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Constraining the mechanisms driving coccolith δ88/86Sr: new perspectives from cultures and the sediment record

Luz María Mejía (1), Adina Paytan (2), Anton Eisenhauer (3), Florian Böhm (3), Ana Kolevica (3), Clara Bolton (4), Ana Méndez-Vicente (5), Lorena Abrevaya (5), Gerald Langer (6), Kirsten Isensee (7), Patrizia Ziveri (8), and Heather Stoll (1)

(1) ETH, Geological Institute, Zürich, Switzerland (luz.mejia@erdw.ethz.ch), (2) Institute of Marine Sciences University of California, Santa Cruz, USA, (3) GEOMAR Helmholtz Zentrum für Ozeanforschung Kiel, Germany, (4) Aix-Marseille Université, CNRS, IRD, CEREGE, France, (5) Dept. Geología, Universidad de Oviedo, Spain, (6) The Marine Biological Association, Plymouth, UK, (7) UNESCO Intergovernmental Ocean Comission, France, (8) ICREA-UAB, Barcelona, Spain

Coccolithophores are main contributors to the marine $CaCO_3$ production and export to the deep ocean and are therefore important modulators of climate and biogeochemical cycles. During coccolith calcification, Sr substitutes for Ca to some extent. Therefore, as key $CaCO_3$ contributors, significant changes in coccolith's abundance and their Ca or Sr isotopic fractionation could have affected past seawater isotopic compositions. Despite this, the mechanisms driving Sr isotopic fractionation in coccolithophores remain unclear and studies on this matter are very scarce.

The negative correlation found between Sr isotopic composition (δ88/86Sr) and growth rates led the authors of the sole coccolith δ88/86Sr study to imply a potential for kinetic effects driven by temperature. With the aim of identifying the mechanisms controlling coccolith δ88/86Sr, here we apply the published CaSri-Co cellular model proposed for Ca isotopes (δ44/40Ca) and Sr/Ca to a new set of δ88/86Sr, δ44/40Ca and Sr/Ca data from coccolithophores cultured at similar temperatures but varying growth rates. Some of the mechanisms potentially driving δ44/40Ca variability (e.g. calcification rate and characteristics of the solvation environment) appear to also affect δ88/86Sr in coccolithophores.

In this study we also show the first δ88/86Sr records of sedimentary coccoliths (Site 905 in the Arabian Sea and Site 925 in the Western Equatorial Atlantic). As observed for cultures, during the last 30000 years in the Arabian Sea, coccolith δ88/86Sr was found to be anticorrelated to CO_2 variations, implying a potential effect of carbon limitation. The analysis of δ88/86Sr of two different size fractions (3-5 and 8-10 μm) of coccoliths of the Western Equatorial Atlantic during the last 11 My indicates that there may be vital effects, as opposed to the results observed in the δ44/40Ca record, which show no differences between the two size fractions.

Applying the CaSri-Co model to the new culture and sedimentary dataset will allow a better understanding of the processes determining Sr isotopic fractionation in coccolithophores. Further development of this quantitative cellular model in terms of Sr isotopes is required to decipher the cellular pathways of Sr to the site of calcification and better understand how sedimentary coccolith δ88/86Sr records may be used to better interpret biogeochemical cycles.