 888495

The Taseko copper-gold-molybdenum deposits, central British Columbia

W.W. OSBORNE
Westpine Metals Ltd., Vancouver, British Columbia

D.G. ALLEN
A and M Explorations Ltd., Vancouver, British Columbia

ABSTRACT

The Taseko copper-gold-molybdenum property is located 225 km north of Vancouver, British Columbia and east of the Taseko Lakes. The area has a complex history going back to 1909 when bog-iron deposits were first discovered.

The claims cover the east-west contact between the Coast Range Plutonic Complex to the south and intensely altered volcanic rocks to the north. In the Empress area, which has been the focus of exploration since 1988, the contact between these two rock types dips steeply north for 100 m to 220 m and then is sub-horizontal at a depth of 107 m to 220 m. This sub-horizontal nature of the contact is at least 640 m wide and has been traced for as much as 4280 m east-west.

Two mineral occurrences have been found within the altered volcanic rock. The first is in the Empress area where a mineral resource of 10 004 000 tonnes grading 0.61% Cu and 0.789 g/t Au has been established, using a cutoff of 0.40% Cu. The East zone occurs 1000 m east of the Empress but has not been defined. The mineralization is associated with intense zones of advanced argillic alteration and silicification. The zone of advanced argillic alteration has been traced for 18.5 km in an east-west direction.

Several mineral occurrences are found in the intrusive rock. They include the Buzzer, Buzzer West, Rowbottom and Granite Creek zones as well as several on adjacent properties. These zones consist of mainly disseminated chalcopyrite, molybdenite and gold in granitic rock, in places brecciated, with varying degrees of alteration. Old reports indicate that the Buzzer has 4.99 million tonnes grading 0.35% Cu, 0.031 Mo and some gold (not all of the core was assayed for gold). There are a series of copper anomalies of greater than 200 ppm extending for 2440 m west of the Buzzer and including the Buzzer West zone. Outside of the Buzzer, this area has never been drilled.

It is believed that the mineralization and alteration in the Taseko area is associated in origin to the development of a large porphyry system. The age of this event was about 85 million years ago.

A suite of rocks from the area was sent to the lab for whole rock determination, and the results were subjected to Pearce element ratio analysis. Several interesting interpretations came out of this exercise. It indicated that there are two separate phases of intrusive rock and also two separate styles of mineralization.

Introduction

The Westpine Metals Ltd. exploration group has been working on the Taseko project since 1988. Work on the property has raised a number of problems as to interpretation of geological history and sequence of events.

Several mineralized zones exist within the property; since 1988, most of the work has been done in the Empress area where intensely altered rock overlies unaltered and unmineralized intrusive rock. Extensive alteration has made it difficult to determine the protolith(s). Much of the area of interest is covered with overburden; so mapping has not helped to clarify the picture.

To attempt to get some answers as to the origin of and relationship between the volcanic rock, phases of intrusive rock and alteration, a suite of rocks was subjected to whole-rock determination, and the results were analyzed through the use of Pearce element ratio analysis.

Results of the exploration, drilling and Pearce element ratio analysis are presented in this paper. As is the case with ongoing exploration, this report presents a snapshot of the state of knowledge on the property at this time; the picture could change with subsequent exploration.

The Taseko property is located 225 km north of Vancouver and 48 km northwest of Gold Bridge in NTS 930/3W at Latitude 51°05′N and Longitude 123°27′W (Fig. 1). It lies east of the southern end of the Taseko Lakes, mainly south of the Taseko River.

The property lies along the eastern side of the Coast Mountains. The main physiographic features are broad U-shaped valleys, occupied by the Taseko River and its tributaries, and rugged mountain crests. Slopes along valley bottoms, and much of the area underlain by the Taseko alteration zone, are generally subdued and contain numerous small lakes and marshes, although steep-walled canyons occur along the lower section of the Taseko River and locally along Amazon and Granite creeks (Fig. 2). Elevation on the property ranges from 1500 m along the Taseko River to 2350 m on mountain crests. Figure 3 is a picture looking east along the Taseko River with the Empress area in the foreground.

Overburden is extensive, comprising glacial till, fluvial gravels in places along the valleys and of talus and slide material adjacent to the steeper slopes. Outcrops in the Taseko alteration zone, in general, are few and confined to creek and river bottoms, canyon walls, and scattered knobs on both sides of the river.

History

As summarized by Lambert (1991), exploration in the immediate claim area dates back to 1909 when extensive bog-iron deposits were discovered between Honduras and Amazon creeks. In 1922, disseminated copper mineralization of the Mohawk and Spokane prospects was discovered. Consolidated Mining and Smelting Co. Ltd. dug numerous trenches and drove cross-cuts on these prospects in 1927 and 1928. The Mother Lode prospect was also discovered at this time. Further work was carried out on the Mohawk and Spokane showings by Taseko Motherlode Gold Mines between 1933 and 1935.

No further significant work was carried out in the area until 1956 when Canadian Explorations Ltd. conducted trenching and

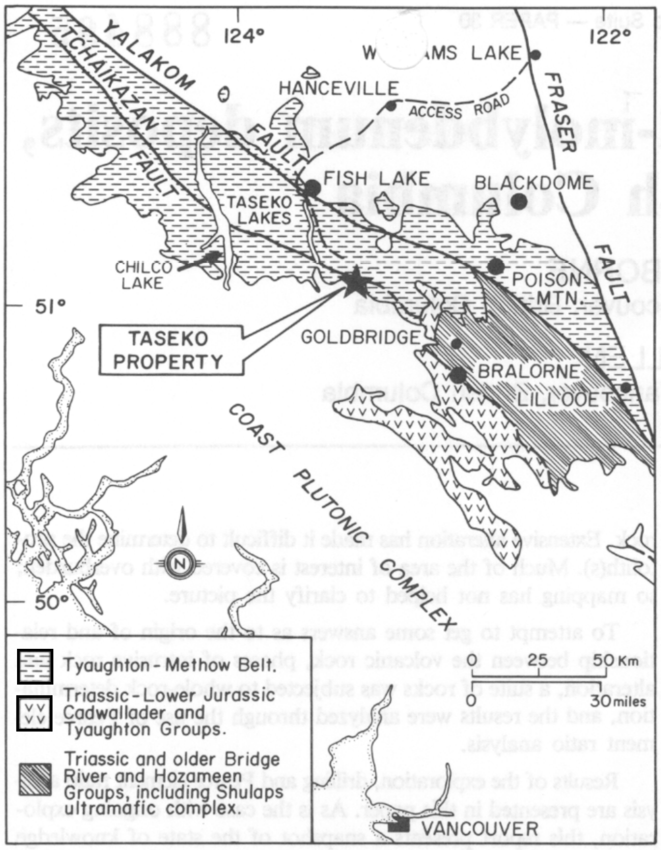

FIGURE 1. Location map and geological setting of the Taseko property. Modified after Glover et al. (1988).

drilling on the Spokane prospect and investigated the Rowbottom showing. Phelps Dodge Corp. of Canada Ltd., in 1963, conducted diamond drilling in eight holes within the area between the Spokane and Buzzer showings in search of copper-molybdenum mineralization in granodiorite of the Coast Plutonic Complex. From 1969 to 1976, the Buzzer and Empress zones and prospects, adjacent to the Taseko property, were extensively explored for porphyry copper-molybdenum mineralization by the following companies:

1. Scurry Rainbow Oils Ltd. — 16 diamond drill holes, geological mapping, trenching, geophysical surveys;
2. Sumitomo Metals Mining Canada Ltd. — 64 percussion drill-holes, geological mapping, geochemical and geophysical surveys;
3. Quintana Minerals Corp. — 9 diamond drill holes, 39 percussion holes.

In the mid-1980s, Westmin Resources Limited and Esso Minerals Canada explored their Bluff claims and the Taylor Windfall property, optioned from Taywin Resources, both northeast of and adjacent to the Taseko property, for epithermal gold-silver mineralization. In 1985, Esso Resources conducted a program of surface mapping, sampling and geophysical surveys on part of the western Taseko alteration zone, looking for epithermal gold mineralization.

