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# A Modern Seismic Interpretation System

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## Introduction

Advances in computer hardware have made a host of seismic processing algorithms possible, including pre-stack migration. The last time any of us were involved in a discussion about DMO was in the nineties, the period in which we also started to see powerful visualisation systems. These were very impressive, expensive software systems running on expensive hardware.

Since the nineties, hardware costs have plummeted and the available power has increased many times over. The whole landscape has changed, pre-empting the question—has our visualisation/interpretation software kept up? Modern software languages have also made the development of quality software much quicker and easier—have we reaped the benefits of this?

It is difficult to talk about modern systems without, of course, taking into account the internet. How does the availability and bandwidth of the internet impact seismic interpretation and visualisation systems?

Modern software makes workflows intuitive and simple to carry out. In doing so, a lot of time can be saved; that is, modern software can become major productivity tools. But in doing so, perhaps the largest gain is not in productivity, but rather the freedom and time created for the interpreter to focus on the technical aspects of his work.

Finally, what makes up a modern seismic interpretation system and what are the tasks we really need to achieve? We need to be able to work effortlessly with pre-stack datasets (image gathers and spectrally decomposed datasets) and to integrate rock physics with our seismic interpretation. We need to be able to undertake model building while interpreting and to take advantage of lithology and fluid classification tools. Another important aspect of modern systems is their ability to integrate across disciplines.

## Discussion

The internet has a large role to play in the delivery and support of software systems. Software can be downloaded immediately from the web with comprehensive installation help, eliminating the need to wait for a CD to arrive or waiting for appropriate time zones.

Comprehensive resources can be made instantly available through the web, including software manuals, FAQs, 'How Tos' in traditional forms or as movies and picture galleries for inspiration, tutorials for self education, and forums for community discussions and peer support. These resources can be well planned and well tested, offering critical advantages over phone support in some cases (however, there is no substitute for phone or on-site support for really sticky problems).

Geophysicists wishing to work with pre-stack data have been largely ignored for a long time. The software available for these people has generally been very unimaginative. The interpretation system needs to be fully

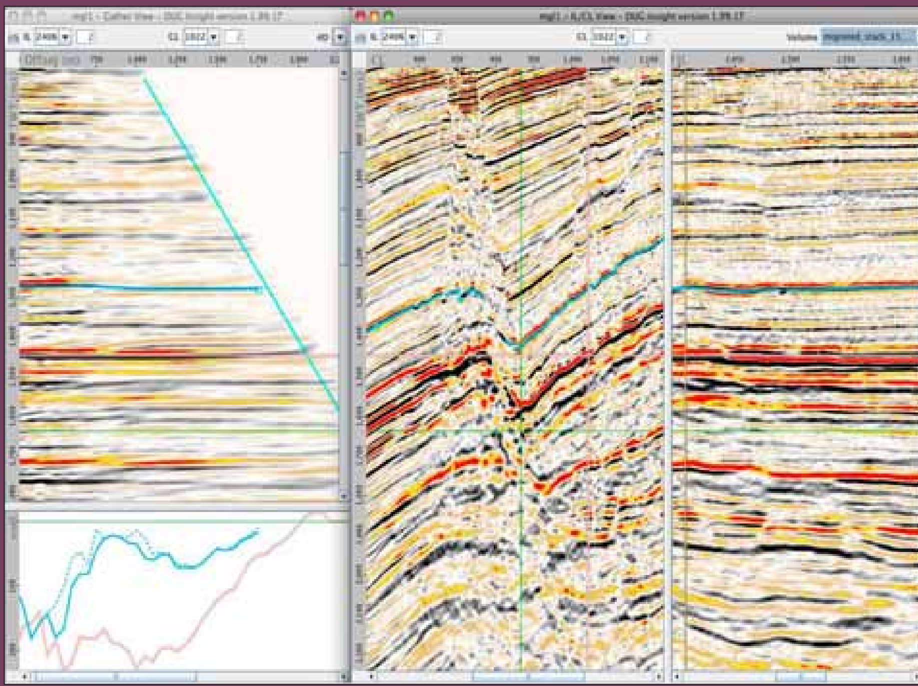


*Fig. 1. A picked gather view together with the amplitude extractions across the gather and an il/cl view. This is an example of an integrated gather view from the DUG Insight software.*

