Uranium series rate meters for ocean processes

GIDEON M. HENDERSON[1*], YU-TE HSIEH[1], MARK D. BOURNE[1], WALTER GEIBERT[2], FEIFEI DENG[1], ALEX L. THOMAS[1]

[1] University of Oxford, Department of Earth Sciences, South Parks Road, Oxford, OX13AN, UK, gideonh@earth.ox.ac.uk
[2] University of Edinburgh, School of Geosciences, Edinburgh, UK

Uranium-series nuclides have a range of solubility in seawater which, coupled to their diverse half-lives, make them excellent timekeepers for a wide variety of ocean processes. Not only do they record the timing of growth of marine precipitates (most notably corals) but they provide information about the rates of ocean processes such as mixing and circulation, and about chemical fluxes into and out of seawater and sediments. Recent analytical advances are reinvigorating the use of U-series approaches to assess ocean processes. This presentation will illustrate the power of these new measurement techniques to assess three critical ocean processes.

Development of new mass-spectrometric approaches to measurement of ^{228}Ra in seawater [1] allow lower detection limits and higher precision. This precision allows use of ^{228}Ra to quantify ocean mixing and chemical inputs more accurately than before, and in settings not previously investigated, as we will demonstrate with results from the Cape Basin (South Atlantic) and Loch Etive (Scotland).

Measurement of Th isotopes in dissolved form and settling particles enables assessment of downward fluxes of material in the oceans. Th-234 has been widely used to assess downward carbon fluxes, for instance. But increasing precision of ^{230}Th and ^{228}Th measurements in seawater now allow these nuclides to be used to provide complementary information about downward fluxes on other timescales. These tools have huge potential for assessment of other ocean fluxes, including those of micronutrients critical for ocean life and, via measurement of a fourth Th isotope – ^{232}Th – of detrital inputs to seawater such as mineral dust [2].

Th-230 is also frequently used as a constant flux proxy to assess variations in sedimentation rate. We will illustrate how this approach can be used to assess the duration of past events [3] with well-constrained uncertainties, and to assess chemical fluxes both into and out of marine sediments.

[1] Hsieh and Henderson (2011) Journal of Analytical Atomic Spectrometry **26(7)**, p1338-1346.
[2] Hsieh et al. (2011) EPSL **312** p280-290
[3] Knudsen et al. (2007) GRL **34(22)** L22302

Silicon isotopes in glassy sponges as a tracer of silicic acid in seawater

KATHARINE R. HENDRY[1,2]

LAURA F. ROBINSON[2,3]

[1]School of Earth and Ocean Sciences, University of Cardiff, Main Building, Park Place, Cardiff, CF10 3AT, UK, HendryKR@cardiff.ac.uk
[2]Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution, Woods Hole Road, Woods Hole, MA 20543, USA.
[3]Department of Earth Sciences, Bristol University, Wills Memorial Building, Queen's Road, Bristol, BS8 1RJ, UK.

Dissolved silicon, or silicic acid, is an essential nutrient that feeds the growth of opaline diatoms, which are a photosynthetic organism responsible for a significant proportion of carbon export production in the oceans. Deep-sea glassy sponges also produce their skeletal elements, spicules, out of opal and, while they most likely play a less important part in carbon cycling, they can provide valuable information about seawater composition. Recent work has shown that the silicon isotope composition of spicules reflects the concentration of silicic acid in the ambient seawater in which the sponge grew. Here, we present a global dataset of silicon isotopes in modern and core top spicules, which shows that the relationship between silicic acid concentration and silicon isotopes in sponges is universal. A biological mechanism, linking uptake kinetics of silicic acid in sponges and fractionation, can explain this relationship. This theoretical framework, together with the modern and core top calibration work, supports the view that the isotopic composition of sponge spicules is a robust geochemical proxy, and downcore records can be interpreted in terms of past ocean silicic acid concentration.