Vanadium enrichment in lateritic soils: mineralogical and pedoclimatic controls

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ABSTRACT

Vanadium (V) is considered a critical raw material due to its increasing importance in metallurgy and energy storage technologies. Although its average abundance in the continental crust is relatively high, economically exploitable deposits remain scarce, and the mechanisms responsible for its enrichment are still poorly understood. Lateritic covers, which occupy nearly one-third of the continental land surface, provide valuable natural archives for understanding vanadium concentration processes, as the weathering gradients record its mobilization, oxidation, and sequestration throughout the alteration process.

In this perspective, this study aims to identify the mineralogical and geochemical processes controlling vanadium enrichment in two lateritic profiles developed under contrasting geological and climatic settings: the Syerston profile (Australia), developed on ultramafic rocks, and the Leo Falls profile (Suriname), developed on metamorphic schists. Despite moderate vanadium concentrations in the parent rocks (70–80 mg kg^{-1}), both profiles display significant enrichment, reaching approximately 1,000 mg kg^{-1} at Syerston[1] and up to 3,700 mg kg^{-1} at Leo Falls[2] questioning the origin of such differences. On the basis of preliminary geochemical and mineralogical analyses, we used an X-ray absorption spectroscopy (HERFD-XANES) approach to identify vanadium host phases and track its redox evolution along the weathering profiles.

The results demonstrate that HERFD-XANES V-*K* edge sensitivity to oxidation state and local electronic environment makes it an appropriate tool to follow V speciation along the studied alteration profiles. The coupling between *in situ* spectra obtained through microbeam analyses and acquisition on bulk samples reinforces our ability to identify the proportion of the distinct V-bearing phases and the mechanisms by which V is trapped. The evolution of V speciation along the two studied profiles, developed over distinct parent rocks and under contrasted pedoclimatic conditions, helps discuss the mechanisms responsible for V accumulation during supergene weathering.

REFERENCES

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