



Sequestration of selenium on calcite surfaces revealed by nanoscale imaging

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Selenium is an important element because of its high toxicity in natural systems. In-situ atomic force microscopy observations of calcite surfaces during contact with selenium-bearing solutions demonstrate that selenium trapping can occur under conditions in which calcite both dissolves and precipitates. The contact of solutions containing selenium in two states of oxidation (either $\text{Se}^{(IV)}$ or $\text{Se}^{(VI)}$) onto a growing or dissolving calcite surface either changes the growth pattern or results in precipitates formed during dissolution. In the form of selenite ($\text{Se}^{(IV)}$), but not as selenate ($\text{Se}^{(VI)}$), selenium can be incorporated into calcite during growth. During dissolution, in the presence of selenate ($\text{Se}^{(VI)}$), the precipitates formed remained small during the observation period. When injecting selenite ($\text{Se}^{(IV)}$), the precipitates grew significantly, and were identified as $\text{CaSeO}_3 \cdot \text{H}_2\text{O}$, based on SEM observations, Raman spectroscopy and thermodynamic calculations. An interpretation is proposed where dissolution of calcite increases the calcium concentration in a thin boundary layer in contact with the surface, allowing the precipitation of a selenium phase. This process of dissolution-precipitation provides a new mechanism for selenium sequestration and extends the range of thermodynamic conditions under which such a process is efficient.