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Mercury Isotope Perspectives on Vegetation-Enhanced Nickel Mobilization and Migration During Laterite Formation

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Vegetation is very important to the formation of pedosphere, and it enhances the release of metals from weathered mafic-ultramafic rocks, and facilitates the generation of economically important laterite deposits. Vegetation accumulates mercury (Hg) mainly through foliage uptake of gaseous Hg(0), and therefore vegetation-derived Hg displays negative Δ^{199}Hg values, which enables Hg isotopes as effective proxy to trace the role of vegetation in supergene mineralization. In this study, we conducted mineralogical, elemental, and Hg isotopic analyses of two typical profiles from the Yuanjiang nickel (Ni) laterite deposit in SW China. Both profiles have concurrent negative Δ^{199}Hg peaks (-0.65 to -0.39 ‰) above the Ni-enriched zones, even in the deep saprolite and saprock horizons, implying that (1) the laterite receives a substantial amount of Hg from vegetation; (2) the vegetation-derived materials could penetrate deep in laterite; and (3) vegetation may play a critical role in promoting Ni mobilization during weathering. Vegetation-derived materials, including organic matter, can significantly acidify the surface soils and generate local reducing environments, favoring the formation of mobile Ni (exchangeable, adsorbed and organic-bound Ni) through breakdown of silicate minerals and/or iron (Fe) oxides, and also facilitate the development of preferential flow pathways for vertical Ni leaching. Thus, Ni is depleted in upper vegetation-input zones and enriched in the lower zones through incorporation in Fe oxides and secondary silicate minerals. This work highlights the application of Hg isotopes to trace the influence of vegetation in laterite development, and sheds light on the role of vegetation in the genesis of Ni laterites, which is also important to understand the biogeochemical cycle of Ni during chemical weathering.