PROBING THE SECULAR EVOLUTION OF THE MID-TO LOWER CONTINENTAL CRUST

Ketchum[1], J.W.F., Percival[2], J.A., and EASTON[3], R.M.
1. GEMOC ARC National Key Centre, Department of Earth and Planetary Sciences
Macquarie University, NSW, 2109, Australia, jketchum@els.mq.edu.au
2. Geological Survey of Canada, 601 Booth St., Ottawa, ON, K1A 0E8
3. Ontario Geological Survey, 933 Ramsey Lake Road, Sudbury, ON, P3E 6B5

We examine mid- to deep-crustal evolution from the perspective of secular change. The midto lower continental crust (MLCC) is broadly defined here as crust that currently or once resided in the lower half of the crust, either now or during orogenesis. Low temperature examples (e.g., blueschists) are not considered. With the possible exception of lowermost crust, crust of ‘normal’ thickness (35-45 km) is static, having undergone the bulk of its evolution during formation and orogenic activity. Hence geophysical and xenolith data can be used to examine MLCC of variable age. Uplifted crustal sections and impact structures provide similar opportunity.

MLCC of all ages typically contains a range of mafic to felsic rock types. Combinations of tectonic, magmatic, and metamorphic activity can account for this variability. Seismic reflection profiles generally indicate subhorizontal discontinous layering, and seismic velocities suggest an intermediate (mid-crust) to mafic-intermediate (lower crust) bulk composition irrespective of age. No consistent secular variations in Moho character are known. At face value, these similarities are intriguing as the tectonothermal evolution of continents should have varied due to secular change. The most important variable is heat: although debate continues, the Archean crust and mantle were probably hotter than today. Crustal heat production was 2-3 times greater, suggesting that under ‘ideal’ conditions (i.e. sufficient abundance of heatproducing elements (HPEs)), Archean crust was less viscous and therefore more susceptible to deformation and partial convective overturn. Secular cooling also appears to have modified some aspects of plate tectonics.

The age-independent features of MLCC noted above suggest that secular influences on crustal evolution are partly to completely masked by first-order features. For instance, substantial growth of continental crust in plate margin settings has likely yielded a broad crustal uniformity over time (within observational resolution). Similarly, geochemical and tectonic modification of the MLCC is unlikely to have substantially varied. HPEs are concentrated in upper crust of all ages due in large part to metamorphic and magmatic extraction from the MLCC. This represents an important cratonization process that drives MLCC toward a common endpoint (melt-depleted, anhydrous, high pressure-temperature deformation history). Lateral ductile flow of MLCC is likely under these conditions, contributing to subhorizontal reflectivity. Geodynamic and seismic data indicate that tectonic activity of all ages will only enhance this deep reflection pattern. Orogenic burial of HPE-rich units will result in crustal anatexis and probable return of HPEs to the upper crust, a form of geochemical selforganization.