Understanding the repercussions of dryland irrigation on pedogenic carbonate development

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The dryland area covers more than 40% of the land surface on Earth and hosts more than two billion people. The population growth and increase of food demand have converted natural dryland to irrigated agriculture coverage. Indeed, soils developed on the Rio Grande floodplains in the late Holocene have been intensively cultivated for the last 200 years in southern New Mexico and western Texas of Southwest United Stated. Water from the Rio Grande River is used for flood irrigation in these managed soils and its high salinity has led to accumulation of evporate minerals. The irrigation water is oversaturated to calcite and continuous evapotranspiration concentrates the solute and drive calcite precipitation.

The foramation of calcite releases CO_2. To date, however, few studies have quantified the production and emission of CO_2 during the development of pedogenic carbonate in dryland agricultural settings. The challenge is to separate the contributions of biogenic CO_2 (from soil respriration) and abiotic CO_2 (from calcite precipitation). We studied such soil-water-gas interaction in a flood-irrigated pecan field in El Paso, Texas, and characterized the organic matter and cabonates in the soil profiles, dissolved inorganic carbon and major cations in the irrigation and soil waters, and CO_2 in soil gases, as well as CO_2 efflux from land to atmophsere. Using stable carbon isotopes and caron mass balance, we modelled the dynamics of inorganic carbon, quantified the pedogenic carbonate development (soil C sequestration) and soil-atmosphere CO_2 exchange.

This study clearly demonstrated that supplies of Ca and DIC by irrigation accelerated accumulation of pedogenic carbonates, and thus the secondary calcite observed in the agricultural sites is mainly induced by agricultural practices and considered young. Preliminary work shows a measurable flux of CO_2 as a consequence of calcite formation and suggests that this might be an important process in land-carbon-climate feedback.