SORPTION OF PHOSPATE AND ZINC ONTO HEMATITE AND MAGNETITE AS A MECHANISM OF ATTENUATION OF CONTAMINATION IN AGRICULTURAL SOILS

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Excess of natural and synthetic fertilizers applied to agricultural soils is a well-known source of contamination of nitrates and potential source of contamination of metals (copper and zinc) and phosphates (Alloway 2010). Mineral phases such as iron oxides, are present in agricultural soils and they might play a main role in the retardation of the transport of different contaminants (Giménez et al. 2007). The present communication shows the experimental study of sorption of phosphate and zinc onto magnetite (Fe_3O_4) and hematite (Fe_2O_3) in order to investigate the role of these oxides as potential attenuating phases to incorporate contaminants when fertilizers are used.

Batch experiments were performed by mixing 0,2 grams of mineral and 15 mL of aqueous solution (phosphate or zinc) at different conditions (contact time, pH and concentration of phosphates and zinc). Kinetic results of phosphate sorption were satisfactory adjusted considering a pseudo second-order reaction model, with rate constants $4{,}1\cdot10^5$ and $3{,}3\cdot10^5$ $m^2\ mol^{-1}\ h^{-1}$ for magnetite and hematite, respectively.

Equilibrium studies were performed after 72 h of contact time. The initial pH of the solutions ranged from 4 to 9, but the equilibrium pH was always around 7. This value is very close to the point of zero charge (pH_{zpc}) of the solids, determined to be 6,4 and 6,2 for magnetite and hematite, respectively. The total phosphate concentration ranged from 10^{-5} M (1 mg L^{-1} to $5{,}8\cdot10^{-5}$ M (55 mg L^{-1}). Langmuir isotherms were satisfactory fitted in both iron oxides and fitting parameters are shown in the following table:

Mineral	Q_{max} ***(mol m^{-2})***	***b (L mol^{-1})***	R^2
Magnetite	$5{,}0\cdot10^{-7}$	$3{,}67\cdot10^4$	0,998
Hematite	$2{,}010^{-6}$	$3{,}51\cdot10^4$	0,994

The main objective of this work was to determine if zinc sorption was favoured in magnetite and hematite already saturated with phosphate, because the formation of phosphate complexes on the surface of the solids could change the net charge of the solids facilitating the sorption of positively charged species such as zinc. In this sense, the sorption of different concentrations of zinc ($1.3\text{-}7.1\cdot10^{-4}$ mol L^{-1}) was tested in solids saturated with phosphate. The results obtained showed a slight increase of zinc adsorbed onto minerals saturated with phosphate. This indicated that the presence of phosphate facilitated the sorption of zinc on the iron oxides.

The main conclusion of this work is that magnetite and hematite in agricultural soils adsorb phosphate from fertilizers and that this sorption slightly attenuates the impact of zinc on groundwater.

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References

ALLOWAY, B. J. *Heavy Metals in Soils*. Editorial Springer London, 2010.

GIMÉNEZ J., MARTÍNEZ, M., DE PABLO, J., ROVIRA, M., DURO, L. Arsenic sorption onto natural hematite, magnetite and goethite. *Journal of Hazardous Materials* 141 (2007) 575-580