The present Taseko property was acquired, and work was completed in the period from 1988 through 1991 by Westpine Metals Ltd., the present owner, and a related company. Work included geological mapping, soil and rock sampling, an areal geophysical survey and 9670 m of diamond drilling in 62 holes. A mineral reserve in the Empress area was established, and the East, Granite Creek and Buzzer West zones (Fig. 2) were discovered. A small program was carried out by Westpine Metals Ltd. in 1993, consisting of geological mapping, a lithogeochemical study and 218 m of drilling. During this period, from 1988 through 1993, E. Lambert logged most of the core, D.G. Allen mapped much of the property and W.W. Osborne managed the project.

In 1990, 1991 and 1993, Shogun Properties Inc. completed I.P. surveys and a diamond drilling program on the property covering the Spokane and Syndicate showings southwest of the Taseko property. Shogun has optioned the property from Canmark International Resources Inc.

Ownership

Scurry Rainbow Oils Ltd. owned much of the Taseko property from 1969 to 1988. In 1988, part of the property was dropped, and it was re-staked by New World Mines Development Ltd. who then optioned it to Alpine Exploration Corporation and Westley Mines Limited. Alpine and Westley, in 1989, vended their interest to Westpine Metals Ltd. In 1990 and 1991, ASARCO Exploration Company of Canada, Limited held an option on a 60% interest in the property and funded approximately one million dollars of exploration. Westpine now owns the property, subject to a 2½% net smelter royalty up to 1.5 million dollars less past option payments. The property at present consists of 264 claims or units.

Reserves

A study by James Askew Associates, Inc. of Englewood, Colorado (1991), using a cutoff of 0.40% Cu, estimated in situ resources in the three zones of the Empress area to be 10 004 000 tonnes grading 0.61% Cu and 0.789 g/t Au. Askew calculated 9 502 000 tonnes of mineable reserves in an open pit operation grading 0.582% Cu and 0.754 g/t Au with a stripping ratio of 5.9:1. This figure was calculated using a 10% dilution of in situ reserves with a grade of dilution estimated at 0.20% Cu and 0.514 g/t Au. It should be noted that if a lower cutoff grade were used, for example 0.40 Cu equivalent, it would add reserves above the main zone, and consequently lower the stripping ratio.

A second mineral inventory was completed, by Peatfield (1991) on the Lower North zone. Using a 0.15% Cu cutoff where the overall section did not fall below 0.20% Cu, Peatfield calculated the probable and possible overall inventory to be 6 763 000 tonnes grading 0.73% Cu and 0.823 g/t Au. He also defined a high-grade core of a probable 432 000 tonnes of 2.33% Cu and 2.777 g/t Au.

Livingstone (1976) indicates that the Buzzer zone contains 4.99 million tonnes grading 0.35% Cu and 0.031 Mo. Gold occurs, but not all of the holes were assayed for gold.

Applied Exploration Techniques

Applied exploration techniques used on the Taseko property have included geological mapping, trenching, soil sampling, induced polarization surveys, magnetic surveys, diamond and percussion drilling, and an airborne geophysical survey.

Geological mapping was helpful in understanding the overall picture, but in the critical area over the Empress and east to the Buzzer zone, very little rock is exposed. Trenching, which was done mainly in the Empress area, was of little use, because overburden was generally too deep. Soil sampling is useful in that it indicates the presence of, for example, copper in the approximate area of the anomalous soils, but because of what is thought to be local transport of residual soils by glacial action and also transported anomalies, it is risky to spot drill solely on the basis of soil anomalies. Nevertheless, Figure 4 shows extensive areas of soil anomalous in copper. The anomalous soils to the southeast occur over intrusive rock whereas those to the northwest occur over volcanic rock.

I.P. appears to be effective over areas underlain by intrusive rock but not in areas underlain by the intensely altered and highly mineralized volcanic rock where abundant sulphides occur in most of the rock. There is a good correlation between copper-gold mineralization and magnetite, so magnetic surveys are an effective exploration tool, although the correlation between copper and gold drops off where the magnetite is more massive.

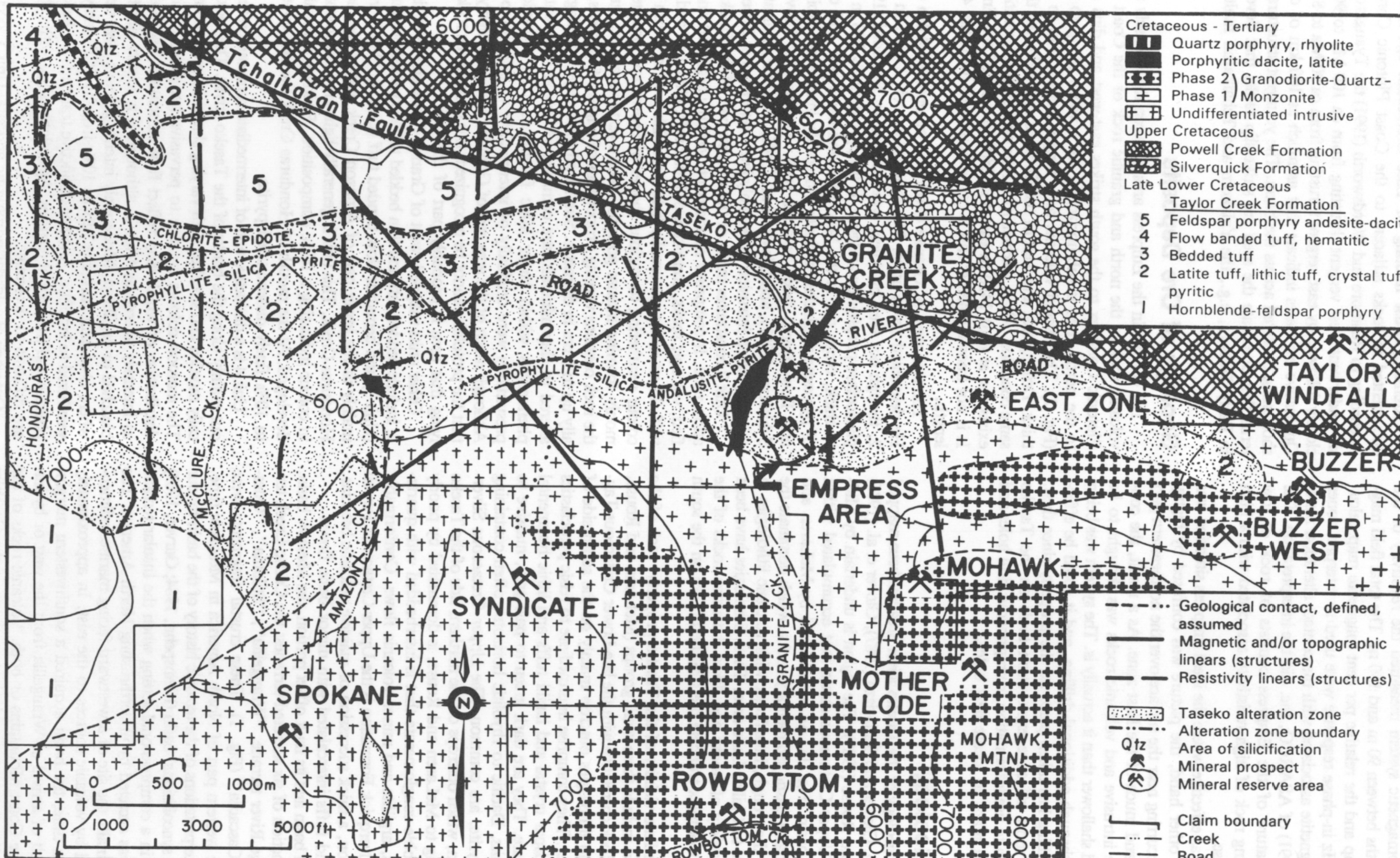

FIGURE 2. Geological map of the Taseko property and surrounding areas.

A 1990 airborne geophysical survey was used to attempt to establish a geophysical signature over Empress and to identify look-alike areas for drilling in 1991. The Dighem IV multi-frequency helicopter electromagnetic system measured the resistivity of the lithologies to depths between 90 m and 150 m. The total field magnetic contour map and the relative per cent magnetite map calculated from 900 Hz in-phase response were used to interpret zones of secondary magnetite associated with the contact alteration zone. Carl Windels (1991) of ASARCO, Inc. did the interpretation. The geophysical signature of the Empress consists of rock of low resistivity overlying rock of high resistivity associated with a high magnetic response.

