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Period(s) of activity and internal structures of sub-seafloor methane escape features in the Nyegga pockmark field, offshore Norway

Andreia Plaza-Faverola, Stefan Bünz, Juergen Mienert, and Joerg Petersen
Institute for Geology, University of Tromsø, Norway (andreia.a.faverola@uit.no)

Hundreds of pockmarks associated with methane escape through chimneys occur in the Nyegga area, north of the Storegga slide, offshore Norway. The periods of activity, internal structure and factors controlling their distribution are the major focus of our current investigation. High resolution PCable-3D seismic data allow the detailed investigation of a group of gas chimneys located within an area of ∼30 km2 above the highly faulted Eocene-Miocene Brygge formation at the top of the Helland Hansen arch. The chimney structures can be categorized by the depth at which they terminate. Whereas many chimneys terminate at or very close to the seafloor, several other chimneys terminate at shallow sub seafloor depth between 80 – 120 mbsf. In addition, some chimneys show truncation of seismic reflectors against their flanks at depth. Both observations suggest a specific period of time, where these chimneys have developed or have been reactivated. Chimneys reaching the present seafloor and presenting truncations at sub-seafloor reflectors suggest episodic activity with several reactivation periods. Elongated and circular cavities with sedimentary infill of approximately 25 m, located at about 50 m beneath the present gas hydrate stability zone (GHSZ) are interpreted as paleo-pockmarks. Seismic features beneath the current base gas hydrate stability zone characterized by chaotic facies and dimming of seismic amplitudes may be indicators of hydrate dissociation in the past as a consequence of the upward migration of the base of the GHSZ. Superposition of structural maps at different depths, using different resolution data sets, confirms that some of the chimneys alignments are deep routed and follow the trend of faults and deeper structural features in the region. The integration of detailed seismic observations using different frequencies data sets and analysis of seismic attributes together with the results of high resolution velocity modeling from previous investigations allows a classification of Nyegga chimneys according to their apparent period (s) of activity, vertical extension and internal structures.