Stack it and see

As oil companies move into more challenging reservoirs, they need an understanding of what's happening subsurface. Big data solutions are emerging as a way to make more accurate interpretations and discover data quality problems ahead of time. **Bill Shea**, CEO of Sharp Reflections, speaks to Abi Millar about why pre-stack data is the future of seismic interpretation.

It's a fact of life in the oil industry that at a time of dwindling reserves, companies need to get smarter about where they drill. On one hand, this means extracting more from their existing oil fields. But it also means detecting entirely new sources of hydrocarbon, often from unconventional reservoirs in harsh environments.

This task is notoriously tricky. In order to work out which reservoirs might have potential, geoscientists need to build up an accurate picture of what lies beneath the surface, which in turn means using the highest-quality data.

For decades, their visualisations have relied on post-stack seismic data – data that has been through a process known as 'stacking'. Stacking, which was invented over 50 years ago, makes the dataset far more practical and manageable.

Bill Shea, CEO of Norway-based data analysis company Sharp Reflections, has a good analogy – if the stack is more like a JPEG file, then pre-stack is more like the raw file on a digital camera.

"The raw files contain more information," he says. "It used to be that you could fit only five to ten raw files on a camera card, but hundreds of photos if you convert them to JPEG. We see something similar with migrated pre-stack seismic versus just the stacks."

He adds that, historically speaking, pre-stack data was underused by most interpreters – merely a stepping stone towards the final product. Computer workstations simply were not up to the task of examining it.

"The size of the data has been a real obstacle to the take-up of pre-stack," he says. "It has created a clear dividing line between what processing companies do and what data interpreters do, so it's only tended to be very specialised interpreters in oil companies who have made use of the pre-stack data."

> "It's very exciting that we managed to take some general principles of the value of pre-stack information and apply them to a different type of reservoir system."

In today's world, however, data is a true differentiator, spelling the difference between a successful operation and a failure. As a result, a number of oil companies are seeking to view their pre-stack data directly.

"With things like seismic inversion, the results are highly dependent on the quality of the inputs – we talk about garbage in and garbage out," says Shea. "If the data aren't processed very accurately and precisely, the predictions you make from advanced interpretation techniques can ultimately be unreliable."

Bang on trend

Sharp Reflections was founded in 2010 with an eye to this oncoming industry trend. With R&D funding from Statoil, the company set to work on its flagship product, Pre-Stack Pro. This software harnesses big data computing techniques, allowing users to easily view and process their pre-stack data. As the company would have it – more data, more often and in more detail. Pre-stack is the future of seismic interpretation.

Such a proposition would not have been viable until recently. It is only thanks to rapid advances in computing power, and increases in storage capacity, that interpreting these enormous datasets is possible.

"We're giving the interpreters the tools to make those decisions themselves," says Shea. "There have been tools around for 20 years to allow the real specialists to do the work, but it might take one to two weeks to run a batch job on the dataset at their workstation, and that's simply too long. We can get that down by factors of ten to 100 on all kinds of computer systems, so then we're talking hours."

Early in the software development process, the company homed in on what Shea calls a "game-changing idea". They realised that when you visualised the pre-stack data, you could see all kinds of artifacts and information that simply wouldn't have been visible post-stacking.

"We got motivated to make a kind of hybrid tool that combined processing and visualisation," he recalls. "Basically, the visualisation was showing all kinds of problems that you hadn't been aware of, and we were motivated to make tools that would fix them. That jumped us into processing blocks of data."

Of course, when data is processed perfectly, the near, mid and far stacks will give a reliable indication of the rock and fluid properties. However, interpreters have no way of verifying that the data has been processed perfectly unless they go into the pre-stack.

"When Ronald Reagan was the US president, he was talking about arms reductions treaties and saying 'trust but verify' – you want to believe that everyone's building down their nuclear arsenal, but you have to have checks in place to make sure that's actually happening," says Shea. "Similar to how, if you simply trust your seismic vendor to give you perfect data, you might find that they haven't actually done that."

