. The age, stratigraphy, and structure of the supracrustal rocks is uncertain. Little (1960) included them in the Triassic to Early Jurassic (?) Slocan Group. However, Hyndman (1968) split the section, placing the basic volcanic rocks on the northern slopes of Tillicum Mountain (Fig. 5) into the Triassic Kaslo Group, and the remaining metasedimentary rocks into the Pennsylvanian to Triassic Milford Group.

The supracrustal rocks have undergone a post-Early Jurassic phase of regional metamorphism and folding (Hyndman, 1968; Parrish, 1981) that predates the Middle to Late Jurassic intrusion of the granitoid stocks (Read and Wheeler, 1976). This event resulted in sillimanite grade metamorphism throughout most of the Nemo Lakes belt (Parrish, 1981); however, the grade was lower around Tillicum Mountain and resulted in the formation of biotite-muscovite-chlorite and amphibole. In addition to the regional metamorphism, the rocks have locally been subjected to at least two episodes of contact metamorphism. The first either preceded or accompanied the regional deformation and is associated with swarms of

feldspar porphyry sills that may be spatially and genetically related to some of the gold-silver mineralization in the district. The second hornfelsing postdates the regional deformation and is related to intrusion of the large granitoid stocks. The area also contains swarms of late lamprophyre dykes that cut both the supracrustal rocks and the Goatcanyon-Halifax Creeks stock.

GEOLOGY OF THE TILLICUM MOUNTAIN AREA

The simplified geology of the area between Tillicum Mountain, Arnies Flats, Grey Wolf Mountain, and Hailstorm Peak is shown on Figure 5. The northern part of the area is underlain by coarse-grained plutonic rocks of the Goatcanyon-Halifax Creeks stock; the southern portion is largely occupied by a highly deformed sequence of metasedimentary rocks. A small area of mafic metavolcanic rocks occupies an embayment adjacent to the Goatcanyon-Halifax Creeks stock, immediately north of Tillicum Mountain (Fig. 5).

GOATCANYON-HALIFAX CREEKS STOCK (UNIT H)

This stock, which is Jurassic and/or Cretaceous in age (Hyndman, 1968), is largely of quartz monzonite composition (unit H1). It generally contains between 3 and 10 per cent mafic minerals which mainly comprise biotite with sporadic hornblende. Southwest of Londonderry Creek (Fig. 5), the stock includes a 200 to 700-metre-wide, northerly trending zone of highly mafic diorite and quartz diorite (unit H2) containing between 15 and 80 per cent hornblende. This rock probably represents hybridized country rock in the stock since the unit lies on strike with a belt of mafic volcanic rocks that underlies the northern slopes of Tillicum Mountain. In thin section phenocrysts of hornblende up to 0.5 centimetre in length are observed; these contain pale brown cores and dark green margins. Minor amounts of chloritized, deformed biotite are present, and the unaltered, fresh matrix largely comprises hornblende and plagioclase (An₃₆₋₄₂). Minor to trace amounts of quartz, epidote, sphene, apatite, and carbonate are also present.

The third rock type identified within the Goatcanyon-Halifax Creeks stock is a distinctive, porphyritic biotite-hornblende granodiorite (unit H3) that contains up to 15 per cent mafic minerals; the rock is characterized by feldspar phenocrysts up to 2 centimetres in diameter. This unit occurs along the margins of the stock east of Londonderry Creek and north of Hailstorm Peak (Fig. 5). An 80-metre-wide dyke of this unit also intrudes metasedimentary rocks immediately south of Hailstorm Peak (Fig. 5).

The margins of the stock generally show no decrease in grain size, but immediately east of Londonderry Creek, the marginal phase of the quartz monzonite contains abundant xenoliths. The contact with the country rock is generally poorly exposed and is locally faulted. North of Hailstorm

Peak, however, a clear intrusive relationship is seen; dykes, sills, and stringers of xenolith-bearing, biotite granodiorite become more numerous, and the hornfelsing increases as the main stock is approached. Country rocks adjacent to the stock are recrystallized and often silicified, and many of the calcareous metasedimentary rocks have undergone weak skarn alteration. Screens and xenoliths are generally rare in the stock, but some relatively large, apparently fault-bounded units of country rock occur west of Arnie's Flats, northwest of Hailstorm Peak, and west of Tillicum Mountain (Fig. 5). These areas are poorly exposed but contain abundant float of highly hornfelsed, granitized metasedimentary rocks derived from arkosic and calcareous sediments.

