Spatio-temporal evolution of laterization: Insights from mineralogical characterization and reactive transport modelling of Zambales nickel laterite deposit, Philippines

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Nickel laterites are products of deep intensive chemical weathering typically formed over partially to heavily serpentinized ultramafic rocks. This deposit is defined by a characteristic mineralogical zonation comprising limonite, predominantly composed of goethite and other iron oxyhydroxides, saprolite, marked by characteristic Mg silicates, and bedrock. While there are extensive studies on the mineralogy and chemistry of laterites worldwide, the temporal and spatial mineralogical development of a typical nickel laterite profile is still poorly constrained. In addition to this, investigations on the laterization process involving only geochemical and mineralogical characterization of laterite profiles address only the spatial variation within the deposit and lack an important aspect on the temporal evolution of this complex and dynamic process. Here we report results of X-ray diffraction (XRD), X-ray fluorescence spectroscopy (XRF), and petrographic analysis, coupled with reactive transport geochemical modelling via the Geochemist's Workbench, of a laterite profile from Sta. Cruz, Zambales. We present a spatio-temporal model of laterization replicating the typical zonation within a laterite profile showing the behaviour of key minerals (e,g, goethite and Mg silicates) over depth and time. Moreover, X-ray diffraction analysis of the goethite (110) peak reveals a downward decrease in the crystallinity of goethite within the limonite that correlates with the downward decrease in Ni content. Present communication will be one of the few studies that will focus on the spatio-temporal evolution of the nickel laterite profile and is an important contribution to the understanding of laterite formation in a tropical region such as the Philippines.