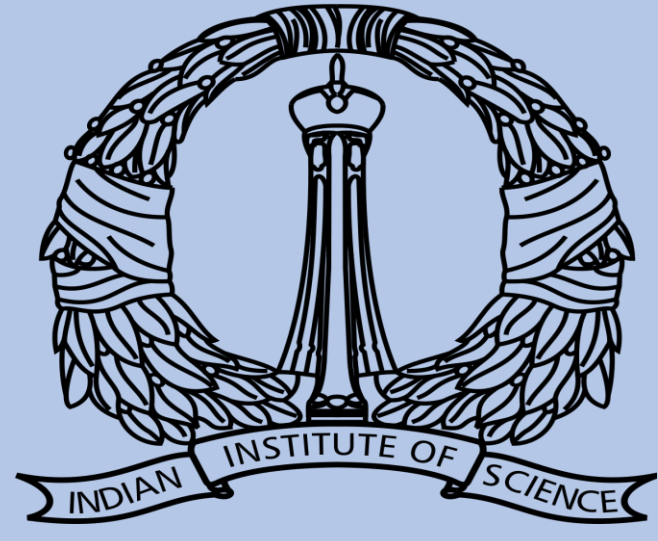


Geochemical and $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{44/40}\text{Ca}$ Compositions of Ediacaran Carbonates from the Indian Shield: Understanding Preservation of Local versus Global Biogeochemical Signatures during Periods of Extreme Environmental Changes

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1. Introduction

- ❑ The Neoproterozoic era represents extreme environmental changes with major glaciation and deglaciation events
- ❑ Associated with these glaciation and deglaciation periods are high amplitude positive and negative $\delta^{13}\text{C}$ excursions which have been observed in the rock records, suggesting perturbations in oceanic biogeochemical cycles. However, whether these isotopic records reflect primary depositional signature and open ocean condition are debated
- ❑ This study focuses on the geochemistry, radiogenic Nd-Sr and stable Ca isotope composition of carbonates from the Marwar Basin of the Indian Shield (Fig 1)
- ❑ The magnitude of negative $\delta^{13}\text{C}$ excursion from the Marwar Basin carbonates is comparable with the Shuram excursion

- What was the extent of connectivity of the Marwar Basin to the global open ocean?
- Do the Marwar carbonates reflect primary depositional signature?
- What are the possible mechanisms behind anomalous Neoproterozoic Ca isotope cycle?

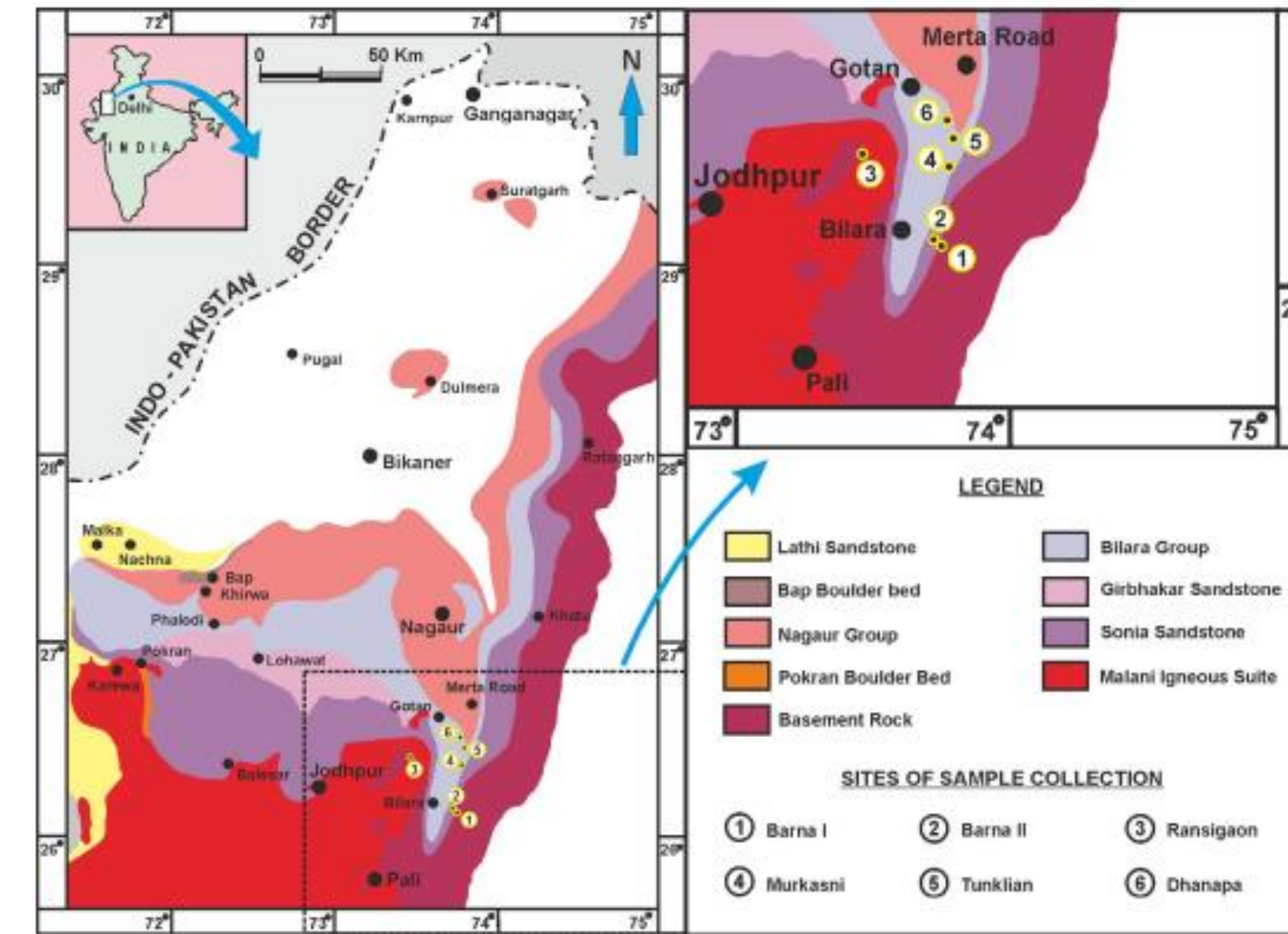


Fig. 1: A generalized geological map of the study area Marwar Basin of the Indian Shield (after Ansari et al., 2018) showing the sample locations

