Forum

Stable warm tropical climate through the Eocene Epoch: COMMENT and REPLY

COMMENT: doi: 10.1130/G24021C.1

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Pearson et al. (2007) reported paleotemperature estimates derived from stable oxygen isotopes of exceptionally well-preserved foraminifera and from organic molecules (using the TEX_{86} index) in Paleocene and Eocene hemipelagic clay deposits in Tanzania. They concluded that tropical sea-surface temperatures (SSTs) were stable throughout the Eocene, a finding that is surprising given substantial stable isotope data from deep-sea cores that display gradual SST cooling in the tropics and at higher latitudes from the early Eocene onwards. Pearson et al. attribute this discrepancy to pervasive diagenetic overprinting of tropical surface-dwelling foraminifera, and argue that foraminiferal overgrowth becomes systematically more pronounced upsection at the deep-sea sites.

The intent of this Comment is (1) to challenge the notion that tropical paleotemperatures remained stable during the Eocene, and (2) to argue that systematic increases in diagenetic overprinting are not responsible for the cooling trend obtained from deep sea cores, a natural corollary of (1).

We show in Figure 1 that by plotting all of the data from Pearson et al., a cooling trend is observed during the Eocene, whereas the culled data set presented in their paper shows more stable high temperatures. Pearson et al. extracted the warmest seasonal paleotemperature estimate from the pool of data for mixed-layer planktonic foraminifera in each sample, mixing both the taxa and size fractions being compared from different time slices. In contrast, the deep-sea data (Bralower et al., 1995; Dutton et al., 2005) consist of monogeneric samples from a restricted size fraction, providing a more realistic estimate of average long-term climate trends. Hence the discrepancy in SST trends reported by Pearson et al. is, at least partially, an artifact of comparing seasonal extreme values (warmest temperatures and/or highest runoff) from Tanzania, to monogeneric SST trends from deep-sea sites.

Independent paleobiogeographic evidence also points toward tropical cooling. Tropical foraminiferal and nannofossil assemblages show increases in the relative proportion of mid-high latitude species during the late middle Eocene (e.g., Haq et al., 1977). In light of these considerations, we maintain that evidence from Tanzanian foraminifera, deep-sea cores, and biogeographic data all provide a coherent and strong argument for a cooling trend in tropical SSTs during the Eocene. The TEX_{86} proxy from Tanzania displays relatively stable SSTs during this interval (Pearson et al., 2007), perhaps representing a more stable seasonal (summer) signal.

Diagenesis likely contributes to some of the difference in absolute temperatures between the deep sea and the Tanzanian shelf; however, given that SST cooling is observed in both the pelagic deep-sea cores and the more coastal Tanzanian foraminiferal stable isotope data, it follows that diagenesis is not the origin of the cooling trend observed in the Eocene. In fact, middle to late Eocene foraminifera from Site 1209 are generally more dissolved than specimens from older time intervals, which is not consistent with the secondary recrystallization mechanism proposed by Pearson et al. Developing techniques to quantify the degree of alteration in deep-sea data, which are likely more representative of global trends, is crucial to combining them with data from glassy foraminifera in clay-rich sediments that are more primary in origin.

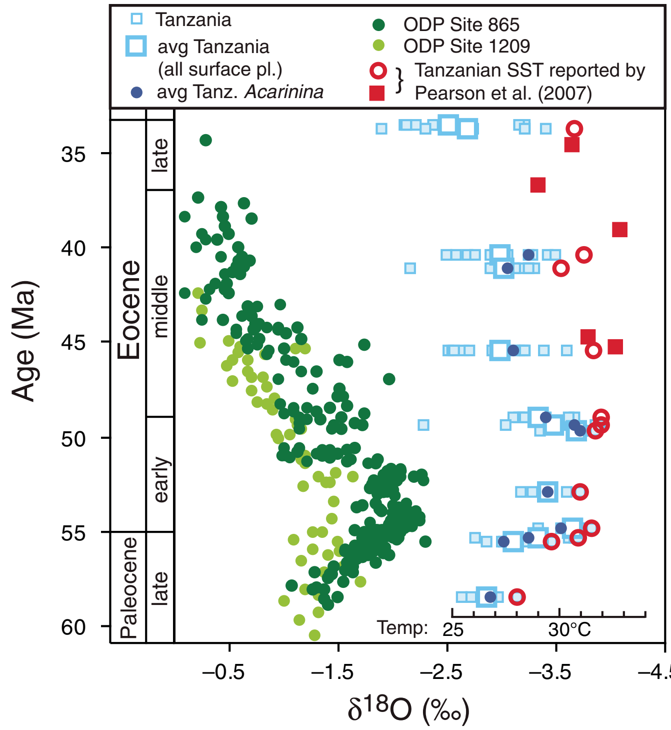

Figure 1. $\delta^{18}O$ **data of mixed-layer foraminifera from Tanzania (Pearson et al., 2001; Pearson et al., 2007) with average values of all mixed-layer planktonics and the genus *Acarinina* superimposed. Minimum** $\delta^{18}O$ **values increase across the early/middle Eocene boundary; hence, implied temperatures only remain stable if a change in seawater** $\delta^{18}O$ **occurs at this point (Pearson et al., 2007). Both deep-sea sites and the more coastal Tanzanian site display cooling trends during the Eocene.**

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