METAVOLCANIC ROCKS (UNIT V)

This unit comprises an interlayered, highly deformed sequence of metamorphosed basalt, mafic tuff, and volcanic breccia, together with some argillite. It is largely confined to an area northwest of Tillicum Mountain where it forms an arcuate, apparently folded unit over 500 metres in outcrop width. Minor amounts of mafic volcanic rock immediately adjacent to the faulted margin of the Goatcanyon-Halifax Creeks stock, southwest of the Silver Jack mineral zone (Fig. 5), may represent part of this unit.

The metabasalts are massive to weakly layered to schistose; they comprise hornblende and calcic plagioclase with lesser amounts of biotite, chlorite, tremolite-actinolite, and carbonate. Some flows are characterized by flow brecciated margins and deformed, feldspar-filled amygdales up to 0.5 centimetre in diameter. The tuffs and coarse volcanoclastic rocks locally contain coarse hornblende crystals that can exceed 1.5 centimetres in diameter, and in most cases the clasts are highly deformed and stretched.

A few, thin mafic volcanic flows are present within the main metasedimentary sequence throughout the district. Two of these flows are seen north and northwest of the Silver Queen mine adit and each is traceable for over 300 metres along strike (Fig. 5). Both display amygdaloidal tops (?) on their northwestern margins; they may form part of a single flow that has been displaced by faulting.

METASEDIMENTARY ROCKS

Metasedimentary rocks underlie most of the southern and southeastern part of the area (Fig. 5). They comprise an interfolded, interlayered succession of mainly siltstone, arkose, and wacke with local calc-silicate-rich layers. Rare, thin beds of dolomitic limestone, marble, and impure quartzite are locally developed; the calcareous siltstone (unit Sc) and calcareous arkose (unit Mc) beds contain variable amounts of calc-silicate minerals. Argillites are relatively rare in the

sequence; most outcrop north of Tillicum Mountain where they are intimately associated with the mafic volcanic and volcanoclastic rocks (unit V). The slaty argillities (unit A) are generally very poorly bedded; they consist mainly of chlorite, biotite, quartz, feldspar, and tremolite with variable amounts of pyrite. Some argillites contain thin, discontinuous beds of siltstone and calc-silicate rock.

No marker horizons are recognized in the metasedimentary rocks. This, together with rapid lateral and vertical changes in lithology and the complex deformation, makes it difficult to outline lithological boundaries between the various metasedimentary rock units. Despite the deformation and metamorphism, however, sedimentary structures, including graded bedding, are locally preserved.

The siltstones (unit S) are massive to well-bedded, fine to medium-grained rocks that generally contain biotite, sericite, and chlorite totalling more than 8 per cent by volume. The arkoses (unit M) are generally leucocratic, feldspathic rocks that vary from massive to poorly bedded to weakly schistose. These generally carry biotite and sericite totalling less than 8 per cent by volume. Turbiditic wackes (unit W) are well developed in the vicinity of Grey Wolf Mountain where they display graded bedding, rare crossbedding, and some slump structures. The calc-silicate-rich sedimentary rocks are often massive, medium to coarse grained, and recrystallized. However, remnant bedding is locally preserved, together with coarse clastic horizons that may represent reworked volcanoclastic material. The calc-silicate-rich rocks contain tremolite-actinolite, clinozoisite, epidote, carbonate, and some diopside.

In a few localities, the supracrustal sequence contains thin beds of dolomitic limestone and marble (unit L), and impure quartzite (unit Q) that are interbedded with either wacke or siltstone. Individual beds seldom exceed 1 metre in thickness and many measure less than 3 centimetres. Coarse-grained, recrystallized, and deformed dolomitic marble beds crop out west and southwest of Grey Wolf Mountain, and some skarn-altered, mineralized calcareous horizons and marble beds are seen in the vicinity of the defunct Silver Queen mine (Fig. 5).

LESSER INTRUSIVE ROCKS

These are divisible into four main suites, namely: feldspar porphyries (unit P) that have been affected by the regional deformation and metamorphism; granodiorite sills (unit H1) that are related to the Goatcanyon-Halifax Creeks stock; aplitic dykes that cut the stock and probably represent a late phase of its intrusion; and swarms of late stage lamprophyre dykes that appear to be the youngest intrusions in the district. Due to their small dimensions the aplites and lamprophyres are not shown on Figure 5.

