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The Use of Leucosome Patterns in Migmatites to Decipher Rates of Melt Production, Melt Percolation and External Deformation: Insights from Numerical Modelling

Giulia Fedrizzi[1], Sandra Piazolo[2], Daniel Koehn[3], and Sam Pegler[4]
[1]EPSRC Centre for Doctoral Training in Fluid Dynamics, University of Leeds, Leeds, UK (scgf@leeds.ac.uk)
[2]School of Earth and Environment, University of Leeds, UK (S.Piazolo@leeds.ac.uk)
[3]GeoZentrum Nordbayern, Friedrich-Alexander University of Erlangen-Nuremberg, Germany (daniel.koehn@fau.de)
[4]School of Mathematics, University of Leeds (S.Pegler@leeds.ac.uk)

Melt production and migration are important phenomena in the lower and middle crust. The presence of melt in a volume of rock has a significant impact on its rheology and on the structure of the Earth's crust in general. Once partial melting starts, the molten portion can either flow towards shallower crustal levels or stay in the area where it originated. A partially molten rock can eventually solidify and be brought to the Earth's surface, where the distribution of the former melt can provide insight into the conditions in which the rock formed.

Here we present a set of numerical experiments utilising an innovative DEM-continuum model to simulate partial melting and the initial formation of porosity channels. This hybrid model incorporates porous flow to solve for pervasive percolation of melt and a network of springs on a second grid to represent the linear elastic behaviour of the host rock. The latter also includes phenomena such as fracture formation and propagation.

We show under which conditions melt-filled fractures can emerge from local areas of melt production and evolve into larger melt channels. Importantly, our models show that leucosome patterns seen in outcrops can be used to constrain the relative rates of melt diffusion along grain boundaries, syn-migmatisation deformation, and local melt production. Based on the relative rates of these processes, we define regimes with specific melt pattern distributions. The definition of these regimes can be a useful tool for the interpretation of the history of a migmatite.