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Weathering profiles altered by agricultural and restored prairie land use in a Midwestern USA critical zone

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The near complete conversion of Midwestern USA tallgrass prairie to row crop agriculture has altered the structure and function of the Critical Zone (CZ) but we lack understanding of how these near surface changes impact the deeper CZ and ultimately the streams integrating watersheds. Here we aim to investigate how soil chemical and physical properties evolve with land use change from cropland back to tallgrass prairie. The study site at Glacier Creek Preserve (GCP) in eastern Nebraska has a first-order groundwater-fed stream draining a 4 km^2 and 1km wide watershed. Parent material is Peoria Loess overlying Sangamon age glacial till. The northern half of the watershed has been managed as corn/soy agriculture for ~150 years while the southern half was restored to prairie from agriculture 56 years ago. A series of deep (> 4m) sediment push cores were collected from the ridgetop, midslope, and footslope topographic positions of both agriculture and restored prairie land use and analyzed for physicochemical properties. The southern restored prairie part of the watershed consists of silty loess overlying glacial till with higher clay and gravel content. The northern agricultural part of GCP has more complex stratigraphy with loess overlying glacial till interspersed with lenses of sandy outwash that are not correlated across the watershed. Within the loess parent material, weathering profiles show similar depletion of Ca and Mg at the surface but differ in the depth of elemental depletion; a deeper Ca and Mg weathering front under restored prairie suggests that weathering products may be flushed deeper into the CZ whereas weathering products in the agricultural soil accumulate ~1.2 m below the modern soil surface. These geochemical profiles point to weathering differences induced by land use, which has implications for other elemental transformations in the CZ (i.e. nutrients and metals). These insights will help to explain how land management decisions such as prairie restoration could impact soil health and water quality as well as how Midwestern CZs may respond to long-term environmental changes (i.e. climate shifts).