Chappelle Gold-Silver Deposit, British Columbia

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Abstract

High-grade gold-silver mineralization associated with electrum and argentite was discovered in a quartz vein at the Chappelle property, 273 km north of Smithers, B.C., in 1969 following a regional geochemical reconnaissance program in the Cassiar-Omineca Mountains. Subsequent exploration resulted in the discovery of numerous quartz veins with associated precious-metal values in a belt 17 by 3 km in area centrally located within Toodoggone Group volcanic and sedimentary rocks of Lower to Middle Jurassic age and a window of Takla Group volcanic rocks of Upper Triassic age.

More detailed investigations, consisting principally of 5677 m of surface drilling in 57 holes and crosscutting, drifting and raising on Chapelle Vein A, has outlined a high-grade gold-silver-bearing shoot with a strike length of 200 m, an average width of about 3 m and extending to an average depth of about 40 m below surface.

Introduction

RICH GOLD-SILVER-BEARING float fragments were discovered on the present property in 1969. The source lies at an elevation of about 1700 m in a sub-Alpine environment at the west margin of the Omineca Mountains (latitude 57°16′N; longitude 127°06′W), about 273 km north of Smithers, British Columbia (Figs. 1 and 2).

Present access to the property is by aircraft to a gravel airstrip at Black Lake, about 7 km to the southeast. A dirt road provides access from the airstrip to the property. Black Lake is 65 km north of the present terminus of the Omineca Road. The road has been extended for 240 km northerly from Germansen Landing to this portion of British Columbia over a 25-year period by the B.C. Department of Mines and Petroleum Resources to promote prospecting activity. The property also lies about 88 km northeast of the proposed northern extension of the British Columbia Railway to Dease Lake.

This paper discusses the mode of discovery, history of exploration, geologic setting, mineralization, and geophysical and geochemical characteristics of the Chappelle gold-silver deposit.

History

The earliest recorded prospecting activity in the area was associated with placer gold mining on Toodoggone River, 6 km north of the property, in the early 1930's. Lead-zinc mineralization in skarn, which lies 1500 m southwest of the Chappelle gold-silver deposit, was also discovered, staked and explored by Cominco during this period.

In 1968, Kennco Explorations (Western) Limited carried out geochemical reconnaissance surveys in

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Keywords: Chappelle deposit, Gold deposits, Silver deposits, Geology, Exploration, Geochemical exploration, Geophysical exploration, Mineralization, Ore genesis.

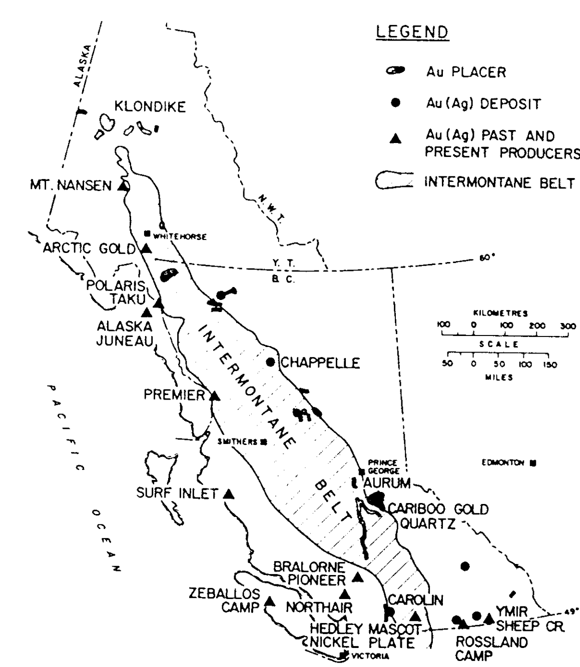


FIGURE 1
PRINCIPAL LODE & PLACER GOLD DEPOSITS
CANADIAN CORDILLERA

FIGURE 1 — Principal lode and placer gold deposits — Canadian Cordillera.

the search for porphyry copper deposits in the vicinity of the Hogem and Cassiar batholiths. Several base-metal anomalies were defined which were considered of further interest. During follow-up of a molybdenum-silver soil anomaly at the present property in 1969, Gordon Davies, a prospector employed by Kennco, noted leached, pyritic quartz float in felsenmeer. His curiosity aroused by the precious-metal possibilities in an area which appeared to possess only limited base-metal potential, Davies and others were gratified when one of several fragments collected assayed 85.7 g Au/tonne (2.5 oz/ton) and 2229.0 g Ag/tonne (65 oz/ton). Between 1970 and 1972, exploration, consisting principally of trenching, resulted in the discovery of quartz veins near the mineralized talus and at six other locations within the general area.

The only significant precious-metal mineralization discovered to date occurs in Vein A, near the site of the original discovery of gold-silver-bearing float. Detailed surface sampling on Vein A indicated an average content of 34.3 g Au/tonne (1.0 oz/ton) and 617.4 g Ag/tonne (18 oz/ton) for a length of 230 m and across an average width of 3.0 m. Two X-ray drill holes in the assumed plane of the vein in 1971 indicated persistence of high-grade mineralization to a depth of at least 20 m and gave confidence to the belief that this mineralization was not related to supergene enrichment processes.

In 1973, Kennco decided that the property should be dealt to outside parties and an agreement was entered into with Conwest Explorations Ltd., who drove an adit for 150 m to intersect the downward extension of

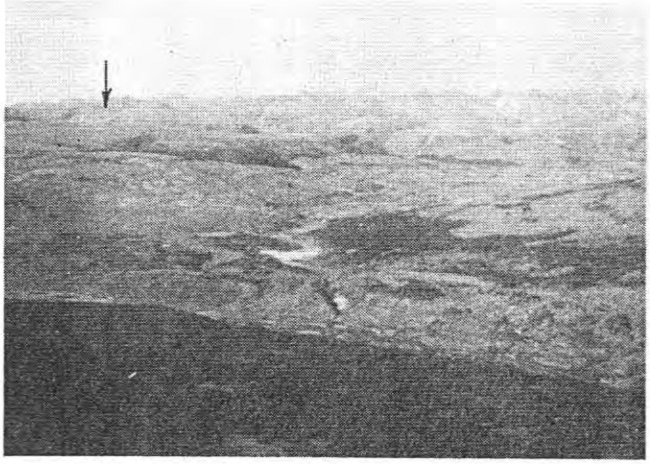
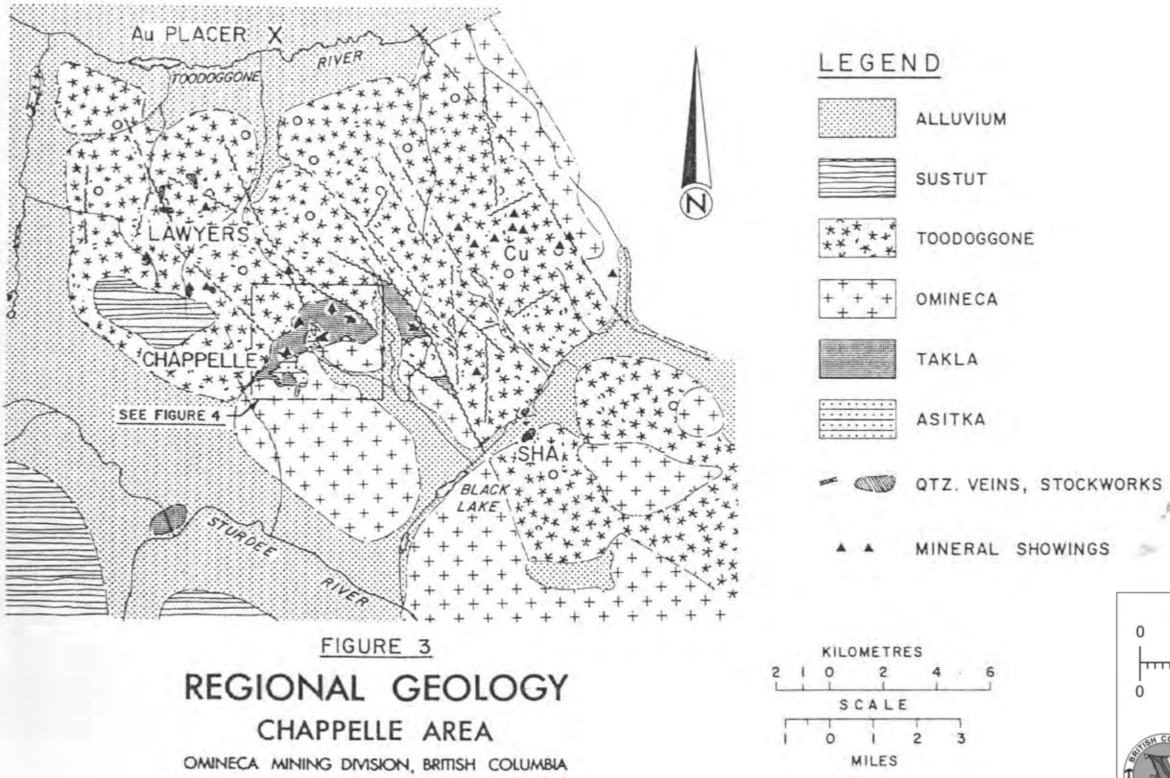


FIGURE 2 — View north across Sturdee River to Chappelle area. South end of Black Lake to right of center. Present road from Black Lake airstrip to property extends up valley to the northwest. Cassiar-Omineca Mountains on skyline. Arrow points to Vein A.

Vein A and drifted on the vein for 50 m. From these workings, 546 m of diamond drilling were completed in 11 holes. Some underground diamond drilling was also completed; however, the results of the underground program were not particularly encouraging and Conwest terminated its option at the end of 1973.

Early in 1974, Du Pont of Canada Exploration Limited optioned the property and by the end of 1976



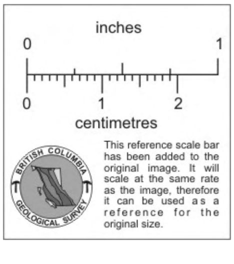


FIGURE 3 — Regional geology — Chappelle area.

had spent about $750,000 mostly in exploring the extensions of the Vein A system, and in further evaluation of other quartz veins in the area. This program included 5677 m of surface diamond drilling in 57 holes, 59 m of underground drilling and 186 m of drifting and raising on the shoot in the Vein A system which contains the delineated high-grade mineralization.