This means the first real benefit of pre-stack information is to be able to directly assess whether there are any processing artifacts in the data. Once it has been stacked, you lose your only means of telling.

Know the drill

Another key benefit is that you can take your own approach to interpretation. Users can visualise the data on their desktop, generating the exact stacks and attributes needed to target promising anomalies. They can adjust any parameter and see the desired results in seconds.

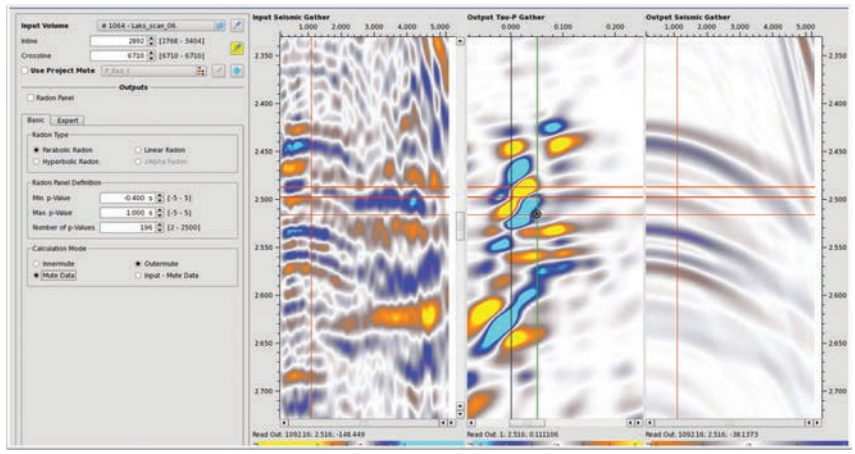
"The seismic companies are aware if they are too aggressive in eliminating noise, they may actually be cutting into the primary signal," says Shea. "That means that the tendency is to be conservative, and to leave noise that will obscure the signal. We put those decisions about where to draw the line between too much or too little noise removal into the hands of the person who is actually using the data. They know which reservoirs they're going to be focused on, and are in a better position to decide where they put that boundary."

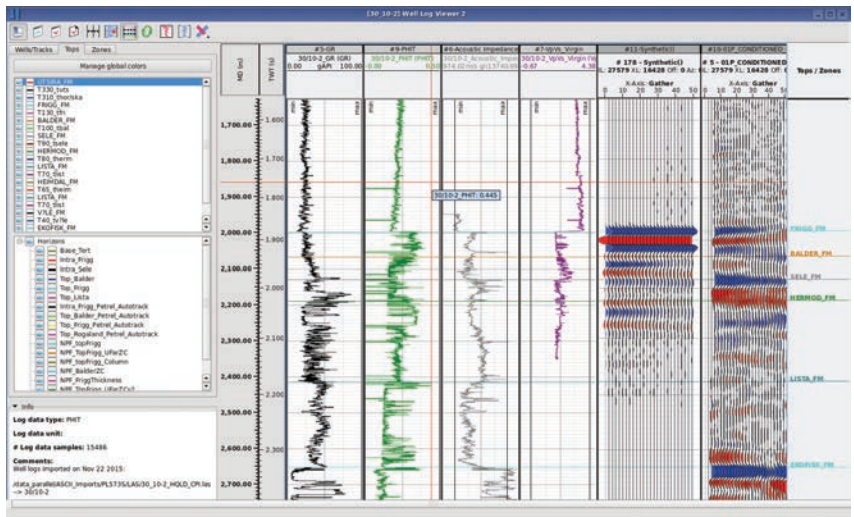
As he explains, Pre-Stack Pro leads to sharper data and more intelligent selection of the stacking ranges. This in turn leads to more confident identification of fluid properties – whether the reservoir is filled with water or hydrocarbon.

