Geology

Toba ash layers in the South China Sea: Evidence of contrasting wind directions during eruption ca. 74 ka: Comment and Reply

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Notes

FORUM

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COMMENT

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Bühring et al. (2000) reported that the ash layers in two cores from the South China Sea dated ca. 74 ka are distinct from the volcanic glass supplied from the Philippines and the northern South China Sea, but are almost identical in terms of the chemical compositions to the Toba ash. They reached this conclusion from the similarities they found in the age and chemical compositions of the glass shards between the tephra layers in their cores and those in the Youngest Toba Tuff eruption.

Studies of the late Quaternary tephra layers in the South China Sea area are quite limited (Chen and Zhou, 1992). Very recently, however, the 17 tephra layers of the International Marine Past Global Change Study (IMAGES) Core MD972142 from north of Palawan, in the southeastern South China Sea (lat 12°41.33′N, long 119°27.90′E) at a water depth of 1557 m have been studied in great detail. The deepest tephra layer (layer 17) in this core was found at the interval 24.01 to 24.08 m, where the major elements of glass are very similar to the related published data for ash layers in Cores 17961-2 and 17962-4 in the South China Sea (Bühring et al., 2000) and in the Toba co-ignimbrite eruptions (Chesner, 1998) (Table 1 and Fig. 1A here). The tephra layer in our Core MD972142 was dated about 0.5 Ma, on the basis of its correlation with the major characteristic isotopic events in standard SPECMAP chronology (Chiu et al., 2000). It is well known that there are three major rhyolitic co-ignimbrite eruptions of late Quaternary age in the Toba caldera. The $^{40}Ar/^{39}Ar$ age of the Oldest Toba Tuff is 0.84 ±0.03 Ma, that of the Middle Toba Tuff is 0.501 ±0.005 Ma, and that of the Youngest Toba Tuff is 74 ±2 ka (Chesner and Rose, 1991). In like manner, on the basis of the age and major element composition of glass in ash layer 17 of IMAGES Core MD972142, it can be confirmed that eruption of the Middle Toba Tuff is the most likely origin of this ash layer. Nevertheless, the compositions of the volcanic phenocrysts and isotopic ratios of glass may be more reliable tools for long-distance ash-layer correlations (Haynes et al., 1995). The major element compositions of the biotite crystals and the isotopic fingerprints of glasses in tephra layer 17 were analyzed. The results show that the biotite phenocrysts in layer 17 in Core 972142 have distinctly lower FeO/MgO ratios than those of the Middle Toba Tuff (Fig. 1B). Moreover, the $^{87}Sr/^{86}Sr$ value of the glass shards is 0.70506 ±0.0008, which is obviously lower than that of the Toba eruptions in Sumatra, Indonesia (0.7128 to 0.7152; Chesner, 1998). The differences

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TABLE 1. CHEMICAL COMPOSITIONS OF GLASS IN THE SOUTH CHINA SEA

Core	SiO_2	Al_2O_3	TiO_2	FeO	MnO	MgO	CaO	Na_2O	K_2O	References
17961-2	78.04 ±0.24	12.45 ±0.06	0.05 ±0.02	0.85 ±0.05	0.07 ±0.02	0.06 ±0.01	0.76 ±0.03	2.86 ±0.06	4.86 ±0.08	Bühring et al. (2000)
MD972142	76.98 ±1.13	13.24 ±0.29	0.09 ±0.05	0.72 ±0.11	0.03 ±0.01	0.12 ±0.04	0.80 ±0.25	3.03 ±0.35	4.97 ±0.25	This study

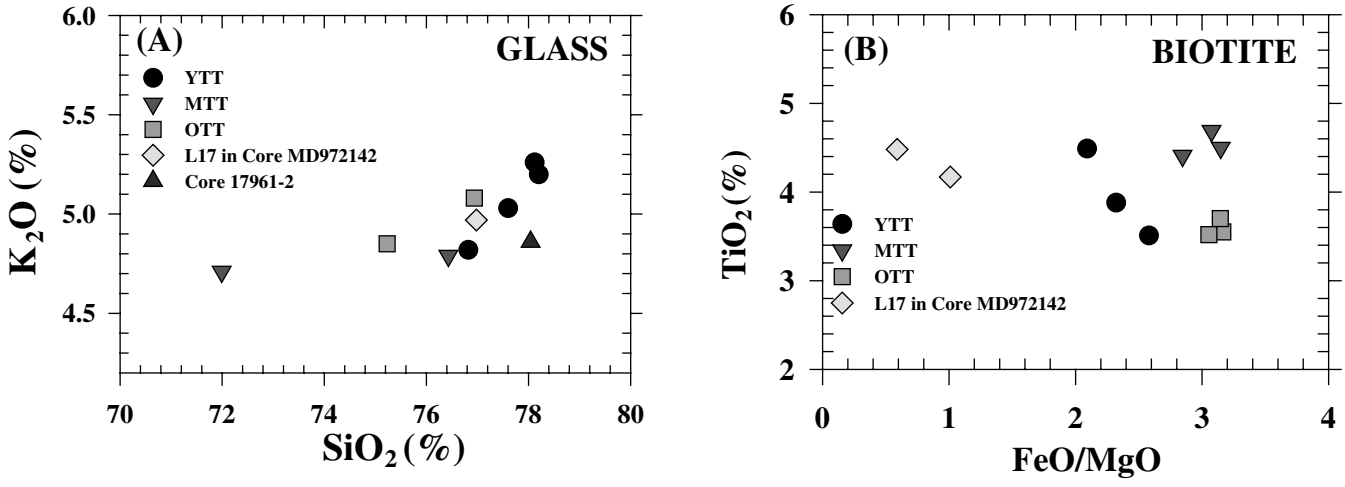

Figure 1. Major element chemical variation diagrams for (A) glasses from Toba eruptions, layer 17 in Core MD972142 and Core 17961-2 (Bühring et al., 2000), and for (B) biotite grains from Toba eruptions and layer 17 in Core MD972142. All data on Toba eruptions in Sumatra are from Chesner (1998). YTT—Youngest Toba Tuff; MTT—Middle Toba Tuff; OTT—Oldest Toba Tuff.

in the isotopic values of glass and phenocryst chemistry demonstrate that they were derived from two compositionally different magma sources.

This evidence strongly suggests that glass and biotite in ash layer 17 do not correlate with the Middle Toba Tuff eruption in northern Sumatra, about 0.5 Ma, even though they have similar major element compositions in glass shards. The strong correlation of the ash beds in Core 17961-2 and 17962-4 in the IMAGES study and the Youngest Toba Tuff in the South China Sea indicates that they do not have just the similarities of ages and glass chemistries of the ash layers. Further chemical studies of phenocrysts and isotopes in tephra layers will help to confirm the possibility of alternative ash sources.

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REPLY

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It is interesting to us that Chen et al. in their Comment on our paper (Bühring et al., 2000) do not cite their own recent publication (Song et al., 2000). In that paper, Song et al. reported on an ash layer from the same stratigraphic position as we did, but in another core from the South China Sea, a layer that they likewise identified as Youngest Toba Tuff by microprobe and rare earth element analyses. They thereby confirmed our conclusion based on microprobe analysis (Bühring et al., 2000, published in March 2000, not cited in the paper of Song et al., 2000, published in July).

We do not see any need to reconsider our identification of the Youngest Toba Tuff layer at the MIS 5/4 boundary because of the questions raised by Chen et al., which concern a different, older ash layer, assigned to the Middle Toba Tuff (not discussed in our paper). On the contrary, we thank Chen et al. for their support of our findings.

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