

TIN AND TUNGSTEN VEINS AND SKARNS IN THE McQUESTEN RIVER AREA, CENTRAL YUKON

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ABSTRACT

Tin and tungsten veins and skarns in the McQuesten River area occur in the contact zones of Cretaceous feldspar-porphyrific biotite granite stocks, plugs, and dykes. Most occurrences are located in the exocontact of plutons, in the brittle metasedimentary country rocks known as the Grit Unit of Upper Precambrian to Lower Cambrian age. Cassiterite (+/- silver) occurs in chlorite-, tourmaline-, and quartz-matrix breccias with fragments of quartzite, schist, and vein material of chlorite, tourmaline or quartz; in thin veinlets with little gangue of tourmaline, K-feldspar, or muscovite; and in actinolite-quartz-epidote-axinite-garnet skarn (+/- pyrrhotite, pyrite and chalcopyrite). Scheelite is mainly disseminated in fine-grained, diopside-quartz, or actinolite-quartz (+/- pyrrhotite) exoskarn which is interlayered with white wollastonite-quartz skarn. Scheelite (+/- molybdenite) also occurs in sheeted quartz (+/- feldspar) veins in both the endo- and exocontact regions of two feldspar-porphyrific granite stocks. Rarely do tin and tungsten occur together, however some low tin values are found in some tungsten occurrences; and vice versa. Tungsten occurs closer to the associated intrusion than tin.

INTRODUCTION

The McQuesten River is located about 30 km northwest of Mayo, traversing an area approximately 65 x 40 km containing occurrences of tin and tungsten (Fig. 1). Aside from exploration companies' assessment reports, very little is documented on the nature of this mineralization. The purpose of this report is to concisely describe and compare the tin and tungsten occurrences and give some guidance in further exploration. This study is based on property visits carried out in July and August, 1985 and a review of assessment reports.

History and Previous Work

Placer gold was discovered in the McQuesten and Mayo areas soon after the start of the Klondike gold rush, and mining still takes place mainly on Highet, Johnson, Duncan and Haggart Creeks (Bostock, 1957). Placer scheelite was also recovered from 1976 to 1978 at Dublin Gulch, on Haggart Creek (Debicki, 1983). Abundant placer cassiterite is also noted to occur in this creek (Mulligan, 1974).

A few kilometres northeast of the study area lies the Keno Hill-Galena Hill district where silver-lead veins cutting quartzite have been mined intermittently since the early 1900's (Tempelman-Kluit, 1970; Boyle, 1965; Franzen, 1986, Lynch, 1986, and Watson, 1986 - all this volume).

The McQuesten River area has been prospected for lode deposits since the early 1900's. Lode gold was soon found at Dublin Gulch (MacLean, 1914). Lode tin was found at Dublin Gulch in 1943, and tungsten, at Scheelite Dome in 1945 (Mulligan, 1974). Some work was done in the area in the 1960's and early 1970's, but more intensive exploration for tin and tungsten was carried out from 1978 to 1982, mainly by CCH Resources, INCO and Billiton Canada Ltd. of the Cortin Joint Venture, Cominco Ltd. and Canada Tungsten Mining Corporation. Reconnaissance stream sediment geochemistry, followed by more detailed geochemistry and geological mapping were the exploration methods employed. SCHEELITE DOME, OLIVER CREEK (EPD), and SUNSHINE CREEK (SP) are among the few properties that were trashed and drilled.

A detailed report is available on the TIN DOME (SHEPPARD) tin-bearing vein (and breccia) at Dublin Gulch by Thompson (1945). Recently, two properties in the Mayo and McQuesten area have been the subject of Master of Science theses. One thesis is on the KALZAS tungsten-tin-molybdenum porphyry located approximately 70 km southeast of Mayo, by Lynch (summarized in Lynch, 1985), the other is on the OLIVER CREEK (EPD) tin-silver-bearing breccia/vein deposit, by the author (Emond, 1985), which followed up a less detailed BSc thesis by Noble (1980).

