

Modelling the composition of H₂O-CO₂-rich incipient melts in the upper mantle

MALCOLM MASSUYEAU¹, EMMANUEL GARDES²,
YANN MORIZET³ AND FABRICE GAILLARD¹

¹ISTO, Université d'Orléans-CNRS, Orléans, France
(malcolm.massuyeau@cnsr-orleans.fr, gaillard@cnsr-orleans.fr)

²CEA-CNRS-ENSICAEN-Université de Caen Basse Normandie, Caen, France (gardes@ganil.fr)

³LPGN, Université de Nantes, Nantes, France
(yann.morizet@univ-nantes.fr)

The presence of CO₂-rich melts inside the upper mantle has so far been revealed by experimental petrology and by textural and chemical evidence in oceanic and cratonic xenoliths undergoing metasomatism. However, the equilibrium chemical composition of these melts in the upper mantle ranging from a carbonate-rich to a silicate-rich melt is not well defined in a P-T space. We provide here a model showing that sharp changes in melt composition from carbonate to basanite can occur due to temperature increase of 50°C, water content increase from 0 to 10 wt.% or decompression of 0.5 GPa.

Using Margules' formalisms, we established a multi-component model describing the Gibbs free energy of melt produced by mantle melting in presence of CO₂-H₂O. This parameterization is calibrated on crystal-liquid, redox, fluid-liquid and liquid-liquid equilibria obtained by experimental studies in the P-T range 1-14 GPa and 1090-1800°C.

We calculate the composition of melts produced in the oceanic upper mantle as a function of ages (temperature) and chemical heterogeneities (water, alkalis). Hydrous carbonatitic melts are stabilized in most of the upper mantle. Carbonated silicate melts, with SiO₂ > 25 wt.%, are produced above ~60-100 km, and can coexist with an immiscible carbonatite. This depth range corresponds to the Low Velocity Zone (LVZ), and may be the source of the petit spot lavas. In our presentation, we will define the P-T- conditions and the chemical composition (alkalis, water) required to produce kimberlite melts below cratons.