A Markov chain Monte Carlo approach to trace element modelling of disequilibrium fractional melting

KLÖCKING, M.[1,2]*, OLIVEIRA, B.[2], AFONSO, J.C.[2,3]

[1]Research School of Earth Sciences, Australian National University, Australia (*correspondence: marthe.kloecking@anu.edu.au)
[2]Department of Earth and Planetary Sciences, Macquarie University, Australia
[3]CEED, Department of Geosciences, University of Oslo, Norway

We have developed a new model of trace element behaviour during disequilibrium fractional melting. We couple expressions for the steady-state kinetics of melting with thermodynamic calculations of phase abundances and physical properties. Major assumptions include the derivation of melts from a single, homogeneous, continuously upwelling mantle source and that melt generation is confined to the asthenospheric mantle. The composition and thermodynamic properties of both melt and residual solid are calculated as a function of source composition, mantle potential temperature and melting depth. Aggregate melt compositions can then be compared with observed compositions of mafic volcanic rocks. The model is built in a flexible way to allow for a number of thermodynamic (e.g. Perple_X, alphaMELTS) or parameterised model approaches depending on user preferences [1,2]. Probabilistic inversion is achieved via delayed reaction adaptive Metropolis sampling. In this way, source composition, mantle temperature and lithospheric thickness can be estimated from volcanic compositions in a variety of settings.

We are working to integrate this model into a multi-observable probabilistic inversion framework (LitMod_4INV) that solves for the thermal and chemical structure of the shallow upper mantle [3]. This joint geochemical-geophysical inverse approach opens up new exciting avenues to improve our understanding of the lithosphere-asthenosphere system. We present first synthetic results demonstrating the benefits and limitations of joint inversion of surface wave dispersion curves and mafic volcanic compositions.

[1] Connolly (2009), *G-cubed* 10(10), 1-19. [2] Smith & Asimow (2005), *G-cubed* 6(1), 1-8. [3] Afonso *et al.* (2016), *JGR Solid Earth* 121(10), 7337-7370.