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# Fast and Slow Phosphate Sorption by Goethite-Rich Natural Materials

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**Abstract:** Although phosphate sorption by goethite and other less-abundant Fe oxides strongly influences the concentration of this anion in the soil solution and aquatic environments, relatively little is known on the P-sorption characteristics of natural goethites. For this reason, we examined the P-sorption capacity and time course of P sorption of 10 goethite-rich soil, ferricrete and lake ore samples, in which the content and nature of mineral impurities were unlikely to affect P sorption significantly. Phosphate sorption could be adequately described by a modified Freundlich equation including a time term. The amount of P sorbed after 1 day of equilibration at a concentration of 1 mg P/liter ranged widely (0.36– 2.04  $\mu\text{mol P/m}^2$ ). The total P sorbed after 75 days of equilibration varied less, in relative terms (1.62– 3.18  $\mu\text{mol P/m}^2$ ), i.e., a higher slow sorption tended to compensate for a lower initial (fast) sorption. Total sorbed P ( $X^{-} = 2.62$ ,  $SD = 0.52 \mu\text{mol P/m}^2$ ) was similar to the sorption capacity of synthetic goethites, suggesting a common sorption mechanism and the predominance of one type of crystal face, which, according to previous transmission electron microscope observations, might be the (110).

The extent of the slow reaction correlated to the ratio between micropore surface area and total surface area, as well as to oxalate-extractable Fe, which is an estimation of the ferrihydrite content. Ferrihydrite impurities might affect the slow reaction by contributing to the microporosity of some samples. Silicate adsorbed on the surface of the goethites was readily desorbed during phosphate sorption and did not significantly affect the extent of the slow sorption process.

**Key Words:** Adsorption • Ferrihydrite • Goethite • Iron oxides • Phosphate • Porosity • Silicate • Sorption

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