Clim. Past Discuss., 6, C846–C849, 2010
www.clim-past-discuss.net/6/C846/2010/

Climate of the Past Discussions

Interactive comment on "Southern Ocean warming and hydrological change during the Paleocene–Eocene thermal maximum" *by* A. Sluijs et al.

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Received and published: 7 October 2010

GENERAL COMMENTS I have read the review by Jerry Dickens and support many of his general comments and most of his technical corrections, so won't repeat those here. I don't share his concerns relating to TEX-86 but have different concerns as I'll outline below. I agree that more consideration should be given to the eastern New Zealand PETM records, especially in relation to discussion of hydrology.

Overall I consider this to be a well-written succinct article on a very important discovery – a PETM record in marginal marine sediments offshore south-eastern Australia that includes (1) the first paleotemperature record through the PETM in the South Pacific region and (2) yet another enigmatic pre-PETM acme for Apectodinium. I have four specific comments to make relating to paleobathymetry, paleoclimate, sediments and dinoflagellate paleoecology.

SPECIFIC COMMENTS 1. Paleobathymetry. The ODSN reconstruction shown in Fig.1 is not accurate and gives the impression that (a) NZ was submerged in the early Eocene and (b) NZ was disconnected from the Lord Howe Rise and Challenger Plateau. The authors need to replace the figure with one based on a more accurate paleogeographic reconstruction (e.g. Cande and Stock 2004, AGU monograph 151). This is important because it then becomes clear that there is something wrong with the Huber et al. (2004) circulation. Huber's more recent circulation model (see Hollis et al. 2009) has improved paleobathymetry in the north Tasman region (I believe) and suggests a slightly more restricted proto-Ross gyre juxtaposed against an anticyclonic gyre that has a downward directed tongue at the junction of the Lord Howe Rise and the Australian margin, which I suggest may be the source of South Tasman tropical waters and migrating Apectodinium. Kennett's proto-East Australian Current needs serious reconsideration in light of the tropical sea temperatures recorded in the PETM and EECO in the SW Tasman Sea and NZ's Canterbury Basin (Bijl et al. 2009; Hollis et al. 2009). See how the modern EAC works here: http://www7320.nrlssc.navy.mil/global_ncom/anims/anz/sst12m.gif

2. Paleoclimate. This paper and the Bijl et al. (2009) paper are very important paleotemperature records but they are largely reliant on a single proxy. The authors need to be a better job of convincing readers like Jerry Dickens that TEX-86 based temperature estimates are realistic. This includes consideration of the high-latitude effect – as discussed by Jerry, but also note should be taken of the nearby multi-proxy study of the EECO (Hollis et al. 2009), which showed that TEX-based temperatures of $\sim$30C are consistent with estimates for both sea surface and sea floor temperatures derived from d18O and Mg/C. This study further implies that sea floor temperatures at these two sites are much warmer than indicated by the deep sea benthic record, and so both

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sites must be isolated from the proto-Ross surface gyre during these times of peak warming. John Creech has just had his paper on the detailed Mg/Ca record through the NZ EECO interval accepted in EPSL. (Creech et al. in press. Eocene sea temperatures for the mid-latitude southwest Pacific from Mg/Ca ratios in planktonic and benthic foraminifera. EPSL)

The other line of supporting evidence missing from this paper is any discussion of tropical indicators in the PETM pollen record, or from EECO sites in the SE Australian hinterland. Leaf fossil-based temperatures from eastern Australia may also help to corroborate relative temperature ranges for the early Paleogene.

3. Sediments. As noted by Jerry Dickens, the paper suffers from a lack of detail on the lithological succession across the PETM. A figure with core photos and lithologic interpretation should be accompanied by a more detailed description to help in understanding the significance of the XRF variations, the enigmatic pre-PETM acme of Apectodinium, and the other curious relative abundance variations in the dinocyst assemblages that are suggestive of pre-PETM sea level changes, e.g. the first Glaphyrocysta spike.

The authors also need to clarify how Ca XRF intensity translates into carbonate content – what range of wt% $CaCO_3$ variation is implied by the range shown in Fig. 2.

4. Dinocysts and hydrology. I find most of the argument presented in section 4.4 to be highly speculative and unconvincing. Abundance peaks of Senegalinium could simply mean brackish or very nearshore conditions – why opt for a more complex interpretation? Terrestrial palynomorphs are remarkably low for this setting (compare with much deeper water Tawanui record) and combined with the low BIT index, I don't see good evidence for high freshwater runoff. Comparison with Tawanui is very superficial when there is a wealth of dinoflagellate data presented for both Tawanui and Moeraki-Hampden in Crouch and Brinkhuis (2005). The record of Senegalinium at Moeraki is consistent with it being a very nearshore-brackish indicator.

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The argument for PETM storminess based on the goniodomids doesn't stack up. I think a more plausible theory would be the development of hypersaline lagoons as a consequence of extreme warming and marine incursion. This would be consistent with the low BIT and terrestrial paly values. Are goniodomids common in the hypersaline lagoons in SE Australia today? Is anyone monitoring their response to global warming?

And what about that Apectodinium acme below the PETM? This record is distinctly different from the New Jersey shelf records where the start of warming and of the C13 excursion is only slightly higher than the increase in Apectodinium and the acme crosses the PETM. Here you have two acmes, with the PETM acme the smaller of the two. You could argue that the negative shift in C13 and the warming trend starts at the base of the first acme, and perhaps signals seasonal warming (assuming TEX-86 is a proxy for mean SST after all)?

TECHNICAL CORRECTIONS (see Jerry's comment) 1702 6: Biotic responses include a global ABUNDANCE PEAK (acme) of the subtropical 1703 19: recrystallization 1718 03: Such surprisingly warm SSTs for this latitude INDICATE that Figure 1. Revise paleogeographic reconstruction to conform with Cande and Stock (2004) or similar.

Interactive comment on Clim. Past Discuss., 6, 1701, 2010.