Magma-related hydrothermal system in volcanic terrain: An example of the alteration in Unzen USDP-4 scientific drilling

Satoshi Hamasaki[1], Masaru Kurokawa[2], Hideo Hoshizumi[1], Setsuya Nakada[2]

[1]Geological Survey of Japan, AIST, Japan, [2]Earthquake Research Institute, University of Tokyo, Japan

E-mail: hamasaki-st@aist.go.jp

Magmatic heat sources form hydrothermal systems in volcanic areas. Magmatic fluids transport various elements and produce secondary minerals as a result of reactions with surrounding rocks. For describing the hydrothermal system inside volcanic terrain, this study examines the characteristics of the hydrothermal alteration undergone by sample drilled cores and cuttings. The samples were taken from a site located about 840 m above sea level on the northern side of Mt. Heisei-shinzan. The conduit drilling USDP-4, International Cooperative Research with Scientific Drilling, began here in 2003. In July 2004, the drilling head reached the conduit zone corresponding to the 1990-1995 eruption (Nakada et al., 2005). The total length of the USDP-4 drilling hole is 1995.75 m. Cuttings were sampled every 2 m along the drilled hole, and sixteen cores named C1 to C16 were sampled at depths exceeding 1582 m. The drilled cores consist of hornblende-bearing andesite to dacite lavas or pyroclastic rocks.

According to the cutting samples, fresh volcanic rocks can be found at depths less than 200 m. Smectite and pyrite occur at depths of more than 1100 m and 1400 m, respectively. Smectite disappears at a depth of 1600 m in both cuttings and core samples. Chlorite appears at depths more than 1700 m in the core samples. The occurrence of these alteration minerals shows generally good correlation with those expected at these depth. On the other hand, some minerals such as kaolinite occur along fractures or faults. Therefore, it is considered that a relatively high temperature solution rose along the fractures or faults, which provided good pathways for hydrothermal fluids. In addition, hydrothermal breccia-bearing veins up to 1 m wide can be observed, indicating that some hydrothermal solution rose explosively. Tuffisite veins are chlorite-altered with green color, which suggests that these veins made good pathways for the migration of volcano-related fluids. Calcites occur as veinlets at depths of less than 1900 m in the drilled cores. The calcite veins often cut through the tuffisite veins, suggesting that the calcite was precipitated at the latest hydrothermal period.

Inside the Unzen volcanic terrain, the hydrothermal alteration is very similar to those of epithermal vein-type gold deposits or geothermal fields. According to the alteration minerals, it can be estimated that the smectite zone shallower than 1600 m was formed at 100 to 150℃, while the chlorite zone deeper than 1700 m was formed at temperatures higher than 190℃. These mineral assemblages correspond to II to IV zones (Izawa et al., 1990) in the hydrothermal systems such as Hishikari, Kushikino gold deposits, and Ogiri geothermal field in Kyushu.