

The adsorption of mono- and poly-vanadate ($V(V)O_4^{3-}$) onto hematite: A multi-technique approach

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Vanadium (V) is wide spread trace element in the environment. However, it can be toxic to marine systems and terrestrial plants at high concentration due to anthropogenic emission such as mining activities and fossil fuels. V commonly exists as tetrahedral oxyanion monovanadate ($V(V)O_4^{3-}$) in the environment. Polyvanadate is tetrahedral coordination as well except octahedral decavanadate. Iron oxides such as hematite (Fe_2O_3) is ubiquitous in subsurface soils and sediments and can control the mobility of V due to their high surface area and reactivity.

Previous studies investigated vanadium adsorption to ferrihydrite and hematite applying solution analysis and Infrared technique. The aim of this project is to characterise the adsorption behaviours and bonding structure of V(V) to hematite under varying environmental conditions including pH (3-14), ionic strength and adsorbent concentrations, applying multi-technique approach such as aqueous chemical analysis, Attenuated Total Reflection-Fourier Transform Infrared Spectroscopy (ATR-FTIR), PHREEQC geochemical modelling, and X-ray Absorption Spectroscopy (XAS). PHREEQC and ATR-FTIR analysis indicated tetrahedral monovanadate and polyvanadate (except decavanadate) were dominant species at pH over 9, while octahedral decavanadate composed a significant proportion at pH up to 7. Future work using Extended X-ray Absorption Fine Structure (EXAFS) analysis provides details of V(V) adsorption mechanisms to hematite in a molecular scale. This is combined with aqueous chemical analysis, ATR-FTIR, PHREEQC, and XANES to provide a comprehensive dataset for determining the mono- or poly- vanadate species and the environmental mobility of V(V) in a variety of geochemical systems.