Nickel isotope fractionation during laterite Ni ore smelting and refining: Implications for tracing the sources of Ni in smelter-affected soils

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Abstract

Being able to trace the imprint of anthropogenic activities by metal isotope signatures in natural environments represents a promising area in the research on metallic pollution. The present study aims to evaluate (1) the nickel isotope fractionation associated to the Ni-laterite ore smelting and refining in two metallurgical plants located in the Goiás State, Brazil (Barro Alto and Niquelândia), (2) the potential of Ni isotopes for tracing the natural *vs* anthropogenic Ni in soils. The Ni isotopic composition (δ60Ni) of soils, feeding material, wastes and final product ranges from -0.26 to 0.27 . Feeding material exhibit a large range of δ60Ni values (0.02 to 0.20 , n=7), which can be explained by the diversity of Ni-bearing phases, i.e. phyllosilicates and Fe-oxides. Fly ash δ60Ni values (n=10) are not significantly different from the feeding material ones as well as the final FeNi produced (0.05, n=2). This latter positive value, close to the feeding material one, is expected due to the very high production yield of the factories. However, reduction slags present the heaviest δ60Ni values of all smelter samples, with δ60Ni ranging from 0.11 to 0.27, (n=8).

Soils were also collected near and far from the Niquelândia metallurgical plant, to evaluate the Ni isotopes potential for tracing the natural vs anthropogenic Ni in soils. The Ni isotopic composition of the topsoils ranges from - 0.26 $\pm$ 0.09 to 0.10 $\pm$ 0.05 (n = 24).

This slight but significant enrichment in heavy isotopes during the smelting and refining highlights the potential of Ni isotopes for discerning anthropogenic samples (heavier δ60Ni values) from natural ones (lighter δ60Ni values). However, given the global range of published δ60Ni values associated to natural weathering of ultramafic rocks (from -0.61 to 0.32), the use of Ni isotopes for tracing environmental contamination from smelters will remain challenging.

Keywords: Nickel, isotope, smelting, refining, soil, source

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