REGIONAL GEOLOGY

The McQuesten area is in the northwestern Selwyn Basin and is underlain mainly by Upper Precambrian to Lower Cambrian metasedimentary rocks of the 'Grit Unit' (Fritz et al., 1983) (Fig. 2). To the north, these rocks are thrust on to by Ordovician to Devonian Road River Formation sedimentary rocks. Numerous small, high level, acid intrusions and some coeval volcanic rocks, in the southeast part of the area are Cretaceous (83-103 Ma age for

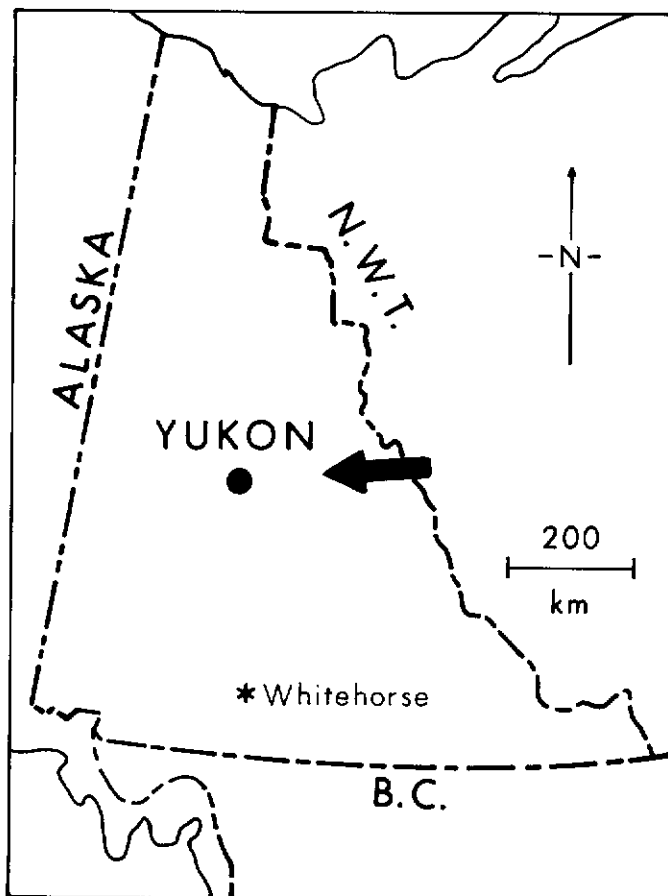
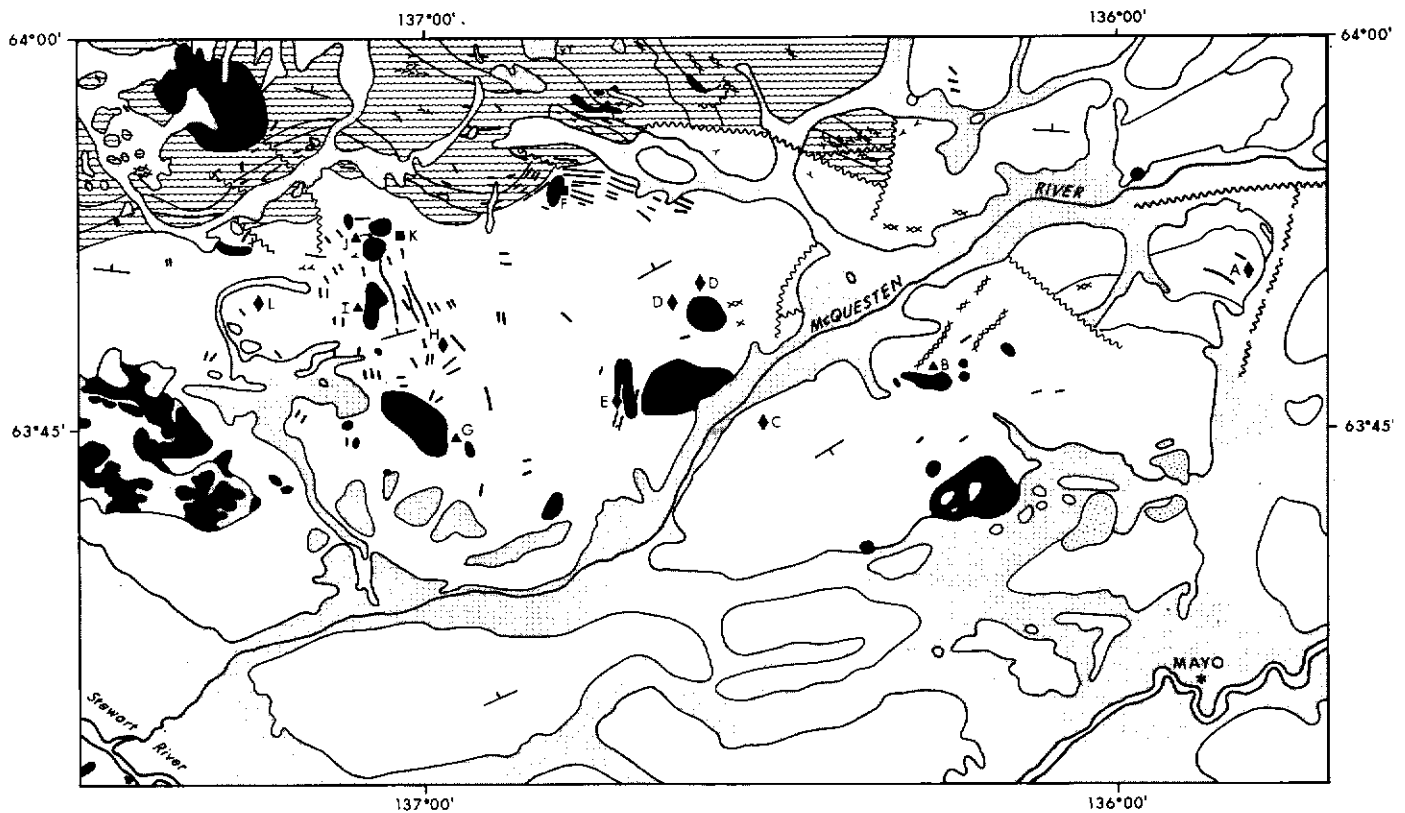


