

LOOKING
AT THINGS
FROM A
DIFFERENT

ANGLE

The challenges for today's oil and gas professionals include looking for new and faster methods of finding and exploiting hydrocarbons while reducing cycle time and driving down production costs. Getting the most out of data across multiple domains, improving methods to interpret and integrate geological and seismic data critical to maximising reservoir understanding and finding new, innovative ways of mapping and visualising assets are critical to efficient hydrocarbon exploration and production. Making optimal drilling decisions in many of today's plays requires the application of advanced analysis techniques, which have traditionally been available only in niche tools manned by a handful of specialists. The requirement for a more detailed understanding of the reservoir, combined with the pace of today's E&P operations, fuels the need for asset teams to leverage these advanced techniques in combination with their

Fred Poland, LMKR and Gabriel Gil, LUMINA, explain how new opportunities can be found using novel seismic inversion techniques.

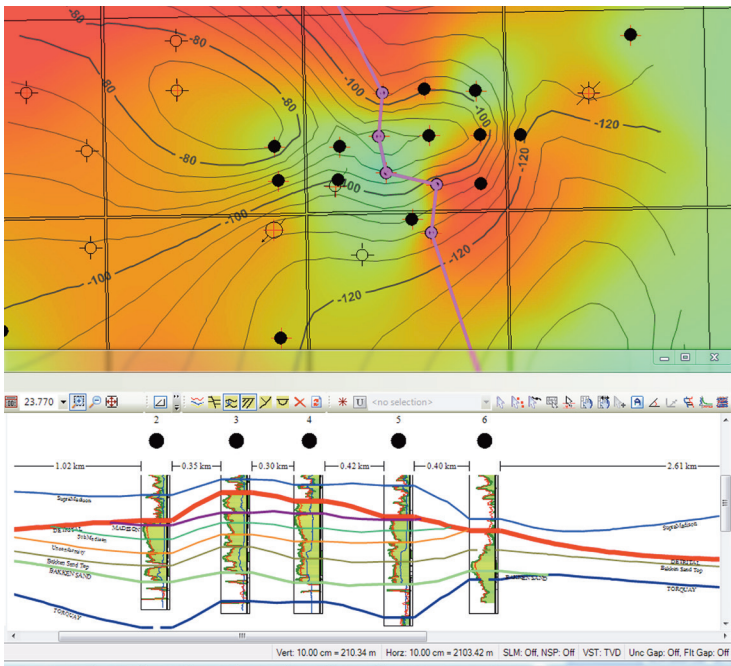


Figure 1. Structure map on top of the Detrital unconformity and a cross-section across the axis of the structure showing the structural and sequence stratigraphic relationships.

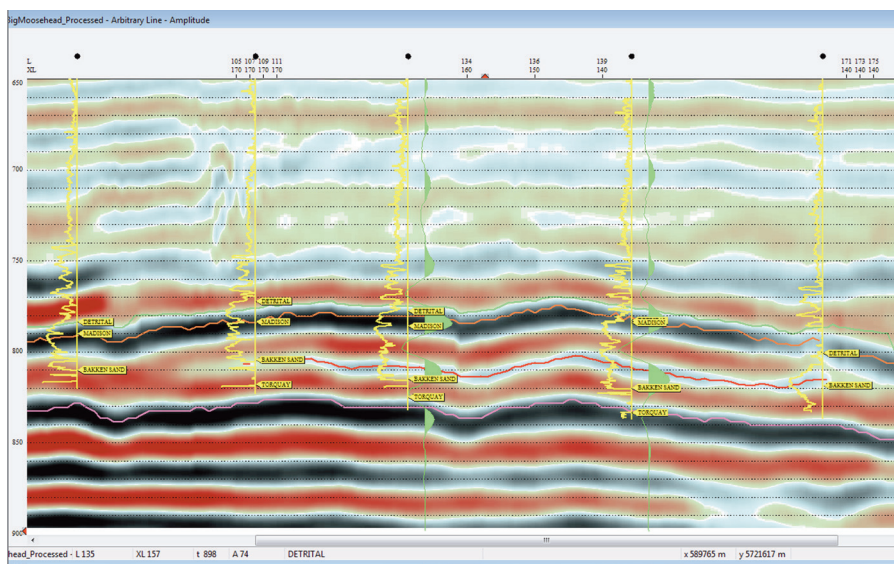


Figure 2. Time amplitude seismic section across the axis of the structure showing synthetic seismogram ties and Vshale curves, indicating the presence or absence of sand.

