Origins of ^{142}Nd heterogeneity in Deccan flood basalts

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Ocean islands fueled by mantle plumes have been the recent focus of studies characterizing the remnants of Hadean geochemical signatures in the ^{146}Sm-^{142}Nd and ^{182}Hf-^{182}W systems. In contrast, there are relatively few data for corresponding continental flood basalt (CFB) provinces. In part, this is because interpretation of CFB isotopic signatures requires careful consideration of the effects of lithospheric and crustal assimilation on measured isotopic compositions. To evaluate this effect in more detail, we present new ^{142}Nd data for a diverse suite of Deccan Traps basalts that span nearly the complete subaerial extent of Deccan flows. Geochemical analyses of genetically linked ocean island basalts (OIB) from Réunion Island indicate that the Réunion hotspot parental magma contains high abundances of Nd, meaning that Deccan Traps lavas may offer an opportunity to partly circumvent the effects of crustal assimilation on ^{142}Nd.

Two studied samples display μ^{142}Nd compositions (the ^{142}Nd/^{144}Nd composition of a sample relative to a laboratory standard) of +12.9 ±1.6 (2σ s.d., n = 3) and +7.7 ±3.0 (2σ s.e., n = 1), which are statistically resolved from the JNdi terrestrial standard. Both samples come from more northerly exposures of Deccan flows, where pre-existing and Deccan-synchronous rift zones locally thinned the continental crust. In contrast, samples from more southerly Deccan flows are not resolved from the terrestrial standard, and overlie crust that is 30-40 km thick. Moreover, northern and southern Deccan flows overlie two distinct cratons, which may have distinct ages and μ^{142}Nd compositions that give rise to distinct patterns of crustal assimilation for short-lived radiogenic isotopes like ^{142}Nd. Both cratons have as yet unknown μ^{142}Nd signatures.

Our data reveal that there exists potential for discerning information about the Hadean heritage of plume heads through CFB. Recent geodynamical modeling has indicated that plume heads may carry distinct Hadean geochemical signatures compared to plume tails, and future data collection may permit more detailed appraisal of whether geologically young CFB can be a resource for studying the early Earth.