$U_K^{37'}$ in eastern tropical Pacific surface sediments: Implications for alkenone paleothermometry at the 'warm end'

M. KIENAST[1*], G. MACINTYRE[1], N. DUBOIS[1,2], S. HIGGINSON[1], S.S. KIENAST[1], AND T.D. HERBERT[3]

[1]Dalhousie University, Dept. Oceanography, Halifax, Nova Scotia, Canada, markus.kienast@dal.ca (* presenting author)

[2]now at: School of Earth, Atmospheric and Environmental Sciences, The University of Manchester, Manchester, UK

[3]Brown University, Dept. of Geological Sciences, Providence, Rhode Island, USA

Introduction

The eastern equatorial Pacific (EEP) is arguably the oceanic region where reconstructions of past sea surface temperature (SST) variability based on different proxies disagree most significantly. For instance, foraminiferal Mg/Ca and alkenone paleothermometry-based SST estimates disagree on the timing and pattern of the glacial-interglacial warming, and the inferred amplitude of the glacial cooling, in particular in the cold tongue off Peru, ranges from 2 to 8 °C depending on the proxy used.

Results and Conclusion

Here we present the first regional calibration of alkenone unsaturation in surface sediments versus World Ocean Atlas (WOA) 09 mean annual sea surface temperatures (maSST). Based on 81 new and 48 previously published data points, it is shown that open ocean samples conform to established global regressions of $U_K^{37'}$ versus maSST and that there is no systematic bias from seasonality in the production or export of alkenones, or from surface ocean nutrient concentrations or salinity. The flattening of the regression at the highest maSSTs is found to be statistically insignificant. For the near-coastal Peru upwelling zone between 11-15 °S and 76-79 °W, however, we corroborate earlier observations that $U_K^{37'}$ SST estimates significantly over-estimate maSSTs at many sites. We posit that this is caused either by uncertainties in the determination of maSSTs in this highly dynamic environment, i.e. by substantial small-scale SST variability not captured by WOA, or by biasing of the alkenone paleothermometer toward El Niño events as postulated by Rein et al. [1].

[1] Rein, B., et al. (2005), El Niño variability off Peru during the last 20,000 years, *Paleoceanography*, 20(4), doi:10.1029/2004PA001099

Ancient water and isolated ecosystems in crystalline bedrock

RIIKKA KIETÄVÄINEN[1*], LASSE AHONEN[1], ILMO T. KUKKONEN[1], NINA KORTELAINEN[1], MARI NYYSSÖNEN[2,3], AND MERJA ITÄVAARA[3]

[1]Geological Survey of Finland, Espoo, Finland, riikka.kietavainen@gtk.fi (* presenting author), lasse.ahonen@gtk.fi, ilmo.kukkonen@gtk.fi, nina.kortelainen@gtk.fi

[2]Lawrence Berkeley National Laboratory, Berkeley, CA, USA, mjnyyssonen@lbl.gov

[3]Technical Research Centre of Finland, Espoo, Finland, Merja.Itavaara@vtt.fi

Introduction

Saline groundwaters with distinct water stable isotope composition above the Global Meteoric Water Line (GMWL) are common in continental shields all over the world [1]. Microbial life thrives in these extreme environments. The 2516 m deep Outokumpu Deep Drill Hole, located in eastern Finland, is an uncased hole hosted by Palaeoproterozoic turbiditic metasediments, ophiolite-derived altered ultramafic rocks and pegmatitic granitoids, and provides a direct access to gas rich formation waters, where diverse microbial communities have been found [2]. Isotopic composition of water and dissolved strontium as well as geochemistry has been used to characterise the drill hole water profile in order to trace water origin and evolutionary time scales [3]. Along with microbiological studies this helps to reveal the extent of isolation of sub-surface ecosystems.

Results and conclusions

Water stable isotope composition of the Outokumpu Deep Drill Hole water is typical for shield brines, and clearly different from shallow fresh groundwater in the area. High salinity up to 70 g l^{-1} of total dissolved solids and high $^{87}Sr/^{86}Sr$ ratio also indicate strong water-rock interaction. Five isotopically and geochemically distinct water types occur along the 2.5 km drill hole section. Two-component mixing between the ^{18}O and ^{2}H enriched saline water and lighter meteoric water can not explain the isotopic composition and trends observed. Instead, ancient meteoric waters recharged at different, warmer than present climatic conditions and subsequent evolution of groundwater by hydration of silicates is the most likely cause for the observed variation. In the plate tectonic and palaeoclimatic framework, residence times in the order of tens of millions of years are suggested. However, the time which these waters have been isolated from surficial waters and from each other may differ substantially between the water types. Changes in bacterial communities with depth correlate with the different water types indicating the occurrence of separate ecosystems at different depths.

[1] Kloppmann et al. (2002) *Chem. Geol.* **184**, 49-70. [2] Kukkonen (2011) *Geol. Surv. Finl. Spec. Pap.* **51**. [3] Kietäväinen et al. (subm.) *Appl. Geochem.*