$^{231}Pa/^{230}Th$ as a paleocirculation proxy outside the North Atlantic

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Since its first application as a proxy for the rate of past ocean circulation more than a decade ago [1], $^{231}Pa/^{230}Th$ has been applied predominantly to cores in the North Atlantic. In this setting, the advection of surface waters to depth resets the $^{231}Pa/^{230}Th$ "clock", and the uniform southward movement of water masses make interpretation of sediment values relatively straightforward. The applicability of $^{231}Pa/^{230}Th$ in other settings, where water-masses may not be clearly reset, or where several water masses with different flow paths overlie one another remains unclear.

We will present an overview of the potential for $^{231}Pa/^{230}Th$ in the Southern Hemisphere. Data from the southern Indian Ocean [2] demonstrate that scavenging of ^{231}Pa at the opal belt resets the $^{231}Pa/^{230}Th$ clock providing potential for application of the proxy to northward flowing water masses in the southern hemisphere. We will present new modelling that also indicates the sensitivity of southern hemisphere sediment $^{231}Pa/^{230}Th$ to changes in ocean circulation, and will focus particularly on the Argentine Basin. We have investigated the use of the $^{231}Pa/^{230}Th$ proxy in four cores spanning all deep-water masses in that basin. Modern-day conditions are similar to those expected in the North Atlantic during the last glacial maximum with overlying southward and northward flowing water masses. Down-core $^{231}Pa/^{230}Th$ results reflect changes in ocean circulation, but these are compounded with other effects, probably due to changing boundary scavenging. Approaches to deconvolve these effects and to use $^{231}Pa/^{230}Th$ as a proxy for southern hemisphere deep-water flow will be presented.

[1] E.F. Yu, *et al*., *Nature* **379**, 689 (1996); [2] A. L. Thomas, *et al*., *Paleoceanogr.* **22** (4) (2007)

Sponge spicules as recorders of deep-water silicic acid

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The distribution of silicon (Si) in the global oceans significantly influences ocean productivity and atmospheric CO_2. Understanding changes in Si distribution, ocean circulation and the resulting influence on biological productivity and carbon drawdown, requires quantitative constraints on intermediate and deep-water silicic acid concentration. Previously, only records of surface waters have been available. Here, we have used the silica spicules formed by sponges to provide a record of deep ocean chemistry giving a unique insight into past marine Si cycling. We present here a calibration of the Si isotope composition of modern sponges from the Southern Ocean, which shows a linear inverse relationship with silicic acid concentration, such that sponges that grow under high Si are isotopically light. We apply our new method to deep-water sediment cores from the southern Scotia Sea in order to assess whether there have been changes in the silicic acid concentration of deep Southern Ocean waters since the Last Glacial Maximum (LGM). Our results show there is no significant difference in deep-water silicic acid concentration (<20 μM) between the LGM and modern deep water. This new result implies that Southern Ocean surface nutrient conditions, reconstructed by diatom opal, are controlled by changes in biological utilization rather than modification of upwelling nutrients. These changes in Southern Ocean productivity have the potential to impact directly the drawdown of atmospheric CO_2 on glacial-interglacial timescales.