Uranium isotope variation across the Smithian-Spathian boundary

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The Smithian-Spathian boundary (SSB) was recently identified as a major biocrisis on the road of marine ecosystem following the end-Permian mass extinction. Marine anoxia has been hypothesized to have played an important role in the SSB biocrisis. However, the relationship between marine anoxia and the SSB biocrisis has been hampered by the limited knowledge of the timing, duration, and extent of anoxia across the SSB. A recent U isotope study suggests that the SSB biocrisis was associated with an episode of extensive marine anoxia[1]. However, this inference is largely based on three U isotope measurements at the SSB. Here, to confirm the significance of this study, we present a high-resolution U isotope record from carbonates that span from middle Smithian to the early-middle Spathian. Our U isotope records show persistent and widespread negative values (averaging –0.56‰) in late Smithian. There was a remarkable positive shift in U isotope immediately at the SSB (from ~−0.78‰to ~ –0.10‰). This positive excursion was followed by another shifting back to lower δ238U values in the early-Middle Spathian. U isotope mass balance modeling suggests that the global area of anoxic seafloor expanded strongly during the late Smithian and the early-middle Spathian, but that it reduced sharply at the SSB. The redox variation documented by our U isotopes show a very good first-order correspondence to the previously published sea surface temperature curves where peak anoxia coincided with the late Smithian hyperthermal event, and diminished anoxia with a pronounced global cooling event at the SSB. The late Smithain marine anoxia was corresponded to the low biodiversities of many marine clades, suggesting that anoxia may have played a significant role in the SSB biocrisis.

[1] Zhang et al. (2018) Science Advances, in press.