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Authigenic carbonate mounds from active methane seeps on the southern Aquitaine Shelf (Bay of Biscay, France): evidence for anaerobic oxidation of biogenic methane and submarine groundwater discharge during formation

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Abstract

The widespread methane emissions that were discovered in 2013 on the Aquitaine Shelf at water depth between 140 and 220 m are associated with authigenic carbonate crusts that cover meter-high subcircular reliefs of 10 to 100 m in diameter. These authigenic carbonates are primarily aragonite plus calcite and dolomite, which cement the fine- to medium-grained sandy sediment. The carbonate cement is often pierced by numerous circular cavities of 5 to 10 µm in diameter that are considered to be moulds of gas bubbles. Conversely, micron-sized cavities in the aragonite crystals are attributed to dissolution features, in relation to the production of CO_2 during the aerobic oxidation of methane. The oxygen isotopic compositions of bulk carbonate (+1.7 to +3.7‰) and aragonite cements obtained from microsampling (-0.1 to +1.4‰) indicate that these carbonates were precipitated in mixtures of seawater and freshwater, i.e., in the context of submarine groundwater discharge at the seafloor. The carbon isotopic compositions of authigenic carbonates (-51.9 to -38.1‰) and of aragonite cements (-49.9 to -29.3‰) show that the dissolved inorganic carbon of pore fluids was mostly produced by the anaerobic oxidation of biogenic methane and also partly from the groundwater system.