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900-m high gas plumes rising from marine sediments containing structure II hydrates at Vestnesa Ridge, offshore W-Svalbard

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We study an arctic sediment drift in ~1200 m water depth at Vestnesa Ridge, offshore western Svalbard. The ridge is spotted with pockmarks that range in size from a few meters to hundreds of meters in diameter and centimeters to tens of meters in height (e.g. Vogt et al., 1994). There is a strong negative-polarity seismic reflection below the ridge that is interpreted to record a negative impedance contrast marking the boundary between gas hydrate and water above and free gas and water below: it is the bottom-simulating reflector (BSR). Seismically transparent zones, interpreted as gas chimneys, extend from pockmarks at the seafloor to depths below the BSR (180-220 meters below the seafloor) (Bünz et al., 2012). Gas flares, gas hydrate, and methane-seep-specific biological communities (pogonphora and begiatoa bacterial mats) have been observed adjacent to pockmarks at the ridge (Bünz et al., 2012).

We present new single-beam echosounding data that were acquired during 2010 and 2012 cruises on the R/V Helmer Hanssen at Vestnesa Ridge using a Simrad EK60 system that operates at frequencies of 18 and 38 kHz. During both cruises which lasted 3-5 days, we detected continuous bubble release from 4 separate pockmarks in 2010 and 6 separate pockmarks in 2012. There were no noticeable, short-term (hourly or daily) variations in the bubble release from the pockmarks, indicating that the venting from the pockmarks does not undergo rapid changes. Plumes from the pockmarks rise between 875 to 925m above the seafloor to a final water depth of 325 to 275m, respectively. This depth is in excellent agreement with the top of the hydrate stability zone (275 meters below sea level) for the gas composition of hydrate sampled at the ridge (96.31% C1; 3.36% C2; 0.21% C3; 0.11% IC4; 0.01% NC4). This suggests that hydrate skins are forming around the gas bubbles, inhibiting the dissolution of gas, and allowing the bubbles to rise to such great heights in the water column. Our results provide hard constraints for bubble-dissolution models (e.g. McGinnis et al., 2006) that can validate whether a gas-hydrate-rimmed bubble can survive the ~900m rise through the water column. Long-term monitoring of such gas-hydrate and fluid-flow systems is important for quantifying methane fluxes to the ocean, for identifying the source(s) of the venting gas, and for better understanding the environmental conditions under which deep-sea biological communities exist.

References

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