Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.29231

The application of paleosalinity proxies: from shale to carbonate, marly sediments, and banded iron formations (BIF)

WEI WEI[1], THOMAS J. ALGEO[2], CAIYUN LAN[3], XUEQI LIANG[4] AND KURT O. KONHAUSER[4]

[1]China University of Geosciences Wuhan

[2]State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, Chengdu University of Technology, Chengdu 610059, Sichuan, China

[3]Northwest University

[4]University of Alberta

Paleosalnity proxies have been extensively utilized for reconstructing watermass salinity in ancient shale and siliciclastic mudstone formations; however, their applicability to carbonate-rich lithologies, particularly limestones and marls, remains insufficiently validated. In carbonate-dominated facies, the Sr/Ba ratio proves unreliable due to the substantial contribution of carbonate-derived Sr, while the S/TOC ratio exhibits limited effectiveness owing to typically low organic matter content. Nevertheless, the B/Ga ratio demonstrates significant, though previously unexplored, potential as a paleosalinity indicator in carbonate-rich sequences. To assess this potential, we conducted comprehensive geochemical analyses of B, Ga, Al, Ca, and other lithology-sensitive elements in an extensive collection of modern and ancient carbonate samples, encompassing both sedimentary deposits and fossil materials.Our analytical results reveal that B/Ga ratios are characteristically elevated in carbonate-rich materials due to the inherently low Ga concentrations, as Ga is predominantly associated with the detrital siliciclastic fraction. In marly sediments, robust salinity facies determinations can be reliably achieved for samples containing Ga concentrations as low as 3 ppm, contrasting with the typical range of 15-20 ppm observed in shales. For carbonate samples with Ga concentrations below 3 ppm, accurate salinity facies estimates can be derived using excess boron (Bxs), calculated as Btotal - 6 × Ga. Marine carbonate facies typically exhibit excess boron contents of ~10-20 ppm, with deviations from this range indicating watermass salinities outside the normal marine range of ~33-38 psu (practical salinity units). Notably, this study represents the first application of paleosalinity proxies, specifically B/Ga ratios and boron isotopes, to banded iron formations (BIFs). The results demonstrate a similar mechanism of excess boron accumulation, establishing these proxies as viable indicators for paleosalinity reconstruction in BIFs. This investigation provides the first systematic framework for evaluating depositional salinities in ancient carbonate and marl formations, while simultaneously pioneering the application of these methodologies to BIFs. The establishment of these geochemical proxies offers a valuable tool for future paleoenvironmental reconstructions across diverse lithological contexts.