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Geochronology and stable isotope geochemistry of cold-seep carbonates from the Sea of Marmara

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Numerous sites of active gas venting were discovered during the *Marnaut* cruise (2007; R/V *Atalante*) in the Sea of Marmara, along the submerged section of the North Anatolian Fault. A suite of carbonate crusts covering the seafloor was recovered during submersible surveys, from various geochemical environments. Buried carbonate concretions were also collected by gravity coring at the Western-High ridge, from two active mound structures expelling brines with thermogenic gas and oils. These fluids most likely come from a deep hydrocarbon-reservoir, migrating upward through a plumbing system provided by the fault fractures.

In this study, we report carbonate absolute U-Th ages and stable isotope compositions for a series of authigenic carbonate samples. These samples correspond to aragonite-rich phases selected carefully after microscopic observation, and were sampled using a computer-assisted microdrill system.

Most seafloor authigenic carbonates exhibit typical negative δ^{13}C values (-45.2 to -17.1 ‰ VPDB) attesting that they mainly derive from microbial methane oxidation. U-Th ages show that they have precipitated during the late mid-Holocene (between about 0.4 to 6.6 thousand years ago) most probably in relation to local fluid activity associated to the North Anatolian fault system. Oxygen isotopic compositions are close to equilibrium with the ambient bottom seawater (δ^{18}O=+2.8 ‰ VPDB, calculated for aragonite), but sometimes display lower values (as low as +0.7 ‰ VPDB) indicating precipitation with brackish waters that originate from buried late-Pleistocene lacustrine sediments.

At the Western-High sites, numerous carbonate concretions were found downcore, at sediment depths below the present-day sulfate methane transition zone. The wide range of their carbon isotopic compositions (-22.4 to +14.2 ‰ VPDB) indicates a complex mixing of multiple sources of dissolved inorganic carbon in pore waters. Presumably, the high δ^{13}C values measured in some carbonate samples could reflect the migration of ^{13}C-rich dissolved DIC produced in the methanogenic zone and in the petroleum reservoir by the degradation of oil and other organic substrates. Most of these concretions were found at the sediment depth corresponding likely to the transition between lacustrine and marine environment, about 13 kyr ago. U-Th dating of these concretions indicates that an important phase of carbonate precipitation occurred at these sites between about 11 and 7 thousand years ago. These ages suggest that the major paleoenvironmental changes that took place in the Sea of Marmara at that time, from lacustrine to marine conditions, played an important role in fluid circulation patterns.