Thermal property measurements of core samples retrieved from Futagawa fault drilling

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In 2017˜2018, to retrieve rock samples from the Futagawa fault ruptured during the 2016 Kumamoto earthquake in Japan, a borehole was drilled down to 700 m depth through the fault in Mashikimachi, Kumamoto prefecture located in the southwest of the Aso volcano. In this borehole, temperature depth profile was measured from ˜50 m to ˜650 m below the surface (Lin et al., 2019 JpGU). As a preliminary result, an anomaly of temperature, about 1 ℃/km geothermal gradient, was found in the depth range of 310 - 430 m (Lin et al., 2019 JpGU). To examine if this this temperature anomaly comes from thermal conductivity change of the ricks, we collected rock core samples from the borehole and measured their thermal properties.
We measured density, porosity and three thermal transport properties (thermal conductivities, thermal diffusivities, specific heat capacities) of 20 cores drilled from the borehole in the depth range from 300 m to 700 m. I selected typical rock cores to cover not only the depth intervals and also all the main rock types. The rock types of cores are basal sedimentary rocks in 300 m - 353 m , andesite in 353 m - 514 m, sandstone and/or conglomerate in 514 m - 562 m, and tuff in 562 m - 700 m. Measured wet densities and porosities are 1.57 g/cm^3 - 2.02 g/cm^3, 40.0% - 47.8% for basal sedimentary rocks, 2.31 g/cm^3 - 2.95 g/cm^3, 3.1% - 25.5% for andesite, 2.29 g/cm^3 - 2.41 g/cm^3, 21.6% - 29.4% for sandstone and/or conglomerate, 1.99 g/cm^3 - 2.29 g/cm^3, 9.4 % - 35.8% for tuff. Measured thermal conductivities are 0.88 W/(mK) - 1.10 W/(mK) for basal sedimentary rocks, 1.00 W/(mK) - 1.81 W/(mK) for andesite, 1.26 W/(mK) - 1.31 W/(mK) for sandstone and/or conglomerate, 0.96 W/(mK) - 1.27 W/(mK) for tuff. And measured thermal diffusivities and specific heat capacities are 0.85 J/(g･K) - 3.46 J/(g･K) for alluvium, 0.48 m^2/s - 0.91 m^2/s, 1.36 J/(g･K) - 2.60 J/(g･K) for andesite, 0.49 m^2/s - 0.66 m^2/s, 1.95 J/(g･K) - 2.70 J/(g･K) for sandstone and/or conglomerate, 0.40 m^2/s - 0.99 m^2/s, 1.40 J/(g･K) - 2.93 J/(g･K) for tuff. From data of measured temperature of borehole and thermal conductivities of the cores, we calculated heat flow of in the borehole. Using this heat flow and thermal conductivities, we reconstructed the temperature profile in the borehole.
In this estimation, we couldn't reproduce the anomaly of measured temperature. So we conclude that the anomaly of measured temperature is not caused by the significant change of the thermal conductivity in 310 m - 430 m depth.

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