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Effects of biocrust formation and moss colonization on biogeochemical properties of basaltic tephra

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Landscape Evolution Observatory (LEO) at University of Arizona Biosphere 2 is a large-scale facility that examines landscape development that is happening as a result if interactions between hydrologic, geochemical, and biological processes [1]. Three replicate LEO slopes, formed with loamy sand sized basaltic tephra, have been exposed to rainfall for ten years and recently started to develop areas with observable biocrust and moss on the soil surface. This study describes changes in biogeochemical properties of basalt under influence of increasingly complex biological drivers. LEO slopes were sampled in January 2022, when surface material without any cover, with crust, and with crust and moss were collected at different locations downhill and across the slope. Samples were photographed and species of moss colonizing the surface were identified. Samples were homogenized and analyzed to determine concentrations of organic and inorganic carbon and nitrogen. Composition of organic compounds present in the soil was determined in water extracts. Bacterial, archaeal, and fungal composition and relative abundance were also determined after microbial DNA extraction. In addition, samples were subjected to sequential chemical extraction to quantify weathering of basalt and formation of new minerals. Original basalt used to create LEO soil was very low in carbon and nitrogen and had low microbial abundance. After 10 years of colonization with microorganism, and later moss, significant accumulation of organic carbon and nitrogen was observed. It was more pronounced in areas with biocrust and colonized by the moss. This was accompanied by increased metabolic complexity of extracted organic compounds and microbial diversity. There was also difference across locations on the slope relative to the length of the water flow path. All examined areas accumulated inorganic carbon, but no differences were observed in inorganic carbon accumulation between different biological treatments and slope locations. While there was significant variability in organic carbon and nitrogen between replicate slopes that received same amount of rainfall, it was not reflected in composition of organic matter or microbial diversity. This study demonstrated rapid change in soil properties during colonization by microorganisms and mosses, initial steps of soil development.

[1] Pangle et al. (2015), *Geomorphology* 244, 190-203.