Unzen Scientific Drilling Project: Logging Data of the Well USDP-4

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The Unzen Volcano Scientific Drilling Project (USDP) has been conducted to target the magma conduit shortly after the 1990-1995 eruption. After two drillings of 752 m and 1463 m deep at the flank site, the conduit surveying well (USDP-4) was drilled to the depth of 1995.7 m in the mountainside to clarify the ascending and degassing mechanisms of magma. We have conducted physical logging in the USDP-4 well to elucidate the structure and material properties in and around the conduit. The logging items are as follows: Gamma Ray (167 to 1780 m), Resistivity (167 to 1795 m), Self-Potential (167 to 1775 m), Density (392 to 1782 m), Neutron Porosity (770 to 1777 m), Sonic velocity (392 to 1787 m), Full-bore Formation Micro Imager (FMI : 167 to 1540 m), Formation Micro Scanner (FMS : 1550 to 1791.5 m) and VSP (237 to 737m). Because of the high inclination of this well (Sakuma et al., this meeting), we used the Tough Logging Condition System (TLCS) below the depth of 800 m where the well inclination is up to 70 degrees. We had some concern because of a possible well collapse and high temperatures at the conduit zone before drilling. However, a good well condition and low temperature enabled us to obtain good logging data from this well.

Comparing the logging data and lithology, determined mainly from drilled cores and cuttings (Nakada et al., this meeting), we can make clear the features of its formation and material properties found within the well. Gamma Ray varies between 40 API to 100 API, with the high (90 to 100 API) value coinciding with a lava dike. Resistivity structure can be classified into 5 layers. The value of resistivity above 240 m, 240 to 550 m, 550 to 1100 m, 1100 to 1760 m and below 1760 m are a few hundred ohm-m, 500 to 1000 ohm-m, about 100 ohm-m, about 10 ohm-m, about 100 ohm-m, respectively. The lava dike indicates a characteristic feature of about 100 ohm-m even though it is distributed in the 10 ohm-m layer. P-wave velocity varies 3 to 5 km/s through all depths. The velocity of Pyroclastic rocks, lava flow, volcanic breccia and lava dike is 3 km/s, about 4.5 km/s, 4 km/s and 5 km/s, respectively. The density of Pyroclastic rocks, lava flow, volcanic breccia and lava dike is 2.3 to 2.4 g/cm3, about 2.5 g/cm3, about 2.5 g/cm3 and 2.6 g/cm3 respectively. The porosity of the lava flow and lava dike is low (0.1), and high porosity (0.4) coincides with low resistivity (10 ohm-m), low velocity and low density zones. Furthermore, the high porosity zone around 1700 m coincides with the zone where a high NaCl concentration in the drilling mud was observed during the drilling. The anomaly of Self-Potential recognized around the lava dike seems to be related to the fluid flow.

FMI and FMS images show not only the boundaries of lava dikes but also vertical pyroclastic veins in the conduit zone. Some conductive layers are recognized in the lava dikes. Drilling induced tensile fractures and borehole breakouts were also partly recognized. According to the FMS analysis, the main dips and strikes of the boundary of lava dikes and pyroclastic veins are a high dip and in an east-west direction. These measurements are indispensable to better understand the dynamics of magma emplacement, tectonic settings, and mechanical controls on the orientation of fractures.

The estimated formation temperature based on the temperature loggings(S.T.=13h and 20h) at the bottom hole is from 160 to 182 deg.C. Minimum homogenization temperature of the fluid inclusion of the bottom core is 171 deg.C.