KEY PROCESSES CONTROLLING BIOGENIC SILICA PRESERVATION IN MARINE SEDIMENTS

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Diatoms, accounting for >40% of global marine primary production, are ideal tracers for upwelling and water mass transport since their productivity is tightly coupled to the 'new supply' of nutrients. The geological record of biogenic silica is therefore believed to reflect past climatic conditions and the paleoproductivity of diatoms. Although a substantial part of the biogenic silica dissolves in the water column, biogenic silica can be traced in sediments that are several 100,000 years old, suggesting effective preservation upon arrival at the sea floor.

Until recently it was believed that preservation of biogenic silica is a passive process. Settling diatom frustules would dissolve as long as they were in contact with corrosive, undersaturated bottom waters. In the sediment, dissolution would continue until thermodynamic equilibrium between the biogenic silica solid phase and the pore water was reached. Our studies however have suggested that preservation is an active process that takes place on the sediment-water interface, where solute exchange is governed by molecular diffusion. The prolonged contact between the biogenic silica solid phase and the elevated solute concentrations in the pore water, notably dissolved metals and specifically aluminium, will promote the diagenetic alteration of the biogenic silica, lower its solubility and dissolution rate and will favor preservation over dissolution. Little is known about the rates at which these diagenetic alterations take place and which source supplies the aluminium needed for the reaction to take place.

In a series of experiments, early diagenetic processes that could occur at conditions typical for the sediment-water interface have been simulated in the laboratory, with emphasis on the role of aluminium. To ensure the absence of any previous diagenetic alterations, all experiments were carried out using the most pristine biogenic silica possible: fresh, cultured diatoms that have not been in contact with any sedimentary component. These diatoms

The cultured diatom *Thalassiosira punctigera* used for the experiments.

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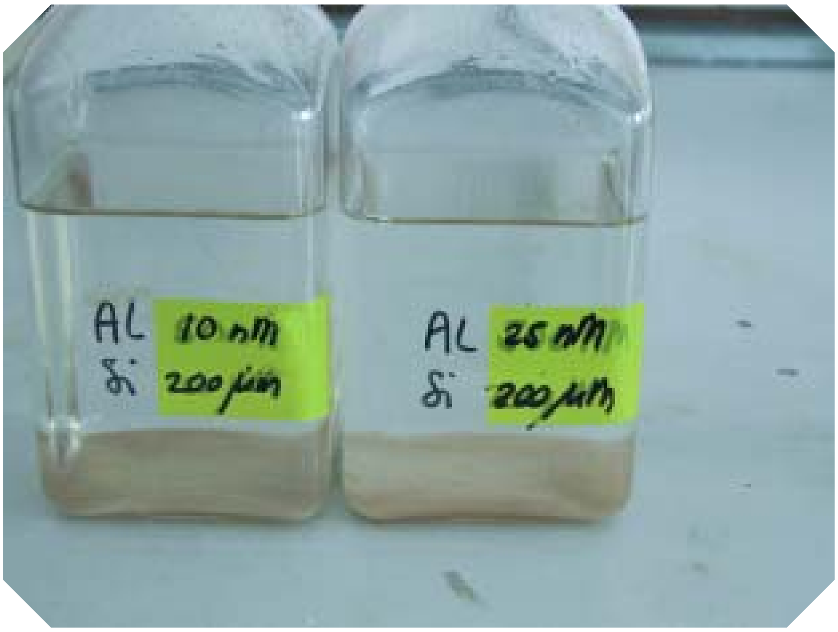
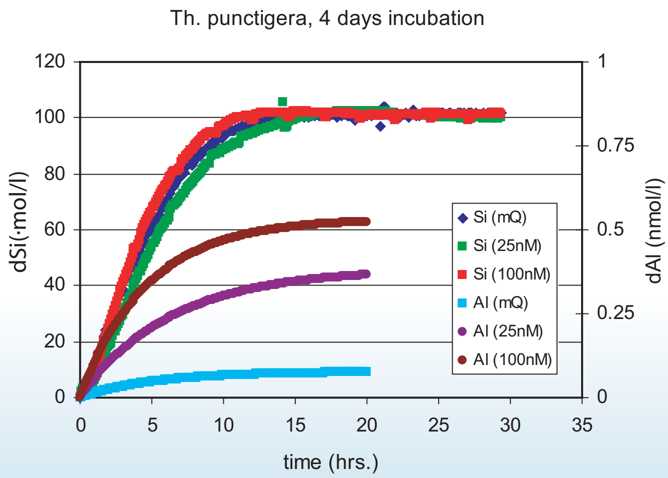


Incubation of diatom frustules of *Thalassiosira punctigera* in natural seawater at increasing concentrations of dissolved aluminium.

were incubated, at controlled temperature and pH conditions, in filtered natural, low-nutrient seawater containing a range of dissolved silica and/or dissolved aluminium concentrations representative for natural pore waters. Within only a few days of incubation, uptake of aluminium could be recorded in the diatom frustules. This aluminium had not been adsorbed on the outer surface but had been incorporated into the biogenic silica lattice. These results suggest that even a small flux of dissolved aluminium diffusing from the pore waters would be sufficient to rapidly induce the diagenetic alteration of biogenic silica. Such an efficient uptake mechanism could result in efficient preservation of biogenic silica in larger areas of the ocean and would not be restricted to tropical estuaries where rivers eroding a tropical hinterland supply the aluminium.



Time series of dissolution of *Thalassiosira punctigera* after 4 days of incubation in seawater with different levels of added dissolved aluminium, showing the uptake of aluminium into the biogenic silica solid phase.