Composition of diatom silica frustules: A watershed in marine sciences

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Separation of aluminosilicates from diatom frustules is extremely difficult and thus the composition of diatom frustules remains unknown. Community members assume that diatom frustules are almost pure opal in the absence of analytical evidence.

In the hope of acquiring compositional information for diatom frustules, we studied rare earth elements (REEs) in the settling particles collected in the Bering Sea, one of the most diatomaceous productive seas. We observed that the concentration of terrigenous elements in siliceous matter of settling particles showed a strange relationship with opal flux: hyperbolic relationships with non-zero asymptotic values. This relationship could mean that infinite diatom production requires an infinite supply of terrigenous matter. We tentatively assumed that the asymptotic values pertain to the REE composition of diatom frustules.

The tentative composition has further been subject to several intensive studies. In this paper we describe the rationale leading to the presence of terrigenous elements in diatom frustules utilising two new pieces of supporting evidence below.

1) Self-consistent calculation of REE composition of diatom frustules

2) 27Al-NMR measurement of sediment trap samples

By accepting the presence of REEs in diatom frustules, the picture of REE cycling in the oceans needs to be rebuilt. Our new understanding is much more simple, consistent and robust. Without the geochemical information provided by REEs, it would have been almost impossible to seize the elusive nature of diatom frustules. If our conclusion is correct, its influence should be enormous and will have ramifications for, e.g. oceanic cycling of terrigenous elements (Si, Al, Fe, REE etc.), which has the potential to influence our interpretation of oceanic Nd isotope, sedimentary opal, clay and elements therein.