Hydrothermal alteration and stable isotope geochemistry observed in the Unzen Scientific Drilling Project core, USDP-4.

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The USDP-4 drilling, International Cooperative Research with Scientific Drilling for Understanding Eruption Mechanisms and Magmatic Activity (MEXT-USDP), begun at the site of about 840m above sea level on the northern side of Mt. Heisei-shinzan in 2003. The drilling that started vertically until about 200m under the ground surface changed toward SSE direction. In July 2004, the drilling head reached the conduit corresponding to the 1990 eruption and all of the drilling operation was over. The length of the all USDP-4 drilling hole is 1995.75m. Cuttings were sampled at every 2m point of the drilled hole and sixteen cores, named as C1 to C16, were sampled at the points deeper than 1582m of the drilled hole (Nakada et al., 2005). The drilled cores consist of hornblende-bearing andesite to dacite lavas or pyroclastic rocks. Hamasaki et al.(2006) described the hydrothermal alteration and the composed secondary minerals of the USDP-4 core by observation and X-ray diffraction. This study has analyzed oxygen and carbon isotopic composition of calcite veins in the drilled core and considered the geochemical characteristics of the hydrothermal system inside the Unzen volcanic terrain.

The hydrothermal alteration in the USDP-4 core shows generally correlation with the depth, although the weakly and strongly altered parts are observed at any depth and some unaltered parts exist even at the deep core. For example, smectites occur at the points shallower than 1600m and chlorites begin to appear in the core deeper than 1700m. Pyrites also occur greatly in the core deeper than 1850m. On the other hand, it is considered that the occurrence of the alteration is largely influenced by fractures and faults. For example, kaolinites occur only part of 1585-1590m, 1698-1700m, 1795-1797m and 1896-1902m, which correspond to the crushed or strongly altered part. Therefore, it is considered that the relative high temperature solution rose along the fractures and faults, which could provide good pathways for migration of volcanic-related fluids. In addition, hydrothermal breccia-bearing vein, several centimeters to one meter wide, can be observed at the 1585-1590m, indicating that some hydrothermal solution rose explosively. It is considered that tuffisite veins have also become good pathways for the fluid during the hydrothermal period. (Hamasaki et al., 2006)

Calcites occur as veinlets with width less than several millimeters at the points shallower than 1900m of the drilled core. Stable isotope ratios were measured for the vein calcites, 2 to 6 mm wide, which consist of only calcite or paragenesis with quartz and are hosted in the almost unaltered to various altered andesite lava or pyroclastic rock. As a result of previous analysis, carbon isotopic values were -5.6 to -4.5 per mil and oxygen isotopic values were +5.8 to +13.1 per mil. Although the oxygen values are various, the carbon values are almost same. The oxygen values show a tendency to be higher and lower at the shallow and deep part of the drilled core, respectively. The carbon values are independent of the depth, indicating that the hydrothermal system circulates with large scale inside the Unzen volcanic terrain. In addition, compared with the carbon isotopic compositions of the epithermal vein-type deposits, the carbon values of the USDP-4 core are clearly higher than Kushikino area: -11 to -8 per mil and Hishikari area: -9 to -6 per mil (Morishita, 1993). It is possible that these carbon values are caused by the difference of the host rocks between Shimanto Supergroup in the both deposit areas and the andesite in the Unzen volcano.