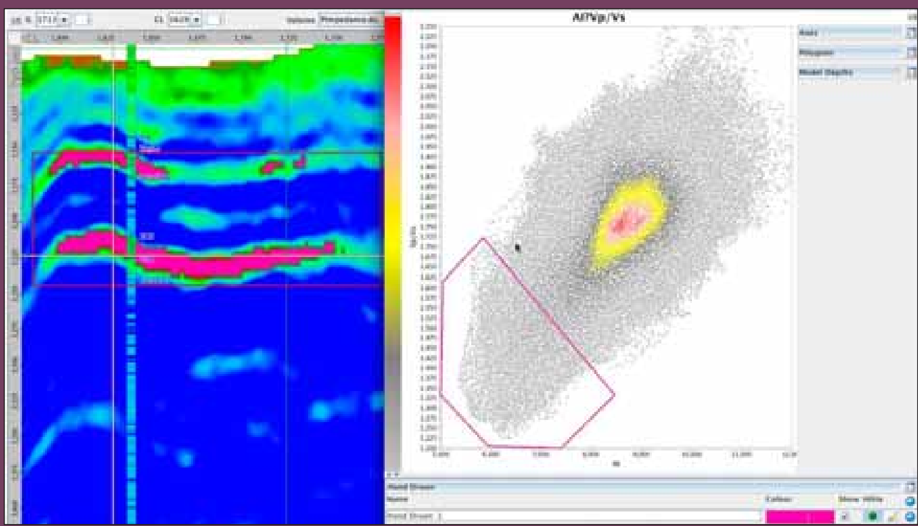



*Fig. 2. The crossplotting functionality. In this figure points within a polygon on the crossplot are highlighted back on the inline.*

integrated, which means having data with an extra dimension (i.e. offset or frequency) fully integrated. With a modern seismic interpretation package, data can be randomly accessed and brought into all views as appropriate. To gain maximum value from datasets it is imperative they can be visualised in numerous ways. Traditional visualisation displays can include a common offset or common frequency ensemble of data being substituted for the traditional stack of data. These need to be expanded to include regular gather views as well as horizontal gather views, and all the views should be integrated.

It goes without saying that full waveform pickers embedded in a good workflow are also essential to a modern seismic interpretation system—the key is the control or guidance of the automatic systems throughout the operation.

All tools, such as propagators, should work with the pre-stack data; that is, propagators need to be able to be run within 4D data. Amplitudes extractions also need to work with 4D data.

Figure 1 shows a picked gather view together with the amplitude extractions across the gather, and an inline/crossline view. This is an example of an integrated gather view from the *DUG Insight* software.

Figure 2 illustrates the type of cross-plotting functionality that should be available in today's seismic interpretation systems. It is important to be able to crossplot data from horizons, volumes and wells. It is also important to be able to highlight points in any view (including a 3D visualisation window) and to display those points into other views. In this figure points within a polygon on the crossplot are highlighted back on the inline. This is base functionality that really needs to be in any seismic interpretation package.

Figure 3 shows a map view together with an arbitrary line through the 3D seismic volume. Again the points from the cross plot are highlighted on the map view, wells are posted on the arbitrary line.

