Detailed Basement Mapping in the Deepwater Gulf of Mexico from Integrated Modeling

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Summary

Detailed mapping of Moho relief, crustal thickness, detailed basement structure, and a tectonic framework for the deepwater Gulf of Mexico has recently been completed. Input data for this work includes a 3,500 well database, 120,000 line miles of newly acquired high-resolution gravity and bathymetry data, and 300,000 line miles of detailed aeromagnetics. The work involved includes over three man-years of effort by senior project geophysicists. The poster presents a review of input data, interpretation flowchart, and a statistical analysis of deepwater discovery locations versus basement structure as illustrated in **figure 5**.

Introduction

Detailed mapping of the deep structures in the U.S. Gulf of Mexico has been a challenge for as long as exploration has been undertaken, primarily due to a lack of detailed and high quality data. Industry's need for accurate crustal thickness, composition, and basement structure has driven the acquisition of new detailed gravity, bathymetry and magnetic data sets. When combined with well data and regional data compilations, this database becomes a powerful tool in the hands of the interpreter.

This poster illustrates the following points, and is primarily focused on presenting the method of interpretation used:

- Input data quality and sampling
- Interpretation methods and integration flowchart
- Applications of the detailed basement structure in exploration for hydrocarbons
- A statistical analysis and comparison of the location of deepwater discoveries vs. basement structure.
- Interpreted hydrocarbon migration pathways based on basement structure and associated faulting.

Interpretation Overview

Input data for the interpretation:

- 120,000 line miles of new marine gravity and bathymetry data, acquired by Fugro-LCT in conjunction with the TGS-NOPEC deepwater 2D and 3D seismic surveys as illustrated in **figure 1**. Post-adjustment misties for the primary grid of 20,000 line intersections is on the order of 0.15 milligals.
- Bathymetry data includes the NOAA Gulf of Mexico multibeam grid, merged with the new ship track bathymetry data.
- Aeromagnetic data was acquired by Geoterrex (now Fugro Airborne Surveys) on a 0.5 x 1.0 mile to 1.0 x 1.0 mile grid over the area illustrated in **figure 2**.
- MMS well database, edited by IGC, inclusive of over 3,500 published wells illustrated in **figure 3**.
- Regional Moho surface which was created via inversion of a regional satellite-derived plus public domain ship track gravity database, enhanced and refined during the interpretation using the new ship track gravity and bathymetry data.

Interpretation Steps:

- Aeromagnetic data was all interpreted on a line-by line basis using multiple depth determination algorithms as illustrated in **figure 4**.
- Magnetic basement and faulting was mapped from the line analyses, using calibration points from published seismic refraction data (Buffler, et al).
- Refined Moho surface was created using the new ship track gravity data over the study area.
- Crustal isopach was interpreted (basement minus Moho)
- Crustal density distribution was mapped using the basement surface and gravity data. Interpretation of continental versus oceanic crust was made.
- A new 1st order residual gravity field was created using the deep geologic control for use in future detailed seismic/gravity integrated modeling of salt geometries in the sedimentary section.

Conclusions

The detailed interpretation of deep structure in the U.S. Gulf of Mexico provides a new context for the interpretation of the sedimentary section for hydrocarbons. Using new high quality data, high-confidence results have been achieved.

By input of these results into the workstation environment, interpreters can more thoroughly assess structure, migration pathways, heat flow and maturation processes, reducing risk in deepwater Gulf of Mexico exploration.

Acknowledgements

The authors would like to acknowledge the prior work done in the deepwater Gulf of Mexico by Buffler and his co-workers. We also appreciate the data provided by Fugro-LCT, Fugro Airborne Surveys, and the support of Integrated Geophysics Corporation (IGC).

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Figure 1. High Resolution Gravity and Bathymetry Data

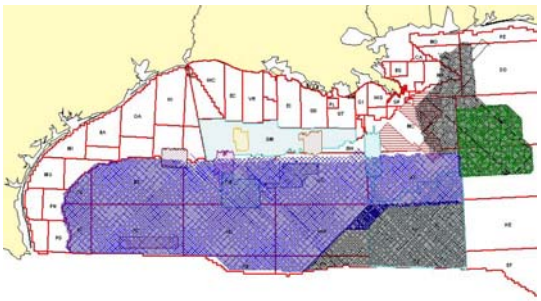

Figure 2. High Resolution Aeromagnetic Data

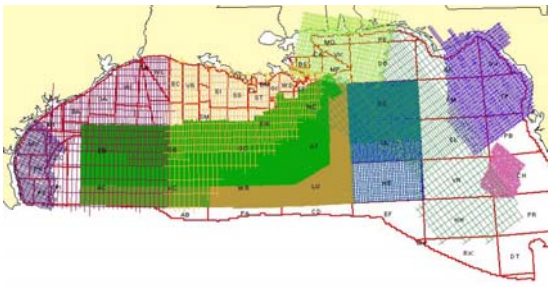

Figure 3. Edited MMS Well Data

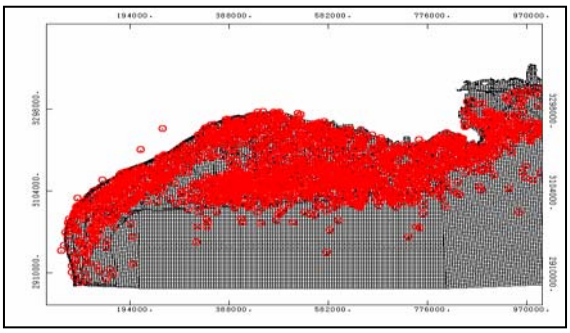

Figure 5. Example from Analysis of Discovery Well Locations

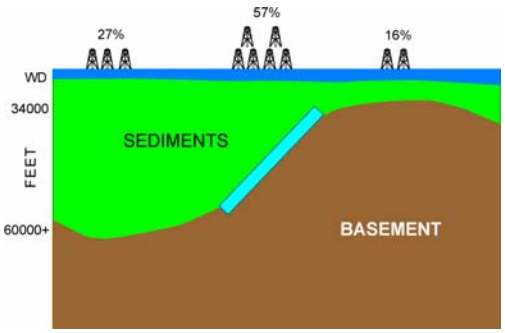

Figure 4. Aeromagnetic Profile Interpretation