Coccoliths coasting through the Elderfield Curve

R. E. M. RICKABY[1], M. HERMOSO[2], R. B. Y. LEE[3], AND H-L MCCLELLAND[4]

[1]Department of Earth Sciences, South Parks Road, Oxford OX1 3AN, UK
[2]Institut de Physique du Globe de Paris, Sorbonne Paris Cité, Univ Paris Diderot, UMR 7154 CNRS, Paris, France.
[3]School of Biological Sciences, University of Reading, Berkshire, RG6 6UB
[4]Department of Earth and Planetary Sciences, Washington University in St. Louis, One Brookings Drive, St. Louis, MO 63130-4899, USA

Traditional geochemical proxies have relied on the rich geochemistry of foraminifera as the purveyors of information from the past, due to the ease of separation of single species from sediments and decades of development of foraminiferal proxies. But the sensitivity of those geochemical proxies to the environment, as preserved within foraminifera, can rarely be shoehorned into the inorganic framework which often inspires their application. The challenge of foraminifera laboratory culture and reproduction has hindered a broad physiological understanding of how the signals trapped within their calcite relate to the environment.

By contrast the geochemistry of coccolithophores, which can be easily grown and manipulated in the laboratory have, until now, been largely overlooked due to large and enigmatic "vital effects". Recent culture experiments [1,2], coupled with modelling [3], and advanced methods for separation of different species from sediments have started to unveil insight into the co-evolution between adaptation of these photosynthesising biomineralisers, the expression of the vital effects, and the changing environment. Such evolutionary adaptation leaves a physiological footprint in the isotopes of both the composition of coccolith calcite and the organic molecules (polysaccharides) encapsulated therein [4]. Coccolith geochemistry therefore offers a new approach to reading past changes in e.g. ambient carbon availability and coccolithophore physiological adaptation, based on a mechanistic and biological understanding of the proxy, which can be extended into the Meso-Cenozoic Eras.

[1] Hermoso, M., *et al*., (2016) *Biogeosciences* 13, 301-312; [2] Hermoso, M., *et al.,* (2016) *Geochim Cosmochim Acta* 189, 132-142,.[3] McClelland H. L. O., *et al.,* (2017) *Nat Comms,* doi: 10.1038/ncomms14511,[4] Lee, R. B. Y., *et al.,* (2016) *Nat Comms*, doi:10.1038/ncomms13144.

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