Predicting overpressure using stacking velocity data: a pre-drill exercise in PEP 38479, northern Taranaki Basin, New Zealand

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Summary

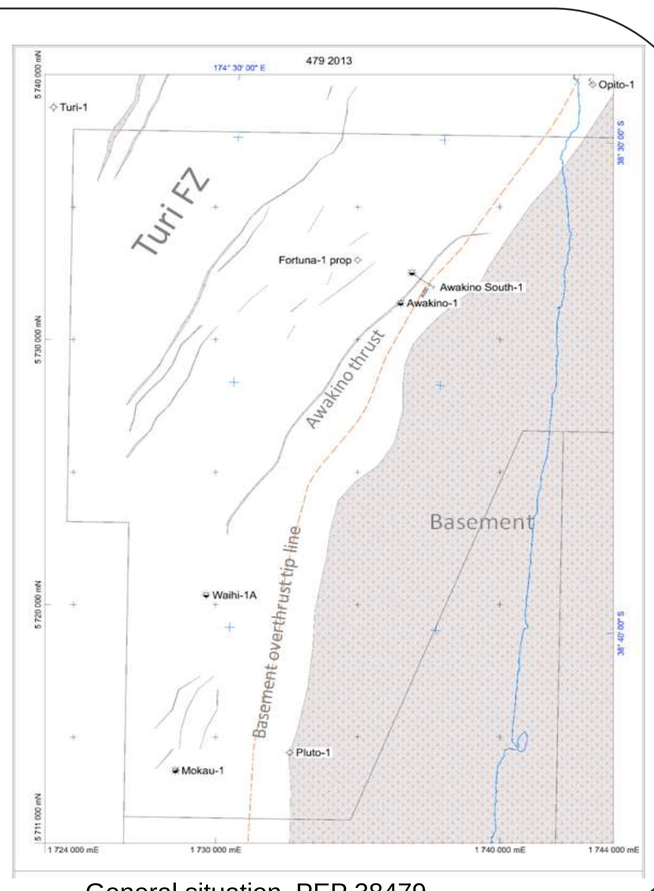
In clastic basins where compaction is the chief control on seismic velocity, zones of significant overpressure can manifest in the seismic stacking velocity data.
In essence, a zone where the stacking velocities are consistently lower than the expected trend-line may be an indication of higher than normal pore pressure.

Where there is a very strong deviation from trend-line compaction-based velocities, this may show as a velocity inversion: that is, the interval velocities are actually lower than in shallower sections, as opposed to merely not increasing at the expected rate.

Waihi-1 experienced a pressure event within the Mangahewa Formation which required a mud weight of 13.1 ppg to control. Review of well and stacking velocity data shows that:

(i) this zone corresponds to an inversion in the checkshot-derived interval velocities;
(ii) this zone also corresponds to an inversion in the Vstk-derived interval velocities;
(iii) the pressure cell might extend into the northern part of PEP 38479 where Loyz Energy Ltd have identified the Fortuna Prospect.

The stacking velocity data are from the high-quality 2003 Kahu 3D, reprocessed by Ion GXT in 2013.