This study presents geochemical, radiogenic Nd-Sr, and stable Ca isotope data of Bilara Group of carbonates from the Marwar Basin of the Indian Shield

2. Analytical techniques



- ❑ Elemental concentrations were measured using Inductively Coupled Plasma Mass Spectrometer (ICP-MS, Thermo Scientific, X Series II) at the Centre for Earth Sciences (CEaS), IISc.



- ❑ Nd isotopic ratios were measured using a Thermal Ionization Mass Spectrometer (TIMS, Triton Plus) at CEaS, IISc following established protocols.¹⁰

3. Results and Discussion

Marwar Basin: A shuram excursion site

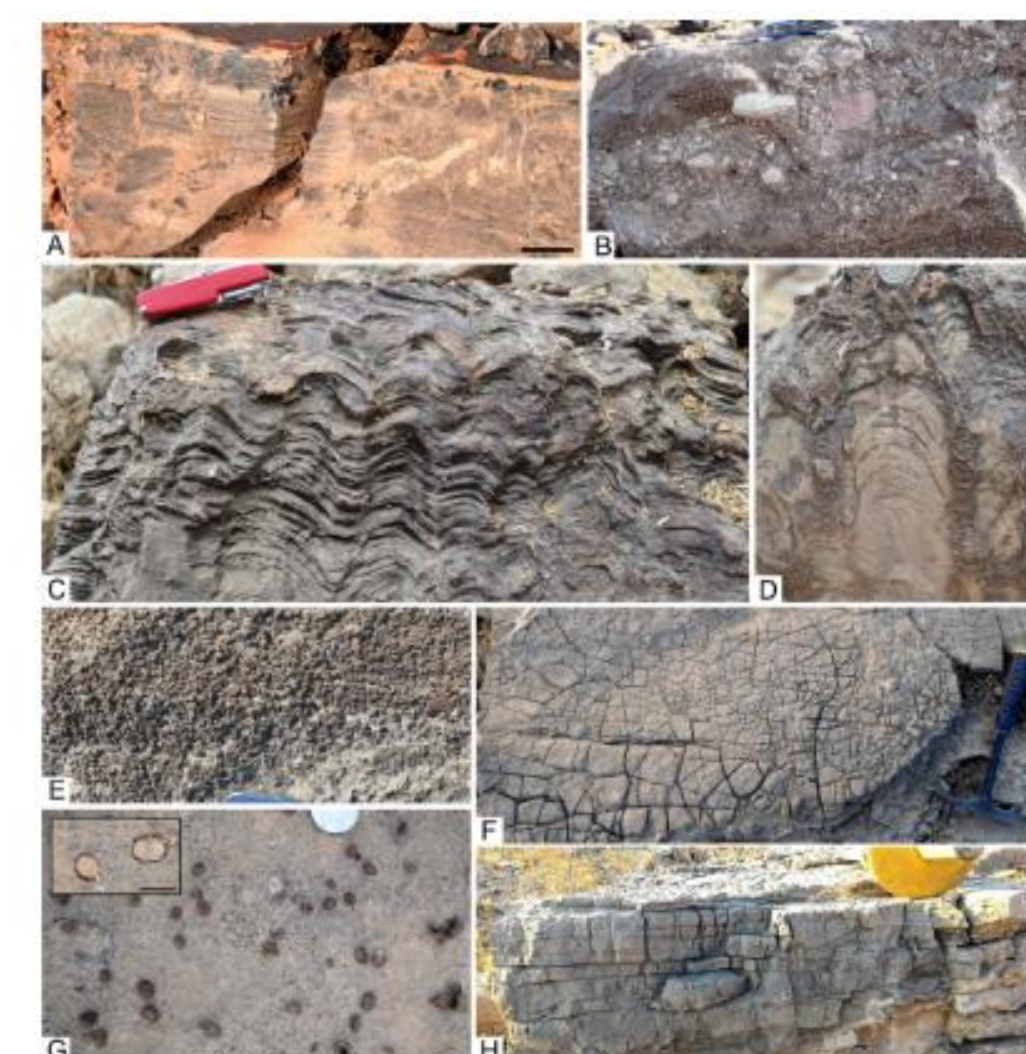


Fig. 2: Representative field occurrence of Bilara Group carbonates from the Marwar Basin, Indian Shield (Ansari et al., 2018)

