U isotope variation in marine carbonates across the Permian-Triassic boundary

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The ~252-Ma Permian-Triassic boundary (PTB) represents the largest mass extinction event in Earth history [1-3]. Despite extensive prior work, many aspects of this crisis remain poorly understood, including the timing, extent, and intensity of ocean anoxia [4]. Previous work by Brennecka et al. [5] showed evidence for widespread ocean anoxia based on a negative shift in the uranium (U) isotopic composition of marine carbonates deposited at the time of the extinction. However, Brennecka et al. [5] studied only a single eastern Paleo-Tethys section from South China (Dawen).

Here we report the U isotopic composition of a well-preserved PTB marine carbonate section from Zal, Iran, which was located in the western central Tethys during the Late Permian. The average $\delta^{238}U$ value of samples deposited prior to the extinction horizon (EH) is –0.11‰. An abrupt and significant shift in $\delta^{238}U$ values at the EH to values as low as –0.69‰ was observed essentially synchronous with the PTB negative carbon isotope shift. The $\delta^{238}U$ excursion persists well after the recovery of the $\delta^{13}C$ excursion, possibly indicating a protracted interval of ocean anoxia. The overall variation in $\delta^{238}U$ observed in the Zal section across the PTB is similar to that reported by Brennecka et al. [5] for the Dawen section. Essentially identical $\delta^{238}U$ records from these two paleogeographically widely separated sections suggest that these $\delta^{238}U$ variations are primary and record widespread ocean anoxia during the Permian-Triassic transition.

[1] Erwin, et al. (2002), *Geol. Soc. Am. Sp. Pap.* **356**, 353-383. [2] Irmis and Whiteside (2011), *Royal Soc. B*, 9 pp. [3] Shen et al. (2011), *Science* **334**, 1367-1372. [4] Bond and Wignall (2010), *Geol. Soc. Amer. Bull.* **122**,1265-1279. [5] Brennecka et al. (2011), *PNAS* **108**,17631-17634.