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Improved reservoir characterisation from inversion of high resolution 3D seismic data

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A comparison of the acoustic impedance data is made between standard processing and ***short offset*** (high resolution) processing carries out by Robertson Research for a 3D seismic data set acquired in the Malay Basin. Fugro-Jason's inversion technique removes the wavelets from the seismic data (thereby further increasing resolution) and therefore allows a more meaningful comparison of the two datasets in terms of rock properties, not influenced by effects of tuning, phase difference and other boundary effects. The short offset re-processing was aimed at increasing the fidelity of seismic data for shallow hazard assessment and to improve the deeper data for reservoir characterisation. It was hoped that the higher quality of the seismic data could lead to significant differences in interpretation of thin reservoirs in terms of reservoir extent, distribution of reservoir quality and connectivity. The original 3D seismic data was acquired using a dual source, six cable configuration, the streamer length being 4,800 m with 100 m separation. The data was originally processed using a standard processing flow that included flexi-binning and was migrated post-stack.

The main differences between the short offset processing and standard processing are:

1. There is no resampling of the data in either space or time. This means that frequencies of up to 250 Hz can remain in the data with no aliasing effects. The lack of any spatial resampling (trace sum, trace drop) avoids 'smearing' of the data and increases spatial sampling for the input to the migration operator.
2. The data is limited to the near offset ranges only, typically 3–6 fold depending on signal/noise ratios and hence excludes the requirement for far offset corrections prior to zero offset migration. Restricting processing to near offsets also reduces ray-path and stacking complications in areas of non-hyperbolic move-out (e.g. areas affected by shallow gas concentrations) which leads to improved imaging.
3. Data imaging is exactly honoured in short offset processing i.e. the data are not binned prior to migration. This reduces spatial averaging and results in more accurate migration data positioning and hence improves lateral resolution. Data regularisation is achieved via either a 1 pass or a 2 pass Kirchhoff migration approach.

The high-resolution data was then inverted using Fugro-Jason's global constrained sparse spike inversion algorithm and compared with a similar inversion carried out on the original 3D seismic data. The inversion focussed on a known hydrocarbon interval where the reservoirs were deposited in a tidal flat setting. Sandstones, siltstones and mudstones are interbedded in metre to decametre-scale with occasional tidal and, more rarely, fluvial channel sand bodies which are in the tens of metre scale. Sand development within background tidal flat deposits shows a km-scale lateral variability similar to modern day analogues.

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The short offset processing produces a seismic volume with higher frequency content (80 Hz compared with 60 Hz on the original processing). The increased bandwidth obviously produces higher resolution data. Both seismic volumes provide a good match to the well data within their respective bandwidths. After inversion of both seismic volumes to acoustic impedance, a comparison was made for a known gas sand that was 18 m thick at well penetration. The inversion of the short offset processed data showed the down dip extent of the gas to be increased, the location of the lowest impedances within the channel to be changed and the connectivity between different channels to be altered.