Dynamics of methane seepage at Leirdjupet Fault Complex (SW Barents Sea) since last deglaciation and possible future scenarios

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Methane emissions from Arctic continental margins may increase due to global warming. Present-day ocean fluxes seem to provide a minor contribution to the atmosphere methane pool, but large uncertainties still remain on the magnitude of future emissions from methane seeps and gas hydrate-bearing sediments. The Barents Sea is a natural laboratory to study the evolution of methane seeps in relation to climate change, as it recorded several phases of ice-sheet advance and retreat during the Pleistocene. Glaciations and its concurrent denudation of the Barents Sea influenced the subsurface, causing reservoir expansion and fracturing, thereby driving hydrocarbon (mostly gas) migration which resulted in a sustained regional fluid flow system. New data from this area can shed light on future response of other high-latitude continental shelves worldwide. Here, we present reconstructed methane emission dynamics at Leirdjupet Fault Complex (LFC), SW Barents Sea, since last deglaciation (occurred after ~19 cal Ka BP). The geochemical composition of sediment cores indicate prolonged methane emissions, which started after 14.5 cal Ka BP. Geochemical proxies for anaerobic oxidation of methane in the sediment (barium, calcium and sulfur enrichments, isotopic composition of foraminifera) indicate an overall decrease in seepage intensity over the Holocene toward present-day conditions. Methane-derived authigenic carbonates with aragonite mineralogy and heavy δ¹⁸O signature recorded an episode of gas hydrate destabilization in this region. Paleo-hydrate stability models suggest that this event was triggered by the influx of warm Atlantic water and isostatic uplift linked to the retreat of the Barents Sea Ice Sheet. Present-day distribution of methane seeps at LFC is strongly linked to underlying faults. Methane hydrates are stable in the southern part of the investigated seepage area and might respond to a future increase in bottom water temperatures.