Age of Mineralized Porphyry at the Logtung deposit W-Mo-Bi-Be (Beryl, Aquamarine), Northwest BC

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KEYWORDS: *Logtung, tungsten, molybdenum, beryl, beryllium, aquamarine, bismuth, wolframite,*

INTRODUCTION

Logtung is a large tonnage, low-grade tungsten-molybdenum deposit that straddles the BC-Yukon border between Watson Lake and Whitehorse (Figure 1; MINFILE 104O016). Current unclassified resources are estimated at 162 million tonnes grading 0.052% MoS_2 and 0.13% WO_3 (Noble *et al.*, 1984). Bismuth and copper occur in lesser concentrations with traces of gold and tin. Gangue minerals include sky blue beryl. Small crystals of transparent blue beryl (var. aquamarine) less than 2mm in diameter are common, with some transparent crystals reaching more than 1 cm in diameter (P. Wojdak, personal communication, 2001), but gemstones cut from Logtung beryl have not been reported. Approximately 2 km south of the deposit, beryl is sufficiently abundant to be considered a source of beryllium, although the locality has yet to be drill tested (Wojdak, 1998). Both porphyritic and skarn mineralization are associated with monzonitic granite and a monzonite porphyry dike swarm (Noble *et al.*, 1984) that intrude calcareous, quartz-rich metasediments of Paleozoic to Triassic age (Mihalynuk *et al.*, 2000; Roots *et al.*, 2002). Objectives of this report are to briefly describe the petrography and U-Pb isotopic age data from the mineralized monzonite.

PREVIOUS WORK

Logtung was discovered in 1976 by Cordilleran Engineering Ltd. as a result of tracing tungsten stream sediment geochemical anomalies to their source in the Two Ladder Creek and Logjam Creek areas (Christopher, 1978). Canamax Resources (then Amax Potash Ltd.) optioned the property in 1977 and conducted an extensive property evaluation including the construction of a dirt road, and a 496 m decline for collection of a bulk sample. The dirt road provides access from the Alaska Highway at kilometre 1210.3 and winds north for about 15 km to the headwaters of south-flowing Logjam Creek. The last large program conducted on the British Columbia portion of the property was an electromagnetic survey in 1984 (Roth, 1984) for Canamax Resources Inc.

Early reconnaissance geological mapping north of the border was conducted by W.H. Poole who first mentioned

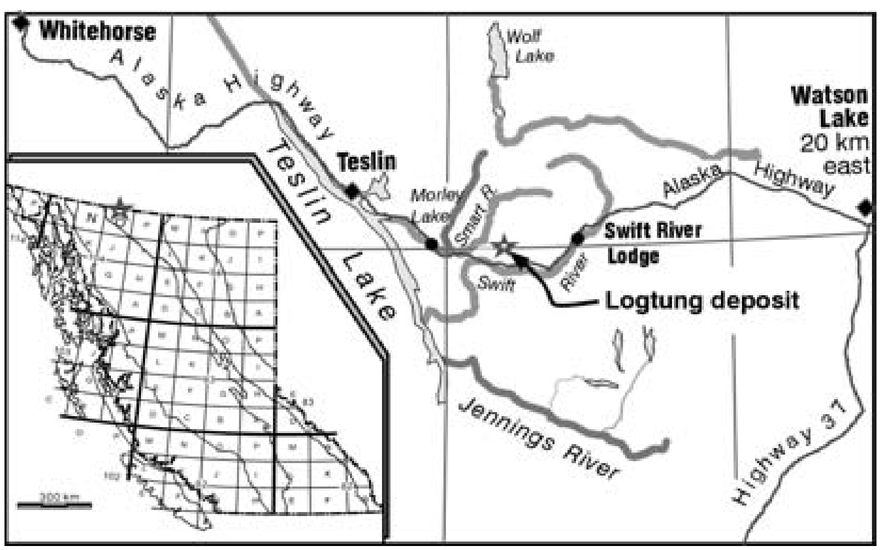

Figure 1. Location of the Logtung Porphyry near the BC - Yukon border.