The feldspar porphyries (unit P), which occur as sill-like bodies varying from 1 to over 100 metres in width, tend to concentrate in swarms. They may have economic significance because the skarn alteration and mineralization in both the Heino-Money zone and the Silver Queen mine area are spatially, and possibly genetically, related to these sills. Originally, company geologists considered these rocks to represent felsic volcanic flows, but rare crosscutting intrusive features and xenoliths are seen, and the sills are widely distributed throughout the district. These rocks are generally of diorite to quartz diorite composition; they are leucocratic and are characterized by abundant plagioclase phenocrysts up to 1 centimetre in diameter. Biotite generally forms less than 10 per cent by volume and is the commonest and most widespread mafic mineral; however, some rarer, more mafic sills contain appreciable quantities of hornblende.

Igneous textures and euhedral feldspar phenocrysts are seen in the central portions of the larger sills but the margins are often schistose with highly flattened feldspar crystals. In thin section the margins of the oligoclase phenocrysts are often recrystallized, being rimmed with small crystals of fresh untwinned plagioclase. In many areas this recrystallization process is complete and the phenocrysts are pseudomorphed by a mosaic of small plagioclase crystals, each less than 0.1 millimetre in diameter. The fine-grained matrix mainly comprises plagioclase and random to subaligned flakes of biotite; there are minor to trace amounts of quartz, hornblende, chlorite, and sulphides. Country rocks immediately adjacent to the feldspar porphyry sills are often weakly hornfelsed, and at many localities throughout the district the sills are spatially associated with calc-silicate skarn alteration which is geochemically anomalous in gold and silver.

Granodiorite to quartz monzonite sills and dykes (unit H1) related to the Goatcanyon-Halifax Creeks stock are up to 50 metres thick; most are found within 300 metres of the main stock margin. They are generally leucocratic and locally contain abundant xenoliths of country rock. Most sills are biotite bearing, but southwest of the Silver Jack zone (Fig. 5) one 200-metre-long sill contains up to 25 per cent hornblende and biotite.

Aplite or alaskite dykes and sills, mostly less than 2 metres wide, are common in the area; they cut both the Goatcanyon-Halifax Creeks stock and the surrounding country rocks. The leucocratic sills have sharp margins and are white to grey in colour. Some bodies contain round quartz phenocrysts up to 3 millimetres in diameter; a few of the larger dykes also contain some biotite and hornblende phenocrysts. These rocks appear to represent a late phase of the Goatcanyon-Halifax Creeks stock.

Lamprophyre dykes up to 15 metres in width are common in the district. They have sharp margins and generally occur in swarms that follow pre-existing, northerly to northeasterly trending fault zones. In outcrop they form dark, medium to coarse-grained, massively textured

rocks that carry coarse crystals of biotite, amphibole, and possibly pyroxene. It is likely that several different mineralogical lamprophyre suites are present in the area. In rare instances these rocks exhibit compositional layering parallel to the dyke margins, and the central portions of some bodies carry either rounded feldspathic clots up to 5 centimetres in diameter or vague, diffuse, mafic xenoliths. A narrow lamprophyre sill in the Silver Queen mine area consists predominantly of highly clouded feldspar laths up to 1 millimetre in length. Biotite makes up 15 per cent by volume and forms weakly chloritized, randomly oriented crystals up to 0.5 millimetre long. Large pseudomorphs after phenocrysts of amphibole or pyroxene are entirely replaced by chlorite, and the rocks contain small, rounded quartz-filled amygdales (?). The groundmass carries trace amounts of tremolite-actinolite, quartz, carbonate, and sulphides.

