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Distribution and enrichment of Ni, Sc, Au in the Bavanat Ni-Laterite, Iran

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Nickel-bearing laterites are globally important resources. This study evaluates the origin, lateritization intensity, and elemental behavior of Ni together with scandium, and gold across 3 lateritic profiles developed in the Bavanat Ni-laterites, Iran. Serpentinized harzburgite as the dominant parent rock support a mainly autochthonous (in-situ) development. However, lateritic profile architectures reflect different degrees of post-lateritization reworking: Rostami, Mazayejan and Pirkado represent residual, reversed, and transported profile; respectively. Weathering indices (UMIA, IOL), combined with the pervasive absence of high-degree lateritization minerals (e.g., garnierite, smectite, gibbsite), indicate that the Bavanat system records a relatively low degree of lateritization compared with many global Ni-laterites.

Progressive enrichment of Fe, Al, Cr, Ni, and Co from protolith to oxide horizon is consistent with intense leaching of Si and Mg in the oxidized zone. Rostami exhibits the highest lateritization intensity and strongest Ni enrichment (<1.3 wt.%), that are closely linked to saprolite development and the degree of serpentinization. Ni-rich serpentines in the saprolite are as Ni hosts, where Ni and Fe substitute for Mg. Strong positive correlation between Ni and Fe, implying that Fe cycling exerts first-order control on Ni mobility; dissolution–reprecipitation of Fe-(oxy)hydroxides (goethite), enhanced by microbial reduction and/or organic-ligand processes, likely promotes downward Ni transfer and concentration in saprolite under humid tropical conditions.

Mobilization of Ni and more labile rare earth elements fractions from primary silicates followed by efficient scavenging via co-precipitation with Fe-(oxy)hydroxides. This mechanism is inferred to contribute to Sc enrichment and residual Au concentration in oxide horizons. Sc (<52.4 ppm) tracks Fe–Al behavior, consistent with predominantly residual enrichment, release during pyroxene breakdown, and incorporation into goethite, with possible redistribution during goethite recrystallization. Au precipitation within the Rostami oxide horizon (<8.2 ppb) occurs through Fe^{2+} oxidation, local pH decreases, or exposure to oxygenated waters, resulting in Au immobilization via adsorption onto Fe-(oxy)hydroxides, co-precipitation with goethite and hematite, or direct nucleation as submicrometric native particles. Bavanat laterites demonstrate that geomorphic history and secondary reworking can dominate the final distribution of Ni and critical by-products (Sc, Au) in low-degree laterite systems, with direct implications for exploration targeting and by-product assessment.