Contemporaneous occurrence of spheroidal dolomites and framboidal pyrites in the Shimokawa deposit, Hokkaido, Japan

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Primary dolomites are commonly associated with SEDEX deposits hosted in clastic rocks, but only known for volcanogenic massive sulfide deposits such as bimodal felsic, bimodal mafic and siliciclastic mafic sub-type deposits⁽¹⁾. It has slightly been reported in the submarine hydrothermal deposits and active hydrothermal fields such as the Middle Valley⁽²⁾, Kagoshima Bay⁽³⁾ and the Okinawa Trough⁽⁴⁾. It became clear for the first time that spheroidal dolomites (SDs) containing framoidal pyrites (FPs) made up the carbonate matrix of pyrite ores in the Shimokawa deposit that was originated from the submarine hydrothermal deposit. This kind of pyrite ores containing SDs and FPs also occur in layered sulfides intercalated in argillites. The SDs with uniform diameter of 0.5 mm (±) are consisted of fibro radial dolomites and calcites infill the interstices of dolomites. Clear maltese crosses (black cross extinction) were observed under crossed polars. Fibrous dolomite crystals have a large number of inclusions and pores arranged parallel to the direction of fibers, and at the same time, pores that are arranged concentrically in the direction perpendicular to fibers. A ring nearly $10\,\mu$ m width consisting of fine talc crystals develops inside the SD. FPs embedded within the dolomite cements range in diameter from 2.4 to 20.3 μ m and relatively larger than that of syngenetic FPs (2.9^{-10.1} μ m) in unaltered argillites away from the sulfide deposits. FPs are overgrown by petal-like pyrite crystals with a length of $31.5 \,\mu$ m just like a sunflower and make aggregates. However no obvious spatial relationship between FP and SD is observed. TOC of argillites indicates 0.4-0.8wt%, whereas that of baked argillites adjacent to diabase sills records almost 0wt% due to thermal degradation of organic matter. Consequently CO2, CH4 and NH3 caused by intrusion of sill are thought to have ascended via the interstices of the clastic particles and fissures, and seeped to the seafloor. The $\delta^{13}C_{PDB}$ of organic carbon in argillites shows -25.7‰ (n=53), whereas the δ^{13} C PDB of matrix dolomites and calcites indicates -5.5 ‰(n=15) and -5.2‰ (n=4) respectively. That reflects the influence of pore seawater in unconsolidated sediments, which contain nearly 0% δ^{13} C _{PDB}. Since dolomite is highly ordered crystal, it is necessary to overcome the kinetic barrier which prevents the dolomite nucleation⁽⁵⁾. As indicated by the reaction as $CH_4 + SO_4^{2-} \rightarrow (HCO_3)^{-} + HS^{-} + H_2O$, decrease of SO $^{2}_{4}$, increase in alkalinity and Mg²⁺/Ca²⁺ caused by methane oxidation and bacterial sulfate reduction possibly promote the nucleation of dolomites and contemporaneous crystallization of FP. Although there have been reports that microbes were involved in the formation of spheroidal textures ⁽⁶⁾, but there is no positive evidence of microbial involvement in this study, and it is thought that heterogeneous nucleation due to increased supersaturation and rapid crystal growth, such as spherulites formed by polymers and guenched basaltic melts. We postulate that sulfide ores containing FPs and SDs in the Shimokawa deposit were precipitated under reduced environment just beneath the seafloor prior to the high temperature mineralization rich in chalcopyrites, pyrrhotites and sphalerites.

References

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