Coccolith chemistry considered

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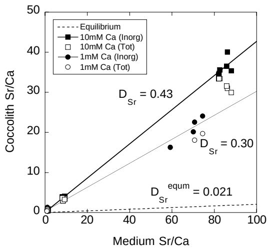
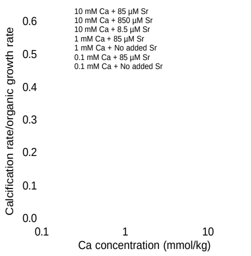
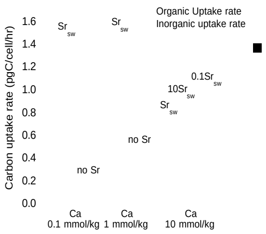
Abstract

The isotopic and trace metal chemistry of marine biogenic calcites has the potential to act as a tool to probe past ocean conditions and related climate change. The composition of biogenic carbonates depend on ocean chemistry, and also on the partitioning associated with mineral formation. We challenge the view that the partitioning occurs according to predictions for inorganic calcite precipitation. Instead we propose that the chemistry of the biogenic calcite is controlled by biological discrimination during the calcification process.

We investigate the chemistry of calcite produced by coccolithophores cultured in various Ca and Sr media. Coccolithophores assemble their liths in an intracellular vesicle and therefore provide the biological end member of the spectrum between equilibrium precipitation of calcite and biologically mediated precipitation (Fig 1). Altered concentrations of Ca and Sr also affect the biological processes and growth of coccoliths (Fig 2, 3). We suggest that the biological discrimination between similarly sized ions by Ca^{2+}-selective channels and pumps, or the organic template, is the dominant control on the chemistry of the calcite. Similarly we investigate the role of Sr and Ca in calcification and other biological mechanisms.







References:

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Does the ocean iron cycle destabilize the glacial climate system?

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Recognition of the role of feedbacks is a long established element in the analysis of system behaviour in disciplines such as electrical engineering. However, as the environmental sciences move towards a more holistic approach to understanding climate change on a range of time scales (so-called "Earth system science") it is becoming increasingly clear that feedbacks are also integral to the operation of the Earth system. For instance, climate models suggest that positive feedbacks between vegetation and rainfall can give rise to the existence of two distinct states for the Sahel region, one relatively moist and vegetated, and the other, arid. Here, a climatic sub-system having the necessary properties for positive feedback is identified, with the iron-sensitive regime of the Southern Ocean as its central component.

Results of recent open ocean iron enrichment experiments, together with numerical models of the ocean-atmosphere carbon cycle all appear to be consistent with the "iron hypothesis" – increased dust supply to the Southern Ocean during glacial periods driving a lower mixing ratio of CO_2 (xCO_2) in the atmosphere. However, dust may play a far more integral role in determining climatic behaviour than simply as a passive 'communicator' of events between different components of the Earth system. If changes in dust flux affect atmospheric xCO_2, and with it climate (though radiative forcing by greenhouse gases), and dust fluxes are in turn responsive to global climate (such as through changes in sea level and the strength of the hydrological cycle), a positive feedback is formed. During glacial periods, operation of this feedback might give rise to two distinct states in the Earth system, one of 'high-xCO_2 low-dust', and the other 'low-xCO_2 high-dust'. This is broadly consistent with data from the Vostok ice core, and with developing views of the Earth system as being characterized by the presence of different quasi steady states with abrupt transitions between them. By enabling an inherently unstable 'super-glacial' state to be periodically attained, the dust-sensitive carbon cycle of the Southern Ocean may also help set the pre-conditions necessary for precipitating the collapse of the Northern Hemisphere ice sheets, thus terminating the glacial state.