STRUCTURAL HISTORY OF THE TILLICUM MOUNTAIN AREA

A postulated history of events in the area is shown in Table 1. Minor folds and reliable bedding-cleavage intersections are rare in the district. Nevertheless, two episodes of regional deformation are recognized; these are tentatively correlated with the two structural phases outlined in the Nemo Lakes belt further east (Parrish, 1981). The earliest (D1) produced large-scale folds with an associated axial planar cleavage-schistosity. Fold axes, as measured from the rare bedding-cleavage intersection lineations, now plunge approximately 30 degrees in a southwest to south-southwest direction. Younging directions recorded from both graded and current bedding are mostly vague and uncertain. However one fault-bounded panel west of Grey Wolf Mountain (Fig. 5) appears to be structurally inverted, while the sedimentary package immediately to its east is upright. This, together with the absence of hinge zone structures in the area and the widespread parallelism of bedding and cleavage, suggests the D1 folding was isoclinal. Major slicing probably took place along the fold hinges. Also the presence of isoclinally folded veins that crosscut the finely preserved bedding, indicates that considerable transposition occurred parallel to bedding. D1 vergence indicators suggest that most of the sedimentary rocks antiform toward the northwest. This would indicate that the intimately associated volcanic, volcanoclastic (unit V) and argillite (unit A) rocks represent the oldest portion of the supracrustal assemblage (Table 1).

A few minor D2 folds were seen in the area; these produce open to tight structures that deform the bedding and the D1 cleavage. This structural event is also believed responsible for many of the large scale orientation changes of the bedding-cleavage and for the arcuate swing in the trend of the mafic volcanic unit west and northwest of Tillicum Mountain (Fig. 5).

Several fault sets are identified. A major set of normal north to northeasterly trending faults partly controlled emplacement of the

lamprophyre dyke swarms. Following intrusion of these dykes, this fault set was reactivated to produce fault breccias containing angular clasts of lamprophyre and country rock set in a matrix of white, vuggy, crystalline quartz. Some movement along this northerly trending fault system is post-Eocene in age, because faults of this set cut the Nemo Lakes stock (Parish, 1981).

A less important, southeast to south-southeasterly trending fault set occurs west of the Silver Queen mine, while west of Arnie's Flats (Fig. 5) an east-northeast-striking zone of intense faulting is seen. This follows, in part, the margin of the Goatcanyon-Halifax Creeks stock and appears to control the Silver Jack mineralization.

TABLE 1
HISTORY OF EVENTS IN THE TILLICUM MOUNTAIN AREA

- (8) Reactivation of northerly trending faults.
- (7) Intrusion of lamprophyre dykes along pre-existing, north-south to northeast-trending faults.
- (6) Intrusion of aplite sills and dykes.
- (5) Intrusion of the Goatcanyon-Halifax Creeks stock with widespread hornfelsing along margins. Possible remobilization of some gold-silver mineralization as seen at the Silver Jack zone.
- (4) D2 regional open to tight folding of schistose supracrustal rocks.
- (3) D1 regional tight to isoclinal folding together with regional upper greenschist to amphibolite facies metamorphism. This was accompanied by the intrusion of the feldspar porphyry sills. Local hornfelsing, skarn formation, and introduction of gold-silver mineralization at the Heino-Money and Silver Queen mine zones.
- (2) Deposition of the mainly sedimentary sequence of arkose, siltstone, turbiditic wacke, and marls with rare mafic volcanic flows.
- (1) Basaltic volcanism and deposition of volcanoclastic rocks and argillites.

MINERALIZATION IN THE TILLICUM MOUNTAIN AREA

The gold-silver mineralization in the district can be broadly separated into two types, namely:

- (1) Gold and/or silver mineralization within skarn alteration that has a spatial, and possibly genetic, relationship to some feldspar porphyry sills (unit P) in the area. This type, which is widespread throughout the district, is best represented by the Heino-Money zone and mineralization at the Silver Queen mine.