Figure 4 shows a unique spectral decomposition layout. On the left of the plot is an arbitrary line (arbline); the trajectory of the arbline is shown on the map view on the right, it runs down the centre of a channel. The middle panel is a more conventional gather display, but shows data with the fourth dimension of frequency rather than offset. All data in this set of displays has been proportionally flattened using multiple horizons. At the bottom of the arbline is a horizontal gather. As the channel sediments change thickness along it's length, it is expected that the tuning thickness will meander across the frequencies in this horizontal gather. The arbline view shows the seismic data as wiggles on top of the chosen frequency slice. Of course, all of these view panels are linked, so, for example, choosing a new frequency on a gather will update the frequency slice displayed on all other views. Horizons can also be interpreted across these frequency slices.

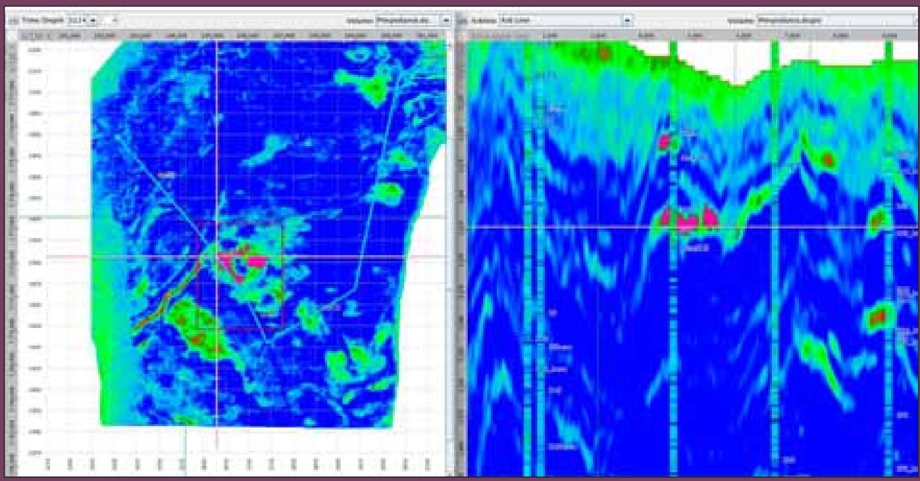


*Fig. 3. A map view together with an arbitrary line through the 3D volume. The points from the crossplot are highlighted on the map view. Wells are posted on the arbitrary line.*

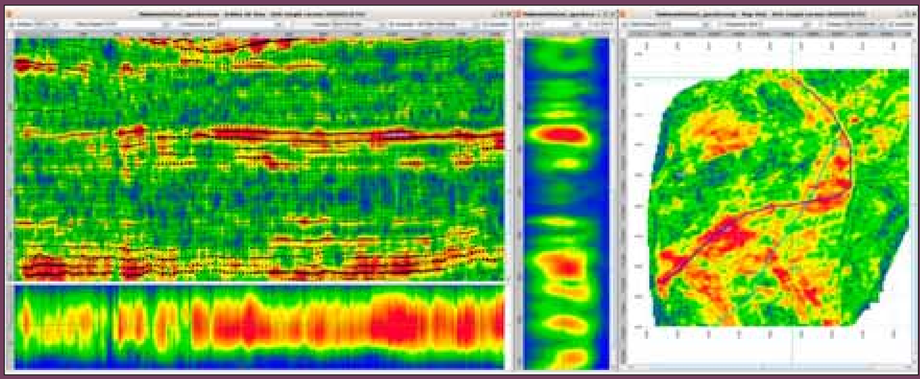


*Fig. 4. A unique spectral decomposition layout. All views are linked, choosing a new frequency on a gather, for example, updates the frequency slice displayed on all other views. Horizons can be interpreted across frequency slices.*

