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Epithermal mineralization at Takarajima of the Tokara Islands

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[Introduction] The Ryukyu volcanic arc is located southwest of Kyushu across 1200 km length. Volcanic isldans of the Tokara Islands are known to belong to the Ryukyu arc, whereas several submarine volcanoes in the west part have not been well investigated. Yokose et al. (2007, 2010) proposed existence of some large submarine calderas at intervals of about 100 km in this region. Takara Shima island and Ko-Takara Shima Island located about 80 km north of Amami-Oshima, are considered as to constitute a part of somma of the Takara Shima Caldera. In Takara Shima Island, occurrence of altered tuff breccias associated with obvious quartz veins including sulfide minerals had been reported (Osako, 1976; Nakano et al., 2008). A few trials of mining operation had been attempted in the island, such as at the Takara Shima gold mine and Sagigazaki copper mine, until 1960's. In May 2013, we found large boulder rocks of a few meters diameter associated with numerous quartz veins, at the Tsumiishi coast located at the east part of the island. We report mineralogy of the quartz veins and sulfide minerals within them, and discuss pressure and temperature conditions of the mineralization.

[methods] We collected about 10 samples from the Tsumiishi coast and the ruin of the Takara Shima gold mine. The former samples were split off with a hammer from the boulder. The later samples were collected from the ground where used to be a spoil bank of the gold mine. Rock forming minerals and sulfide minerals were investigated by microscopic observation, and analysis using an electron probe micro analyzer (EPMA) and x-ray diffract meter (XRD). Chemical composition of the sulfide minerals was determined by EPMA analysis. Abundance of trace elements in the quartz veins was examined by instrumental neutron activation analysis (INAA). Homogenization temperature of fluid inclusions in the quartz veins was detemined using a heating stage.

[results] Variety of quartz veins were observed from vein of dozens cm width to stockwork texture with a few μm width. We identified chlorite, pyroxene and plagioclase as rock forming minerals, among which some of pyroxene was altered to chlorite. As ore sulfide minerals, chalcopyrite, galena, sphalerite and pyrite were identified in most of the samples. As minor sulfide/sulfate minerals, covelline, tetrahedrite, chalcocite, greenockite and barite were identified. Electrum was found in only one sample collected from the gold mine ruin, whereas trace amount of Au was determined by INAA in the quartz veins of the samples collected both from the gold mine ruin and Tsumiishi coast. Pseud-acicular and mosaic (jigsaw) textures were observed in the quartz veins in some samples from the Tsumiishi coast. Homogenization temperature of fluid inclusions containing two phases in the quartz vein was determined as above 210 ℃ for only one sample from the Tsumiishi coast.

[discussion] The characteristic textures of the quartz vein suggest boiling of hydrothermal fluid (e.g., Henley, 1985) which may accompany precipitation of metal sulfide minerals . Existence of liquid-vapor two-phase fluid inclusions in the quartz vein supports this idea, and enables.us to estimate mineralization depth around 200-300 m based on the homogenization temperature. Together with this range of mineralization depth, the observed assemblage of sulfide minerals suggests intermediate sulfidation type epithermal mineralization, which is usually observed at about a few km away from the heat source magma (e.g., Sillitoe, 2010). Therefore, the epithermal mineralization at Takara Shima island could be attributed to hydrothermal activity which is driven by a heat source magma beneath the submarine caldera (sea)floor. Present activity of high temperature (nearly 100 ℃) hot spring at the Ko-Takarashima may suggest continuity of the hydrothermal system.

Keywords: Hydrothermal mineralization, Submarine volcanic caldera, sulfide mineralization