Th, Pa and U isotopes in Bahamas seawater by MC-ICP-MS

LAURA F. ROBINSON[1] & GIDEON M. HENDERSON[2]

Department of Earth Sciences, Oxford University, Parks Road, Oxford, OX1 3PR. UK
[1]laurar@earth.ox.ac.uk
[2]gideonh@earth.ox.ac.uk

Thorium and protactinium isotopes in water are becoming widely used as oceanographic tracers in the open ocean. Their short residence time means that they can respond to processes on short timescales (annual to decadal). In this study we build upon recent attempts (e.g. Choi et al. 2002, Moran et al. 2001) to make precise and rapid measurements of small (4-5 litres) water samples. We use a Nu Instrument ICP-MS equipped with multiple ion counters. This set up enables synchronous analysis of Th and Pa isotopes thereby increasing ion yields and removing the necessity of separating Th from Pa chemically.

We present Th isotope data from the Bahamas, a near-shore environment in which oceanic chemical tracers are not overwhelmed by terrestrial inputs, and where there is a complex topography and water flow system. The Tongue of the Ocean, which separates the Great and Little Bahama Banks, exhibits a $^{232}Th/^{230}Th$ (atom ratio) minimum at ~400m. $^{232}Th/^{230}Th$ decreases from >20,000 in surface waters down to ~10,000 at 400m. This change is interpreted as ingrowth of ^{230}Th in the water column and suggests a residence time of ~8 years in the Atlantic thermocline. Below this depth $^{232}Th/^{230}Th$ increases to reach values close to surface water, suggesting either downward flow of dense surface waters, advection of water from the Florida Straits or exchange with settling particles. Similar U concentrations in surface and deep water favour the former explanation. U isotopes were also analysed and indicate that seawater $\delta^{234}U$ does not vary by more than 2 ‰.

Surface waters from the bank top and from Exuma Sound, taken at high tide, have $^{232}Th/^{230}Th$ that vary by a factor of two. This difference between waters in close proximity shows that the $^{232}Th/^{230}Th$ can evolve very rapidly. Measurements on modern carbonates from the Bank Top have the same $^{232}Th/^{230}Th$ as bank-top waters. This result supports the assumptions inherent in U-Th dating of Bahamas carbonates.

References

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Weathering reactions within a basaltic glacial outwash plain

Z.P.ROBINSON[1], I.J.FAIRCHILD[1], B.SPIRO[2], AND A.J.RUSSELL[1]

[1]School of Earth Sciences and Geography, Keele University, Staffordshire, ST5 5BG, UK (z.p.robinson@keele.ac.uk)
[2]Natural History Museum, Cromwell Road, London, SW7 5BD, UK

Glacial environments are important contributors to global geochemical fluxes. Significant solute fluxes can be produced from glacial outwash plains in volcanic regions, due to a combination of highly reactive basaltic material, high precipitation, large volumes of glacial melt, and highly permeable unconfined aquifers formed from the outwash material. This study is based at Skei_arársandur in south-east Iceland, reputedly the world's largest active outwash plain with an area of c.1000 km^2.

Weathering reactions and solute sources within the groundwater system have been studied using chemical and isotopic techniques. Initial results of $\delta^{34}S$ suggest several different sources of solute. High conductivity groundwater from the sandur mirrors the $\delta^{34}S$ and $1/SO_4$ signatures of water collected from a localised hydrothermal area, while higher $\delta^{34}S$ values were measured in the Skei_ará river during a drainage event from the Grímsvötn caldera. Thus additional to low temperature weathering within this glacial and proglacial environment, localised and more regional hydrothermal areas add significantly to the solute input from the sandur.

A series of water and weak acid leaches have been carried out on a range of materials from the sandur environment in order to determine the sources of strontium in the groundwater. Initial $^{87}Sr/^{86}Sr$ ratios from groundwater have shown significantly more radiogenic values (0.7035 to 0.7038) than $^{87}Sr/^{86}Sr$ ratios of products from the active volcanic centres beneath the Vatnajökull ice cap (0.7030 to 0.7032 from Sigmarsson *et al*, 2000) which produce the majority of the sandur surficial deposits during recent jökulhlaups. The $^{87}Sr/^{86}Sr$ ratios in the groundwater closely correspond to values from the young rocks from the Öræfajökull volcanic centre (0.7035 to 0.7038 from Prestvik *et al*, 2001) to the east of the sandur, which erupted in 1362. This suggests that the stratigraphy of the sandur from large historical eruptions may play an important role on the solute fluxes from the sandur.

References

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