Figure 1. Location map of McQuesten River area.



LEGEND

- Quaternary sediments
- Cretaceous felsic volcanic rocks
- Cretaceous felsic intrusive rocks
- Jurassic/Cretaceous gabbro
- Ordovician metasedimentary rocks
- Late Proterozoic/Early Cambrian metasedimentary rocks
- Late Proterozoic/Early Cambrian marble

- foliation
- fault

- mineral occurrence - tin
- mineral occurrence - tungsten
- mineral occurrence - gold/silver

Mineral Occurrences

- | | |
|------------------|--------------|
| A-JOUMBIRA | G-LUGDUSH |
| B-SCHEELITE DOME | H-JABBERWOCK |
| C-OLIVER CREEK | I-RHOSGOBEL |
| D-SUNSHINE CREEK | J-PUKELMAN |
| E-BOULDER CREEK | K-JOSEPHINE |
| F-MAHTIN | L-BARNEY |

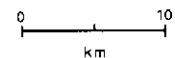


Figure 2. Geology and mineral occurrence map of the McQuesten River area.

granites, K/Ar on biotite, Stevens et al., 1982a; 89 Ma age for volcanic flow rock, K/Ar on biotite, Stevens et al., 1982b).

GEOLOGY

The Grit Unit is a homogenous, thick, blocky grey-weathering unit consisting of highly deformed, greenschist facies metamorphosed quartzite, quartz-mica schist and phyllite with minor intercalated limestone, dolomite and amphibolite. A large NE-trending anticline, the "McQuesten Anticline" (Mulligan, 1974), traverses through the area, just north of the McQuesten River. Foliation dips shallowly northwest to the north, and shallowly southeast to the south of the anticline.

Cretaceous intrusions vary from syenite in the north to granite and quartz monzonite in the south and centre. Most are stocks, plugs and dykes; the latter are locally sheeted. These intrusive rocks are grey- to orange-weathering and predominantly feldspar-, or feldspar-quartz porphyries. Feldspar phenocrysts are up to 10 cm in length, but more commonly 0.5 to 2 cm. Biotite is the dominant mafic mineral, and commonly makes up 5 to 10% of the rock. Hornblende occurs with biotite in the syenite. Creamy

weathering aplite dykes are found in the contact zones of many stocks and plugs.