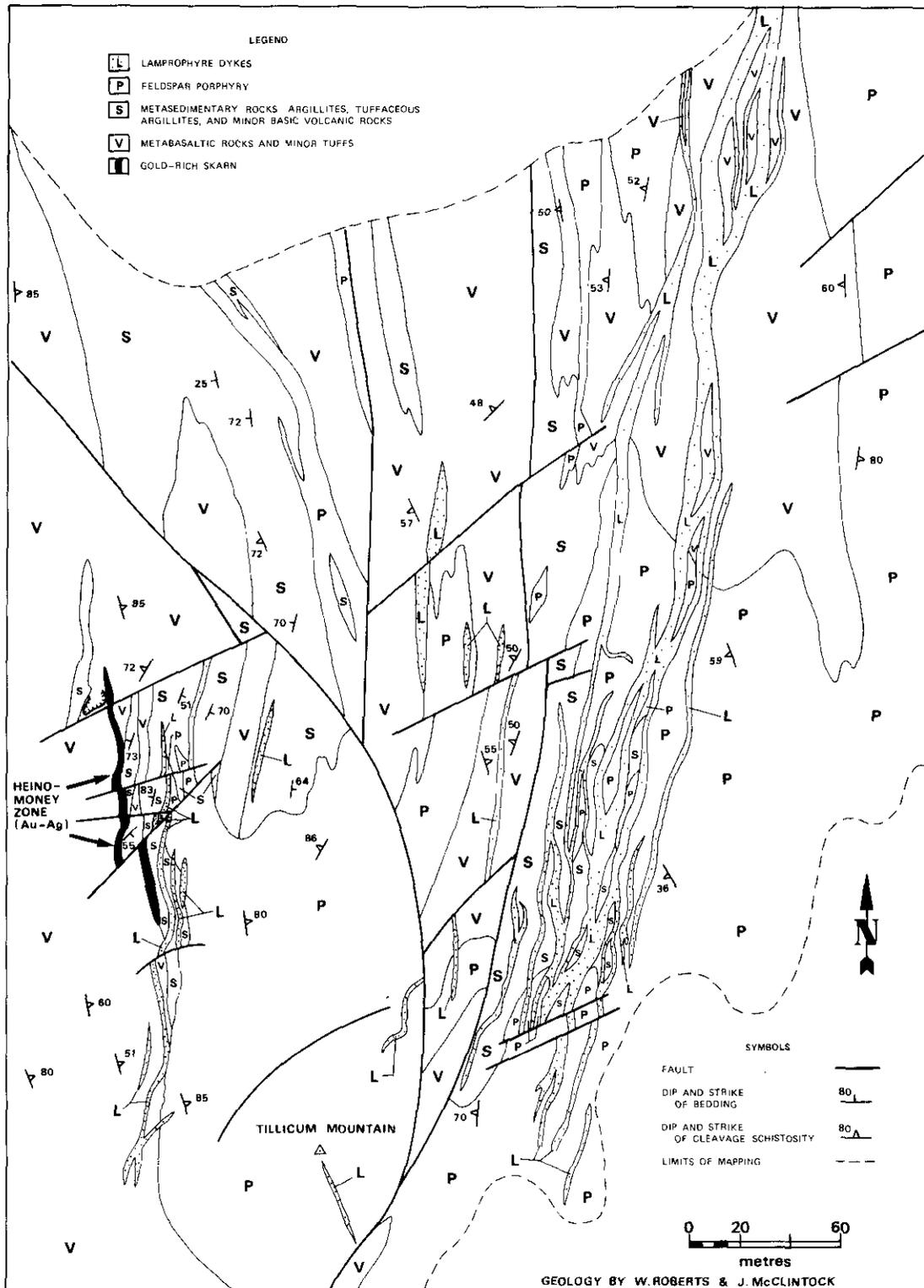


Figure 6. Geology of the Heino-Money zone.

- (2) Silver-gold mineralization within a siliceous and potassium-rich shear zone that shows no skarn development and is apparently unrelated to the feldspar porphyry sills. The Silver Jack mineralization, which is still very poorly understood, is the only example of this type identified in the area.

These two types of mineralization are described as follows:

SKARN-RELATED MINERALIZATION

At numerous localities throughout the Tillicum Mountain area, the margins of some feldspar porphyry sills, and the immediately adjacent country rock, are overprinted with skarn alteration that often carries geochemically anomalous amounts of gold and/or silver. These skarns are divisible into gold-rich and silver-rich types as represented respectively by the Heino-Money and Silver Queen mine mineralization.

At the Heino-Money zone the gold-bearing, siliceous, calc-silicate skarn alteration is stratabound; it is mainly hosted in a thin, wedge-shaped package of andesitic tuff and tuffaceous sediment which is bounded to the west by metabasalts and to the east by a large altered feldspar porphyry body (Fig. 6). The skarn is characterized by a pinkish green colour, and is generally well layered with subparallel, thin, quartz veins and variable amounts of sulphides. The skarn assemblage includes quartz, tremolite-actinolite, clinozoisite, plagioclase, diopside, biotite, garnet, and microcline with minor amounts of sericite and carbonate. Free gold occurs as fine to coarse disseminations and fracture fillings within and along the walls of quartz and sulphide impregnations; it is often associated with pyrrhotite, pyrite, galena, and sphalerite (Roberts and McClintock, 1984).

