

The impact of element speciation on apparent partition coefficients

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Liquids, including aqueous fluids and silicate melts, are strongly underrepresented in the geologic record. This is unfortunate, because fluids and melts play a disproportionately large role in the mobility and cycling of elements, as well as in the rheology of the Earth. To constrain the compositions of these liquids we commonly turn to cogenetic minerals, which are readily available in the geological record, and reconstruct liquid compositions using data on the partitioning of elements among minerals and fluids. Lattice-Strain Theory (LST) provides the reference frame for understanding the systematics of this partitioning, by linking partition coefficients to the extent of charge and/or radius mismatch of an element in the mineral lattice [1]. A large mismatch results in a low partition coefficient and vice versa. This partitioning approach has proven highly successful for silicate melts, and is equally applicable to mineral-aqueous fluid systems [2]. However, partitioning studies are generally mineral-centric and regard the liquid as a passive reservoir from which the mineral selectively incorporates elements depending on their fit. It thereby ignores the variable complexation, or speciation, of elements in melts and fluids.

We have evaluated the impact of speciation on partition coefficients by experimentally determining the trace element partitioning behaviour among minerals and fluids in aqueous solutions with varying ligands. Experimental results, complemented with data from natural systems, show that differences in speciation among the elements change apparent (i.e. measured) partition coefficients by up to 4 orders of magnitude. Speciation exerts control on partitioning by determining the concentrations of the species involved in element uptake [2]. If speciation is known, this effect can be incorporated in LST modelling by correcting concentrations for the proportion of an element present in the species relevant to element uptake.

We conclude that the liquid is not a passive reservoir in element partitioning with minerals. Speciation effects have to be accounted for to accurately reconstruct liquid compositions from minerals. However, if speciation is known, its effects can readily be accommodated in Lattice-Strain Theory.

[1] Blundy & Wood (1994) *Nature* **372**, 452–454; [2] van Hinsberg, Migdisov & Williams-Jones (2010) *Geology* **38**, 847–850.

Aluminium in an ocean general circulation model and observations

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The distribution of dissolved aluminium (Al) in the ocean is of interest because of the impact of Al on remineralisation of diatom opal and the use of surface ocean Al as a tracer for dust. The main thermocline Al concentration has been simulated reasonably well with only a dust source and scavenging as the removal process [1].

In this study the simulation is significantly improved by the addition of a sediment resuspension source (Fig. 1). This supports the idea that the most significant sources of Al to the ocean are dust deposition and sediment resuspension.

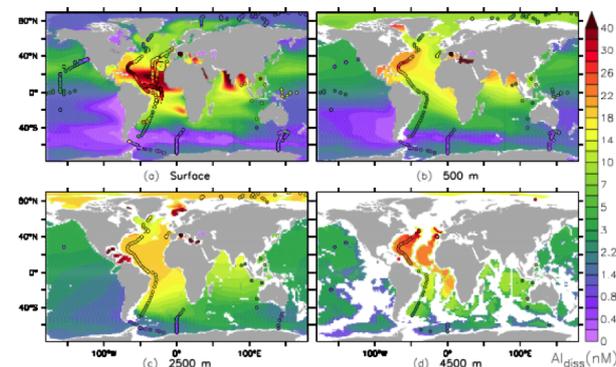


Figure 1: Modelled dissolved aluminium concentration at four depths in the world ocean. Observations as coloured dots. Both simulated and observed concentrations are in nM. Experiments with biological incorporation have been performed as well. These show that this can be an important removal process.

[1] van Hulten, M.M.P., A. Sterl, A. Tagliabue, J.-C. Dutay, M. Gehlen, H.J.W. de Baar, and R. Middag (2012). "Aluminium in an ocean general circulation model compared with the West Atlantic Geotraces cruises". In: *Journal of Marine Systems*. ISSN: 0924-7963. DOI: 10.1016/j.jmarsys.2012.05.005.