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tungsten mineralization in the area (Poole, 1956; Poole *et al.*, 1960). Parts were remapped by Abbott (1981) during study of the Seagull tin district. Reconnaissance mapping of the adjacent area south of the border was conducted by H. Gabrielse (1969). Thesis studies by Noble (1982) and Stewart (1983) addressed the mineralization and related plutons at Logtung.

GEOLOGIC SETTING AND MINERALIZATION

Mineralization at Logtung is developed within monzonitic granite and crosscutting porphyritic felsic dikes and adjacent hornfelsed country rocks. Country rocks are Paleozoic to Triassic clastic strata that have been thermally metamorphosed by an en-echelon set of north-west-elongated Early Jurassic plutons (Mihalynuk *et al.*, 2000; Poole *et al.*, 1960; C.F. Roots, written communication, 2000, 2001). Jurassic bodies crop out within two kilometres, both southwest and northeast, of the Logtung deposit (Figure 2).

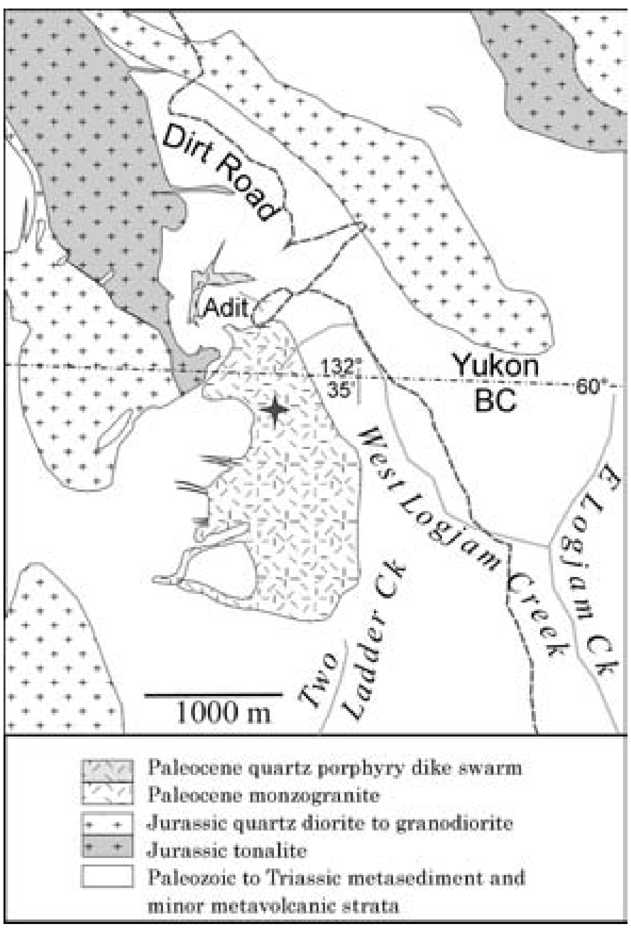

Figure 2. Generalized geological map of the Logtung area. Geology from Mihalynuk *et al*. (2000), Noble *et al.* (1984) and C.F. Roots (written communication, 2001). U-Pb age date sample locality is denoted by the star.

Logtung monzogranite is an orange-pink colour with phenocrysts of greasy grey quartz, white feldspar and black biotite (Figure 3a). Petrographic analysis shows that the monzogranite also contains fine-grained muscovite, sphene and intergranular fluorite (Figure 4a). Feldspar is dominated by perthite and normally zoned plagioclase (Figure 4b). Biotite contains abundant apatite and zircon inclusions. Fission of radioactive uranium and thorium within the zircon inclusions has caused extensive lattice damage in the biotite, resulting in broad halos (Figure 4a). Noble *et al.* (1984) also report primary scheelite, ilmenite, magnetite, pyrite and allanite.

Porphyritic felsic dikes such as that in Figure 3b are white and fine to medium-grained with subidiomorphic to idiomorphic quartz phenocrysts. Smokey quartz and interstitial fluorite are common, as in the monzogranite. Muscovite occurs as fine-grained glomerocrysts and as matrix alteration.

