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The terrestrial Permian–Triassic boundary event is a nonevent

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We are pleased to reply to Ward et al. (2012) about the stratigraphic record of the Karoo Basin where the terrestrial ecosystem response to the End-Permian extinction is recorded.

The present extinction model envisions a marine and terrestrial response coupling. The Permian–Triassic boundary (PTB), the zenith of marine extinction, is recognized at the first appearance datum of *Hindeotus parva* in the Global Boundary Stratotype Section and Point at Meishan, China, associated with a negative $\delta^{13}C$ excursion. On land, it is reported at the last occurrence of *Dicynodon* in the Karoo Basin (e.g., Ward et al., 2005) and elsewhere.

The Karoo's last *Dicynodon* co-occurs with a negative $\delta^{13}C$ excursion in a unique, laminated, meters-thick, sandstone-shale unit. This interval, termed the "event bed," is "associated with the P-T extinction" (Smith and Ward, 2001, p. 1148), and described as an "anomalously lifeless bed immediately above the last occurrence of *Dicynodon"* (p. 1149). The negative $\delta^{13}C$ trend was used to correlate marine and continental records, and the base of this facies is the datum to correlate boundary sections basinwide (e.g., Ward et al., 2000, fig. 1; Ward et al., 2005, fig. 2). Botha and Smith (2006, p. 503) report that this "regionally extensive interval of maroon coloured thinly bedded laminites" allows for correlation between Graaff-Reinet and Bethulie, >150 km distance, following Retallack et al. (2003, p. 1135). Hence, this facies correlation serves as a time marker across the Karoo. We are not alone in our understanding that this is the terrestrial expression of the isotopic anomaly and PTB identified in the marine record.

Erwin (2006, p. 142–143) states that "the shift in isotopes occurred in a finely laminated mudstone bed between the Permian olive-gray mudstones, and the overlying Triassic maroon mudstones and large sandstone beds." He notes a remarkable similarity in $\delta^{13}C$ trend between the Karoo and Meishan, and that the Ward et al. (2005) study, of which he is coauthor, "strongly suggests that the overlap zone coincides with the marine Permian-Triassic boundary" (Erwin, 2006, p. 141). Similarly, Benton (2003, p. 220), referencing Smith and Ward (2001), remarks that they "pinpointed the exact position of the Permo-Triassic boundary in the Beaufort Group sequence," at the base of the laminites.

Our results generally agree with Smith (1995) where a transitional stratigraphy shows evidence of increasing crevasse splay progradation in hydromorphic paleosols. We interpret the laterally and vertically discontinuous heterolithic intervals, the boundary facies, as avulsion channel fills (Gastaldo et al., 2009) in a paleosol sequence, and demonstrate the facies is not restricted to a single stratigraphic horizon. It occurs both below and above the biostratigraphically defined PTB (e.g., Prevec et al., 2010), and Ward et al. (2012) acknowledge this observation. We now are a bit confused with their paleosol designation and Triassic age assignment of the thick, concretion-bearing paleosol. They now assign the western interval to a Karie pedotype (Triassic), distinctive from the Num pedotype "in the scheme of Retallack et al. (2003)." Retallack et al. (2003) neither report, define, describe, nor illustrate a Num pedotype in their paleosol scheme; it is not part of their GSA Data Repository item 2003122. The identification of multiple isotopic excursions associated with the latest Permian or earliest Triassic sequence, and their relationship to the marine record, are important to understand a terrestrial ecosystem response. Tabor et al. (2007) demonstrate that the pedogenic nodule, carbonate-cement geochemistry represents precipitation under either atmospheric equilibrium conditions or the result of methanogenesis in wetland soils. Hence, more data are needed to resolve the Karoo events, including geochemical profiles of boundary sections, allowing for discrimination between changes in atmospheric gas trends, important for marine correlation, and fractionation associated with organic decay. We look forward to Ward and colleagues providing (1) a new basinwide correlation of PTB sections using a new datum; (2) a high resolution description of the pond facies and its aerial extent in space and time; and (3) biostratigraphic trends of boundary-section vertebrates demonstrating the multiple mass extinctions (Ward et al., 2012). We still miss geochronometric constraints, which will place events in a temporal framework. Interpretations are always open to change as new data are acquired. As such, our understanding of Earth systems, their response to perturbation, and what these deep-time lessons provide require continued probing to refine models that may be applicable to our own future.

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