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Facet-specific adsorption and oxide formation of manganese on goethite

SEONYI NAMGUNG[1], SUNGSIK LEE[2], KIDEOK KWON[3], SANG SOO LEE[2] AND GIEHYEON LEE[1]

[1]Yonsei University
[2]Argonne National Laboratory
[3]Kangwon National University

Presenting Author: hysy0514@yonsei.ac.kr

Geochemical processes occurring at solid-water interface are those of the most fundamental and primary reactions in the environment. In particular, the mineral surfaces play a critical role in the mobility and the phase transformation of aqueous species. Thereby, extensive studies are currently focusing on surface-induced chemical transformation such as heterogeneous nucleation process. This is the primary process responsible for diverse solid formation in the natural aqueous systems but still far beyond what we currently understand mainly due to the multiple facets with their distinct properties in a single mineral.

This study examined the interfacial geochemical behaviors of manganese on goethite (α-FeOOH) surface. We first characterized Mn(II) adsorption to goethite under anoxic conditions and subsequently monitored surface-catalyzed oxidation of the adsorbed Mn(II) by exposing it to the atmospheric oxygen. For this, sets of Mn(II) adsorption and oxidation experiments were conducted by reacting 120 or 480 μM Mn(II) with 1.0 g/L goethite at pH 9.0 under anoxic or oxic conditions. The results showed that Mn(II) predominantly adsorbed to {110} facets of goethite and formed inner-sphere bidentate surface complexes. When the adsorbed Mn(II) was exposed to O_2, groutite (a-MnOOH) was formed by heteroepitaxial growth only at {021} facets. We will present that a specific facet may customize a specific reaction and thereby facilitate the corresponding geochemical processes at solid-water interface.