
Sorption Mechanisms of Lanthanum on Oxide Minerals

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Abstract: The retention of hazardous species, including many of the lanthanides, on soils and sediments is vital for maintaining environmental quality. In this study, high-resolution transmission electron microscopy (HRTEM) was used to identify surface precipitates of La and their degree of atomic ordering on oxides of Mn (birnessite), Fe (goethite) and Ti (rutile) over a pH range of 3 to 8. At pH > 5.5, the aqueous concentration of La was fully depleted by all three metal-oxides. On birnessite, surface precipitation of La-hydroxide occurred at pH \geq 5 and appears to be the dominant sorption mechanism on this mineral. Surface precipitation was not observed on rutile or goethite until much higher pH values, 6.5 for rutile and 8.0 for goethite. Precipitation is thus correlated with the points of zero charge (PZC) of the minerals, 6.3 for rutile and 7.8 for goethite, and in each case was observed only at pH values above the PZC. Although La sorption was extensive on all of the minerals at the higher pHs, the depletion of La from solution by rutile and goethite at pH values well below the PZC indicates that the sorption mechanism differs from that on birnessite. While surface precipitation was found to be the dominant sorption mechanism of La on birnessite, surface complexation of monomeric or small multinuclear species appears to predominate in La retention on rutile and goethite at most commonly encountered pH values.

Key Words: Electron microscopy • Lanthanum • Metal-oxides • Sorption

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