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Precipitation condition of antimony-rich and gold bearing hydrothermal minerals associated with shallow-water hydrotherm

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The eastern part of the innermost part of Kagoshima Bay contains a small, crater-like depression called Wakamiko Crater, where maximum water depth is approximately 202 m. Active fumaroles have been reported in this area (Kagoshima Prefectural Government, 1978; Oki and Hayasaka, 1978), resulting in its designation as an active volcano named Wakamiko. In addition, occurrences of hydrothermal petroleum and mineralization related to hydrothermal fluid-sediment interaction have also been reported within the crater (Yamanaka et al., 1999, 2000; Ishibashi et al., 2008; Nakaseama et al., 2008), strongly suggesting occurrence of hydrothermal activity at the crater floor. In 2007 during the dive study of ROV/HyperDolphin belonging to Japan Agency for Marine-Earth Science and Technology (JAMSTEC) we found vigorous hydrothermal venting at the northwest area in the crater at depth 200 m, measured temperature of the venting fluid was reached up to 192?C. We found three vents, and the venting fluid were emitting from the top and foot of the chimney like cone-shaped mineral precipitations (about 2 m in height and 3˜4 m in diameter at the foot), respectively. The chimneys are composed mainly talc and carbonate with minor amount of anhydrite and stibnite. It is very rare that shallow water hydrothermal venting involve forming chimney like mineral precipitation. On the other hand, those talc-rich chimneys were formed on the mounds, which deposit of blackish boulder size (up to 50 cm in diameter) lump of sulfide minerals. The lump was aggregate of almost stibnite with minor amount of talc and pyrite. The stibnite aggregate was composed ˜1 mm length needle-sharp stibnite. Although any characteristic inner structure was not observed to the aggregate, pumice-like vague vestiges replaced by talc was rarely found in the aggregate. From the bulk analysis Au was detected in the those precipitations, bulk concentration of Au in the stibnite aggregate was reached 19 ppm. Therefore, we considered the precipitation condition of the stibnite aggregate using REE pattern.

Significant contents of REEs were detected in barite minerals occurred in the stibnite aggregate. The condrite-normalized REE patterns of the aggregate shows a pronounced positive Eu anomaly that is probably inherited from the hydrothermal fluid, suggesting insignificant contribution of seawater during precipitation. Total REE contents of the aggregate were higher than those of the chimney precipitations, it may reflect low growth rate of precipitation minerals in the aggregate.

Au and Ag were concentrated significantly on stibnite relative to talc and barite, and their contents in the aggregate and chimney precipitation formed inner part of the chimneys were one order of magnitude higher than those of the chimney precipitations formed outer part of the chimney. The precipitation temperature of the chimneys between the inner and outer parts were expected different based on the oxygen isotope geothermometer using talc, the estimated precipitation temperatures were 195 deg-C for the inner part and 174 deg-C for outer part. Although the oxygen isotope data of the aggregate was not measured, the high Au and Ag concentrations in the aggregate suggests that the precipitation temperature of the aggregate is close to the inner part of the chimney precipitations.

From those results the stibnite aggregate is expected to form beneath seafloor and erupted on the seafloor. It suggests that such antimony-rich precipitation is expected to distribute extensively beneath the seafloor, and the estimated amount of the precipitins is not negligible compared to the case of aggregate depositing as hydrothermal mineral mound as a result of collapse of chimney precipitations.

Keywords: shallow-water hydrothermal activity, hydrothermal precipitation, Antimony, gold, REE