Ni enrichment associated with Fe isotope fractionations in Ni laterite deposits, Sulawesi island, Indonesia

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Ni laterite deposits, formed by chemical weathering of ultramafic rocks, are important Ni resources and also potential targets for some critical metals, such as Co and Sc. Ni laterite deposits are well developed in modern and ancient tropical and subtropical regions, such as New Caledonia, Western Australia, and Southeast Asia, including Philippines and Indonesia. Among them, few systematic studies have been carried out for those in Philippines and Indonesia. In this study, we investigated the geochemistry and Fe isotopic compositions of 4 Ni laterite profiles developed on peridotites with different degrees of serpentinization in Soroako area and Pomalaa area, Sulawesi Island, Indonesia, to understand chemical weathering processes of ultramafic rocks involving enrichment of Ni and other critical metals.
The SiO_2 and MgO, major components in the bedrocks, decrease upward through the depth profile at all Hills. Conversely, contents of other elements, such as Fe_2O_3 and Al_2O_3 increase dramatically. The NiO content shows significant enrichment in the upper limonite horizon with highest concentrations of <3.10% at Watulabu and Konde Hills which have peridotite as bedrocks. In contrast, Petea and Willson Hills show the highest NiO contents in saprolite horizons <4.65%, which are higher than those in Watulabu and Konde Hills. The result of elemental transfer calculation of major and minor elements using TiO_2 contents as an immobile element shows that Si and Mg show absolute losses, with up to ~99% losses in the profiles at all the Hills. Thus, Si and Mg are high loss elements during the weathering. The other major elements such as Fe and Al show a middle to high gain in limonite horizon and Ni shows high gain in limonite or saprolite horizon. Highest gain or Ni and Fe in the profile at Petea Hill may indicate that the degree of chemical weathering is extremely high. The measured δ^{56}Fe values show slight variations among the profiles, except for the Petea Hill. At this Hill, whereas limonite horizon tends to show δ^{56}Fe values (-0.07‰) isotopically lighter than that of the bedrock, saprolite horizon show heavier δ^{56}Fe values (+0.03‰). This may suggest that light Fe isotope values may be found in the limonite layer in the profile where chemical weathering is prominent accompanying with high Ni enrichment and secondary migration of Fe.

Keywords: ultramafic rock, weathering, Ni laterite, Fe isotope, critical metal