Molybdenum and tungsten are believed sourced from the monzonite and porphyritic dikes. Petrographic textures indicate that scheelite and fluorite are intergrown with quartz and feldspar, and geochemical analysis of unaltered samples reveal highly anomalous W and Mo values (Stewart, 1983). Paragenesis of the molybdenite and scheelite mineralization is related to four quartz vein systems according to (Noble *et al.*, 1984). Earliest quartz-molybdenite-scheelite veins (system I) formed in the thermo-metamorphic halo during late crystallization of the monzogranite stock. Quartz- molybdenite and quartz-scheelite veins (systems II and III) formed before and during felsic dike emplacement. Sheeted W-Mo veins (system IV) post-date most, but not all of the felsic dikes. Mineralization at Logtung has characteristics of both molybdenite skarn and tungsten porphyry (deposit models K07

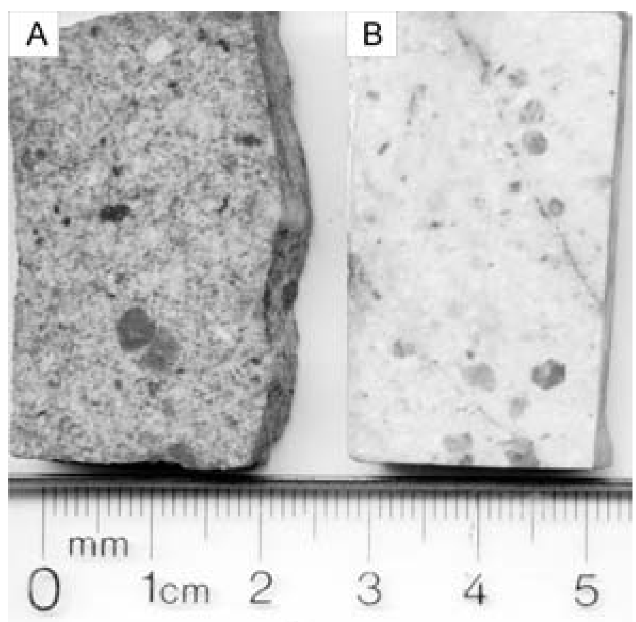

Figure 3. Rock slabs from the Logtung monzogranite (a) and felsic porphyry dikes (b). Dark crystals are smoky quartz phenocrysts.

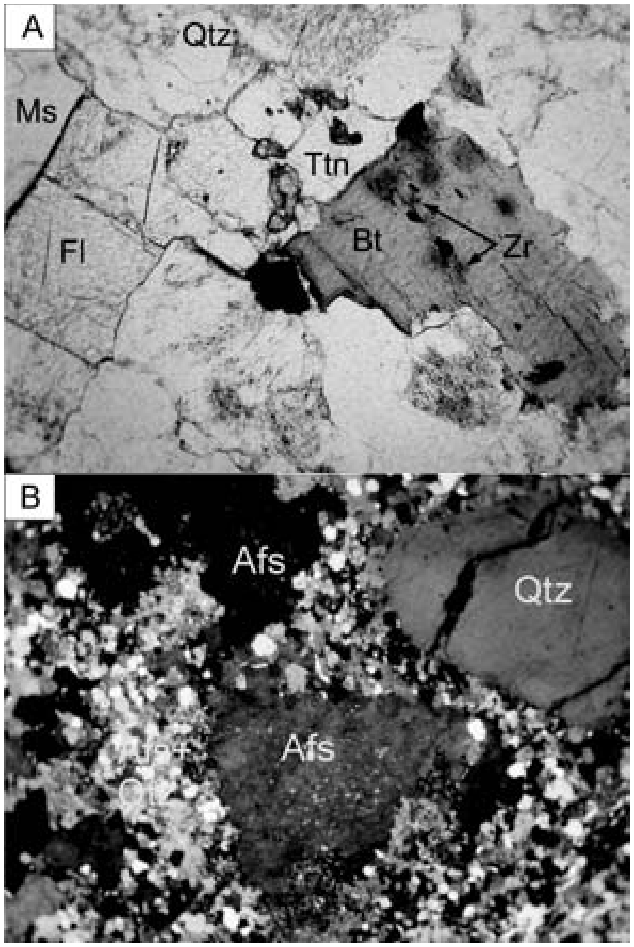

Figure 4. Representative thin section views of the Logtung monzogranite. Width of the photomicrographs represents approximately 2mm. Mineral abbreviations are: Afs = alkali feldspar; Bt = biotite; Fl = fluorite; Ms = muscovite; Qtz = quartz; Py = pyrite; Tnt = titanite; and Zr = zircon?

and L07 of Lefebure *et al.,* 1995), but it is generally acknowledged as a porphyry deposit (cf. Noble *et al.*, 1984).