Vertically columnar-jointed, grey-weathering, porphyritic hornblende rhyolite flows located just southeast of Mayo Lake, likely represent a down-faulted remnant of flows coeval with the Cretaceous intrusions.

STYLES OF TIN AND TUNGSTEN MINERALIZATION

Characteristics of the mineral occurrences are summarized in Table 1 and properties are located on the map in Figure 2. Veins, breccia-veins, sheeted veins and skarns containing tin and tungsten are near the margins of plutons and dykes in both country rocks (exocontact), and in intrusive rocks (endocontact).

Veins

Veins bearing tin are on the JOUMBIRA (on Mt. Haldane) and the JABBERWOCK (central West Ridge) properties, in the exocontact of dykes and/or stocks. They are mostly controlled by joints in the country rock, and thus tend to occur in steeply-dipping to vertical sets. The veins are generally less than 5 mm

TABLE 1
Description of tin and tungsten occurrences in the McQuesten River area.

| IDENTITY | PROPERTY NAME (CLAIMS) | N.T.S. | STYLE OF MINERALIZATION | HOST ROCK | ASSOCIATED INTRUSION | DESCRIPTION |
|----------|----------------------------------|----------------------|--|---|--|--|
| A | JOUMBIRA | 105 M 13 | 1) VEIN SN 2) VEIN SN 3) VEIN AG | 1) QZIT (GRIT U.) 2) PPQZ DYKE 3) QZIT (GRIT U.) | SMALL PPQF GRANITE STOCK, SEVERAL PPQF & PPQZ DYKES | 1) TO (+CT) IN NEAR VERTICAL JOINTS, QZ-TO VEINS 2) QZ-TO (+CT) VEINLETS & TO IN JOINTS 3) QZ-TO (+ASP-GL-SL) & QZ-MU VEINS |
| B | SCHEELITE DOME (SUN, GLOW) | 115 P 16 | SKARN W, AU | QZIT, SHST, LMST (GRIT U.) | PPFS - BI GRANO- DIORITE STOCK | ACT-QZ-PR-SCH SKARN IN STEEPLY DIPPING 4 M THICK LENSE; WOLL-QZ-TREM SKARN; QZ-MU-TO VEINS |
| C | OLIVER CREEK (EPD) | 115 P 9,10, 15,16 | 1) BRECCIA SN, AG 2) SKARN SN, BM (MINOR) | QZIT, SHST (GRIT U.) | PPFS - BI GRANITE PLUG | 1) CL (+CT-AG-BM) - MATRIX & TO (+CT-AG-BM) - MATRIX BRECCIAS 2) ACT-CL-PR (+CT) SKARN |
| D | SUNSHINE CREEK (SP, A) | 115 P 15 | 1) BRECCIA SN, AG 2) BRECCIA AG | QZIT, SHST (GRIT U.) | 1,2) PPFS GRANITE STOCK 2) PPQF DYKE | 1) QZ MATRIX BRECCIA, TO MATRIX BRECCIA, ABUNDANT FE STAIN 2) SILICA-RICH MATRIX BRECCIA |
| E | BOULDER CREEK (SNARK, TEE) | 115 P 15 | 1) SKARN (SN?) 2) SKARN SN 3) BRECCIA PB, ZN, AG | QZIT, SHST (GRIT U.) | 1) LARGE PPFS GRANITE STOCK 2) SMALL PPFS GRANITE STOCK, PPFS DYKE 3) SMALL PPFS GRANITE STOCK | 1) GT-ACT-EP-AZ (+CT?) SKARN 2) ACT-EP-AX-QZ (+GT-PR-PY-CP- CT-SL) SKARN 3) QZ MATRIX BRECCIA (+GL-SL?) ABUNDANT FE AND MN STAIN; ALSO QZ STOCKWORK NEAR MARGIN OF GRANITE STOCK |
| F | MAHTIN | 115 P 15 | 1) BRECCIA AG 2) VEIN AG 3) SKARN (AG?) | 1,2) PPFS GRANITE STOCK 3) LMST, CHRT, SHAL (ROAD (RIVER FM) | PPFS - BI GRANITE STOCK, PPFS SYENITE DYKES | 1) TO-ASP (+PY) MATRIX BRECCIA CUTTING QZ VEIN (CENTRAL STOCK AREA) 2) QZ-ASP (+SCOR) VEIN, STEEPLY DIPPING (MARGIN OF STOCK) 3) DIOP-QZ-CC-ASP (+PY-PR) SKARN |
| G | LUGDUSH (SPUD) | 115 P 10,15 | 1) SKARN W 2) VEIN PB, AG (FLOAT) | QZIT, SHST, LMST (GRIT U.) | LARGE PPQF - BI GRANITE STOCK | 1) DIOP-QZ-CC (+SCH) SKARN, WOLL-QZ SKARN 2) QZ-GL VEIN MATERIAL |
| H | JABBERWOCK | 115 P 15 | 1) VEIN SN 2) BRECCIA SN, AG 3) VEIN SN | QZIT, SHST (GRIT U.) | PPFS DYKES | 1) CT (+KFS) IN NEAR VERTICAL JOINTS 2) TO MATRIX BRECCIA (+CT IN VUGS), TOURMALINITE 3) CT IN VUGGY QZ-LI VEINS |
| I | RHOSGOBEL | 115 P 14 | 1) SKARN W 2) VEIN W, OR SHEETED VEIN W 3) VEIN AU (+AG) | 1) QZIT, SHST, LMST (GRIT U.) 2) PPFS GRANITE 3) HNFLS | PPFS - BI GRANITE STOCK | 1) DIOP-QZ-PLAG-SCH SKARN, WOLL-QZ-PLAG SKARN 2) QZ (+SCH?) VEINS 3) QZ-ASP VEINS |
| J | PUKELMAN | 115 P 14 | 1) SHEETED VEINS W, MO (ENDOCON- TACT) 2) SHEETED VEINS W (EXOCONTACT) 3) VEIN AU (EXOCONTACT) | 1) PPFS GRANITE 2) HNFLS 3) QZIT, SHST (GRIT U.) | PPFS - BI GRANITE STOCK | 1) QZ-KFS (+SCH-MO-PY) VEINS 2) QZ-KFS-SCH VEINS, VEINLETS 3) QZ-ASP (+GL) VEINS |
| K | JOSEPHINE | 115 P 14 | VEIN AU | QZIT, SHST (GRIT U.) | GRANODIORITE STOCK | QZ-ASP VEINS |
| L | BARNEY | 115 P 14 | BRECCIA (SN?) | QZIT, SHST (GRIT U.) | PPQZ DYKE, PPFS - BI GRANITE STOCK | ROCK FLOUR MATRIX BRECCIA, FE STAINED (+CT?) MATRIX; QZ-MU GREISEN VEINS |

