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Evidence for visco-elastic upward gas percolation through sediments of the outer continental shelf offshore Israel from high resolution seismic profiling

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The autumn 2008 cruise of Charney School of Marine Sciences (CSMS) was focused on high resolution geological and geophysical investigation of the outer continental shelf (50 to 85 m seafloor depth) offshore Haifa Bay, Israel. The cruise corroborated collection of an oceanographic transect, acquisition of a grid of 2 km long high resolution (∼1-2.5 kHz) single channel seismic reflection profiles with a nominal spacing of 100 to 200 m, and the collection of sediments dredge and core samples. The top sedimentary section, imaged down to a depth of about 50 m beneath the seafloor, comprises generally of two major units: (1) massive sub-bottom ridges concentrated in the south-western part of the survey area and composed probably of calcareous sandstone (Kurkar) common in the inner shelf in this area; (2) finely (∼1 m thick) layered sediments onlapping in places the massive bodies, and generally prograding north-westwards. The finely layered sedimentary unit is presumably represented by dark sticky clay dredged by us from the seafloor in the survey area. About 20 msec band of intense scattered reflectivity is observed within the finely layered sediments unit throughout most of the extent of this unit. This band of reflectivity is interpreted by us to represent the presence of biogenic gas bubbles within the sediments. The top of the scattered reflectivity form a generally coherent surface, defining a gas layer dipping sub-parallel to the seafloor at a depth about 1.25 times the depth of the seafloor (about 15 to 20 m beneath the seafloor). The gas ‘layer’ is clearly discordant to, and truncating, the sedimentary layering. This discordance and the relation to the seafloor depth suggest that a physical buoyancy type mechanism controls the depth of the gas layer, rather than a lithological boundary. Separate patches of reflectivity (about 10 to 200 m wide horizontally) are imaged at shallower depths (by about 10 m), mostly in the vicinity of higher massive (Kurkar) ridges. Tens of meters wide sets of seismic diffractions were imaged in two locations within the water body up to about 20 m above the seafloor, indicating bursts of gas bubbles. No clear discontinuities in the sedimentary layering were found to provide escape routes for either the elevated patches of gas within the sediments, or the bursts of gas bubbles imaged within the water body. We suppose that upward gas transport in mechanically weak sediment is accomplished by dynamic fracturing, rather than by gas flow through pre-existing interconnected fracture networks.