

Sorption of Selenium Onto Natural Iron Oxides

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Selenium (Se), a toxic as well as essential element, plays an important role in environmental analysis as well as in health studies. Excess of selenium intake can cause toxic reactions of living organisms. Therefore, predominantly inorganic selenium compounds, mostly of anthropogenic origin and emitting into the environment, are of significant interest in environmental studies. Selenium may be toxic to plants directly or may accumulate in plants thereby entering the animal and human food chain. Adsorption of Selenium by soils has received little attention although the factors affecting plant uptake of Se have been determined (Frost et al 1977). Due to its toxicity, this metal has been object of several studies focused on the assessment of its mobility through soils and aquifers. The ubiquity of iron oxide minerals, and their ability to retain metals on their surface can represent an important retardation factor to the overall mobility of Selenium through the geosphere. In this work, we have undertaken the study of the sorption of Se(IV) and Se(VI) onto three different natural iron oxides: magnetite, goethite and hematite. The influence of pH (2 to 12), total metal concentration (10^{-6} to 10^{-3} M), solid weigh to volume ratio (0.0025 to 0.05kgdm^{-3}), selenium oxidation state (Se(IV) or Se(VI)) and ionic strength (0.001 to 1 mole dm^{-3}) on the sorption process was evaluated by means of batch experiments at room temperature. Typical sorption edges were obtained, with a decrease in the sorption extent with pH, especially in the case of hematite. In the case of Se(IV) sorption percentage varied from 72% at pH 2 to 11% at pH 13 and for Se(VI) sorption percentage varied from 18% at pH 2 to 7% at pH 13. The sorption edge coincides with the predominance of HSeO_3^- (aq) for Se(IV), while in the case of Se(VI) with

the predominance of SeO_4^{2-} . In most cases Se(IV) showed an enhanced sorption with respect to Se(VI) and the maximum sorption was observed in the case of hematite. For Se(IV), the systems reach the maximum surface converge, with the following values: hematite: 1×10^{-6} mol m^{-2} ; magnetite and goethite: 3×10^{-6} mol m^{-2} . In the case of Se(VI) the surface of hematite do never was saturated in the concentration range studied, while the maximum selenium(VI) sorbed onto the surface of magnetite is 4×10^{-6} mol m^{-2} and 7×10^{-7} mol m^{-2} for goethite. No influence of the ionic strength was observed in all systems studied. The experimental results were adjusted by using non-competitive Langmuir isotherm and the parameters obtained are shown in the next table:

Iron oxide	pH	Se species	Kads	Γ_{max}	R ²
Magnetite	4.2	Se(IV)	$(1.19 \pm 0.07) 10^6$	$(3.13 \pm 0.06) 10^{-6}$	0.975
		Se(VI)	$(2.98 \pm 0.11) 10^5$	$(3.46 \pm 0.23) 10^{-6}$	0.995
Goethite	4.3	Se(IV)	$(1.48 \pm 0.16) 10^4$	$(3.13 \pm 0.45) 10^{-6}$	0.995
		Se(VI)	$(2.30 \pm 0.23) 10^4$	$(6.85 \pm 1.14) 10^{-7}$	0.983
Hematite	4.3	Se(IV)	$(1.10 \pm 0.18) 10^4$	$(1.04 \pm 0.22) 10^{-5}$	0.994
		Se(VI)	$(3.67 \pm 0.83) 10^4$	$(2.65 \pm 0.80) 10^{-6}$	0.972

In general, a good applicability of the Langmuir model to the experimental data was observed, which indicates monolayer coverage on the iron mineral surface by each of these species, individually.

Frost RR & Griffin RA, *Soil Sci. Soc. Am. J.*, **41**, 53-57, (1977).