A polished section study of the Heino-Money mineralization (Northcote, 1983) indicated that individual gold grains range from less than 0.0025 millimetre to over several millimetres in diameter. The gold occurs as plates and anhedral grains which are generally free, but are also intimately associated with pyrrhotite, arsenopyrite, sphalerite, and pyrite-marcasite. Some pyrrhotite grains are rimmed with colloform pyrite-marcasite, while others contain small masses of hematite and graphitic material. Northcote (1983) also reports minor to trace amounts of tetrahedrite, chalcopyrite, and possible electrum.

The Silver Queen mine property was active in the 1930's, but reportedly work terminated after a spring avalanche closed the adit and caused the death of some miners. Intrusion of feldspar porphyry sills into a 30-metre-wide zone of impure calcareous metasedimentary rocks and thin marble beds was accompanied by stratabound skarn development. Two mineralized horizons up to 10 metres thick are recognized; mineralization and skarn alteration is found in both the altered marbles and the adjacent feldspar porphyry sills. However, mineralization differs from the Heino-Money zone in that it is silver dominant and gold is generally

absent. The skarn assemblage includes quartz, tremolite-actinolite, clinozoisite, garnet, biotite, and carbonate with minor amounts of epidote and sphene. Anhedral garnet crystals up to 1 millimetre in diameter have clear margins but abundant inclusions in their cores. In some instances the garnet cores have overgrown and clearly preserved a biotite schistosity. Mineralization is traceable for 300 metres along strike and grades from 3 to 240 grams silver per tonne; gold is generally not detectable. Sulphides identified include pyrite, pyrrhotite, tetrahedrite, sphalerite, galena, and pyrargyrite.

SHEAR-RELATED MINERALIZATION

The only known example of shear-related mineralization is the Silver Jack zone on Arnies Flats, approximately 1.5 kilometres southwest of Tillicum Mountain (Fig. 5). The area is poorly exposed; the showing was discovered during follow-up work on a spectacular silver geochemical soil anomaly. Mineralization, which includes fine pyrite, sphalerite, rare chalcopyrite, and traces of molybdenite, extends for more than 300 metres along strike and averages 6 metres in width. It appears to occupy and follow a prominent east-southeast-trending shear zone that is quartz and potassium feldspar rich. This shear follows, in part, the margin of the Goatcanyon-Halifax Creeks stock and also cuts arkoses and siltstones in the sedimentary sequence. The zone averages 170 grams silver per tonne and 0.7 gram gold per tonne (McClintock and Roberts, 1984).

CONCLUSIONS

The Tillicum Mountain area contains a highly deformed supracrustal assemblage which is tentatively divisible into an older mafic volcanic-volcaniclastic sequence and a younger sedimentary sequence; there is no evidence that these are separated by either a structural break or unconformity. On lithological grounds the sedimentary rocks are correlated with the Slocan Group, while the older volcanic-argillite package are correlated with either the Slocan or Kalso Groups (Fig. 5).

The regional structural deformation involved an early D1 period of large scale, isoclinal folding with considerable shearing and attenuation along the hinge zones. Two hornfelsing episodes are recognized; the earliest is related to the intrusion of the feldspar porphyry sills (unit P), while the second was more widespread, postdates the regional deformation, and is associated with emplacement of the Goatcanyon-Halifax Creeks stock.

Most of the gold and/or silver mineralization in the district is associated with skarn development which is spatially, and possibly genetically, related to the intrusion of the feldspar porphyry sills. Garnets in the skarn alteration at the Silver Queen mine overgrow a pre-existing biotite schistosity; this suggests that the foliated,

deformed feldspar porphyry sills were intruded sometime during the D1 regional folding. Thus the skarn-related mineralization, like the D1 structural event, is probably post-Early and pre-Late Jurassic in age.

The skarns are divisible into gold-rich and silver-rich types, as seen respectively at the Heino-Money and Silver Queen mine zones. It is uncertain whether these two types are synchronous and reflect a district scale gold-silver zoning, or whether they indicate two or more generations of mineralization. A third type of gold-silver mineralization is present at the Silver Jack zone. This is not related to skarns but is hosted in a silicified shear zone; the age and source of the Silver Jack mineralization are unknown.

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