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Gas-controlled seafloor doming on Opouawe Bank, offshore New Zealand

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The process of gas accumulation and subsequent sediment doming appears to be a precursory process in the development of methane seep sites on Opouawe Bank and might be a common characteristic for gas seeps in general. Seabed domes appear as unimpressive topographic highs with diameters ranging from 10-1000 m and exhibit small vertical displacements and layer thickness in comparison to their width. The dome-like uplift of the sediments results from an increase in pore pressure caused by gas accumulation in near-seabed sediments. In this context sediment doming is widely discussed to be a precursor of pockmark formation. Our results suggest that by breaching of domed seafloor sediments a new seep site can develop and contrary to ongoing discussion does not necessarily lead to the formation of pockmarks. There are clear differences in individual gas migration structures that indicate a progression through different evolutionary stages, which range from channeled gas flow and associated seismic blanking, to gas trapping beneath relatively low-permeability horizons, and finally overpressure accumulation and doming. We present high resolution sub-bottom profiler (Parasound) and 2D multichannel seismic data from Opouawe Bank, an accretionary ridge at the Hikurangi Margin, offshore New Zealand's North Island. Beneath this bank, methane migrates along stratigraphic pathways from a maximum source depth of 1500-2100 mbsf (meter below seafloor) towards active cold seeps at the seafloor. We show that, in the shallow sediment of the upper 100 mbsf, this primary migration mechanism changes into a process of gas accumulation leading to sediment doming. Modeling the height of the gas column necessary to create different dome geometries, shows that doming due to gas accumulation is feasible and consistent with field observations. The well-stratified, sub-horizontal strata that exist beneath Opouawe Bank provide favorable conditions for this type of seep development because shallow sub-vertical gas migration is forced to traverse sedimentary layering in the absence of faults that might otherwise have provided more efficient gas migration pathways. Thus, gas has to generate its own migration pathways through the progressive process of doming and breaking through the strata. The data from offshore New Zealand document that shallow sediment doming does not have to be associated with seafloor pockmarks and that models in which fluid migration through soft sediments necessarily culminates in pockmark formations are not applicable everywhere.