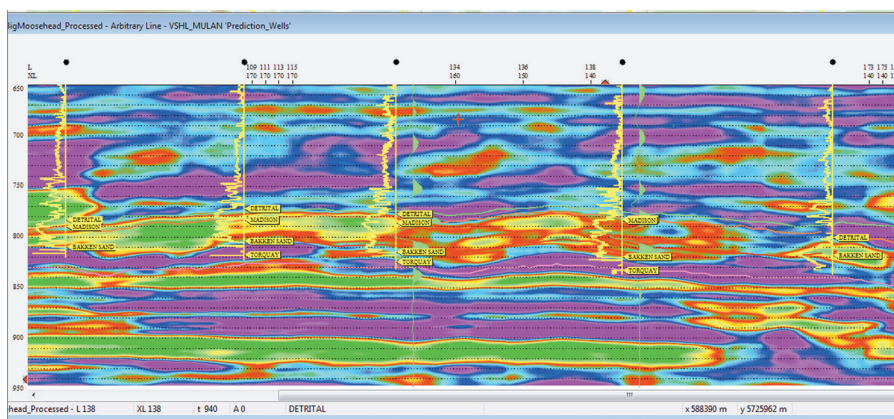


Figure 3. Vshale inversion time seismic section along the same line of section as in Figure 2, showing the correlation between the Vshale curves at the well locations and the indicated presence of sand in the inversion data.

knowledge of the local geology on a more frequent basis in order to improve success rates.

LMKR recently announced a technology partnership with LUMINA. This partnership is directly aimed at improved methods to interpret and integrate geological and seismic data critical to maximising reservoir understanding. LUMINA offers unique methodologies and tools for quantitative interpretation that allow for more geological information to be extracted from geophysical data. Combined with LMKR's experience in commercial software development, this partnership has resulted in the planned release of Predict 3D™.

Predict 3D is a multi-attribute inversion solution based on spectral decomposition and state-of-the-art optimisation techniques developed over the years by Dr. John Castagna of LUMINA. The solution is completely integrated with the GeoGraphix® suite of products and can also be used in standalone mode. This proprietary approach shows geological details not observable in the conventional seismic data and allows for more detailed and accurate interpretations than are possible with the input data alone and conventional inversion methods. The multi-attribute inversion process predicts rock properties from well logs away from and in between the wells that have been used for correlation, thus generating property volumes that are

invaluable in understanding the character of the reservoir. This helps understand the nature of the reservoir away from the wells, reducing risk in well planning and field development, especially in thin-bed or shale plays. The benefits of using this solution include:

- ▶ More informed and accurate decisions: Higher resolution reservoir property volumes help in understanding the distribution of rock properties away from the correlation wells, significantly improving understanding of the reservoir. All members of the asset team – geologists, geophysicists and engineers – are better prepared to make timely, informed decisions.
- ▶ More accurate field planning, well planning, geosteering and completions: The ability to predict reservoir properties away from the wells enables more accurate field and completion planning. Detailed reservoir property volumes allow geoscientists to plan wells more accurately, select good landing zones for their horizontal wells and enable geosteers to keep the bit in the heart of the sweet spot.
- ▶ Ease of use: Full integration with GeoGraphix solutions streamlines implementation of the prediction process and brings this capability to the desktop of asset team interpreters and engineers. Predict 3D has been designed to produce useful results and time-effective projects with minimal input from the user.

Switching focus to this solution in action in the field, the example in Figure 1 of a Madison Group/Bakken sand oilfield in Saskatchewan, Canada. The structure map in Figure 1 showing an eastwardly plunging anticline is on the Detrital unconformity at the top of the Madison Group. The cross-section across the axis of the structure is showing a

structural and sequence stratigraphic interpretation of the producing wells within the field. The colour density map is displaying a petrophysical interpretation of the reservoir quality within the area of the field where the cooler colours indicate good reservoir quality and the hotter colours indicate poorer reservoir quality.

The conventional interpretation would indicate that the oil is being trapped by poorer reservoir quality up dip of the producing wells and that there seems to be no further opportunity to extend the field in that direction.

Fortunately, there is a 3D seismic survey over the area. The seismic section in Figure 2 is along the same line-of-section as the cross-section above. The two synthetic seismograms tie the geology to the geophysical data. The yellow curves are Vshale (shale volume) curves generated by the petrophysical model mentioned previously.

It can be seen that the Vshale curves indicate thick sand packages in the first four wells on the left and a thin sand package in the well on the right. Other than some tuning effects due to thickness changes beneath the unconformity, there is no amplitude character indicating the loss of the thick sand within the Madison Group and Bakken sands.

The Predict 3D application accepts the amplitude seismic data, the Vshale curves and a velocity model as input to the proprietary multi-attribute inversion process. The result is a Vshale inversion time volume that is displayed in the seismic section in Figure 3.

The red through green colours indicate the presence of low Vshale and, by inference, thick sand. The four wells on the left indicate thick sand and the well on the right indicates thin sand, thus confirming the petrophysical interpretation.

By integrating the seismic interpretation with the geological interpretation, a clearer understanding of the field emerges. The structure at the top of the unconformity in Figure 4 is now being modelled by both well and depth converted seismic horizon control and indicates an extended closure of the anticline to the west. The cross-section along the axis of the anticline displays both Vshale log curves and a depth-converted Vshale inversion backdrop. The line to the west of the well on the left in the cross-section indicates the presence of thick sand beneath the closed structure. By this interpretation, there should be a good chance of finding thick oil bearing sand by extending the field to the west.

