Petrogenesis of gold-bearing sulphides within the Lake George polymetallic system, southwestern New Brunswick, Canada: results from LA ICP-MS analyses and in situ sulphur isotopes

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Approximately 40 km to the southwest of Fredericton, New Brunswick is the Late Silurian-Early Devonian Lake George Granodiorite stock and the contact-metamorphic aureole that surrounds it contains known tungsten, molybdenum, antimony, and gold mineralization. A number of publications systematically describe the tungsten-molybdenum mineralization and the antimony mineralization for which the deposit was mined on and off all through the 20th century. The gold mineralization was only identified in the late 1980s due to the "invisible" nature of the gold, the very fine-grained nature of the sulphides, and narrow and discontinuous nature of the vein(lets). The cross-cutting relationships of each of the various magmatic-hydrothermal events were identified by previous researchers. All hydrothermal activity in the area post-dates peak contact metamorphic conditions. The gold-bearing veins and veinlets cross-cut the tungsten-molybdenum mineralization and are cross-cut by the antimony veins the deposit was mined for.

LA ICP-MS spot analyses and trace element mapping were used to identify the hosts for gold mineralization and to characterize their trace element compositions. The gold-bearing phases present include arsenopyrite and arsenian pyrite. This revealed a positive correlation between gold concentrations and As, Cu, Bi, and Sb that all occur in solid solution within the cores of arsenic-rich pyrite. Concentrations of gold within the cores of arsenic-rich pyrite reach up to 225 ppm. The results of the trace element mapping show the pyrite has zonation features indicative of coupled dissolution-reprecipitation reactions, which record dynamic changes in the physio-chemical conditions of the ore-forming fluids.

As a way to understand the source of the mineralizing fluids, in situ sulphur isotope analyses were conducted using SHRIMP II. Sulphur isotopic signatures were gathered on pyrite from three different generations; gold-bearing arsenian pyrite, and pyrite from the granodiorite, and pyrite within contact metamorphosed sedimentary rocks. The S isotopic signatures of the gold-bearing arsenian pyrite had a range in $\delta^{34}S$ from -4.90 ± 0.08‰ to -8.55 ± 0.04‰. This slightly negative signature suggests a significant sulphur contribution from a reduced sulphur source. The pyrite from the Lake George Granodiorite had a range in $\delta^{34}S$ from 0.05 ± 0.05‰ to 2.30 ± 0.05‰, which is generally in agreement with other magmatic sulphide $\delta^{34}S$ signatures. The pyrite from the contact metamorphosed sedimentary rocks had a range in $\delta^{34}S$ from -3.31 ± 0.08‰ to -8.51 ± 0.06‰.

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