Implications of short-term exchange of foraminiferal tests for proxy application

MATTHEW S. FANTLE[1], PIYALI CHANDA[2], CHRISTOPHER GORSKI[3], ROSEMARY OAKES[4]

[1]Dept. of Geosciences, Penn State Univ., University Park, PA 16802; mfantle@psu.edu

[2]Dept. of Geoscience, Univ. of Wisconsin, Madison, WI 53706

[3]Dept. of Civil and Environmental Engineering, Penn State Univ., University Park, PA 16802

[4]Academy of Natural Sciences of Drexel Univ., 1900 Benjamin Franklin Pkwy, Philadelphia, PA 19103

Fossilized foraminiferal tests are valuable proxy archives that are used to constrain paleooceanographic conditions, including past sea surface and bottom water temperatures. However, relatively little is known about the extent to which these calcareous tests exchange with seawater prior to burial. This study uses a ^{45}Ca radiotracer approach to quantify the extent and rate of foraminiferal calcite-fluid exchange over a three-month period. Experiments occurred in solutions that were close to chemical equilibrium, and evaluated the exchange behavior of modern (*O. universa* and *G. ruber*; 250-500 μm, Cariaco Basin) and fossil (*O. universa, G. sacculifer,* and *G. bulloides*; 250-500 μm, ODP Site 807A) tests, compared to inorganic Iceland spar. Modern tests reacted at the fastest rates, followed by fossil tests and inorganic calcite. Increased Ca^{2+}, Mg^{2+}, and Sr^{2+} concentrations in parallel tracer-free reactors indicate that partial dissolution of tests occurred, even though no overt changes in test morphology – as indicated by both scanning electron microscopy and μ-CT imaging – were observed. In addition, tests took up more ^{45}Ca from solution than could be explained by sorption alone. These observations, along with time-dependent box model simulations of aqueous elemental and solid ^{45}Ca chemistry, support the hypothesis that calcite-fluid exchange occurred via dissolution-reprecipitation and was driven by intra-test chemical heterogeneities. The findings of these short-term exchange experiments are applicable to reactions that can occur in the seawater column and at the sediment-seawater interface. This work suggests that dissolution-reprecipitation in such settings has the potential to overprint the chemistry of foraminiferal tests (~10% decrease in Mg/Ca ratio) without overt physical alteration, which can lead to a potential bias (~1˚C) in paleo-temperature estimates.