Reconstruction of deep-sea temperature across the Early Eocene climate transition

Vittoria Lauretano[1], James C. Zachos[2], Marcel Polling[3], Kate Littler[2], Appy Sluijs[3], Lucas J. Lourens[1]

1-Faculty of Geosciences, Utrecht University, Utrecht, The Netherlands
2-Earth and Planetary Sciences Department, University of California, Santa Cruz. Santa Cruz, CA, USA
3-Faculty of Geosciences, Laboratory of Palaeobotany and Palynology, Utrecht University, Utrecht, The Netherlands

Introduction

The Late Paleocene-Early Eocene warming trend (55-50 Ma) is marked by a series of short-lived global warming events, known as hyperthermals. The Paleocene-Eocene Thermal Maximum, (PETM), is the most pronounced, followed by the ETM2 (Elmo) and the ETM3 ("X-event") up to the Early Eocene Climatic Optimum (EECO). These transient greenhouse episodes are characterized by an extreme increase in temperature associated with the release of large amounts of isotopically light carbon into the ocean-atmosphere system. The effects of these extreme greenhouse conditions coincide with negative carbon isotope excursions (CIE) recorded in the bulk carbonate $\delta^{13}C$ record. Lourens et al., (2005) suggested that hyperthermal events coincide with eccentricity maxima, implying that they are astronomically paced. In this study, we reconstruct changes in deep ocean temperature and carbon cycle across the Early Eocene climate transition, using a high-resolution benthic stable isotope record from the deepest and shallowest sites of the Walvis Ridge ODP Leg 208 depth transect in the southeastern Atlantic Ocean.

