

## Assessing the solubility controls on vanadium in groundwater, northeastern San Joaquin Valley, CA

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The solubility controls on vanadium (V) in groundwater were studied due to concerns over possible harmful health effects of ingesting V in drinking water. Vanadium concentrations in the northeastern San Joaquin Valley ranged from  $< 3 \mu\text{g/L}$  to  $70 \mu\text{g/L}$ , with a median of  $21 \mu\text{g/L}$ . V concentrations were highest in oxic groundwater and lowest in anoxic groundwater. In oxic groundwater, adsorption/desorption reactions with particle surfaces were indicated as the primary solubility control of  $\text{V}^{5+}$  oxyanions in groundwater. V concentrations in oxic groundwater generally increased with increasing groundwater pH. However, data from adsorption isotherm experiments indicated that small variations in pH (7.4-8.2) were not likely as an important factor as the inherent adsorption capacity of the solid phase. In suboxic groundwater, V concentrations in groundwater decreased with increasing pH indicating that V may exist as an oxycationic species [e.g.  $\text{V}(\text{OH})_3^+$ ] or that V may complex with dissolved inorganic and organic ligands, which could alter adsorption behavior. Under anoxic groundwater conditions, speciation modeling predicts that aqueous V exists as the uncharged  $\text{V}(\text{OH})_3$  molecule. However, V concentrations were exceedingly low in anoxic conditions, indicating that V is sparingly soluble. This suggests that V may be precipitating as  $\text{V}^{3+}$ - or mixed  $\text{V}^{3+}/\text{Fe}^{3+}$ -oxides in anoxic groundwater, which is consistent with results of a previous laboratory study. The fact that V appears relatively insoluble in anoxic groundwater of the study area, indicates that reductive dissolution of Fe- and Mn-oxides may not be an important mechanism for increasing V concentrations in groundwater. Sequential extraction procedures (SEP) applied to aquifer material indicated that V was not associated with the solid phase as an easily exchangeable fraction. Results also indicated that the greatest V saturation of sorption sites occurred on amorphous and poorly crystalline oxide solid phases.