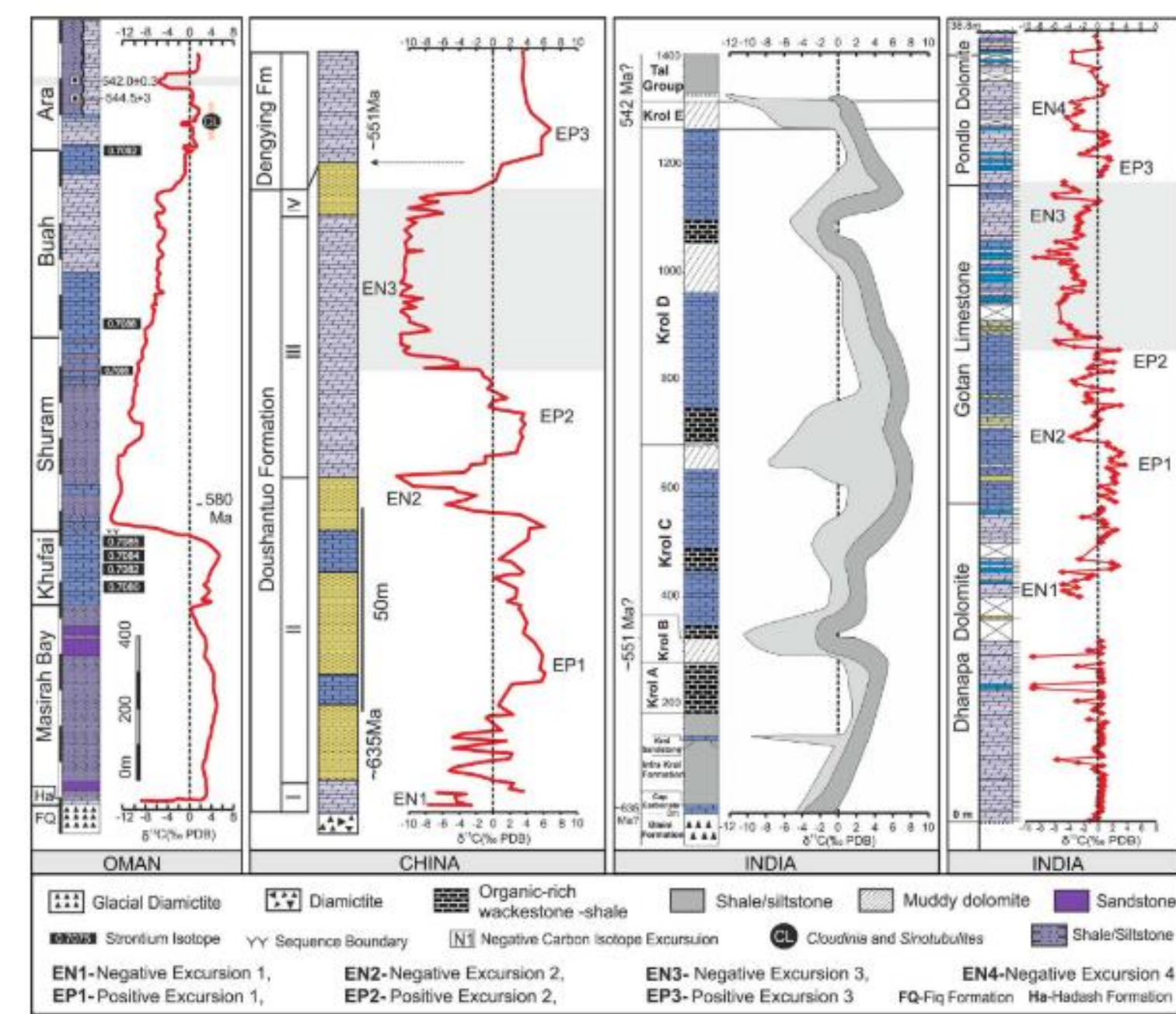


Fig. 3: The magnitude of negative $\delta^{13}\text{C}$ excursion from the Marwar Basin is comparable with other Shuram excursion sites (Ansari et al., 2018)

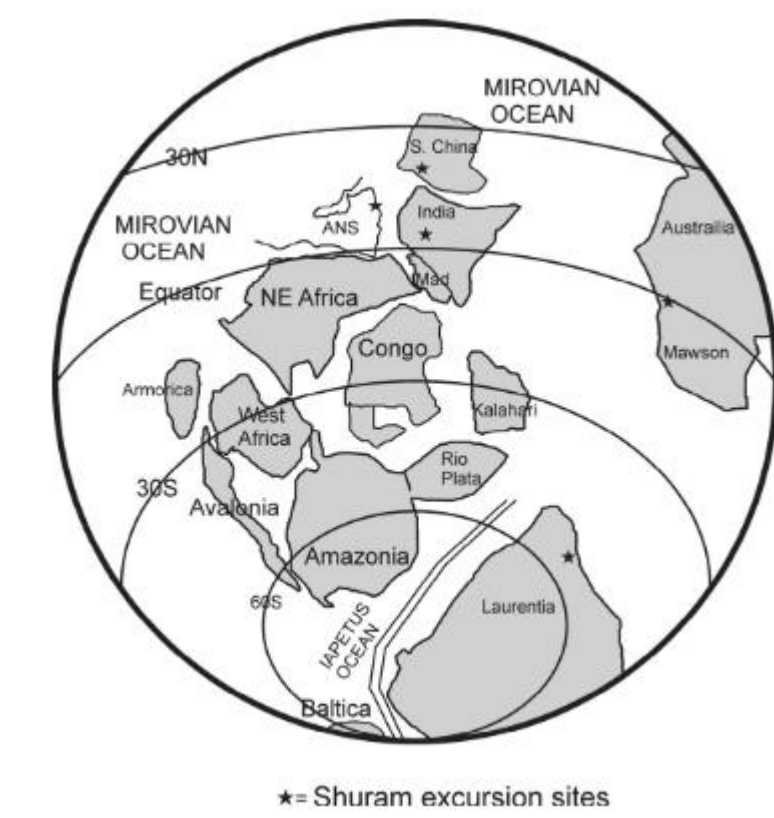


Fig. 4: Paleogeographic map showing distribution of landmass around 565 Ma and Shuram excursion sites (After Meert and Lieberman, 2008; Ansari et al., 2018)

Does the Marwar carbonates reflect open ocean condition?

