Making the Most of Your Shale Wells

Although each play is unique, certain things will hold true for the "ideal shale well":

- The well must be drilled in a zone that has a high TOC
- Intercepted shale must be brittle enough to frac
- Induced fractures resulting from the frac job must intercept a natural fracture system and porosity
- Induced fractures must remain open for a sufficient period of time to allow economic volumes of hydrocarbons to be produced

But engineers are busy. Drilling and fracing is all consuming, so taking advantage of the wealth of information contained in the seismic data often takes a backseat.

What if you could turn well and seismic data into actionable knowledge and help geoscientists and completion engineers easily determine the optimal surface location to place a pad, the best azimuths for their laterals, the precise landing depths, and which stages will best contribute to production? What if you could help your drilling engineers guide the drill bit toward the sweet spots and away from faults and other drilling hazards?

With integrated GeoEngineering™ workflows, you can.
Target the Sweet Spots by Knowing In order to represent data adequately, we guarantee a precise representation in time and depth of a structural framework. This ensures that our inversions honor structural complexity near the faults and provide an accurate representation of the reservoir heterogeneity.

Our robust approach to building 3D geologic models of natural fracture density, Total Organic Content (using gamma ray as a proxy), porosity, and brittleness has proven to be successful when applied to different geologic settings worldwide.

Predictive Reservoir Understanding

The SIGMA³ Reservoir Characterization group delivers integrated workflows that provide a direct link between G&G and engineering needs, including the ability to predict well performance with a high degree of confidence. Complex G&G data is translated into a simple engineering result that can be used by geoscientists or completions engineers. These integrated workflows can replace cross-plotting analysis of engineering data versus seismic attributes, traditionally used to try to understand reservoirs.

SIGMA³ workflows make use of optimal processes to condition seismic data while preserving relative amplitude.

State-of-the-art broadband spectral inversion provides high-resolution seismic that reveals new features unseen in the original data.

The log on the left shows the ties to the original data, but it is concealing a secret – a slump block of carbonate with a head wall scarp and a toe thrust that is not resolved by the data. Broadband spectral inversion shows the details that were buried in the original data in the relative-impedance section.

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Volumetric curvature using the original seismic.

Volumetric curvature using proprietary spectral inversion techniques to reveal small-scale faults.

After broadband spectral inversion the enhanced frequency spectrum of the data provides optimum input to volumetric curvature and spectral attributes.

High-Resolution Imaging of Carbonate Slump Feature
Continuous Natural Fracture Modeling

When modeling unconventional and fractured reservoirs, SIGMA³ relies on simultaneous use of multiple seismic attributes. A proprietary neural network is used to find a relationship between the reservoir properties and the multitude of seismic attributes available, which are then ranked to identify the attributes that are directly correlated with reservoir, geologic and rock properties.

Stochastic inversion is used to further enhance the resolution of our geologic models by integrating well log data with the enhanced seismic resolution provided by our broadband spectral inversion tools. The result is a detailed variation of reservoir properties needed to capture the effects of reservoir heterogeneity on fluid flow.

Our Continuous Natural Fracture Modeling (CNFM™) technology allows us to combine derived seismic attributes and geologic models to closely estimate the distribution of the natural fracture density of the reservoir. Such information has been tested successfully by the drill bit.

When pre-stack seismic data are available, the results of using our workflow are enhanced by estimating key elastic properties to derive brittleness, as well as other petrophysical properties, such as gamma ray and porosity generated through our Extended Elastic Inversion (EEI) method.
The success of the SIGMA³ workflow consists of an integration of high-resolution seismic attributes with geologic and reservoir modeling to determine the key shale drivers:

- Total Organic Content
- Porosity
- Brittleness
- Natural fracture density

The shale drivers are combined into a shale capacity model which is able to predict production performance with a typical correlation coefficient of above 0.7.

This unprecedented level of integration and analysis of the correlation between the Relative Intercepted Shale Capacity (RISC) and well performance can allow you to predict performance of wells to be drilled in the sweet spots that are revealed by SIGMA³ shale capacity models.

The SIGMA³ workflow provides a tangible product, shale capacity, that allows the prediction of well performance with a correlation coefficient that exceeds 0.7.

Drill & Frac Where it Delivers

Armed with better insight, asset teams can make the optimal drilling targets, completion design, and field development in unconventional and fractured reservoirs. Around the world, SIGMA³ workflows have been applied to all major shale basins, as well as many clastic and carbonate reservoirs.