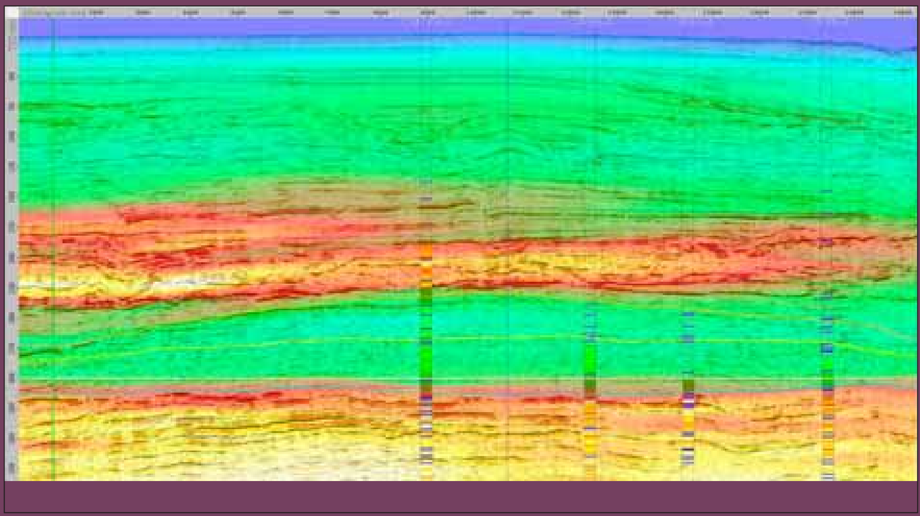


*Fig. 5. An arbline view with a full stack co-rendered with a velocity field. The display also has velocity logs posted at the well trajectory positions.*

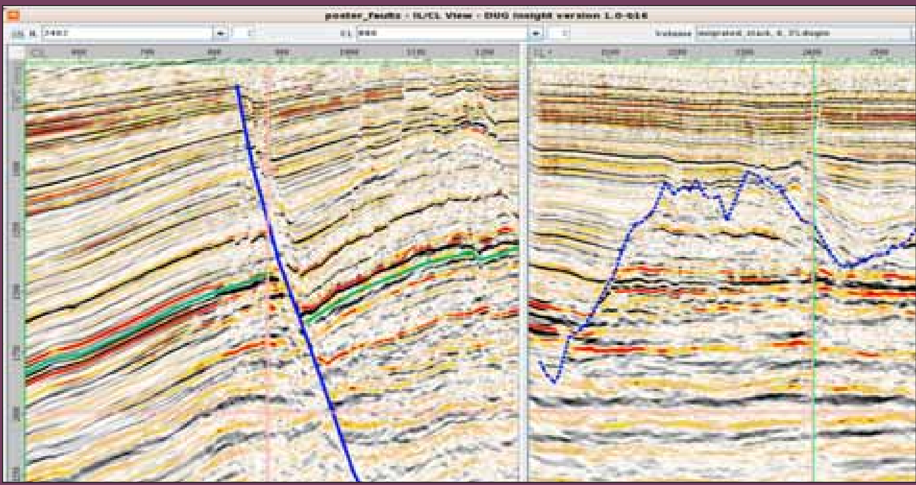


*Fig. 6. A picked fault. The fault picks are interpolated on the fly so that the minimum number of manual picks are used to put together the fault surface.*

