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Ni-Co mineralogy and geochemistry in the Wingellina laterite deposit (Western Australia)

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The Wingellina Ni-Co laterite deposit (Metals X Ltd), located in Western Australia, hosts a resource of 168 Mt of ore at 0.98% Ni and 0.08% Co. The deposit is derived from the weathering of the mafic-ultramafic intrusion of the Giles Complex (Mesoproterozoic), consisting mainly of peridotite and gabbro. The lateritic profile comprehends two ore zones, characterized by the occurrence of oxy-hydroxides (i.e. limonite) and silicates (i.e. saprolite).
The Co grade within the deposit is controlled by the MnO distribution, whose concentration is low in the saprolite zone (up to 0.036 wt% Co and 0.82 wt% MnO). Cobalt and MnO undergo a significant gain at the boundary between the saprolite and the limonite units, wherein they reach the highest concentration (up to 1.23 and 33.87 wt% Co and MnO, respectively). The Ni grade is more variable and is controlled by the geochemical (and mineralogical) evolution of the lateritic profile itself. The high Ni grades in the saprolite (up to 3.33 wt% Ni) occur below the so-called Mg-discontinuity, where the laterite profile has still remarkably high SiO_2 and MgO concentrations (up to 62.87 and 23.14 wt% SiO_2 and MgO, respectively). The transition between the saprolite and the limonite zone is characterized by a decrease in the MgO and SiO_2 contents as well as by a variation in the Ni distribution, which in the upper zone is correlated with MnO and $Fe2O_3$ (Putzolu et al., 2019). In fact, the occurrence of Mn-hydroxides and their mineralogy are the main factors that control at Wingellina the spatial distribution of the highest Co and Ni grades in the limonite unit. The highest Ni and Co grades occur in the so-called lithiophorite-asbolane intermediates, whereas other less abundant Mn-phases (i.e. romanèchite, ernienickelite-jianshuiite and K-birnessite) show lower ore concentrations. The Ni and Co concentration is higher in the late stage Mn-phases, resulting from the leaching of early formed Mn-hydroxides (Putzolu et al., 2018).
Even though the limonite is the best developed zone in the Wingellina deposit, Ni reaches its highest concentration within the saprolite unit (Putzolu et al., 2019), where the mineralogy of the Ni-bearing phyllosilicates is heterogeneous and appears to be controlled by the geochemistry and mineralogy of the parent rock of the laterite. In particular, the dominant Ni-phyllosilicates in the gabbro-derived saprolite are dioctahedral smectites (e.g. montmorillonite), with trioctahedral type occurring as minor phases. The saprolite zone that develops from the ultramafic lithology (likely peridotite) has a more complex mineralogy. In this zone the Ni-bearing phases comprise both smectite clays (as nontronite and saponite) and hydrous Mg(Ni)-silicates (serpentine, chlorite and talc). The hydrothermally formed serpentine is commonly overprinted by Fe-oxy-hydroxides/quartz aggregates, as well as by the dioctahedral and trioctahedral smectites, whose genesis is associated with the lateritization stage.