The geometry of the unconformity structure becomes much clearer when viewed in 3D in Figure 5. The termination of the existing producing oil wells and the opportunity to extend the field to the west within the closed structure.

Removing the unconformity structure and turning on a vertical section and horizontal depth slice through the features in Figure 6 further advance the understanding that the productive wells are drilled into thick sand and the non-productive wells are drilled into thin or absent sand.

Conventional exploration approaches often fall short of providing an adequate understanding of the production within existing oilfields and the opportunity for further development. By acquiring additional data and applying advanced processing and interpretation techniques as illustrated above, new life can be given to old fields, thus increasing their ultimate production and enhancing their economic return. ■

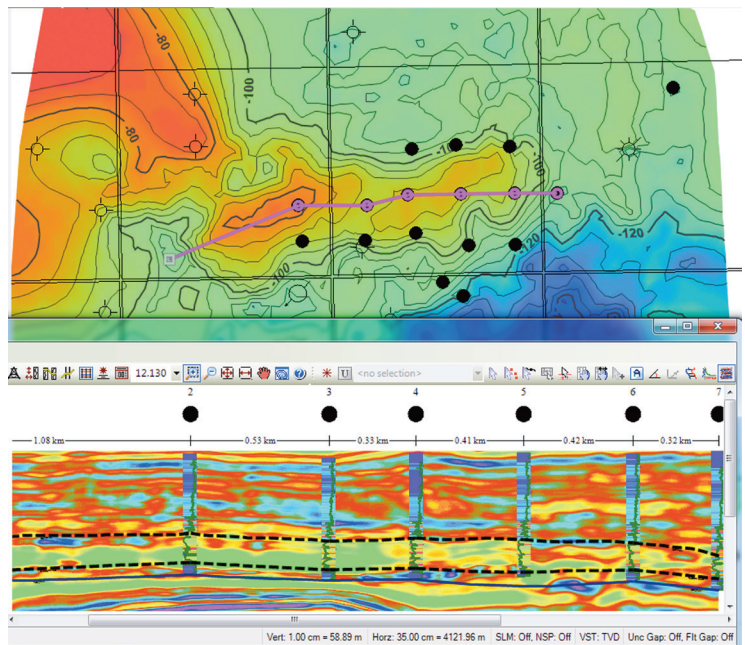


Figure 4. Structure map on top of the Detrital unconformity from the combined geologic and seismic interpretation and the Vshale inversion depth seismic section along the axis of the anticline, indicating structural closure and the presence of sand to the west of current production.

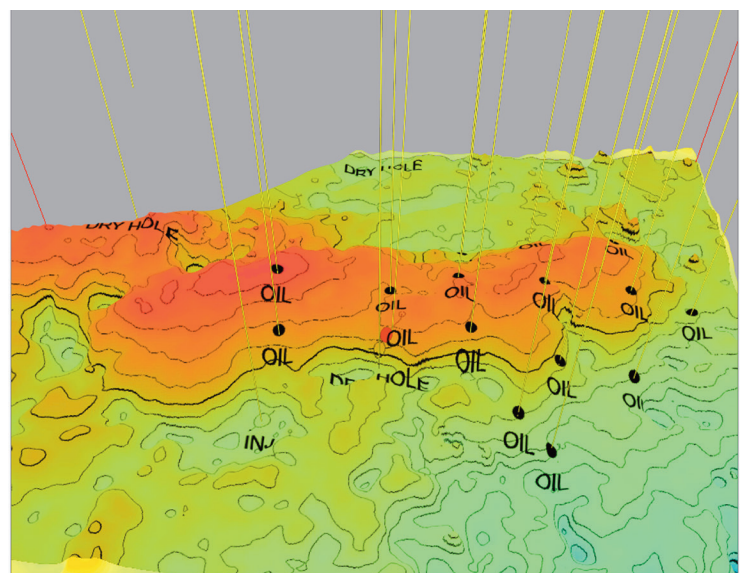


Figure 5. 3D visualisation of the structure on the Detrital unconformity surface.

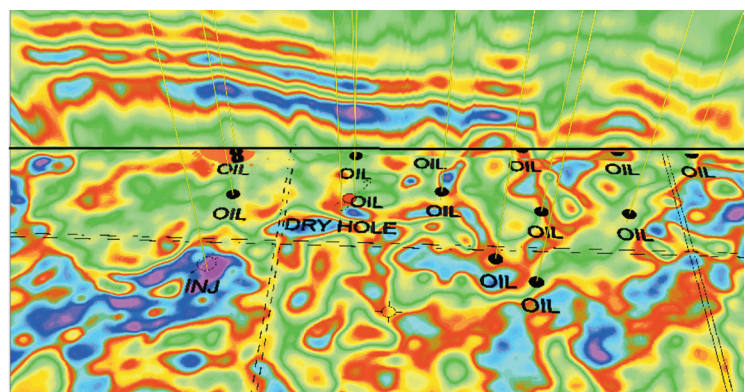


Figure 6. Vshale inversion depth seismic section and slice along through the structure showing the correlation between producing wells, dry hole (in black circle), and the presence of sand beneath the unconformity.