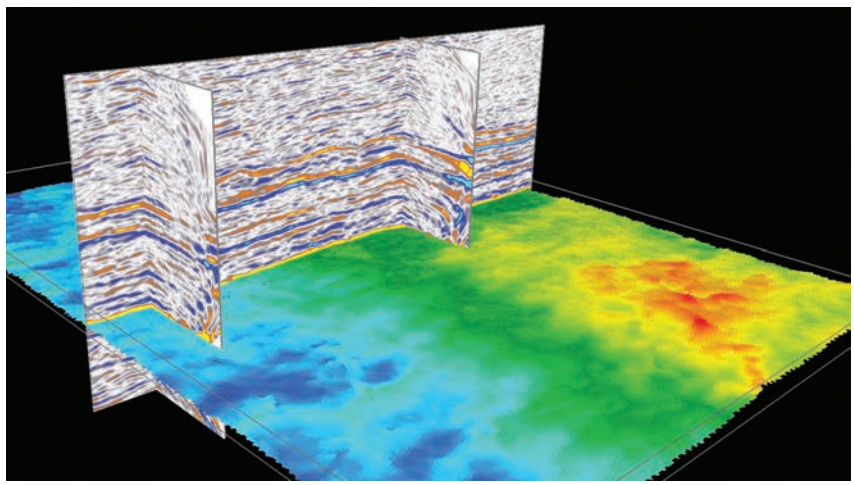
"The other thing we are doing is that we have integrated a very modern pre-stack seismic inversion algorithm into our software, so you can proceed straight from the post-migration processing into inversion without switching software tools," he says.

"This eliminates that traditional barrier between interpretation and seismic processing, which is a big vision that we have been chasing."

In July 2018, Shea attended the Unconventional Resources Technology Conference (URTeC) in Texas. He found that many of Sharp Reflections' clients are now applying the tools to unconventional resources, which pose a number of additional challenges. For one thing, the pre-stack volumes are an order of magnitude higher, owing to the extra data points that are needed for an accurate interpretation. ››







Pre-Stack Pro, Sharp Reflections' flagship product, allows users to view and process pre-stack data by harnessing big-data computing techniques – more data, more often and in more detail.

"You may drill the reservoir in one location and find it's very brittle and has a good response to fracking, but move 20km away and you are not so sure," says Shea. "To actually see differences between different locations in the reservoir you really need the pre-stack data, because now you're looking at very subtle changes in the amplitude response that are occurring as a function of direction."

Analysts working with these reservoirs are seeking to make two key predictions – first, what is the stress state of the rocks prior to fracking, and second, how much natural fracturing is there already. This requires an eye for subtleties, which in turn requires high-quality data processing.

