6.2.23

^{142}Nd in Deccan Traps and early mantle differentiation

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This study investigates the existance of ^{142}Nd anomalies in rocks derived from deep mantle plume material. The Deccan Flood Basalt Province in western India was formed by the impact of a mantle plume 65 Ma ago. Silica undersaturated basalts from the province carry a high ^{3}He signature [1] confirming their deep mantle origin. If the lower mantle source of the Deccan Traps was modified due to differentiation of deep magma ocean or burial of LREE enriched protocrust during the first 300 Ma of Earth history, it would result in a ^{142}Nd deficit resulting from the decay of short-lived ^{146}Sm ($t_{1/2}$ = 103 Ma).

The analysed samples range from primitive picrites and silica-undersatured high MgO basalts to tholeiitic basalts. The primitive samples have ^{87}Sr/^{86}Sr and ^{143}Nd/^{144}Nd values close to that of primitive endmembers of the Deccan Traps and from Réunion [2], suggesting little crustal contamination. This is further supported by ^{187}Os/^{188}Os ratios of 0.1271-0.1274 for the picrites close to that of the upper mantle.

High precision Nd isotopes analyses were done using the Triton TIMS at Dartmouth College. Data are given in fig.1.

The primitive samples show no ^{142}Nd anomaly, whereas some of the more evolved samples show a hint of a negative ^{142}Nd anomaly (Fig.1); this requires further investigation. The absence of anomalies in the primitive samples suggests that the lower mantle component does not carry a ^{142}Nd anomaly. If the more evolved/contaminated lavas do have a negative ^{142}Nd anomaly, it would indicate contributions from early buried protocrust.

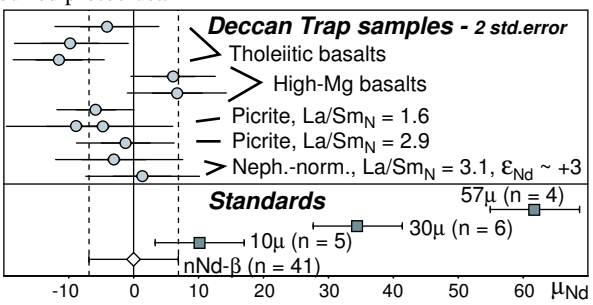

Fig.1: μ_{Nd} values giving ppm deviation from nNd-β standard. External reproducibility of nNd-β = ± 6.9 ppm (2σ).

References

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6.2.24

High Hf- and Nd-Initials: Early differentiation in crust and mantle or metamorphic overprint?

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Reasons for high (supra-DM) Hf(WR)- and Nd(WR)-initials of early Archaean crustal rocks if corrected to their respective U/Pb zircon ages are highly debated. Two possible explanations are offered by several authors: (i) an early and extreme differentiation of BSE into crust and mantle with following rehomogenisation of the early DM reservoir or (ii) open-system behaviour of the Sm-Nd and Lu-Hf isotope systems during metamorphism leading to a de-coupling of the Hf- and Nd-WR information of the U/Pb zircon age and thus overcorrection.

We have analysed samples from the two igneous basement suites (TTG and GGM) of Barberton Mountain Land (Kaapvaal craton, South Africa) that were previously interpreted as directly mantle-derived with only lesser amounts of crustal assimilation [1]. Thus, the first prerequisite for back-correction is fulfilled (derivation of the modelled DM reservoir) and the second prerequisite can be tested (undisturbed mother/daughter ratio). U/Pb zircon ages of the two igneous suites are 3.5 to 3.23Ga for TTG and 3.2 to 3.1Ga for GGM, respectively. Recently, an amphibolite-facies metamorphism was recognised at 3.23Ga and thus, only TTG are overprinted. This situation offers the perfect possibility to check for open-system-behaviour of the Sm-Nd and Lu-Hf isotope systems. Indeed, only the TTG show high Hf- and Nd-initials at their respective U/Pb zircon ages. We analysed two TTG plutons on a mineral basis and results prove reaction to the mentioned metamorphic overprint. Lu-Hf and Sm-Nd mineral isochrons will be presented that agree well with the externally derived age of metamorphism. In addition, Ar-Ar amphibole data of these two plutons show age spectra that are clearly different to the respective U/Pb zircon ages and can be related to the metamorphism.

In conclusion, strong evidence is given for a de-coupling of the age informations saved in zircons and 'zircon-free WR'. Calculation of Hf- and Nd-WR signatures towards U/Pb zircon ages can therefore be – at least in the case of Barberton Mountain Land – interpreted as overcorrection and thus, argumentation for an extreme and early differentiation in crust and mantle is not supported by this study.

References

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