High-precision Nd isotope and HFSE analysis of Deccan Traps weathering profiles

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Accurately quantifying the flux of elements from landmasses during pedogenesis necessitates knowledge of the parent rock chemistry and some control on whether allochthonous materials (e.g., dust) have beem added to the profile during exposure. This is important, for instance, in calculating weathering rates from U-series isotopes in young profiles or interpreting stable isotope depth signatures. The Deccan Traps provide an ideal natural laboratory for studying chemical weathering due to the thick succession of mafic flows which have been weathered to varying degrees on different time scales. In addition, the isotopic and elemental composition of the basalt parent rock contrasts significantly with most potential dust sources (e.g., Archean-Proterozoic crust of the Dravidian Shield).

Deeply weathered laterite of the Deccan Traps has experienced significant accumulation of aeolian material during its long exposure history. For example, in a full laterite profile near Bidar, an upward increase in Th concentration and accompanying decrease in the Nb/Th ratio is evident from the base to top. If Nb is assumed to be immobile during pedogenesis and least affected by dust addition, Th is enriched up to 400% relative to the parent rock in the most contaminated samples. Variations in the Nb/Th ratio are well correlated with the $^{143}Nd/^{144}Nd$ ratio, implicating the source of the contaminant as being incompatible element enriched and less radiogenic than the Deccan basalt.

Near Chhindwara, a sub-Recent weathering profile is exposed which spans across two identifiable basalt flows. The individual flows can be fingerprinted with variations in their HFSE composition, highlighting another important consideration in mass balance calculations of a weathering profile. Even more interesting, however, are the uppermost samples of the lower exposed flow with alkali element, HFSE ratios, and subtly less radiogenic Nd isotope values which again suggest contamination with an allochthonous component. This is interpreted to represent the entrainment of sediment in the lava flow top during emplacement or the accumulation of dust during post-eruption volcanic quiescence prior to the emplacement of the overlying flow.

U-Pb dating vs. Sr isotope chemostratigraphy on Neoproterozoic carbonates: Shedding light on blind dating?

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Sr isotope ratios of carbonate rocks have been extensively used for global correlations especially on Precambrian rocks due to lack of fossils and scarcity of dating targets to constrain their depositional ages. This “blind dating” procedure has been questioned before but it is still commonly used. Here we present a case study on carbonates from the basal units of the Bambuí Group (central Brazil) where Sr, C, and O chemostratigraphy was combined with U-Pb ages from detrital zircons recovered from pelitic intercalations. Our results show a strong incompatibility between $^{87}Sr/^{86}Sr$ ratios and the detrital zircons record.

The Bambuí Group is composed of a carbonatic-pelitic sucession which overlies a glacial diamictite (Jequitaí Fm.) correlated to the Sturtian or Marinoan ice-ages. U-Pb ages from detrital zircons from the diamictite sets the maximum depositional age at 875 Ma. The cap carbonate that overlies this diamictite has $\delta^{13}C$ negative values and was dated at 740 ±22 Ma, indicating a Sturtian age. Limestones and dolostones overlying the cap carbonate show $\delta^{13}C$ values around 0 ‰. Upsection, carbonates are organic-rich limestones displaying highly positive $\delta^{13}C$ values. All carbonates, including those overlying the diamitite, show $^{87}Sr/^{86}Sr$ ratios between 0.7074 to 0.7076. These ratios are compatible with depositional ages as old as 650 Ma according to the global Sr isotope evolution curves available in the literature. However, detrital zircons yielded U-Pb ages as young as 540 Ma, pointing to depositional ages close to the Precambrian-Cambrian boundary or even younger, when more radiogenic Sr isotopes ratios (ca. 0.7085) are expected. This may result from a restricted sea context for the Bambuí carbonate platform; consequently their Sr isotope ratios do not correspond to that of contemporaneous ocens. Several lines of evidence suggest this is not an unusual scenario for Neoproterozoic carbonate platforms. Our work shows that worldwide correlations based only on Sr isotopes must be considered with caution.

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