CHAPTER 8

Discussions and Conclusions

8.1 Discussions

The initial stages of the study comprised rock physics analysis and reservoir characterization feasibility assessment. Lithology discrimination was deemed feasible considering pre-stack seismic inversion for both acoustic impedance (AI) and shear impedance (SI). In contrast, fluid fill identification was considered to be very challenging, distinguishing hydrocarbon bearing sandstones from water bearing sandstones. This was illustrated by results derived from the rock physics feasibility study and the AVO modeling. The lack of fluid sensitivity in the area was believed to be caused by low porosity values present in the reservoir sandstone in combination with high pore stiffness.

The original time-depth relationships at Well-A, Well-C and Well-D were based on check shot data. These were further optimized through careful application of time shifts and stretch-squeeze, using synthetic seismograms and cross-correlation displays to QC the final results. Wavelets were extracted at each well location, and for all angle stacks. Each wavelet was subject to QC to analyze variations in phase, frequency and amplitude. The extracted wavelets at Well-A showed higher amplitudes and anomalous wavelet shape compared to extracted wavelets at the other well locations. Thus, final averaged wavelets of near, mid and far angle stacks were calculated using the extracted wavelets at Well-C and Well-D only, and would be used as input to seismic pre-stack simultaneous inversion.

The low frequency models are significant to transform the seismic derived relative elastic impedance values to absolute elastic properties. The final low frequency models; acoustic impedance, shear impedance and density, were created by combining ultra-low frequency models that were based on seismic stacking velocity trends with low frequency models using well data. Ultra-low frequency models were produced by transforming seismic interval velocity to elastic properties and calibrated with well data. The initial low frequency models were based on interpolated well log data that were constrained by stratigraphic framework (constructed from interpreted horizons with known depositional environment).

The 3D seismic pre-stack simultaneous inversion produced absolute and relative elastic properties, such as acoustic impedance, shear impedance, Vp/Vs and density using a constrained sparse spike inversion (CSSI) approach. The input data were comprised seismic partial stacks (near, mid and far angle stacks), extracted wavelets, and final low frequency models. The limited numbers of available partial stacks used as input for seismic inversion were considered to directly affect the quality of the inverted density results, mainly due to lack of far angle data beyond 40°. However, the available seismic angle stacks were of sufficient quality to provide good results for both inverted acoustic impedance and Vp/Vs. The results showed a good match between the inverted elastic property volumes and the corresponding well log data. The final results were also optimized in a manner that only produced minimum amounts of seismic residual energy.

The final absolute acoustic impedance and absolute Vp/Vs volumes were used as input when carrying out the geostatistical process of constructing lithofacies and probability cubes. Thorough and detailed rock physics and AVO analyses were performed to define appropriate classification scheme, mainly based on analysis of probability distribution in an acoustic impedance – Vp/Vs crossplot. The lithofacies cube was a result of the combination of the most probable lithologies (sandstone, shale and carbonate). The probabilities of sand, shale and carbonate were calculated using Bayesian 2D of probability density functions that were derived from well data (acoustic impedance and Vp/Vs).

8.2 Conclusions

Vp/Vs was the key parameter to enable seismic reservoir characterization in the study area. Thicker sandstone layers were mostly efficiently classified from the other most common lithology types in the area, such as shale and carbonate. The comparison between lithology logs and lithology cubes showed a good correlation at all wells.

However, the seismic detectability in the area was limited by the low acoustic impedance contrast between sand and shale. It was assumed that individual sand layers thinner than approximately 23 meters could not be accurately classified, based on the seismic reservoir characterization applied in this study.