



Remediation of Hexavalent Chromium and Selenium Using the Mineral Ettringite

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Ettringite is a mineral phase with formula $\text{Ca}_6[\text{Al}(\text{OH})_6 \cdot 12\text{H}_2\text{O}]_2(\text{SO}_4)_3(\text{H}_2\text{O})_2$. It can be found occurring naturally and is also one of the main hydration products of cement. Its structure is well characterised^[1] and consists of cation columns with composition $\text{Ca}_3[\text{Al}(\text{OH})_6]_2 \cdot 12\text{H}_2\text{O}$ ³⁺ that run parallel to the *c* axis, with the remaining sulfate anions and water molecules in the channels that run parallel to these columns (Figure 1).

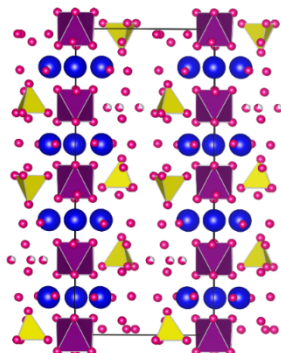


Figure 1. [11-20] projection of ettringite parallel to the *c* axis: Al(OH)₆ purple, SO₄²⁻ yellow, Ca blue, O pink

Ettringite has been shown to accommodate other cations (Fe³⁺, Ga³⁺) on the aluminium sites^[2] and other oxyanions (NO₃⁻, CO₃²⁻) in place of the sulfate anions^[3]. This ability of the structure to accommodate a wide range of cations and anions gives it the potential to be used to encapsulate waste ions and therefore remediate waste streams. This study is particularly concerned with the oxyanions CrO₄²⁻ and SeO₄²⁻. These contain the elements chromium and selenium in their hexavalent oxidation state. When in this oxidation state they are both harmful to human health and the environment. The presence of Cr⁶⁺ in public water streams is mostly caused by runoff from industry^[4], while Se⁶⁺ is present in coal mine water and fly ash pile waste^[5]. This project aims to test the viability of using ettringite precipitation as a method to remove hexavalent chromium and selenium from water. This has been tested by setting up an experiment where a simple starting material, tricalcium aluminate (Ca₃Al₂O₆) one of the phases found in cement clinker, was added to a synthetic waste solution containing either Cr⁶⁺ or Se⁶⁺. The resulting solid products were separated after a range of reaction times and analysed using a variety of techniques (PXRD, FT-IR and ICP-OES).

References:

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