

Evaluating a high temperature residual model for the petrology and chemistry of the lower continental crust

DAVID T MURPHY, CRAIG O'NEILL AND EMMA J. CONWAY

Queensland University of Technology

The composition and geodynamic significance of the largely inaccessible lower continental crust remain topics of ongoing controversy. In active tectonic settings it acts as a conduit zone with material transferring to and from the mantle and to and from the upper crust. In stable tectonic settings it is a passive geochemical reservoir, the petrology and geochemistry of which plays a critical role in long term crustal stability and the nature of the geotherm.

The key constraints include the petrology and composition of granulites, surface and Moho heat flows, geotherm, and seismic velocities. Petrological and geochemical observations from lower crustal granulite xenoliths, such as exsolutions in pyroxene and feldspar, Ti in zircon thermometry and resetting of U-Pb in zircon, consistently indicate temperatures in excess of 900° during their lower crustal petrogenesis. Such high temperatures and the observation of high heat flow measurements and temperature estimates in current crustal production zones (eg. North Island, NZ; Cascades, N. America) require the interaction of mantle derived melts with pre-existing crust.

Thus, models for the average compositions for the lower crust must consider its stability at the conditions it experienced during formation. It is essential to consider stable phase assemblages that form initially at temperatures of 900°C and above prior to cooling to ambient lower crustal temperatures.

To do this we use an iterative Markov Chain Monte Carlo approach coupled to thermodynamic modelling to model compositions for the lower crust that are internally consistent with critical observations including Vp, Vs, density, internal heat production, and the thermal state of the crust. This provides a range of viable compositions that we will compare to xenolith and granulite compilations from different settings.

Preliminary observations indicate the most viable petrological assemblage for the lower crust is clinopyroxene, orthopyroxene, plagioclase ± garnet and accessory phases. Such two pyroxene granulites represent mafic residues after melt-solid hybridisation and loss of differentiated magma together with most of the system budget for heat producing elements. Proposed intermediate compositions for the lower crust stabilises hornblende below 900°C, which melts at higher temperatures anticipated during crustal formation, and would leave a two pyroxene granulite residue.