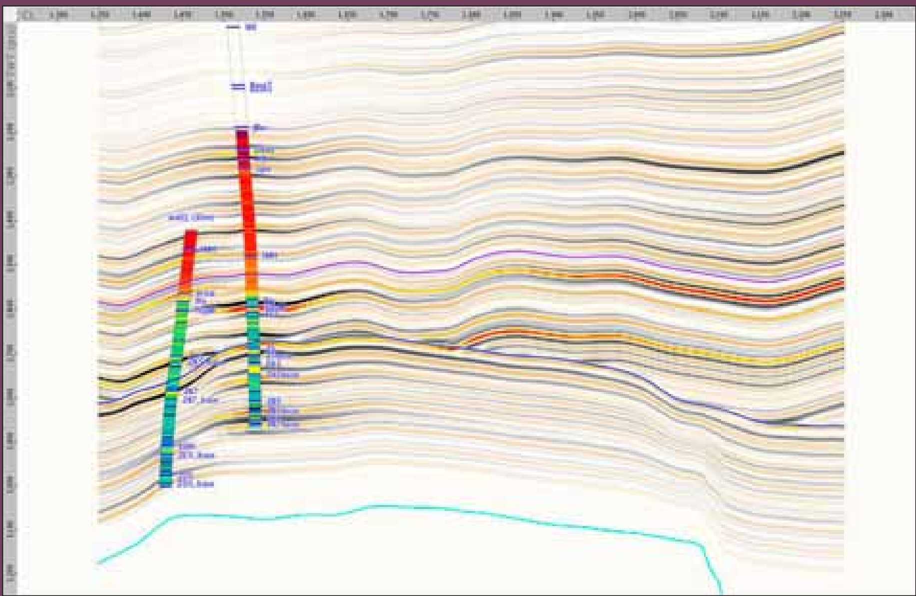


*Fig. 7. An example of model building while interpreting.*

Another important functionality is the ability to co-render of different datasets. Figure 5 shows an arbline view with a full stack co-rendered with a velocity field. The display also has velocity logs posted at the well trajectory positions. Figure 6 shows a picked fault. It is important that fault picks are interpolated on the fly so that the minimum number of manual picks are used to put together the fault surface.

Model building while interpreting is very powerful, allowing 'what if' scenarios to be tested rapidly. The model building process is aided by the ability to quickly model gathers as well as sections (Figure 7 is an example of this capability). *DUG Insight* works on a 'pull' model (i.e. only the data the user is currently looking at is produced during an operation). So, for example, when model building while interpreting, the necessary calculations are done as if producing a 3D volume (e.g. using all input wells), but only the tiles actually being viewed are produced. This allows rapid and iterative model building.

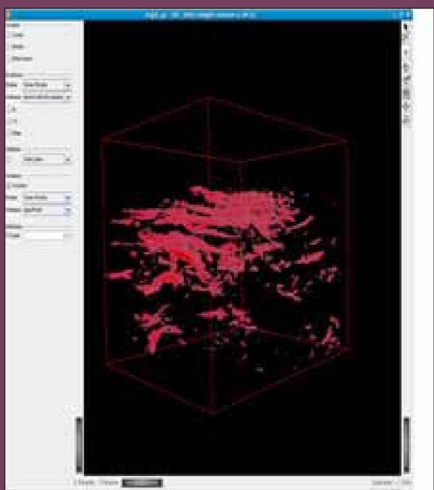


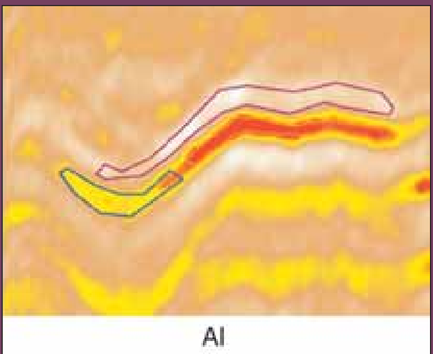
Fig. 8. DUG Insight's *3D window. All objects can be displayed in this view. The use of transparency is very important.*

Figure 8 shows the 3D window available in *DUG Insight*, in which all objects can be displayed. Visualisation of multiple datasets and the use of transparency are powerful analysis tools. Figure 9 is taken from a 2008 paper by Lamont et al—it is a powerful image showing the registration of modelled lithology and fluid combinations (modelled from well information) with rock properties from inverted seismic data. Registration such as this generates great confidence in the lithology and fluid interpretation of the bodies in the inverted data, showing the power of using rock physics and modelling results to constrain interpretation. Figures 10 and 11 show further use of the rock physics-based modelling to guide stratigraphic body interpretation.