ABBREVIATIONS:

| | | | | | | | |
|-------|-----------------------------|------|-----------------|-----|--------------|------|--------------|
| QZIT | quartzite | PPQF | feldspar-quartz | PY | pyrite | SCH | scheelite |
| SHST | schist | | porphyry | PR | pyrrhotite | EP | epidote |
| LMST | limestone | QZ | quartz | CP | chalcopyrite | AX | axinite |
| HNFLS | hornfels | TO | tourmaline | MO | molybdenite | WOLL | wollastinite |
| CHRT | chert | CL | chlorite | LI | limonite | GT | garnet |
| SHAL | shale | MU | muscovite | GL | galena | PLAG | plagioclase |
| PPQZ | quartz porphyry | CC | calcite | SL | sphalerite | KFS | K feldspar |
| PPFS | feldspar porphyry | DIOP | diopside | ASP | arsenopyrite | | |
| PPQF | quartz-feldspar porphyry | ACT | actinolite | CT | cassiterite | | |
| | | BI | biotite | BM | base metals | | |

wide with euhedrally-terminated cassiterite crystals, and little gangue. Gangue minerals consist of radiating tourmaline aggregates on joint surfaces on JOUMBIRA; and euhedrally terminated K-feldspar crystals on joints, fractures, and in vugs on JABBERWOCK.

A cassiterite-bearing quartz-tourmaline-chlorite-limonite vein occurs at the SHEPPARD (TIN DOME) occurrence, located 20 km north of JOUMBIRA, at Dublin Gulch (Mulligan, 1974). This vein is in the exocontact of a granodiorite stock and is noted to have associated tourmaline-matrix breccias and tourmalinized metasedimentary rocks.