Woodsworth *et al.* (1992) included the Logtung pluton with the Mid Cretaceous Cassiar suite, presumably based upon the preliminary 118±2 Ma Rb/Sr age determination on the monzogranite stock that is reported in Stewart (1983; published in Noble *et al.*, 1984); recalculated as 117.6 ±3.5 in Mortensen (1999). The age of the stock should place a maximum age on the mineralizing event because the monzogranite stock crystallization is synchronous with the oldest mineralization.

ISOTOPIC AGE DATING

A sample of monzogranite was collected from outcrops near the Yukon border and mineralized porphyry was collected from the test dumps near the Logtung exploration adit, on the Yukon side of the border. In order to best constrain the maximum age of mineralization, the monzogranite was crushed for U-Pb age determination (sample number 99-Th-03-02). Relatively abundant zircon was recovered using standard techniques (Heaman and Machado, 1992). Most of the zircon has an unusual morphology, occurring as irregular, faint tan grains with rare well-developed facets, often forming inclusions within fragments of quartz. These are characteristics observed in other examples of hydrothermal zircon. However, the Th/U ratios of 0.7 and 0.4 are within the typical range for igneous zircon crystallizing from felsic magmas, and such an origin cannot be ruled out. A few resorbed tips of zircons were also recovered, as was abundant molybdenite.

Two fractions of "hydrothermal" zircon were analyzed and the U-Pb results are presented in Table 1 and Figure 5. Uncertainties associated with these two analyses are large reflecting the low uranium content (17-23 ppm). The $^{206}Pb/^{238}U$ age of 58±6 Ma obtained for fraction #1 is interpreted as the best estimate for the time of hydrothermal zircon growth. Clearly additional zircon analyses are required to confirm this interpretation. Analysis of additional fractions is in progress and when completed the data will be available on-line, together with an updated age date. Persons interested in this data should refer to Geofile 2002-1 at http://www.em.gov.bc.ca/Mining/Geolsurv/Publications/catalog/cat_geof.htm.

DISCUSSION

Monzonitic porphyries of Late Cretaceous and Early Tertiary age that contain W-Mo, and more commonly Mo+/-W mineralization, are known in British Columbia and Yukon. However, most are dated by K-Ar techniques; we know of none other than Logtung that have been dated by the more robust U-Pb technique. One such deposit is Red Mountain, located nearly along strike approximately

TABLE 1
U-Pb RESULTS FOR THE ANCIENT CONTINENTAL MARGIN PROJECT

		Concentration (ppm)					Atomic Ratios ± 2σ error				Apparent age ± 2σ error (Ma)			
Description	Weight (ug)	U	Pb	Th	Th/U	TCPb (pg)	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	% Dis.
99-TH-03-02														
8 irregular grains in qtz faint tan some eu faces M0	11.2	23	4	15	0.7	43	21	0.0090 ± 10	0.017 ± 68	0.0139 ± 545	58.0 ± 6.4	17.4 ± 67.2		
10 irregular grains faint tan M0	51.0	17	8	7	0.4	372	24	0.0468 ± 22	0.444 ± 147	0.0687 ± 230	295.1 ± 13.6	372.7 ± 102.4	888.9 ± 200	68.3

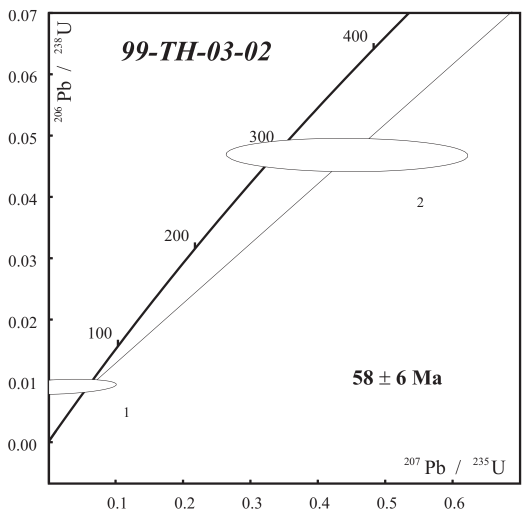

Figure 5. Concordia plot for geochronological data presented in Table 1. The best estimate for the age of the Logtung monzogranite stock is 58 +/- 6Ma.

