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Dynamics and pathways of deep root nutrient acquisition traversing the soil – saprolite interface

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The capacity of some plants to access water and nutrients at depths greater than one meter is a functional trait that can confer advantages to deep-rooted plants and surrounding ecosystems. Working in a subalpine montane meadow in the East River Watershed, Colorado, we revealed the dynamics and pathways for sagebrush (*Artemisia Tridentata*) acquisition of water from rock moisture, major nutrients from silicate weathering, and phosphorus from apatite dissolution. We combined geochemical depth profiles, strontium stable isotope signatures, root exudate and tissue metabolomics, bacterial and fungal community profiling, and microscale geochemical imaging of sagebrush rhizosphere across shallow and deep rooting zones. These data show that sagebrush exhibit distinct shallow and deep rhizosphere processes for nutrient acquisition and cycling. Sagebrush utilization of bedrock elements is dependent on precipitation and water availability, and benefits from synergistic interactions between root exudates of secondary metabolites that influence deep phosphorus and iron biogeochemistry.