The system was effective where the ideal Empress situation was present. On the other hand, the picture was confused by highly silicified zones occurring near the surface over the northeastern part of the Empress and much of the East zone. As a result, the contact between the intrusive and volcanic rocks was thought to be further north and shallower than it actually is. The system was being refined in 1991 through additional drilling, and it could be effective, but little drilling has taken place on the property since then.

One of the most effective exploration tools on the Taseko property has been to use information from previous drill holes and from geophysical maps to locate new holes.

Regional Geology

The regional geology of the Taseko River area has been mapped by Tipper (1978), Glover and Schiarizza (1987), Glover et al. (1986) and McLaren and Rouse (1989). The region is underlain by Middle Jurassic to Upper Cretaceous strata that accumulated within the Tyaughton basin (Fig. 1). As summarized by McLaren and Rouse (1989), coarse clastic sedimentary rocks, which dominate the axial regions of the trough, interfinger with volcanic lithologies in the Taseko Lake to Chilko Lake area. These lithologies have been intruded by a variety of stocks and dikes. Intrusive rocks of the Coast Plutonic Complex truncate the stratified rocks on the south and southwest.

In the immediate vicinity of the Taseko property, rock of the Tyaughton basin include three main groups (McLaren and Rouse, 1989) (Fig. 2). Rock correlative with the late-Lower Cretaceous Taylor Creek Group lithologies outcrop mainly on the south side of the Taseko River. They comprise intermediate to felsic pyroclastics and flows. Feldspar crystal and lapilli tuffs and lithic fragmental tuffs predominate. They are dark green to pale grey, massive to well layered units. Dacitic to rhyolitic horizons, often containing disseminated pyrite, are common. The Upper Cretaceous Silverquick Formation, which outcrops on the northern side of the Taseko River, according to McLaren and Rouse, is dominated by poorly sorted chert-pebble conglomerate that is interbedded with quartz-rich sandstones, argillite and minor volcanic flows. Conformably overlying the Silverquick Formation is the Upper Cretaceous Powell Creek Formation, a thick succession of massive volcanic breccias, agglomerate and tuffs intercalated with minor basic flows.

The Tyaughton basin and its fault offset portion, the Methow basin, overlap the junction of six accreted terranes: the Cache Creek terrane, the Bridge River terrane, "Wrangellia", "Stikinia", "Quesnellia" and "Cascadia" (Fig. 1). These crustal fragments were accreted to the western part of North America in Mesozoic time. More recent interpretations of the tectonic history of the basin favour deposition in a syncollisional basin (Kleinspehn, 1984; Garver, 1989) which formed in a compressional setting when the Insular terrane (Wrangellia) was accreted by underthrusting North America. The basin was originally the site of a westward facing marine sedimentary wedge fed by volcanic sources to the east. In approximately mid-Cretaceous time, the basin acquired a southwestern margin, either as a result of arrival of Wrangellia from the west or by initial uplift of the Coast Mountains or both. Volcanic rocks of the Taylor Creek Group are age-equivalent to those of the Gambier Group (roof pendants in the Coast Plutonic Complex) and the Harrison Lake Sequence, and define an Early Cretaceous volcanic arc sequence on the south side of the basin that was established at about 130 Ma and continued through Albian time.

Extensive thrust faulting of Late Cretaceous age has been documented in rocks adjacent to the Coast Plutonic Complex. According to Rusmore and Wordsworth (1991) the Tyaughton basin underwent west vergent thrusting from ca 100 Ma to 90 Ma, closely followed by east vergent thrusting from ca 90 Ma to 85 Ma. Qualitative estimates indicate that as much as 100 km of crustal shortening occurred across the basin. The youngest structural patterns that dominate the area are strike-slip faults that developed in Early Tertiary, e.g., the Yalakom and Tchaikazan faults.

Geology of Ore Deposits

The contact in the Empress area between the intensely altered volcanic rock to the north and granitic rock of the Coast Range Plutonic Complex to the south strikes east-west and dips steeply to the north; then is sub-horizontal for a width of up to 640 m (Fig. 2). The altered volcanic rock ranges from 100 m to 220 m thick. Drilling east and west of the Empress area indicated that the same condition, where volcanic rock rests on a shelf of granitic rock, exists for at least 1480 m east and 2800 m west of the Empress. It is not known whether this is continuous over the entire 4280 m length.

The area west of Granite Creek was mapped by Allen (1991). He delineated seven units. The lowermost rock, Unit 1 in Figure 2, though not seen by Allen, was mapped by Bradford (1985) as plagioclase porphyritic andesite. It is approximately 200 m to 250 m thick, crops out at the head of Honduras Creek and consists of pyroxene plagioclase andesite with locally intercalated lapilli tuffs and flow-layered felsic volcanic rock. Mapping by Glover and Schiarizza (1987), and Glover et al. (1986), however, indicates that this may be an intrusion of possibly late Cretaceous or Eocene age.

Unit 2 constitutes much of the western part of the Taseko alteration zone. It comprises nondescript, variably argillized and silicified, volcanic rocks, consisting of latitic tuff, lithic tuff and crystal tuff. These rocks are usually light brownish grey to bluish grey in colour weathering to various shades of brown and orange, commonly forming intense gossans. Where textures are recognizable, the rock contains varying proportions of angular fragments, generally up to 5 cm in diameter. Subhedral phenocrysts of plagioclase, altered to clay minerals, are common as crystal fragments or as phenocrysts within larger lithic fragments. The volcanic rocks presumably were originally of intermediate to acid composition. Although much of the area east of Granite Creek is so highly altered that the protolith cannot be recognized, it is thought the rock underlying that area is probably part of this unit.

Other units mapped, west of Granite Creek and overlying Unit 2, include bedded tuff and thin bedded tuffaceous sedimentary rocks (Unit 3) and hematitic flow banded tuff (Unit 4). Unit 3 crops out mainly in the lower part of Amazon Creek and at the mouth of Honduras Creek. This unit is generally light grey to brownish grey in colour indicating a felsic composition. Bedding is usually well-developed. At the mouth of Honduras Creek the unit contains up to 10% finely disseminated pyrite.

Unit 4 is a distinctive unit of intermediate composition that crops out mainly along the banks of the Taseko River. The rock is typically mottled and streaked with varying shades of grey and maroon. The maroon colours are due to pervasive hematite, the irregular distribution of which may reflect flow structures. The unit is not as intensely altered as Unit 2, although it is locally silicified and bleached or argillized. Moderately intense gossans have developed where abundant hematite (up to 10% iron by ICP analysis) has weathered to limonite. Another distinctive feature is the lack of porphyritic and fragmental textures. Age relationships with other units are difficult to determine.

Outcrops of feldspar porphyritic andesite, Unit 5, occur along Amazon Creek, McClure Creek and between McClure and Honduras creeks. In the Amazon Creek area it overlies Units 2 and 3. The relationship with other units is not obvious in the Taseko River canyon area where some of the outcrops may be erosional remnants and distribution may also be affected by faulting. The rock is typified by 20% to 40% white to translucent plagioclase phenocrysts, 2% to 10% augite and hornblende phenocrysts, along with 1% to 3% accessory magnetite in a fine-grained brownish grey to maroon grey groundmass. Except for minor amounts of epidote and chlorite, and locally developed hematite-coated shears and fractures, the rock appears to have escaped the alteration that has affected Units 1 to 3. No gradations into unaltered rock were observed. This unit, therefore, may be younger than the alteration event. It has a jointing pattern which is parallel to bedding in adjacent units and may reflect flow layering.

Dikes of variable texture and of dacitic to latitic composition occur in outcrop in Amazon Creek and are reported by Melnyk and Britten (1986) and Bradford (1985) to occur in the upper McClure Creek area. They are commonly porphyritic with 1 mm to 4 mm plagioclase phenocrysts in a light to medium brownish grey groundmass.

Six separate types of intrusive rock were delineated. Not all of the units were seen in contact, so the exact nature of their relationships is not known. The sequence of some units is determined in this study by their spacial relationship. Starting with what is thought to be the oldest intrusive rock and progressing to the youngest, the first is quartz monzonite-granodiorite which underlies the Empress and East zones and is thought to underlie much of the area beneath the altered volcanic rock east and west of the Empress. It is non-porphyritic to sub-porphyritic with subhedral grains of plagioclase up to 5 mm in length. Irregular clots of biotite in various stages of chloritization, quartz, orthoclase and magnetite also occur. This rock constitutes Phase 1 in Figure 2.

