
Yukio Isozaki *, Ayano Ota

Department of Earth Science and Astronomy, The University of Tokyo, Tokyo 153-8902, Japan

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We appreciate the comment by Ali and Wignall, as it provides us with an appropriate opportunity to explain the link between volcanism and extinction at the Guadalupian–Lopingian (G–LB) event that was not the main topic of the commented article (Ota and Isozaki, 2006). Continental flood basalts (CFB) have often been regarded as the ultimate cause of mass extinctions on account of their apparent chronological coincidence with the extinction-related boundaries of the Phanerzoic (e.g., Courtillot, 1999; Wignall, 2001; Ernst and Buchan, 2003). For the Permo-Triassic boundary (P-TB), the Siberian Traps are the most popular candidate (e.g., Renne and Basu, 1991; Campbell et al., 1992; Kamo et al., 2003; Saunders et al., 2005; Racki and Wignall, 2005). As to the G–LB extinction, the Emeishan Traps in western South China and the Panjal Traps in northern India are likewise favored by many because of their apparent coincidence in timing (e.g., Chung et al., 1998; Zhou et al., 2002; Ali et al., 2002).

In our research focused on the G–LB extinction, we have emphasized the geological significance of a felsic tuff called the Wangpo bed (1–2 m-thick) in South China and its correlatives in the accretionary complexes in Japan (Isozaki and Ota, 2001; Isozaki et al., 2004; Ota and Isozaki, 2006; Isozaki, 2006). Here, we wish to disagree in four ways with the comment by Ali and Wignall who favor a direct cause–effect link between the Emeishan volcanism and the G–LB extinction. First, the Wangpo bed occurs between the Guadalupian Maokou Formation and the Wuchiapingian (Lower Lopingian) Wujaping Formation in its type locality in Shaanxi (Lu, 1956; Isozaki et al., in preparation), in Sichuan (Isozaki et al., 2004), and in Hunan (Li et al., 1991), indicating no survival of the Guadalupian fauna after the Wangpo volcanism. This unique bed is also recognized at Qingying and at Xinchang near Mt. Emei(shan) in central Sichuan; above the Maokou Formation and below the Emeishan Traps (Fig. 1). As no other thick tuff occurs around the G–LB horizon in South China, the Wangpo tuff represents a prime stratigraphical and chronological marker bed of the G–LB with high-precision synchronism. In addition, a 0.8 m-thick mudstone/sandstone with plant fossils (Pecopteris sp. identified by T. Ohana; unpublished data) occurs immediately above the Wangpo bed and below the Emeishan basalt at Qingying, suggesting an appreciable time-gap between the termination of the Guadalupian fossiliferous carbonates and the basalt eruption. These stratigraphic relationships indicate that felsic volcanism of regional extent occurred considerably before the main eruption of the Emeishan Traps, and that the G–LB extinction was caused unlikely by the trap volcanism.

Second, recent geochronology of the Emeishan Traps has identified that the main eruption age was at 256–259 Ma (Zhou et al., 2002), whereas age constraints for the Panjal Traps are insufficient for precise correlation. The age of the G–LB mass extinction has not yet been tightly constrained yet; however, an age of 260.4 ± 0.7 Ma was proposed by Gradstein et al. (2004). Thus, the current data indicate that the trap volcanism apparently postdated the mass extinction by 1–4 Myr. This age gap may have been much greater, because the G–LB horizon is...
defined by the first appearance datum (FAD) of a new conodont taxon that belongs to the Wujiapingian fauna in Guanxi (Jin et al., 1998). Judging from the information in mid-oceanic paleo-atoll carbonates (Ota and Isozaki, 2006), the main extinction horizon of the Guadalupian fauna is located at a much lower stratigraphic horizon below a post-extinction barren interval. Our current dating project will define the precise eruption age of the Wangpo tuff.

Third, we did not ignore that some andesitic basalt and rhyolite units occur within the Emeishan traps. Their occurrence is confined, however, to the middle–upper part of the traps, not to the basal parts (e.g., Xu et al., 2001) as Ali and Wignall mentioned. This higher stratigraphic portion of the felsic units within the traps contradicts with the above-mentioned tuff stratigraphy. Moreover, these felsic units are too small in volume to account for the entire wide extent of the regional ash fall (the Wangpo tephra) over South China (e.g., 1–2 m in thickness in Shaanxi, Sichuan, Hunan) and western Panthalassa (~1 cm).

Fourth, as to the main basaltic volcanism of the Emeishan Traps, a global warming appears like the most promising kill mechanism (Wignall, 2001; Racki and Wignall, 2005) when we assume the cause–effect link between volcanism and extinction. In this case, the expected volcanogenic greenhouse effect should have started in the main phase of the volcanism, however, this contradicts with the lately documented fusuline extinction pattern during a cool period (Kamura event) in the low-latitude Panthalassa prior to a warming (Isozaki et al., 2007) and with low sea-level in the late Guadalupian (Hallam and Wignall, 1999).

According to the above discussion, the Emeishan Traps were neither a likely source of the G–LB felsic tuff nor the ultimate cause of the G–LB extinction. This suggests that we must identify another source for the volcanism, a felsic one in particular, at the end of the Guadalupian. A similar situation exists at the P-TB. The initial eruption age of the Siberian Traps was defined as 251.7 ± 0.4 Ma by Kamo et al. (2003), whereas the age of the P-TB extinction was dated as 252.4 ± 0.3 Ma at Meishan or 252.6 ± 0.2 Ma at Shangsi (Mundil et al., 2004). We admit that there is still an appreciable gap between the extinction and CFB volcanism with respect to the error range, and that the extinction apparently predated the basalt volcanism by 1–2 Myr. Even though the Siberian Traps are associated with felsic volcanics in higher stratigraphic horizons, they also could not be the source of the P-TB tuffs in South China.

In all previous proposals on possible cause–effect relationships, the absence of material-based hard evidence that directly links the extinction with the CFB volcanism remains a major obstacle regardless of the credibility of coincidence in mutual timing. The boundary felsic tuffs in South China and Panthalassa represent the only available hard evidence that can link volcanism with the two major mass extinctions at the end of the Paleozoic; therefore, their unique felsic composition needs a more detailed scrutiny. The petrological characteristics and geochronology of the Wangpo tuff will be reported elsewhere shortly (Isozaki et al., in preparation).

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