Burial history and implications for seismic AVO signatures in the Western Barents Sea

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Introduction

Rock physics properties and present day seismic signatures are strongly influenced by burial history (Avseth and Lehocki, 2016). The western Barents Sea has a complex tectonic history with episodes linked to both local extension and regional episodes affecting the entire area. The most significant exploration challenges relates to the severe uplift and erosion that took place during Cenozoic times. Net erosion estimates varies from more than 2000 meters in the northeast to no net erosion in the westernmost areas (Baig et al., 2016, Johansen, 2016). To investigate how AVO signatures are affected, we performed AVO modelling constrained by burial history.

Method

The modelling of the AVO responses was done in three steps (Avseth and Lehocki, 2016). First, we modelled mechanical and chemical compaction of sands and shales as a function of burial history. Then, based on the compaction modelling we modelled rock physics and seismic properties of sandstones containing various types of pore fluids. Finally, based on the rock physics modelling of sandstones and shales we modelled the expected AVO signatures for the reservoir intervals for the given burial history.

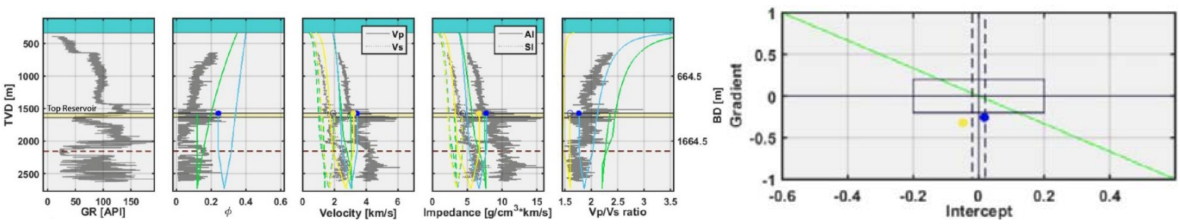

Figure 1. Modelled burial curves for a sandstone case saturated with brine (blue) and gas (yellow) above. The burial curve for the overlying shale (green) and the corresponding velocities, impedance and Vp/Vs-ratio for both the shale and the sandstone. The modelled AVO response show the effect of the fluid substitution.

Results and discussion

Seismic AVO responses were modelled for the Jurassic Stø and Tubåen reservoir sandstones using the approach explained above. Figure 2 shows both the AVO classes and the actual fluid content in the reservoir. The modelled wells are plotted in an intercept versus gradient cross plot together with the corresponding in situ fluids. Both the brine filled and the hydrocarbon filled sandstones are included in the diagram. The plot also shows the interpretation of the AVO classes.

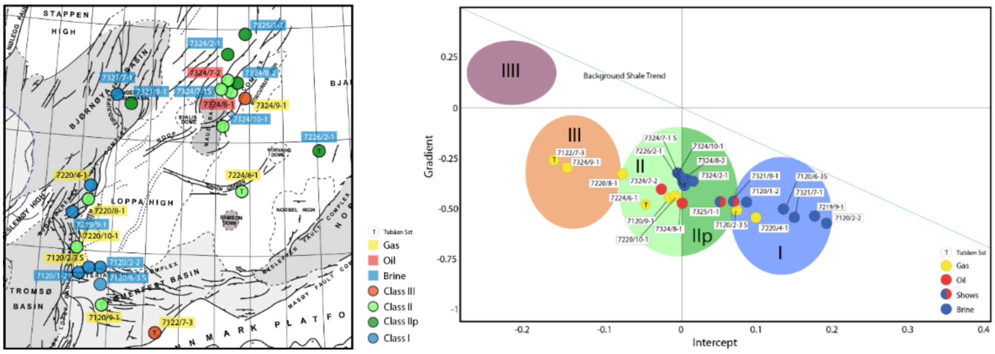

Figure 2. Left: Geographical distribution for the AVO responses from sandstone modelling (Stø or Tubåen Formation). Right: AVO responses from sandstone modelling.

In Figure 3 fluid trend lines area suggested for brine, oil and gas to the left. The trend lines plot left of the background shale trend, as expected when going from brine filled to hydrocarbon filled reservoirs. For the sandstone intervals maximum burial depth were found using the net erosion estimate from the sandstone modelling, and the maximum burial depth was assigned to each well. Now we also see a clear trend with increasing burial depth indicated by the arrow in the diagram.

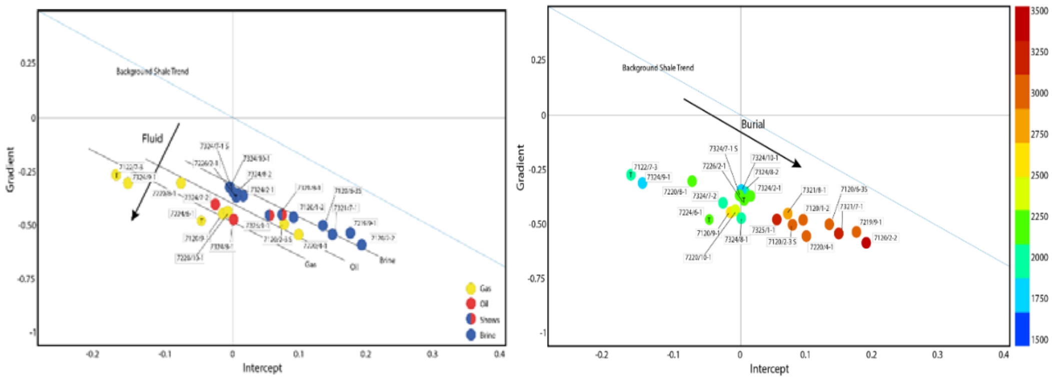

Figure 3. Left: Intercept versus gradient cross plot with suggested trend lines for brine, oil and gas. Right: Intercept versus gradient cross plot color-coded with maximum burial depths to the top of the reservoir sandstones. The arrow in the diagram indicates the trend with increasing maximum burial depth. See Figure 2 (left) for location of wells.

Conclusions

When including net erosion estimates in modelling of seismic AVO signatures for the Stø and Tubåen reservoir formations, we found that AVO signatures are strongly influenced by the net erosion magnitude. The AVO modelling demonstrates that both effects of fluid types within the reservoirs and the maximum burial depth have strong influence on observed AVO classes.

Acknowledgements

We would like to thank Tullow Oil, First Geo and TGS for providing data.

References

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