Biogeochemical vs. erosional contributions to landscape lowering

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In theory, it should be possible to distinguish the relative contributions of erosional transport and biogeochemical weathering-induced solute loss from landscapes and to separate the contributions of inorganic and biological processes to chemical weathering. This analysis requires a field site where landscape lowering can be modelled by linear diffusion and absolute lowering rates are known. It is also necessary that a conservative geochemical tracer is available. Research has been conducted at two very closely spaced sites in southern NSW, Australia. Using cosmogenic nuclide analysis, Heimsath et al. (2000) determined that the granitic terrain is lowering at ~7-53 m/Myr. At the nearby site, extensive geochemical and mineralogical analyses were used to determine the geochemical behavior of Ce and to establish that it is essentially immobile (Taunton et al. 2000). Assuming the two sites are comparable, results indicate 15-95 % of landscape lowering at these sites occurs via solute loss. Established geomorphological theory states that soil production and landscape lowering rates are inversely proportional to soil depth. Our calculations indicate that the solute loss component does not vary significantly with soil thickness, suggesting that differences in erosion transport rates are primarily responsible for this correlation. The SiO_2 flux determined using this approach is comparable to those reported by Stonetrom et. al. (1998). Ongoing efforts to complete the geochemical dataset from the Nunnock River site will clarify if these scenarios are correct.

The microbial contribution to chemical weathering will depend upon the population size, organisms present, and their spatial distribution. Direct cell count data combined with total lipid biomass determinations show that microbial cells are abundant at the soil-saprolite interface, thus potentially significantly impact the soil-to-saprolite transformation. The total biomass decreases from > 10^8 cells/g in the soil to ~ 10^7 cells/g in the saprolite. Microbial populations and community structure in soil and saprolite collected from a trench changed with depth, with lower diversity in samples up to a meter below the soil-saprolite interface. Laboratory experiments have been designed to evaluate microbial contributions to mineral dissolution rates.

References

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Implications for post-sapropel aridity on land in the Eastern Mediterranean region

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Speleothems from several caves located in the semi-arid Eastern Mediterranean (EM) type climate (Israel) were studied through high resolution U-^{230}Th TIMS dating and stable isotope composition. Their oxygen isotope ($\delta^{18}O$) records, covering the last 250 kyr, show striking similarities, indicating that they are a robust proxy for the climatic conditions on land. These speleothem $\delta^{18}O$ records show a strong match with the marine $\delta^{18}O$ records of the planktonic foraminifera *G. ruber*, which reflect sea surface conditions. The almost constant value of $\Delta_{G.ruber\text{-}speleothems}$ suggests a direct connection between the isotopic composition of EM Sea surface (the rainfall source) and on-land rain, and that calibrated sea surface temperatures (SST) serve as a good proxy for land temperatures.

Presently, minimum rainfall $\delta^{18}O$ values occur during periods of enhanced rainfall. The $\delta^{18}O$ minima of the speleothems formed during sapropel periods and correspondingly high water level stands in the caves, point to high rainfall on land in the EM region during these periods. This agrees with evidence for increasing rainfall in the entire Mediterranean during sapropel events (Kallel et al., 2000).

The EM sea-surface water $\delta^{18}O$ value during the post-Holocene sapropel S1 period was similar to present, because there is no evidence for addition of large water amounts from external sources. Thus, it is reasonable to assume that changes in sea surface $\delta^{18}O$ mainly reflect temperature variations. Assuming that the calculated SST (Emeis et al., 2000) represent land temperatures, we have calculated the $\delta^{18}O$ of the rain and cave water from which the speleothems were deposited. The corresponding amount of rainfall was then estimated using the last decade relationship between mean annual rainfall amount and its $\delta^{18}O$. These calculations show that post-sapropel conditions were associated with a decrease in rainfall, followed by an aridity trend on land. This pattern probably characterizes the conditions that developed after earlier interglacial sapropel periods.

References

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