Utilisation of visualisation and modelling functionality is only possible with effective use of hardware. When working with pre-stack datasets, effective use of the computer's RAM in conjunction with disk or network access to data is imperative. While RAM is typically used to cache recently viewed data and soon-to-be-viewed data, pre-stack datasets can run into the terabytes and, hence, cannot be stored in RAM. Efficient random access to large datasets on disk is necessary, and, used in conjunction with RAM, will enable access to very large datasets while maintaining an interactive feel to the application.

Another powerful feature of modern seismic interpretation systems is on-demand time-to-depth conversion. That is, the ability to toggle between time and depth domains using a chosen velocity model. This allows volumes and base data to be stored as TWT data, but worked with in depth or time as required. A simple update of the velocity model allows new depth conversions on the fly—for example, when a well is drilled and the velocity model has been upgraded appropriately.

A modern interpretation system naturally needs to be able to work with any number of surveys and volumes at one time. There should be no restrictions on sample rates; users should be able to mix data with different sample rates and trace lengths. The inability to load and visualise data with different sample rates will cause bottlenecks on data-loading, require regeneration and filtering of datasets and, hence, a loss of information. This is a



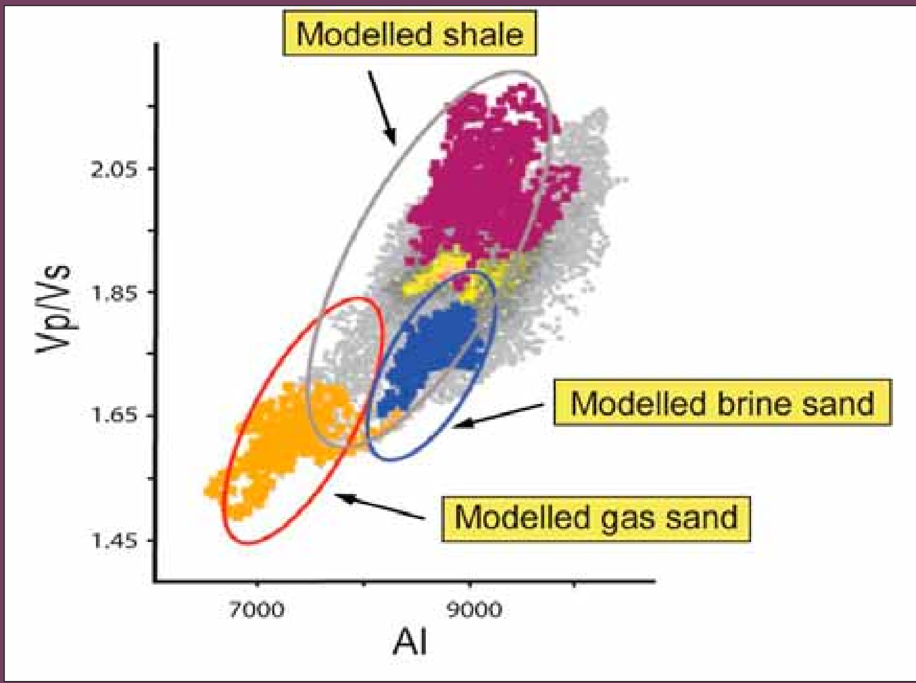




*Fig. 9a and b (above and right). A powerful image showing the registration of modelled lithology and fluid combinations (modelled from well information) with rock properties from inverted seismic data (Lamont et al 2008).*

significant time and cost restriction over the life of a project—it is amazing that in this day and age this inflexibility still appears in some of the most expensive interpretation systems.

One final functionality to discuss is the visualisation of data from different perspectives. A modern interpretation system should have the ability to easily access multiple attributes and perform various operations. There should be many easily accessible attributes built in to the software that can be viewed in many different ways.

## Conclusions

Modern hardware and modern software languages have revolutionised the development of software. Using a relatively small (10 to 20 people versus many hundreds in companies dealing with legacy systems) high-end group of developers, a new breed of powerful integrated software is being produced.

