

## **The formation of stratabound V rich highly metalliferous black shales**

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As the world transitions to a green economy, a wider range of elements in the periodic table are needed. Vanadium is one that is particularly important, both for its use in steel needed to construct green energy infrastructure, like wind turbines, but also due to its potential use in redox flow batteries needed for energy storage. One potential new mineral resource is metalliferous shales, but there is currently no consensus on how these deposits form. One model is that they form from direct precipitation from seawater under euxinic to anoxic conditions combined with extremely low sedimentation rates. However, the wide spatial extent of the mineralization suggests that the drawdown would be over too wide an area to be plausible and accompanying elements are not consistent with the required background sedimentation. The alternative hypothesis is that they form from hydrothermal or petroleum-based fluids. However, this explanation seems unlikely given that there are no known vent sites in the area for the hydrothermal fluids and that mineralization occurs over too wide an area to be the result of a single hydrothermal source. Further, V is typically low in modern seafloor hydrothermal systems. The lack of a single satisfactory geological model for the formation of these deposits hampers development of an exploration strategy for new, higher grade mineralization. In this study, we present results of analyses from the Van and Rod properties in northwestern Canada that contain 0.3 – 0.5 wt.% V across a stratigraphic thickness of 10s of meters, with elevated Zn, Ni and Mo contents. To develop a more holistic model for deposit formation, we utilize a combination of techniques, including bulk rock geochemistry (major and trace elements, TOC, TIC and TS), <sup>51</sup>V isotope analysis, laser ablation inductively coupled plasma mass spectrometry, optical petrography, scanning electron microscopy, and geologic mapping. Initial interpretations suggest that the direct precipitation model is unlikely due a lack of consistent <sup>51</sup>V isotope signatures, vanadium not being bound in oxide phases, sedimentary features indicating a higher energy depositional environment than would be expected, and bulk geochemistry not being consistent with an anoxic to euxinic depositional environment.