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Assessing the Co fertility in laterite systems by means of Multivariate Statistical Analysis: the Santa Fe' (Brazil) and Wingellina (Western Australia) case studies

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Cobalt is one of the most important commodities to drive the transition towards a low-carbon society. Ni-laterite deposits might play a primary role in supporting the future global demand for Co. The Co fertility in laterite systems can be controlled by pre-lateritic and syn- to post-lateritic processes. The former controls the Co speciation in primary phases that can have a variable response to chemical weathering, while syn- to post-lateritic processes have an impact on the stability and the nature of supergene phases. We have investigated the effectiveness of the Co enrichment in the Santa Fe' and Wingellina Ni-laterite deposits through an integrated approach based on the Principal Component Analysis (PCA) on geochemical assays and mineralogical and petrological characteristics of the deposits. The goal of this work was to assess if the nature of the pre-lateritic history of the protoliths could have an impact on Co availability during the supergene process. The Santa Fe' laterite was developed from the alteration of the Santa Fé ultramafic alkaline pluton, while the Wingellina deposit was developed from the weathering of a mafic to ultramafic subalkaline intrusion. The PCA show that at Santa Fe' most of the Co variance is explained by its association with Cr and Mn, which is related to the presence of minor amounts of Co in chromite and ferritchromite. Instead, in the Wingellina ore the Co variance is solely explained by its association with Mn, following the special affinity between Co and Mn-oxy-hydroxides. The different speciation of Co detected in the studied deposit reflects the contrasting pre-lateritic Co deportment during the orthomagmatic and hydrothermal stages experienced by Santa Fe' and Wingellina ultramafic suites. In the Santa Fe' deposit, the Co-Cr association has been promoted by the Co partitioning in chromite during the orthomagmatic stage, and by the Co enrichment in secondary spinels during the hydrothermal stage. At Wingellina the lower Co partition in chromite, with the absence of a hydrothermally-related elements redistribution in spinels, enhanced the Co concentration in ferromagnesian minerals, thus leading to a higher availability of Co during the supergene process.