The remaining five types of intrusive rock were grouped under Phase 2 in Figure 2. The reason for this will be explained under "Discussion and Conclusions". The second oldest intrusive rock, inequigranular biotite granodiorite, is a massive unit which is found on the southwest side of Mohawk Mountain. Its total area of occurrence is not known. One traverse to the south indicates that it could underlie a major part of the area.

Mohawk biotite granodiorite occurs on the top of Mohawk Mountain. It is an inequigranular to porphyritic biotite granodiorite-quartz monzonite, pinkish grey in colour with fewer mafics than are found in other phases. A sub-group is similar to the above except that the texture is distinctly porphyritic. Grey biotite quartz diorite-granodiorite has been mapped on the top of Mohawk Mountain in the shape of an hourglass oriented northeast-southwest and ranging from 180 m to 550 m wide. Its southwest limit is not known due to the lack of outcrop. It consists of subhedral plagioclase from 0.1 cm to 0.7 cm in diameter in an equigranular matrix of quartz, K-feldspar and biotite.

Porphyritic hornblende-biotite granodiorite crops out in the southwestern part of the map area in the Rowbottom and surrounding areas. Due to the lack of outcrop, its full extent is not known to the north. In addition it occurs in the Buzzer area. It consists of an inequigranular to porphyritic rock with euhedral to subhedral, crowded plagioclase crystals, up to 1 cm long but averaging 0.05 cm, in interstitial quartz, orthoclase, biotite and hornblende. The quartz and orthoclase are generally fine-grained and euhedral. Miarolitic cavities also exist.

The sixth intrusive unit is a leucocratic fine- to medium-grained rock with interlocking grains of quartz and highly argillitized feldspar. This rock occurs as fragments in the Buzzer West area. Specks of magnetite, constituting less than 0.05% of the rock, exist.

In general some quartz diorite was observed with the quartz monzonite and granodiorite. Accessory minerals include rutile, sphene, apatite, hematite, magnetite and pyroxene. A variety of dikes intrude the intrusive and volcanic rocks on the Taseko property. These include quartz latite, dacite, rhyolite, felsite, and porphyritic andesite.

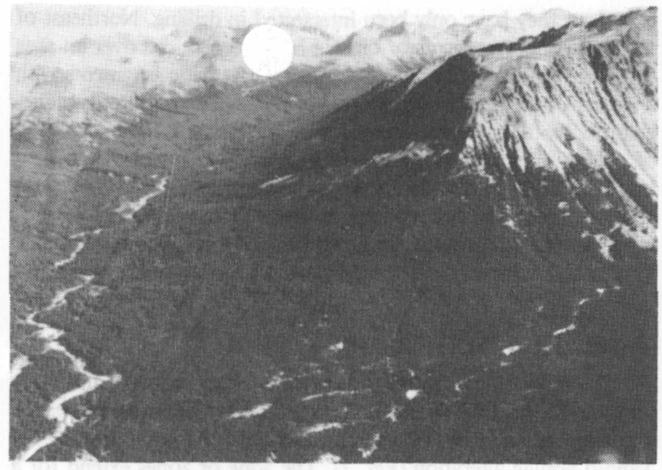

FIGURE 3. View looking east along Taseko River with the Empress area in foreground. The Buzzer zone occurs southeast of the most distant open area along the river. Note the airstrip on the lower left corner and the 1971 baseline.

Geochronology

Two previously unpublished age determinations have been made available by Andre Panteleyev of the British Columbia Ministry of Energy, Mines and Petroleum Resources. These determinations are argon-argon plateau ages from sericite and alunite (variety of mimetite) from the McLure Creek area. The age from the sericite is 85.9 ± 1 Ma, and the age from the alunite is 85.3 ± 1 Ma.

Earlier argon age dating by McMillan (1976) from biotite in granodiorite, sericite from the alteration zone at the Mohawk and biotite from a postmineral dike zone gave ages of 86.7 ± 2.5 Ma, 84.9 ± 2.5 Ma, and 84.7 ± 2.5 Ma, respectively, which agrees well with Panteleyev's determinations. The dating indicates a similar age for the intrusion of the granitic rock and the alteration event.

Structure

The main structural element in the Taseko area, as shown on regional geological maps by Tipper (1978) and Glover (1986), is the Tchiakazan Fault (Fig. 1). They interpret it as trending east-southeast along the Taseko River between the Powell Creek and Silverquick formations to the north and the Taylor Creek to the south and then continuing to the southeast. This fault was not identified in field work, but it could be reflected in strong magnetic and topographic lineaments immediately north of the river northwest of Honduras Creek. The strongest fault observed in the Taseko River Canyon is a 5 m zone of intensely crushed rock.

Generally, in the area west of the Amazon Creek, faults are fairly common throughout all rock types and trend mainly northwesterly. Bedding attitudes, when discernible, strike mainly west-northwesterly and dip gently to the north. Fracture trends in the feldspar porphyritic andesite are similar.

Much of the structural information comes from the Dighem Survey interpreted by Windels (1991) and from drill core. Most of the area underlain by intrusive rock was not covered by the survey. Major northerly-trending resistivity linears dominate west of Amazon Creek, whereas east of Amazon Creek there is one northeasterly and one northwesterly linear. The major magnetic linears are north, northeasterly and northwesterly (Fig. 2). The northeasterly linear lines up with the 76 zone in the Empress area.

Intense fracturing has been seen in drill core, especially in the Upper North zone of the Empress area. One study on the upper 100 m of a drill core from here recorded at least nine episodes of fracturing and rehealing.

Several areas of brecciation occur on the property. These areas are not shown in Figure 2 because they are relatively limited in extent, or they have only been intersected in drilling. Northeast of the East zone, fragments of breccia h een traced over an area of 90 m by 150 m. The breccia consists of felsitic fragments with a variety of matrices including one or more of quartz, tourmaline, chlorite, biotite, magnetite and pyrite. A zone of breccia consisting of quartz fragments in a magnetite matrix was intersected over a length of 25 m in one drill hole in the East zone. Finally, several zones of breccia have been located on Mohawk Mountain including the Mohawk showing, which consists of granodiorite fragments in a quartz matrix.

Alteration and Mineralization

The main alteration feature on the Taseko property and areas to the east, held by Westmin Resources Limited and Homestake Canada Ltd. and by Taywin Resources, is the large area of advanced argillic alteration (Fig. 2). The zone or zones extend for a total of 18.5 km in an east-west direction. Lane (1987) reported two major zones of advanced argillic alteration on the properties east of the Taseko property. They are the east-west Rae Spur zone, measuring 2000 m by 6000 m, and the Taylor-Windfall zone, 100 m by 1350 m.

Neither of these are shown in Figure 2 although the Taylor-Windfall zone trends east from the Taylor-Windfall mine. Lane reported that the Rae Spur zone consists of quartz-alunite-pyrophyllite-diaspore-kaolinite, which indicates the current topographic surface is situated high up in the epithermal system. The Taylor-Windfall zone, consisting of andalusite, pyrophyllite, diaspore, corundum, dickite or kaolinite, alunite and quartz, suggests that rock in this area is lower in the system.

Allen (1991) reported pyrophyllite and quartz, with or without alunite and andalusite, east of Amazon Creek which is probably comparable to the Rae Spur zone. The advanced argillic assemblage in the volcanic rock east of Granite Creek consists mainly of andalusite, pyrophyllite and quartz which indicates that it is lower in the system than the Taylor-Windfall zone.

Both phyllic and propylitic alteration are prominent. Weak propylitic alteration, as defined by the presence of chlorite and epidote, is widespread and mainly related to the granitic rock. Moderate propylitic alteration occurs southwest of the Rowbottom area. An area from Amazon Creek to McClure Creek in the volcanic rock is also moderately propylitized. Weak phyllic or sericitic alteration is also widespread. Sericite is not easily distinguishable from pyrophyllite; thus more sericite may be in the volcanic rock than has been recognized. The intrusive rock in the Granite Creek zone northwest of the Empress area, is moderately to intensely sericitized. The feldspar in the Buzzer West zone is either argillized or is being broken down by weathering.

