Comparative analysis of zero-order hillslope carbon and nitrogen heterogeneity using solid and liquid samples

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Objectives

The Landscape Evolution Observatory (LEO) at Biosphere 2 near Tucson, AZ is a unique and singular experimental setup in which scientists are able to tackle large-scale earth science questions involving soil formation, nutrient cycling, and chemical weathering in a way that is unavailable in true Earth systems. Three identical zero-order 330 m² drainage basins are each filled with 330 m³ of ground basaltic tephra with a loamy sand texture sourced from northern Arizona for its capacity for carbon sequestration. Mapping of carbon and nitrogen spatially allows scientists to track chemical changes occurring within the slopes.

Methods

To obtain information on accumulation of carbon/nitrogen on LEO slopes as a result of biological and abiotic processes, six soil cores distributed across three locations (5, 3, and 6 shown above) in the LEO hillslopes were collected and six depths including 5, 20, 35, 50, and 85 cm were analyzed in a Shimadzu total carbon and nitrogen analyzer. Seepage samples from biweekly rains on LEO from the same time period were collected from a subset of the 1500 total available samplers and analyzed for pH, conductivity, carbon, nitrogen, cation, and anion concentrations.

Results

Inorganic carbon concentrations varied depending on slope location; in the east slope, it is concentrated along the flow path towards the center of the slope. However, in the west and center slopes, inorganic carbon seems to be concentrated along the outer areas of the slope and less so in the center. Inorganic carbon can come from inorganic processes such as weathering or biotic microbial activity. Nitrogen is accumulated on the soil surface in all three slopes, and in center slope significantly along the channel area. Total nitrogen concentrations in liquid samples did not have a distinct pattern. Significant accumulation of nitrogen and inorganic carbon after three years of simulated rainfall indicate incipient soil formation. Concentrations are expected to increase in solid phase and patterns would become more obvious over time as the soil weathers more. Future plans for LEO include the addition of plants to the slope to further study the effects of biotic and abiotic processes on soil carbon and nitrogen cycling.

Discussion

To summarize, this study demonstrates the potential of LEO as a unique and singular experimental setup for studying coupled Earth surface processes. The results highlight the importance of considering both biological and abiotic processes in understanding soil formation and nutrient cycling. Future studies will focus on understanding the long-term effects of these processes and their potential impact on larger Earth systems.

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References