Methane hydrate saturations at the Southern Hikurangi margin (New Zealand) estimated from seismic and rock physics inversion

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Geophysical data indicate that the Hikurangi subduction margin on New Zealand's East Coast contains a large gas hydrate province. Gas hydrates are widespread in shallow sediments across the margin, and locally intense fluid seepage associated with methane hydrate is observed in several areas. Glendhu and Honeycomb ridges lie at the toe of the Hikurangi deformation wedge at depths ranging from 2100 to 2800 m. These two parallel four-way closure systems host concentrated methane hydrate deposits. The control on hydrate formation at these ridges is governed by steeply dipping permeable strata and fractures, which allow methane to flow upwards into the gas hydrate stability zone. Hydrate recycling at the base of the hydrate stability zone may contribute to the accumulation of highly concentrated hydrate in porous layers.

To improve the characterisation of the hydrate systems at Glendhu and Honeycomb ridges, we estimate hydrate saturation and porosity of the concentrated hydrate deposits. We first estimate elastic properties (density, compressional and shear-wave velocities) of the gas hydrate stability zone through full-waveform inversion and iterative geostatistical seismic amplitude versus angle (AVA) inversion. We then perform a petrophysical inversion based on a rock physics model to predict gas hydrate saturation and porosity of the hydrate bearing sediments along the two ridges.

Our results indicate that the high seismic amplitudes correspond to the top interface of highly concentrated hydrate deposit, with peak saturations around 35%. Because of the resolution of the seismic data we assume that the estimated properties are averaged over layers of 10 to 20 meters thickness. These saturation values are in agreement with studies conducted in other areas of concentrated hydrate accumulations in similar geologic settings.