An integrated application of natural geomaterials for heavy metals removal in aqueous system

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The present work has been conducted to evaluate the potential application of natural geomaterials, from Tunisia, in removing toxic metals from aqueous solutions in mono- and multiple-elements systems. Adsorption experiments were performed using batch sorption methodology as an appropriate technique in the current study. The chemical and mineralogical characterizations showed that limestone samples from southern Tunisia contained up to 99.6% calcium carbonate with small amounts of clay minerals, including smectite, kaolinite and illite. The characterization of the collected samples allowed the selection of the most auspicious sites that could be excavated for use as adsorbent. We examined the effects of impurities in limestone on its capacity to retain several selected heavy metals. The experimental data showed highly efficient materials in the removal of heavy metals (Pb, Cd, Cu and Zn). Kinetic data demonstrated a high degree of fitness to the pseudo-second order and intra-particle diffusion models. The selectivity sequence of the studied metal was Pb(II) > Cu(II) > Zn(II) ≈ Cd(II) in single and mixed systems. The applicability of Tunisian natural clays, from Gabes and Gafsa areas, in the removal of several metal ions was also evaluated. Mineralogical and spectroscopic characterizations indicated that the clay of Gabes area was mainly montmorillonite whereas the sample collected from Gafsa district contained high amount of carbonates. From the adsorption studies, it was concluded that both smectitic and calcareous clays could be used for the removal of several metal cations in aqueous systems. The sequence of heavy metals adsorption in single and multi-element systems onto the studied clays was: Pb(II) > Cu(II) > Zn(II) > Cd(II). In the mixed systems, the adsorption capacity decreased for each metal due to the competitive effect. Such findings are contingent upon some physical properties of the studied metals (i.e., relative binding strength, hydrated radius, electronegativity and hydrolysis constant).

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