The early stages of mimetite dissolution in EDTA studied with atomic force microscopy and scanning electron microscopy

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Abstract

A mineral mimetitie $Pb_5(AsO_4)_3Cl$ is one of the most insoluble minerals and continues to be considered a viable remedial strategy for immobilization of Pb and As from contaminated soils. It has been recognized that many well-known naturally occurring and synthetic chelators strongly influence dissolution processes in near-surface geological environments. EDTA (ethylene diamine tetra-acetic acid) is a chelating agent which most effectively increases solubility of mimetite is characterized by a low degree of biodegradability in groundwater and a high level of complexing capacity with respect to heavy metals. In this study optically clear crystals of mimetite (in wt.%: of 22.87 As_2O_5, 0.20 P_2O_5, 74.25 PbO, 0.44 CaO, 2.38 Cl) were observed in SEM and AFM before and after dissolution in 2 mM EDTA solution at pH 3.5. Direct in situ observations at room temperature made in a fluid cell AFM revealed that the total grain surface area increased due to the development of etch pits and the development of etch pits continued until grain disintegration was reached. Both hexagonal and prismatic walls developed dissolution features about 0.5 micrometer deep over six hours of the experiment. Secondly, as dissolution proceeded towards complete dissolution, the surface area available for dissolution decreased as the individual grains dissolved. SEM observations showed the development of rounded edges on hexagonal walls and elongated, oval etch pits on the prismatic wall.