Relationship between Thermal Conductivity and Elastic Wave Velocity of Rock Core Samples Collected from Aso Volcanic Region in Kumamoto, Japan

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Rock thermal conductivity is essential to understand the thermal structure and/or heat flow of subsurface environment, while it remains difficult to measure thermal conductivity directly in situ. Therefore, relationships between thermal conductivity and other physical properties that can be measured remotely from the ground (e.g., elastic wave velocity) are growing in interest. This research seeks to derive an empirical formula that can be used to obtain thermal conductivity form elastic wave velocity through laboratory measurements on rock core samples collected from borehole FDB-1, which was drilled trough the source fault of 2016 Kumamoto Earthquake main shock. And information on mineral composition of rocks in this borehole is expected to be obtained from structural observation using thin sections of rock core samples.
Rock core samples used in this research were taken from the depth range of 300 m to 666 m underground of the borehole FDB-1, covering two kinds of lithology mainly: andesite and sedimentary rocks including tuffaceous rocks. Thermal properties of these samples were measured through the commercial thermal constant analyzer TPS 1500 using the transient plane method. And ultrasonic velocity method was utilized to measure P- and S-wave velocity. Measurements were conducted under water saturated and dry conditions to simulate the nature state of rocks below the ground water level and figure out effects of pore water, respectively.
Compared with porosity of these rock core samples, both thermal conductivity and P-wave velocity showed a decreasing trend as porosity increases. And a formula between thermal conductivity and elastic wave velocity was derived from their respective relationships with porosity. The obtained formula and the plotted graph presented a relatively high degree of fitness. The results of structural observation using thin sections showed some correlation between the volume fraction of rock-forming minerals and other physical properties.

Keywords: Thermal Conductivity, Elastic Wave Velocity, Aso Volcanic Region, Thin Section

