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# Identification, Characterization, and Groundtruthing of Deepwater Thermogenic Hydrocarbon Macroseepage Utilizing High-Resolution AUV Geophysical Data

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## Abstract

An Autonomous Underwater Vehicle (AUV) geophysical survey that acquired detailed bathymetry, side scan sonar, and sub-bottom acoustic profiling was used to identify potential hydrocarbon seep features in Green Canyon Block 607 and 608, west of the Marco Polo field, in the Gulf of Mexico. The high-resolution seafloor and near-seafloor characterization provided by the AUV survey detected morphological characteristics that can be directly tied to the perturbation of sub-bottom sediments associated with potential hydrocarbon seeps. Combining this information with conventional seismic data, the seafloor characteristics can then be related to deeper features (structures and faults) establishing the link between subsurface reservoirs, migration pathways, and potential seafloor seeps.

Utilizing this approach, a seafloor-coring program was designed to sample some of the apparent hydrocarbon seeps in the Green Canyon Block 607/608 area. Morphologic characteristics of potential seepage seen in the AUV data allowed for the high confidence pre-selection of coring sites expected to yield: a) high potential thermogenic hydrocarbon seepage, b) regions of reduced hydrocarbon concentration, and c) areas of no hydrocarbon seepage (control). The results of the coring program clearly demonstrate the enhanced utility of a detailed AUV geophysical survey in the identification, classification, and subsequent ground-truthing of tell tale seafloor seep features. Using this detailed data is clearly superior to the traditional method of seep feature identification using conventional 2-D or 3-D seismic data.

## Introduction

In many deepwater petroleum plays, the search for seafloor hydrocarbon macro-seepage is an important part of the exploration program. Detecting thermogenic hydrocarbons at the seafloor provides strong evidence for the presence of a working petroleum system in the subsurface. Thermogenic hydrocarbons recovered from seeps can provide insight into the contents of the subsurface reservoir such as its relationship with previously discovered hydrocarbons and/or the identification of potential source rocks before an exploratory well is ever drilled. As an integral part of a comprehensive exploration program, this knowledge can substantially reduce the risk in drilling expensive deepwater wells.

Using conventional seismic data to detect potential seep features is often inadequate. Where only 2-D seismic data is available, recognition of potential seeps is limited to the seafloor directly along the seismic grid lines. 3-D seismic data provides greater areal coverage, but also has limitations. Hydrocarbon seeps are often small features that episodically vent thermogenic hydrocarbons to the seafloor. As such, they are not always easily recognized in seafloor extractions from 3-D data due to lack of resolution. Small to moderately sized seep features may therefore be easily overlooked when relying on these conventional data.

In contrast, AUV geophysical surveys utilizing detailed multibeam bathymetry, side scan sonar, and sub-bottom acoustic profiling allow for enhanced high-resolution seafloor and near-seafloor characterization. The morphological characteristics of detected seafloor features can be directly tied to the perturbation of sub-bottom sediments below each feature, providing insight into the presence of potential hydrocarbon seeps. This can then be related to deeper features (structures and faults) imaged on conventional seismic data establishing the link between subsurface reservoirs, migration pathways, and potential seafloor seeps.

This study will show how higher resolution AUV data was used to select coring locations in the vicinity of the Marco Polo field in the Green Canyon area of the Gulf of Mexico. The detailed AUV geophysical survey was an extremely valuable tool in the identification, classification, and subsequent ground-truthing of seafloor seep features. The combination of detailed bathymetry, sidescan sonar, and sub-bottom profiling was essential for differentiating between coring locations with high potential for thermogenic hydrocarbon seepage, areas with lower hydrocarbon concentration, and places where no hydrocarbon seepage was expected. This detailed characterization of the seafloor features also provided insight into the seepage process and helps to improve the selection criteria for future sampling.

## AUV Description