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# Measuring the temperature dependent thermal diffusivity of geomaterials using high-speed differential scanning calorimetry

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Heat diffusion in the Earth's crust is critical to fundamental geological processes, such as the cooling of magma, heat dissipation during and following transient heating events (e.g. during frictional heating along faults), and to the timescales of contact metamorphosis. The complex composition and multiphase nature of geomaterials prohibits the accurate modeling of thermal diffusivities and measurements over a range of temperatures are sparse due to the specialized nature of the equipment and lack of instrument availability.

We present a novel method to measure the thermal diffusivity of geomaterials such as minerals and rocks with high precision and accuracy using a commercially available differential scanning calorimeter (DSC). A DSC 404 F1 Pegasus® equipped with a Netzsch high-speed furnace was used to apply a step-heating program to corundum single crystal standards of varying thicknesses. The standards were cylindrical discs of 0.25-1 mm thickness with 5.2-6 mm diameter. Heating between each 50 ºC temperature interval was conducted at a rate of 100 ºC/min over the temperature range 150-1050 ºC. Such large heating rates induces temperature disequilibrium in the samples used. However, isothermal segments of 2 minutes were used during which the temperature variably equilibrated with the furnace between the heating segments and thus the directly-measured heat-flow relaxed to a constant value before the next heating step was applied.

A finite-difference 2D conductive heat transfer model was used in cylindrical geometry for which the measured furnace temperature was directly applied as the boundary condition on the sample-cylinder surfaces. The model temperature was averaged over the sample volume per unit time and converted to heat-flow using the well constrained thermal properties for corundum single crystals. By adjusting the thermal diffusivity in the model solution and comparing the resultant heat-flow with the measured values, we obtain a model calibration for the thermal diffusivity of corundum.

Preliminary calibration tests suggest a very good correlation between the measured results compared with literature values of the thermal diffusivity of this standard material. However, more measurements on standard materials are needed to guarantee the accuracy of the presented technique for measuring the thermal diffusion of materials and apply this method to numerical models for relevant processes in geoscience.