The behaviour of chromium isotopes during the oxidative weathering of ultramafic rocks

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The chromium isotope system has been proven to be a redox-sensitve proxy in ancient and modern environmental studies (e.g. [1], [2]). In this study we investigated Cr isotope fractionation during soil formation from Archean (3.1-3.3 Ga) ultramafic rocks, intruded into metamorphic rocks of the Iron Ore Group in the southern Singhbhum Craton (Orissa, India)[3]. A modern weathering profile was logged in an active open cast chromite mine (Sukinda valley).

The Cr isotope data of samples from the weathering profile are fractionaed. While the least weathered horizons at the base of the profile reflect mantle inventory values (-0.124±0.101‰ [4]), the δ^{53}Cr values from the more weathered upper part of the profile are as low as -1.28±0.08‰, indicative of the loss of an isotopically heavy (^{53}Cr enriched) fraction to the runoff. Mass-balance calculations show that the highly weathered horizons are characterised by a Cr loss of up to 74 %.

These data are consistent with the findings of Crowe *et al.* [2] who also studied the effects of weathering of ultramafic rocks in Indonesia on the Cr isotope system. These authors demonstrate that oxidation of Cr(III) to Cr(VI) in the soils is accompanied by isotopic shifts. Thereby the Cr(VI) lost to runoff is enriched in the heavier ^{53}Cr, while the lighter ^{52}Cr preferentially remains in the residual Cr(III) pool of the soils. We measured high (up to 1.2 ppm) concentrations of total dissolved Cr in the mine drainage waters. Isotopically the mine waters are slightly heavier than mantle inventory, indicating input of ^{53}Cr enriched Cr(VI) during continious rock weathering. δ^{53}Cr values in the main river (Damsal Nala) which discharges its dissolved loads into the Indian Ocean are positivley fractionated with values up to 0.7‰.

[1] Ellis *et al* (2002) *Science* **295**, 2060-2062. [2] Crowe *et al* (submitted for publication) *EPSL*. [3] Mondal *et al* (2006) *Precambrian Res.* **148**, 45-66. [4] Schoenberg *et al* (2008) *Chem. Geol.* **249**, 294-306.