Phosphate Sequestration by Calcium Carbonates

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The formation of apatites from calcium carbonates can be regarded as an effective way of sequestering phosphate. Because of its low solubility, apatite is used for phosphorus recovery, in wastewater management (heavy metal immobilization) and can potentially provide a solution for eutrophication. This reaction path of apatite formation, depending on various conditions (e.g. solution composition, temperature, pH etc.), involves the replacement of the original calcium carbonate. We have investigated the mechanism of this replacement reaction experimentally using both biogenic aragonite (Kasioptas et al. (2007)), and inorganic aragonite and calcite as starting materials, reacted in a batch reactor with phosphate solutions over a range of temperatures. In all experiments the reaction product is hydroxyapatite (HAP). The replacement reaction is pseudomorphic and even in a morphological structure as complex as the cuttlebone of Sepia Officinalis, the morphology is preserved after complete replacement of the aragonite by HAP. In the experiments with inorganic aragonite and calcite, the replacement proceeds along a sharp interface that moves from the original crystal surface into the parent, with a polycrystalline product made up of hexagonal needles of HAP. The reaction involves a molar volume decrease and the reacted rim is porous, thereby allowing mass transport between the internal reaction interface and the fluid reservoir. These textural features are typical of an interface-coupled dissolution-reprecipitation mechanism (Putnis A (2002); Putnis and Putnis (2007)).

References

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