

The sulphur isotopic composition of Neoproterozoic to early Cambrian seawater – evidence from the cyclic Hanseran evaporites, NW India

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Marine evaporitic sulphates provide information about the sulphur isotopic composition of ancient seawater. This is based on the observation, that the pure precipitation of sulphate minerals from evaporating seawater is associated only with a negligible isotope fractionation (e.g. Strauss, 1997). Thus, marine evaporites have been utilized to reconstruct temporal variations in $\delta^{34}\text{S}_{\text{seawater}}$ through Phanerozoic (e.g. Claypool *et al.*, 1980) and Precambrian (e.g. Strauss, 1993) times. As such, they serve as proxy signals for this central reservoir within the sulphur cycle, reflecting major changes which might have occurred through time. Time resolution, however, is greatly limited as a consequence of erosion and/or non-deposition of evaporites. This is particularly true for the Precambrian and early Palaeozoic, where only few evaporite deposits have been preserved. We present here sulphur isotope data for the cyclic Hanseran evaporites from NW India, previously unstudied as a proxy for ancient seawater composition.

Geological setting

The subsurface occurrence of a large Neoproterozoic to early Cambrian evaporite basin (100,000 km²) has been confirmed through numerous drill holes in NW India and across the border into Pakistan. Stratigraphically, the Hanseran evaporites are part of the Marwar Supergroup, which represents a succession of clastic sediments (Jodhpur Group), chemical sediments (Hanseran Group) and followed by clastic sediments again (Nagaur Group). Thicknesses as well as type of chemical sediment (i.e. carbonates, sulphates, chlorides) vary in relation to the palaeogeographic position within the depositional basin. The evaporites have been subdivided into a maximum of seven different evaporitic cycles (e.g. Dey, 1991) which can be traced along profiles across the basin. Given the low number of ancient

evaporites, this deposit and its characteristic cyclic appearance represents a most valuable source of information with respect to ancient seawater chemistry.

Results and discussion

The sulphur isotopic composition for anhydrite and anhydrite-bearing halites determined for the Hanseran evaporites ranges from +27.5 to +35.6 ‰. Thereby, individual evaporitic cycles display characteristic differences in their sulphur isotope values.

These data from NW India confirm the previously known positive sulphur isotope signature for late Neoproterozoic to early Palaeozoic (lower Cambrian) sulphates. Initially, this pattern was described for evaporite deposits in Siberia (e.g. Claypool *et al.*, 1980). Further reports from Australia, China, Oman, Iran have confirmed this characteristic range in $\delta^{34}\text{S}_{\text{sulphate}}$, which represents the maximum of the appropriate temporal variation in the isotopic composition of Precambrian and Phanerozoic seawater. Mass balance considerations demand the substantial formation and burial of reduced and ³⁴S depleted sulphur during this time frame, likely in the form of sedimentary pyrite. The latter, however, frequently shows an equally distinct strongly positive sulphur isotope signature, which might be a consequence of enhanced sulphate reduction causing rapid sulphate limitation (for a review see, e.g. Strauss, 1997).

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