Quantifying biotic responses to past abrupt climate change: Thresholds and sensitivities

S.J. GIBBS[1]*, K.M. EDGAR[1,2], P.R. BOWN[3], S.A. O'DEA[1], A. SLUIJS[4], B.H. MURPHY[5] AND J.C. ZACHOS[5]

[1]School of Ocean and Earth Sciences, National Oceanography Centre, Southampton, SO14 3ZH, UK (*correspondence: sxg@noc.soton.ac.uk)

[2]School of Earth and Ocean Sciences, Cardiff University, CF10 3AT, UK.

[3]Department of Earth Sciences, University College London WC1E 6BT, UK.

[4]Biomarine Sciences, Institute of Environmental Biology, Utrecht University. The Netherlands.

[5]Department of Earth and Planetary Sciences, University of California, Santa Cruz, CA 95064, USA.

Paleogene hyperthermals represent transient global warming events associated with massive carbon injection into the ocean-atmosphere system. Because the rate and magnitude of carbon release varied between the events, they are natural experiments ideal for exploring the relationship between carbon cycle perturbations, climate change and biotic response. Here we investigate how we can quantifiably compare biotic responses to events of differing magnitudes and environmental character, to utilise the wealth of high-resolution microfossil data emerging across a range of climate change scenarios. We quantify marine biotic variability through several hyperthermals from 56 to 40 million years ago, using records of evolutionary turnover and assemblage variance. Microfossil records from the biologically and functionally distinct plankton groups show a linear relationship between assemblage variability and the magnitude of carbon cycle perturbation during the various hyperthermals. These Paleogene plankton data show threshold behavior and scaled response to environmental changes associated with carbon cycle perturbations reflecting behaviour likely inherent in planktonic ecosystems and may suggest future biotic response may scale at least in a similar way to the hyperthermals.

Experimental investigation of the differentiation of iron-rich peralkaline magma

CHRISTOPHER GIEHL*, RAINER BABIEL, STEPHAN REICHE, MICHAEL MARKS AND MARCUS NOWAK

Institute for Geosciences, Eberhard-Karls-University, 72074 Tuebingen, Germany (*correspondence: christopher.giehl@uni-tuebingen.de)

In this study we investigate the magmatic differentiation of peralkaline Fe-rich phonolitic melts. These are highly evolved compositions ((Na+K)/Al ratios >1) and are believed to be differentiated from mantle-derived alkali basaltic and nephelinitic sources. The studied composition (FeO_{tot} = 11.6 wt%, #Fe = 0.98, (Na+K)/Al = 1.46) resembles a dyke rock, which is a potential source magma for parts of the Ilímaussaq peralkaline nepheline syenite complex, South Greenland [1].

However, the liquid line of descent of such Fe-rich phonolitic compositions is not well understood because of a lack of experimental data. Therefore, we performed crystallization experiments with synthetic glass as starting material at 1 kbar and 950 to 750°C. We used hydrothermal rapid quench vessels and covered a wide range of water activities and oxygen fugacities using gold capsules and graphite-lined gold capsules. To achieve near-equilibrium conditions, run times of 4 hours were sufficient for H_2O-saturated experiments, in nominally anhydrous experiments run times of 3 weeks were necessary. H_2O-saturated experiments reproduce only parts of the observed early magmatic phases of the dyke rock (sp + cpx). In contrast, under nominally anhydrous and more reducing conditions, the complete early magmatic phase assemblage of the dyke rock (sp, cpx, ol, afs, ne) and an alkali-rich residual melt ((Na+K)/Al = 1.65) was successfully reproduced at and below 850°C. Experiments already conducted were carried out using an equilibrium crystallization approach. Upcoming experiments will simulate fractional crystallization using multi-step differentiation to elucidate the complex differentiation process due to the unusually large temperature interval of crystallization suggested for such magma compositions.

[1] Marks & Markl (2003) *MinMag* **67**, 893-919.