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Fossilisation by Mg-calcite: mineralized microbes in methane-derived carbonates from the Vestnesa Ridge, off western Svalbard

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Offshore western Svalbard, methane-derived authigenic carbonate rocks were sampled from the seabed of the Vestnesa Ridge in 1200 m water depth using a remotely operated vehicle, and from 23 meters below the seafloor with the MeBo seafloor drill rig. Negative δ13C-carbonate values as low as $-36‰$ VPDB indicate carbonate precipitation induced by microbial mediated sulphate-dependent anaerobic oxidation of thermogenic methane (AOM). Back-scatter scanning electron microscopy (SEM) of polished thin sections revealed abundant clusters of 10 to 30 μm sized spherical and grape-like structures cemented in aragonite. The structures resemble in size and shape microbial aggregates of AOM-mediating methane-oxidizing archaea and sulphate-reducing bacteria. Element mapping using SEM energy dispersive X-ray analysis of these structures revealed that they comprise finely layered ($< 5\mu$m) magnesium-calcite.
Here we show the results of high-resolution focused ion beam-transmission electron microscopy (FIB-TEM). The FIB-TEM technique allows nanometre scale characterization of the mineralogical and elemental compositions of these structures. These results help to better understand the fundamental mechanisms of microbial mineralization in methane-derived carbonates.