Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.34997

Modelling sorption of cadmium and zinc in agricultural soil at naturally low concentrations.

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Cadmium (Cd) is a non-essential element originating from both geogenic and anthropogenic sources. It is toxic to humans even at low concentrations. Zinc (Zn), in contrast, is an essential micronutrient, although it can also be toxic at elevated concentrations.

Understanding Cd and Zn sorption at naturally occurring concentrations is crucial for improving Cd and Zn risk assessments. A deeper knowledge of Cd and Zn sorption enhances our understanding of their mobility and availability. Furthermore, soil sorption influences both crop uptake and leaching – key components of element mass balances.

Although Cd and Zn sorption is generally well understood, with organic matter often acting as a primary sorbent, particularly for Cd, the specific mechanisms governing Cd and Zn release at naturally low concentrations remain uncertain (Gustafsson et al., 2024).

Applying current geochemical models, such as SHM and NICA-Donnan, is a cost-effective and rapid approach for predicting dissolved Cd and Zn concentrations in soils. In ongoing research, we collect detailed data on dissolved Cd and Zn in 8 Swedish agricultural soils as a function of pH and total Cd and Zn concentrations. Based on this data set, we evaluate the ability of SHM and NICA-Donnan to describe the observed data and to identify possible model improvements. Extraction methods for Cd and Zn are also assessed.

Preliminary data show that Cd and Zn sorption at naturally low concentrations is often predicted poorly using standard assumptions and geochemical reactivity parameters derived from 0.43 M HNO_3 (Figure 1) and EDTA extractions. Further details will be presented at the conference.

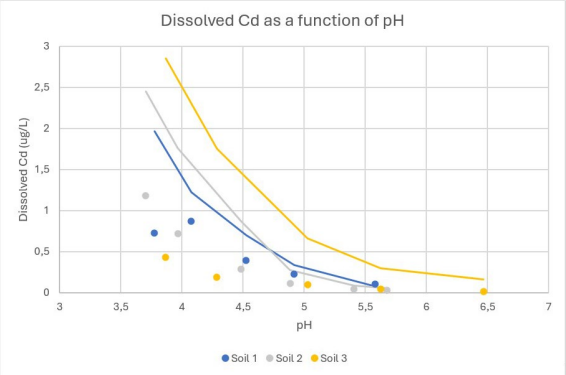

Fig 1. Dissolved Cd as a function of pH. Lines represent modelled values (Cd input: 0,43 M HNO_3 extraction) and dots measured values.

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