Some tin-bearing veins also occur on the OLIVER CREEK (EPD) property, but most are extensions of breccias. These veins are more gangue rich, with chlorite, or tourmaline gangue.

Tungsten-bearing veins are separate from those with tin, located mainly on the RHOSGOBEL and PUKELMAN properties (at the north end of West Ridge). Sheeted quartz-scheelite (+/- K-feldspar) veins occur in both the endo- and exocontacts of the feldspar porphyry granite stocks. They occur in a vertical to steeply-dipping set of cooling joints which is continuous in the stock and surrounding country rock. The veins are mostly 0.5 to 1.5 cm thick, but reach 7 cm in the main showing, the PUKELMAN occurrence, where the veins cut hornfels. As much as 10% scheelite occurs in the fine grained quartz veins. Veining occurs in the Pukelman stock (west of the occurrence), and in the metasedimentary rocks between the Pukelman and Josephine stock (east of the occurrence). In the Pukelman stock, veining is most dense in the central part. Large flakes of molybdenum and crystals of pyrite occur in some vein material. Similar veining is also present in the central Rhosgobel stock (to the south).

Minor quartz stockwork containing molybdo-scheelite and scheelite also cuts metasedimentary rocks at the SCHEELITE DOME (south of the McQuesten River).

The KALZAS (FLO) tungsten-molybdenum-tin stockwork-vein deposit is located 70 km southeast of Mayo, just north of Big Kalzas Lake. On both peaks of the Kalzas Twins, several types of mineralization overprint each other in rocks of the Grit Unit. Wolf-ramite, molybdenite, and cassiterite mineralization occur in sets of large planar, coarse grained quartz veins. A concentric alteration halo has an outer sericite dominated zone, an inner 'potassic' core and intense tourmalinization throughout the potassic zone and part of the sericite fringe. Intense fracture and quartz-tourmaline veinlet stockworks are present. An underlying pluton is suspected (Lynch, 1985 p. 79). Cassiterite also occurs as euhedrally terminated crystals in gangue-poor veins in a few localities, similar to those at JABBERWOCK.

Breccias

Breccia-vein tin +/- silver occurrences are the OLIVER CREEK (EPD), SUNSHINE CREEK (SP, east of East Ridge), BOULDER CREEK (TEE, southern East Ridge), JABBERWOCK, and SHEPPARD (TIN DOME) properties. These breccias mostly consist of subangular to subrounded fragments of quartzite or vein material (i.e., quartz, tourmaline, or chlorite) in a matrix of crystalline quartz, tourmaline, or chlorite. Cassiterite mainly occurs as grains within the matrix. The breccias are matrix-supported with up to 60% matrix and are thus identified by the matrix material.

At OLIVER CREEK, the main tin- and silver-bearing breccia is chlorite breccia, along with some tourmaline- and rock flour-breccias. The rock flour breccia is a clast-supported breccia with 5-10% matrix made up of comminuted quartzite. Fragments of quartzite are mostly in close to original position (jigsaw texture).

Cassiterite and native silver, along with pyrrhotite, pyrite, chalcopryrite and sphalerite occur in the matrix of these breccias.

The SUNSHINE CREEK and BOULDER CREEK (TEE) properties are mostly quartz breccias with some tourmaline breccia on the former. The quartz breccias are vuggy with euhedrally-terminated quartz matrix and are commonly stained with manganese oxides. Silver values are present at SUNSHINE CREEK. Both the JABBERWOCK and SHEPPARD occurrences have tin-bearing tourmaline breccias. At JABBERWOCK, the breccia contains visible cassiterite in vugs and veins along with K-feldspar.

The breccias mostly occur in the exocontact of small plutons or dykes. Tourmaline-arsenopyrite breccia occurs within a quartz monzonite stock on the MAHTIN property (north part of East

Ridge), and contains some silver, but no tin. All of the breccias are steeply-dipping and vein-like, and are presumably fault controlled. Most are about 1 m wide, but reach 7 m at SUNSHINE CREEK and 15 m at OLIVER CREEK. The lateral extent is up to 250 m on the SUNSHINE CREEK and BOULDER CREEK (TEE), and 1 km at OLIVER CREEK.

