LA-ICP-MS Analysis on Sulfide Minerals from the Higashi-Aogashima Knoll Caldera Hydrothermal Field to Understand the Host Phase of Gold

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The Higashi-Aogashima Knoll Caldera hydrothermal field, 12 km east offshore from Aogashima Island, Japan, was discovered in 2015. This seafloor hydrothermal field occurs at a water depth of ~750 mbsl, and an abnormal gold enrichment was preliminarily reported. The first multi-disciplinary research cruise (KS-21-20) was conducted in 2021 to collect rock, seawater, hydrothermal fluid, and (micro)biological samples.

Bulk Au concentrations of the sulfide/sulfate-rich rock are 22.54 ± 41.34 ppm (*n* = 34, ± 1SD), ranging from 0.01 to 178.7 ppm. Average Au concentrations at the Central Cone (*n* = 26), Southeast (*n* = 5), and East sites (*n* = 3) are 25.6, 17.4, and 14.1 ppm. The maximum Au concentration of 178.7 ppm was observed at the mound of the Central Cone Site. Au concentrations show positive correlations with those of Zn (*r* = 0.64), Cd (*r* = 0.54), Te (*r* = 0.51), and Pb (*r* = 0.48). In situ LA-ICP-MS analyses on sulfide minerals (*n* = 446) yielded average Au concentrations, in ppm, of 12.0 (pyrite; *n* = 53), 4.62 (sphalerite; *n* = 176), 10.0 (chalcopyrite; *n* = 105), 1.33 (galena; *n* = 58), 3.66 (tetrahedrite; *n* = 38), 0.10 (stibnite; *n* = 12), 0.47 (unidentified As-S mineral; *n* = 3), and 4.20 (enargite; *n* = 1). Under the microscope, electrum-rich parts are (1) at the edge of sphalerite and (2) on silica (opal) and unidentified clay minerals next to sphalerite. The electrum grains occur as an aggregate of nano- and micro-particles, suggesting that electrum is precipitated after sulfide minerals, trapped in their cracks and defects, and then recrystallized, producing the “apparent” positive correlations between the bulk Au and Zn (and Pb) concentrations. Our observation would be direct evidence of the recently observed nano-particle precipitation of electrum through boiling processes of the seafloor hydrothermal fluid.