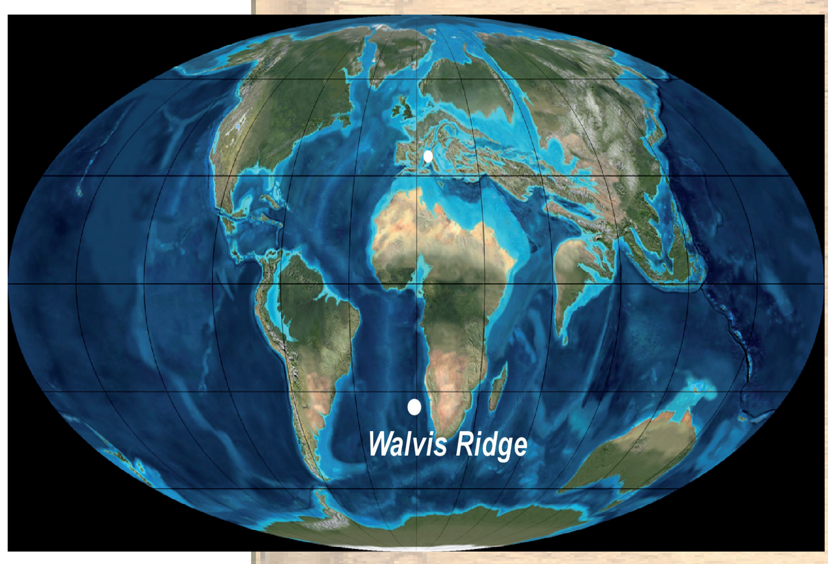

Fig.1: Location map showing early Paleogene paleogeography

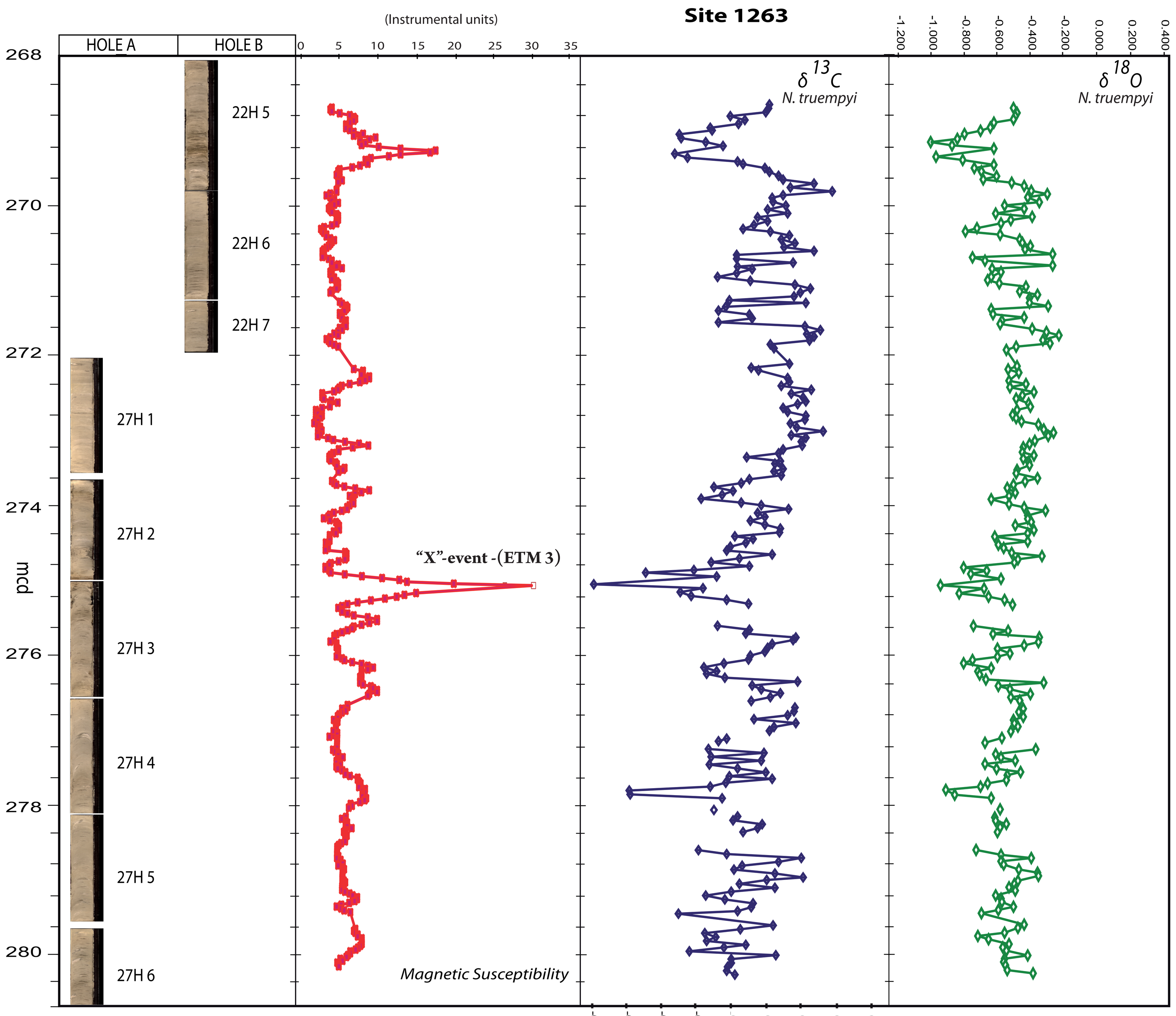

Fig.3: Site 1263- $\delta^{13}C$ and $\delta^{18}O$ plotted vs MS data, in a depth scale

Leg 208 - Sites 1263 and 1262

Site 1263 is the shallowest site located in the SE Atlantic Ocean at a water depth of 2717 m, just below the crest of a north-south-trending segment of Walvis Ridge. The paleodepth was about 1500 m.

Site 1262, the deepest, is located near the base of the NW flank of Walvis Ridge at a water depth of 4759 m. The paleodepth was of about 3600 m. It forms the deep anchor of the Leg 208 depth transect and is located close to the calcite compensation depth (CCD) in the present ocean, making the site most suitable to document fluctuations in the depth of the CCD.

