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Formation of Magnetites within Submarine Massive Sulfide Deposit Structure: Insights from Ocean Drilling into PACMANUS Hydrothermal Field

Sang-Mook Lee
School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea (smlee@snu.ac.kr)

The spatial distribution of magnetites and titanomagnetites within massive sulfide deposit and variations in their properties can provide important information on the physical and chemical conditions inside a submarine hydrothermal system. Here we report the results of detailed rock magnetic analyses on samples retrieved from seafloor drilling into PACMANUS hydrothermal field, Papua New Guinea, as part of Ocean Drilling Program Leg 193. Rock samples were collected at three different sites: Sites 1188, 1189 and 1191. Drilling results show pockets of high magnetic intensity being present several hundred meters deep within the submarine hydrothermal system. The reason this discovery is intriguing is because these zones occur in regions where alteration should have completely erased the magnetic signature of the host volcanic rocks. For instance, at Site 1188, a zone of high remanence is found between 135 and 211 mbsf with peak value reaching 11 A/m. Below 275 mbsf, another zone of high remanence is found with the maximum NRM intensity of 12.7 A/m at 337 mbsf. A similar pattern is found in Site 1189. We explore the possible cause of the high remanent magnetization sections within the hydrothermal vent field. One argument is that these high magnetization zones are the consequence of iron oxides being precipitated on the seafloor near the vent field as the hot hydrothermal fluid venting out of volcanoes came in contact with the oxygen-rich, cold seawater. Another scenario is that magnetites were formed by hot acidic iron-rich magmatic fluid rising from the bottom to the top inside the volcanic structure below the seafloor, and thus the depths where magnetites are found represent the location where the anoxic magmatic fluid came into contact with cold seawater. The two hypotheses differ in that in the former case the magnetites are the result of iron-rich deposits which accumulated on the seafloor near the vent but over time became buried by the piles of extrusive lava flows. In the latter case, we argue that the magnetites crystallized iinside the volcanic system and thus may provide insights on the physical and chemical conditions at the time of their formation.