Deep Structure: Strength through integration in the deepwater Gulf of Mexico

Exploration interest in the deepwater US Gulf of Mexico is at an all time high following the discovery, in 2001, of thick Paleogene submarine turbidite sands in the Baha #2 well. This *'Wilcox' sand play* has now expanded across most of the deepwater and is the main reservoir target. These reservoir targets are typically 3 and 4 way structural closures, obscured by a thick allochthonous salt canopy and cored by deep allochthonous salt.

Other potential deepwater plays include the Late Jurassic Norphlet aeolian dune play and the Upper Cretaceous submarine fan play in the Western deepwater Gulf. These potential plays combined with the Wilcox play ensure that the deepwater sector will be an important exploration target for many years to come. This was further reinforced by the record-breaking MMS lease sales for the Western and Central Gulf of Mexico in 2007.

Understanding these play-fairway opportunities requires a regional, structural and stratigraphic context for the Paleogene Wilcox including sub-salt sediment distribution and a better understanding of the tectonic framework of the basement. Moreover, mapping the structure of the rifted basement will progress our understanding of its impact on sedimentation, the distribution of autochthonous salt, and the location of the Continental-Oceanic Boundary (COB).

Despite the huge volume of seismic data (2D and 3D) acquired in the region, one of the most fundamental challenges facing the industry is the problem of sub-salt imaging. Even with the latest processing technologies, seismic imaging of the sub-salt stratigraphic section is problematic due to the allochthonous salt canopy.

"Deep Structure"

The purpose of "Deep Structure" is to combat the sub-salt imaging problem by using an integrated approach. By integrating long-offset (10km) Deep Focus seismic data, high resolution marine gravity data and high resolution airborne magnetics data, Fugro has significantly increased its understanding of the sub-salt geology of the Deepwater Gulf of Mexico. Although each dataset can be interpreted in isolation and used as a stand-alone product, integration of these datasets has lead to a better understanding of the sub-salt section and has produced a robust and comprehensive interpretation. The new interpretation and modeling results provide a solid platform for future exploration and research in the sub-salt arena.

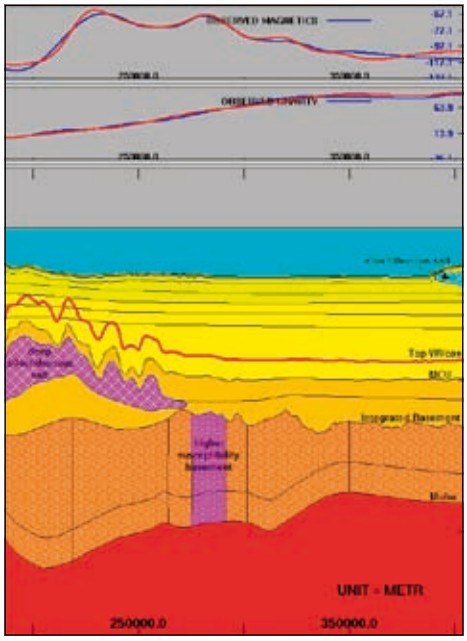

Image of a 2D gravity and magnetic model using 2Mod™.

The new integrated basement interpretation relies heavily on the seismic data outboard of salt where seismic imaging is best. This area has been called the calibration area and is the best area to compare the magnetic basement and acoustic basement without the influence of a salt canopy.

In the calibration area we have looked at the relationship between acoustic basement and magnetic basement anomalies. This allowed us to better assess the relationship underneath salt and enabled us to trace some of these anomalies back under salt where seismic imaging is more of a challenge.

The new interpreted magnetic basement was constructed using standard depth-to-basement techniques. This quantitative analysis of the magnetic data was primarily carried out by means of Werner deconvolution, Euler deconvolution and Peters half slope methods. Gravity data was used to help resolve areas of discrepancy between the basement surfaces prior to finalizing the integrated basement surface.

Constraining basement

This integrated basement, together with top and base allochthonous salt horizons from the Deep Focus work outlined above, were then used as the cornerstone for 2D and 3D gravity and magnetics inversion and forward modeling work. Again this integration has lead to a much better constrained basement for assigning density and susceptibility values.

Fugro has also developed a workflow to distinguish basement signal from autochthonous and deep allochthonous salt signals during the 3D modeling process.

All of this work has lead to a new understanding of the morphology and structure of the basement and sub-salt stratigraphy in the area of Phase 1 (see inset figure) that could not have been achieved from using seismic data alone. The implication of all of this is that as we move into planned Phases 2 and 3, the lessons learned and the techniques developed will allow Fugro to better cope with the inevitable complexities that will be encountered as we work through Garden Banks, Green Canyon and East Breaks.

We have developed an important example of the power of integration and its importance in geophysical and geological interpretation.