Polymetallic ultramafic rock-associated, Fe-Cu-Co-Ni-Zn deposits of the Maryland Appalachians, and their role in Appalachian ore genesis

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Questions remain concerning the genesis of, and effects of metamorphism on the ultramafic rock-associated mineralization of the Sykesville District, Maryland, USA. The Sykesville District is located in the Piedmont of the mid-Atlantic Appalachians, and classification of the polymetallic Fe-Cu-Co-Ni-Zn mineralization is still open to interpretation. Associated rock units include metasedimentary rocks, serpentinized ultramafic mélange, and banded iron formation. We have evaluated the hypothesis that metamorphic fluids in equilibrium with Sykesville, and related massive sulfide ores in the Appalachians, can serve as sources for gold in orogenic gold deposits structurally higher in the orogen. Toward this end, optical microscopy, and EDS and WDS analyses of thin and polished sections on rocks from drill core were performed. The mineralization of the Sykesville District contains trace minerals (e.g. hessite, electrum) and textures (e.g. dendritic chalcopyrite) indicative of seafloor deposition. Gold in minerals such as electrum that formed decorations around larger chalcopyrite crystals have been re-incorporated into chalcopyrite (on an area basis) yielding an estimate of the gold concentration of chalcopyrite at model peak metamorphic conditions of 510ºC and 500 MPa. Thermodynamic calculations were performed by using these gold concentrations in chalcopyrite to make estimates of the composition of a fluid that may have been in equilibrium with Sykesville-type mineralization during metamorphism. SUPCRT92 was used to evaluate the equilibrium between gold in solid solution in chalcopyrite, and the aqueous $(Au(SH)_2)^{-1}$-bearing metamorphic fluid. Calculations yield model gold concentrations in a metamorphic ore fluid of ~ 1 ppm. If fluids in equilibrium with Sykesville-type mineralization at deep levels in the orogen are channeled into an active ductile shear zone, then 10^{11} kg of this fluid would be required to form an orogenic gold deposit with 100 tons of contained gold. A model gold lode that is 10 m x 1000 m in cross section x 1000 m deep would require integrated fluid flux on the order of 10^7 kg fluid per m^2. The integrated fluid fluxes calculated here are on the same order of magnitude as those in the literature, suggesting these deposits can contribute to the gold inventory of orogenic gold deposits.