Silicification is the second most widespread alteration type. Extensive silicification was found in drilling the Empress area as described below and is evident mainly in the volcanic rock along Amazon Creek where it is found in fault or fracture zones. It also occurs within intrusive rock of the Buzzer zone. Allen found a northeasterly-trending zone of jasperoid 170 m by 1350 m just west of Honduras Creek. Part of this zone is shown on the northwestern corner of Figure 2.

The main mineralized zones discovered to date in the volcanic rock on the Taseko property occur in the Empress area. The rock is so intensely altered that little remains of the protolith. In logging the core, E. Lambert distinguished four alteration units. Figure 5 shows a north-south cross-section along Line 1400 E through the centre of the Empress area outlined in Figure 2. Below is a description of these units from the present surface down:

1. Quartz-Andalusite-Pyrophyllite (QAS). QAS generally occurs within the top 107 m of the surface. It is characterized by an equigranular texture consisting of grains less than or equal to 1 mm in size. Pyrite is disseminated throughout, ranging from 2% to 15%. Additional minerals include finely disseminated magnetite, clots of chlorite, specks of clay and gypsum in veins.
2. Plagioclase-Quartz-Pyrophyllite-Andalusite (PQSA). PQSA also occurs within the f 07 m in zones within the QAS. It consists of plagioclase, which can be white, light green or pink, pyrophyllite, andalusite, magnetite, corundum, quartz, chlorite and clay. Where QAS and PQSA are adjacent, the QAS is in a state of alteration by PQSA.
3. Quartz Rock (QR). QR generally occurs in the range of 107 m to 167 m below the surface. It also is found in narrow zones within QAS and PQSA. Units of this rock also are found near the surface in the southeastern part of the Empress area. The quartz occurs typically as interlocking grains with a texture resembling quartzite and a variation in size from cryptocrystalline to 1 mm in diameter. It is white, light grey, dark grey and various shades of brown in colour. Brown cryptocrystalline quartz is in a state of alteration by white granular quartz.
4. Quartz Magnetite (QM). QM occurs between QR and the underlying intrusive rock from 167 m to as deep as 223 m. It is similar to QR but contains greater than 5% magnetite. Magnetite commonly constitutes 10% to 20% of the rock but is locally massive, reaching 50% to 70%. The magnetite is found interstitial to quartz grains and in fractures. It also occurs in the matrix in breccia with quartz fragments. Chlorite and hematite are common.

In general, gypsum, quartz, calcite and white or green clay are common in fracture fillings or as veins. Accessory minerals include tourmaline, fluorite, rutile, apatite, bastnaesite (E.L. Faulkner, pers. comm.) and possibly dumortierite.

The East zone, 1000 m east of the Empress area, has only been intersected in three drill holes. There appears to be more QR and QM in general. In the initial drilling, the sequence from top to bottom consists of QR and QM, then QAS and PQSA and finally QR and QM above the granitic rock.

Copper-gold mineralization at the Empress occurs in three definable zones: the 76, Lower North and Upper North zones (Fig. 5). The 76 zone has been traced for 260 m in an east-northeast direction. Drilling indicates it could be cut off by the intrusive-volcanic contact to the southwest, but it is still open to the northeast. Although its configuration appears to change along the strike length of the zone, it measures up to 32 m wide and 103 m in a vertical direction.

The Upper North zone is located 185 m north of the 76 zone. Although its configuration is somewhat irregular, it appears to strike northeast, is up to 90 m wide, and is confined to the upper alteration zone of QAS-PQSA. It has been traced for 185 m in length, appears to be cut-off to the southwest and is open to the northeast. The copper-gold mineralization in the 76 and Upper North zones is found associated with PQSA and QAS in contact with PQSA where the rock is highly fractured or faulted. The zone seems to be associated with a fault in the 76 zone and highly fractured rock in at least part of the Upper North zone.

The Lower North zone is an elongate lens up to 60 m thick and 245 m wide. The top surface of the lens is from 135 m to 167 m below surface and is oriented in a north-northeasterly direction. An intersection in Hole 91-48, however, indicates that the lens is starting to increase in thickness to the east. It generally occurs in QR and/or QM along the contact between them.

Rock in the Empress is highly mineralized with pyrite, magnetite and chalcopyrite. In general, these minerals are disseminated but also occur in fractures. Pyrite is ubiquitous; it averages 1% to 5% by volume and locally exceeds 10%. Chalcopyrite is mainly disseminated but also occurs along fractures. Magnetite is found in all alteration zones but it is most common in QM. It is mainly disseminated but also, massive, locally banded and as the matrix in a breccia with quartz fragments. Rare specks of molybdenite occur in the PQAS.

There is a strong correlation between chalcopyrite and gold and a good correlation between chalcopyrite, gold and magnetite. The content of chalcopyrite decreases, however, where magnetite is massive. There is generally a reverse correlation between chalcopyrite

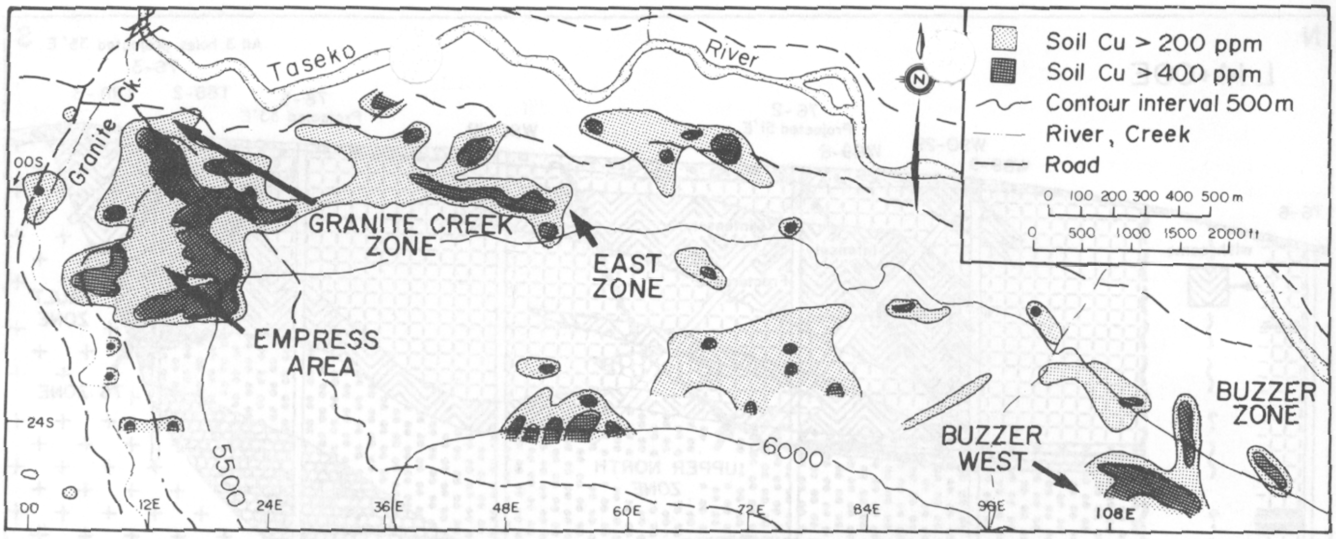

FIGURE 4. Map showing the copper soil geochemistry zone area between and including the Buzzer zone and the Empress area.

and chlorite or hematite.

There are several mineralized zones within the intrusive rock. The most important are the Buzzer, Buzzer West, Rowbottom and Granite Creek zones. Mineralization consists of chalcopyrite, molybdenite and gold, although it is not known whether the gold is native or occurs with pyrite and chalcopyrite. Both the Rowbottom and Buzzer zones consist of chalcopyrite, molybdenite and pyrite. The minerals are disseminated where, especially at the Rowbottom, they have replaced partly chloritized biotite and hornblende. They also occur in vugs. At the Buzzer area, the mineralized rock consists of a dull pink granodiorite within grey granodiorite. On a broken surface the pinkish colour gives way to a brown limonite. This rock is moderately silicified. Some of the rock is porphyritic with plagioclase phenocrysts. The Buzzer has an areal extent of around 150 m by 150 m, and is open to the northwest; whereas the Rowbottom is approximately 120 m by 180 m.

