Cobalt speciation in lateritic deposits - implications for development of novel extraction strategies

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Cobalt is a strategic and critical metal finding applications from rechargeable batteries to superalloys and medical implants. Its high economic importance coupled with a high supply risk led to Co being included on the EU list of critical raw materials. Cobalt is currently recovered as a by-product of other base metal mining, primarily Ni and Cu. With no dedicated processing and extraction technology over 50% of Co is lost to waste. A better understanding of the chemistry and mineralogy of Co resources, its host-phases and the crystal chemical mechanisms of incorporation is needed to develop more efficient extraction and processing techniques. Oxide laterites contain 20-30% of the global Co supply and we are undertaking an atomic scale study of the Co ore minerals in these deposits. Samples from Shevchenko (Kazakhstan), Piauí (Brazil) and Nkamouna (Cameroon) are being studied using bulk chemical and mineralogical methods with spatially resolved electron and μ X-ray fluorescence spectroscopy, μ Raman and μ X-ray absorption spectroscopy (μXAS).

Manganese oxides were identified as the primary Co hosting phase even in samples where they were of low abundance (< 1 wt %, Shevchenko and Piauí). These phases were poorly crystalline, chemically complex and heterogeneous with micro-textural intergrowths of Fe oxides. In the material from Shevchenko and Piauí, Mn oxide grains were more enriched in Ni than Co while grains from Nkamouna contained Co with concentrations twice that of Ni. We classified the primary Mn-oxides as asbolane in the material from Shevchenko, asbolane-lithiophorite at Piauí and lithiophorite at Nkamouna. XAS analysis revealed the Co is incorporated as octahedrally bound Co^{3+} in all of these Mn-oxides. EXAFS analysis shows high structural order around Co which either substitutes for Mn or is present as layers of CoOOH.