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Recycling of elements from particles in the ocean water column: evidence for in situ reduction and release of dissolved manganese

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Macroscopic aggregates (>0.5mm diameter), also known as marine snow, are ubiquitous throughout the ocean. The majority of this particulate material derives from planktonic material (Biddanda and Pomeroy, 1988) and appears very important in the geochemical cycling and fluxes of organic and inorganic materials in the ocean (Simon et al, 2002; Lee and Fisher, 1992). These carbon rich micro-habitats, have substantial microbial communities and chemical gradients within which processes of photosynthesis, decomposition, and nutrient regeneration occur at highly elevated rates (Alldredge and Silver, 1988). These microbially mediated processes are anticipated to have a major influence on recycling of a range of important nutrients and trace metals, and lead to modification of vertical fluxes of material to the benthos (Alldredge and Youngbluth, 1985).

Actual measurements of rates and magnitude of these important recycling processes are rare. This reflects difficulties with the scale of chemical and reducing gradients (expected to be similar to those of bacteria, i.e. $\sim$1 μm), relative to the best resolution measurements (oxygen - circa $\sim$10 μm), the anticipated low concentrations of many released elements, and unknown release rates.

In laboratory experiments the reduction of manganese dioxide added to algal phytodetritus was measured to give an indication of redox conditions within the aggregate. The released dissolved Mn(II) has a relatively long half life relative to oxidation by oxygen and was sampled in the surrounding seawater using small scale DGT (diffu-

sive gradients in thin films) collectors. Release of dissolved Mn was shown over a timescale of tens of hours, even when the surrounding water was oxic. These preliminary experiments show the presence of micro-reducing zones within aggregates and thus emphasizes the potential for bacterially mediated processes in the recycling of elements in the oceanic water column and “twilight” zone.

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