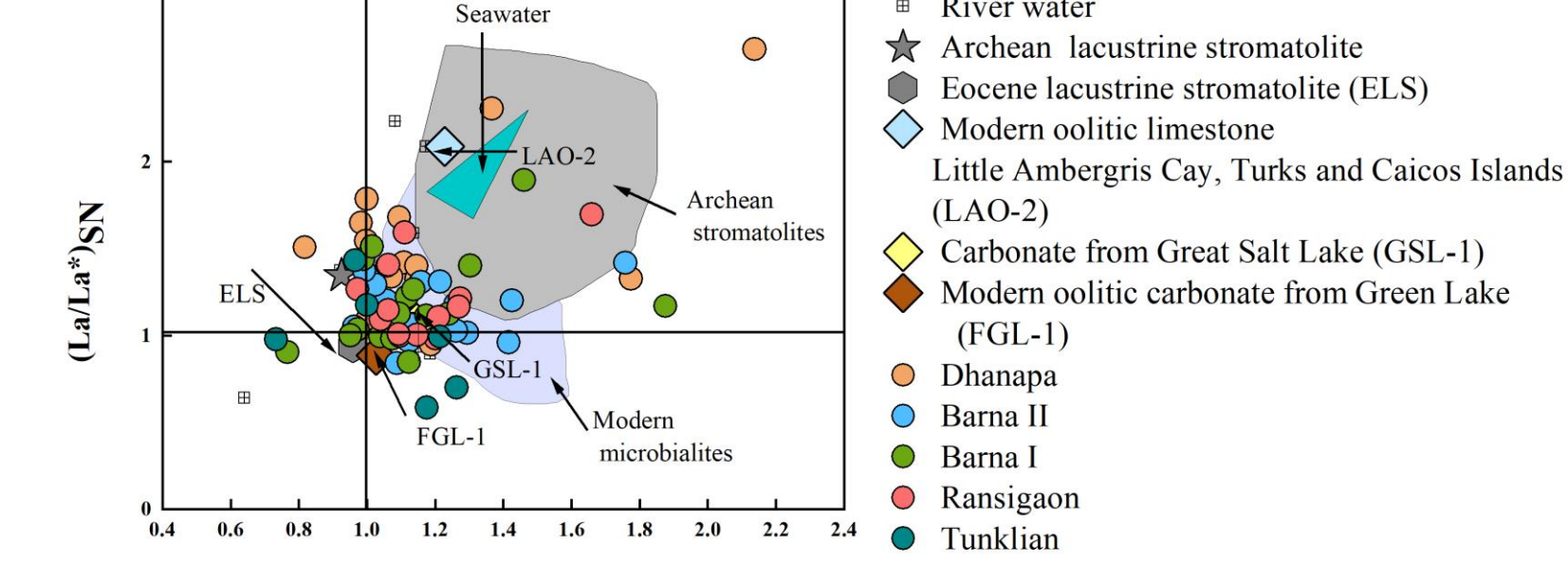
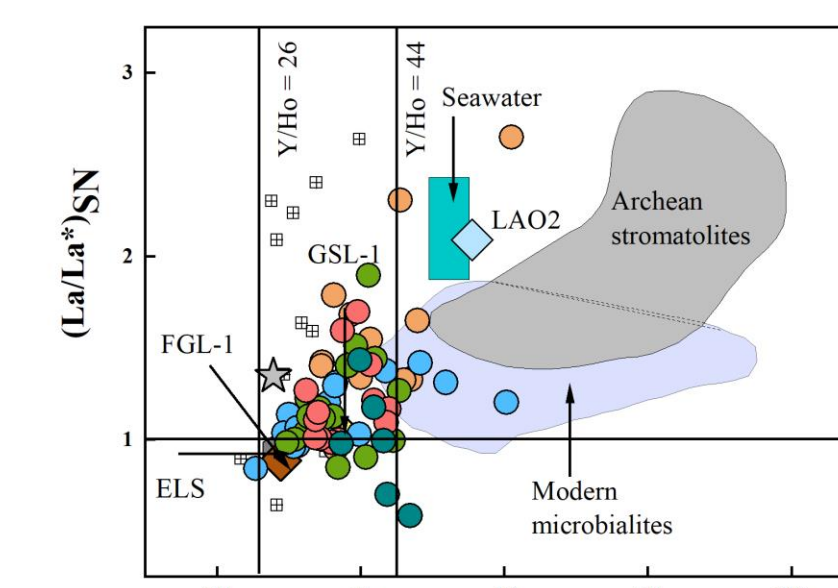


Fig. 5: Analysis of sixty-eight carbonate samples from five locations of the Marwar Basin show presence of $\text{Y}/\text{Ho} > 40$ and positive La , Gd anomaly (La/La^* , Gd/Gd^*) > 1 suggesting open ocean condition

