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A review of the use of seismic attributes for risk reduction and reservoir characterisation

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Summary

In the early 1990's 3D seismic established itself as the principle technology for exploration risk reduction and an increasingly important one for reservoir appraisal and development. Much of the benefit came from improved structural mapping but much also came from the use of seismic attributes for the direct detection of hydrocarbon fluid contacts, for reservoir delineation and in some cases for the direct estimation of reservoir parameters such as porosity and net-to-gross.

There was however much to learn about how to make reliable use of seismic attributes. There were spectacular successes but also some expensive mistakes. By the end of the 1990's though we had a much clearer idea of what worked and what didn't.

For exploration risk reduction the key insight was the need to analyse patterns in a geological space rather than a geophysical space; observing attributes within a stratigraphic and structural framework rather than say looking at AVO response only on pre-stack seismic. We needed to think of AVO as a tool to create enhanced images rather than geophysical measurements. This approach allowed the integration of the attributes with an understanding of the trapping geometry. Inspection of pre-stack data remained vitally important but primarily as a quality assurance step rather than data analysis.

We also learnt to avoid an excessively statistical approach in the use of seismic attributes. With modern interpretation systems it's easy to generate dozens of different attributes and probably find some correlation with the often sparse well data. However the risk of spurious correlations is high so basing predictions on this approach without an understanding of the physical basis for the correlation is dangerous.

For reservoir characterisation the most reliable approach has been to keep things simple; exploiting 2-term AVO, but probably not yet 3-term and working within the seismic bandwidth rather than using complicated inversion algorithms incorporating interpretive models. Tight integration with petrophysical rock property studies is required to ensure a good understanding of the possibilities and the limitations of the seismic.

But underpinning all of his is the need to obtain the highest quality seismic data quality; no amount of clever analysis will compensate for poor quality data. For reservoir characterisation we need to worry about not only the correct positioning of events but also the fidelity of the amplitudes. We also need to push the bandwidth as far as we can to maximise resolution but in doing so we've learnt that it's the low frequencies that are really important; they first need to be recorded but then carefully 'nurtured' during the processing.

In recent years improved acquisition techniques have had a major impact on data quality. Offshore the use of wide and multi-azimuth towed streamer techniques as well as sea-bed node acquisition, all pioneered by BP, together with increased use of sea-

bed cable systems have meant that we are now able to make more confident use of seismic attributes even in areas of more challenging data quality. On land BP's development of Independent Simultaneous Source seismic is allowing 3D seismic to be acquired for the same cost as conventional 2D opening up the possibility of wider application of attribute based techniques onshore.

In this talk I'll review some of the key lessons in the use of attribute analysis over the past 20 years. I'll discuss some of the risk reduction and reservoir characterisation technology currently in use by BP including extended elastic impedance, coloured inversion and seismic net pay prediction and I'll say a few words about where I think the science may be heading next.