

Trace element dissolution rates during the decomposition of large marine particles: *in vitro* experiments and the role of biological activity

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Large sinking marine particules play a key role in the cycle of the elements in the ocean. During their settling through the water column, they interact with the solution and small particles by aggregation-disaggregation, adsorption-dissolution, biodegradation... However, our understanding of these processes is still scarce mostly due to the lack of experimental and/or field data. Among these processes, the effect of the direct dissolution of large marine particles in response to bacterial activity is poorly constrained. An *in vitro* experiment has been set up in order to study simultaneously the behaviour organic and inorganic matter during the decomposition of large particles by bacteria (Sempéré *et al.*, 1998; Roy-Barman *et al.*, 1998). Here, we report results obtained for a selection of trace elements that are essential for studying the transport and fate of matter in the ocean. Aluminum is used as a tracer of the lithogenic fraction in the water column. Barium is used as a tracer of the exported production in the present ocean and as a tracer of the ocean palaeoproductivity. Manganese is sensitive to the redox conditions of the environment and precipitation of Mn oxy-hydroxides plays a key role in the scavenging of trace metals in the water column.

The sampling site (DYFAMED) is located in the Mediterranean Sea 5 miles off Nice. Large volume of seawater were filtered through 60 μm grids using *in situ* pumps at 30 m and 200 m. The particles were then distributed among different batches in sterile (0.2 μm filtration) seawater and left for variable incubation times (from 0 to 20 days) in the dark, at the *in situ* temperature and with oxic conditions. Each incubations was stopped by filtration on a 0.2 μm filters yielding a filtered solution and residual particles. Some samples were sterilized by gamma

irradiation in order to distinguish between biotic and abiotic processes. Filtered solutions (30 m and 200m) and some of the residual particles (30 m) were analysed by ICPMS.

The percentage of dissolution (D) of an element on particles is obtained by comparison of the increase of concentration in solution and the quantity present on particles: at 30 m $D \leq 2-3\%$ for Al, $D = 41-64\%$ for Ba, $D = 18-33\%$ for Mn. The labile fraction of the elements on the particles is defined as the maximum percentage of dissolution. The low labile fraction obtained for Al support the use of Al as litogenic matter tracer. The temporal evolutions of the concentrations in the filtered solutions show distinct behaviours for Ba and Mn. Assuming that the dissolution of the labile fraction follows a 1st order kinetic, residence times (τ) of labile Ba and Mn on particles are estimated based on the data collected during the first days of incubation. For Ba, $\tau = 0.6$ days at 30 m and $\tau = 2.8$ days at 200 m. The temporal evolutions of Ba in the irradiated and non-irradiated samples are similar suggesting that the Ba dissolution is mainly an inorganic process. Ba in marine particules often occurs as BaSO_4 . The difference of residence time suggests a faster dissolution of BaSO_4 at the surface compared to 200 m that is consistent with the evolution of BaSO_4 cristallization states with depth. For Mn, $\tau = 2$ days at 30 m and $\tau = 3-5$ days at 200 m. During the first days of incubation, the temporal evolutions of Mn in the irradiated and non irradiated solutions are similar suggesting an inorganic process. After 20 days, the Mn concentration is lower in the non irradiated solutions compared to the irradiated solutions for both depths, suggesting a biology mediated precipitation of Mn oxides on the particles.

References

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