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Bitter Spring $\delta^{13}\text{C}$ anomaly in the Vindhyan Supergroup, Rajasthan, India

Ray, J.S.

Physical Research Laboratory, Navrangpura, Ahmedabad 380009, India, E-mail: jsray@prl.res.in

The Balwan Limestone is the topmost carbonate formation of the Vindhyan Supergroup, India and is developed only in the western sector, in Rajasthan. It underlies the youngest horizon of the supergroup, the Dholpur Shale, and belongs to the Bhandar Group, which is known for occurrences of numerous controversial fossils of earliest animal life. The lone available age constraint based on Pb-Pb dating of carbonates, though not very robust, suggests a depositional age of 860 ± 180 Ma [1], making it one of the few possible Cryogenian carbonate deposits in India.

The Balwan Limestone Formation is exposed along the northwestern slope of an 18 km long and SW-NE trending anticlinal ridge, representing the Maihar (Sikhaoda) Sandstone, near the township of Lakheri. Lying conformably over the sandstone, the formation varies in thickness from ~50 to 120 m. The lower part is characterized by molar tooth structures and stromatolites and the upper part is dominated by stromatolites that are different from the older member. An intra-formational conglomerate horizon, 10-20 m, bounded by beds containing chert nodules at the bottom and bedded chert at the top, is present in the middle of the formation. $\delta^{13}\text{C}$ of the least-altered calcite matrix components from five sections, of 15 to 72 m thick, shows no obvious correlation with $\delta^{18}\text{O}$, thus its variations can be considered primary. The $\delta^{13}\text{C}$ hovers around 0 (± 1.5) ‰ in the bottom half of the sections and dips to -5.3 ‰ in the cherty horizon, and then bounces back to positive values (4.0 ± 2.0 ‰) in upper portions – reaching as high as 6.6 ‰ in one section. There is a basin wide consistency in the $\delta^{13}\text{C}$ variation and it mimics the ~800 Ma Bitter Spring anomaly observed globally [2]. The lowest observed $^{87}\text{Sr}/^{86}\text{Sr}$ of 0.70676, associated with lowest Mn/Sr and high positive $\delta^{13}\text{C}$ (4.5‰), suggests that the Balwan Limestone most likely was deposited during 780 ± 100 Ma [3]. This would mean that the sedimentation in the Vindhyan basin continued well into the Neoproterozoic and the closure of the basin predates the major global glacial events of the Cryogenian.

References:

[1] Gopalan et al. (2013) *Precam Res* 233: 108-117

[2] Halverson and Shields-Zhou (2011), *Geol. Soc. Mem.* 36, 51-66

[3] McArthur et al. (2012) *The Geologic Time Scale 2012*, ch. 7, 127-144