Skarns

Several tungsten skarns occur on the margins of McQuesten area plutons, including SCHEELITE DOME, LUGDUSH (on southern West Ridge), RHOSGOBEL, and RAY GULCH (near Dublin Gulch, Lennan, 1985). Scheelite is disseminated in medium- to dark-green diopside-quartz (+/- pyrrhotite) calc-silicate rock inter-layered with relatively barren white wollastonite-quartz calc-silicate rock and biotite quartz hornfels. At SCHEELITE DOME, actinolite is present instead of diopside in the dark green layers. Diopside-quartz skarn on the MAHTIN property is adjacent to a feldspar porphyritic granite and contains arsenopyrite, and no scheelite.

Some tin-bearing skarn was noted on the BOULDER CREEK and OLIVER CREEK (EPD) properties. At BOULDER CREEK, actinolite-epidote-axinite (+/- pyrrhotite, pyrite, chalcopryrite) skarn containing cassiterite in vugs occur at one locality (near the TEE claims). Another, tin-bearing garnet-epidote-actinolite-axinite-calcite skarn occurs at another locality on the property (in the southeastern SNARK claims). It is approximately 12 m thick and exposed over 25 m strike length. At OLIVER CREEK, some cassiterite-bearing actinolite-pyrrhotite skarn is intercalated with metasedimentary rocks.

DISCUSSION

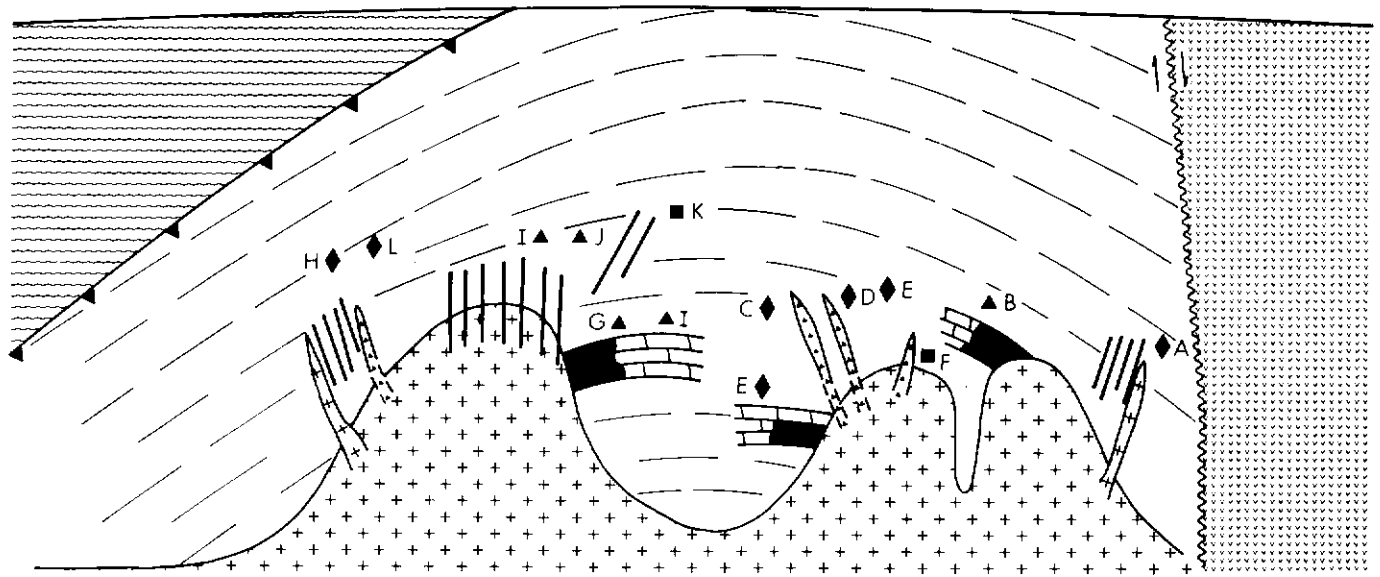
A mock east-west cross section of the McQuesten River area in Figure 3 shows the lithophile occurrences approximate location with respect to the geology. Most occurrences are close to cupolas of the Cretaceous felsic intrusions and are believed to be genetically related to their activity (orthomagmatic model). Cassiterite is mostly in fractures of brittle quartzite, as gangue-poor, or gangue-rich (chlorite, tourmaline, or quartz) veins and/or breccias; and scheelite is mostly in lenses of calc-silicate rock intercalated with the quartzite, and hornfels, and also in sheeted quartz veins in both intrusive cupolas and surrounding hornfels. Thus, aside from proximity to granite cupolas, this mineralization is mainly controlled by fractures in the metasedimentary rocks, joints in both intrusion and surrounding country rock, and location of calc-silicate horizons. The fractures may be either related to emplacement of the intrusion, or pre-intrusive regional patterns. The joints are likely due to cooling of the granite. A structural study of the area would be beneficial to the explorationist.