At the Buzzer West zone, disseminated chalcopyrite and molybdenite occur in highly weathered granitic fragments with argillized feldspar. Similar fragments have been traced in a westerly direction for 270 m. A series of copper soil anomalies of greater than or equal to 200 ppm extend west from the Buzzer for 2425 m (Fig. 4) and include this area. Drilling has not tested this area west of the Buzzer.

Only one drill hole intersected the Granite Creek zone. This hole intersected 0.035% Mo over 76.5 m (from 56.7 m to 133.2 m) in QAS with some PQSA and veins of gypsum constituting 3% to 25% of the rock. It also intersected 89.0 m (from 186.2 m to 275.2 m) of 0.23% Cu and 0.274 g/t Au in granitic rock variably altered to sericite, quartz and pyrite.

The Mohawk, Spokane, Syndicate and Taylor-Windfall mineral occurrences (Fig. 2) are not within Westpine claims. The Mohawk showing consists of breccia with felsite fragments in a matrix consisting of quartz, sericite and sulphides. Chalcopyrite and gold are found with scattered molybdenite.

The Spokane and Syndicate showings are held by Shogun Properties Inc. At the Spokane, chalcopyrite and pyrite are found in predominantly northeasterly- and southeasterly-striking veins in shear zones and along altered fractures in biotite-hornblende granodiorite. The Syndicate showing consists of a breccia zone with fragments of quartz diorite in a felsitic matrix. Chalcopyrite, with some molybdenite, occurs in drusy quartz veins cutting the breccia and is disseminated in the breccia. The upper part of the Syndicate is thought to be 45 m by 76 m (Nakashima, 1970).

The Taylor-Windfall occurrence, owned by Taywin Resources Ltd., occurs in a zone of advanced argillic alteration in volcanic rock. The gold was found mainly in tension fractures striking 060° and dipping 70°SE and to a lesser degree in bedding shears striking 090° and dipping 20°N. The zone has been traced for greater than 100 m (Lane, 1985).

Genesis of Deposits

It is postulated that the copper-gold mineralization in the intensely altered volcanic rock, such as those zones in the Empress area, and the porphyry-type copper-gold-molybdenum occurrences are related in origin to the genesis of a large porphyry system.

The Taylor Creek Group volcanic rocks are the oldest rocks present. Mapping in the area west of Amazon Creek has defined five separate units, consisting of tuffs and flows. Whole-rock analyses of rocks, to be discussed in the next section, indicates, however, the highly altered volcanic rock in the Empress area of Unit 2 (Taylor Creek Group) can be further broken down into groups of rock from three different sources. These include what is now QAS and two units of QR-QM combinations.

The next event was the intrusion of Phase 1 rock. It is believed that little alteration or mineralization was associated with this emplacement. Although, as discussed later in this paper, there is some question as to the exact sequence, it is thought that Phase 1 was followed by the intrusion of Phase 2. Part of this event included the intrusion of dikes and irregular intrusive bodies into rock of the Taylor Creek Group. Examples of this event are seen as PQSA (Fig. 5). PQSA has not been seen in drill core of QR, QM or Phase 1 rock. It may have been totally silicified if it occurred in QR and QM.

It is believed that the alteration and mineralization accompanied the intrusion of Phase 2. It is not known how the altering and mineralizing fluids accessed the volcanic rock in the Empress area because of the fact that unaltered Phase 1 rock underlies most of the Empress area. These fluids may have accessed rock of the Empress area possibly from the Granite Creek zone to northwest where Phase 1 rock is highly altered. During the alteration phase, tuff altered to QAS, granitic rock in the tuff altered to PQSA and the rock below QAS, possibly volcanic glass, altered to QR and QM. Variations in the nature of protoliths may explain the different alteration types. At the contact between PQSA and QR, however, the PQSA is in a state of alteration by QR.

In general the higher temperature silicification found adjacent to the intrusive grades to higher temperature, then lower temperature advanced argillic alteration and finally propylitic alteration with distance from the intrusive. The large extent of the advanced argillic alteration zone is thought to be due to the size and strength of the porphyry system as well as the porous and highly fractured sec-

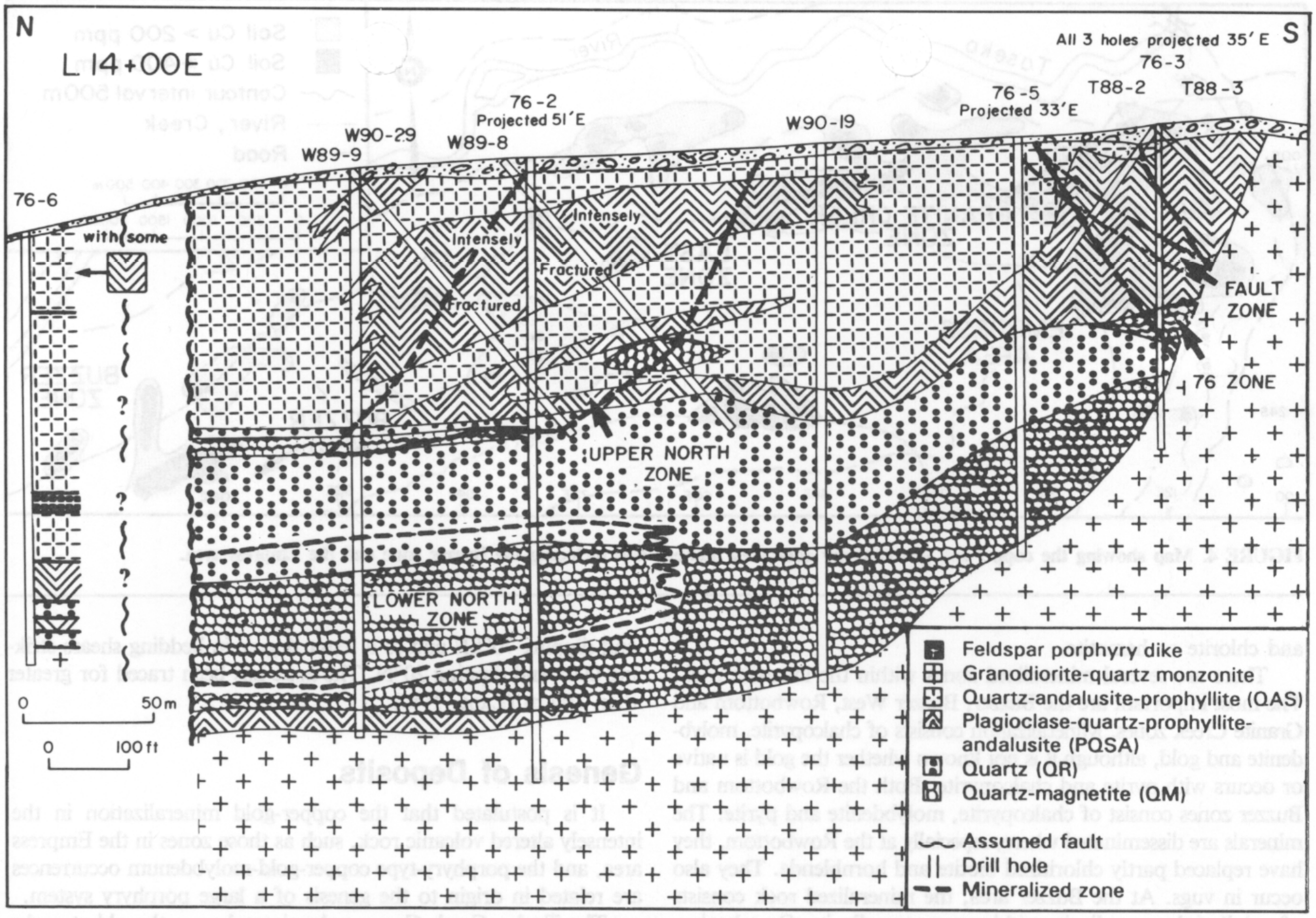

FIGURE 5. North-south cross-section through the Empress area along Line 14-100E, looking east.

tion of the host tuffs.

Two separate styles of mineralization are recognized. The first style is gold and copper in the intrusive and in the volcanic rock (QAS) associated with significant alkali loss, calcium metasomatism and variable silicification. This would include the 76 and Upper North zones as well as the various zones in the intrusive rock. As seen in Figure 5, there is a close association between PQSA and these zones, and the mineralization may be related in genesis to the PQSA. It is believed that the 76 and Upper North zones were localized by fracturing and faulting. There is a northeasterly-trending lineament that lines up with the 76 zone. Molybdenite is an important constituent in the Buzzer, Buzzer West and Rowbottom zones, but it is rare in the other zones.