Geological Setting

The locations of the principal lode and placer gold deposits in the Canadian Cordillera are shown in Figure 1. Although more than 100 lode gold mines have operated in British Columbia since the turn of the last century, two-thirds of the lode gold produced by 1975 was recovered from five mines or mining camps, mainly the Rossland camp, the Nickel Plate Mine at Hedley, the Pioneer and Bralorne mines in the Bridge River area, the Premier Mine in the Portland Canal District and the Cariboo Gold Quartz and Island Mountain mines in the Barkerville district (Bacon, 1975). The average grade of these producers was about 17 g Au/tonne (0.5 oz/ton) and they each mined from 3 to 7 million tonnes during their operating lives, varying from 28 to 43 years. Most of the lode gold produced has been derived from veins occupying fractured and faulted zones in Mesozoic volcanic and sedimentary rocks near both margins of the Intermontane Belt and closely associated with a variety of intrusions.

The Chappelle property lies near the eastern margin of the Intermontane Belt (Fig. 1). The vein systems which contain the gold-silver mineralization occur within a small window of Takla Group volcanic rocks of Upper Triassic age, which are intruded by granitic stocks of the Omineca Intrusions and overlain unconformably by Jurassic and younger volcanic and sedimentary rocks (Fig. 3). The oldest rocks recognized are occasional wedges of crystalline limestone, up to 150 m or more thick, which are part of the Asitka Group of Permian age. To the north and east, the Takla Group rocks are unconformably overlain by Toodoggone Group rocks, of Lower to Middle Jurassic age, which also contain gold-silver-bearing quartz veins. Several kilometres to the west of the property, the Toodoggone Group rocks are uncomformably overlain by Sustut Group sedimentary rocks of Upper Cretaceous to Tertiary age.

Rocks in the property area have been subjected to extensive normal block faulting from Jurassic to Tertiary time and by thrusting of the Asitka Group rocks over the Takla Group rocks during Middle Jurassic time.

ASITKA GROUP

Asitka Group rocks, comprising about 80 per cent calcite marble, 15 per cent chert, and 5 per cent argillite, sandstone and skarn with minor amounts of volcanic rocks, are well exposed in three separate parts of the map-area (Fig. 4). Calcite marble occurs immediately to the west of gold-silver-bearing Vein A and is inferred from drilling and surface mapping to have a minimum thickness of 150 m in this thrust-

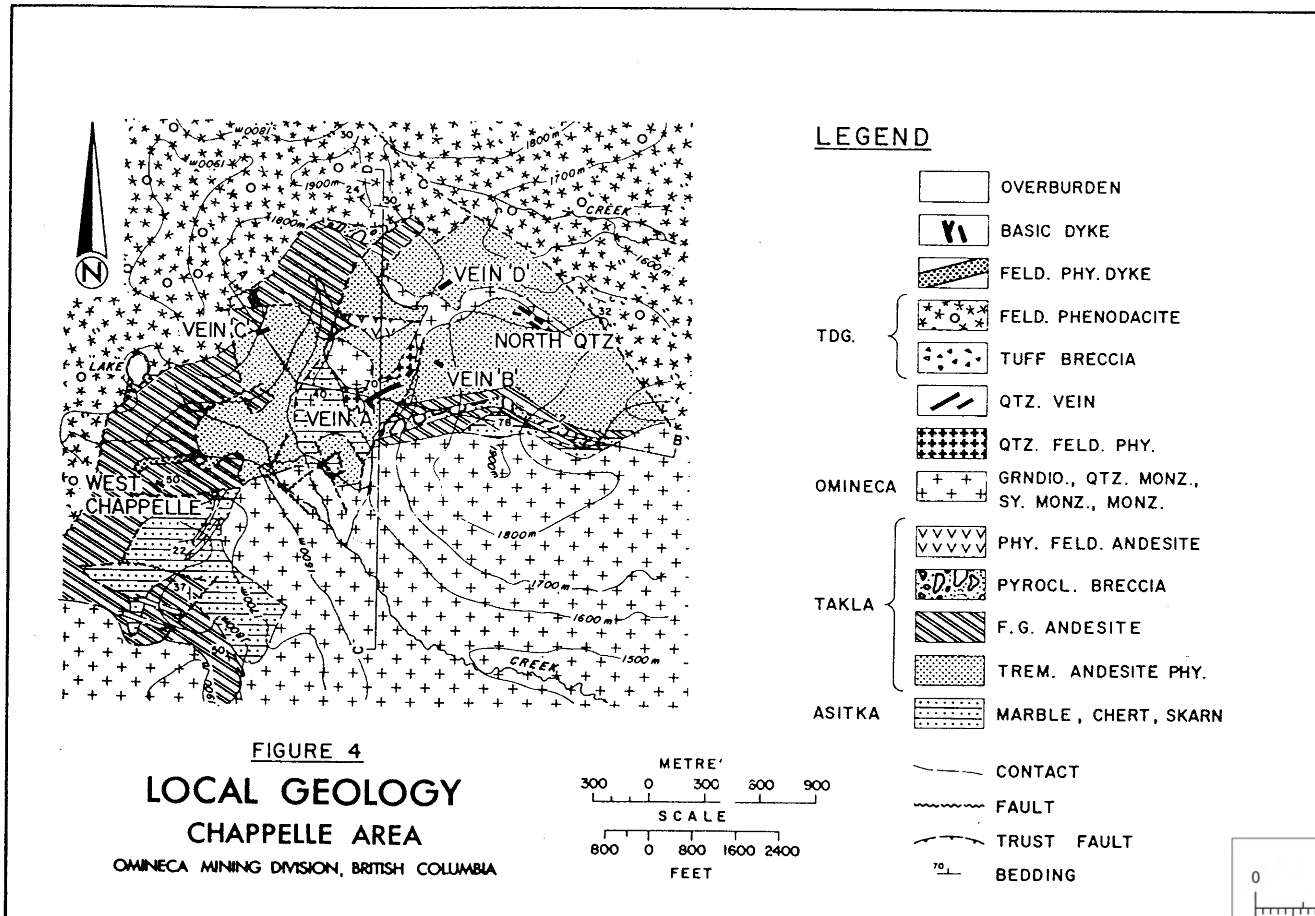


FIGURE 4 — Local geology — Chappelle area.

faulted block (Fig. 5). Garnetiferous calcite marble and limestone occur in another thrust-faulted remnant in the eastern part of the map-area. A slightly recrystallized limestone is exposed in the extreme southwestern part of the map-area (G. Popp, in report by Drown, 1975).

The calcite marble has lost all evidence of its original texture, whereas the limestone and garnetiferous calcite marble retain some of their depositional textures.

Skarns which have developed near contacts with the Omineca Intrusions commonly contain garnet, magnetite, tremolite and galena and are the hosts for silver-lead-zinc deposits explored by Cominco and others in the southwest part of the map-area.

Small chert beds intercalated with the more massive limestone are intensely folded. Carter (1972) has noted that in the southwestern part of the map-area, limestone is thrust in a southerly direction over the volcanic rocks and planes of schistosity in the limestone reflect the limbs of a recumbent isoclinal fold which has been warped into a broad open fold, with a northwest-striking axis, during a second period of folding probably related to thrust faulting.

TAKLA GROUP

All the larger quartz vein systems discovered to date within the map-area shown in Figure 4 occur in the Takla Group. The most recent mapping completed (Drown, 1975) has led to the recognition of four principal units: tremolite andesite porphyry, fine-grained andesite, pyroclastic breccia and porphyritic feldspar andesite. Underground mapping by Maclean (1977) in 1976 led to the recognition of a dacite unit (Fig. 6a), about 10-20 m thick, in the footwall of the Vein A deposit. The unit is tentatively grouped with the tremolite andesite porphyry unit.

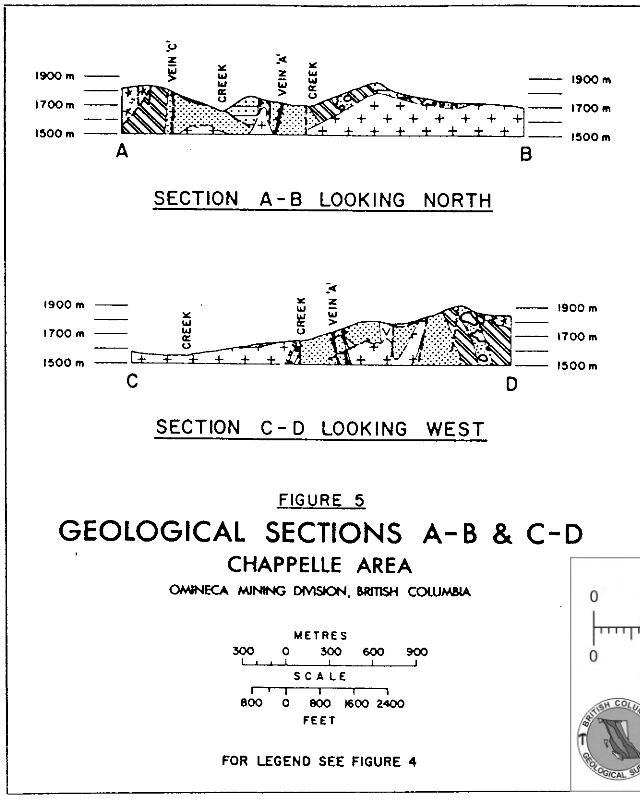
The oldest and most abundant unit of the Takla Group is tremolite andesite porphyry (Fig. 6b), which typically consists of large (3-4 mm) euhedral phenocrysts of tremolite in a dark grey aphanitic groundmass composed predominantly of oligoclase and minor tremolite and magnetite. It generally contains about 1 per cent pyrite by volume.

