American Mineralogist, Volume 104, pages 1533–1545, 2019

Crossroads in Earth and Planetary Materials

Thermal diffusivity and thermal conductivity of granitoids at 283–988 K and 0.3–1.5 GPa

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Abstract

The thermal diffusivity and thermal conductivity of four natural granitoid samples were simultaneously measured at high pressures (up to 1.5 GPa) and temperatures (up to 988 K) in a multi-anvil apparatus using the transient plane-source method. Experimental results show that thermal diffusivity and thermal conductivity decreased with increasing temperature (<600 K) and remain constant or slightly increase at a temperature range from 700 to 988 K. Thermal conductivity decreases 23–46% between room temperature and 988 K, suggesting typical manifestations of phonon conductivity. At higher temperatures, an additional radiative contribution is observed in four natural granitoids. Pressure exerts a weak but clear and positive influence on thermal transport properties. The thermal diffusivity and thermal conductivity of all granitoid samples exhibit a positive linear dependence on quartz content, whereas a negative linear dependence on plagioclase content appears. Combining these results with the measured densities, thermal diffusivity, and thermal conductivity, and specific heat capacities of end-member minerals, the thermal diffusivity and thermal conductivity and bulk heat capacities for granitoids predicted from several mixing models are found to be consistent with the present experimental data. Furthermore, by combining the measured thermal properties and surface heat flows, calculated geotherms suggest that the presence of partial melting induced by muscovite or biotite dehydration likely occurs in the upper-middle crust of southern Tibet. This finding provides new insights into the origin of low-velocity and high-conductivity anomaly zones revealed by geophysical observations in this region.

Keywords: Thermal diffusivity, thermal conductivity, granitoid, crust