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Thermal conductivity determinations on granitoids from central India: A comparison between measured and calculated thermal conductivity

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Granite is an important part of the upper continental crust and its thermal conductivity plays an important role in understanding the lithospheric thermal structure in a region. An attempt is made here to study the difference between the measured and calculated thermal conductivity of the granitoids and gneisses from the Bundelkhand craton, central India. Thermal conductivity of the samples are measured in the laboratory and also calculated from their mineral compositions considering one and two-phase systems. Studied samples consist of, K-feldsfar enriched pink granitoid, biotite enriched granitoid, mafic minerals/Na-feldspar enriched grey granitoids and TTG gneisses. Using steady-state divided-bar method, bulk thermal conductivity is measured in the laboratory on the studied rock samples, at saturated conditions. Study shows that mean thermal conductivity at saturated conditions varies between 2.5 to 2.8 W m^{-1} K^{-1}. Density and porosity are also calculated by measuring weight of the rock samples in dry and saturated conditions. Mean density varies between 2.6 and 2.7 g cm^{-3} and porosity is very low (<1%) for all samples. Mineralogical compositions for these set of samples are determined from the petrographic and geochemical studies (using high resolution ICPMS and XRF). Thermal conductivity of the samples are calculated on the basis of their mineralogical compositions and thermal conductivity of individual minerals, using various mathematical mixing models, namely, arithmetic mean, geometric mean, harmonic mean, effective mean and Hashin-Shtrikman mean.

Results show that, in case of non-availability of proper sample for thermal conductivity measurement in the laboratory, bulk thermal conductivity of granitoid rock with very low porosity could be determined by assessing its modal mineralogy very accurately and considering appropriate mineral thermal conductivity. The harmonic mean model provides the best agreement (deviation ranging from 1 to 15 %) between measured and calculated values for the studied rocks by considering minimum thermal conductivity of the minerals. Considering two-phase system there is little improvement in the measured thermal conductivity. Result also indicates that minerals are predominantly aligned parallel in the studied rocks which need to be verified by geological studies.