Fine-grained andesite overlies the porphyritic tremolite andesite porphyry (Drown, 1975) and is the second most common member of the Takla Group in the map-area. It is typically a massive light green to green-grey fine-grained andesite with small (1 mm) anhedral feldspar phenocrysts. It contains an average of 1 per cent pyrite, but is only occasionally magnetic.

A restricted area of dark grey porphyritic feldspar andesite occurs about 300-400 m north of Vein A. It consists of medium-sized (2 mm) subhedral feldspar phenocrysts accompanied occasionally by small pyroxene phenocrysts in a fine-grained matrix. It is non-magnetic and only weakly pyritic.

Pyroclastic breccia occurs in the northern and eastern parts of the map area and is typically composed of lapilli-sized multi-coloured clasts of fine-grained andesite in a fine-grained beige to grey-green matrix. Pyrite is common in the eastern exposure, but is rarely observed in the northern exposure. The member is non-magnetic.

With the exception of the dacite unit, the Takla Group rocks are all epidotized and the tremolite andesite porphyry, fine-grained andesite and dacite are commonly silicified, particularly in the vicinity of quartz veins. Pyroxenes are generally chloritized and



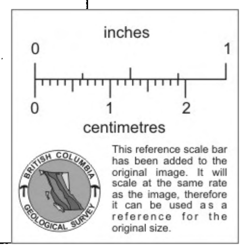


FIGURE 5 — Geological Sections A-B, C-D — Chappelle area.

feldspars are sericitized, with more intense alteration present near quartz veins and in faulted areas. Laumontite, a pink zeolite, commonly occurs on fractures in the Takla Group rocks and in other rocks. Anhydrite commonly occurs as veinlets and fracture fillings at depths of 70 m or more below surface.

Because of the massive nature of the Takla Group, attitudes are rarely determinable. However, limited observations indicate that units strike north in the southwestern part of the map-area (Fig. 4) and northeasterly in the eastern part of the map-area, with steep to moderate dips. As exposed, the sequence appears to represent part of a northeast-striking and southwest-plunging anticline.

The more pyritic portions of the Takla Group rocks produce extensive gossans throughout the area, but to date no significant base-metal occurrences have been discovered in these areas.

OMINECA INTRUSIONS

Both the Asitka Group and Takla Group rocks are intruded by granitic stocks of the Omineca Intrusions (Fig. 6c). The largest of these, named the Black Lake Intrusion, extends southeasterly for 9 km from the Chappelle property and varies in composition from granodiorite to quartz monzonite. Radiometric K-Ar dates obtained by the Geological Survey of Canada on hornblende from this pluton indicate an emplacement age of 186 m.y. Another pair yielded ages of 189 m.y. and 200 m.y. on biotite and hornblende respectively (H. Gabrielse, pers. comm.).

Two small syenomonzonite intrusions occur immediately to the north of the Black Lake Intrusion near Vein A. The typical rocks are pink to white, coarse to medium grained and commonly porphyritic, with subhedral to anhedral augite phenocrysts.

Highly altered quartz-feldspar porphyry, which ap-

FIGURE 6 — Photographs of Rock Specimens.

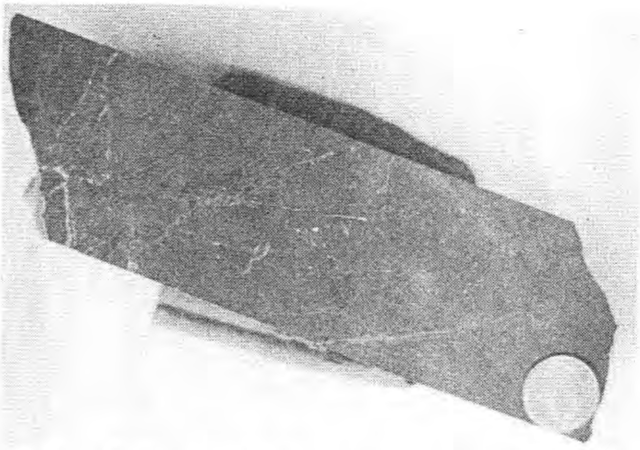


Fig. 6a — Drill core of silicified dacite in area occupied by southwest extension of Vein A (coin diam. 1.75 cm).

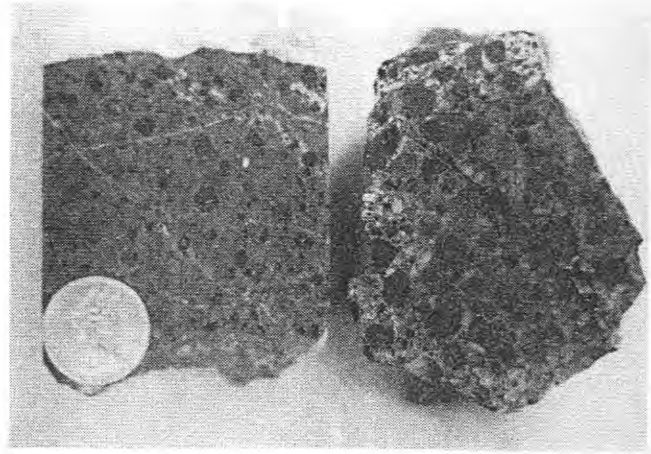


Fig. 6b — Porphyritic tremolite andesite and andesite porphyry near Vein A (coin diam. 1.75 cm).

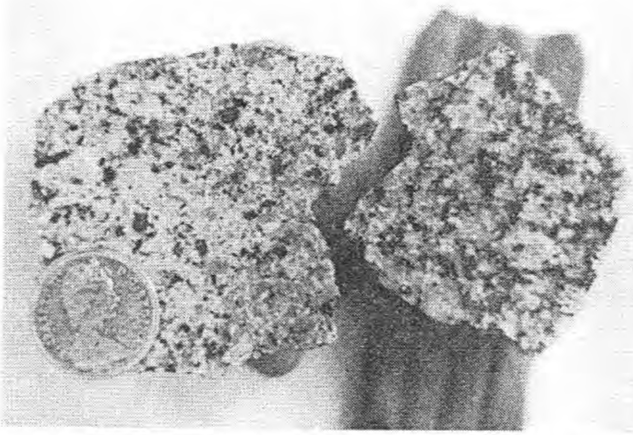


Fig. 6c — Altered hornblende granite from north edge of Black Lake Intrusion (coin diam. 1.75 cm).

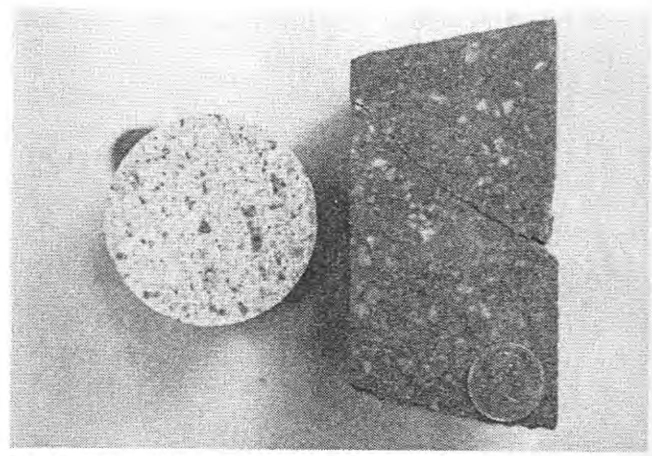


Fig. 6d — Bleached quartz-eye feldspar porphyry (left) and less altered feldspar porphyry (right) from dykes northwest of Vein A (coin diam. 1.75 cm).

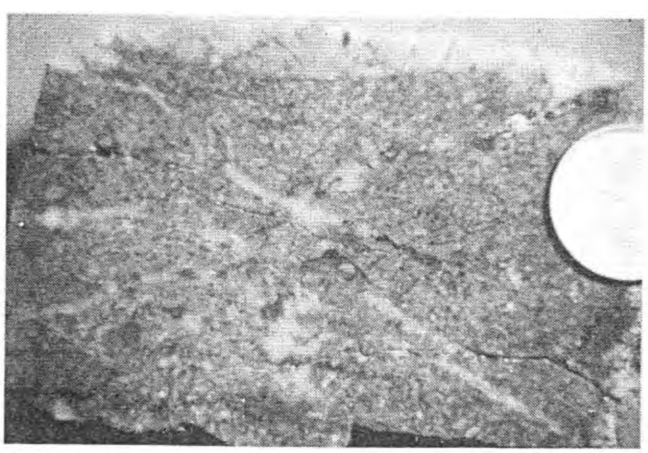


Fig. 6e — Quartz veinlets cutting Toodoggone Group tuffaceous volcanic rocks on SHA claims showing (coin diam. 2.3 cm).

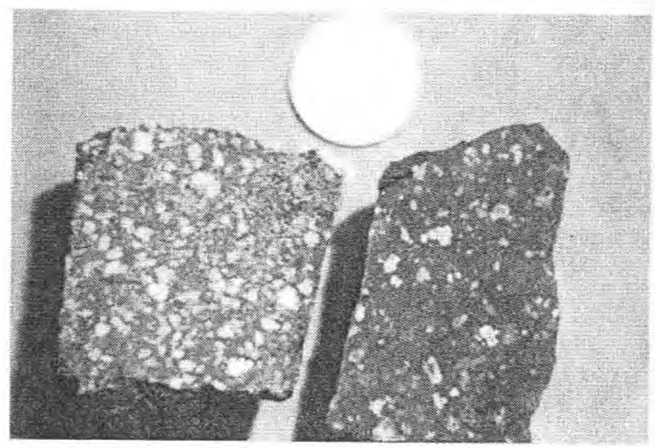


Fig. 6f — Altered andesite porphyry (Takla Group) near West Chappelle Vein (coin diam. 2.3 cm).

pears to be a late phase of the syenomonzonite intrusions, occurs immediately to the north of Vein A. It consists of medium-sized (2-3 mm) feldspar phenocrysts and quartz-eyes in a light grey aphanitic groundmass with accessory pyrite (Fig. 6d). Near the vein it is altered to quartz, sericite and clay minerals. The main portion of the quartz-feldspar porphyry unit lies at the fault contact between Asitka Group and Takla Group rocks near the western end of Vein A. Dyke-like apophyses of this body, varying from 1 to 30 m in thickness, subparallel and intersect the northeast extension of Vein A.

