HAFNIUM-NEODYMIUM ISOTOPES ON EARLY DECCAN FLOOD BASALTS: IMPLICATIONS FOR THE COMPOSITION AND STRUCTURE OF A STARTING PLUME

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Introduction

The Deccan Traps volcanic province (western India) is one of the largest (>500,000 km^3 on land) continental flood basalt provinces. Recent data suggests that up to 90% of the Deccan Traps volume erupted within a short (<500,000-year) interval 65 m.y. ago [1], possibly linking this massive volcanism to the mass extinctions recorded at the K/T boundary. This immense volcanic eruption is attributed to the initial eruption of the Reunion plume beneath the north-drifting Indian continent. The Reunion plume is still active today and has produced a 5800 km volcanic track, similar to that of the Hawaiian chain [2]. Here we present the first Hf-Nd isotope study on alkali basalts from Kutch area, NW of the Western Ghats, the type-locality of the Deccan province. The Kutch basalts are thought to be the initial pulse of the Deccan volcanism [1] and can thus constrain the mechanisms of the initial plume eruption and the composition of the plume.

Results and Discussion

Isotope analyses were performed at the Geochemistry Division, NHMFL, using a Finnigan MAT-262 TIMS (for Nd, Sr) and the ISOLAB (a modified VG 54 MS with Hot-SIMS) for Hf isotopes. The Sr-Nd isotope variability (not shown) in the Kutch region mimics that of other Deccan localities [3 and references therein]. Three endmember compositions are recognized: a depleted endmember with relatively radiogenic $^{143}Nd/^{144}Nd$ ratios, an enriched endmember with very radiogenic $^{87}Sr/^{86}Sr$ ratios, thought to reflect extensive crustal contamination, and component with low $^{143}Nd/^{144}Nd$ for a given $^{87}Sr/^{86}Sr$ ratio, explained by involvement of the subcontinental lithospheric mantle in the volcanism. The Hf-Nd data from Kutch (Fig.1) show a large variability. The samples with the most radiogenic Hf-Nd isotopes (i.e. minimum crustal contamination) have more radiogenic compositions than the present-day Reunion plume represented by lavas from Reunion and Mauritius. In fact, the Kutch lavas trend towards the Indian MORB compositions (i.e. high Hf for a given Nd), which are distinct in Nd-Hf space than the Atlantic and Pacific MORB (Fig. 1). The data suggests that during the eruption of the Deccan flood basalts, at least in the Kutch region, an Indian MORB-type mantle was also involved in the melting event. In the context of plume dynamics, this can be explained by entrainment of the starting plume head by ambient mantle [4], of Indian MORB affinity. After the end of the flood volcanism, the plume tail remains relatively isolated from the upper mantle and the relatively "pure" plume signature is now recognized in the Reunion and Mauritius lavas.

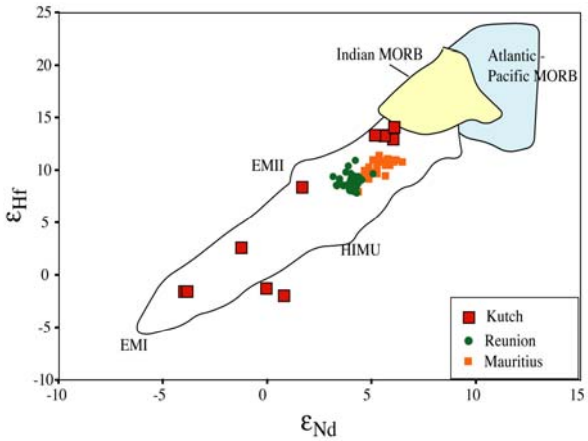

Fig. 1. Hf-Nd isotope compositions of the Kutch alkali basalts, compared with recent lavas from Reunion and Mauritius (A. Pietruszka, unpub., D. Bosch unpub.). The Kutch lavas have more radiogenic Nd and Hf isotopes than the Reunion plume lavas, and trend towards the Indian MORB compositions.

Conclusions

Hf-Nd isotope data from the Kutch basalts suggests the involvement of Indian MORB-type mantle, distinct from the Reunion plume, during the Deccan Traps volcanism. The data supports geophysical models [4] that predict entrainment at the head of a starting thermal plume by cooler ambient mantle, followed by limited subsequent contamination of the trailing plume tail.

References

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