Comparison of ore formation processes between VHMS deposits and a submarine hydrothermal ore deposit in Okinawa Trough

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Construction of an appropriate ore deposit model is prerequisite for exploration and development of submarine hydrothermal ore deposits. However, their internal structures beneath the seafloor and evolution of ore mineralogy throughout hydrothermal activities have not been well understood. The CK16-05 cruise, operated from November to December, 2016 under SIP program, drilled through submarine hydrothermal ore deposits in Izena Hole, Okinawa Trough to investigate mineralogical, geochemical, and geophysical characteristics of both mound and lower sulfide deposits at the site. In this study, we are focused on Holes C9027A and B cores, which drilled through a mound sulfide deposit up to 72.5 m below seafloor.

Results of microscopic observations demonstrated that, samples at shallow depths are dominated by sphalerite and galena. In contrast, sample from the middle to deeper depths are more abundant in pyrite and chalcopyrite, and pyrite, respectively. The mineralogical change was comparable to that of some VHMS deposits, such as Matsumine deposit in the Hokuroku district, Japan. Our Fe isotope study suggests that such a distinct ore zonation in Matsumine deposit is governed by replacement of sphalerite- and galena-rich ores by chalcopyrite- and pyrite- rich ores during long-term hydrothermal circulation. Based on the similarity in the ore distribution with depth, the mound sulfide deposit was also likely to be formed by the same processes. On the other hand, pyrrhotite and anglesite, which are rarely found in VHMS deposits, are present in samples from the shallow part in the submarine hydrothermal ore deposit. Textural evidence as well as EPMA analysis for Fe content in sphalerite suggest that pyrrhotite was replaced by pyrite or marcasite at deeper depths possibly by the change in the fluid chemistry.