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Thallium sorption onto illite and smectite

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Thallium (Tl) is a trace element mainly encountered in S-rich minerals, K-rich minerals (e.g., feldpsars, micas…) but also in rare Tl-rich minerals such as dorallcharite and lanmuchangite. Weathering of these minerals and mining activities (e.g. sulfide and coal ores) are the main sources of Tl for the environnement. Tl compounds are also volatile and some amounts of Tl are released in the surrounding environments of cement production plants for instance. In addition, Tl belongs to Technical Criticals Elements (TCEs)[1] and coupled with its toxicity, the interest in understanding Tl geochemistry and its cycle in the environment is increasing.

Tl remain mainly labile in the environment but its mobility is generally attributed to interaction with oxides (iron and manganese oxides) and silicates. Recents studies identified clays minerals, especially illlite[2,3] as an important retention phase for Tl. However, processeses responsible of Tl sorption onto clays are poorly known.

In this study, Tl sorption onto both illite and smectite, two major clay minerals found in soil or sediments was investigated. Four matrices, Na-illite, Ca-illite, Na-smectite and Ca-smectite were used in batch experiments for sorption/desorption isotherms (as functions of pH and Tl concentrations) with 204Tl as radioactive tracer. Results were analyzed by liquid scintillation and modelled with a Multi-site ion exchanger model.

Results show a higher affinity for illite than for smectite. With logKd (Kd in mL.g-1) up to 4, Na-illite has the strongest affinity for Tl. Exchange of Tl with Na+ cation is more extensive than Ca2+ which is consistent with the fact that Tl+ is the main Tl species in solution. Then, these results are compared with others existing data (e.g. natural organic matter, manganese oxides…) in order to bring new insights on the phases that control Tl mobility and how it can affect its cycle in the environement (e.g., from soil to suspended particulate matter in aquatic systems). In conclusions, this work offer new considerations on Tl geochemistry for sub-surface environments.

[1]Cobelo-Garcia et al. (2015) Environ. Sci. Pollut. Res. 19, 15188-15194. [2]Jacobson et al. (2005) Science of the Total Environment, 345, 191-205. [3]Voegelin et al. (2015) Environ. Sci. Technol. 49, 5390-5398