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Buried soils as sources of ancient carbon along eroding loess landscapes

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To predict the vulnerability of soil carbon (C) to changes in climate and landscape disturbance, we need to more accurately quantify C storage in pools that may be sensitive to environmental change, identify the mechanisms contributing to storage and turnover in these pools, and evaluate their response rates to changing environmental conditions. Most of our understanding of soil C comes from surface soils, due to long-standing assumptions that deep soils contain little C and what little C was found at depth was unreactive on short time scales. The presence of partially-decomposed, large soil C stocks in buried soils at depth challenges these assumptions. Buried soils or paleosols, that represent former surface horizons, can store more reactive organic C than mineral horizons at equivalent depths, defying modeled expectations about C dynamics down the soil profile. Any disturbance event that reconnects buried soil C reservoirs to modern surface conditions may reactivate microbial decomposition of ancient C.

Here we present data on the spatial distribution, composition and bioavailability of C in a loess-paleosol sequence, which developed in response to changes in climate during the late Pleistocene to early Holocene transition in the U.S. Central Great Plains. We sampled along burial and erosional transects to characterize spatial variability in the depth of the Brady soil from the modern landscape surface and to determine how these differences may alter the amount and composition of soil C. Differences in the carbon-to-nitrogen ratios and in the spatial distribution of organic matter along mineral surfaces as determined by nano-scale secondary ion mass spectrometry (nanoSIMS), support differences in composition and potential mechanisms of stabilization between the paleosol and equivalent modern soil horizons. Soil physical and chemical properties, such as soil texture and pH of the paleosol remain relatively constant with increasing exposure along the erosional transects. On the other hand, organic C decreased and total soil C increased as the paleosol neared the modern landscape surface, suggesting increased losses of ancient C with increasing exposure to the atmosphere and incorporation of inorganic carbonates in this semi-arid ecosystem. We will explore the vulnerability of ancient C to decomposition through analysis of organo-mineral associations and through manipulative soil incubations. This information will improve predictions of regional C reservoirs and of the potential of these previously little described C pools to become future C sources.