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Ocean chemistry archived in modern evaporites: implications for robust seawater and CO_2 reconstructions from Earth's past

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The chemical history of seawater provides key information on Earth's geologic processes and is fundamental for robust CO_2 reconstructions. The knowledge of the secular evolution of the oceanic boron isotope budget is particularly important for CO_2 reconstruction from boron isotopes. The boron isotope composition of seawater ($\delta^{11}B_{sw}$) is homogeneous, but varies on multi-million year time scales, given its residence time of approximately 10 million years. To date, the secular evolution of the oceanic boron isotope budget has been difficult to constrain, posing a major uncertainty for boron-based pH and CO_2 reconstructions from Earth's geologic past and critically limiting our understanding of the global biogeochemical cycling of this important element through time. Evaporitic minerals bearing fluid inclusions – and halites in particular – have provided important insights on past variations in major and minor ion composition, and present a highly appealing archive for reconstructing $\delta^{11}B_{sw}$ (as well as other isotopic systems) given their direct origin from seawater. However, the interpretation of their signatures is not straightforward due to the possibility of fractionation during evaporation, crystallisation, and local biogeochemical interactions. Here we present data illuminating the evolution of boron isotopes and various other elements during evaporite formation from laboratory experiments and natural modern evaporitic settings across the globe, accompanied by new analytical developments for high-precision single fluid inclusion measurement using laser ablation. These data enable us to critically evaluate the evaporite archive, paving an avenue to robust seawater and CO_2 reconstructions from Earth's geological past.