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Sorption of cadmium in agricultural soil at naturally low concentrations

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Understanding cadmium (Cd) sorption at naturally low concentrations is crucial for improving Cd risk assessments. A deeper knowledge of Cd sorption enhances our understanding of Cd mobility and availability, as well as improves the precision of mass balance models.

Cd is a non-essential element present in all soils, originating from both geogenic and anthropogenic sources [1]. It is toxic to humans even at low levels and bioaccumulates in various tissues. Due to its long half-life in the human body, lifetime exposure is more important than single high-intake events. To better assess the environmental risk of Cd, a more detailed understanding of the processes governing its mass balance in the soil-crop-fertilizer system is required.

One such process is Cd sorption in soil, which influences both crop uptake and leaching – key components of the Cd mass balance. While Cd sorption is generally well understood, with organic matter often acting as a primary sorbent, the specific mechanisms at naturally low concentrations remain uncertain. For example, it is unclear whether sulfur or oxygen functionalities play a dominant role and how this affects Cd bioavailability [2].

In ongoing research, we study Cd sorption onto a range of Swedish agricultural soils as a function of pH, Cd and Zn concentrations. Current geochemical models (SHM and NICA-Donnan) are applied to assess their consistency with the data and to determine whether improvements in model descriptions are necessary. Preliminary results will be presented at the conference.

[1] McLaughlin, M.J., Smolders, E., Zhao, F.J., Grant, C., Montalvo, D., 2021. Chapter One - Managing cadmium in agricultural systems, in: Sparks, D.L. (Ed.), Advances in Agronomy. Academic Press, pp. 1–129. https://doi.org/10.1016/bs.agron.2020.10.004

[2] Gustafsson, J.P., Affholder, M.C., Dahlin, A.S., 2024. Cadmium accumulation in soil resulting from application of biogas digestate and wood ash – mass balance modelling. Appl. Geochem. 165, 105951. https://doi.org/10.1016/j.apgeochem.2024.105951