The climatic and biotic thresholds on soil elemental cycling along an arid to hyperarid rainfall gradient

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Across much of the planet, soil properties and biogeochemical processes vary monotonically with changes in rainfall. The studies that provide these observations have generally been performed in landscapes supporting biota. In this study, we examined soils along a rainfall transition from arid (vegetated) to hyperarid (abiotic) in northern Chile, and find that key geophysical and biogeochemical processes exhibit a sharp non-monotonic response across the transition from biotic to nearly abiotic conditions. All sites are ~ the same age (late Pliocene) and have similar lithologies, so that any chemical differences are due primarily to rainfall. Here we focus on N and S: elements intimately involved in biological processes. Atmospheric deposition is the main input at all locations, but soil retention and *in situ* biogeochemical alteration is strongly dependent on rainfall and biota. At the arid (vegetated) site, soil N is predominantly organic and exceedingly low (0.03 kg m^{-2}), while at the extreme hyperarid endmember, soil N is predominately NO_3^- and much higher than at the arid site (5.4 kg m^{-2}). Sulfate retention increases with aridity, to 240 kg m^{-2}. In the driest soil, a large vertical variation in the SO_4 S and O isotope composition indicates inorganic isotope fractionation during dissolution/reprecipitation and downward transport of sulfate. In summary, the removal of water and biota essentially closes the common soil N and S cycles, resulting in soils that passively accumulate these elements as soluble inorganic ions. The long-term absence of biota strongly alters the behavior and fate of elements, highlighting the signature of life on Earth surface geochemistry.

Phosphorus, barium and boron in the deep-sea coral *Desmophyllum dianthus*: Preliminary calibrations

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We present new data for element/Ca ratios in modern samples of *D. dianthus*, with the goal of developing skeletal proxies for subsurface nutrient and carbonate system proxies. The samples were collected from Atlantic and Pacific regions (~350-1400m) representing a wide range of nutrient and carbonate system concentrations. Mean element/Ca ratios for each coral were obtained for lines along the exterior surfaces of septa using 193nm laser ablation HR-ICP-MS. To test the relationship to seawater chemistry, means for each sample were regressed against hydrographic data from nearby stations. The P/Ca values showed reasonable correlation with seawater phosphate (D-PO4~1.0, where D=El/Ca-coral divided by El/Ca-seawater; R2~0.7). When a single high point is ignored, D-PO4 decreases to ~0.3 and the correlation improves (R2~0.78), supporting the potential for a direct seawater nutrient proxy. However, this D value is far lower than the D-PO4~7.0 reported by Montagna *et al*. (2006) for the same species, and more consistent with inorganic incorporation of an oxyanion. The Ba/Ca values are strongly correlated to seawater Ba/Ca (R2~0.95) with D~1.7, close to that of surface corals. Skeletal B/Ca values were examined for relationships to carbonate system variables. We found a positive correlation with seawater carbonate ion concentration (R2~0.77), and a weaker one with pH (R2~0.51). These new findings provide a preliminary context for exploring the potential for reconstruction of past nutrient and carbonate system distributions using deep-sea corals.

References

Montagna P., McCulloch, M., Taviani M., Mazzoli C., Vendrell B. (2006), *Science* **312** 1788-1791.