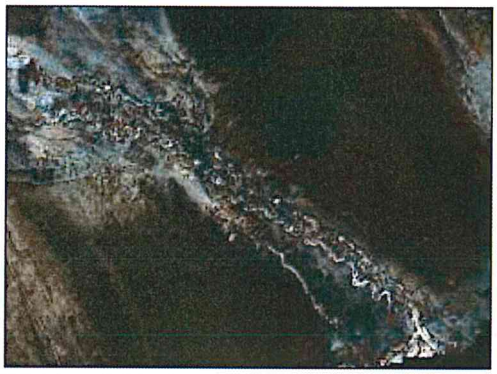
The Geological Approach to Seismic Interpretation

Major increases in interpretation productivity will enable operators to manage the data explosion and generate the return on investment required from seismic acquisition and processing.



Geological expression is based on converting seismic images into geological images. (Image courtesy of ffA)

Contributed by Jonathan Henderson, ffA

Three-D seismic data has been one of the great technology success stories in hydrocarbon exploration and resource development. It has allowed exploration in ever more challenging environments, opening up whole new basins, and has made a significant contribution to extending the economic life of mature areas such as the North Sea and Gulf of Mexico. The importance of 3-D seismic is signified by the fact that well more than 10 million sq km (3.8 million sq miles) of the earth's surface is now covered by 3-D seismic data.

The imperatives of improving hydrocarbon recovery and reserves replacement are placing ever greater demands on what geophysicists need to get out of 3-D seismic data. As a result, seismic acquisition companies are engaged in something of an arms race to deliver improved resolution and better quality data. The resulting data explosion is threatening to overwhelm the already stretched seismic interpretation community at the same time that it is dealing with the "great crew change" necessitated by interpreter demographics. However, better data deliver no benefit if they cannot be converted into better information. The purpose of seismic interpretation is to convert data into knowledge and an improved understanding of the geology of the subsurface. Without effective seismic interpretation, investment in seismic acquisition and processing delivers no value.

Seismic interpretation is a multistage and multifaceted process. Traditionally, interpretation has been the domain of the geophysicist. This makes sense when it comes to the more quantitative aspects of interpretation, such as estimating rock and fluid properties or analyzing potential reservoir changes from 4-D time lapse data. However, quantitative analysis of seismic data is an ill-posed problem in that the number of independent variables that can be measured is small and the number of parameters/properties that affect the seismic signal is large. For quantitative interpretation to deliver meaningful and reliable information, it needs to be constrained by an understanding/model of the geology being analyzed. Unsurprisingly, obtaining this understanding requires as much, if not more, of a geological view of the information contained in the seismic data than a geophysical view. To do this, techniques that help convert seismic images into geological images are needed – or, put another way, there is a need to directly convert geophysical data into geological information. To accomplish this, techniques must enable geophysicists to examine how geology is expressed in seismic data, a process that has been termed "geological expression."

The geological expression approach to seismic interpretation takes advantage of the enormous increase in the compute power available in most interpreters' workstations and what this enables in terms of 3-D visualization and attribute analysis. Tying these factors in with novel, interactive methods for data-driven, interpreter-guided delineation of the geological elements required to construct a 3-D model makes geological expression uniquely powerful. The data-driven, interpreter-guided concept is critical to improving interpretation productivity.

Geological expression improves productivity by enabling geoscientists to fully exercise their skills and experience because it implicitly recognizes that there is always more than one interpretation that can fit the available data. Defining which of the possible scenarios is most plausible requires an understanding of context at a range of geological scales. This is something that interpreters do naturally and intuitively, but they are a long way off having computational techniques that can match this facility. However, to be able to assess risk and economics and define different exploration and exploitation scenarios, a geological model needs to be constructed. To do this accurately, objective analysis must be embraced within interpretation workflows.

Therefore, the goal for geological expression is to make it possible for the interpreter to interrogate the data, unveil the geological information it contains, and guide the building of a 3-D model in a seamless flow. ffA is striving towards this goal with its GeoTeric software.

In GeoTeric, analytic interpretation techniques that just a few years ago would have meant a long sit and wait can now be completed in just a couple of minutes or even seconds. These are being linked with a unique geobody delineation technology, Adaptive Geobodies, which greatly increases the efficiency and accuracy with which complex geological elements can be defined and incorporated into a 3-D geological model.

It is only with major increases in interpretation productivity that geoscientists will be able to manage the data explosion and generate the return on investment that are required from seismic acquisition and processing. ■