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Ice sheet-gas hydrate interactions: examples from the Barents Sea

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Large amounts of the powerful greenhouse gas methane are stored in the Arctic as gas hydrate. These exist within a narrow envelope of temperature and pressure conditions, small changes in which can destabilise the gas hydrates and trigger large-scale methane release. Under the extreme conditions of past ice ages, storage of methane as gas hydrates was much more extensive. During these periods, vast ice sheets covered much of the Arctic. The high pressure, low temperature conditions beneath these ice sheets would have provided ideal conditions for the formation of thick, stable gas hydrate reservoirs.

We combine state-of-the-art marine geophysics with high-resolution ice sheet modelling to study how advance and retreat of successive Barents Sea ice sheets has influenced methane storage and release, and how subglacial gas hydrate formation has influenced ice sheet dynamics. Examples include: kilometre-scale seafloor craters in the central Barents Sea, inferred to have formed by catastrophic methane gas release from destabilizing gas hydrate reservoirs after deglaciation of this area; and regulation of ice stream flow due to the initiation and maintenance of high basal traction conditions as a consequence of subglacial gas hydrate formation.

Our new understanding is crucial to improve the prediction of greenhouse gas release from the Greenland and Antarctic ice sheets, and to understand controls on ice sheet dynamics and stability.