

Selenate uptake by green rust

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Green rust is a generic term for a large family of Fe²⁺/Fe³⁺ layered double hydroxides found under anoxic conditions, for example in soils such as gleysols where green rust is termed “fougerite”, or in engineered environments where it usually results from anoxic corrosion of steel or iron materials. Like clay minerals, green rust has a layered structure and usually a minute particle size but, in contrast to clay, the permanent charge of the green rust layer is positive, mainly due to the isomorphic substitution of Fe²⁺ by Fe³⁺. This makes green rust extremely reactive to a wide variety of anions, and this phase is therefore suspected to play a significant role in the geochemical cycle of several nutrients and anionic contaminants. In addition, cations such as transition metals (Co, Zn) can be incorporated into the structure of the green rust layer by isomorphic substitution, further emphasizing the important role played by green rust in influencing the geochemical cycling of elements.

Selenium (Se) is a double-edged sword element: it is a macronutrient, meaning its deficiency is detrimental to living organisms, but it is also very toxic at high concentrations, the range between the two detrimental effects being very narrow. Understanding, quantifying, and modelling its interactions with solid phases is fundamental for our capacity to predict its mobility and hence its (bio)availability in preserved and polluted areas, but also in the context of waste storage.

Here, we studied selenate [Se(VI)] uptake by green rust containing initially interlayer Cl⁻. The kinetics and mechanisms of adsorption were quantified by combining laboratory kinetics flow-through experiments and mineralogical characterization of the reaction products as a function of time, including the redox state of the different elements involved in the reaction. The relative importance of adsorption and redox reactions could be quantified, and a model for Se(VI) interaction with green rust is proposed.