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Methane release from hydrate dissociation on the West Svalbard continental margin

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Sonar data from the West Svalbard continental margin in August-September 2008 have shown the presence of plumes of methane bubbles emanating from the seabed up-slope from the upper limit of the methane hydrate stability zone. In the same area, there is evidence for an increase in bottom water temperatures of 1^{o}C over the last 30 years. Numerical modelling has been used to evaluate the effect of such warming of the seabed on the release of methane from dissociation of hydrate within the gas hydrate stability zone.

The amount of methane released at the seabed, derived from dissociating hydrate, depends on a number of often poorly constrained variables. The time history of seabed temperature, the concentration of hydrate and its distribution in the sediment beneath the seabed and the effective permeability of the sediments affect the amount of gas produced and the time it takes for the gas to flow to the seabed. Using a numerical model, many different scenarios have been examined, derived from the uncertainty in the data describing the system.

Over the 30-year warming period, numerical models show that gas reaches the seabed within this period if the hydrate is less than 5 metres below the seabed with a permeability of $>9\text{x}10^{-14}$ m^2 and an initial hydrate concentration of $>10\%$ of pore space. Deeper hydrate layers undergo less dissociation as it takes time for seabed warming to move down through the sediments. Small amounts of dissociation and less concentrated hydrate layers will produce less gas and gas flow will be slower due to reduced relative permeability. Lower absolute permeability also slows the gas flow to the seabed.

The time history of temperature change at the seabed over the last 1000 years could have redistributed hydrate within the hydrate stability zone. Warming associated with the Medieval warm period would shoal the base of the hydrate stability zone (BHSZ) and increase hydrate concentration at this depth. The subsequent cooling would deepen the BHSZ leaving a layer of high hydrate concentration above the BHSZ. Such a process could be responsible for moving hydrate close enough to the seabed that it has released gas to the seabed in the last 30 years. Our results show a time lag between the seabed warming and the release of gas at the seabed caused by the time taken for the hydrate to dissociate and the time for gas to flow to the seabed. The numerical models have been run into the future and the duration of gas release due to 30 years of warming is presented.