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Plumes of bubbles release methane gas from the seabed along the West Spitsbergen continental margin

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Over 250 plumes of gas bubbles have been discovered emanating from the seabed of the West Spitsbergen continental margin, at and above the upper limit of the gas hydrate stability zone (GHSZ), at depths of 150-400 m. Some plumes extend upward to within 50 m of the sea surface. The gas is predominantly methane, and seismic reflection data indicate free gas beneath the plume field. A 1°C warming of the northward-flowing West Spitsbergen current over the last thirty years is likely to have increased the release of methane from the seabed by reducing the extent of the GHSZ, causing the liberation of methane from decomposing hydrate. If this process is widespread along Arctic continental margins, the methane released could be a large proportion of global methane flux. Methane released from gas hydrate in submarine sediments has been invoked as an agent of past climate change, yet comparatively little is known about methane fluxes in the present-day marine environment. Global atmospheric methane concentration continues to rise, following a period of stability between 1998 and 2006.

A multidisciplinary marine geological, geophysical, and geochemical expedition was undertaken with the Royal Research Ship James Clark Ross between 23 August and 24 September 2008, as part of the International Polar Year, to investigate the role of the GHSZ in the release and retention of methane from geological sources along the West Spitsbergen continental margin, between 78° and 80° N. The techniques employed in the expedition included: detailed (10-m resolution) mapping of sea-floor morphology; detailed acoustic imaging of sea-floor stratigraphy and of features extending into the water column; seismic portrayal of geological features to depths of several hundreds of metres beneath the seabed, such as depositional and tectonic structures and the bottom-simulating reflector (BSR, the boundary between free-gas-containing sediment and hydrate-containing sediment); sediment coring to obtain sequences for geochemical and palaeoceanographic investigations; water-column sampling for chemical analyses of the water and dissolved gases; and atmospheric sampling for gas concentration (notably methane). In the Arctic, the GHSZ is especially sensitive to climate-induced changes in temperature, because the degree of temperature change is greater than at lower latitudes. The GHSZ for a specific gas or gases and salinity of water is defined by conditions of temperature and pressure (dependent on water depth plus depth beneath seabed), both of which have varied greatly in this area over the past 15 kyr. At present, the GHSZ (for pure methane gas and water with 3.5 wt % NaCl) is expected to taper out at its landward limit where water temperature is 3°C at a depth of about 396 m. It is in water just shallower than this depth that most of the bubble plumes occur.