Explicitly representing microbes, enzymes, mineral interactions, and tracer transport to predict depth-resolved SOM stocks and turnover under warming: A component of the LBNL TES SFA

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Recent work by our and other groups indicates that emergent soil organic matter dynamics depends on microbes, enzymes, and mineral surface interactions. As part of the LBNL TES SFA in Belowground Carbon Cycling, we are developing and applying models that explicitly represent microbial physiology, thermodynamic constraints on uptake, internal physiology, and surface complexation with mineral surfaces. Our enzyme submodel accounts for production, interactions with dissolved organic substrates, and surface complexation. Temperature sensitivities of the various processes are separately represented and are being integrated into the existing reactive transport solver in CLM4.5. We have also integrated these results into the reactive transport solver TOUGHREACT, and will present results demonstrating that this model structure can accurately predict vertically resolved SOM stocks and $\Delta^{14}C$ values across a mineralogical gradient. We also show that these complex interactions result in non-intuitive functional dependencies that cannot be calibrated, implying that directly simulating SOM dynamics requires explicit representation of these processes.