EGU21-12488
https://doi.org/10.5194/egusphere-egu21-12488
EGU General Assembly 2021

Thermal properties evaluation of granitoid rocks by using Digital Imaging Analysis (DIA) and 2D modelling simulation

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Seven granitoid rocks were selected due to the well-defined mineralogical content, the typical the holocrystalline texture, their absent (or very poor) Crystal Preferred Orientations (CPOs), and very-low porosity in order to apply a predictive approach that quantifies and simulates the rock thermal properties by considering the contributions of the mineral phases content. For this purpose, thermal properties of granodiorite, tonalite, granite, and gabbro rock samples were analysed and compared by *(i)* direct measurements on the bulk rock samples, *(ii)* by applying Quantitative Phase Analysis (QPA) on Digital Imaging Analysis (DIA) and Xray diffraction Rietveld method, and *(iii)* by 2D numerical modelling.

The results confirm the good accuracy of DIA-QPA method by the good according with data refined by X-Ray diffraction Rietveld method, and indicate the potential reliability of the more attractive approach in terms of prediction of the 2D modelling starting by the Quantitative Phase Analysis (QPA) based on Digital Imaging Analyses (DIA). This method, indeed, permits to observe concurrently different mineralogical and textural parameters (such as mineral abundance, grain size and grain size distribution), and it also provides a deep knowledge of the rock's thermal behaviour.

Numerical modelling results indicate that a steady-state condition (SSC) is reached by the combination of thermal contribution given both in terms of modal mineral abundance (mainly controlled by mineralogical phase content related to the quartz occurrence) and in terms of rock texture (by the grain-size dimensions and the geometrical distribution of minerals), considering negligible the porosity.

The use of predictive models for the evaluation of the rocks thermal properties can find many important applications (e.g., in deep and shallow geothermal systems, as well as in building construction materials), and also permits to evaluate the expected energy performance of borehole heat exchange probes, involving granitoid lithologies, representing a suitable alternative also in cases where direct measures are not possible.