Carter (1972) has observed that if the dykes are related to the syenomonzonite intrusions, the mineralization is of Omineca Intrusion age. He has also noted the similarity between the dykes and one of the Toodoggone Group units, and he suggests that the dykes are feeders and the vein is related to this period of volcanism. This observation is consistent with the inferred age and derivation of precious-metal mineralization in Toodoggone Group rocks (q.v.) at the nearby Lawyers property.

TOODOGGONE GROUP

Overlying the Takia Group unconformably is a pile of complexly intercalated volcanic and sedimentary rocks of Lower to Middle Jurassic age, 500 m or more thick, named the Toodoggone Group by Nick Carter in 1971. The Toodoggone Group occupies an area of 85 by 15 km, oriented northwesterly and centered on the Chappelle property. The Toodoggone Group has been investigated by various geologists, including: H. Gabrielse, C. J. Dodds and Mansy (1975) of the Geological Survey of Canada, and N. C. Carter (1972), A. Panteleyev (1971), T. J. Drown (1973), V. Ryback-Hardy (1975), G. Popp and L. Eccles (report by T. J. Drown, 1975).

Most workers at the Chappelle and Lawyers properties have recognized three principal subdivisions:

1. A lower, dominantly pyroclastic assemblage which includes purple agglomerates, tuffs and dacites.
2. An overlying acidic assemblage which includes rhyolites, dacites and quartz-feldspar porphyries. At the Lawyers property, several kilometres to the northwest of the Chappelle property, a coeval period of volcanic activity is recognized during which explosive brecciation resulted in the formation of lahars. This activity included the intrusion of syenite-monzonite dykes, silicification and precious-metal deposition (Ryback-Hardy, 1975).
3. An upper assemblage, which includes dacites and quartz-eye feldspar porphyries.

The Toodoggone Group rocks display broad, open folds with dips of 15-25 degrees. Steeper dips are observed where rotation and tilting of fault blocks has occurred (Panteleyev, 1971).

In the northwest portion of the Chappelle area, Toodoggone Group rocks unconformably overlie Takla Group rocks along a northeast-trending contact. In most other areas, fault contacts have been observed.

Alteration of Toodoggone Group rocks appears to be restricted to slight propylitization (Drown, 1975).

Apart from the gold-silver-bearing quartz veins and silicified breccia zones described in a later section, the Toodoggone Group rocks also contain several small copper and copper-lead-zinc showings associated with silicified volcanic breccia.

The Toodoggone Group rocks are unconformably overlain by relatively flat-lying Sustut Group sedimentary rocks of Upper Cretaceous to Tertiary age which outcrop along the eastern margin of Spatsizi Plateau several kilometres to the west of the Chappelle property.

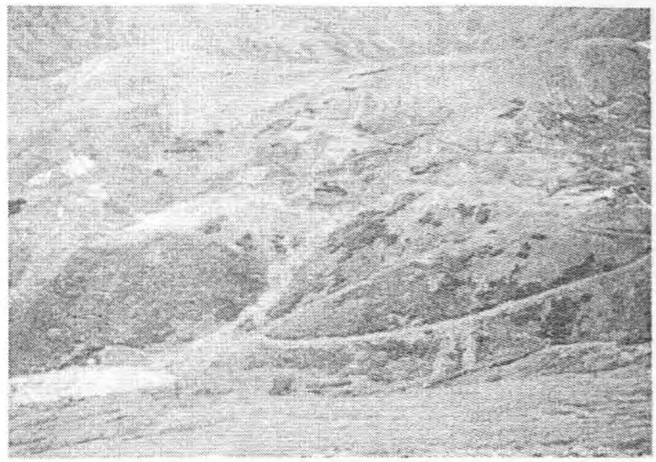


FIGURE 7 — View westerly across Vein A area. 5420 level portal and dump in lower left (Photo by T. Schroeter).

QUARTZ VEINS

Individual quartz veins and quartz vein systems occur intermittently within a belt 3-4 km wide extending for 17 km from the Lawyers property, 8 km northwest of Vein A on the Chappelle property to the SHA claims occurrence, 9 km south-southeast of Vein A (Fig. 3).

Although most of the veins carry low gold and silver values, only Vein A on the Chappelle property (Fig. 7) and possibly the Amethyst Gold Breccia Zone on the Lawyers property contain precious metals in sufficient quantity to be considered of potential economic significance, based on current knowledge.

The precious-metal-bearing quartz veins cut both Takla Group and Toodoggone Group rocks. Although quartz veins occur in the Omineca Intrusions, they are less than 0.3 m wide and are unmineralized.

On the SHA claims, several gold-silver-bearing quartz veins occur in portions of a northerly elongated area 400 by 1200 m in extent, underlain by altered crystal and lapilli tuffs of the Toodoggone Group (Fig. 6e).

On the Lawyers claims, six gold-silver-bearing showings have been discovered, all of which are associated with north-northwest-trending faults or associated breccia zones, of which the most important is a northwest-trending quartz-filled breccia zone which transects trachyte porphyry of the Toodoggone Group. The zone is about 60 m wide and extends for at least 500 m. It consists of incipiently brecciated fragments cemented by quartz, amethyst quartz and calcite. The core of the breccia zone is almost entirely replaced by quartz and amethyst. Mineralization consists of native silver, electrum and lesser argentite occurring as microscopic grains (0.1 to 0.05 mm). The strongest mineralization is associated with the most intensely silicified portion of the breccia zone.

On the Chappelle property, seven quartz vein sysems cutting Takla Group rocks have been investigated. These are: Veins A, B, C, D, North Quartz Zone, West Chappelle and Black Creek gossan. The veins occupy two principal trends: northeast and east-southeast.

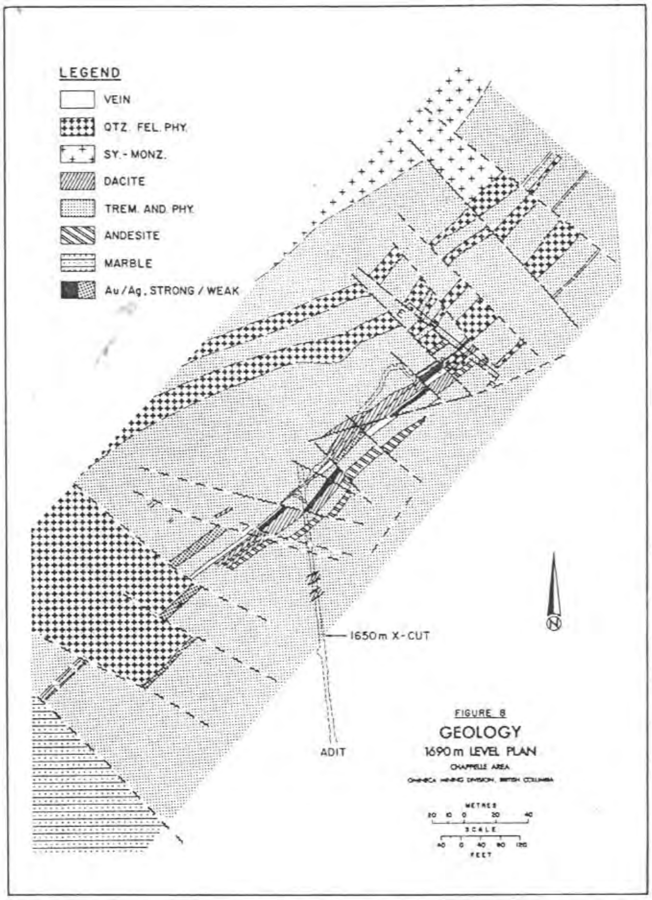


FIGURE 8—Geology—1690-m level plan—Chappelle Vein A.

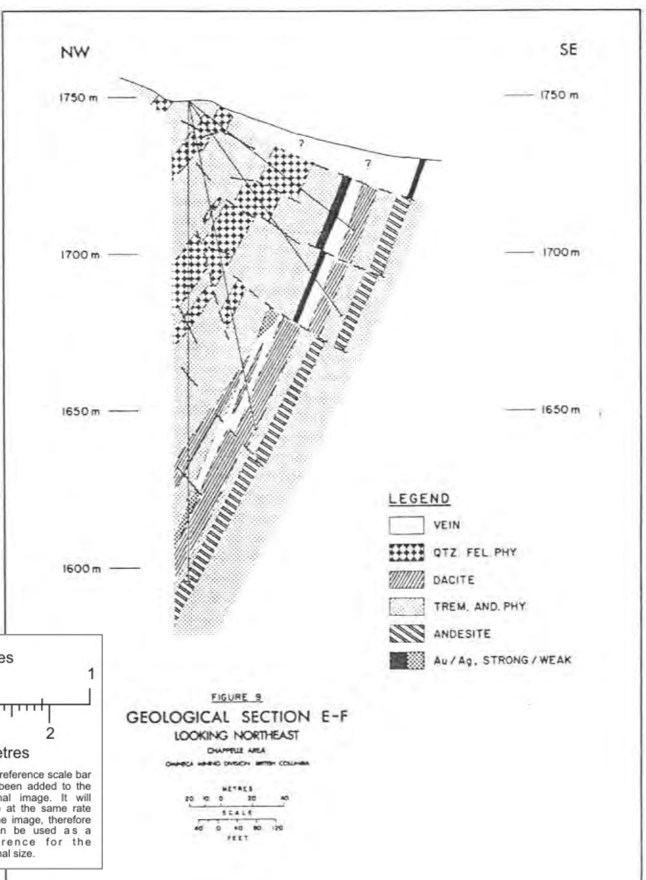


FIGURE 9—Geologic Section E-F—Chappelle Vein A.

