Assessing Vanadium Speciation in Hyper-Enriched Black Shales to Identify the Geochemical Controls Involved: Insights from X-Ray Absorption Near-Edge Spectroscopy

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The demand for Vanadium (V) is increasing rapidly every year due to its critical role in supporting the green energy revolution. One of the major drivers of this demand is vanadium redox flow batteries. Additionally, V is used as a steel alloy to improve the lifespan of steel products while reducing energy consumption. The ultimate goal is to provide a deeper understanding of V enrichment, which will aid in the exploration of additional V resources and contribute to the green energy revolution.

To meet the demand for V, it is necessary to explore new V deposits. One potential source of V is hyper-enriched black shales (HEBS) found, and widely spread, in the Selwyn Basin, Yukon. The source of this enrichment is still debated, with two scenarios being direct precipitation from seawater (top-down) or seafloor hydrothermal activity (bottom-up). While the oxidation state of V can range from –III to +V, only +III, +IV, and +V occur in natural settings.

Synchrotron-based spectroscopy techniques can precisely determine the speciation of V, such as its oxidation state, coordination, molecular environments, and hosting phases. A selection of samples was analyzed using μ-XANES at the Advanced Photon Source (BL-13-IDE). Our preliminary results indicate the presence of two V species: (a) V(+IV) bound to sulfur atoms and (b) V(+III) bound to oxygen atoms. The V(+IV)–S species is predominant and suggests the top-down scenario might control V burial. This study is still ongoing work, and additional geochemical analyses like isotope chemistry, whole-rock, and scanning electron microscope analyses are being conducted.