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Fate and behavior of Chromium in mining-impacted paddy soils

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Our goal is to determine to what extent Cr isotopic composition can help to understand Cr behavior and fate when released from mining areas to the surrounding paddy soils. We focus on the mining area of the Sukinda Valley (Orissa, India) which comprises ~98% of India's chromium ore reserve. The activity produces huge amounts of tailings. Tailings are non-economically viable materials stored outdoor. They are characterized by 80 and 15wt% of hematite and chromite respectively. A selection of 3 uncontaminated paddy soils was used as reference. They are composed of 74 and 55wt% of silica and hematite, respectively, and less than 2wt% of chromite. Contaminated paddy soils picked up in the surrounding area of tailings displayed the same mineralogy with a chromite content that reaches up to 8wt%.

Batch experiments were performed to determine the leachability of chromium bearing phases from both the tailings and the reference soils. These later contain light Cr (δ^{53}Cr = -1.21 +/- 0.09‰), but the corresponding leachates hardly reached 30 µg/L of Cr that is mostly trivalent and globally enriched in light isotopes (δ^{53}Cr up to -0.8+/-0.07 ‰). Up to 2000 µg/L of Cr was leached from tailings as Cr(VI) after 18 hours. This Cr displays enrichment in heavy isotopes, with a δ^{53}Cr values up to 0.13+/-0.09‰, whereas the bulk tailing is light (δ^{53}Cr = -0.47+/-0.04‰). In the contaminated area downstream the tailings, the leachates of the two contaminated soils have opposite patterns. Bulk soils are both enriched in heavy isotopes (δ^{53}Cr = 1.84+/-0.43 and 1.30+/-0.09‰ respectively). The first one releases Cr(VI) that is anomalously enriched in light isotopes (δ^{53}Cr = -1.42+/-0.08‰). This may be explained by the Cr reduction in the presence of dissolved Fe(II). While in the second one, Cr is mostly leached as Cr(III) with light δ^{53}Cr signatures (δ^{53}Cr = -1.98+/-0.08‰) compared to the bulk.

The chromium transfer through paddy soils when irrigated with tailing leachate was then mimic using opened-flow columns, to help deciphering the impact of Fe and Mn oxides on Cr speciation and isotopic composition when transfer into the paddy soils from the tailing leachates.