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The role of nanophases in critical zone dynamics

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A recent estimation of nanophase fluxes within the critical zone suggests that the vast majority of these compounds are of natural origin, composed of clays and oxides released from soil [1]. We are using mesocosms and the unique functionality of the Landscape Evolution Observatory (LEO) in Tucson, Arizona, USA to discover the mechanisms leading to the production of nanophases during soil formation. The LEO facility consists of three 10° replicate artificial hillslopes 30m in length and covered with 1m of crushed basalt. This extraordinary instrumentation allows us to collect soil and effluent solutions at high frequency, and under a variable hydrological regime in complex, field-like mineral assemblages subjected to weathering under controlled conditions. Samples are analyzed using ICP-ToF-MS in single particle mode, coupled with data processing methods (hierarchical agglomerative clustering). Through this approach, we are able to characterize nanophases through identification of their multi-elemental composition, concentration, and size distribution. Particular emphasis is placed on nanoparticles carrying major elements such as: Mg, Al, Si, Mn, K, Ca, Fe. We show in particular how sample preparation techniques and data treatment can be optimized to improve our ability to identify and quantify natural nanophases.

[1] Hochella et al.. (2019). *Science*, *363*(6434)