Geology of the Vein A Area

Vein A is part of a fault-controlled quartz vein system composed of two or more subparallel veins which trend northeasterly and dip from 80 degrees southeast to about 70 degrees northwest (Figs. 8, 9). The quartz vein system has been traced for a strike length of 435 m and across a width varying from 10 to 70 m. Individual veins within the system vary from 0.5 to 10 m in width. Drilling indicates that the vein system persists for at least 150 m vertically from surface. Vein A is the most southeasterly of the two principal veins in the vein system and, where both veins have been intersected in drill holes, they generally lie about 15 m apart.

Throughout most of its length, Vein A lies within altered Takla Group tremolite andesite porphyry and dacite, which are intensely silicified on vein walls. At intervals, it lies partly along a contact between quartz-feldspar porphyry on the northwest and Takla Group volcanic rocks on the southeast. Near its southwest limit, a lobe of quartz-feldspar porphyry extends northwesterly along the contact between a small stock of syenomonzonite and the aforementioned wedge of Asitka Group marble.

The quartz vein system is cut by numerous cross-faults which offset portions of individual veins, commonly for 1 to 15 m and in one instance for an inferred plan offset of 30 m in a small graben structure. Most of the faults are northwesterly trending normal and reverse faults dipping to the northeast and dip-slip strike faults dipping at shallow angles, generally to the southeast.

A variety of quartz vein textures and cross-cutting relationships indicate a complex history of veining with multiple depositional stages (Fig. 10). Much of the quartz is massive and drusy (Fig. 11), whereas a distinctive earlier ribboned variety is common, particularly near vein contacts (Fig. 11c, d). The quartz varies in colour from white to grey to dark grey.

FIGURE 10 — Multiple quartz veining in 5420 drift (ruler 15 cm long).

Distribution of Gold-Silver Mineralization

Gold-silver values are generally associated with highly fractured and occasionally brecciated white to grey, vuggy quartz veins containing 1 to 10 per cent pyrite, and to a lesser extent occur in silicified wall-rock. Xenoliths of altered andesite and dacite frequently occur in the veins. The only other common gangue mineral is carbonate, which fills fractures.

Higher-grade mineralization is associated with grey quartz, which occasionally contains visible argentite, described as acanthite by Harrison (1976), commonly associated with disseminated grains of pyrite, chalcopyrite and very minor sphalerite (Fig. 11). High-grade gold-silver values occasionally occur in narrow (1-5 cm) cross-cutting silicified shears. Visible gold is exceedingly rare. The volcanic rocks adjacent to quartz veins commonly contain 3 to 15 g Ag/tonne (0.1 to 0.48 oz/ton).

Detailed surface sampling on Vein A showed a common concentration of higher-grade precious-metal values along the hanging wall of the vein, with a relatively abrupt decrease of values on the hanging-wall side and a gradual drop in values toward the footwall. The same relationship was not as evident in mineralized drill-core intercepts, although it commonly pertains.

Polished-section or electron-microprobe studies have been completed by various individuals, including J. Rucklidge (1969), E. L. Gasparrini (1970), J. A. Gower and A. N. Mariano (1972), M. Vreugde (1972) and M. Harrison (1976). Harrison examined 27 polished concentrate and rock sections and 14 hand specimens using reflected-light microscopy, micro-hardness and X-ray diffraction tests and electron-microprobe analyses, and his studies are the most comprehensive carried out to date. These studies indicate that pyrite is the dominant mineral, constituting about 90 per cent of sulphide mineralization. It occurs as euhedral grains and includes blebs of chalcopyrite, electrum, argentite, bornite and sphalerite (Fig. 12). Pyrite exhibits mutual boundary relationships with chalcopyrite, which occurs as anhedral to subhedral grains and as exsolution laths or blebs in sphalerite and bornite (Harrison, 1976).

Sphalerite constitutes about 3 per cent of the sulphides and occurs as anhedral to subhedral grains, commonly enclosed in pyrite. Exsolution blebs of chalcopyrite are very common (Fig. 12).

Argentite occurs as angular interstitial grains up to 3 mm in diameter and as blebs in pyrite down to 5 microns in diameter (Fig. 12). It is most commonly interstitial between pyrite, chalcopyrite and gold. Harrison (1976), who recognizes the mineral as

FIGURE 11 — Specimens from Vein A.

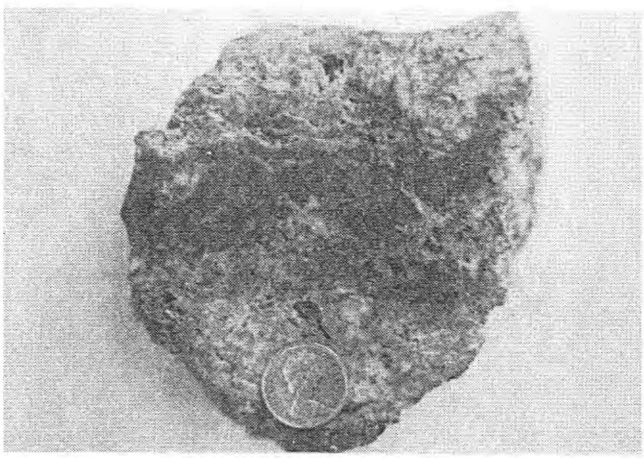


Fig. 11a — Well-mineralized specimen from surface showing dark grey quartz containing pyrite, sphalerite and high precious-metal values (coin diam. 1.75 cm).

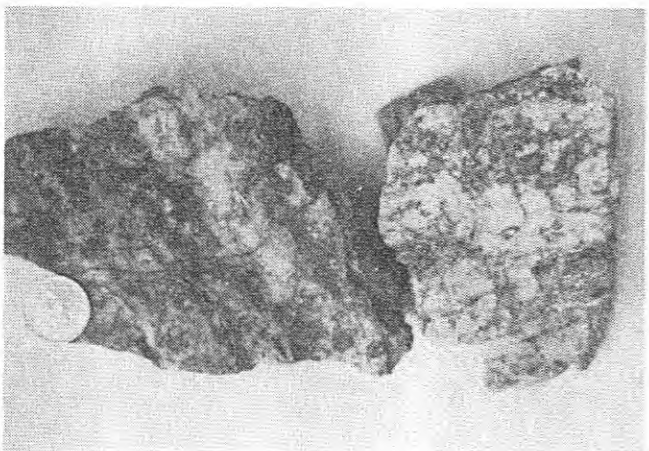


Fig. 11b — High-grade specimens from 54.50 raise about 10 m below surface (coin diam. 1.75 cm).

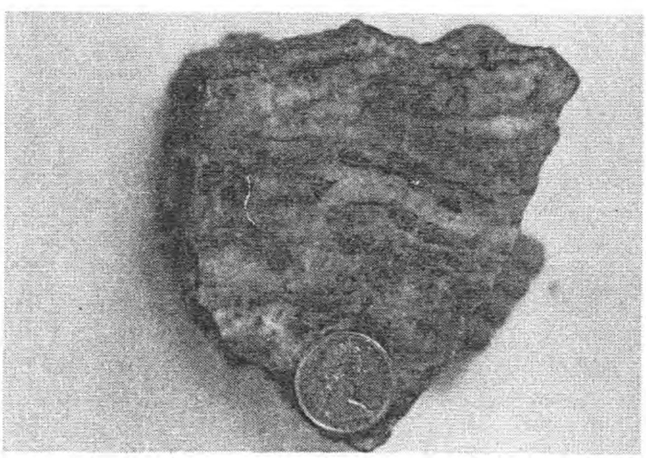


Fig. 11c — Banded vein from 54.50 raise (coin diam. 1.75 cm).

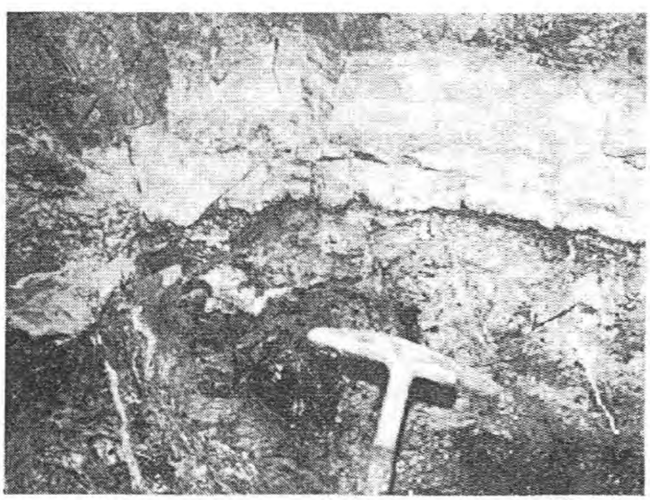


Fig. 11d — Banded part of vein against chloritized hanging wall in 5420 drift (coin diam. 1.75 cm).

FIGURE 12 — Photomicrographs of Selected Polished Sections.

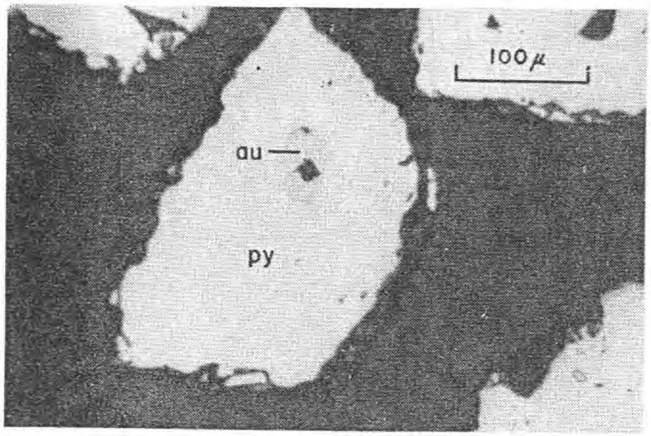


Fig. 12a — Grain mount showing inclusion of gold (au) in pyrite (py). Small square in gold is microindentation. (Photo by M. Harrison.)