The second style of mineralization, with gold and copper, is associated with pervasive silicification of one of the tuff units (QM-QR units) and probably accompanied the silicification. The control is not yet known because of the complete alteration and subsequent destruction of original textures and structures.

Economics

The Taseko property is still in the exploration stage, thus a detailed analysis of the economics is premature. As discussed earlier, doing a new reserve estimate using 0.40% Cu equivalent rather than 0.40% Cu should add tonnage from the Upper North and 76 zones and lower the stripping ratio.

Bacon Donaldson and Associates Ltd. (1991) completed some preliminary test work on a section of core from 153 m to 219 m in Hole W90-21, which is in the Lower North zone. Their work resulted in a recovery of 97.1% Cu and 69.3% Au. The test concentrate graded 27.0% Cu and 21.184 g/t Au. The report recommends a microscopic examination of the rock to determine processing options to recover the rest of the gold, which is either in pyrite or native.

Discussion and Conclusions

Geological interpretation, especially in the Empress area, has presented a dilemma because of the intensity of alteration and the lack of outcrop in what are considered to be key areas. To attempt to get some answers on the nature and relationship of the various rock units, it was decided to carry out a preliminary lithogeochemical study whereby results of whole-rock determinations by Chemex Labs Ltd. were subjected to a Pearce element ratio analysis by Madeisky (1994).

On the basis of an Al_2O_3 vs Zr immobile element scatterplot, a suite of 48 samples of rock from the property was analyzed to determine co-genetic groups of rock. The analyses is based on conserved elements where ratios remain constant in a group of rock regardless of the type or intensity of alteration. Plotting the percentages of two conserved elements of a number of different samples from a single co-genetic group of rocks should result in a situation where all points fall on a line that starts from the origin.

Plotting the results for the conserved elements Al_2O_3 and Zr from rocks on the Taseko property resulted in the definition of five separate groups as seen in Figure 6 from Madeisky (1994). The QR and QM samples were found to fall in two separate groups (Groups 1 and 2) with both QR and QM in each one of the groups. The nature of the original rock is not known because of the intense alteration, but it is postulated to be tuffaceous sediments in origin.

The intrusive rock was found to fall also into two groups, Groups 3 and 4, corresponding respectively to Phases 1 and 2. These are thought to represent two separate phases of a co-genetic intrusive suite. It is not known for certain which of these two phases came earlier. Although Group 4 is earlier in the fractionization sequence as seen from the graph, this grou he mineralized phase, and it may have originated from a deeper part of the magma chamber at a later time. Groups 3 and 4 rocks have rarely been seen in contact. On the basis of relationships seen in the field and drill core it is believed that Group 3 preceded Group 4. Evidence includes the alteration of Group 3 rock in the Granite Creek zone (this was altered by a subsequent intrusion, presumably related to Group 4) and the situation in the Buzzer and Buzzer West areas where Group 4 rock appears to be surrounded by Group 3 rock. It must be noted that two of the three samples (W93-173 and W93-190) of intrusive rock from the Buzzer West do not seem to fit within the groups on the TiO_2 versus Zr conserved element scatterplot. This could indicate a third phase, or it may be just due to analytical error.

The volcanic rocks constitute Group 5. One unaltered volcanic sample was included in this group. One of the surprises to come out of this exercise was the fact that a sample of supposedly volcanic origin, consisting of plagioclase-quartz-pyrophyllite-andalusite (PQSA), fell into the intrusive Group 4. Unfortunately it was the only sample of PQSA tested.

One of the problems posed by the interpretation of the whole rock analyses is the apparent discrepancy between this study and the mapping of the intrusive rock. Mapping has delineated five different intrusive phases within Group 4, whereas the lithogeochemical analysis shows one. There could be two different explanations for this. First, the "phases" identified in mapping could merely be textural variations within one phase of the intrusion or, on the other hand, the separate mapped phases could be separate phases from the same magma chamber where little fractionation took place between intrusive pulses.

One of the unique aspects of the Taseko property is the existence of extensive zones of advanced argillic alteration. Panteleyev (1988;1992) and Panteleyev and Koyanagi (1993) have made a study of the association of advanced argillic alteration and mineral deposits in British Columbia. In his British Columbian Epithermal Model (1988), Panteleyev describes the advanced argillic transition zone as having been formed from 1 km to a maximum of 3 km below the paleosurface. He has documented the association of advanced argillic alteration to a variety of mineral deposits ranging from porphyry copper-molybdenum through mesothermal veins to epithermal veins.

The range of levels for the Taseko alteration system on the British Columbia Epithermal model is wide, extending from the porphyry copper-molybdenum level with quartz and andalusite-quartz-pyrophyllite in the Empress area to a potential epithermal association in the Rae Spur zone with quartz-alunite-pyrophyllite-dispose-kaolinite.

Panteleyev (1992) states that the advanced argillic alteration with its siliceous and aluminous mineral assemblages is a product of strongly oxidized, sulphur-rich, acidic hydrothermal fluids that generally occurs at late stages of mineralization during declining hydrothermal activity. If this holds true for the Taseko property, what is the location of the earlier stages of mineralization? Do they exist?

With the exception of a small $40,000 program of exploration completed on the Taseko property in 1993, there has been no activity on the property since 1991. Intriguing targets remain to be tested. These include that large area extending for 2440 m west of the Buzzer zone, including the West Buzzer, where soils anomalous in copper occur. The Granite Creek and East zones remain to be defined. There is also the potential to discover additional Empress-like zones along the volcanic rock just north of the 4280 m long volcanic-intrusion contact on the Taseko property. Other targets remain to be tested.

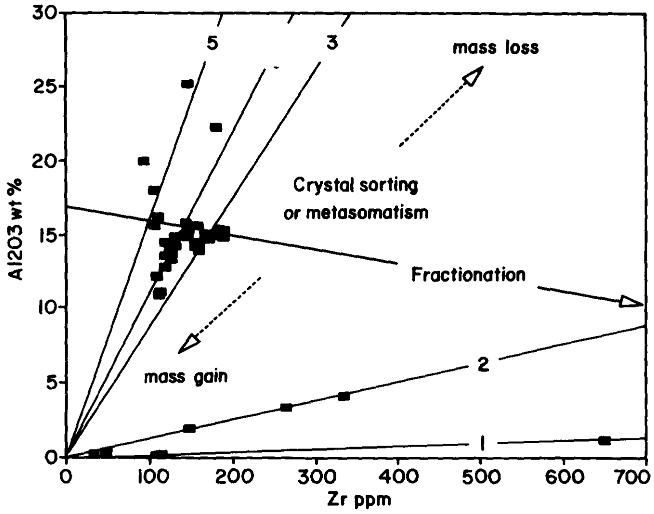

FIGURE 6. Al_2O_3 vs Zr immobile element scatter plot of a suite of rocks from Taseko property (Madeisky, 1994).

Acknowledgments

The authors would like to thank Ellen Lambert for her painstaking work in logging the core and other support during the project. Hans E. Madeisky is acknowledged for providing some answers to difficult questions through his analysis of whole-rock determinations. Thanks are extended to Joseph E. Worthington, Michael McClave and Robert Gale for their input into the planning of the programs in 1990 and 1991, and to Carl Windels for his interpretation of the airborne geophysical data, when ASARCO Inc. had an option on the property. Also deserving acknowledgment are Jim MacNeill and Andre Panteleyev. Finally, thanks are given to Catherine Knight and Susan Lusk for typing and drafting, respectively.

REFERENCES

ALLEN, D.G., 1991. Geological and geochemical report on the Taseko alteration zone. Unpublished company report, ASARCO Exploration Company of Canada, Ltd. and Westpine Metals Ltd.

BACON DONALDSON & ASSOCIATES LTD., 1991. Alpine Au/Cu ore preliminary metallurgical testwork progress report #1. Unpublished company report, Westpine Metals Ltd.

