

Title: Carbon Dioxide Production in Bedrock beneath Soils Substantially Contributes to Forest Carbon Cycling

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Project Abstract:

Soils are widely considered the primary terrestrial organic matter pool mediating carbon transactions with the atmosphere and groundwater. However, in many terrestrial environments, roots and the associated microbial communities extend below soils and into fractured bedrock. While it is likely that this extension of the rooting zone alters the hydrologic and biogeochemical dynamics of the ecosystem, it is not known if these dynamics have a significant impact on carbon cycling within and from the subsurface. Here we show substantial production of CO₂ in weathered bedrock at 4-8m below the thin soils (<0.5 m thick) of a Northern California forest using innovative monitoring technology for sampling gases and water in fractured rock. The deep CO₂ production supports a persistent upward flux of CO_{2(g)} year round from bedrock to soil, constituting up to 29% of the average daily CO₂ efflux from the land surface. When water is rapidly traversing the fractured bedrock vadose zone, nearly 50% of the CO₂ produced in the bedrock dissolves into water, promoting water-rock interaction and export of dissolved inorganic carbon (DIC) from the unsaturated zone to groundwater, constituting as much as 80% of the DIC exiting the hillslope. These results indicate we should consider carbon cycling within weathered and fractured rock in larger climate and ecosystem models as a source of CO₂ to the atmosphere, groundwater, and streamwater.