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Evidence for High Overpressure in the Saglek Basin, Labrador Shelf; The Implication for Future Exploration

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Summary

All the RFT and DST data available for the Labrador Shelf record small magnitudes of overpressure but show no evidence for high overpressure at depth as might be expected when compared to other similar settings, e.g. Mid-Norway. However there is evidence for high overpressure in the Saglek Basin that resulted in the premature termination of one well and resulted in significant underbalanced drilling in other wells.

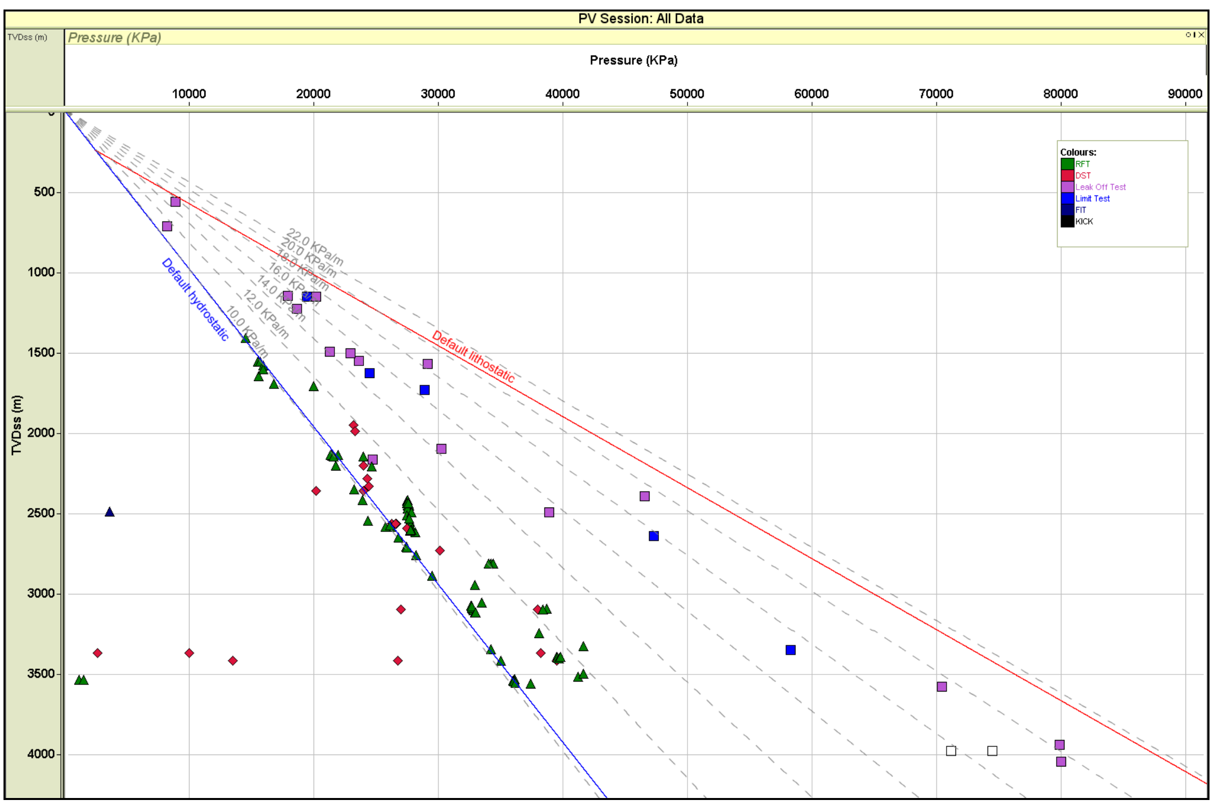

Figure 1: Multi-well Pressure-Depth plot of all data for 25 wells on the Labrador Shelf. The data are coloured by tool type. The open squares represent the Kick taken in Pothurst P-19 based on the Shut-In Drill Pipe Pressure (SIDPP) immediately after the Kick was taken and 90 mins after the Kick to show a range of uncertainty.

Introduction

Pothurst P-19, in the Saglek Basin, recorded the only direct evidence for high overpressure in the Labrador Shelf. The Kick was 30000-35000 kPa of overpressure at 4000 mTVDss (~18 kPa/m) causing major operational issues and leading to the premature termination of the well.

A detailed examination of the drilling history, e.g. gas levels, of a neighbouring well, Rut H-11, within the same basin shows further evidence for high overpressure that did not result in a Kick but was above the mudweight used in the wells. The evidence from the drilling history of Rut H-11 could have been used to inform on the drilling of Pothurst P-19 as the well was drilled earlier yet the importance was not recognized.

The dominant mechanism responsible for generating high pore pressure in offshore environments is considered to be undercompaction with the potential for an additional component due to secondary mechanisms. Secondary mechanisms are temperature-controlled processes (>80-100°C) that generate additional pore pressure and are most typically identified by velocity-density cross-plots. Cross-plotting velocity and density allows a trend of undercompaction to be identified and any deviations from this trend can be related to secondary mechanisms if they also relate to increasing depth and temperature.

The Karlsefni A-13 well (Saglek Basin) shows clear evidence for secondary mechanisms consistent with chemical compaction (compaction due to the transformation of Smectite into Illite) and the subsequent cementation of the matrix due to the precipitation of Quartz released during the reaction process. Two further wells (Gilbert F-53 and Rut H-11) show some evidence for secondary mechanisms but the data is less clear in these examples.

Conclusions

Evidence for high pore pressure is not always taken from reservoir pressure test data alone. Kicks are a clear piece of evidence for high pore pressure but interpretation of gas levels during drilling as well as analysis of the wireline data can all inform on the presence of high pore pressure. Whilst the magnitude of pore pressure contributed by secondary mechanisms cannot always be quantified, recognizing the presence of active mechanisms should indicate the potential for high overpressure within the deep reservoirs.

The Rut H-11 well is a prime example where there are no direct indicators of high pore pressure yet both the drilling history and the velocity-density cross-plot build a qualitative argument for elevated pore pressures. When the Rut H-11 is put in context, i.e. the same rocks at the same depth in the same basin as the Pothurst P-19 well which took a significant Kick then the qualitative evidence can be used to build a definitive geological-pressure model for the Saglek Basin.

The evidence from the wells of the Saglek Basin is that high overpressure is present and represents a significant drilling hazard if a permeable unit is encountered. As exploration looks to move from the shelf into the deep-water the likelihood of deep high pressure is increased, due to more shale-rich fine-grained sediments, hence accurate geological-pressure modeling is critical to safe exploration.

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