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Dual clumped isotopes indicate the control of diagenetic systems on the formation of cold seep carbonates

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While methane-derived authigenic carbonates (MDACs) are widely used to reconstruct paleoclimate and biogeochemical cycles, such interpretation comes with a challenge in that the C and O isotopic values of MDACs may have experienced significant kinetic isotope effects induced by rapid precipitation and increased alkalinity during their formation. In order to further understand the non-equilibrium process during the formation of MDACs, we analyzed a suite of modern samples from North, Barent and Marmara Sea using the dual clumped isotope approach (Δ_{47} and Δ_{48}), a novel proxy for investigating kinetic isotope effects. The four petrographic textures of our MDACs, that include aragonite matrix, cavity filling cements, Mg-calcite, and dolomite, show a range of Δ_{47} and Δ_{48} values. The aragonite matrix and cavity filling cements have more positive Δ_{48} values and more negative Δ_{47} values relative to expected equilibrium values, comparable to the samples in South China Sea, which was interpreted as a product of rate-limiting bicarbonate dehydration/dehydroxylation in an open-system environment [1]. In contrast, the Δ_{48} values of the Mg-calcite and dolomite show negative Δ_{48}-disequilibrium, generally recognized in the carbonate minerals mediated by microbial sulfate reduction [2, 3]. Such a disequilibrium is mostly attributed to the elevated concentrations of dissolved inorganic carbon relating to CO_2 hydration/hydroxylation in a closed system in which the produced CO_2 slowly diffuses into ocean, rather than the rapidly degas. The differential disequilibrium of the dual clumped isotopes highlights the importance of diagenetic systems (open vs closed) in controlling the formation mechanism of MDACs and defining their geochemical signatures.

Reference

[1]Staudigel, P., Feng, D., Peckmann, J., Bernecker, M., Davies, A., Tagliavento, M. and Fiebig, J. (2024) Resolving and correcting for kinetic biases on methane seep paleotemperature using carbonate Δ_{47} /Δ_{48} analysis. Science Advances, 10, eadn0155.

[2]Lu, C., Murray, S.T., Klaus, J., McNeill, D.F. and Swart, P.K. (2024) Dual clumped isotopes (Δ_{47} and Δ_{48}) reveal non-equilibrium formation of freshwater cements. Geochimica et Cosmochimica Acta, 379, 145-157.

[3]Lu, C. and Swart, P.K. (2024) The application of dual clumped isotope thermometer (Δ_{47} and Δ_{48}) to the understanding of dolomite formation. Geology, 52, 56-60.