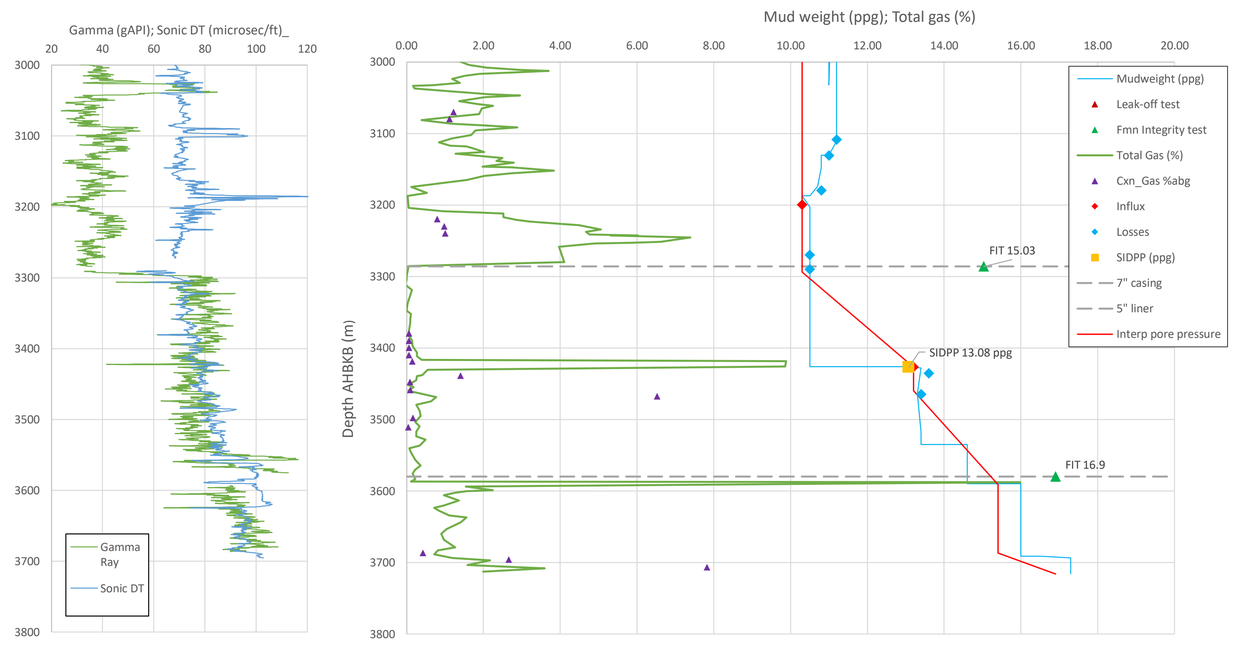


General situation, PEP 38479

Pore pressures from well data – Waihi-1/1A

Waihi-1/1A is regarded as the most relevant offset well to the proposed Fortuna well, because it lies in the same structural block to the west of the Taranaki Fault-related thrusts.

In Waihi-1/1A, there is a slight increase in pore pressure from ca. 1960 m in the lower Miocene (to 10.3 ppg EMW), but a significant jump in pressure occurs within the lower Mangahewa Formation, over a short interval within a thick mudstone unit. Between 3294 and 3427 m, pore pressure increases from ca.10.3 ppg to 13.1 ppg EMW, a gradient of at least 4.28 psi/ft (0.097 MPa/m).
It is likely that the pore pressure gradient continues to increase significantly through the remainder of the well (to ca. 17 ppg at 3716 m TD). This is indicated by the rapidly-increasing sonic DT and correspondingly-decreasing resistivity, but difficult to confirm with non-wireline data, which are limited to two major formation gas peaks and a few connection gas peaks.

