A New Frontier: Deep Gas Exploration Offshore South Texas, USA—An Assessment Tool

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EXTENDED ABSTRACT

Since the 1930s, the Mexican Burgos Basin has been known to be gas prone. It has appealed to a range of exploration companies including major players like PEMEX and small independents who have experience working in South Texas (Baker and Wilson, 1996). One of the producing regions on trend to the Burgos Basin is the South Texas offshore area; some exploration and assessment concepts will be presented in this paper.

The South Texas offshore area is located in the Gulf of Mexico and appears to have been “under the radar” of many companies (Fig. 1). Its deep gas potential interests oil and gas exploration companies because this area is under-explored, is located in the favorable position immediately north of the gas-prone Burgos Basin, is a downdip extension of South Texas geology, is in close proximity to markets, and there is a favorable economic model and a friendly government, the Minerals Management Service (MMS).

South Texas basins and Mexico’s Burgos Basin have similar tectonic control, depositional systems and trapping styles. Several Texas plays have been correlated to major producing regions in the Burgos Basin (Scotia Group, 2002). Identified traps include both listric and normal faults and anticlinal structures (Cuevas Leree et al., 2004). The normal faulting and anticlinal structures are possibly basement related, which leads the explorationist in an investigation of the configuration of the magnetic basement. A first look at a magnetic basement structure map tends to show major provinces which are distinguishable by their individual trend direction, structural style, depth range, areal distribution, and probable crustal type.

The geologic term “basement” can be defined in several different ways. In the Gulf Basin Province, “basement” has been equated by some authors to a mid-Jurassic sequence boundary (MJS) which lies above high-density formations of various lithologies (Buffler and Thomas, 1994; Rosenthal and Buffler, 1987). While that definition has important geologic meaning, it does not fully describe the potentially thick wedge of unaltered, relatively nonmagnetic older sediments overlying magnetic, or crystalline, “basement.” Acoustic basement is a term used for the surface below which little if any seismic energy can penetrate. Locally, it could be equivalent to Buffler basement, magnetic basement, or even some other surface.

The definition of “Magnetic Basement” by Integrated Geophysics Corp (IGC) in the northern Gulf Basin Province includes the Precambrian metamorphic and igneous rocks, Paleozoic metamorphic and igneous rocks, and Triassic and younger igneous intrusive and extrusive rocks.

The deep gas potential for South Texas can be assessed with the incorporation of an exploration strategy that includes an interpretation of magnetic basement structure utilizing High Resolution AeroMagnetic (HRAM) data. A new HRAM dataset, employing a
modified Cessna 404 aircraft, was acquired in this area in 2006. The survey covers the Mustang Island, Corpus Christi, South Padre Island and Port Isabel protraction areas and extends from the coastline to over 100 miles offshore to the East Breaks and Alaminos Canyon protraction areas. The HRAM data was acquired on a 0.5 mile x 1.0 mile grid, utilizing GPS positioning, at an elevation of 450 feet, with a 10 Hz sample rate which equates to approximately 25 feet per sample. The tight grid, low level and precise positioning survey design provides a powerful mapping tool for both basement and intra-sedimentary magnetic anomalies.

The structural trends interpreted from the HRAM data relate to the continental margin of the North American continent bordering its neighboring ocean to the east from Paleozoic to recent times. Faults trending from southwest to northeast were interpreted as regional parallel-coastal trends which can form zones of weakness for transfer faulting. The magnetic basement structure map clearly shows the main characteristics of the region.

The top of basement is the deepest potential prospect horizon in any basin. In the Gulf Coast region, depth to top of basement is over 50,000 feet and will probably not be reached by the drill bit. The top of basement structure is important, however, due to its influence on the overlying sediments, which has been found to extend upwards to sediments as young as Mesozoic and Tertiary age on the Louisiana shelf (Alexander, 2003). This critical influence establishes the basement structure’s greatest importance in South Texas exploration—the relationship between mapped basement structure and the location of oil and gas accumulations. The crests and flanks of structural highs are prominent sites for structural and stratigraphically trapped hydrocarbon accumulations. Because basement fault may have influenced the faulting and “plumbing” occurring in the overlying sediments, it is necessary to take a new look at structural low areas initially
considered of no interest. Basement features thus have the potential to become corner-
stones of new exploration concepts in the southern Texas Gulf Coast region.

Additional assessment tools can be derived from the integration of the basement
structure surface with other seismically derived or wellbore derived horizons. One ex-
ample would be an isopach map based on the magnetic basement structure and Buffler’s
mid-Jurassic sequence boundary (MJS). The resulting thicks and thins could assist the
interpreter in the determination of deep gas potential. In general, HRAM based data
enhancement products can identify shallow low-susceptibility zones (e.g., salt) in the
sedimentary section as well as minibasins and depositional fairways.

The methodology used to interpret the magnetic basement structure will be illus-
trated. The discussion displays will focus on illustrating how a high level of confidence
can be placed in these assessment tools.

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