RETENTION OF Pb USING THERMALLY-TREATED PALYGORSKITE UNDER DYNAMIC SORPTION CONDITIONS

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ABSTRACT

Palygorksite-rich clays are known for their exquisite sorption properties regarding potentially toxic elements (PTEs), such as Pb, Cu, Cr, As, Cd, etc. due to their high surface area, permanent surface charge, and fibrous texture. The sorption capacity of palygorskite clay can be further increased by thermal treatment, which induces an increase in microporosity. The present study aims to compare the sorption capacity of raw and thermally-treated palygorskite-rich clay samples regarding Pb ions from mono-elemental aqueous solutions, under dynamic sorption conditions.

A commercial clay sample (Pal0) was supplied by Geohellas S.A. and heated at 200°C (Pal200) and 400°C (Pal400) respectively, in a muffle for 6 hours. The XRD analysis of the samples prior to and after the thermal treatment, showed that the raw sample (Pal0) consists mainly of palygorskite and smectite. After heating at 200°C (Pal200), smectite phase was destroyed, whereas the main intensity peak of palygorskite significantly decreased. At 400°C (Pal400), only a small peak of the palygorskite phase remained. Additionally, the specific surface area (SSA, m^2/g) of the samples decreased in the order Pal0(198)>Pal200(153)>Pal400(112), whereas the pore diameter (in nm) increased as Pal400(9.1)>Pal200(7.3)>Pal0(5.6).

Dynamic sorption experiments were carried out in fixed-bed columns containing mixtures of palygorskite clay and quartz sand at a 1:7 ratio[1]. The retention efficiency of raw and thermally treated palygorskite samples was assessed by plotting the respective breakthrough curves (C/C_0 vs t) at flow rates of Q=0.35 and 0.7 mL/min, initial solution pH=3.5 and 5.5 and initial Pb concentrations C_0=50 and 100 mg/L Pb. The maximum amount of Pb sorbed by the beds (q_{max}, mg/g) was observed for initial concentration C_0=100 mg/L at pH=5.5 and Q=0.7 mL/min as follows: Pal400(46)>Pal200(42)>Pal0(31). The amount of Pb retained by the quartz sand was <1mg/g.

The obtained results demonstrated that thermal treatment of palygorskite can readily improve its sorption capacity regarding metal ions, such as Pb. Heating induces the folding of the palygorskite structure and increases its microporosity enabling the diffusion of Pb ions further within the clay mass. The experimental approach used, showed that dynamic sorption experiments can accurately describe the sorption behavior of non-expandable clays, such as palygorskite, under flow through conditions, similar to those that take place in natural systems.

KEYWORDS: Palygorskite, clays, PTEs, dynamic sorption, environmental remediation

REFERENCES

[1] Kypritidou, Z., & Argyraki, A. (2020). *Environ Geochem Health.* 43: 2483–2503.