Zoning appears to only occur on the scale of each intrusive system. For instance, at Mount Haldane quartz-muscovite (+ scheelite) greisen veins occur in the contact zone of the intrusion, and further away (approximately 1 km from the intrusion) cassiterite veins occur in the quartzite. Another example is KALZAS (Lynch, 1985). Tungsten occurs closer to the intrusion than tin. In most cases the intrusion has either tungsten, or tin mineralization associated, but not both. Recent study of the nearby Keno Hill-Galena Hill silver-lead area by Lynch indicates interesting mineral zonation indicating an intrusion at depth (Lynch, pers. comm., 1985).

The McQuesten River area is one of the two major areas of vein and skarn deposits of tin and tungsten in Yukon, along with the Seagull district in southern central Yukon. In both areas, mineralization occurs in Upper Precambrian to Mississippian metasedimentary autochthonous rocks of the ancient North American craton, or in Cretaceous granitoid plutons, intruded after collision of an island arc with ancient North America (Tempelman-Kluit, 1981).

Intrusions in the Seagull area are large concordant batholiths, whereas those in the McQuesten are small discordant stocks, plugs and dykes which were intruded to higher crustal levels.

This difference in size of intrusion accounts for the difference in mineralization styles of the two areas. Large greisen deposits of tin and tungsten, such as that at the East Kemptville tin mine in Nova Scotia, would be more likely to occur in the larger plutons of the Seagull area than in the McQuesten. Some greisenized rocks



◆ mineral occurrence - tin ▲ mineral occurrence - tungsten ■ mineral occurrence - gold/silver



Cretaceous felsic volcanic rocks



Cretaceous felsic intrusive rocks



Ordovician metasedimentary rocks



Late Proterozoic/Early Cambrian metasedimentary rocks



Late Proterozoic/Early Cambrian marble



foliation



fault



thrust fault



skarn



breccia



dyke



sheeted veins

Mineral Occurrences

- A-JOUMBIRA
- B-SCHEELITE DOME
- C-OLIVER CREEK
- D-SUNSHINE CREEK
- E-BOULDER CREEK
- F-MAHTIN
- G-LUGDUSH
- H-JABBERWOCK
- I-RHOSGOBEL
- J-PUKELMAN
- K-JOSEPHINE
- L-BARNEY

Figure 3. Model of tin-tungsten mineralization in the McQuesten River area.

do occur in the Surprise Lake Batholith in British Columbia, west of the Seagull area. A difference in stratigraphy in the two areas, i.e. the presence of much thicker calcareous units in the Seagull area gives it a greater potential for extensive skarn development, another economically important mineral deposit type (i.e., Renison Bell tin mine in Australia).

Although there is no known greisen in the McQuesten area, there is some potential in the intrusions underlying tin and tungsten occurrences. There are several sizeable tungsten skarn deposits i.e., RAY GULCH and SCHEELITE DOME, and there are

also several skarn occurrences which have not been thoroughly explored. Another important target for this area are tin veins and breccia of the type mined in southwest England and in Bolivia. Most tin vein occurrences in the McQuesten area have not been extensively explored and a potential may exist in further development of these properties.

Other areas of important potential are thermal aureoles of intrusions which are not exposed at the surface. These may be identified by zones of porphyroblastic hornfels. Fractures, or calcareous lenses in these zones are important targets.

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