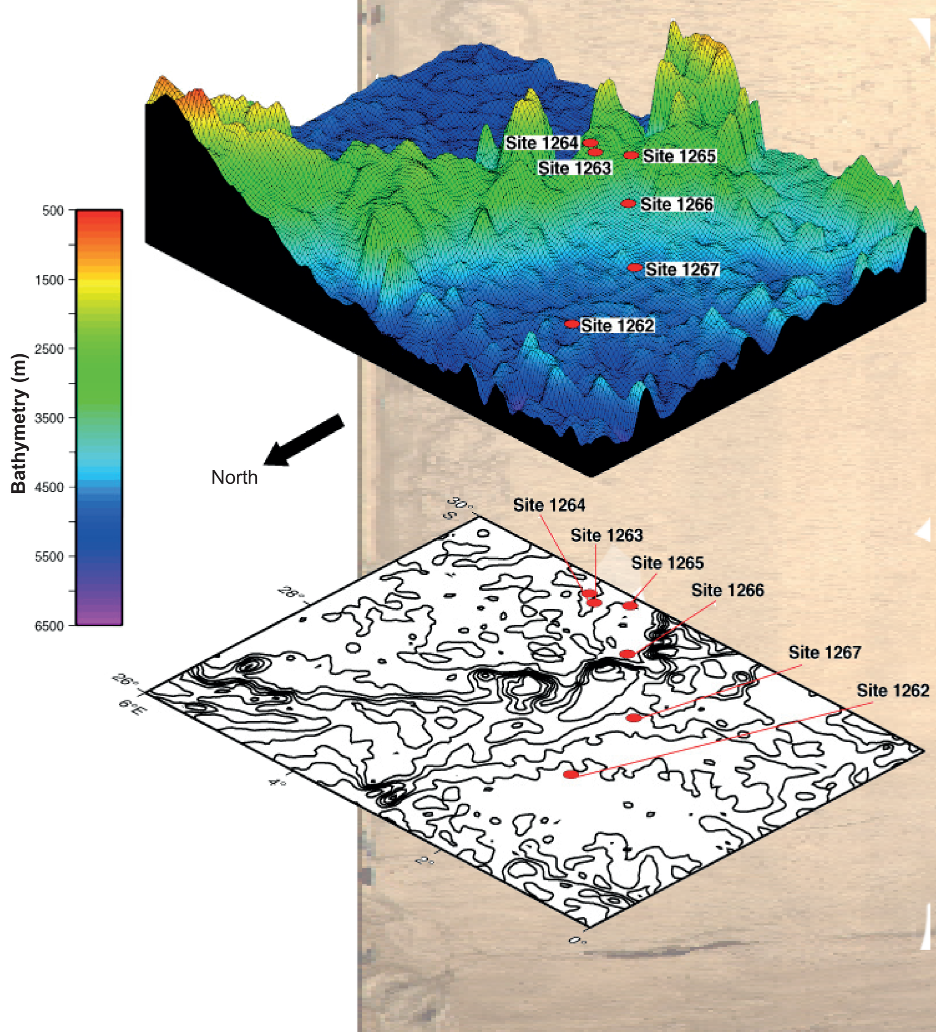

Fig.2: Walvis Ridge transect and sites

We analysed $\delta^{13}C$ and $\delta^{18}O$ of the benthic foraminifera *Nuttalides truempyi.* Records resolution is of approximatively 5 cm for the samples of Site 1263 and of about 3 cm for those of Site 1262. A total number of 225 samples was measured from Site 1263 , and 207 samples from Site 1262.

