Effects of subduction-related melt extraction on Iapetus Ocean mantle

B. O'DRISCOLL[1]*, R.J. WALKER[2], J.M.D. DAY[3] AND J.S. DALY[4]

[1]School of Physical and Geographical Sciences, Keele University, Keele, UK (*correspondence: b.o'driscoll@keele.ac.uk)
[2]Department of Geology, University of Maryland, College Park, MD, USA
[3]Geosciences Research Division, Scripps Institution of Oceanography, La Jolla, CA, USA
[4]UCD School of Geological Sciences, University College Dublin, Dublin, Ireland

Ophiolites enable assessment of the causes and length-scales of mantle compositional heterogeneity because field-based observations can be coupled with geochemical investigations of upper mantle lithologies resolved relative to the petrological Moho. The ~497 Ma Leka Ophiolite (Norway) comprises a section of early-Palaeozoic (Iapetus) oceanic lithosphere with well-exposed mantle and lower crustal sections and remarkably low degrees of serpentinisation (≥20%). The Leka upper mantle section is heterogeneous at the cm-to-m scales, manifested by abundant dunite lenses and sheets in harzburgitic host-rock, especially within ~500 m below the Moho. Abundant chromitite (≥60 vol.% Cr-spinel) and pyroxenite lenses and layers also occur in the uppermost 200-300 m of the mantle section.

The array of mantle lithologies on Leka is considered to have developed during fluid-assisted melt extraction in a supra-subduction zone (SSZ), offering an opportunity to interrogate the nature of Os isotope and HSE abundance heterogeneities developed in such rocks and circumventing, at least in part, the effects of serpentinisation. Initial results show that the Os isotope compositions of the Leka peridotites are quite consistent, with a range of γOs_{497Ma} of -1.57 to +4.43, and Os concentrations ranging from 1.4-24.8 ng g^{-1} Os, for eleven harzburgites and dunites. Given the similarity between Leka peridotites and estimates of Os isotopic composition and HSE abundances in the oceanic mantle (e.g., from abyssal peridotites), we see scant evidence for modification of these elements by SSZ fluid or melt-rock interactions. Comparison of the Leka data with mantle peridotite data from the (~492 Ma) Iapetan ophiolite exposed on the Shetland Islands (Scotland) [1] implies that on ocean-basin scales, SSZ fluid/melt interactions may only play a limited role in processing the HSE in already strongly depleted mantle.

[1] O'Driscoll *et al*. (2012) *EPSL* **333-334**, 226-237.

Earth's Hadean crust: Insights from the Nuvvuagittuq Greenstone belt

J. O'NEIL[1], R.W. CARLSON [2] AND M. BOYET [3]

[1] Depart. of Earth Sciences, Univ. of Ottawa, Ottawa, Canada
[2] Carnegie Institution of Washington, Washington DC, USA
[3] Laboratoire Magmas et Volcans, Clermont-Ferrand, France

The Hadean Eon is still poorly understood due to the scarcity of preserved samples. Most of what we know of early crustal evolution comes from the Hadean Jack Hills detrital zircons. Despite the fact that their host rock has been destroyed, the isotopic composition of these zircons points to a basaltic protocrust reworked to form multiple generations of TTG-like crust. With a minimum age of 3.8 Ga, the Nuvvuagittuq Greenstone Belt (NGB), represents an ideal terrain to investigate early Earth's crustal evolution. Rocks from the NGB show considerable variability in $^{142}Nd/^{144}Nd$ ($\mu^{142}Nd$ = +8 to -18) that can only be produced during the Hadean. The correlation observed between the $^{142}Nd/^{144}Nd$ and the Sm/Nd ratios of the dominant mafic lithology called the Ujaraaluk unit is consistent with their formation between 4.3 and 4.4 Ga. This age, however, has been challenged because the oldest U-Pb ages on zircons from the NGB felsic rocks are ~3.8 Ga. An alternative model suggests mixing of mantle-derived melts in the Eoarchean with some hypothesized reservoir enriched in incompatible elements during the Hadean to produce the ^{142}Nd deficits of the NGB rocks. This conclusion, however, is not supported by our latest ^{176}Lu-^{176}Hf / ^{142}Nd data. Here we present a summary of the geology and geochronology of the NGB and discuss the alternative models of Eoarchean or Hadean age for the belt. We used long-lived and short-lived isotopic systematics ($^{147,146}Sm$-$^{143,142}Nd$, ^{176}Lu-^{176}Hf) for all NGB lithologies including mafic and felsic rocks as well as combined Pb-Hf in zircons to understand the evolution of the NGB and the formation of Earth's early crust. Our data suggest that the protolith of the Ujaraaluk unit includes both tholeiitic and calc-alkalic mafic volcanic rocks originally erupted in the Hadean. Reworking of this basaltic precursor over several hundred million years in the Eoarchean produced TTG-type magmatism. If the Ujaraaluk unit is interpreted as Eoarchean, then one must hypothesize the existence of a Hadean enriched component that has identical compositional and isotopic characteristics to the Ujaraaluk as the source of the low ^{142}Nd in both some Ujaraaluk and the NGB TTG suite. We suggest instead that the Ujaraaluk unit is a Hadean mafic protocrust and may therefore represent the first crust to stabilize after the moon-forming impact and be the closest analogue to the primordial crustal source of the Jack Hills zircons.

www.minersoc.org
DOI:10.1180/minmag.2013.077.5.15