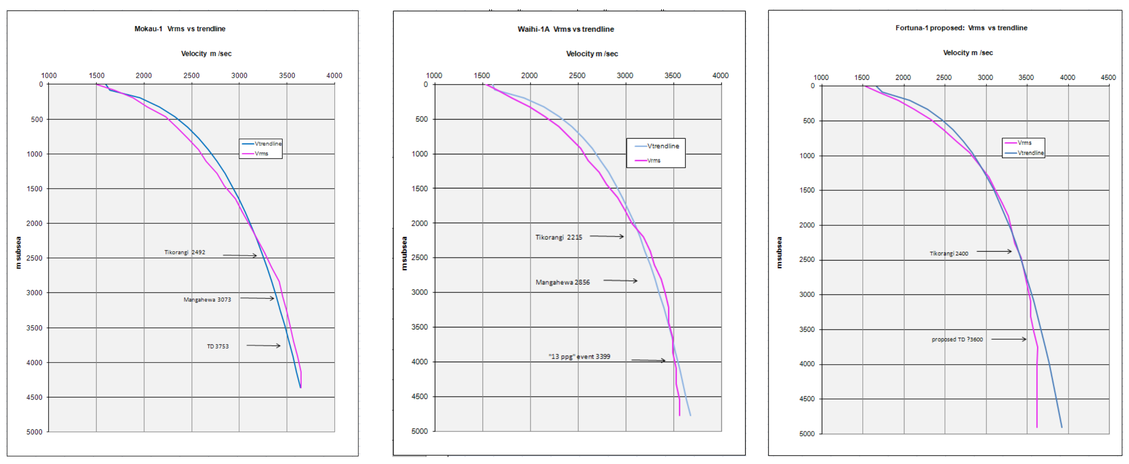


Note: Top Mangahewa Fmn is at 2867 m; the displayed interval is within the mid-lower part of the formation.

Stacking velocity behaviour at well locations

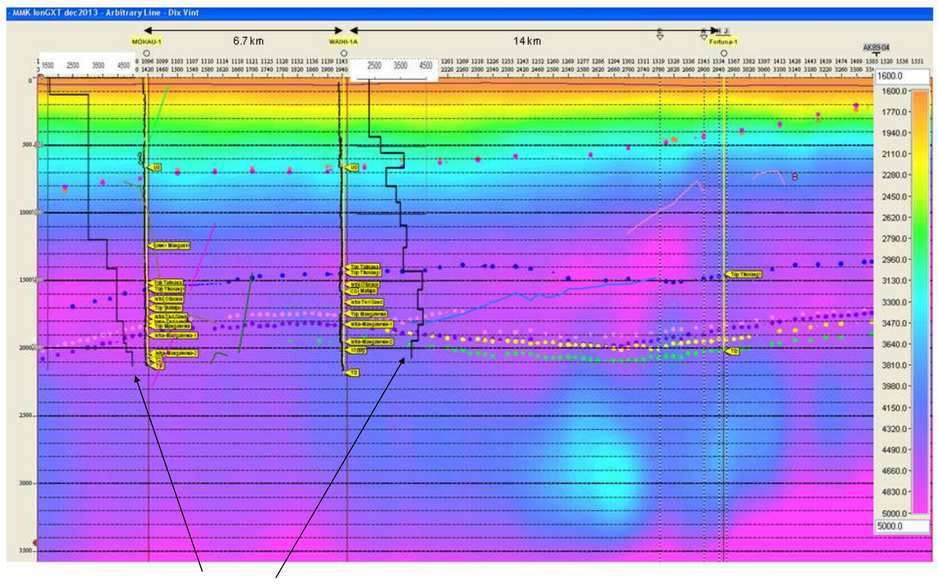
These plots compare average velocities derived from a compaction trend line, and the actual PSTM stacking velocities at the well locations. Significant deviations from the trend line may be an indication of pore overpressures.

The compaction trend line is derived from a compaction function of the form
Z(mss) = K*twt^1.25
which has been observed to be a good fit to most checkshot data in the Taranaki Basin.



Vrms data at each well location have been constructed from an average of the 4 closest functions at each well.

Well vs. seismic interval velocity data



Interval velocity profile for wells calculated from checkshot

This is an arbitrary line through a Dix interval velocity volume. Loyz Energy commissioned this volume from Ion with this type of analysis in mind.

Observations:

- The checkshot-derived Vint seems to match the Vstk-derived Vint data, in trend if not the actual values. Significantly, where the checkshot data show an inversion near the base of Waihi-1, the Vstk data do too. This gives some confidence in the use of this dataset in a predictive way.

- An inversion trend is apparent to the north of Waihi-1 at or below the Green Horizon (top of the lower Mangahewa mudstone unit).

Conclusion:

There may be a similar overpressure event at or near the base of the proposed Fortuna-1 as occurred in Waihi-1. This will impact on well planning: casing design, kick tolerances, mud programme etc.