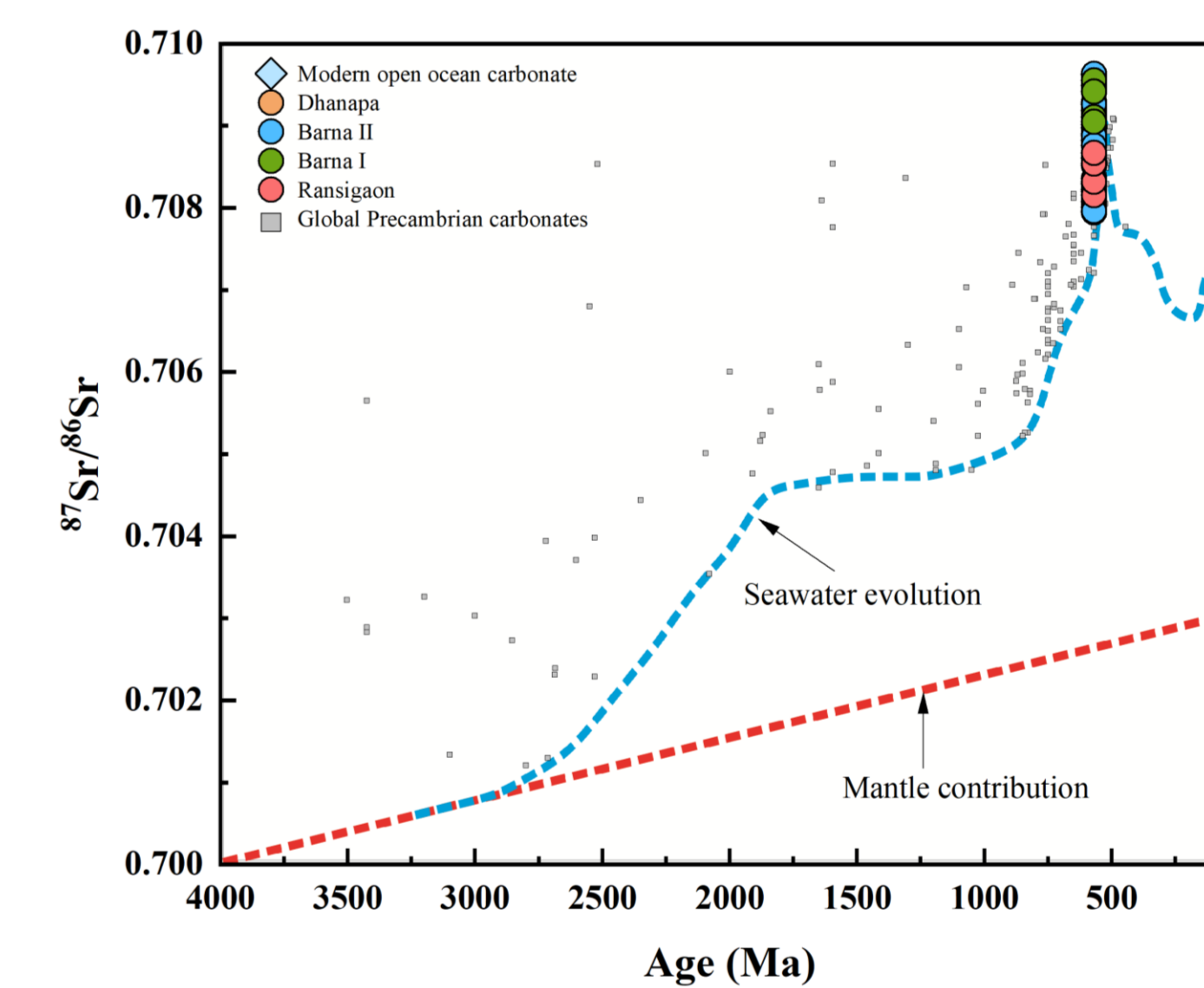


Fig. 6: $^{87}\text{Sr}/^{86}\text{Sr}$ composition of Marwar carbonates are similar to contemporaneous seawater suggesting connectivity to the open ocean

- ❑ REY signature and Sr isotopic composition of Marwar carbonates suggests connectivity to the open ocean

$\delta^{13}\text{C}$ variation in the Marwar Basin

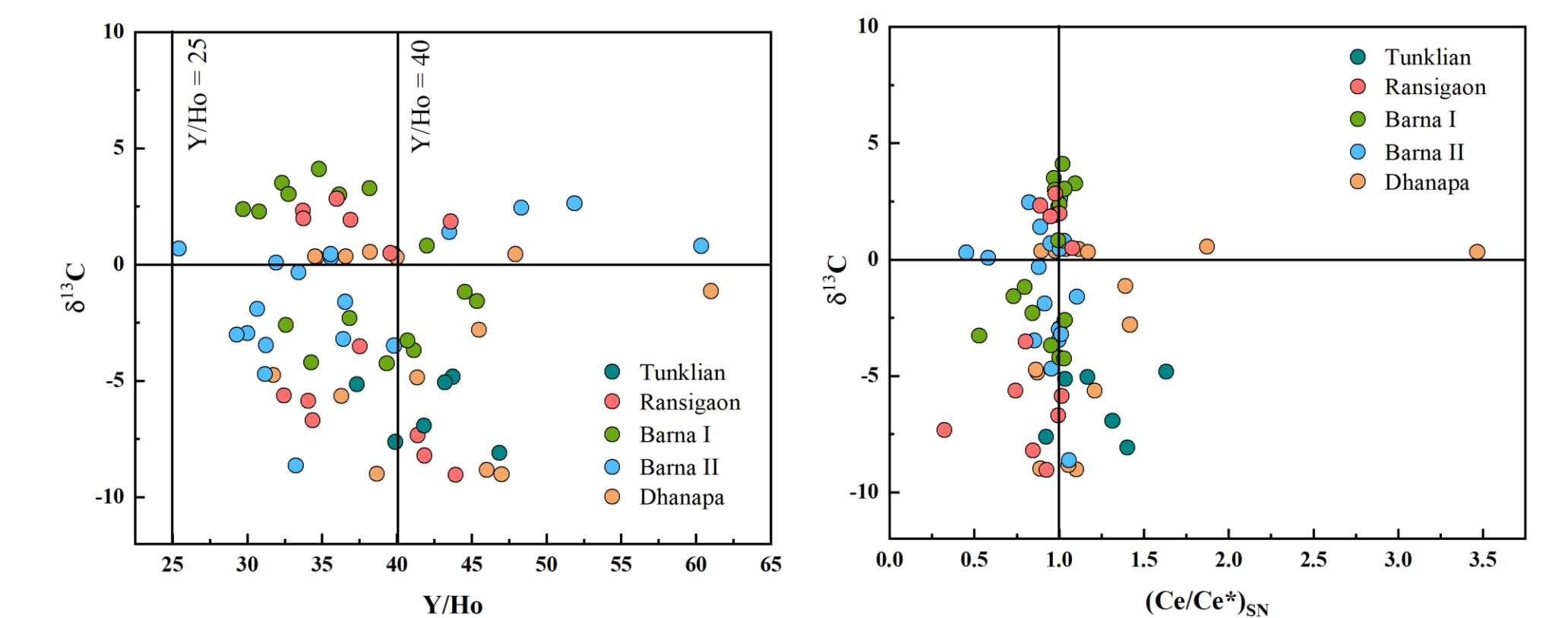


Fig. 7: $\delta^{13}\text{C}$ vs. Y/Ho and $\delta^{13}\text{C}$ vs. Ce/Ce^* plot of Marwar carbonates. $\delta^{13}\text{C}$ composition less than -7‰ has been observed in samples with $\text{Y}/\text{Ho} > 40$ confirming global open nature of the Shuram excursion event. $\delta^{13}\text{C}$ composition do not show any variation with Ce anomaly confirming absence of any paleo-gradient in the Marwar Basin

