

2.2.P01

Phosphate dissolution and precipitation rates in low temperature natural processes

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The major motivation for this study is to quantify the role of phosphates in natural and environmental processes. Apatite dissolution and precipitation rates have been measured at acidic pH as a function of Ca, P, F, and organic acid concentration. All rates have been measured in mixed-flow reactors as a function of solution composition. Far-from-equilibrium apatite dissolution rates are found to be inhibited by aqueous PO_4^{3-} activity but independent of aqueous Ca^{2+} and F^- activity at pH=3 and 25°C. Further experiments at this pH indicate that a variety of aqueous organic acids increase apatite dissolution rates the relative degree of rate enhancement is found to be acetic < oxalic < citric. P inhibition and aqueous organic acid enhancement provides a means for the passive acceleration of apatite dissolution in natural environments.

Further mixed-flow reactor experiments have been performed to measure apatite precipitation rates at near to neutral pH. These experiments have been designed to assess the variation of rates as a function of chemical affinity, and the degree to which precipitation rates are consistent with corresponding dissolution rates. Use of these results is anticipated towards the improved understanding of the role of apatite precipitation and dissolution in a variety of natural near surface processes.

References

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2.2.P02

A kinetic and spectroscopic study of fluorapatite dissolution

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Oxidation of iron sulphides in mining waste releases SO_4^{2-} , Fe(II) and H^+ , resulting in acid mine drainage (AMD) [1]. This acidic leachate water can take part in releasing processes of other metals e.g. Cd, Cu, Pb and Zn in the mining waste. The mobility and bioavailability of these metals depend on their chemical speciation and in this respect adsorption processes to surrounding minerals play important roles.

It has been suggested that the addition of apatite could be an efficient and cost-effective approach for the remediation of soils contaminated by heavy metals [2]. Metal ions can be attenuated by forming phosphate phases in contact with phosphate ions released by apatite dissolution. In Kiruna, Sweden, large quantities of residues from iron ores are being produced. These residues contain a large fraction of fluorapatite ($\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$) which could be available for mining waste remediation.

To understand more about fluorapatite in mining waste remediation a first approach is to perform more detailed studies of the dissolution of the mineral under different conditions. The aim of the present study was to investigate the importance of particle size and pH for the dissolution of fluorapatite in different ionic media and ionic strengths. Most previous studies concerning the dissolution of fluorapatite have been carried out in the temperature range 25-37 °C [3]. To mimic the environmental condition in the north of Sweden, experiments have been performed at low temperatures as well as at 25 °C.

We have employed a multi-technique approach where UV-spectroscopy, atomic adsorption spectroscopy (AAS) and potentiometry have been used together with X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and Fourier transform infrared (FTIR) spectroscopy. The main objectives have been to obtain quantitative dissolution data in combination with detailed analysis of the particles before, during and after dissolution reactions. The results from this study will be presented in this paper and will form basis for further studies of metal immobilisation by fluorapatite.

References

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