

Marine Cements and the Late Cretaceous to Cenozoic History of Magnesium, Strontium, and Calcium in the Ocean

BRADLEY OPDYKE¹, RYAN OWENS¹, JEREMY CAVES²,
PAUL WILSON³ AND ANDRE DROXLER⁴

¹The Research School of Earth Sciences, The Australian National University

²Environmental Earth System Science, Stanford University

³Ocean & Earth Science, National Oceanography Centre, Southampton University of Southampton

⁴Earth Science, Rice University

Relatively unaltered 'pristine' marine cements from neritic environments are recognised as some of the best known proxies for recording marine chemistry through geologic time. Unfortunately, due to their metastable nature they are rarely preserved in the rock record. We have been fortunate enough to recover two examples of such cements from ancient reef environments; one from Site 877 of Leg 144 of the Ocean Drilling Program and one from a RV Melville survey in the Gulf of Papua in 2004. Both were preserved because they were tightly cemented on rapidly subsiding reef platforms and not subject to meteoric diagenesis.

The ODP sample is Maastrichtian in age and the Gulf of Papua sample is from the Early Miocene. These two time intervals represent extremes in the history of strontium incorporation into shallow water depositional environments. During the Late Cretaceous scleractinian corals (which take up large quantities of strontium into their skeletons) were relatively rare, whereas the Early Miocene represents the acme of modern style coral reef growth, with scleractinian corals abundant.

The marine cements record an Early Miocene strontium concentration that is a third of the Late Cretaceous value. Strontium concentrations are similar to or lower than comparable Holocene cements. Magnesium-calcium ratios drop to approximately 3.6 for the Early Miocene and near 2 in the Late Cretaceous. Mass balance of calcium fluxes through over the past 100 million years indicate that the alkalinity has not changed dramatically over this interval. If we hold this total relatively constant then these data confirm previously documented trends in magnesium calcium ratios and for the first time document a significant increase in strontium concentrations in the oceans of the Late Cretaceous relative to the late Cenozoic values.

Changing riverine silicon isotope delivery to the ocean over glacial-interglacial intervals? Evidence from glaciated basaltic terrains

OPFERGELT S.^{1,2}, BURTON K.W.^{1,3}, POGGE VON STRANDMANN P.A.E.¹, GISLASON S.R.⁴ AND HALLIDAY A.N.¹

¹Department of Earth Sciences, University of Oxford, United Kingdom

²Earth and Life Institute, Université catholique de Louvain, Belgium (sophie.opfergelt@uclouvain.be)

³Now at Department of Earth Sciences, Durham University, United Kingdom

⁴Institute of Earth Sciences, University of Iceland, Iceland

The marine primary production is dominated by diatoms which largely depend upon the riverine silicon delivery to the ocean. In paleoreconstruction of Si utilisation by diatoms, a constant Si isotope input from the continent to the ocean is generally assumed. In this study, glacier-fed and direct runoff rivers draining basaltic catchments in Iceland display significantly different dissolved Si isotope compositions, with lighter values ($\delta^{30}\text{Si} = +0.17 \pm 0.18\text{‰}$) associated with the high physical erosion rates in glacial rivers, and heavier values ($\delta^{30}\text{Si} = +0.97 \pm 0.31\text{‰}$) associated with lower physical erosion rates and enhanced formation of secondary minerals in direct runoff rivers. The riverine Si isotopic compositions correlate with those of Li and provide evidence of a climatic dependence that is likely to have led to glacial-interglacial differences in the isotopic composition of Si delivered to the oceans. Based on existing $\delta^{30}\text{Si}$ from diatoms in a sediment record from the Southern Ocean, the interpretation of changes in Si utilisation between the Last Glacial Maximum (LGM) and the early Holocene is revisited accounting for changing Si isotope delivery to the ocean over glacial-interglacial intervals. The results are consistent with a lower Si utilisation during the LGM ($53 \pm 5\%$) relative to the Holocene ($88 \pm 5\%$). During the LGM, Si utilisation values are slightly higher when allowing for changing Si isotope input to the ocean ($53 \pm 5\%$), than when a constant Si isotope input is considered (42 to $47 \pm 5\%$). This study suggests that changes in Si isotope delivery to the ocean should be accounted for in the precise reconstruction of ocean Si utilisation and primary productivity over glacial-interglacial timescales.