Geophysical Research Abstracts
Vol. 15, EGU2013-8735, 2013
EGU General Assembly 2013

A new model for trace-element signatures in foraminifera tests

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The Mg/Ca ratio of foraminifera calcium-carbonate tests is used as proxy for seawater temperature and widely applied to reconstruct global paleo-climatic changes. However, the mechanisms involved in the carbonate biomineralization process are poorly understood. The current paradigm holds that calcium ions for the test are supplied by endocytosis of seawater. Here, we combine confocal-laser scanning-microscopy observations of a membrane-impermeable fluorescent marker in the living benthic species Ammonia tepida with dynamic 44Ca-labeling and NanoSIMS isotopic imaging of its test. We infer that Ca for the test in A. tepida is supplied primarily via transmembrane transport, but that a small component of passively transported (e.g. by endocytosis) seawater to the site of calcification plays a key role in defining the trace-element composition of the test. This identifies a stable, species-specific mechanism for the observed trace-element fractionations and places foram-based paleoclimatology into a strong conceptual framework.