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Characterization of methane hydrates and free gas deposits at Nyegga CNE03 pockmark, using marine CSEM and seismic joint-interpretation

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In recent years, gas hydrate deposits have attracted growing interest from both academic and industry research, due to their potential as an unconventional energy resource and as a geohazard to various marine infrastructures, and to their possible role in climate change. Methane hydrates are known to be widespread in seafloor sediments at water depths ranging from 130 to 2,000 m along offshore continental margins. They are normally found close to the seafloor and are often present in pockmarks that are underlain by chimney-like structures. The Nyegga region is situated on the west Norwegian continental slope and characterized by an extensive pockmark field. The Nyegga pockmarks are characterised by bathymetric troughs, seep-associated organisms, and rich methane-derived authigenic carbonate rocks. A controlled-source electromagnetic (CSEM) survey was performed at the CNE03 pockmark, where high-resolution three-dimensional seismic data was previously collected and analyzed. The aim of this CSEM study is to characterize the hydrate and free gas distribution within and around the CNE03 pockmark. Two-dimensional CSEM joint-inversions were computed using the data acquired by both ocean bottom electrical field receivers (OBE) and a 3-axis towed receiver (Vulcan). Our OBE-Vulcan inversion results confirm the existence of a distinctive resistivity anomaly structure at the CNE03 pockmark, suggesting a shallow anomaly at the underlying chimney center, likely to result from the presence of gas hydrates. Furthermore, a deeper and latterly extensive resistivity anomaly emerged from the inversions of the OBE data, most probably due to the existence of a free gas layer beneath the base of the gas hydrate stability zone (BGHSZ). The CSEM inversion results are consistent with a seismic velocity model for the NW–SE survey line; both support the presence of gas hydrate and free gas accumulations within the CNE03 chimney-like structure. Several more resistivity anomalies were detected near to CNE03, which are currently being investigated. This work will contribute to an accurate estimate of the amount of methane hydrate and free gas both beneath the pockmark and over a larger regional scale, providing valuable information for future exploration of gas hydrate deposits.

Keywords: CSEM, 2D joint-inversion, Nyegga, Chimney, Pockmark, Methane hydrate.