Signatures of long-term rhizosphere processes at depth—xeric versus mesic soil-moisture regimes

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The chemical, mineralogic and morphologic changes induced by root rhizospheres in shallow soil are ephemeral due to bioturbation. Though there are fewer roots at depth, the changes induced by root rhizosphere processes can persist beneath the zone of bioturbation. Soil climo-chronosequences offer insight into the role of moisture in determining rhizosphere effects on mineral weathering and soil structure in deep soil profiles. By comparing soil chronosequences formed in similar geologic settings but under differing climate regimes; we can assess the dynamic influence of rhizosphere processes on soil development and biogeochemistry.

Coastal California has a pronounced N–S gradient of decreasing precipitation with small variation in mean annual temperature. We compared two soil chronosequences, Santa Cruz (~700 mm mean annual precipitation (MAP)), and Mattole (1575 mm MAP). Both developed on relatively homogenous sediments under coastal prairie ecosystems. The oldest soils at Santa Cruz exhibit prominent textural heterogeneity (i.e., reticulate mottling) in the B-horizon. Unlike typical conditions associated with redoximorphic mottles, which form in carbon-rich, oxygen-poor low-lying soils, the carbon-poor Santa Cruz terrace soils are well oxygenated during most of the year. Differences in the physical and chemical characteristics between the various mottle zones are indicative of the processes through which the structures have formed, consistent with the conceptual model of Fimmen et al. (2008) involving long term rhizogenic reactions. In contrast, these processes in the wetter soils in the Mattole chronosequence have formed thick deep (~150cm) A-horizons with more soil organic carbon and no mottling in the B-horizon. The extent to which moisture regulated differences in the rhizosphere control the coupling of soil development and carbon cycling is not well known. Chemical modeling of bulk profile evolution is challenging and limited thus far to one spatial dimension. Ongoing work, including tomographic imaging and spatial mapping of soil properties, may help elucidate how rhizosphere processes contribute to long-term differences in soil formed under contrasting moisture regimes.