Controls on the soil genesis in the alpine Rocky Mountains, Colorado

LIXIN JIN[1], ALAN BARRAZA[1] AND LIN MA[1]

[1]Department of Geological Sciences, University of Texas at El Paso, El Paso, TX 79968, USA

The snow-covered alpine regions are sensitive to climate changes and variation in hydrological dynamics. This will consequently impact rates and extent of soil development during the critical zone evolution in these high-altitude areas. This work compared two soil profiles developed on constrasting lithology (carbonate-rich sandstone versus gneiss) and characterized elemental, mineralogical, and isotopic changes during chemical weathering in the Rocky Mountains, Colorado. One soil profile (~53 cm deep) was collected from the Minturn site that is developed on the sedimentary Minturn Formation, described as sandstone but with different amounts of carbonate minerals. The other soil profile collected at the Peru Creek site and developed on silicate bedrock gneiss, was much thinner (~16 cm deep).

The weathering fronts of carbonate phases (calcite and dolomite) in the Minturn site are sharp, within 3 cm of the bedrock-soil interface. Indeed, soil Ca and Mg, as well as inorganic carbon and Sr, are entirely depleted from the top 50 cm and reach parent composition at the depth of 53 cm. Consistently, strontium isotope ratios are observed to change sharply from silicate mineral-endmember to carbonate-endmember across the 50-53 cm transition zone. The Peru Creek site has high soil organic matter content, but shows limited soil development. The only minerals that are observed to be lost during weathering are pyrite, plagioclase and biotite.

Interestingly, both elemental enrichment (especially Ba, Mn, and Si) and variation in Sr isotopes at shallow soils indicate important loading of eolien deposits at both sites. This wind-transported dust contributes to soil mass balance significantly, especially in shallow Peru Creek soils. The Pb isotope composition of soils, however, show no indication of such dust input, due to either little to no Pb in dust, or similar isotopes between dust-derived Pb and bedrock Pb.

This case study hightlighted low degrees of chemical weathering and soil genesis in these high altitude alpine regions, likely limited by freezing temperature. Carbonate minerals are much more reactive than silicate phases as expected, and thus if present, lead to thicker soils. Eolien deposits have signficantly modified the soil chemistry and future work is needed to determine the dust composition and quantitatively evaluate its flux.