BONHAM, H.F., 1988. Models for volcanic-hosted epithermal precious metals deposits. *In* Bulk Mineable Precious Metal Deposits of the Western United States. *Edited by* R.W. Schafer, J.J. Cooper and P.G. Vikre. Geological Society of Nevada Symposium Proceedings, p. 259-271.

BRADFORD, J.A., 1985. Geology and alteration in the Taseko river area, southwestern British Columbia. Unpublished B.Sc. thesis, The University of British Columbia, Vancouver, British Columbia, p. 23-24.

BRITTEN, R., 1984. Field work at Taseko joint venture project. Unpublished company report, Esso Minerals Canada Ltd.

CORN, R.M., 1977. Alteration mineralization zoning. Red Mountain, Arizona. Economic Geology, 70, p. 1437-1447.

CROSSLAND, F.J., 1920. Taseko Valley iron-ore deposits. *In* British Columbia Minister of Mines Annual Report 1920, p. 175-181.

GARVER, J.I., 1989. Basin evolution and source terranes of Albian-Cenomanian rocks in the Tyaughton Bassin, southern British Columbia: Implications for mid-Cretaceous tectonics in the Canadian Cordillera. Unpublished Ph.D. thesis. University of Washington, Seattle, 227 p.

GLOVER, J.K., SCHIARIZZA, P., UMHOEFER, P. and GARVER, J., 1986. Geology of the Warner Pass area, British Columbia. British Columbia Ministry of Energy, Mines and Petroleum Resources, Open File Map 1987-3.

GLOVER, J.K. and SCHIARIZZA, P., 1987. Geology and mineral potential of the Warner Pass map sheet. *In* Geological Fieldwork 1986, British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1987-1, p.157-169.

HENLEY, R.W. and ELLIS, A.J., 1983. Geothermal systems ancient and modern: A geochemical review. Earth Science Reviews, 19, p. 1-50.

KLEINSPEHN, K.L., 1984. Cretaceous sedimentation and tectonics, Tyaughton-Methow Basin, southwest British Columbia. Canadian Journal of Earth Sciences, 22, p. 154-174.

JAMES ASKEW ASSOCIATES, INC., 1991. ASARCO Incorporated, Taseko Project - British Columbia, Canada, pre-feasibility Study. Unpublished company report, ASARCO Inc.

LAMBERT, E., 1988. Report on the 1988 exploration program of the Taseko Property; Alpine Exploration Corp. British Columbia Ministry of Energy, Mines and Petroleum Resources, Assessment Report #18,921.

LAMBERT, E., 1989b. Geochemical and diamond drilling program of the Taseko Property; Westpine Metals Ltd. British Columbia Ministry of Energy Mines and Petroleum Resources, Assessment Report #19,350.

LAMBERT, E., 1991. 1990 Diamond drilling program of the Taseko Property; Westpine Metals Ltd. British Columbia Ministry of Energy, Mines and Petroleum Resources, Assessment Report #20889.

LAMBERT, E., 1991. 1991 Diamond drilling program of the Taseko Property. Westpine Metals Ltd. British Columbia Ministry of Energy, Mines and Petroleum Resources, Assessment Report #21985.

LANE, R., 1985. Taseko Project, year end report — 1984. Unpublished company report, Westmin Resources Limited.

LANE, R., 1987. Taseko Property: summary report. Unpublished company report, Westmin Resources Limited.

LIVINGSTONE, R.W., 1976. Geology and drilling, Granite Creek project. Unpublished map, Scale 1" = 400', Quintana Minerals Corporation.

McKIBBON, M.A. and ELDERS, W.A., 1985. Iron-zinc-copper-lead mineralization in the Salton Sea geothermal system, Imperial Valley, California. Economic Geology, 80, p. 539-559.

McLAREN, G.P. and ROUSE, J.N., 1989. Geology and mineral occurrences in the vicinity of Taseko Lakes. *In* Geological Fieldwork 1988, British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1989-1, p. 153-158.

McMILLAN, W.J., 1976. Granite Creek Property, 920/3W. *In* Geological Fieldwork 1976, British Columbia Ministry of Energy, Mines and Petroleum Resources, p. 67-84.

MADEISKY, H.E., 1994. Lithogeochemical data analysis — Taseko porphyry copper-gold project, central British Columbia. Unpublished company report, Westpine Metals Ltd.

MELNYK, W.D. and BRITTEN, R.M., 1986. Geological, geochemical and geophysical report on the Babbling Brook No. 1, Flapjack No. 1 and 2, Taseko 36 to 66, Taseko 72-89, Taseko 144-146, Perfect Day and Old & Rare 3; Esso Resources Canada Ltd. British Columbia Ministry of Energy, Mines and Petroleum Resources, Assessment Report #15,755.

MELNYK, W.D., BRITTEN, R.M. and MARSDEN, H., 1986 Geological, geochemical and geophysical report on the Tyaughton Trough Projects; Esso Resources Canada Ltd., British Columbia Ministry of Energy, Mines and Petroleum Resources Assessment Report #15,755.

NAKASHIMA, K., 1970. Report on the geology of the property of Scurry Rainbow Oil Ltd., Taseko Lake Area. Unpublished company report, Scurry Rainbow Oil Ltd.

OSBORNE, W.W., 1992 Report on the 1991 exploration program on the Taseko Property. Unpublished company report, Westpine Metals Ltd.

OSBORNE, W.W. and ALLEN, D.G., 1994. 1993-1994 exploration program on the Taseko Property. British Columbia Ministry of Energy, Mines and Petroleum Resources Assessment Report.

PANTELEYEV, A., 1988. A Canadian Cordilleran model for epithermal gold-silver deposits. *In* Ore Deposit Models. *Edited by* R.G. Roberts and D.A. Sheahan. Geological Association of Canada, p. 31-43.

PANTELEYEV, A., 1992. Copper-gold-silver deposits transitional between subvolcanic porphyry and epithermal environments. *In* Geological Fieldwork 1991. *Edited by* B. Grant and J.M. Newell. British Columbia Ministry of Energy, Mines and Petroleum Resources, Paper 1992-1, p. 231-234.

PANTELEYEV, A. and KOYANAGI, V.M., 1993. Advanced argillic alteration in Bonanza volcanic rocks, northern Vancouver Island — transitions between porphyry copper and epithermal environments (92L/12). *In* Geological Fieldwork 1992. *Edited by* B. Grant and J.M. Newell. British Columbia Ministry of Energy Mines and Petroleum Resources, Paper 1993-1, p. 287-293.

PEATFIELD, G.R., 1991. Mineral inventory calculation for the lower north zone, Taseko Property. Unpublished company report, Westpine Metals Ltd.

QUADROS, A.M., 1981. The Spokane Prospect: A review of the history, geology and economic potential of a gold-silver-copper prospect on Amazon Creek. Unpublished consulting report, Felix Reyes.

RUSMORE, M.E. and WOODSWORTH, G.J., 1991. Coast plutonic complex: A mid-Cretaceous contractional orogen. Economic Geology, 19, p. 941-944.

SILLITOE, R.H., 1983. Enargite-bearing massive sulfide deposits high in porphyry copper systems. Economic Geology, 78, p. 348-352.

SILLITOE, R.H., 1990. Gold-rich porphyry copper deposits of the circum-Pacific region — an updated review. Pacific Rim 90 Congress Transactions. Australasian Institute of Mining and Metallurgy, p. 119-126.

TIPPER, H.W., 1969. Mesozoic and Cenozoic geology of the northeast part of the Mount Waddington map area (92N), Coast District, British Columbia. Geological Survey of Canada, Paper 68-33.

TIPPER, H.W., 1978. Taseko Lakes (920) map area. Geological Survey of Canada, Open File Map 534.

UCHIDA, K., NAKASHIMA, K., SHIBUYA, A., ROBERT, I. and AOKI, K., 1970. Geological survey, Taseko property. 1" = 1000' map for Sumitomo Metal Mining Canada Ltd.

WAIBEL, A.F., 1987. An overview of the geology and secondary mineralogy of the high temperature geothermal system in Dixie Valley, Nevada. Geothermal Resources Council Transactions, 11, p. 479-486.

WINDELS, C.O., 1991. Dighem IV interpretation, Taseko Project, Clinton Mining Division, British Columbia. Unpublished company report, ASARCO Incorporated.

WOLFHARD, M.R., 1976. Granite Creek project 1976 work. Unpublished company report, Quintana Minerals Corporation.