Mineralogical Features of Silver-Bearing Minerals in Chimney Ore from Myojinsho Caldera, Myojin Knoll and Bayonnaise Knoll Seafloor Hydrothermal Area, Izu-Bonin Arc

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Submarine hydrothermal deposits in western Pacific is characterized as volcanic massive sulfide deposits mainly consisting of Cu-Pb-Zn (± Au ±Ag). Recent explorations have resulted in discoveries of submarine mineral resources in the exclusive economic zones around Japan. The previous study reported chimney ores collected from Izu-Bonin arc are of high grade (Au; 24.1 ppm, Ag; 1275 ppm, Cu: 1.14%, Pb: 5.57%, Zn: 35.03%), (Tanahashi et al, 2004). According to this study, chimney ores were characterized by porous constituents and concentric ring structures, white colored barite layer and sulfide mineral layer mainly composed of sphalerite and galena are recognized from the outer surface to the center part. This concentric ring structures may be attributed to order of precipitations during formation of the chimney ores, however only few studies have discussed mineralization of the chimney along the growth axis (e.g., Watanabe & Hayashi, 2014). Purpose of our research is to clarify mineralogical features of silver minerals in chimney ore by identifying the precipitation conditions of hydrothermal fluids in the Izu-Bonin arc. We studied chimney ores collected during the NT13-09 scientific cruise and NT14-06 scientific cruise.The chimney ores collected from Izu-Bonin arc have quite similar mineralogical features. They have a tubular structure and can be divided into three groups along growth axis from outside to inside of chimney; G1: composed of barite; G2: mainly composed of barite and the principal sulfide minerals of submarine hydrothermal ore deposit (sphalerite, pyrite, chalcopyrite and galena); and G3: composed of main sulfides. According to EPMA analysis, barite is observed in G1 and G2 in addition to pore filling barite in G3. These barite formations are considered to mixing of the hydrothermal fluid with ambient seawater and formation temperature estimated for the initial barite mineralization recognized in G1 and G2 as 190-215℃, and for the second barite mineralization in G3 is as 150-195℃, suggesting temperature decrease of the hydrothermal fluid during the formation of chimney ores (Iizasa, et al. 1997). Based on these results, we propose following formation stages. First, G1 are formed by mixing of the hydrothermal fluid with seawater. Subsequently, porous G2 is formed by a change in the mixing ratio of seawater and hydrothermal fluid. Finally, the hydrothermal contribution becomes greater, so that exclusively sulfide mineral can be precipitated in G3. In addition, as shown in barite observed in G3, after the hydrothermal activity stopped, the second barite is precipitated in the void of the porous chimney ore by mixing ambient seawater and hydrothermal fluid. We noticed that the silver-bearing minerals can be observed in G2 and G3 as tetrahedrite-tennantite series minerals (Ave (wt.%): Ag; 2.9, Cu: 11.1, Zn: 7.0, Pb: 46.6, Sb: 4.0, As: 3.0 and S: 10.9) of 1-20 μm. Silver bearing minerals are associated with sphalerite and galena. According to Ag vs. Sb/(Sb+As) diagram, relatively silver-rich hydrothermal fluids contributed to form the chimney ore in Izu-Bonin arc as compared to that of typical with Kuroko type deposits. Especially from the chimney ore of the Bayonaissea knoll, 1-10 μm of tetrahedrite-tennantite series containing a high content of silver (Ave (wt.%): Ag: 52.9, Cu: 9.6, Zn: 1.6, Pb: 37.5 and S: 13.8) are observed at the rims of galena in the boundary between G1 and G2. Silver mineralization may be explained as follows. Firstly, silver present in galena formed during the principal sulfide mineralization moves by equilibrium equation,

$2Pb^{2+} = Ag^{+} + Sb^{3+}$ (Karup-Moller, 1971 and Foord, 1989) towards the right side by decreasing in temperature. As a result, tetrahedrite-tennantite series minerals are precipitated at G2 and G3. After hydrothermal active vent stopped, further temperature drop was introduced and furutobeite is formed from tetrahedrite-tennantite series minerals.

Keywords: Submarine hydrothermal ore deposit, Chimney ore, Izu-Bonin arc