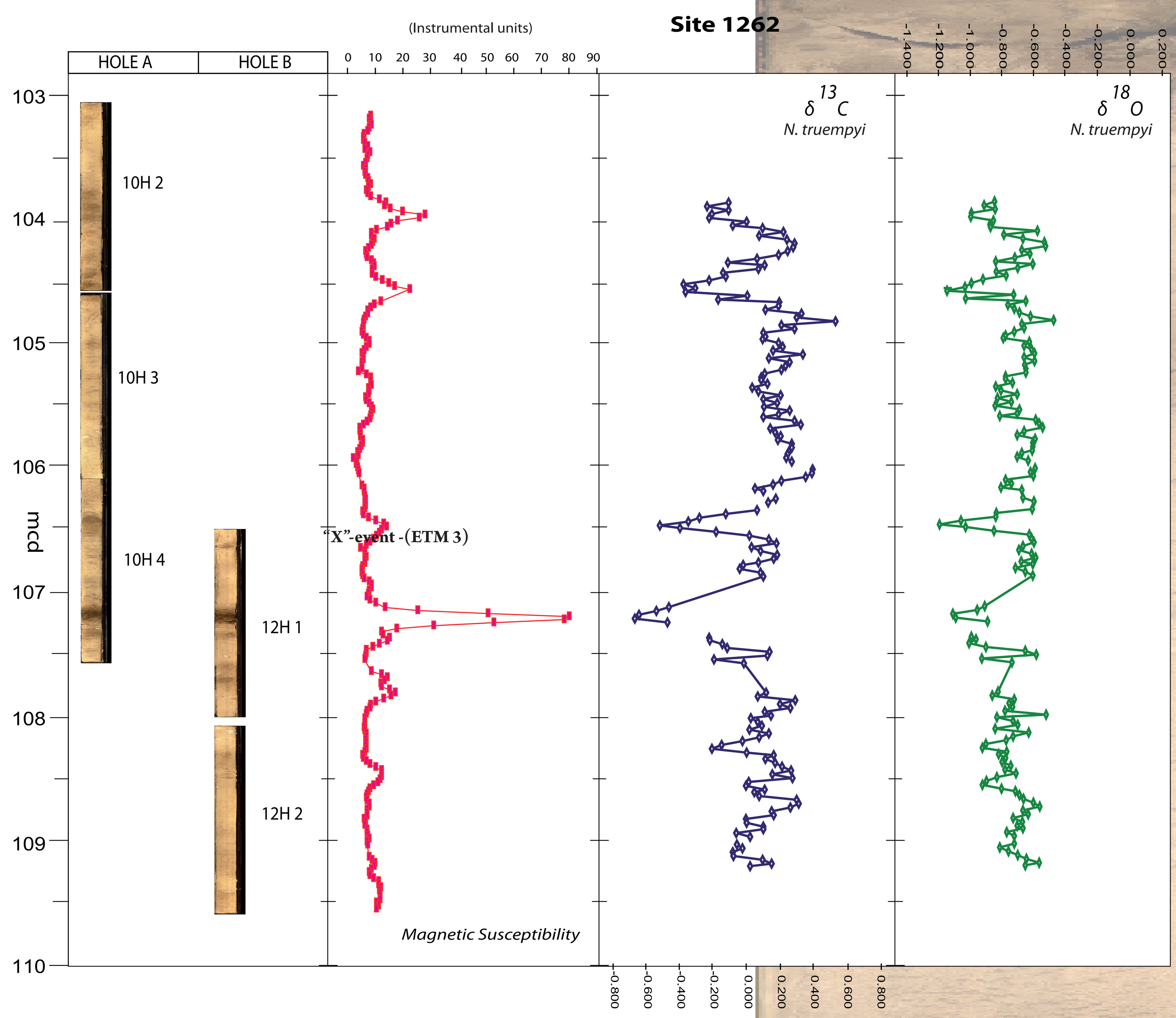

Fig.4: Site 1262- $\delta^{13}C$ and $\delta^{18}O$ plotted vs MS data, in a depth scale

