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Seismic evidence for free gas in the regional gas hydrate stability zone beneath an antlicline on the Hikurangi margin, New Zealand

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Free gas has been reported within the regional gas hydrate stability zone (GHSZ) at several locations worldwide. Seismic high-resolution data across an anticline on the Hikurangi Margin east of New Zealand collected in 2006 show prominent amplitude anomalies above the regional base of the GHSZ as marked by bottom simulating reflections (BSRs). The anomalies are often associated with lateral terminations of BSRs. Their amplitudes are similar to those of the strongest BSRs in the region. We therefore suggest the anomalies to be most likely caused by free gas. We propose three alternative mechanisms for this possible injection of gas into the regional GHSZ: The GHSZ may be upwarped locally because of advective heat flow associated with fluid flow focussing beneath the anticline. In this case, gas would be locally outside the GHSZ, similar to a model proposed for gas chimneys off Cascadia. Gas may move into the GHSZ by hydrofracturing and remain in the gas phase over a prolonged time, e.g., because hydrate seals on fracture walls may limit the supply of water for hydrate formation. For this mechanism, free gas would reside within the GHSZ until sufficient water is made locally available either by diffusion or advection, similar to recently proposed models for the formation of gas hydrates in marine sediments. Gas may also be transported upwards into the GHSZ in its host sediment during folding and not be converted to hydrates for some time because of low rates of water supply in low-permeability sediments. Further analyses particularly of heatflow and geochemical data should allow us to distinguish between these mechanisms. Our observations support previous findings from the Hikurangi margin linking BSRs and, by inference, hydrate deposits to structures that enhance fluid flow, particularly anticlines.