



OTC 19360

Geological and Biological Relationships in the Puma Appraisal Area: from Salt Diapirism to Chemosynthetic Communities

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This paper was prepared for presentation at the 2008 Offshore Technology Conference held in Houston, Texas, U.S.A., 5–8 May 2008.

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Abstract

Salt diapirism to very shallow depths below seabed in the deepwater Gulf of Mexico Puma appraisal area has extensively tilted, thinned and faulted supra-salt strata, and permitted the migration of asphalt, oil and gas to the seafloor and into the water column. Hydrocarbon migration through the shallow strata has resulted in the formation of extensive areas of authigenic carbonate at, and immediately below, the seabed interface. Active hydrocarbon seepage continues to feed chemosynthetic fauna across much of the Puma area. However, population densities are sparser than might be expected based on the extent of authigenic carbonate interpreted from geophysical data.

The integration of surface seismic and autonomous underwater vehicle geophysical data, synthetic aperture radar imagery acquired via satellite, and extensive video acquired in two remotely operated vehicle surveys, has been used to delineate the extent of the above geological and biological relationships to support exploration and appraisal activities in the Puma area. In areas of benign seafloor such extensive site investigation work would not be required. However, the evaluation of areas with complex shallow geology and rugged seafloor that may host environmentally sensitive fauna over extensive areas will benefit from the integrated approach described below.

Introduction

Northern Gulf of Mexico. The Outer Continental Shelf (OCS) of the northern Gulf of Mexico (GoM) is a complex geological setting characterized by salt withdrawal mini-basins and elevated areas of salt diapirism that have deformed the overlying strata (Figure 1). In some areas deformation is so disruptive that thermogenic hydrocarbons migrate easily through the fractured supra-salt section to the seafloor and into the water column (Lerche and O'Brien 1987, McBride et al. 1998, Rowan 1995). Chemosynthetic fauna sometimes colonize these cold seeps (Paull et al. 1984, Kennicutt et al. 1985), an energy source well below the photic zone (Carney 1994, Boetius et al. 2000, Orcutt et al. 2005). U.S. Department of the Interior, Mineral Management Service regulations (MMS) require that high-density chemosynthetic communities are avoided by exploration and production (E&P) activities (MMS 2000).

The MMS has sponsored two major studies of chemosynthetic communities that were largely restricted to the upper slope or water depths from 200 to 1,000 m (656 to 3,281 ft) due to the limitations of available submersibles (MacDonald et al. 1995, MacDonald 2002). In July 2007 field work was finished for a third MMS-sponsored study that focused on delineation and characterization of chemosynthetic communities in water depths greater than 1,000 m (3,281 ft). Technical reports are forthcoming. The most studied chemosynthetic communities in the GoM and best understood with respect to their subsurface geology are located at Bush Hill and around Jolliet Field in the northwest portion of the Green Canyon Protraction Area, U.S. GoM on the upper continental slope (Cook and D'Onfro 1991, Reilly et al. 1996). Information on the occurrence of chemosynthetic fauna (and deepwater fauna in general) across the lower slope is sparse.

Puma Area. The Puma prospect was successfully tested by the Green Canyon (GC) Block 823 #1 well in 2003 (Figure 1). The discovery well was followed by two appraisal wells (GC821 #1 and GC866 #1) which finished drilling in 2007. Reservoir level field appraisal, geotechnical studies to quantify the identified shallow geohazards, and investigation of potential development options are underway. The appraisal area is located in the southeast portion of the Green Canyon Protraction Area on the outer continental shelf immediately north of the Sigsbee Escarpment. Water depths in this area