Websites are being used to deliver quality support and learning resources with the support of real people. Resourceful people will benefit from a large leap forward using the web-based resources, while traditionalists will fall back to phone and email support.

## References

Lamont, M. G., Thompson, T.A. and Bevilacqua, C., 2008, Drilling success as a result of probabilistic lithology and fluid prediction—a case study in the Carnarvon Basin, WA. APPEA Journal. ■

*Figures 10 and 11 show further use of the rock physics-based modelling to guide stratigraphic body interpretation.*

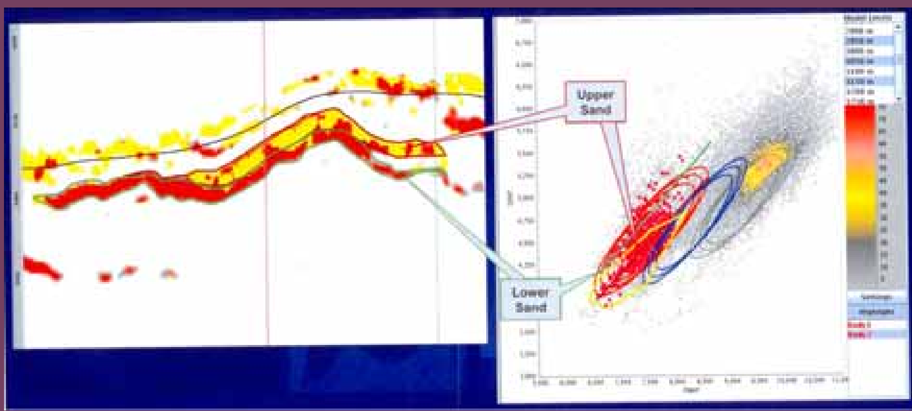



*Fig. 10.*

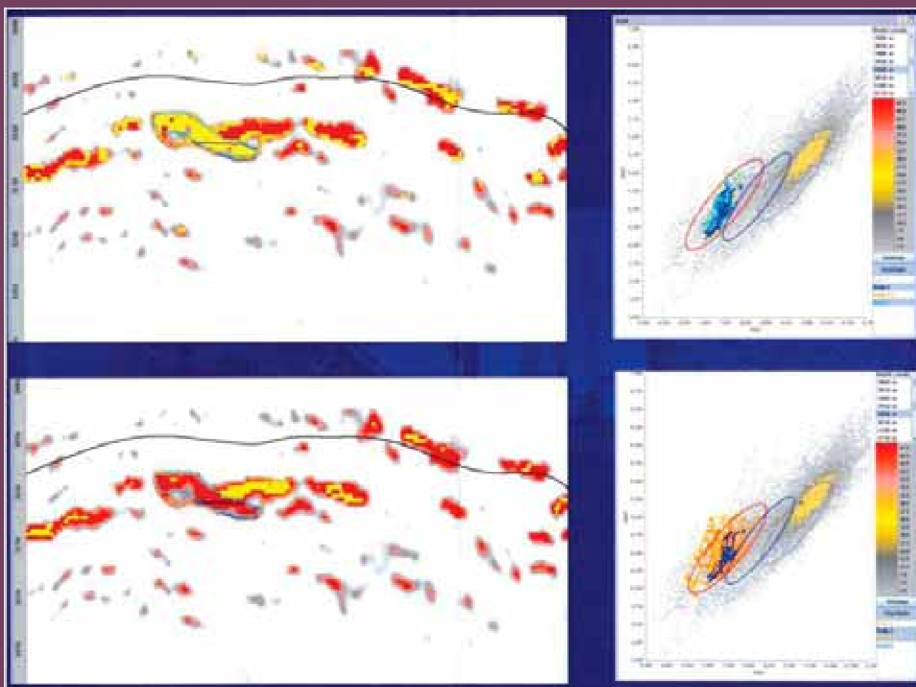


*Fig. 11.*