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Methane-derived carbonates as archives of past seepage activity along the Norwegian margin

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Assessment of timing and flux rates of past methane discharges is in part hindered by the lack of robust age constraints. Authigenic carbonate crusts forming in shallow sediments due to the oxidation of methane are recorders of seepage that can be dated by using U-daughter decay affording the unique opportunity to constrain the absolute timing of methane release events. Methane-derived carbonate crusts exhibiting characteristic 13C-depleted isotopic signatures were collected from several seepage sites on the Norwegian continental shelf, including sites in the North Sea, the Norwegian Sea and the Barents Sea. The U-Th dating results constrain the main episode of carbonate crust formation in the Barents and Norwegian seas during the time interval between 14 and 7 ka. Such ages suggest that the methane seepage along the northern Norwegian margin was most active after the collapse of the Scandinavian ice sheet and deglaciation of the area that took place at about 15 ka. The methane flux for the carbonate crust formation was likely provided by the dissociation of methane hydrates that extensively formed in underlying sediments during the last glacial period, but became unstable due to depressuring effects of retreating ice sheet. The precipitation of studied North Sea carbonate crusts occurred more recently, from 6 to 1 ka, suggesting that their formation is unrelated to the glacial history of the area and gas hydrate stability. Carbonate crust formation in the North Sea is likely related to the methane seepage from the hydrocarbon reservoir and the dating results allow an assessment of the seepage history within individual conduits.