The Ore Fluid-sulfur Isotope Compositional Paradox of the Archean Orogenic Gold Deposits

Biswajit Mishra
Department of Geology & Geophysics
Indian Institute of Technology
Kharagpur 721302
E-mail: bmgg@iitkgp.ac.in

Archean orogenic gold deposits occur within greenstone belts that are commonly metamorphosed at low-P, moderate-to high-T and are associated with syn- to late tectonic granitoids. One of the outstanding problems of these deposits includes recognition of unequivocal fluid source. While fluid composition is usually constrained from fluid inclusions and hydrothermal alteration assemblages, source characterization is done by elemental and isotopic tracers. Mass balance computations, on the other hand, demonstrate evolution in fluid chemistry.

Majority of gold deposits in the Yilgarn Craton and the Superior Province are believed to have formed from low-salinity, near-neutral metamorphic aqueous-carbonic fluids, although there are some proposals for fluids of magmatic parentage. Fluid inclusion microthermometric and Raman spectroscopic studies, undertaken in various gold mining camps such as Kolar, Hutti, Hira-Buddinni, Ajjanahalli and Jonnagiri, involving diverse host rocks (mafic, BIF and granitoid) and their metamorphic grades, reveals that gold formation in the Dharwar Craton was dominantly from low salinity $H_2O + CO_2 + CH_4 +$ NaCl + $Au(HS)_2^-$ post-peak metamorphic fluids. These fluids underwent phase separation and precipitated gold in a broad P-T window of 0.65 – 2.5 kbar/205–320°C, due to reduction in total sulfur and/or mineral-fluid reaction. The $\delta^{34}S$ values in sulfides (mainly pyrite and arsenopyrite) from the above deposits yielded a narrow range of +1.1 to +7.1‰. These values indicate magmatic or average crustal source of sulfur and gold precipitation from reduced ore fluids at near-neutral to slight alkaline pH. The observed craton-scale homogeneity in the ore fluid and sulfur isotope compositions, although apparently inconsistent, can be explained through remobilization of crustal sulfur by the metamorphic fluids during their advection.