Saturation state of seawater with respect to the otavite-calcite solid solution

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In the oceans, the vertical distribution of dissolved cadmium (Cd) generally exhibits a nutrient-type profile. For this reason, it has been admitted that its depletion in the surface waters is regulated by biogeochemical processes. On the other hand, experiments on the sorption of Cd^{2+} to calcite and/or aragonite surfaces have shown the effectiveness of these minerals – especially aragonite – in removing Cd from freshwater solutions (e.g. Prieto *et al*., 2003).

Our aim in this study has been to thermodynamically evaluate the possible occurence of an inorganic removal of Cd from seawater, by sorption/coprecipitation onto/with calcite, to form otavite-calcite solid solutions. This research has resorted to chemical modelling, previous to experimental observations.

Using the geochemical computer code PHREEQC (Parkhurst and Appelo, 2003), and JGOFS data collected from the equatorial Pacific (lat=0º, long=-140º) at depths from 20 to 175 meters, we have calculated the saturation state of this seawater with respect to the pure endmembers of the $(Cd,Ca)CO_3$ solid solution. We observe that seawater is supersaturated with respect to pure calcite and subsaturated for pure otavite. Furthermore, by computing the "stoichiometric supersaturation function" (Prieto *et al*., 1993) for the whole solid solution compositional range, we observe that the maximum supersaturation of seawater deviates slightly from the pure calcite composition, i.e. the solid phase most likely to precipitate from the aqueous solution is a Cd-bearing solid. Also, an increase in the dissolved Cd in the aqueous solution leads to a higher equilibrium distribution coefficient, which in turn results in a higher mole fraction of Cd in the precipitating solid phase.

These findings may suggest that an uptake of Cd from seawater on an inorganic basis might have some influence in the Cd depletion of the surface oceans. This inorganic removal would, however, depend on the availability of inorganic calcitic and/or aragonitic particles in the surface waters, among other factors.

References

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Earthworms and mineral weathering

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The role of organisms in mineral weathering has been investigated by several authors. Studies have shown that bacteria, fungi, lichen and plants all have a role in mineral weathering. The role of annelid worms in mineral weathering has been little studied. Mineral weathering has been demonstrated in marine annelids (McIlroy *et al*. 2003) and there is some indication that earthworms may also play a role in mineral weathering (Suzuki *et al*. 2003). Earthworms interact intimately with the mineral soil and have a major influence on the physical structure and chemistry of soils. They increase the porosity and the water holding capacity of soils. Their casts have more available plant nutrients than the bulk soil. They transport material from the lower horizons to the soil surface and they are responsible for the incorporation of organic matter into the lower horizons. A series of experiments were run to investigate the effect of an epigeic earthworm (*Dendrobaena attemsi*) on soil minerals weathering. The minerals anorthite, biotite, olivine, kaolinite and smectite were mixed with a sterilized manure substrate. Four treatments were used to investigate the effect of the earthworms on the minerals; earthworms and minerals, earthworms and no minerals, no earthworms and minerals, and no earthworms and no minerals. The earthworms were left to process the substrates for 1, 2, 4 and 6 months. Four sacrificial replicates were used. Changes in mineralogy were analysed using x-ray diffractometry, scanning electron microscopy and chemical methods. Results for these experiments will be presented. Changes in peak position, peak height and peak width on X-ray diffraction patterns indicate weathering of smectite, anorthite, biotite and kaolinite but not olivine. Image analysis indicates weathering of anorthite and biotite.

References

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