SOURCES OF CALCIUM AND CARBON IN PEDOGENIC CALCITE OF DRYLAND AGRICULTURAL SOILS

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Elevated soil salinization as a direct result of irrigation is a global problem affecting 10% of agricultural soils, particularly in drylands. Irrigated agriculture in drylands is unsustainable because of high-water demand in water-limited environments. Additionally, the waters used for irrigation typically have high salinity and regional evapotranspiration exceeds precipitation, both leading to salt accumulation in poorly drained soils.

Like many agricultural fields in the arid southwest of the United States, our study site, a pecan orchard in the El Paso, TX region, is irrigated using >1m water per growing season and has high soil salinity and sodicity. Calcite ($CaCO_3$) is oversaturated in irrigation waters and precipitates in soils, accompanied by release of CO_2:
$2HCO_3^{-}{}_{(aq)} + Ca^{2+}{}_{(aq)} \leftrightarrow CaCO_{3(s)} + CO_{2(g)} + H_2O_{(l)}$. Although the impact of pedogenic $CaCO_3$ has been intensively studied in natural systems, few have focused on its irrigation-induced accumulation and its potential to have largescale effects on C-cycling. We collected dust, irrigation water, soil-water, soil-gas, soil samples, and then analysed them for $^{87}Sr/^{86}Sr$ and $^{13}C/^{12}C$ to identify Ca and C sources in soil $CaCO_3$. Our data indicate that irrigation water contributed most to the Ca and C in pedogenic carbonates. Additionally, $\delta^{13}C_{CO2}$ values show signatures controlled by irrigation. These findings support the hypothesis that dryland agriculture is crucial in C-budgets, as they are enhancing secondary carbonate formation. As such, the salt loading through flood-irrigation greatly impacts global Ca and C cycles, given the large area of irrigated drylands worldwide.