Probing early crustal reworking

J. O'NEIL[1], B. WASILEWSKI[1], H. RIZO[2], J.-L. PAQUETTE[3]

[1] Dept. of Earth and Env. Science, University of Ottawa, Ottawa, Canada
[2] Earth Sciences Dept., Carleton University, Ottawa, Canada
[3] Laboratoire Magmas et Volcans, Université Clermont Auvergne, Clermont-Ferrand, France

Granitoids composing Archean cratons have likely been produced by complex and protracted crustal reworking processes. This reworking has obscured most evidence concerning the nature of Earth's first crust. Isotope systems such as ^{147}Sm-^{143}Nd and in situ Hf isotopes in zircons are common tracers used to study the crustal history of cratons, but because they are long-lived isotopic systems and record the overall crustal evolution, it can be challenging to peer through the earliest history of Archean terrains. Short-lived isotopic systems are however not affected by fractionation events after the extinction of the parent isotope and thus can help to better constrain the age and nature of the earliest crust. Here we combine long-lived (^{147}Sm-^{143}Nd, Hf-zircon) and short-lived (^{146}Sm-^{142}Nd) systems to constrain the early crustal evolution of the Northeastern Superior Province and the oldest section of the Nain Province in Canada. The ~2750 Ma tonalites and trondhjemites from the Superior craton are the youngest rocks to yield deficits in ^{142}Nd (as low as μ^{142}Nd = -15). The low μ^{142}Nd values imply the involvement of a Hadean crustal component in their formation. Combined with long-lived ^{147}Sm-^{143}Nd data and subchrondritic εHf values in zircons from Paleo to Eoarchean rocks from the trondhjemite-tonalite-granodiorite suite (TTG), it suggests that a large section of Archean crust was formed by reworking of much older ~4.3 Ga mafic crust. Recent U-Pb work on TTG from the Saglek-Hebron Gneiss Complex of the Nain Province shows that multiple generations of granitoids have been produced between ~3.9 Ga and ~2.8 Ga. In situ Hf isotopic data on these zircons is consistent with derivation from a juvenile Eoarchean component (εHf =+3 at 3.88 Ga) followed by crustal reworking of the oldest TTG to form the younger granitoids, as supported by a εHf vs time trend corresponding to a ^{176}Lu/^{177}Hf ratio of ~0.01. This suggests that no Hadean crustal precursor was involved in the formation on this part of the Nain Province. The high-Mg composition of some Paleoarchean tonalites is however more consistent with a mafic precursor. Assuming a ^{176}Lu/^{177}Hf ratio of ~0.02 for such mafic protolith, εHf values of -2 at 3.6 Ga, would require derivation from a Hadean precursor. Ongoing ^{142}Nd analyses on these TTG will help to determine if, as it is observed in the Superior craton, reworking of Hadean crust was also involved in the formation of the Nain Province.