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Fluid source of the Hutti orogenic gold deposit (India)—constraints from modelling of Sr partitioning and $^{87}Sr/^{86}Sr$ mixing during metamorphic dehydration of greenstone belt basalt and pelite

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The source of the mineralizing fluid in orogenic gold deposits is a widely debated issue. Studies to date argue for a contribution from metamorphic fluid derived by dehydration of greenstone belt–metabasalt and/or metapelites or syntectonic granitoid-derived fluid, or both [1]. In this study, we measured the $^{87}Sr/^{86}Sr$ ratio of hydrothermal scheelite and apatite from the Hutti gold deposit in the Eastern Dharwar Craton of India. The $^{87}Sr/^{86}Sr$ ratios of scheelite (0.70156 to 0.70498) and apatite (0.70158 to 0.70494) from different gold-mineralized reefs of the Hutti gold deposit show moderate variation with a mean value of 0.7030 ± 0.0005. We modelled the partitioning and release of Sr into the devolatilized fluid during prograde metamorphism of greenstone belt mafic and pelitic rocks using a P-T pseudosection and mass balance approach similar to that of Hazarika et al. [2]. The model was used to estimate the $^{87}Sr/^{86}Sr$ composition of fluid produced by mixing metabasalt-derived and metapelite-derived fluid in varying proportions at different metamorphic grades. The model calculation uses the $^{87}Sr/^{86}Sr$ of mafic rocks and those of pelites. It is noted that albite breakdown at ca. 390°C in pelitic bulk composition releases significant amounts of radiogenic Sr, leading to an increase in the $^{87}Sr/^{86}Sr$ ratio of the fluid. In contrast, albite breakdown in mafic assemblage happens at ca. 460°C, which lowers the $^{87}Sr/^{86}Sr$ composition of the fluid as mafic rocks have less radiogenic $^{87}Sr/^{86}Sr$. The $^{87}Sr/^{86}Sr$ ratio of the modelled fluid varies between 0.70068 (metabasalt) and 0.70681 (metapelite), and the hydrothermally precipitated minerals (scheelite/apatite) are expected to have isotopic ratios in this range. Two-component mixing calculations show that 70–95% of metabasalt-derived fluid and 5–30% metapelite-derived fluid can explain the $^{87}Sr/^{86}Sr$ ratios of apatite and scheelite from the Hutti deposit.

Pelitic rock is essential as a source component, as it supplies the gold and sulfur budget of the devolatilized fluid attained by the breakdown of chlorite and transformation of pyrite to pyrrhotite during greenschist to amphibolite facies transition (530°C–570°C).

[1] Goldfarb and Groves (2015). Lithos 233:2–26.

[2] Hazarika et al. (2021). Geochimica et Cosmochimica Acta 304:83–100.