BENTHIC-BIOGEOCHEMICAL RESPONSES TO PARTICLE FLUX: THE MINERALS AND MICROBIOTA OF CROSS SEAMOUNT

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ABSTRACT

This dissertation addresses (1) the biogeochemical link between benthic and pelagic processes as seen in a transient foraminifer population and suboxic conditions at the seafloor-water interface, and (2) ferromanganese-oxide accumulation, and barite precipitation in the surface and deep oceans. Experimental, observational, and statistical approaches were used to investigate the origin, distribution, accumulation rate, and elemental composition of benthic foraminifera and minerals on the seafloor. The experimental component involved the deployment of experimental substrates for known time intervals at four water depths on Cross Seamount (18° 40'N, 158° 17'W). Scanning electron microscopy, interfaced to an analytical energy dispersive X-ray fluorescence detector (SEM/EDS), was used to document the abundance, morphology, and composition of minerals within the chamber walls of benthic foraminifera and on the experimental substrates. The observational study included SEM/EDS analyses of natural ferromanganese-oxide crusts and water column particles.

A 30% decrease in particulate carbon flux recorded in the central Pacific (Karl et al., 1994) appears to be reflected in the abundances of particular benthic foraminifera on the experimental substrates. When particle flux was greatest, motile calcareous foraminifera and an irregular branched agglutinated foraminifer were most abundant. In contrast, the abundance of most attached, agglutinated foraminifera increased with deployment duration, showing no statistical association with particulate carbon flux.

Manganese-oxides and barite were the two most readily identifiable, abundant, and interesting minerals that accumulated on the experimental substrates. The secondary precipitation of manganese-oxides is best explained by reduction and subsequent oxidation of Mn at the interface between the ferromanganese-oxide substrate and seawater. Observation of manganese deposition during the 4- month experiment is remarkable, given the expected accumulation rate of ferromanganese-oxide crusts is 1-10 mm per million years. The accumulation of barite is primarily controlled by the deposition of pelagic particles. Most of the barite particles originated in the water column, however other morphologically and chemically distinct barite crystals were likely precipitated by benthic foraminifera. Calculations presented here suggest that ocean waters are not as undersaturated with respect to barite as previously believed (Church and Wolgemuth, 1972). In fact, mid-depth and likely some deep waters are saturated with respect to barite.