Permeability measurements on conduit drilling core at Unzen Volacano

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The last eruption of Unzen Volcano was effusive to form lava domes, although the magma at depths was considered to contain a sufficient amount of volatile components to cause explosive eruption (Sato et al., 1999). Most of volatile components should have escaped from the magma during its ascent. The escape of gas is controlled by the permeability of magmas and country rocks. Unzen Scientific Drilling Project sampled both the latest conduit and its country rocks (USDP-4). We have measured the gas permeability of these rocks in order to understand the escape mechanism of gas.

The density, elastic wave velocities, and permeability were measured on four cubic specimens (length-25 mm) cut from drilled rocks. All measurements were conducted under atmospheric pressure. The elastic wave velocity was measured by the pulse transmission technique (the resonant frequency=1 MHz). Velocities were measured in three orthogonal directions. The velocity was measured for two shear waves in one direction, which oscillate perpendicularly each other. The averaged velocities are shown below. Though azimuthal anisotropy of the compressional wave velocity was observed (11%), the direction of the highest velocity varies in specimens.

The transient pulse method was employed to measure the permeability. It applies a step fluid pressure difference across a specimen and monitors the decay of the pressure difference. The permeability is obtained from the decay rate. The background leak rate limits the measurable permeability to be higher than 1e-20 m2. The ambient temperature was kept constant within 0.01C in order to minimize the pressure change due to the temperature fluctuation. The permeability in the direction of the core axis has been measured. The similarity in the density and the elastic wave velocities between samples C1 and C12 suggests the difference two specimens have similar composition and porosity. The difference in the permeability may reflect the difference in the connectivity of pores. Pores in the sample C1 are poorly connected, which might be caused by pore-filling calcite. We will measure permeabilities in other directions and discuss degassing process.

Core No. Sample Depth(m) Density(g/cm3) Vp(km/s) Vs(km/s) Permeability(m2)
C1 Old Unzen Lava (country rock) 1582-1590(m), 2.40(g/cm3), 3.99(km/s), 2.47(km/s), 2e-19(m2)
C12 Volcanic breccia (country rock) 1896-1902(m), 2.41(g/cm3), 3.95(km/s), 2.51(km/s), 1e-17(m2)
C13 Lava dike (conduit) 1975-1977(m), 2.57(g/cm3), 5.16(km/s), 3.06(km/s), 2e-18(m2)
C14 Lava dike (conduit) 1977-1980(m), 2.56(g/cm3), 4.97(km/s), 3.05(km/s), 3e-17(m2)