

An update on boron-based paleosalinity proxies

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Salinity is a fundamental property of aqueous systems, with which many other environmental properties covary (e.g., temperature, redox state, pH, nutrient levels, and watermass restriction). Elemental salinity proxies are providing new tools for probing paleoenvironmental conditions, although key questions regarding the application of these proxies have remained unaddressed. In this presentation, we review recent work in the development of boron-based salinity proxies. The B/Ga proxy, which was refined for use in shales by Wei and Algeo (2020), was recently shown to be robust for marls (Al >2%) but not carbonate sediments (Wei et al., 2025a). However, a newly proposed proxy, excess boron (B_{xs}), can be applied to distinguish marine from brackish and freshwater limestones (figure). Combined use of the B/Ga and B_{xs} proxies can effectively reconstruct paleosalinity variation in mixed carbonate-siliciclastic successions, as recently shown for North American Carboniferous cyclothemic (Algeo et al., 2025a) and Cretaceous marine-lacustrine successions (Remírez et al., 2025a). Also, Wei and Algeo (2020) considered salinity variation only over the range from freshwater to normal-marine conditions, without giving attention to hypersaline watermasses. Recently, Remírez et al. (2025b) documented that the B/Ga and B_{xs} proxies yield substantially higher values for hypersaline facies than normal-marine facies, demonstrating that the range of utility of boron-based salinity proxies extends into the hypersaline domain (figure). An issue that has been only intermittently examined is whether the composition of the clay-mineral assemblage affects the amount of boron taken up by shales and marls; illite takes up B more readily than kaolinite and chlorite but the magnitude of this effect and its influence on paleosalinity reconstructions are uncertain. Recently, Algeo et al. (2025b) showed that variation of clay-mineral assemblages within ancient shale formations exerts only a minor influence, and one that is generally negligible, on salinity facies assignments. Finally, Wei et al. (2025b) tested several pretreatment protocols for B concentration analysis by ICP-MS, determining that use of strong acids leads to partial boron loss through volatilization, whereas alkali fusion results in near-quantitative recovery of boron. Collectively, these recent studies address many of the open issues related to optimal application of boron-based elemental salinity proxies.

