

Highly depleted mantle sources of ~3.75 Ga mafic rocks in the early Archean from Isua, SW-Greenland

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The Isua supracrustal belt (ISB) is the best preserved record of mafic and ultramafic early Archean (3.7–3.8 Ga) rocks on Earth. The central part of the ISB consists of high Mg metabasalts, also referred as Garbenschiefer unit. This unit is thought to represent Archean analogues of modern boninites [1]. The unit has been metamorphosed up to amphibolite facies conditions, where the ¹⁴⁷Sm–¹⁴⁴Nd isotope system was partly reset [2]. A possible disturbance of the ¹⁷⁶Lu/¹⁷⁶Hf isotope system in Isua rocks has also been strongly debated in the past. In this study, we used a well characterised suite of samples from the Garbenschiefer unit [2, 3] to determine the range of initial $\epsilon_{\text{Hf}}(t)$ values. An age of 3.75 Ga, inferred from [4], was assumed for the calculation of the initial Hf values.

To evaluate different sample digestion techniques, the samples were digested employing both Li₂B₄O₇ flux fusion and HF-HNO₃-HClO₄ digestion in Parr bombs at 180°C for 4–5 days, respectively. Accurate Lu-Hf values for Garbenschiefer metabasalts could only be obtained with the flux fusion techniques that resulted in initial $\epsilon_{\text{Hf}}(t)$ values ranging from +3.8 to +7.9. Bomb digestion is not a suitable tool to dissolve all phases, yielding much more unradiogenic initial Hf isotope ratios in most cases.

Initial $\epsilon_{\text{Hf}}(t)$ values of up to +7.9 and high ¹⁷⁶Lu/¹⁷⁷Hf of ~0.3 to ~0.6 for the Garbenschiefer metabasalts require a highly depleted mantle source with a long term depletion history in the garnet stability field. Tholeiitic metabasalts from the same unit were generated from a different mantle source, displaying near chondritic initial $\epsilon_{\text{Hf}}(t)$ values (-0.6 to +0.6) and lower Lu/Hf [4], thus reflecting strongly heterogeneous mantle sources for early Archean rocks from Greenland. Collectively, our results provide the first firm Hf isotope evidence from mafic Archean rocks for the persistence of depleted Hadean mantle reservoirs into the early Archean.

[1] Polat, A. *et al.* (2002) *Chem. Geol.* **184**, 231–254.
[2] Gruau *et al.* (1996) *Chem. Geol.* **133**, 225–240. [3] Frei, R. *et al.* (2004) *GCA* **68**, 1645–1660. [4] Polat, A. *et al.* (2000) *GCA* **67**, 441–457.

Mantle myths, mantle reservoirs, and databases

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Geochemical databases are changing the way geochemists do geochemistry, and they allow scientists from other disciplines to look at “our” data with fresh eyes. Long-cherished notions of physically distinct geochemical mantle reservoirs are being replaced by statistical treatments. The well-entrenched homogeneous “depleted MORB mantle” reservoir is a myth created by eliminating enriched samples from the total population. MORB samples are not isotopically uniform but have variabilities only slightly lower than OIB. The reduced variability may be caused by mixing in magma chambers rather than greater source heterogeneity. Average incompatible-element concentrations in global MORB are two to five times higher than published estimates. This fundamentally changes 30-year-old geochemical mass balance estimates of the mantle. OIBs are fundamentally similar to MORBs but are isotopically shifted, on average, to more “enriched” values. Mantle geochemistry is now fully consistent with dynamic models of “whole-mantle” circulation, with the likely exception of a relatively small, reservoir probably hidden near the base of the mantle.

Databases also harbour new risks to the geochemical community. Data known to insiders to be severely flawed (due to poor sample or analytical quality, errors in published data tables, or errors during data entry) are not easily identified by, say, a geodynamicist. This should encourage the geochemists to generate expert data sets from the more general database. Other dangers stem from overrepresentation of over-sampled locations and the general, but generally faulty, assumption of random sampling of the Earth.

Among the most important changes triggered by the new databases are the following: (1) Driven by the data base community, the standards required for reporting geochemical data in publications are changing in fundamental ways. Whereas it was common practice, especially in high-profile journals, to treat the data supporting the claims made in the articles published as relatively unimportant technical detail, journal editors now require much more careful geochemical data reporting that includes reporting data in numerical rather than graphical representation, information on sample locations, analytical methods and uncertainty estimates. (2) Given the ever-increasing production rate of geochemical data, comprehensive use of geochemical data without relational databases is, or will soon be, impossible.