Geochemistry and Nd isotopic characteristics of Earth's primitive crust and Hadean mantle

J. O'NEIL[1], H. RIZO[2], M. BOYET[3] AND R. W. CARLSON[4]

[1]Depart. of Earth Sciences, Univ. of Ottawa, Ottawa, Canada
[2]Depart. des sciences de la Terre et de l'atmosphère, UQAM, Montreal, Canada
[3]Laboratoire Magmas et Volcans, Clermont-Ferrand, France
[4]Carnegie Institution for Science, Washington DC, USA

The Isua supracrustal belt (ISB) and the Nuvvuagittuq greenstone belt (NGB) are among the oldest suites of mafic volcanic rocks preserved on Earth and are the best candidates for representing its early crust. Despite the possible 500 Ma age difference between the belts, their mantle derived rocks show stricking compositional similarities, with features ressembling rocks formed in modern suprasubduction environments. Numerous high precision ^{142}Nd data have now been produced for many lithologies from both belts in order to constrain their early crust-mantle history. Igneous fractionation events occuring in the Hadean, such as crust formation or mantle differentiation, will lead to deviation in ^{142}Nd from the modern Nd standard. Mantle-derived rocks from both the ISB and NGB belts exhibit anomalous ^{142}Nd isotopic compositions, but the datasets for the two belts are significantly different, suggesting a different origin for their ^{142}Nd anomalies. All ISB samples have positive μ^{142}Nd values, including the newly analyzed Garbenschiefer boninitic amphibolites (mean of +12.7 ppm). μ^{142}Nd values for the ISB range mostly between +8 and +15 ppm, with a near Gaussian distribution around the mean μ^{142}Nd value of +11.6. Given typical precisions of ±5 ppm on ^{142}Nd/^{144}Nd measurements, this distribution could simply reflect analytical error about a single μ^{142}Nd. In contrast, the NGB have μ^{142}Nd values ranging from +8 to -18 ppm with a mean of -5.8. The ISB mantle-derived samples show little to no correlation between their ^{142}Nd/^{144}Nd and Sm/Nd ratios consistent with their formation in the Eoarchean via melting of a Hadean depleted mantle. In contrast, all mantle-derived NGB samples display a strong ^{142}Nd/^{144}Nd vs. Sm/Nd correlation, consistent with their crystallization in the Hadean. Both the ISB and NGB mantle-derived rocks have similar ^{142}Nd at the age of formation of the NGB (~4.3 Ga) suggesting the derivation of ISB and NGB rocks from a common early formed mantle source which appears to have been an important source component involved in the formation of the primitive crust during most of the Hadean and Eoarchean eons, from ~4.3 to 3.7 Ga.