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Investigating cadmium sorption to diatoms using spectroscopy

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Unnatural levels of cadmium have been detected in rural and urban runoff, as well as surface and ocean waters globally. The universally toxic effects of cadmium on humans, plants, animals, and microbial life alike emphasize the importance of concern from these discoveries. Cadmium is introduced into the environment both naturally and anthropogenically, but the contribution of cadmium from anthropogenic sources has been increasing, restructuring the cadmium biogeochemical cycle. Anthropogenic sources of cadmium include expelled wastewaters and the displacement of contaminated soils from industrial sites- often urban adjacent.

The efficacy of raw diatomite (amorphous bio-silica), a low-cost biosorbent with sedimentary origins, to adsorb cadmium has been explored and proven; but measures of the adsorbance capacities and binding mechanisms have varied markedly. The inherent heterogeneity of diatomite chemistries, morphologies, and particle integrities may result in the poor replicability of its performance warranting the use of multi-spectral, micro-scale investigation. Applications of Raman spectroscopy as well as Fourier transform infrared (FTIR) spectroscopy are employed in this study to inform a more replete understanding of the physical chemistry of cadmium binding to diatomite. The influence of varying pH within environmentally relevant ranges and cadmium concentration on the diatomite's capacity to sorb cadmium is evaluated. This us done through adsorption isotherms, as a function of Cd concentration and pH, and the amount of Cd removed from solution is monitored using Inductive Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The point of zero charge for diatomite is determined by mass titration to learn the behaviors of cadmium and other exchanged ions in solutions. FTIR spectroscopy was used to determine the bulk binding mechanisms, while Raman spectroscopy helps us determine the variations of Cd sorption as a function of diatom morphology. Reconciling the behaviours of cadmium against diatomite at environmentally relevant conditions aids attempts to mitigate cadmium pollution and modeling its current and future biogeochemical cycle.