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Temperature and Soil Moisture Impacts on Decomposition of Mineral-Associated Carbon: LBNL TES SFA

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Soils are an important reservoir of organic carbon (OC) in the global carbon cycle. It is well established that interactions with minerals are one of the primary mechanisms by which otherwise decomposable carbon accumulates and is retained in soils and sediments. However, the bioavailability of different mineral-associated organic substrates under varying environmental conditions is not well understood. Previous work under this SFA found there was a dramatic decrease in the decomposition of glucose, an otherwise highly decomposable organic substrate, when it was adsorbed to synthetic goethite and ferrihydrite. Specifically, association with Fe (hydr)oxide minerals reduced decomposition of added glucose by over 95%. Although absolute respiration rates of native OC were much lower in the deeper soils, respiration rates normalized by total OC did not differ from surface rates, implying that total carbon availability limits respiration at depth. Following further analysis, we found that the temperature sensitivity of total respiration (native C and glucose) appears to be greater in the deeper soils but sensitivity of mineral-associated organic carbon appears to be less sensitive than native carbon. To assess the impact of temperature and moisture on the decomposability of mineral-associated glucose in soil, we conducted a series of laboratory incubations at two different temperatures (25 °C and 30 °C) and two different moisture levels (20% VMC and 30% VMC) with field- collected soils from two depths (10-20 cm and 80-90 cm). 13C-labeled glucose was added either directly to the soil or after it was adsorbed to with poorly crystalline synthetic iron (hydr)oxide (ferrihydrite). While temperature and moisture enhanced decomposition rates, the effect was more pronounced for native OC than for mineral-associated glucose and greater in surface soils.

Our results show how the changing moisture and temperature regime within a soil affect the sorption-desorption behavior of an otherwise readily metabolized organic substrate and how these moisture- and temperature-induced responses vary with depth.