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Walker and Syers enter the critical zone: Integrating decadal scale root development with longer term soil development to understand terrestrial nutrient cycling

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Abstract

Most terrestrial nutrient sources are hypothesized to shift in dominance from mineral- to organic matter (OM)-derived over millennia. We investigated how overlaying this hypothesis with plant rooting dynamics that can feedback to soil development offers insight into ecosystem functioning. To test the hypothesis that the nutritional importance of OM as mineral weathering proceeds is mediated by rooting system nutrient economies that vary with vegetation development, we paired litterfall decay experiments with soil mineralogical data from diverse forests across the Critical Zone (CZ) Observatory Network. We demonstrate that sources of phosphorus shift from OM-bound stocks to minerals as the rooting zone expands during the transition from mid to late stages of forest growth. Root-driven, plant-soil feedbacks thus can prompt inconsistencies with soil development models that posit a unidirectional transition from mineral to organic nutrient dominance, and illuminate how forest growth and land use influence nutrient bioavailability in Earth's CZ.

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