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Fluid migration within gas hydrate bearing shallow marine sediments offshore Western Svalbard

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A likely consequence of ocean warming in the Arctic is dissociation of marine gas hydrate and release of methane locked in its structure. During a multi-disciplinary cruise in August-September 2008 on RRS James Clark Ross offshore western Svalbard we found plumes of methane rich gas bubbles emanating from the sea floor where the base of the gas hydrate stability zone (GHSZ) intercepts the upper continental slope. We collected several multi-channel high-resolution 2D seismic reflection data (1 ms sample interval and 3.125 m CMP spacing). Prestack Kirchhoff time migration of the seismic data revealed different fluid migration features and a bottom simulating reflector (BSR) on the lower part of the slope indicating the presence of gas hydrates in the area. The BSR is not seen within the glacial debris sediments in the upper-slope. Seismic evidence of fluid migration and free gas includes (a) gas chimneys, (b) velocity pull-down, and (c) areas of reduced seismic amplitude. Within the GHSZ we found fluid escape routes, which either reach the sea floor or terminate in the shallow subsurface. Where the theoretically predicted base of GHSZ intercepts the seabed on the upper-slope, we observe a reduction in the dominant frequency of the seismic wavelet, local zones of low seismic velocity, and bright spots with reversed-polarity. These anomalies are confined to a depth less than 0.35 s TWT beneath the sea floor and indicate the presence of shallow gas. Several vertical amplitude-disturbance zones terminate into the amplitude anomalies. It appears that gas is focused into the shallow sediments of the upper-slope by migration along more permeable strata, and through sub-seismic scale cracks. Gas hydrate dissociation in localized pockets may also explain the preponderance of shallow gas anomalies in this region. We propose that the bubble-plume field is fed by advecting gas from deeper sources and also locally dissociated gas hydrates.