Multiphase Multicomponent Reactive Transport: Disequilibrium Melt-Rock Processes and Geochemical Geodynamics

B. OLIVEIRA[1]*, J.C. AFONSO[1,2], R. TILHAC[1]

[1] ARC Centre of Excellence for Core to Crust Fluid Systems (CCFS) and GEMOC, Department of Earth and Planetary Sciences, Macquarie University, Australia
[2] Centre for Earth Evolution and Dynamics, University of Oslo, Norway
(*correspondence: oliveira.bravo.b@gmail.com)

During partial melting, melt migration, melt-rock reaction and crystallization in the mantle, peridotites and melts interact thermally, mechanically and chemically. As such, these processes constitute Multi-Phase, Multi-Component Reactive Transport (MPMCRT) systems that can, in principle, be experimentally constrained and numerically modelled. This work presents a new conceptual and numerical approach, integrating petrological, geochemical, geophysical considerations into a fully quantitative and comprehensive approach to model disequilibrium melt-rock processes and geochemical geodynamics.

In this contribution we combine (1) a microstructural model for diffusion-controlled trace-element transport and (2) disequilibrium extensions of the dynamically, energetically and thermodynamically constrained multi-phase transport model developed by [1]. This provides a versatile platform, not only able to study the dynamics and feedbacks of multi-phase systems of different nature and over multiple scales, but also rendering possible realistic comparisons between geophysical and geochemical datasets. We apply this integrated approach to decompression melting and demonstrate how the understanding of the petrogenesis of mid-ocean ridge basalts (MORB) can benefit from the modelling of MPMCRT systems. Furthermore, comparisons with the modal-, major- and trace-element compositions of abyssal peridotites notably emphasize the role of disequilibria arising from transport, phase changes and diffusion.

[1] Oliveira *et al.* (2018), JGI **212(1)**, 345-388.