How deep can surface signals be traced in the Critical Zone?

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The collaborative research centre AquaDiva seeks to develop a fundamental understanding of the links between surface and subsurface, especially how organisms inhabiting the subsurface critical zone (CZ) reflect and influence their physical, ecological, and geochemical environment, and affect water and matter transiting the CZ. To achieve this, we have constructed a novel infrastructure platform, the Hainich Critical Zone Exploratory (CZE) in an alkaline geological setting, to study how water and gas fluxes link surface vegetation and soils under different land management to aquifer complexes. A suite of biotic and chemical "fingerprints" specific to surface properties were developed to indicate how signals are transported and transformed as they transit the unsaturated zone into aquifers. Our results demonstrate large differences in the biota and biogeochemistry of two aquifer complexes traceable to differences in aquifer lithology and land use in recharge areas. They also show the importance of antecedent conditions on how groundwater dynamics, chemistry and ecology respond to events. We have applied the full range of 'omics' tools in challenging low biomass subsurface habitats, identifying zones that vary widely, from the genetic potential to active proteins and products. Subsurface autotrophy and rock-derived organic matter supports a surprising fraction of heterotrophy, even in groundwater relatively close to the surface.

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