Metal Ion Sorption Processes in the Marine Environment – An Old Subject Revisited

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The partitioning (or sorption) of trace elements from aqueous solutions onto mineral surfaces and natural organic matter (NOM) has played a major role in determining the trace element content of natural waters, as was first proposed by Goldschmidt (1932) and Krauskopf (1956). Here we review sorption processes on mineral surfaces for nine trace elements (Cr, Co, Ni, Cu, Zn, Sr, Cd, Hg, Pb), focusing on the results of modern x-ray absorption spectroscopic studies. The role of NOM, common bacteria, and marine biomass on trace metal sorption and the effects of coatings of NOM and microbial biofilms on cation uptake on mineral surfaces will be reviewed based on available macroscopic and spectroscopic data. The objective here is to assess the relative importance of inorganic *vs*. organic sorption processes in aquatic systems. We conclude with a discussion of the effects of water composition on trace element removal mechanisms. Comparison of trace metal uptake trends on inorganic and organic marine particles with modern estimates of trace element concentrations in seawater (Nozaki, 2001) indicates that sorption processes on mineral, NOM, and microbial and algal surfaces, including true adsorption and precipitation, are highly effective at removing trace elements from natural waters and generally supports Krauskopf's (1956) conclusion that such processes are likely responsible for the present trace element concentrations in seawater.

Goldschmidt, V.M. (1932) Grundlagen der quantitativen Geochemie. *Fortschritte der Mineralogie* **17**, 112-156.

Krauskopf, K.B. (1956) Factors controlling the concentrations of thirteen rare metals in seawater. Geochim. Cosmochim. Acta 10, 1-26.

Nozaki, Y. (2001) A fresh look at element distribution in the North Pacific. *EOS, Trans. Am. Geophys. Union*, Electronic Supplement.

Combining low temperature apatite thermochronology and cosmogenic isotope analysis in quantitative landscape evolution studies

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Perhaps the most challenging aspect of studying landscape evolution is the need to measure rates of surface processes that operate over vastly different spatial and temporal scales. In recent years major advances in this field have come from the realisation that thermochronologic data (such as apatite fission-track and U-Th/He analysis) can be used to estimate broad, long-term ($\geq 10^7$ yr) erosion rates. However, it is difficult to relate these broad estimates to specific landscape forming processes (eg. escarpment retreat, rates of valley incision), or to actual landscape elements (eg. escarpment faces, ridges or discrete low relief surfaces) or even to similarly broad scale erosion rate estimates made over much shorter time scales (from river sediment and solute load data for example). Cosmogenic isotope analysis can make an important contribution by providing estimates of the pattern and variability of erosion rates over the key intermeadiate spatial and temporal scales and thus a means of extrapolating the wealth of information gleaned from short term process studies to the broader spatial and temporal information obtained from both apatite fission-track and U-Th/He thermochronologic data.

Our recent work from the southeast Australian margin escarpment, the Drakensberg escarpment in South Africa and the continental margin escarpment in Namibia clearly demonstrates the effectiveness of combining these complemetary analytical methods to derive integrated, quantitative denudation histories. In all three studies we have been able to show that the short and long-term rates and pattern of denudation across these escarpment segments are incompatible with a steady, parallel retreat model for the evolution of these important landscape features. We suggest an alternative model where the escarpment is formed by rapid post-break-up river incision seaward of a pre-existing drainage divide located just inland of the present escarpment location, with the escarpment subsequently pinned at this divide and characterised by moderate to low retreat rates ($\leq$ 10-100 m/Ma).