

## Theoretical and observational links between erosion and chemical weathering

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Quantifying the magnitude and nature of chemical weathering is fundamental to understanding CO<sub>2</sub> drawdown and the marine budget of elements of paleo-oceanographic significance. The relationship between chemical weathering and erosion is unclear because chemical weathering, such as occurs during soil formation on stable hillslopes, is a quasi-continuous process but erosion can be episodic, especially rapidly uplifting regions where mass wasting is common. We quantify here the link between chemical weathering associated with soil formation and that associated with mass wasting (dissolution of suspended load and river bedload).

This work is motivated by a recent trip to the southern Sierra Madre in Chiapas, Mexico, a tropical region characterized by rapidly uplifting mountains. Here, landform evolution is controlled largely by landslides, most of which remove the entire soil mantle and expose granitic bedrock (saprolite). Such landform evolution is controlled by a cyclic process in which a soil mantle gradually forms on a hillslope, and when it reaches a critical thickness such that the basal shear stress exceeds the Coulomb-failure criterion, mass wasting occurs.

For a given landform, the growth of soil mantle thickness  $H$  can be expressed as  $H(t) = (1/a) \ln[(1/b) \{e^{(abt)} (E_0 + be^{(aH_0)} - E_0)\}]$  where  $1/a$  is the characteristic lengthscale of an exponentially decaying soil production function,  $E_0$  is the maximum soil production rate,  $H_0$  is the initial soil thickness, and  $b = k (d^2y/dx^2)$ , where  $k$  is the soil diffusivity and  $d^2y/dx^2$  is the curvature of the hill. Averaged over 10+ kyrs, the periodicity (0.5-10 kyr for steep slopes) of mass wasting is controlled by soil formation rate. These results can be extended using empirical dissolution rates to predict the ratio of suspended to dissolved load in rivers. This ratio, however, is much higher than observed in rivers, the discrepancy worsening with increasing topographic relief. This implies that enhanced physical erosion does not simply equate with enhanced chemical weathering. Furthermore, a regolith-based approach overlooks another river component that must be overwhelmingly dominated by dissolved load. Only groundwater weathering satisfies this requirement. If the entire source-to-sink path is of interest, groundwater weathering is thus an essential, but poorly quantified, factor in controlling the chemistries of rivers.

## Geochemistry of amphibolite weathering in different climatic setup of Kaveri catchment of southern India and its implications

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Amphibolite rocks occurring within the Archean Peninsular gneisses in the Kaveri catchment area of southern India have been studied to understand their weathering geochemistry under different climatic conditions. Samples of rocks, saprock and saprolites were collected from semi-arid (annual rainfall: 70-80 cms) and humid (annual rainfall: 300-400 cms) regions in the study area. It has been observed that although all samples exhibit different degrees of physical weathering, not much chemical weathering has taken place in the semi-arid climatic setup. Smectite and chlorite are the major secondary minerals in the weathered products of amphibolites in the semi-arid climatic setup; under the humid conditions, secondary minerals are kaolinite, goethite and gibbsite. The Chemical Index of Alteration (CIA) (Nesbitt and Young, 1984) increases progressively from fresh rock to the most weathered samples (CIA from ~ 32 to a maximum of 87) under semi-arid conditions. In the humid climatic setup, however, the CIA reaches the value of 100 indicating a total loss of mobile major elements.

Behaviour of many trace elements does not show too much dependency to the prevailing climate during weathering. Only the REE and yttrium show dependency on the climate. Under the humid condition, REE are mobilized and fractionated resulting in the removal of HREE and enrichment of Ce; residual saprolites have REE patterns that are similar to those of suspended sediments from many large rivers of the world (Sholkovitz, 1988) and those are complimentary to that of sea-water. The usefulness of REE geochemistry in understanding sedimentary processes needs to be studied in detail.

### References

- Nesbitt H. W. and Young G. M. (1984), *Geochim. Cosmochim. Acta* **54**, 1523-1534.  
Sholkovitz E.R., (1988), *Am. J. Sci.* **288**, 236-281