Geophysical Research Abstracts
Vol. 17, EGU2015-8670, 2015
EGU General Assembly 2015

Quantifying melting and mobilistaion of interstitial melts in crystal mushes

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The deformation of crystals mushes and separation of melts and crystals in is critical to understanding the development of physical and chemical heterogeneity in magma chambers and has been invoked as an eruption trigger mechanism.

Here we investigate the behaviour of the melt in the well characterised, classic crystal mush system of the Skaergaard intrusion by combining experimental petrology and the non-destructive 3D imaging methods. Starting materials for partial melting experiments were four samples from the upper Middle Zone of the Layered Series. Cylinders, 15 mm in diameter and 20 mm in length, were drilled out of the rock samples, placed in alumina crucibles and held for 5 days in electric furnaces at atmospheric pressure and 1050-1100 °C. Redox conditions set by the CO-CO_2 gas mixture were kept close to those of the FMQ buffer. We then use spatially registered 3D x-ray computed tomography images, collected before and after the experiment, to determine the volume and distribution of the crystal framework and interstitial phases, and the volume, distribution and connectivity the interstitial phases that undergo melting and extraction while at elevated temperature. Image analysis has allowed us to quantify these physical changes with high spatial resolution.

Our work is a first step towards quantitative understanding of the melt mobilisation and migration processes operating in notionally locked crystal rich magmatic systems.