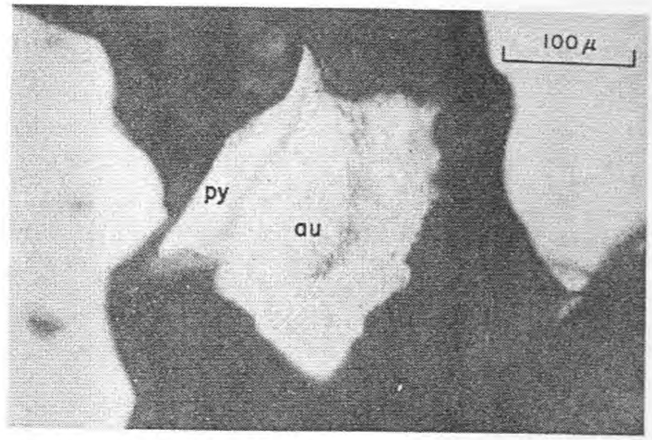


Fig. 12b — Grain of gold (au) and pyrite (py). (Photo by M. Harrison.)

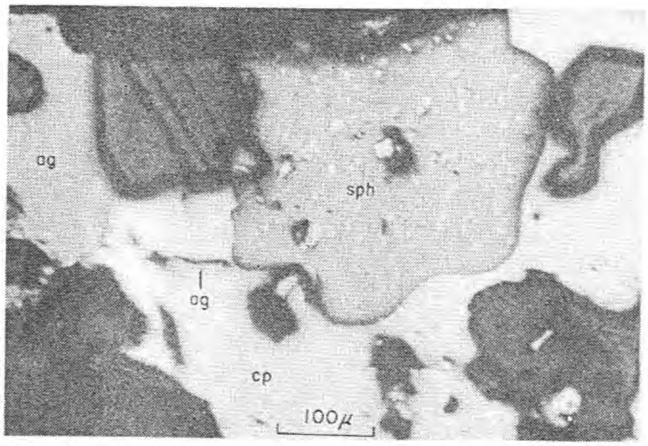


Fig. 12c — Sulphide complex showing sphalerite (sph), chalcopyrite (cp) and argentite (arg). (Photo by M. Vreugde.)

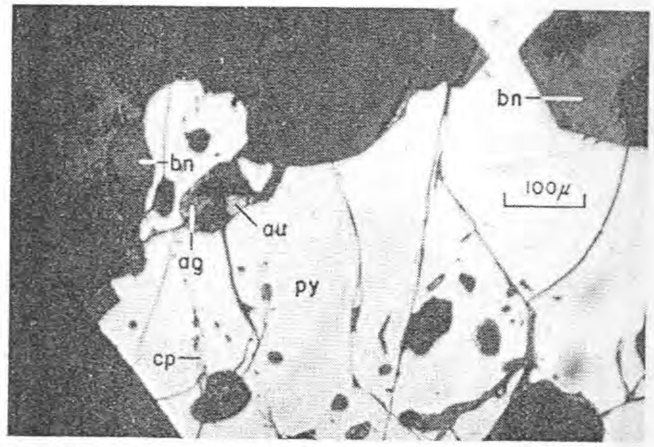


Fig. 12d — Chalcopyrite (cp) and chalcocite (not visible in photo) filling fractures in pyrite (py). Marginal cavity in pyrite contains gold (au) and argentite (ag). Bornite (bn) and argentite also occur on margins of pyrite.

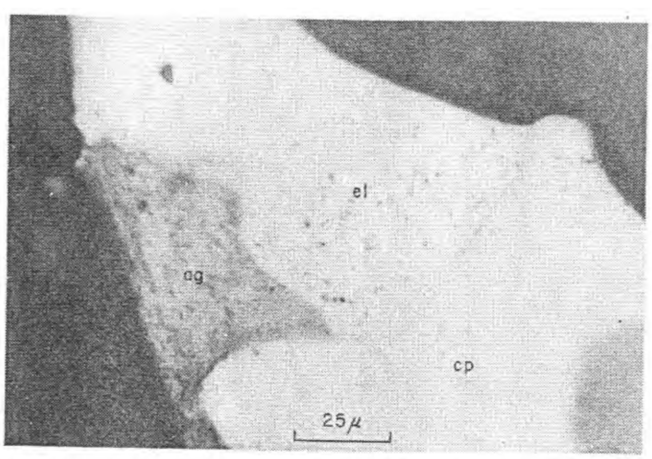


Fig.12e — Another portion of the complex of Fig. 12c, showing electrum (el) bounded by argentite and chalcopyrite. (Photo by M. Vreugde.)

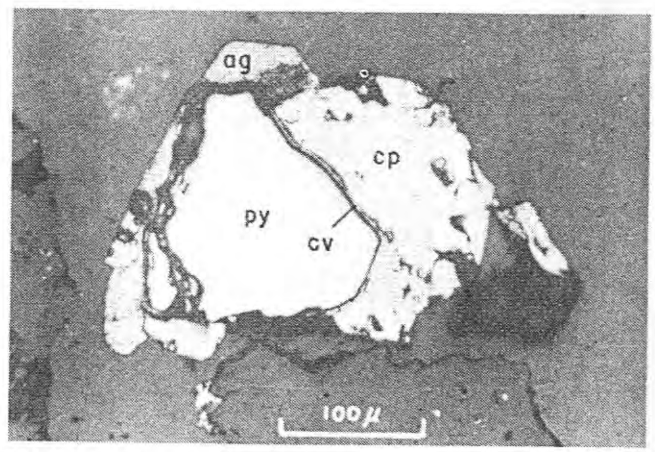


Fig. 12f — Chalcopyrite (cp), pyrite (py) and argentite (ag), with thin coating of covellite (cv), between chalcopyrite and pyrite. (Photo by M. Harrison).

acanthite on data which are partly conflicting, thus leading to the use of the more commonly recognized form 'argentite' in this paper, notes that it is often associated with gold. Less commonly, it forms coatings on pyrite.

Gold, of yellow colour, having a gold-to-silver ratio of 7:3 based on one microprobe analysis (Harrison, 1976), attains diameters of up to 200 microns (Fig. 12b). Its form of occurrence is similar to that of argentite and electrum.

Electrum occurs as grains up to 50 microns in diameter frequently associated with argentite (Fig. 12e) and as blebs 5 to 10 microns in diameter in pyrite. A microprobe analysis on several blebs (Harrison, 1976) gave an average content of 60 per cent silver and 40 per cent gold.

Bornite occurs as blebs in pyrite or with chalcopyrite and shows mutual boundaries with pyrite and sphalerite (Fig. 12d). Galena was observed by Harrison (1976) as rare discrete disseminated grains.

Chalcocite forms thick coatings on chalcopyrite and covellite forms a thin coating on both chalcocite and chalcopyrite in the oxidized part of Vein A. Polybasite and stromeyerite are rare constituents.

Surface oxidation in the Vein A area extends to a depth of 5 m or more below surface and is reflected by the presence of hematite, jarosite and goethite as pyrite alteration products in vugs and fractures, particularly near surface.

The only known mineralization of potential economic interest on the Chappelle property occurs in Vein A. The mineralization was originally exposed intermittently by stripping and trenching through shallow overburden over a strike length of 151 m and across an average width of 3 m. Drilling data indicate that the higher-grade mineralization occurs over a strike length of 200 m, across an average width of about 3 m and to an average depth of about 40 m below surface in one continuous shoot (Fig. 13). The most recent tonnage calculation indicates that the shoot contains about 52,000 tonnes grading 36.7 g Au/tonne (1.07 oz/ton) and 795.5 g Ag/tonne (23.2 oz/ton), with 20 per cent dilution allowed at a cut-off of \$82.6/tonne (\$75.00)[1]. Two isolated drill intercepts indicate the possible existence of another shoot apexing about 60 m below the base of the present shoot; however, considerably more drilling is required before the potential importance of this mineralization can be ascertained.

[1]Based on a recoverable value of Au @ \$100/oz and Ag @ \$4.50/oz.

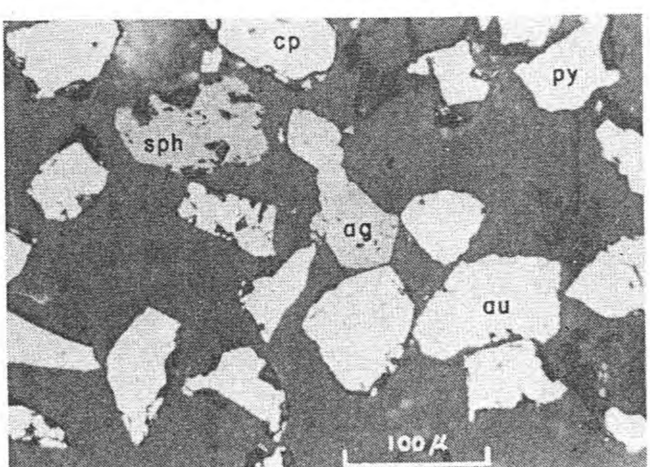


Fig. 12g — Gold (au), argentite (ag), sphalerite (sph), chalcopyrite (cp) and pyrite (py) grains in flotation concentrate. (Photo by M. Harrison.)

Geochemical Investigations

Over 2000 soil, silt and rock samples have been collected and analyzed from the Chappelle property. Reconnaissance stream-sediment surveys completed by Kennco Explorations (Western) Limited in 1968 indicated anomalous copper-molybdenum values and the original Chappelle claims were staked to cover the area of interest. More detailed stream-sediment coverage was obtained in 1971 to produce a silt sample site density of about 9 per km^2 in the property area. The 6-km^2 area underlain by Takla Group rocks, which contain six of the quartz vein systems on the property, was covered at a sample site density of about 15 per km^2.

Several target areas were defined by soil sampling, with sites spaced at 30-m intervals on lines lying about 100 to 120 m apart. Although an attempt was made to collect soil from the B-horizon, this was not always possible and many of the samples consisted of small fragments of felsenmeer.

Figure 14 shows (1) the location of the known vein systems, (2) 148 silt sample sites in the area underlain principally by Takla Group rocks, (3) sample sites having values equivalent to, or above, threshold for gold (0.09 ppm), silver (3.87 ppm) and copper (263 ppm), and (4) sample sites that are considered anomalous.

