Mineral and chemical variability along a climosequence on a tropical ocean island

MADELYN PERCY[1], LARRY BENNINGER[2]

[1]104 South Road. CB #3315 Chapel Hill, NC 27599, madelynp@live.unc.edu

[2]104 South Road, CB #3315 Chapel Hill, NC 27599, lbenning@email.unc.edu

San Cristóbal Island, Galápagos is located just south of the equator and has seen a consistent climate since the Younger Dryas; this has resulted in the development of a long-term climosequence across climate zones that range from arid to extremely humid. We seek to understand how these tropical soils vary across climate zones and to test whether pedogenic thresholds (abrupt changes in soil functioning) can be identified by geochemical and mineralogical markers.

We collected samples from soil pits and across transects through climate zones. We performed chemical and isotopic analyses using ICP-MS, TIMS, and alpha and gamma spectrometry. Mineralogy was determined by XRD, applying pretreatments to enhance the signals from crystalline phases. The amount of amorphous materials was measured using the ammonium oxalate method. Other parameters, such as the soil texture and pH were collected using standard soil science methods.

Our findings suggest that the chemistry of the soils varies strongly across the climosequence. The pH increases moving from the high, humid zone to the low, arid zone, and the grain size distributions also vary with climate. Concentration data show that especially among micronutrients (e.g., K, Mg), there are variations that depend on the climate zone. We use tau plots, a means by which the change in the concentration of a specific element can be plotted relative to an “immobile” element, to demonstrate the differences in weathering intensity across the climate zones. We show that there are major differences in the mineralogy of soils across different climate zones, but we hypothesize that the primary factor affecting soil chemical processes is the amount of amorphous material in the soil. Given the long-term weathering processes that have occurred on San Cristóbal, we suggest that secondary minerals have further decayed to form amorphous aluminosilica gels. We believe that when it comes to the functioning of the soils, the amount of amorphous material is the primary driver behind nutrient availability, weathering of intact primary and secondary minerals, and some physical properties of the soils, like texture. The amount of amorphous material in the soils is thus the best indicator of where pedogenic thresholds are located across the island.