The influence of Critical Zone age on contaminant reactivity along a fluvial chronosequence in the Oregon Coast Range

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Critical Zone (CZ) processes are well recognized as drivers on the sustainability of soil and water resources. However, how stage of CZ development impacts contaminant reactivity and mobility in soils has yet to be investigated.

The objectives of this study were to quantify (1) how CZ development and age of pedogenesis influence contaminant reactivity, and (2) determine solid-phase hosts and soil characteristics that govern contaminant binding and retention within soils from different stages of development. In order to achieve these objectives, soils from a fluvial chronosequence in the Oregon Coast Range with ages 20, 69, 140, 200, and 908 ky from two depths (30 and 100 cm) were subjected to arsenic (As) adsorption isotherms, with As removal from solution serving as a proxy for soil-contaminant reactivity. Sequential extractions and spectroscopic analyses, targeting amorphous and crystalline Fe- and Al-oxides, were conducted on the original and dosed soils to identify the contaminant host phases across the suite of soils. Data were subjected to multiple linear regressions to identify correlations between soil characteristics and derived As sorption capacities.

Older soils (908 ky) at depth (100 cm) have the highest contaminant sorption capacities (5,494 mg kg^{-1}) due to the pedogenetic accumulation of secondary minerals, and thus contaminant reactivity increases with age at depth. The second highest sorption capacities were observed in the youngest (20 ky) and shallowest (30 cm) soils (5,031 mg kg^{-1}) due to the preponderance of high-surface-area amorphous Fe-oxides found in younger soils. The lowest sorption affinities were observed in the 69 ky soils from a depth of 30 cm. Crystalline forms of iron and aluminosilicates are expected to increase with pedogenesis and show a positive correlation with sorption, particularily at depth. This knowledge will assist in developing models for predicting CZ processes and how they govern the sustainability of soil and water quality.