Reconstruction of the North Atlantic Circulation back to the Last Interglacial by a combined proxy approach

E. BÖHM[1]*, J. LIPPOLD[1], M. GUTJAHR[2], J.GRÜTZNER[3], A. MANGINI[1]

[1] Heidelberg Academy of Sciences, INF 229, Heidelberg, Germany
*correspondence: eboehm@iup.uni-heidelberg.de
jlippold@iup.uni-heidelberg.de, amangini@iup.uni-heidelberg.de
[2] National Oceanography Centre Southampton, UK
m.gutjahr@soton.ac.uk
[3] Alfred Wegener Institute, Bremerhaven, Germany
Jens.Gruetzner@awi.de

Studies of past variations of the Atlantic Meridional Overturning Circulation (AMOC) are essential for evaluating possible future developments. In order to asses such past variations two new proxies (Nd isotopes and ^{231}Pa/^{230}Th) have been applied frequently in recent years, but only two combined data sets are available to date [1,2]. The combined use of Fe-Mn oxyhydroxide-derived Nd isotopes (ε_{Nd}), a sensitive chemical water mass tag, and ^{231}Pa/^{230}Th$_{xs}$, a kinematic circulation proxy, from identical sediment core samples allows to obtain information about both the rate of overturning circulation and water mass provenance.

Here we present neodymium isotope compositions of past seawater and ^{231}Pa/^{230}Th extracted from sediments from a high sedimentation rate location (< 10 cm/ka) in the western North Atlantic (ODP Site 1063, Bermuda Rise), back to the Last Interglacial (Eemian).

First measurements of ε_{Nd} have been accomplished for the time range from 53 to 150 ka with a temporal resolution averaging 3 ka. The Nd isotopic record suggests the presence of Southern Source Water during MIS 6 to MIS 6.4 as well as active deep water formation in the North Atlantic at the beginning of the Eemian Interglacial (MIS 5.5). The transition between these two different modes in AMOC is marked by a distinct drop in the ε_{Nd} values (-11.5 to -14). This is consistent with ε_{Nd} results from [1] and [2] at the transition from MIS 2 to MIS 1.1 which implies recurring millenial-scaled identical processes converting the AMOC from a Glacial mode into an Interglacial mode.

Numerous measurements of Pa/Th have been performed in the time range from 65 to 143 ka with a high temporal resolution (1 ka or less). Results show that the Pa/Th method reaches its detecting limit at 125 ka due to the short half life of ^{231}Pa ($T_{1/2}$=33 ka). The interval between 95 and 125 ka displays strong fluctuations (Pa/Th=0.046 to 0.079) with one pronounced peak at 119 ka (Pa/Th=0.095) indicative of a slowdown of the AMOC (no corresponding peak in opal). This is consistent with [3] who found a short cold event with near-glacial surface ocean summer temperatures in MIS 5.5.

[1] Gutjahr, M. and J. Lippold, 2011. Paleoceanography. 26(PA2101). [2] Roberts, N., A. Piotrowski, J. McManus and L. Keigwin, 2010. Science. 327(75). [3] Bauch, H., E. Kandiano, J. Helmke, N. Andersen, A. Rosell-Mele, H. Erlenkeuser, 2011. Quaternary Science Reviews, 30(15-16): 1813-1818.

Fe(II)-mediated reduction of Cr(VI) and U(VI) in the presence of Fe(III) oxyhydroxides

DANIEL D. BOLAND[1*], RICHARD N. COLLINS[1], CHRIS J. GLOVER[2], TIMOTHY E. PAYNE[1,3] AND T. DAVID WAITE[1]

[1] School of Civil and Environmental Engineering, The University of New South Wales, Sydney, Australia, daniel.boland@student.unsw.edu.au. (* presenting author)
[2] Australian Synchrotron Company Ltd, Clayton, Australia.
[3] Institute for Environmental Research, Australian Nuclear Science and Technology Organisation, Lucas Heights, Sydney, Australia.

Reduction of both Cr(VI) and U(VI) generally leads to the precipitation of insoluble phases and, thus, decreases the mobility of these toxic metals. In this study we examined the reduction of Cr(VI) during the Fe(II)-catalysed transformation of ferrihydrite to goethite, and compared the results to our previous experiments examining U(VI) reduction in the same system [1].

Cr(VI) was sorbed to ferrihydrite, silica-coprecipitated ferrihydrite (Si-ferrihydrite) and goethite in pH 6.5 buffered solutions in the form of CrO_4^{2-}, and Fe(II) added at 1mM. Cr K-edge X-ray absorption spectroscopy (XAS) analyses of the resultant solids showed that there was an immediate reduction of Cr(VI) to Cr(III) under all treatments (Figure 1), preceding any changes to the Fe(III) oxyhydroxide initially present. This contrasts to U(VI) in the same system, whose reduction is dependent upon the presence of goethite. Ferrihydrite continued to transform to goethite as expected, which has implications for the reactivity of this now Cr-bearing substrate.

These results are consistent with what may predicted by the relative positions of Cr and U in the "redox ladder". They emphasise the validity of using localised thermodynamic calculations to predict the redox state of trace species present during Fe(II)-catalysed Fe(III) oxyhydroxide transformations.

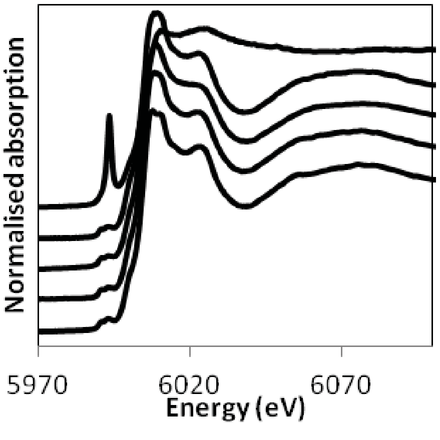

Figure 1: Cr K-edge XAS data. From top: Cr(VI) sorbed on ferrihydrite, following reaction with Fe(II) on ferrihydrite, Si-ferrihydrite and goethite, Cr (III)-substituted Fe(III) oxyhydroxide. Reduction is clear from the diminished pre-edge feature.