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Weathering profiles and solute fluxes in agricultural and restored prairie soils of the Midwestern USA

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The Critical Zone in the Midwestern USA was considerably altered as native prairie ecosystems were converted to intensive row crop agriculture over the last 150 years. Such land use change not only affects near surface soils but can modify water and gas fluxes deeper in the critical zone that impact weathering profiles and solute chemistry. We are investigating how this land use change has transformed the upper 2m of soil in non-irrigated corn-soybean agriculture compared to restored prairie soils in eastern Nebraska and central Illinois as part of the Critical Zone Collaborative Network Critical Interface Network (CINet). Restored prairie soils have stronger soil structure and deeper roots compared to agricultural soils, enabling water and gases to move more rapidly through the soil profile in the well-drained soils. Soil weathering profiles show carbonate reaction fronts that are different between restored prairie and agriculture. In the drier Nebraska site (MAP 78 cm) the carbonate weathering front is deeper in the restored prairie soil compared to the agricultural soil. At the wetter Illinois site (MAP 100 cm) the weathering front is deeper in the agricultural soil drained with a tile compared to the undrained restored prairie soil. Soil porewater in the agricultural soils has consistently higher electrical conductivity and contains higher concentrations of Ca, Mg and Si relative to restored prairie soil porewaters, suggesting water spends more time in contact with weatherable minerals in the agricultural soils. These observations point to the role of land use in controlling how water moves through the soil profile, which ultimately impacts weathering fronts and the solute chemistry of both soil porewater and the streams draining the watershed.