Analysis of seep architecture: a qualitative evaluation of seep near-surface geomorphology utilizing AUV3Dm high-resolution geophysical data in the Mississippi Canyon Area, Gulf of Mexico.

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Abstract

A recent AUV (Autonomous Underwater Vehicle) 3-D micro seismic survey (AUV3Dm) in the Mississippi Canyon protraction area of the Gulf of Mexico has brought about a rare opportunity to study a known naturally occurring hydrocarbon seep in approximately 3,000 ft of water. Offshore hydrocarbon seeps have recently become the focus of several frontier basin exploration programs. These programs utilize remote sensing multibeam surveys to identify potential seep targets on the seabed. These programs utilize remote sensing multibeam surveys to identify potential seep targets on the seabed. The remote sensed targets are subsequently cored, sampled, and geochemically tested for hydrocarbon signature. The results are used in a high-graded approach to exploration that seeks to prove the existence of a hydrocarbon system before the costly acquisition of seismic data.

As hydrocarbon seeps generally tend to be small seabed features their geomorphologic subsurface structural architecture has been modeled in the laboratory but never adequately visualized in-situ by 3-D or 2-D geophysical methods. Thus this new high-resolution and high-quality AUV3Dm survey appropriately accommodates the characterization of the internal physical makeup of a hydrocarbon seep.

The AUV3Dm survey data is utilized to effectively characterize details of the shallow geology and stratigraphy at the seep site. The lattices of small faults, which likely provide the conduits for seepage, were precisely mapped allowing for a qualitative interpretation of the physical processes that occur during the formation of a seabed seep. This interpretation was contrasted with the morphologic characteristics described in an earlier laboratory model providing additional insight into in-situ seep development.

Introduction

As the world’s demand for hydrocarbons continues to increase, the energy industry is always on the lookout for efficient, inexpensive, and precise exploration methods. Industry’s confidence in one such methodology is growing. In several deep-water frontier basins around the globe enterprises are currently utilizing a remote sensing technology tool called multibeam in conjunction with geochemical coring and testing, and the standard collection of 2-D seismic data, to high-grade their approach to frontier exploration. The practice of this new exploration methodology is known as “Seep Hunting” and it is presently in employment offshore North, Central, and South America, Africa, and Indonesia.

A Multibeam Echosounder (MBES) is a survey system that is capable of the collection of large swaths (2 - 5 km width) of high-resolution bathymetry and seabed backscatter at survey speeds of up to 10 knots. MBES is a proven efficient technology in the identification of high-confidence seabed hydrocarbon seepage targets (Gharib 2009). The MBES identified seepage sites are then cored and sampled for subsequent geochemical testing for hydrocarbon signature. The results are integrated with the operator’s basin analysis to create a more-robust basin model that seeks to prove the existence of a hydrocarbon system before the costly acquisition of seismic data.