^{142}Nd evidence for an enriched Hadean reservoir in the root of the Bastar craton (India)

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Variations in the ^{142}Nd/^{144}Nd composition of terrestrial rocks are a sensitive monitor of major silicate differentiation events on Earth that occurred during the Hadean. For example, the ^{142}Nd/^{144}Nd excesses (relative to the La Jolla Nd standard) in some Archaean (3.6-3.8 Ga) rocks from Greenland (e.g., [1–3]) indicate the existence of an early, incompatible element depleted mantle. We have measured ^{142}Nd/^{144}Nd deficits (relative to the La Jolla Nd std.) in some Mesoproterozoic (~1.48 Ga) lithospheric mantle-derived alkaline rocks [4] from the Khariar nepheline syenite complex in southeastern India. The ^{142}Nd/^{144}Nd isotopic signature of these alkaline rocks thus provides evidence for a reservoir that was relatively enriched in incompatible elements, and formed early in Earth's history (>4.2 Ga). This reservoir—or at least some of its Nd isotope signature—persisted for ≥2.7 Gyr without being mixed away into the ambient mantle. Its survival may have been facilitated by long-term storage within the lithospheric root of the Bastar craton.

We propose that the ^{142}Nd/^{144}Nd deficit observed in these Mesoproterozoic alkaline rocks may be the diluted signature of a relatively enriched, Hadean reservoir. (Whereas the Khariar ^{142}Nd signatures suggest early enrichement relative to the prevalent terrestrial Nd, i.e., La Jolla, they would still represent an early depeletion relative to the chondritic reference.) Interestingly, no ^{142}Nd evidence of the early depleted mantle has been observed in <3.6 Ga juvenile rocks, possibly implying that such domains had been effectively mixed back into the convecting mantle by that time. Some early, incompatible element enriched components have apparently escaped this fate. Thus, the mantle sampled by magmatism since 3.6 Ga may be biased towards a depleted composition that would be balanced by more enriched reservoirs existing as Hadean crust [5] or as enriched mantle components sequestered within old cratonic roots or perhaps in the D'' layer of the lower mantle.

[1] Caro *et al.* (2006) *GCA* **70**, 164–191. [2] Boyet & Carlson (2006) *EPSL* **250**, 254–268. [3] Bennett *et al.* (2007) *Science* 318, 1907-1910. [4] Upadhyay et al. (2006) *CMP* **151**, 434–456. [5] O' Neil *et al.* (2008) *Science* **321**, 1828-1831.

Groundwater nanoparticles in the far-field at the Nevada Test Site

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Colloid-like nanoparticles in groundwater have been shown to facilitate migration of several radionuclides: ^{239,240}Pu, ^{137}Cs, ^{152,154,155}Eu, and ^{60}Co [1]. However, the exact type of nanoparticle and the speciation of the associated radionuclides has remained unknown. We have investigated nanoparticles sampled from the far-field at the Nevada Test Site, Nevada, utilizing advanced electron microscopy techniques, including high-angle annular dark-field scanning TEM (HAADF-STEM). Fissiogenic elements: Cs, rare earth elements (REE), activation elements: Co; and actinides: U and Th, were detected. Cesium is associated with U-forming cesium uranate with a Cs/U atomic ratio of ~0.12 (Fig. 1). Light REEs and Th are associated with phosphates, silicates, or apatite. Cobalt occurs as a metallic aggregate, associated with Cr, Fe, Ni, and ± Mo. Uranyl minerals; Na-boltwoodite and oxide hydrates are also present as colloids. Because of these chemical associations with nanoscale particles, in the size range <100 nm, these particles may facilitate transport, and a variety of trace nano-scale phases may be responsible for the migration of fissiogenic and actinide elements in groundwater. In order to accurately model the transport of these contaminants, predictive transport models should include consideration of nanoparticle-facilitated transport.

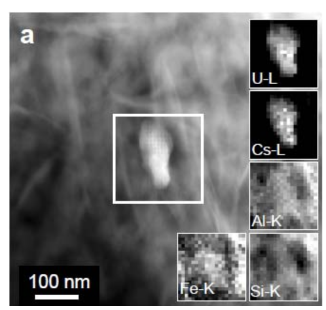

Figure 1: HAADF-STEM of Cs-U-phase with the elemental maps.

[1] Kersting *et al.* (1999) *Nature* **397**, 56-59.