- ❑ The co-variation between REY and $\delta^{13}\text{C}$ composition confirm high amplitude negative $\delta^{13}\text{C}$ excursion in the Marwar Basin reflects open ocean condition

$\delta^{44/40}\text{Ca}$ composition of the Marwar carbonates: Signature of a post-glacial ocean?

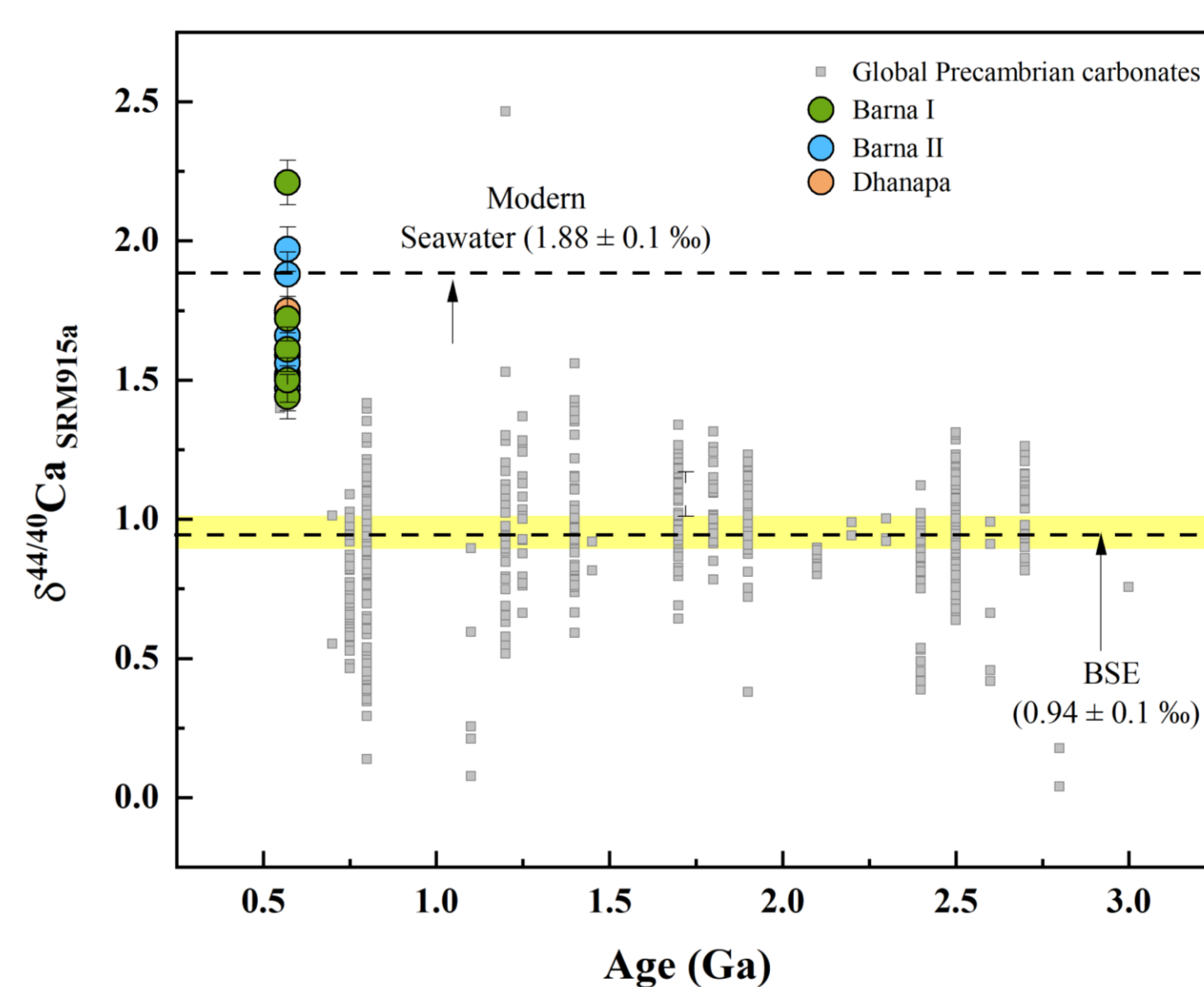


Fig. 8: Marwar carbonates show anomalously high $\delta^{44/40}\text{Ca}$ composition