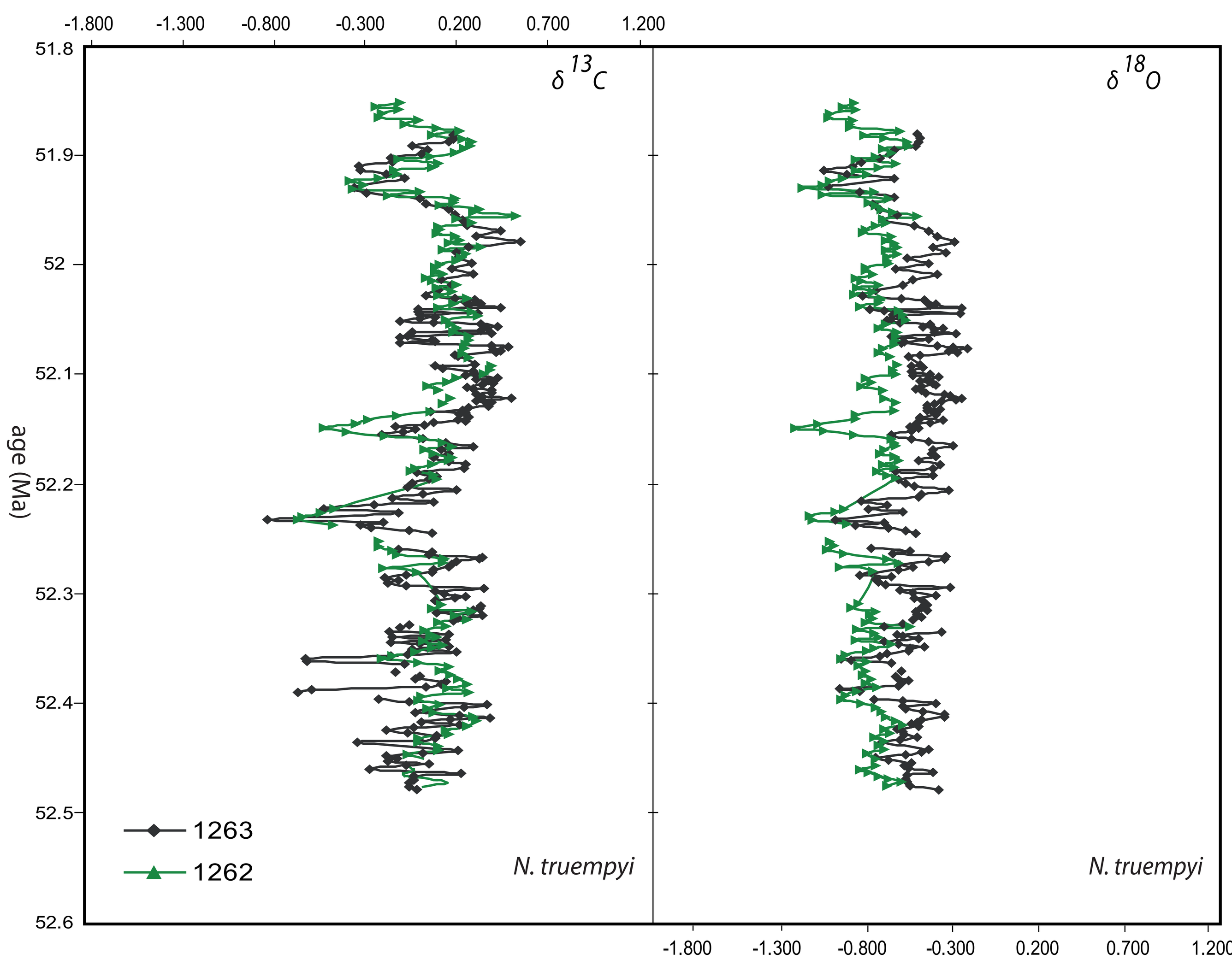

Fig.5: Site 1263 and Site 1262 plotted in time scale (Ma)

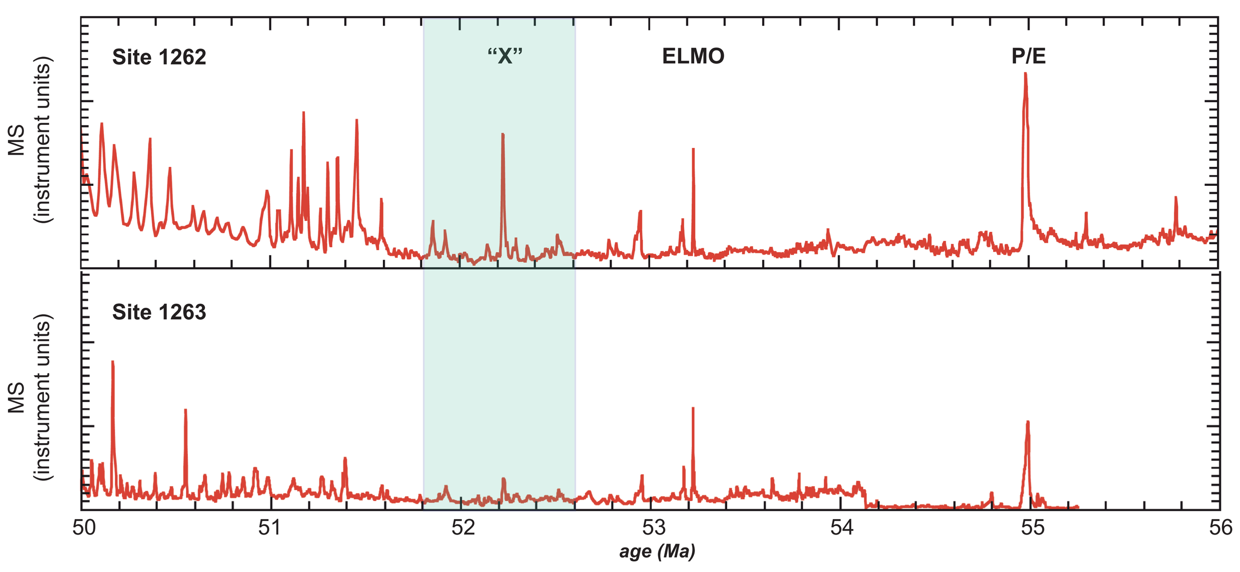

Fig.6: F37- Leg 208- Preliminary Report: MS data (modified) on time scale.

Discussion

The Carbon Isotope Excursion (CIE) of the benthic foraminifera *Nuttalides truempyi* during ETM3 is ~0.6-0.8 per mil in both Site 1263 and Site 1262. This value is approximately half and 1/4 of the CIEs of respectively ETM2 and PETM of the same sites (Stap et al. 2009,2010; McCarren et al., 2008). In both Sites the rapid recovery to pre-excursion values is comparable to what has been shown for the other main hyperthermals event, PETM and ELMO (ETM1 and ETM2), (Stap et al. 2009,2010; McCarren et al., 2008).
A particular pattern is shown by the $\delta^{18}O$ record with on average lower values in the deepest Site 1262 than in the shallowest Site 1263. This reversed $\delta^{18}O$ gradient has been already observed during the ETM2 (Stap et al., 2009) and it can be addressed to either a diagenetic overprint of the oxygen isotope records or a significant gradient in the isotopic composition through the water column.
Our data were calibrated on the initial-cycle-tuned age model proposed for the complete Leg 208 (see Preliminary Reports Volume), and correlated to the MS data, assessing the correspondence of this event with the "X"-event, as defined by Rohl et al, 2005.

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