Agricultural irrigation in drylands leads to development of pedogenic carbonate and release of soil CO_2

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The With limited natural precipitaion, water from the Rio Grande River is used for flood irrigation in agricultural soils of western Texas and southern New Mexico. Its high salinity has led to accumulation of evporate salts, including calcite. To date, however, few studies have examined the rates, controls and kinetics of pedogenic carbonate in dryland agricultural settings. We studied two sites with contrasting soil texture located in El Paso, Texas, aiming to quantify the production rates of pedogenic carbonate in dryland agricultural settings and the accompanied CO_2 efflux from soils to atmosphere.

We investigated such soil-water-gas interactions by combining isotopic and elemental analyses with mass balance modeling, and characterized carbon in all forms: the organic matter and cabonates in the soil profiles, dissolved inorganic carbon and major ions in the irrigation and soil waters, and CO_2 in soil gases, as well as CO_2 efflux. It was demonstrated that calcite accumulation, promoted by continuous supplies of dissolved inorganic carbon and Ca^{2+} through irrigation, was much faster in these managed soils than in natural soils. More than half of the secondary calcite observed in studied soils was accounted for by 100 years of modern agricultural irrigation.

Both efflux and carbon isotope data pointed to contribution of both biogenic CO_2 (from soil respriration) and abiotic CO_2 (from calcite precipitation) to the overall soil gas CO_2. This preliminary work shows a measurable flux of CO_2 as a consequence of calcite formation and suggests that this might be important in land-carbon-climate feedbacks.

This study clearly demonstrated that salt loading 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. More work is needed to understand how human activities such as dryland agriculture have modified global carbon budget.