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High-Resolution 3D Seismic Investigation of Fluid Flow Structures in hydrated Sediments of the Vestnesa Ridge, W-Svalbard Margin

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In July 2007, high-resolution seismic data were acquired with the PCable 3D seismic system of the University of Tromsø to investigate the fluid flow and gas hydrate system of the Vestnesa Ridge at the western Svalbard continental margin offshore Norway. The 3D seismic system consists of an array of up to 16 multi-channel streamers, each 25 m long with 8 channels, which are towed with a horizontal spacing of about 10 m. Two GI guns with a total volume of 240 cubic inch provided seismic energy with frequencies of 20-200 Hz. In total, 32 closely spaced profiles were shot covering an area of about 30 km^2. The resulting 3D seismic data cube was processed using a bin size of 6 m x 12 m. With this bin size, high-resolution images of the sediment in both in-line and cross-line direction are obtained.

The survey area is located within the hydrate stability field in water depths of 1250-1320 m. An abundance of pockmarks on the seafloor indicates recent fluid flow activity. The seismic data are of excellent quality and image the sediment down to about 500 ms TWT bsf (below seafloor). The sediment is well-stratified and shows a bottom simulating reflector (BSR) at about 200 ms TWT bsf. The BSR can be identified by the onset of strong reflectivity in sediment layers crossing the base of gas hydrate stability field. Enhanced seismic amplitudes beneath the zone of gas hydrate stability zone indicate significant free gas accumulations. Evidence for active fluid flow is given by the occurrence of gas accumulations (“bright spots”), gas wipeouts and disturbed reflectivity. These features are observed not only beneath the pockmark structures, but

also in sediment without seafloor expressions of fluid venting.

The 3D data set provides high-resolution images of the sediment and enables a reliable in-depth 3D interpretation of the pockmark and fluid flow structures. Tectonic processes might cause the upward migration of warm fluids from greater depths. Hydrate dissociation associated with increased heat flow is suggested to play a significant role in fluid flow dynamics.