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Timing of methane efflux along the Norwegian and US Atlantic margin

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Methane-related authigenic carbonates (MDAC) provide a robust archive of past methane emissions from cold seeps located along continental margins. MDAC are amenable to U-Th geochronology which can be used to assess the timing and drivers of fluid flow (Teichert et al., 2003; Bayon et al., 2013). The difficulty of sourcing MDAC typically precludes the assembly of datasets with sufficient geographic coverage and resolution to investigate the processes triggering and sustaining methane seeps on a regional scale. To address this, two collaborative projects led by the British, Norwegian and US geological surveys are currently underway, targeting methane seeps located along the Norwegian and US Atlantic margins (Skarke et al., 2014). MDAC samples collected for the two projects come from a range of depths (300-2000 m), and are linked to a variety of processes (e.g. collapse of grounded ice sheet, salt diapirism, dissociation of upper slope gas hydrates, emissions from deep reservoirs through fault networks). MDAC typically present as matrix-supported conglomerate /sandstone/ siltstone, and consist of detrital material of variable grainsize (depending on locality) encased in an aragonite and/or calcite cement. Interconnected voids within the MDAC, which likely represent fluid conduits, are often at least partially filled with clean (>90%), layered aragonite. The latter are ideal materials for U-Th geochronology, and can yield U-Th dates with precision approaching 0.5 % (2σ), with thicker (ca. 2 cm) layered cavity fills showing resolvable growth histories on the order of 1 kyr. While measurements on cavity-filling aragonite give a snapshot of seep activity, quantifying the entire methane emission history of a sample, and crucially, the timing of the onset of emissions, requires the analysis of MDAC groundmass. Such analyses are more challenging as initial detrital 230Th included in the samples must be accounted for. While precise dating of the onset of methane emissions at the studied sites is yet to be accomplished, broad trends within the dataset indicate that methane emissions along the Norwegian margin (1-17 ka) were related to the re-activation of regional fault systems as a result of isostatic rebound and bottom water warming in the aftermath of the collapse of the Scandinavian Ice Sheet. Conversely, dates from seeps located on the US Atlantic margin range between 3-24 ka, with shallower seeps likely to be affected by bottom water temperature variations around the Holocene climatic optimum.

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Skarke, A. et al. (2014), Nature Geoscience 7, 657-661.
Teichert, B. M. A. et al. (2003), Geochimica et Cosmochimica Acta 67, 3845–3857.