Elemental geochemistry of river sediments from the Deccan Traps, India: Implications to sources of elements and their mobility during basalt–water interaction

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Abstract

The abundances of several major (Na, Ca, Mg, K, Al, Ti, Fe) and minor elements (Sr, Ba, Mn, P, V, Cr, Ni, Cu and Zn) have been measured in twenty-eight sediment samples from seventeen rivers belonging to the Krishna headwaters and west flowing Western Ghat rivers, all of which drain the Deccan Trap basalts. These results, particularly those of Na, Ca, Mg and Sr coupled with those reported for these elements in the dissolved phase of the same rivers, provide an assessment of their relative mobility and insight into the nature of chemical weathering of Deccan basalts. The sediments are heavily depleted in Na, Ca, Mg and Sr relative to parent basalts (by ∼60%). The abundance ratios of these elements in sediments are roughly the same as those in basalts and in dissolved phases of these rivers [Das, A., Krishnaswami S., Sarin M. M., Pande K., 2005a. Chemical weathering in the Krishna basin and the Western Ghats of the Deccan Traps: Rates of basalt weathering and their controls. Geochim. Cosmochim. Acta 69, 2067–2084], suggesting their near congruent release from basalts to water during chemical weathering, both at present and over the residence time of particles in the basin. K and Ba show limited mobility relative to the above four elements. The abundances of K and Ba are strongly correlated, most likely due to their association in rock forming minerals. Al, Fe and Ti, are generally enriched in the sediments, resulting from the loss of more mobile elements from basalts and their association with secondary minerals formed during weathering. The data also provide evidence for the fractionation of Fe and Al during chemical weathering and erosion. Fe and Ti exhibit significant correlation, attributable either to their co-occurrence in weathering resistant minerals and/or due to scavenging of Ti by Fe oxy-hydroxides formed during weathering of basalts. The abundance of minor elements (Mn, P, V, Cr, Ni, Cu and Zn) and their ratios with Al show significant scatter, by and large bracketing the range reported for Deccan basalts. The wide and overlapping ranges in the concentration of these elements and their ratios relative to Al, between sediments and basalts place severe constraints in assessing their mobility during weathering and erosion, and in judging the role of anthropogenic sources in contributing to their abundances. Among the minor elements, there is a hint that Zn concentration may have been influenced by anthropogenic inputs. Mn, V and Ni, analogous to Ti, show significant correlation with Fe, either due to their association with Fe–Ti minerals or their sequestration by Fe oxy-hydroxides. The mobility of elements during weathering and erosion of Deccan basalts follows the trend (Na ≈ Ca ≥ Mg ≥ Sr) > (K ≥ Ba) > (Al ≥ Fe ≥ Ti).

There is considerable spatial variability in the intensity of chemical weathering of Deccan basalts. The CIA (Chemical Index of Alteration) values for the sediment range between 42 and 92, compared to ∼37 for the Deccan basalts. The lower CIA values are in sediments richer in CaCO3. This may be a result of semi-arid climate of the region which facilitate CaCO3 precipitation and restrict

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