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Geochemical cycling of rhenium (Re), molybdenum (Mo) and vanadium (V) during basalt weathering

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Concentrations of redox-sensitive elements and their ratios in marine sediments are utilized as tracers of paleo-redox conditions. Additionally, dissolved Re concentrations in rivers serve as as a proxy for weathering and oxidation of petrogenic carbon. The accuracy and reliability of these proxies require a deeper understanding of the behaviour of redox-sensitive elements during weathering and transport.

We investigated the mobility and geochemical cycling of Re, Mo and V in two basaltic weathering profiles (Dalahi and Pakuria), which are located just a few tens of kilometres apart and developed over the Rajmahal Volcanics Series in India. The Re/Mo ratios of saprolites are typically lower than the basaltic values and decrease with increasing chemical index of alteration (CIA) in both profiles. The Re/V ratios also decrease from the basaltic values as CIA increases in the Dalahi Profile, whereas in the Pakuria Proifle, Re/V ratios vary minimally with CIA. In contrast, V/Mo ratios of saprolites are higher than the basaltic values in the Dalahi Profile and do not demonstrate any variation trend with CIA. In the Pakuria Profile, however, V/Mo ratios decrease as CIA increases. The exchangeable phases in both profiles account for only up to 1% of the bulk V and Mo. In the Dalahi Profile, the largest fractions of Mo and V are observed in the clay minerals and these fractions generally increase with CIA. In contrast, in the Pakuria Profile, the organic phases account for up to ~12% of bulk V, with the organic V fractions displaying a positive correlation with with CIA. However, no clear preference for Mo is observed among the exchangeable, oxyhydroxide, and clay mineral phases.

Our investigation reveals the ratios in which these elements are released into the river waters will be a function of, among other parameters, the relative abundance of various phases (oxyhydroxides, organic and clay minerals) in the weathering profiles as well as the weathering intensity. Furthermore, the concentration ratios of these elements in riverine fluxes to the oceans would be different during episodes of intense weathering on the land.