First Toba supereruption revival: Comment and Reply

COMMENT

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The article by Lee et al. (2004) suggests that at least one “supereruption” from the Toba caldera, Sumatra, was associated with a climatic warming, rather than a cooling trend. The background to this is that Rampino and Self (1992, 1993) originally suggested that the supereruption that produced the younger Toba tuff ca. 74 ka could have helped to usher in the last glacial period (isotope stage 4). This long-term climatic feedback effect would be in addition to the severe short-term climatic effects or “volcanic winter” predicted for that eruption. Lee et al. (2004) have studied deep-sea ashes in the South China Sea that they contend were produced by the smaller older Toba tuff eruption at a revised age of 788 ka, which they then propose was not involved in a long-term cooling episode. We here raise three points that challenge the results of their study.

1. The identification of the tephra in the South China Sea core by Lee et al. is based on correlation with layer D in Ocean Drilling Program (ODP) Site 758 in the Indian Ocean. The correlation rests on stratigraphic position and major element glass chemistry, and appears sound. However, the major premise of the paper depends on the assumption that layer D (ca. 800 ka) in the ODP Site 758 core is older Toba tuff. They provide no mineralogical or major and trace element geochemical data on glass shards, nor are there data in other literature, to support this correlation. Previous workers who have studied the Toba ashes in deep-sea cores think that layer E (not D) in ODP Site 758 represents the older Toba eruption. These reservations also apply to interpretations of the long-term environmental impact of the considerably more ancient older Toba tuff event.

REFERENCES CITED


REPLY

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D/South China Sea ash may also be considerably smaller than younger Toba tuff, because, to date, there is no demonstration of correlation to onland pyroclastic flow deposits.

In summary, the proposed younger age for the older Toba tuff is not substantiated, and thus the correlation of the older Toba tuff eruption with any effects on Pleistocene climate remains unknown.

Another point is that the much larger volume younger Toba tuff is now possibly recognized as a large acidity peak in Greenland ice cores (Zielinski et al., 1996), which occurs within a brief cold period prior to the major cooling from isotope stage 5 to 4. Oppenheimer (2002) presents a review of why direct correlations of the younger Toba tuff eruption with climatic and demographic phenomena must be viewed with caution until more precise age dating of the various events and better understanding of the volcanic eruption are available. These reservations also apply to interpretations of the long-term environmental impact of the considerably more ancient older Toba tuff event.
We appreciate the comments by Shane et al. on our paper (Lee et al., 2004). Shane et al. raise several interesting points about the main conclusion of our paper, which is the possibility of a link between the oldest Toba tuff eruption and the Pleistocene climate, although their main criticisms were focused on whether tephra layer D or E from Ocean Drilling Program (ODP) core 758 is the better representative of the oldest Toba tuff. The following is our rebuttal to each of the points raised by Shane et al.

In addition to the data presented in our paper, some handpicked pure glass shards from both layer D and layer E of ODP Site 758, collected by Dr. Dehn, were analyzed recently for their chemical and isotopic compositions. In general, the glass shards from layers D and E are distinct in their Na2O/K2O ratio and K2O content, with lower Na2O/K2O (<0.8) and higher K2O (>4.5%) for layer D, as opposed to higher Na2O/K2O (>0.9) and lower K2O (<4.5%) in layer E. Consequently, the characteristics of lower Na2O/K2O and higher K2O are entirely consistent with those of the oldest Toba tuff (Chesner, 1988, 1998). Moreover, Sr isotopic composition is very different between the glass shards from layer D and layer E. The 87Sr/86Sr value of the glass shard in layer D is 0.71306 ± 0.00003, which is quite comparable to those of the oldest Toba tuff from Sumatra (Chesner, 1988). In contrast, the 87Sr/86Sr ratio of the glass shard in layer E is 0.70559 ± 0.00002, significantly lower than that of the oldest Toba tuff in Sumatra (Chesner, 1988). This is further illustrated in Figure 1, where K2O content is plotted against 87Sr/86Sr for each sample, and it is readily apparent that glass shards from layer D of ODP Site 758 are well correlated, while layer E bears no resemblance to the oldest Toba tuff in Sumatra.

We have also analyzed the tephra glass shards extracted from South China Sea core MD972142 at the depth of 39.04 m for their chemical and Sr isotopic compositions, and they are also plotted in Figure 1. This tephra glass from the South China Sea core MD972142 is characterized by Na2O/K2O ~0.59 and 87Sr/86Sr = 0.71573 ± 0.00002 (Fig. 1), which is again entirely comparable to that observed in oldest Toba tuff from Sumatra and layer D in ODP Site 758.

As stated previously, layer D of ODP Site 758 is the better representative of the oldest Toba tuff. Nevertheless, the tephra layer D of ODP Site 758 along with the similar tephra layers from cores 17957 and MD972142 all are sandwiched between the Brunhes-Matuyama geomagnetic boundary and the Australasian microtektite layer, (Fig. 2 of Lee et al., 2004) remains valid. However, this age is in conflict with that of layer D of ODP Site 758 along with the similar tephra layers from cores 17957 and MD972142. Data of oldest Toba tuff (OTT) in Sumatra are from Chesner (1988). Error tick represents 1σ error in K2O content; 2σ error of Sr isotopic ratio is much smaller than size of symbol.

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