In determining threshold and anomalous values, the geometric mean of silt sample analyses was calculated and threshold was established as the geometric mean plus one log standard deviation; the lower limit of anomalous values was taken as the geometric mean plus two log standard deviations.

Limited soil sampling completed over the known mineralized portion of Veins A and B showed contents of up to 3 g Au/tonne (0.08 oz/ton) and up to 70 g Ag/tonne (2.0 oz/ton). As shown in Figure 14, stream sediment from local drainage in the vicinity of these veins is anomalous in gold and silver. The results of bedrock sampling across Vein A on lines spaced about 1.6 m apart show that the mineralized portions of the vein, aggregating 151 m in strike length, average 34.3 g Au/tonne (1.0 oz/ton) and 617.4 g Ag/tonne (18 oz/ton) across an average width of 3 m.

A high portion of soil and felsenmeer samples collected in the vicinity of the North Quartz Zone are anomalous in gold and silver. The zone consists of randomly oriented quartz veins exposed over an area of 100 by 300 m at the head of a cirque. However, none of the bedrock samples contain anomalous gold contents. Anomalous silver contents occur in bedrock samples collected in the eastern part of the area. The results of surface sampling and drilling in the North Quartz Zone are generally disappointing when compared with soil sampling results.

Both Vein C and Vein D are partly exposed on steep mountain slopes which are so poorly drained that the nearest streams are not considered to contain sufficient derived silt to produce anomalies. Chip samples on Vein C contain anomalous gold and silver contents, the highest being 27 g Ag/tonne (0.8 oz/ton) and 1.3 g Au/tonne (0.05 oz/ton) across a

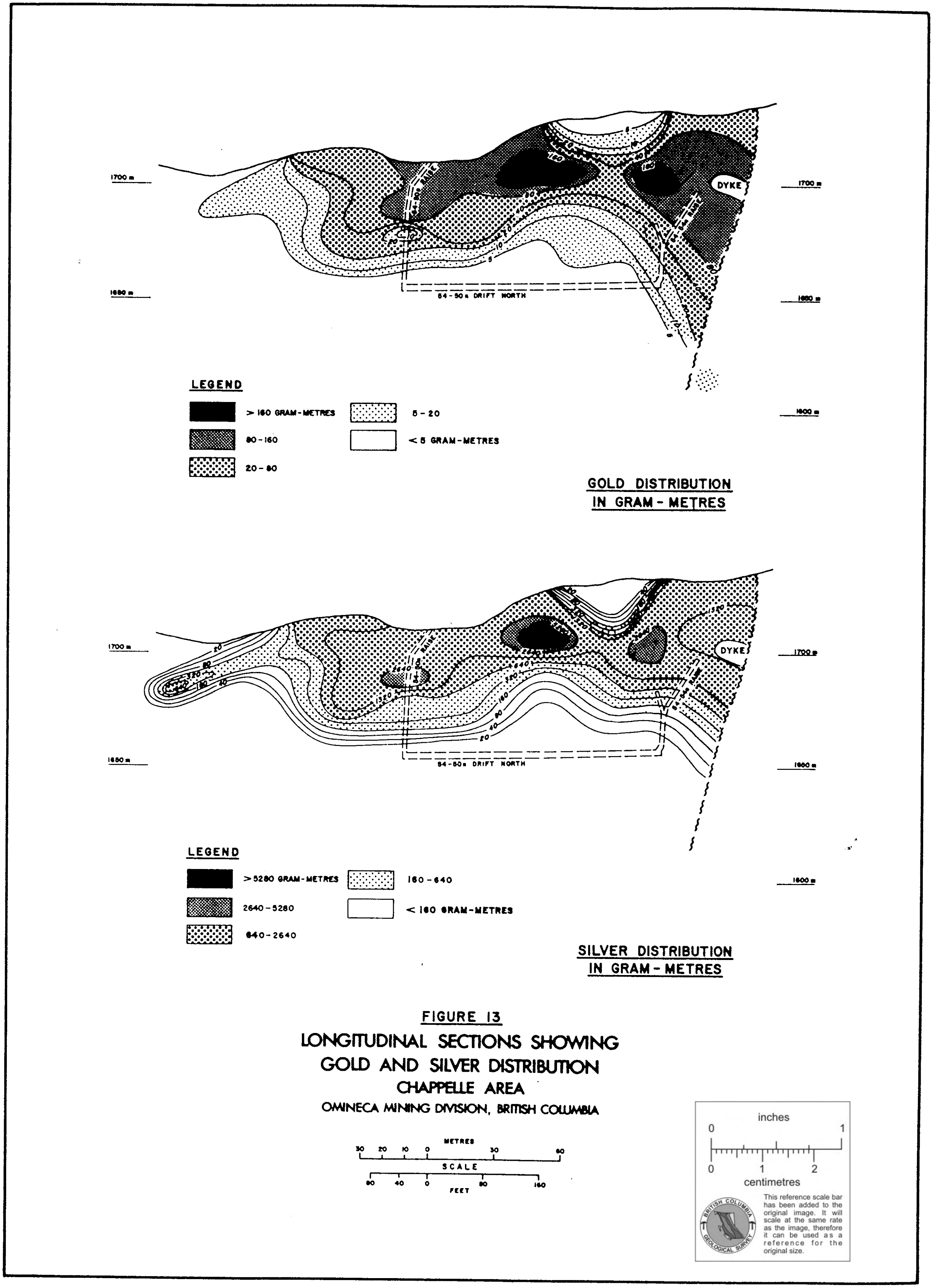


FIGURE 13 — Longitudinal sections showing gold and silver distribution — Chappelle area.

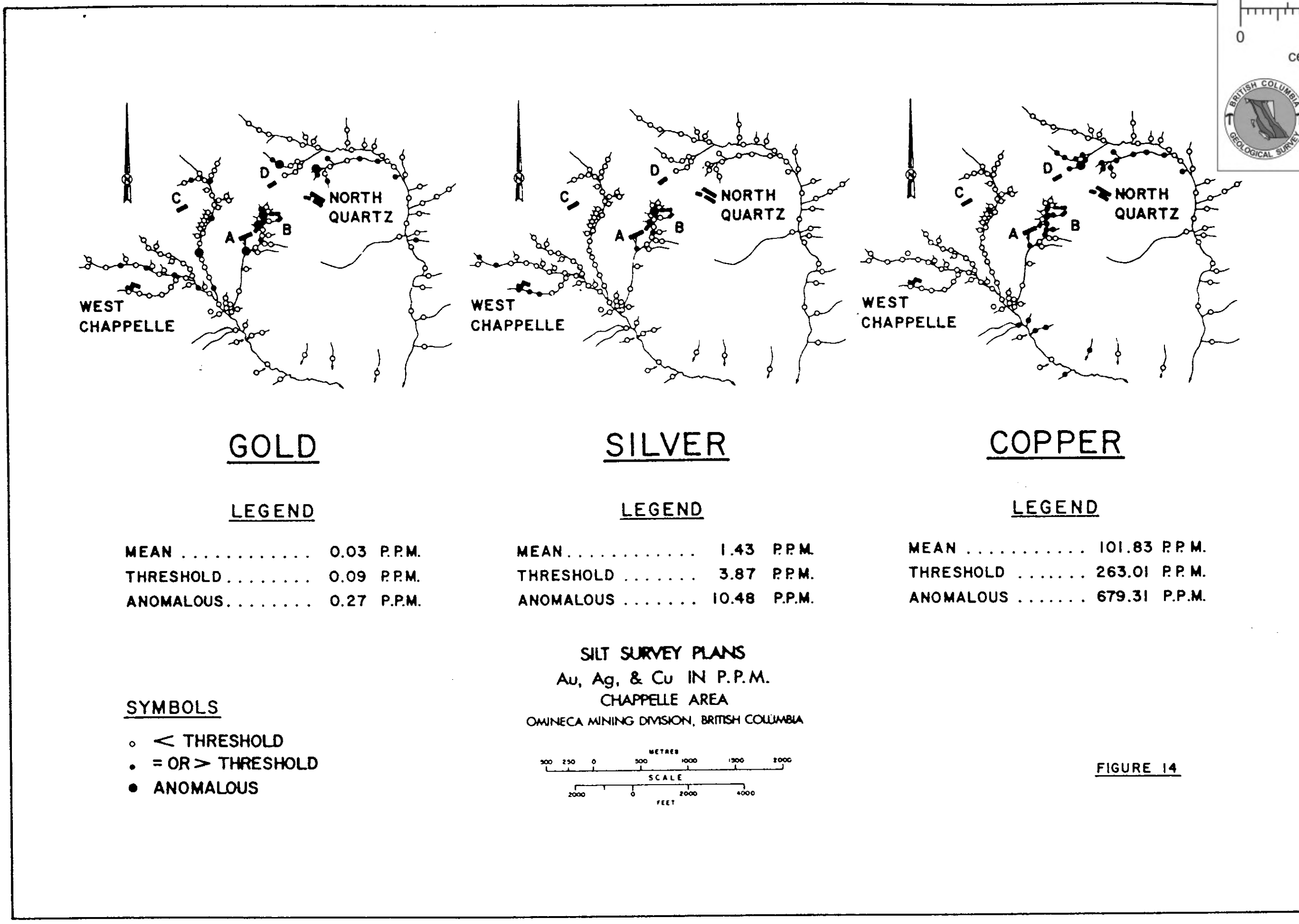


FIGURE 14 — Silt survey plans — Au, Ag and Cu in ppm — Chappelle area.

width of 1.6 m. Vein D is essentially barren of precious-metal content.

About 25 per cent of soil samples collected in the vicinity of the West Chappelle vein system are anomalous in silver, whereas only about 5 per cent are anomalous in gold and none are anomalous in copper. The only significant drill intercept from five shallow holes in the vein is 1.3 g Au/tonne (0.05 oz/ton) and 16.8 g Ag/tonne (0.49 oz/ton) for a core length of 1.2 m.

