Northern Gulf of Mexico basement architecture: crustal study to prospect leads

Michael Alexander - Integrated Geophysics Corporation

Abstract of paper presented at the 1999 Society of Exploration of Geophysics Sixty-Ninth Annual Meeting Workshop: The Seismic Link: Reducing Risk, Houston, TX

The importance of basement architecture to hydrocarbon exploration in the northern Gulf of Mexico basin has been debated for years. It is the intent of this paper, together with an associated paper by Dr. Joel Watkins, to demonstrate that mapping of basement structure and subsequent interpretation of crustal type can profoundly impact not only exploration plays but can also lead to a better understanding of the tectonic and stratigraphic history of the Gulf basin.

The northern Gulf of Mexico basin has been extensively covered by relatively detailed, readily available aeromagnetic surveys suitable for compiling into a uniform data set for qualitative and/or quantitative interpretation. The author's quantitative interpretation of the magnetics reveals a magnetic basement architecture that is much more complex than the mid-Jurassic sequence boundary (MJS) mapped by Rosenthal and Buffler (1987). The resultant magnetic basement structure map also demonstrates that there is no areally consistent correlation between regional gravity values and sediment thickness. However, through integration of the magnetic basement interpretation with gravity and seismic reflection and refraction data, it becomes possible to better differentiate between gravity anomalies sourced by salt, light density clastic sediments, crustal density variations (basement blocks), or subcrustal (Moho) undulations. The two dimensional gravity/magnetic model illustrates our interpreted relationship between sedimentary section, MJS, magnetic basement, Moho, and seismic refraction picks.

Major magnetic basement features include broad horst blocks, interconnected grabens or rift valleys, igneous plugs, and shear zones. Overall structural relief is on the order of tens of thousands of feet. Local basement features include tilted fault blocks, sheared high blocks, faults which may relate to overlying sedimentary faults and/or salt diapirism, and subbasins or minibasins which could have economically significant thickness of pre-Cretaceous source beds. These local features not only provide new seismic leads, but should also be important components of any Earth Models built with existing seismic and gravity data.

Two regional trends of magnetic basement deeps are aligned subparallel to the Texas-Louisiana coastline. Both trends have arms that are subnormal to the coast. A chain of basement high blocks along the Texas-Louisiana coast separates the onshore and offshore deep trends. Seaward of the offshore deep trend, regional basement highs occur in Alaminos Canyon-Keathley Canyon-Garden Banks Areas and in Lund-Atwater Valley-Lloyd Areas. From correlation between magnetic basement structure and regional gravity models we postulate that *many* of the basement deeps are associated with higher density and/or thinner crust, and *many* of the basement highs are associated with lower density and/or thicker crust. However, there are enough significant exceptions to require caution against use of gravity alone to predict sediment thickness or crustal type and thickness.

In additional to basement highs and lows, the magnetic interpretation reveals primary basement fault patterns subparallel to the Gulf coast and secondary faults subnormal to the coast. Many of these secondary faults are interpreted either as segments of major transfer faults described by Hall, Watkins and others (1982, 1995) which influence stratigraphy and control major tectonic elements, or as shears which control local structure.

References

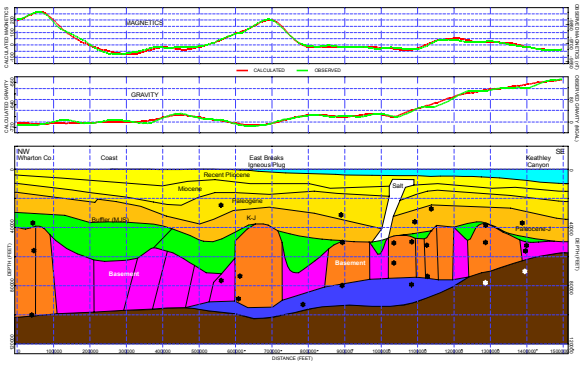
Hall, D. J. et al, 1982. The rotational origin of the Gulf of Mexico based on regional gravity data. AAPG Memoir 34

Rosenthal, D. B. And R. T. Buffler, 1987. Depth to basement, Gulf of Mexico region. UTIG Technical Report 71, UT, Austin, Texas

Watkins, J. S. et al, 1995. Bipolar simple-shear rifting responsible for distribution of mega-salt basins in Gulf of Mexico?

Acknowledgments

Portions of the basement interpretation are based on magnetic surveys by AIRMAG, EDCON, and Geoterrex-Dighem. The author and IGC appreciate permission to show the regional data and/or resulting interpretation. The author thanks K. Aimadeddine, C. Prieto, M. Schulze, and S. Stephens of IGC for their assistance in preparing the data and illustrations for this paper.



Northern Gulf of Mexico
Wharton Co., Texas - Keathley Canyon Model