The composition of melts from a heterogeneous mantle: Application of a thermodynamic model

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Experimental studies on mantle lithologies have advanced and refined our knowledge of mantle melting. Equilibrium melting is determined at the fixed *PT* conditions of an experimental run. However, the polybaric and fractional nature of mantle melting limits the interpretive use of such experimental run products. A thermodynamic model calibrated on experimental data extends the experimental results to full effect by allowing the interpolation between, and extrapolation beyond, experimental conditions, and provides an interpretive framework for the array of basaltic compositions observed on the Earth and beyond.

We use a new thermodynamic model of mantle solid phases and melt to examine melting in the system NCFMASOCr [1]. The model is effective in predicting melt compositions, particularly near-solidus melts, for a range of bulk compositions from harzburgite through to eclogite at the *PT* conditions relevant to melting. This model is used to explore the effect of bulk composition on melting. A trade-off is observed, whereby the melt composition of increasingly enriched lithologies is partly buffered by corresponding changes in the solid assemblage. The consequence of this is a reduced variability in the major element chemistry of melts derived from a lithologically heterogeneous mantle. However, major element chemistry is sensitive to pressure such that a more enriched, fusible lithology which begins melting at high pressure will still produce melts with a distinctive major element composition compared with typical lherzolite. We explore this effect with fractional melting models at different mantle potential temperatures and compositions to highlight the major element characteristics diagnostic of melts from recycled crustal material.

The model is applied to ferropicrite genesis; this enigmatic magma type with its distinctive high FeO and MgO and low Al_2O_3 has been suggested as originating from high pressure melting of pyroxenite beneath thick lithosphere.

[1] Jennings and Holland, Accepted pending revision, *Journal of Petrology*