Following a review of a paper by Al-Atia (1974) which describes the use of Rb as a pathfinder for gold and other deposits, selected drill cores from two holes transgressing the Vein A quartz system were analyzed for Cu, Pb, Zn, Co, As, Rb, Sr, Hg and F. The results showed that Cu, Zn, Sr and Rb appear to have a direct correlation to Au and Ag mineralization or quartz veining. Copper and, to a lesser extent, zinc are directly proportional to gold and silver content, whereas strontium and rubidium contents are inversely proportional to the amount of quartz veining and silicification. The metal contents are about one order of magnitude above background for copper and one order of magnitude below background for strontium and rubidium.

Geophysical Investigations

The results of ground magnetic surveys completed with McPhar M700 vertical-field magnetometer over 48.3 km on lines spaced about 60 m apart, with readings at 15-m intervals, are shown in Figure 15. The survey area covers much of the map-area shown in Figure 4.

Unaltered Takla Group tremolite andesite porphyry produces the highest magnetic response, with values ranging from 1000 to 3000 gammas. In areas of silicified rock, values range from 400 to 800 gammas.

Asitka Group rocks produce a relatively low magnetic response, with values in the 600- to 800-gamma range, and low magnetic relief. Where altered to skarn, at the contact with Omineca Intrusions, the magnetic response may reach 1500 gammas.

Omineca Intrusions exhibit variable magnetic response, ranging from 200 to 3000 gammas, which reflects the variation in magnetic contents of the various lithologies.

The quartz-feldspar porphyry mass and associated dykes have a magnetic response of 800 to 1500 gammas and, as the magnetic relief is similar to that of the Takla Group tremolite andesite porphyry, extensions of this unit beyond the drilled area are not predictable on the basis of magnetic data.

Abrupt discontinuities in magnetic trends and magnetic linears correspond with fault zones, and the extension of these and other geologic features such as rock-type boundaries into till-covered areas have been projected on the basis of magnetic data.

Vein A, Vein B and part of the North Quartz Zone coincide with magnetic troughs, probably a reflection of the broad hydrothermally altered zones which contain the quartz veins. This relationship was used with little success in attempting to predict vein extensions or the location of other quartz veins in till-covered areas.

Genesis

The presence of gold-silver-bearing quartz veins, breccia zones and stockworks in both the Takla Group and Toodoggone Group rocks suggests a probable post-Lower to Middle Jurassic age for their formation. The deposits can be classified as low-temperature fissure fillings.

The localization of quartz veins and breccia zones along hydrothermally altered fault zones at both the Chappelle and Lawyers properties suggests a strong structural control for their emplacement. The northwesterly trend of the 17- by 4-km belt containing the veins across lithologic boundaries is further evidence of structural control.

The localization of the gold-silver-bearing belt within the confines of the mapped limits of Toodoggone Group rocks is noteworthy and further suggests a genetic relationship to this period of volcanism.

On the Lawyers property, Ryback-Hardy (1975) concludes that the association of sub-economic gold and silver values with quartz veinlets up to 2 mm wide and spaced every 15 to 20 cm apart in a trachyte porphyry unit, underlain by lithic and ash-flow tuffs, probably results from mineralizing fluids preferentially replacing the more competent and more readily fractured trachyte porphyry.

All of the gold-silver-bearing veins or breccia zones on the Lawyers property occupy steeply dipping northwest-trending faults which transect flow boundaries in Toodoggone rocks. The alignment of veins on the Chappelle property is more random, however northeast and east-southeast alignments are dominant.

There is a strong probability that the quartz-feldspar porphyry dykes which sub-parallel Vein A are feeders to similar Toodoggone Group volcanic units and further suggest that the veins may be related to this period of volcanism, as is indicated at the Lawyers property.

The similar precious-metal mineralogy at Lawyers and Chappelle, i.e. electrum and argentite, suggests a common precious-metal depositional history.

Although there is no evidence that the quartz veins in the Toodoggone Group or the Takla Group rocks

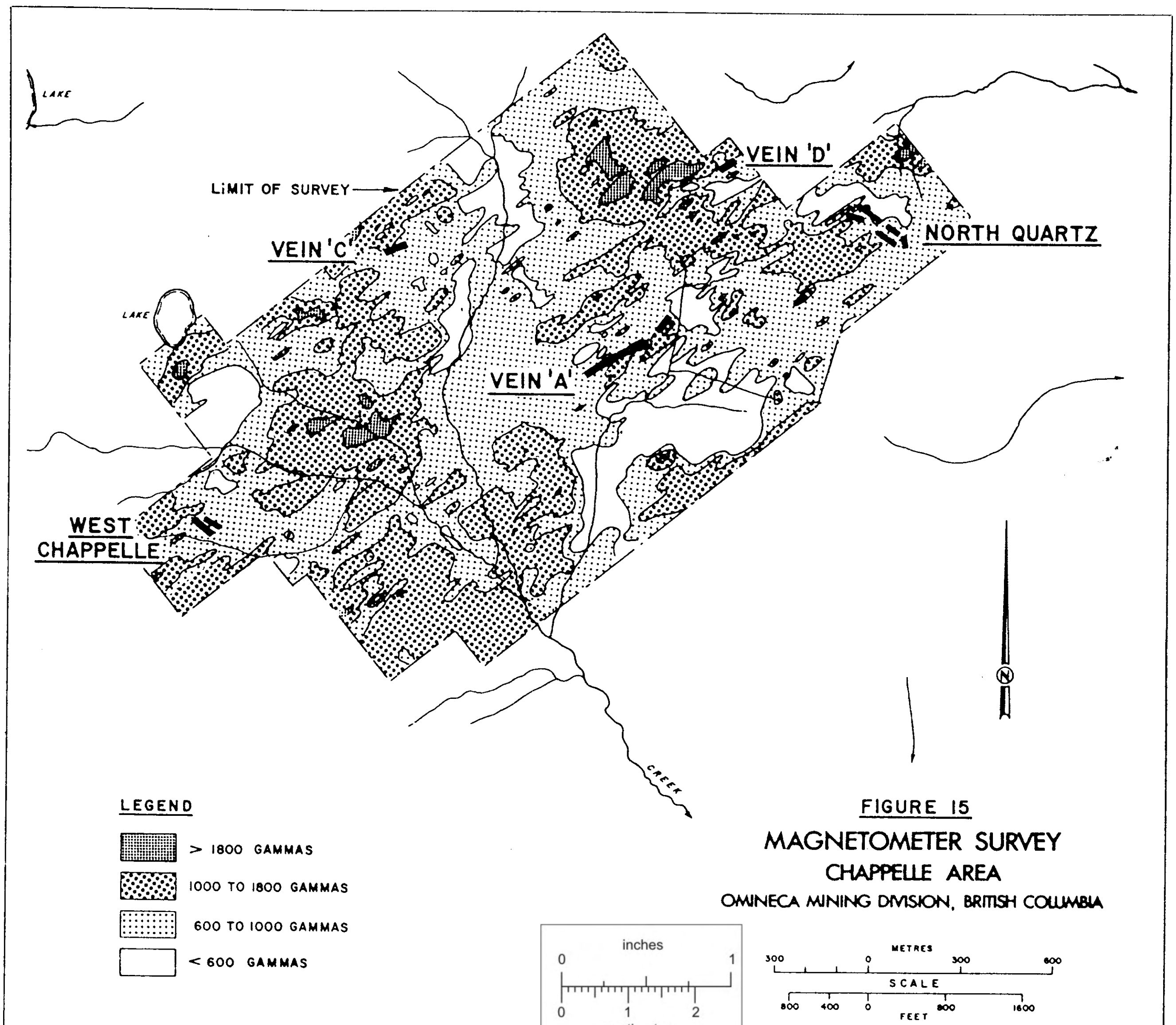


FIGURE 15 — Magnetometer survey — Chappelle area.

were mobilized from an earlier depositional stage in a concordant volcanic exhalative environment, it is interesting to note the close association of Vein A and a relatively narrow band of dacite in a dominantly andesitic assemblage.

Economic Considerations

In common with other prospects at early stages of development, a future production decision at the Chappelle property will be influenced by many considerations.

Because of the small, although high-grade, nature of the indicated reserve, the property cannot support such major capital expenditures as ground access from the nearest road. However, the B.C. Ministry of Mines and Petroleum Resources has indicated its intentions to proceed with the northern extension of the Omineca Road to provide access to a large area that is geologically favourable for a variety of mineral deposits. Such a facility would pass within a few kilometres of the Chappelle property, thus making for lower operating costs and removing the psychological barrier of operating in a relatively remote and mountainous region entirely dependent on air support.

Although the mining method which would be used has not been decided, the most probable is cut-and-fill or shrinkage mining from two or more levels.

The latest metallurgical tests on a representative bulk sample show that up to 99 per cent of the gold and 98 per cent of the silver can be recovered using a combination of flotation and cyanidation of the tailing, after fine grinding.

From the outset, exploration, development and financial planning for eventual production at Chappelle has been directed toward the objective of a neat and tidy mining community with high standards of industrial health and safety, and with minimum disturbance or pollution of the surroundings. To this end, chemical and biological studies of water resources in the immediate property area were completed in 1976 to establish acceptable base-line information on the aquatic environment. On completion of any mining operation, all disturbed and unseeded areas affected by such an operation would be revegetated. Thus, although the property lies near the eastern boundaries of Tatlatui Provincial Park and Spatsizi Plateau Wilderness Park, it will be no more of an environmental hazard than the public roads providing access to the region.

Acknowledgments

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New Report Identifies Energy Conservation Benefits

FOR THE FIRST TIME, a Wall Street report clearly identifies the economic benefits of investment in energy conservation by corporations.

According to a report released by Frost & Sullivan, Inc., the New York research firm, the benefits are achieved through a formula permitting a given company to determine its own capital investment costs for energy conservation, indicating the degree of value added to the company's product mix contingent on its energy usage. This, in turn, is compared with the investment required to meet conservation goals, thereby offering a new rationale for cost control and profit margin protection. It has particular value in slow-growth markets where price and volume are inadequate.

"Cost control through energy conservation is a must," the report stresses. Ranking and evaluating chemical companies by energy usage plus the investment required to meet conservation goals, the report employs data obtained from the U.S. Department of Energy under the Freedom of Information Act.

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