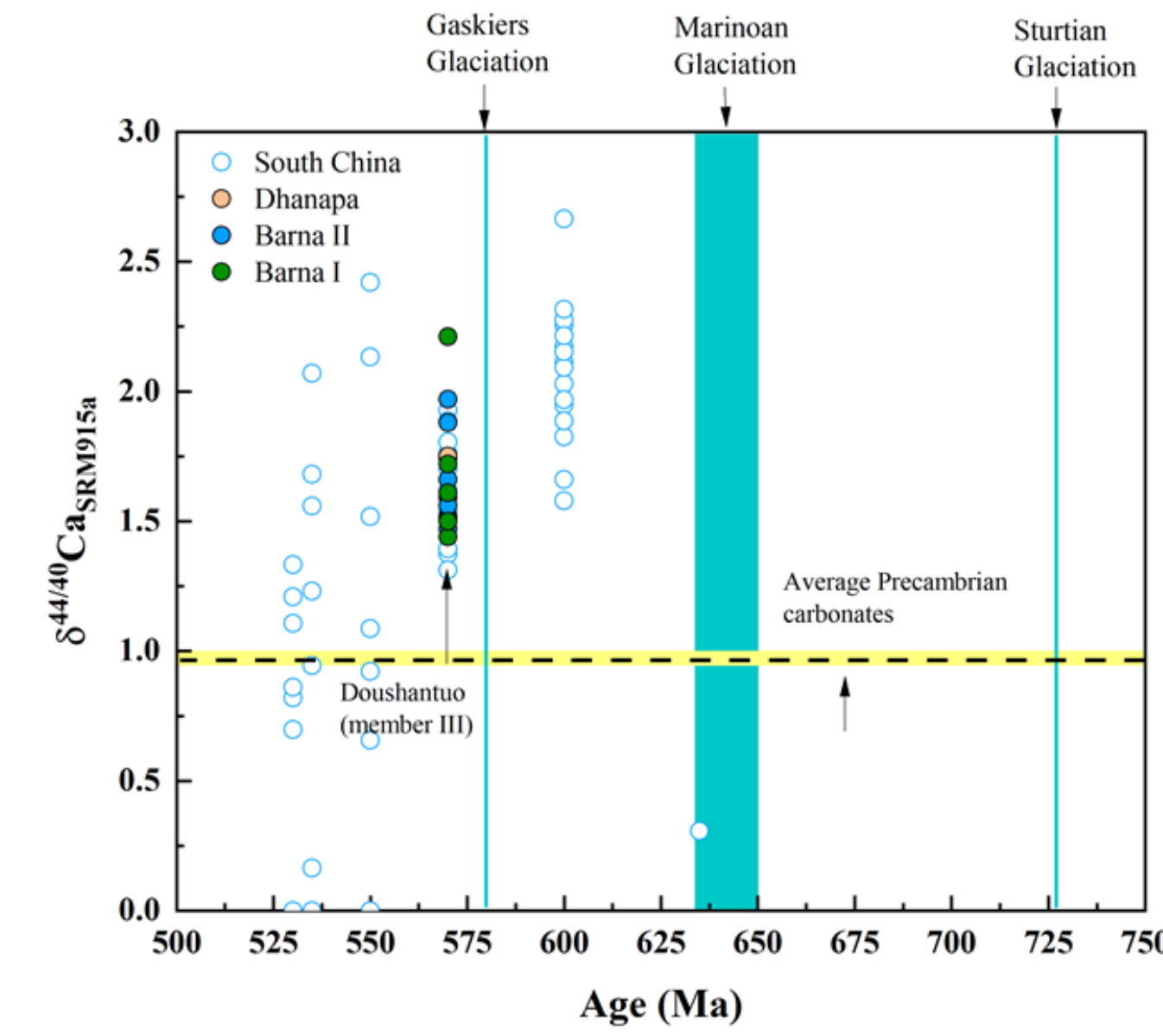
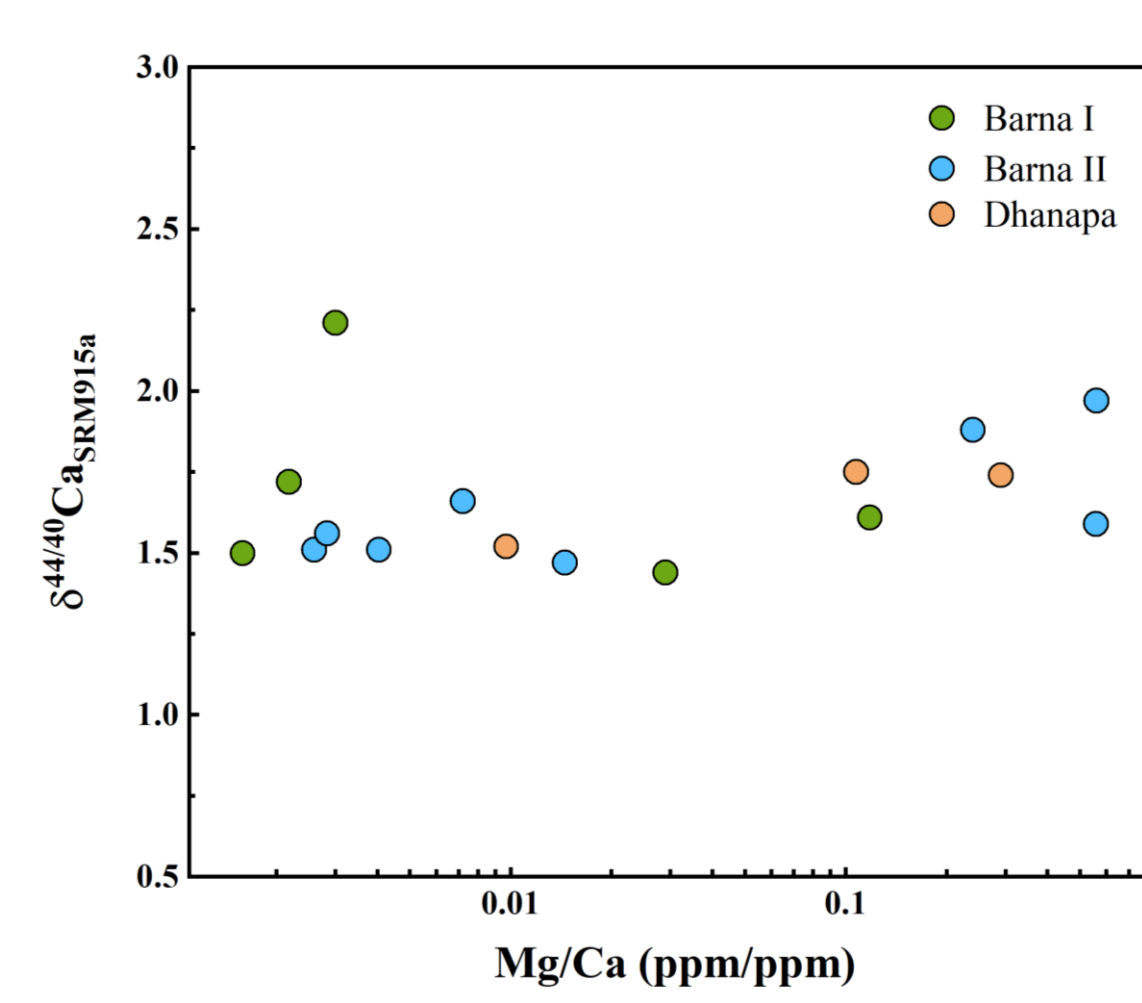