150 km northwest of Logtung. It is a molybdenum deposit with calculated resources of 187 270 000 tonnes grading 0.167% MoS_2 (Brown and Kahlert, 1995), minor tungsten mineralization is associated with the latest mineralizing porphyries. Hydrothermal biotite that grew along with molybdenite is dated by the K-Ar technique as 87.3±2.0 Ma according to W.D. Sinclair (personal communication, 1985; *in* Brown and Kahlert, 1995); whereas the post-mineralization porphyry is 79.0±1.8 (*ibid.*).

About 100 km southwest of Logtung, a polyphase, dominantly porphyritic stock at the Adanac (Ruby Creek) deposit is mineralized with molybdenite as disseminations and in quartz veins that may also contain traces of scheelite +/-fluorite. Ages on four of the quartz monzonite phases range from 70.3±2.4 to 71.6±2.1Ma (Christopher and Pinsent, 1982).

Molybdenum-tungsten fracture and vein-dominated porphyry mineralization characterizes the Glacier Gulch deposit (Hudson Bay Mountain) near Smithers in northwest-central BC. Mineralization at Glacier Gulch is attributed to a quartz monzonite-granodiorite stock and comagmatic radial porphyry dike swarms. K-Ar age determinations on biotite from the stock have returned 67 ±5 (Kirkham, 1966) and 73.3 ±3.4Ma (Carter, 1974); 60 ±5 (Kirkham, 1966) on the porphyry dikes.

Molybdenite +/- tungsten mineralization at Trout Lake, southeastern BC, is hosted in Lower Paleozoic Lardeau Group. Pelitic quartzite, marble, calcareous phyllite and quartzite and metavolcanic rocks that host the mineralization are similar to lithologies hosting mineralization marginal to the Logtung monzogranite stock. Mineralization at Trout Lake is attributed to the nearby 76 Ma (Boyle and Leitch, 1983) granodiorite to tonalite intrusion. Tungsten production was recorded in 1942 (Stevenson, 1943). Resources are reported as 49 Mt grading 0.19% MoS_2 (Linnen *et al*., 1995).

Molybdenum porphyry deposits with associated tungsten mineralization are scattered throughout BC and southern Yukon. Representatives of this type of deposits have an association with intrusions in the 60-87 Ma age range. Whether or not this mineralizing age is significant will be borne out as U-Pb age dating is completed.

Several intrusive bodies located in the same region as the Logtung deposit lack significant mineralization but are of Paleocene age, similar to the Logtung monzogranite. In areas to the west they are included in the ~53-59 Ma Sloko plutonic suite by Mihalynuk (1999). Woodsworth *et al*. (1992) included Early Tertiary intrusions of this region in the Bennett suite, but this name has been abandoned upon the recommendation of Hart (1995) principally because many of the included plutons in the Bennett Lake area are actually of Jurassic age. Bennett suite is restricted to plutons in the 175-178 Ma age range (*see* discussion in Mihalynuk, 1999). In areas to the immediate east, less than 10 km from Logtung, the Seagull batholith has yielded a K-Ar age of 60±6 Ma (Lowdon, 1960). Reanalysis of biotite from this sample returned an age of 101±5 (Wanless *et al*., 1972), consistent with a clustering of five other K-Ar ages from the batholith reported by Mortensen (1999), which range from 94±4 to 102.8±1.1Ma (average 99.6). The 60±6 Ma age appears to be erroneous (*see* Mortensen, 1999).

SUMMARY

A preliminary U-Pb age determination on zircon from the monzogranite stock at the Logtung deposit places a maximum age constraint on the oldest mineralized vein set. This new age of 58 Ma, if correct, is significantly younger than the ~118 Ma Rb-Sr age previously accepted for the Logtung monzogranite stock. Analyses are underway to further refine this U-Pb age. When the data are available they will be posted on-line as Geofile 2002-1 at http://www.em.gov.bc.ca/Mining/Geolsurv/Publications/ catalog/cat_geof.htm.

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