Timing of Gold Mineralization at the Privateer Mine, Zeballos Gold Camp, Vancouver Island, BC: U-Pb and Ar-Ar evidence

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Abstract

The Zeballos gold camp was discovered in the 1930s and closed in 1949 with intermittent artisanal mining continuing to present day. Almost 300,000 oz of gold were removed from the camp with the Privateer mine responsible for more than half of that production. The gold is hosted in numerous late-stage, extensional structures, the Zeballos Stock and associated skarn-type deposits. This study focuses on timing relationships between the late intrusive phases of the Zeballos stock, mafic and dolomite mineralization at the Privateer Mine and lithological, geochronometric and structural controls on gold mineralization. This work entails U-Pb chronology of the intrusive phases, geochronometry, detailed mapping, petrology, alteration, mineralogy, fluid inclusion, stable isotopes and structure of the gold-bearing quartz-carbonate veins. 

Gold mineralization is associated with the mafic rocks of the Zeballos stock over an age range of 39-36 Ma. However, U-Pb zircon geochronometry of the adakitic dyke yields an age of 36 ± 0.5 Ma. Preliminary fluid inclusion studies are consistent with gold deposition from H2O-CO2-NaCl-bearing fluids with an approximate composition of K2O equal to 0.5%, Na2O equal to 3%, FeO equal to 2% and CaO equal to 0.04% (20% NaCl equivalent). Sphalerite in equilibrium with pyrite and pyrrhotite has been used to constrain pressures using the sphalerite geobarometer. American Mineralogist 76, no. 5-6

Fig. 1. Geologic map of the Zeballos region (modified from Stevenson, 1993).

Fig. 2. Schematic diagram illustrating the timing of principal geological events in the Nootka Sound region.

Fig. 3. Two dyke (mafic and felsic) intersections in a vein host rock in 2.3A Van Drift; Privateer Mine. Both dykes are cut by structures associated with Au mineralization.

Fig. 4. Ar-Ar for the mafic dyke, shown in Figure 2. The sample yields an age of 73.0 ± 1.2 Ma.

Fig. 5. U-Pb Concordia diagram for the granodiorite dyke shown in Fig. 3. The zircon yields a concordia age of 35.4 ± 0.9 Ma.

Fig. 6. Unbrided zircon taken from the granodiorite dyke along the 2.3A vein in Privateer Mine, Zeballos, BC.

Gold fineness is approximately 23 weight percent Ag.

Fig. 7. Plane Elm Island (NEW) plot of the adakite rocks from the Zeballos area, including the adakite dyke cut by the 2.3A van gold mineralization at the Privateer Mine. The NE-SW pattern of the 2.3A adakite dyke is consistent with garnet-rite epidotization with some possible sediment assimilation.

Fig. 8. Si/Al ratios of gold-bearing quartz (sph). Van Drift; Privateer Mine. Both minima are cut by structures associated with Au mineralization.

Fig. 9. Au-EDS spectrum for Privateer Mine sample. This is consistent with the gold containing 23 weight percent silver. This metal ratio has a long history and is generally thought to be a feature of epithermal mineralization. The Privateer Mine may have a component of epithermal mineralization in its genesis.

Fig. 10. Photograph showing the back of 2.3A Van Drift; Privateer Mine. Some deformation is accommodated in a brittle manner. However, there are some structures within the vein show ductile deformation textures (see arrow). Hammer (with flagging tape) for scale.

Fig. 11. Photomicrograph of euhedral quartz (Qtz) and calcite (CaCO3) from the gold-bearing quartz-carbonate veins at the Privateer Mine. The two-phase inclusions consist of aqueous liquid (aq) and vapour (vp). Photos taken in plane-polarized transmitted light.

Fig. 12. Photomicrograph of injection sulphides from the gold-bearing quartz-carbonate veins: pyrrhotite (Py), pyrite (FeS) and sphalerite (Sp). Photos taken in plane-polarized transmitted light.

Fig. 13. Sphalerite geothermobarometry showing the isochronal contours for molybdenite. Field for interpretation of the sphalerite and pyrrhotite data. (199106): 1038-1051.

Fig. 14. Pressure-temperature diagram showing the range of conditions for quartz-carbonate veins formation: dark grey from the combined constraints of the two- phase geothermobarometry and the fluid inclusion isotherms.

Fig. 15. Photograph showing back of 2.3A Van Drift; Privateer Mine. Some deformation is accommodated in a brittle manner. However, there are some structures within the vein show ductile deformation textures (see arrow). Hammer (with flagging tape) for scale.

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