

Sulfur Isotope Evidence for Magmatic Contributions to Submarine and Subaerial Gold Mineralization: Conical Seamount and the Ladolam Gold Deposit, Papua New Guinea

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Abstract

Conical seamount is a submarine alkali basalt volcano situated 10 km south of Lihir Island in the Tabar-Feni island chain, Papua New Guinea. Polymetallic (Zn-Pb-Ag-Au-As-Sb) veins, pyritic stockwork, and hydrothermally altered rocks discovered on the summit of Conical seamount represent a unique example of submarine gold mineralization with mineralogical, chemical, and textural characteristics common to some subaerial epithermal systems. The giant Ladolam epithermal gold deposit (42 Moz Au) is situated in the crater of an alkali stratovolcano on Lihir Island. Portions of the epithermal mineralization and alteration assemblages at Ladolam are similar to those observed on Conical seamount.

Conical seamount has the lightest, hydrothermal (i.e., nondiagenetic) sulfide $\delta^{34}\text{S}$ values (-17.5 to $+6.1\text{‰}$) measured to date from modern sea-floor hydrothermal systems. A previous model for the Conical seamount hydrothermal system suggested a contribution of magmatic volatiles in the earliest stages of mineralization (stage 1), followed by a combination of sulfur leached from the underlying volcanic rocks and reduced seawater sulfate during the main base and precious metal precipitating event (stage 2). New sulfur isotope data allow a reinterpretation of this model that suggests a greater input of magmatic volatiles, plus boiling, throughout both stage 1 and 2 mineralization.

Sulfides from the Ladolam gold deposit have a range of sulfur isotope values (-12.9 to $+3.6\text{‰}$) similar to that of Conical seamount. These sulfur isotope data have previously been interpreted as the result of magmatic volatiles escaping from a crystallizing magma and mixing with dilute meteoric ground water. Anhydrite associated with the gold mineralization has two populations of $\delta^{34}\text{S}$ values ($8\text{--}14$ and $20\text{--}22\text{‰}$), which indicate the interaction of magmatic volatiles with seawater that has previously been discounted. The range of sulfide and sulfate $\delta^{34}\text{S}$ values at Ladolam is reinterpreted to be due to a complex interaction of magmatic hydrothermal fluids, meteoric ground water, and seawater. Native sulfur in thermal areas in Luise caldera and pyrite in offshore hydrothermal vents in Luise harbor have similar $\delta^{34}\text{S}$ values to the Ladolam epithermal mineralization, indicating that fluids similar to the young Ladolam ore-forming event are still reaching the floor of Luise caldera.

Sulfur isotope data from Conical seamount and the Ladolam deposit suggest that magmatic volatiles have contributed a significant amount of sulfur to both these gold-rich hydrothermal systems.

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