Anthropogenic impacts as a state factor of soil genesis: enhanced calcite accumulation and abiotic CO_2 emission in irrigated drylands

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Slow accumulation of pedogenic carbonate is characteristic and unique in drylands, controlling soil pH, soil struture, nutrient availability, water dynamics, and landscale evolution. To support growing population and food demand, natural dryland ecosystesms have been irrigated and converted to agricltural fields, making it biogeochemically and hydrologically active. Along with salt buidup and thus elevated soil salinity that challenges the sustainability of dryland agriculture is the enhanced pedogenic carbonate accumulation through chemical loading by irrigation, as well as emission of abiotic CO_2 to atmosphere. As a case study, we have investigated managed agricultural soils along the U.S.-Mexico border in western Texas and southern New Mexico, which are typical and representative of the aridlands around the world. Field, laboratory and modelling apporaches are combined to examine how pedogenic carbonate formation in irrigated agricultural systems, an under-studied process but continuously magnified by human activities, impacts C cycling in one of the largest biomes on Earth.

Master variables that control this chemical reaction rate, are identified including soil texture, and irrigation water intensity and chemistry. Here we report soil gas chemistry data to partition soil respired CO_2, atmospheric CO_2 and calcite-derived CO_2, and combine it with CO_2 efflux data to quantify spatial and temporal variability in abiotic CO_2 emission rates. With implications for similar regions worldwide, results will be scaled up to determine the likely impact and significance in local to biome-wide carbon cycling and this provides key input parameters required for Earth system model. This study highlights that at Anthorpocene, pedogenic carbonate accumulation in irrigated drylands worldwide might emit an important anthropogenically induced flux of CO_2 to the atmosphere.