

Late Jurassic chemosynthetic carbonate mounds of Svalbard (arctic Norway) - preliminary results

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Carbonate mounds, interpreted as being associated with cold seeps, outcrop in the Late Jurassic dark silt- to paper-shale succession (Agardhfjellet Formation, Slottsmøya Member) of the Knorringfjellet area, Spitsbergen, Svalbard. Analyzed samples from one of these mounds include zoned (botryoidal) carbonate of varying yellow to brown colour, fissure-infilling sparite, and bivalve and ammonite shell material. Pyrite films are commonly developed between the different carbonate generations. The macrofauna consists mainly of small to medium sized bivalves (<10 mm), rare brachiopods as well as serpulid worm tubes as interpreted from petrographic thin sections. Embedded ammonites are considered to be ex situ.

The results of the stable isotope analyses show very negative $\delta^{13}\text{C}$ values ($\delta^{13}\text{C} \approx -37\text{‰}$ VPDB) in the zoned carbonate samples whereas the sparite, ammonite and bivalve samples form a separate group at $\delta^{13}\text{C} \approx -22\text{‰}$. The high $\delta^{13}\text{C}$ depletion indicates a methanogenic origin for the carbonate. The value of $\delta^{13}\text{C} \approx -37\text{‰}$, in the primary authigenic carbonate is in the range typical of thermogenic, rather than biogenic (< -60‰ PDB) methane. The ammonite shell was secreted by a presumably pelagic organism, and would originally have a normal-marine isotopic composition. The observed $\delta^{13}\text{C}$ value of -25‰ in the ammonite sample can be explained by recrystallization with introduction of light carbon from the authigenic carbonate.

The comparable $\delta^{13}\text{C}$ value of the bivalve sample indicates that the original carbon isotope composition of the shell, probably fossilized in situ, was similar to that of the ammonite, meaning that the carbon included in the shell was similarly derived from normal-marine seawater rather than from seep fluids and methane. Hence, there is no isotopic evidence for symbiosis with chemoautotrophic bacteria. The isotope values for the secondary sparite fall within the same group, possibly showing secondary precipitation from fluids containing carbonate dissolved partly from the authigenic carbonate and partly from shelly material in the mound. High depletion of $\delta^{13}\text{O}$ in the sparite, ammonite and bivalve material ($\delta^{13}\text{O} \approx -18\text{‰}$), indicates precipitation and recrystallization involving hydrothermal fluids, either syndimentary or in connection with the sill emplacements in the Cretaceous. The recrystallization of authigenic calcite is less pervasive and the $\delta^{18}\text{O}$ less depleted.

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