Fig. 9: $\delta^{44/40}\text{Ca}$ composition of Marwar carbonates do not show significant variation with Mg/Ca ratio indicating mineralogy is not the controlling factor



Nd isotope evidence of post-glacial water-mass mixing

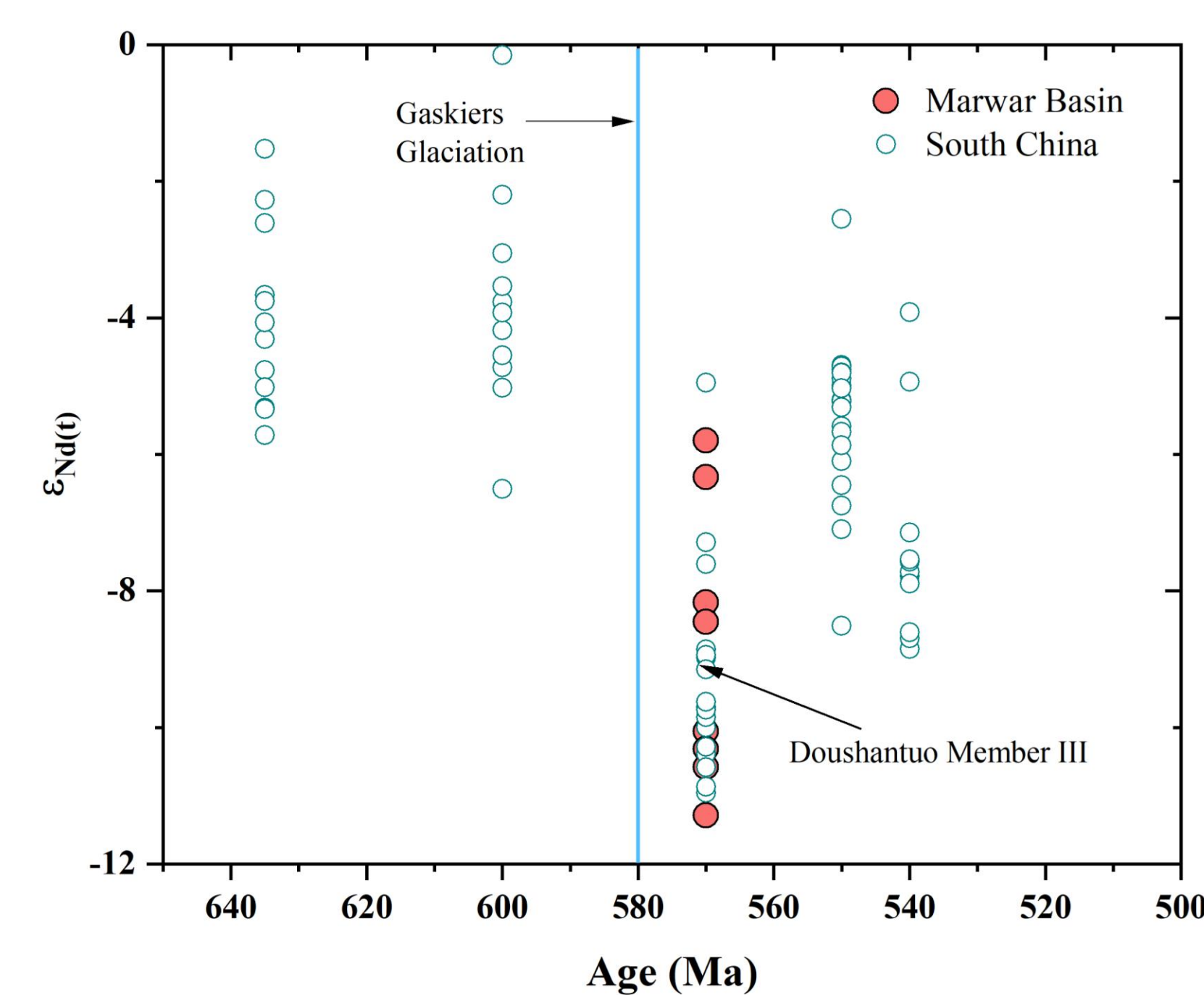


Fig. 11: Initial Nd isotope composition of Marwar carbonates are similar to post-Gaskiers Doushantuo Formation (member III) suggesting connectivity of the water-mass (S. China data from Wei et al., 2020)

- ❑ Initial Nd isotope composition of Marwar carbonates of the Indian Shield show similarity with post-Gaskiers Doushantuo Formation (member III) suggesting water-mass mixing
- ❑ Paleogeographic reconstruction during the Ediacaran show India to be of closer proximity with S. China further supporting post-glacial water-mass mixing

4. Conclusion

- The REY and Sr isotope systematics confirm primary and open ocean nature of the high amplitude negative C isotope excursion observed in the Marwar carbonates
- High amount of calcium carbonate precipitation led to observed anomalously high $\delta^{44/40}\text{Ca}$ composition of Marwar and Doushantuo (S. China) carbonates
- Initial Nd isotope composition of Marwar and Doushantuo (member III) carbonates show similar values suggesting water-mass mixing