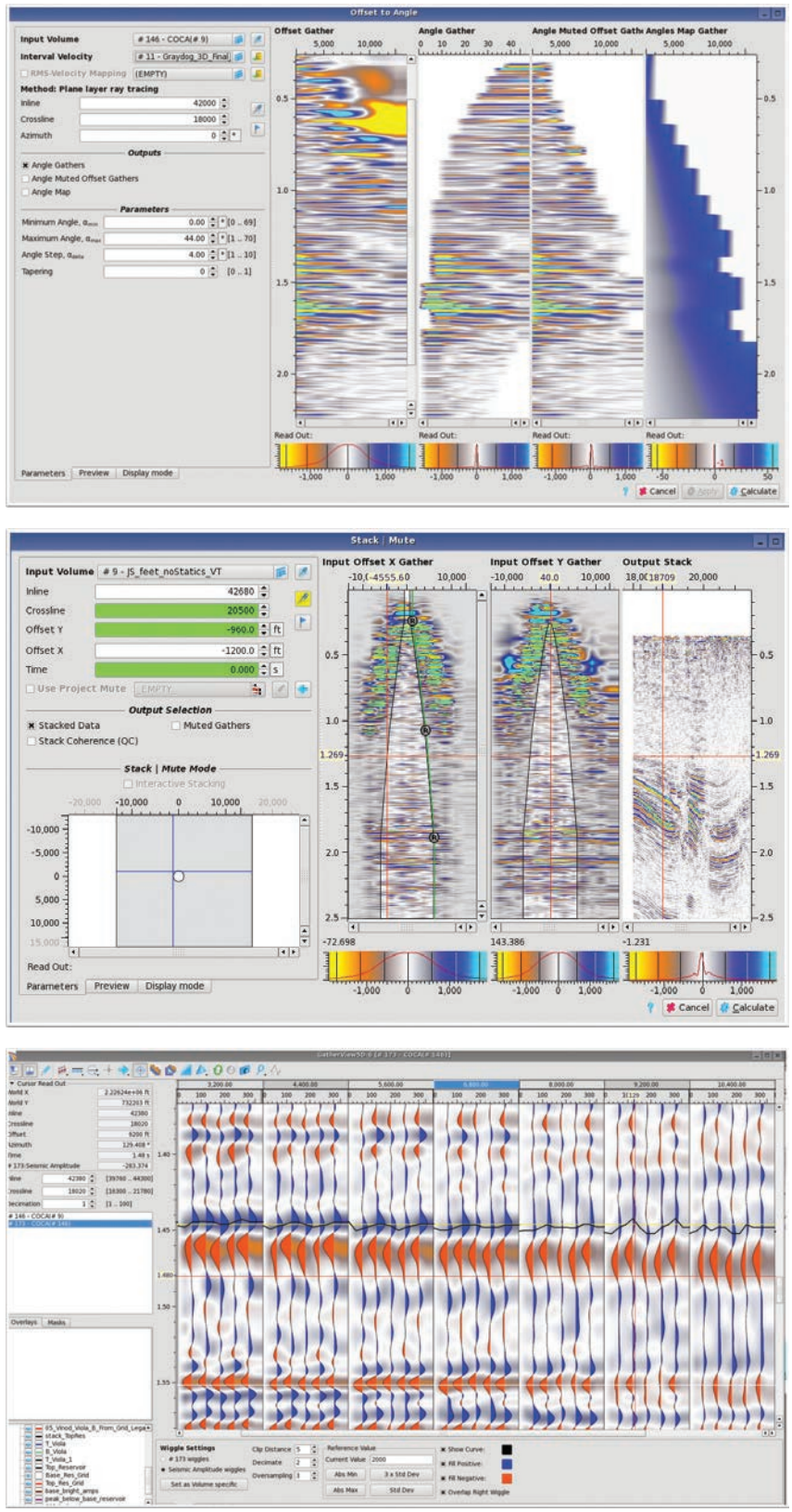
"It is early days, but it's very exciting that we have managed to take some general principles of the value of pre-stack information and apply them to a completely different type of reservoir system," says Shea.

Describing himself as a "technology optimist", he says there will likely be a greater movement towards using pre-stack data in the future.

"Industry scientists who are doing work to extract economic value out of their reservoirs are always going to strive to pull as much information out of their seismic data as they can," he says. "The industry has proved again and again that when they see value in enhancing technology they're very swift to adopt it. So, I think in the oil and gas industry the economic value of using pre-stack information is always being assessed and weighted against the costs."

The general trajectory, of course, is that costs tend to fall as the technology advances. And in this case the technology is moving fast. Already, Sharp Reflections offers its solution in the cloud, which means there is no longer any need for clients to worry about which hardware is most compatible.

"Since they just pay for their hours and the storage they're using, going fast is the same price as going slow," says Shea. "If you have 100 computers doing a job that might take an hour, versus one computer doing a job that takes 100 hours, you pay the cloud vendor exactly the same for A or B. So, why not go fast if there is no price pain you have to pay to get there? That's a big mindset shift for a lot of people.



High-quality data processing and cutting edge technology are required to best ascertain the stress of rocks prior to fracking, as well as the amount of fracturing that already exists.

"Near, mid and far stacks were forced on us as a compromise, or we simply couldn't do the analysis," says Shea. "People still have a set of best practices based on using these techniques because they've shown they work very well. But they can work even better if you don't reduce the data," he concludes. ■