Sorption of Heavy-Metal Cations by Al and Zr-Hydroxy-Intercalated and Pillared Bentonite

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Abstract: The sorption of Cd, Cu, Pb, and Zn ions by Na-rich bentonite, Al and Zr-pillared Na-rich bentonite (Al-MX80, Zr-MX80), the uncalcined hydroxy-intercalated precursors (HAl, HZr-MX80), and commercial Al-pillared bentonite EXM 534 was investigated. Experiments were conducted in ultrapure water and artificial leachate with varying pH. The experiments were performed over periods to 30 wk. Sorption characteristics were described with one and two-site Langmuir isotherms. The non-exchangeable quantities of heavy metals were determined by fusion of the sorbents after ion exchange with ammonium acetate.

The sorption of Cd, Cu, Pb, and Zn by bentonite was dominated by cation exchange. In artificial leachate, the sorption was reduced due to competition with alkali and alkaline-earth cations. The sorption of Cu, Zn, and Pb at pH 4.9 and Cd at pH 6.9 by Al and Zr-hydroxy-intercalated and pillared MX80 was governed also by cation exchange. In contrast, the sorbed quantities of Zn at pH 6.9 exceeded the cation exchange capacity (CEC) of HAl, HZr, Al, Zr-MX80, and EXM 534 and were partially non-exchangeable. The increase of the sorption of Zn with pH and its independence of the ionic strength of the solution at neutral pH suggest a complexation of Zn ions to surface hydroxyl groups of the intercalated Al and Zr-polyhydroxo cations and pillars. This complexation is the dominating sorption mechanism. Removal of dissolved Zn from solution with time is attributed to surface precipitation. Al-hydroxy and pillared bentonites are considered potential sorbents of Zn ions from neutral pH aqueous solutions, such as waste waters and leachates.

Key Words: Heavy Metals • Intercalation • Montmorillonite • Pillared Clay • Sorption

Clays and Clay Minerals; October 1999 v. 47; no. 5; p. 617-629; DOI: 10.1346/CCMN.1999.0470508

Clay Minerals Society (www.clays.org)