Technical Note

Derisking Offshore Transition Zone Exploration Using Ultrasensitive Hydrocarbon Mapping

Offshore exploration is a costly endeavor which utilizes seismic data to evaluate subsurface structures. However, in offshore transition zones seismic imaging is impractical and quite expensive. So, how does one derisk exploration and appraisal activity in transition zones? The solution is inexpensive geochemical imaging.

Ultrasensitive hydrocarbon mapping technology, by Amplified Geochemical Imaging (AGI), has advantages that strongly complement and enhance traditional data. Traditional methods only measure C_1 – C_5 and C_{15}+, **which misses the gas condensate range**. As indicated by the red box in **Figure 1**, AGI measures from C_2 – C_{20}.

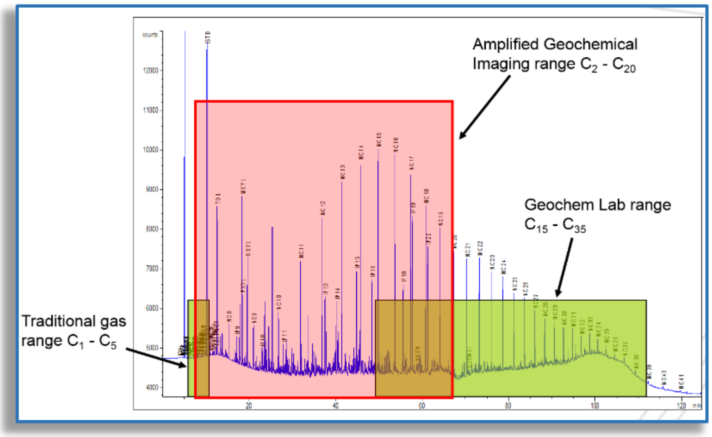

Figure 1.

With ~88 compounds, Hierarchical Cluster Analysis (HCA) can be used to compare various hydrocarbon signatures. Thus, subtle differences can be elucidated from similar hydrocarbon signatures to distinguish if multiple petroleum systems may be present, which cannot be accomplished by traditional methods. The AGI sampler, **Figure 2**, contains a specially engineered oleophilic adsorbent encased in a microporous polytetrafluoroethylene membrane. The membrane pores are small enough to prevent soil particles and water from entering, but allow hydrocarbon molecules to pass through.

Figure 2.

The result is an ultrasensitive technology that is roughly **1,000 times more sensitive than traditional methods**. Sensitivity is critically important when assessing the presence of active petroleum systems, particularly in frontier areas when macroseeps are often not present.

This **Gulf of Mexico (GOM) case study** was performed in conjunction with a geotechnical survey on the shelf in a water depth of <150 ft. The target reservoir was Tertiary at a depth of ~8,500 – 9,000 ft and 20 ft cores were taken with an average spacing of ~1/2 mile. **Previously 6 dry wells and 2 producing wells had been drilled**.

The objectives of the **microseep** geochemical survey were to:

a.) delineate existing field boundaries in the central structure,

b.) confirm prospectivity of untested structures along fault trends,

c.) determine if adjacent fields and structures were charged.

The dark purple areas, in **Figure 3**, represent an 85%-95% probability **of finding gas condensate** similar to the producing wells. The probability map shows gas condensate in the central structure adjacent to the proposed gas/water contact, indicated by the dashed line, and **correctly predicts the two producing wells within**.

Gray indicates areas of low prospectivity. Note the survey also **correctly predicts the two dry wells** in the NE portion of the survey.

The anomaly map also shows charged structures to the east and west that were previously unknown.

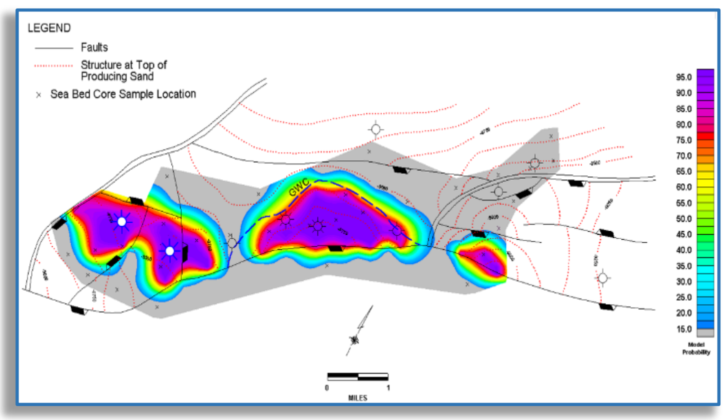

Figure 3.

AGI Surveys Successful in Detecting Hydrocarbons in Transition Zones

Two post-survey wells, indicated with white producing well centers, were drilled in the anomaly west of the central area. Both wells were highly productive, **thus ground-truthing the AGI survey results**.

The second case study took place in the Middle East in a shallow transition zone around an island, see **Figure 4**.

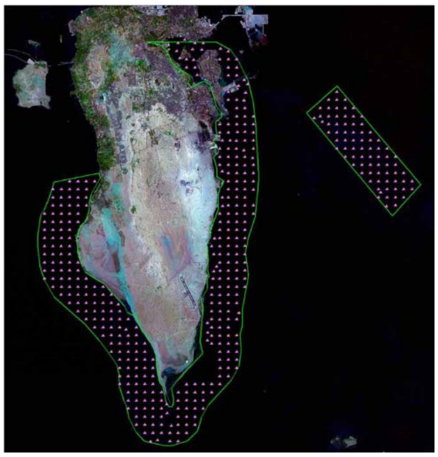

Figure 4.

The survey utilized 500 modules. The module locations are indicated by pink dots on the map.

Access was provided by shallow draft boats. Installation and retrieval were accomplished using three dive teams, see **Figure 5**.

Figure 5.

The modules were deployed for ~21 days in 3 - 4 meter water depths (deepest 8 meters). Positive thermogenic gas signatures were detected and differentiated from local baseline or background signatures, see **Figure 6**. The average thermogenic signature is seen in blue while the average background signature is in red. The thermogenic signature indicated strong gas response with trace amounts of liquid components.

These two signatures were used as end members to generate an anomaly map for the transition area island

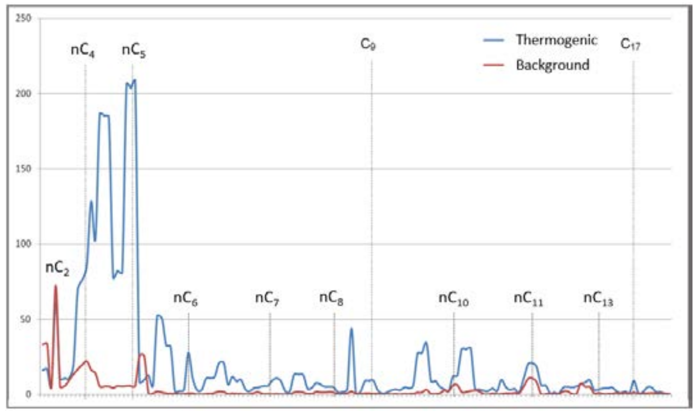

Figure 6.

survey. The results are seen in **Figure 7**. The more prospective areas are shown in red. The data indicated the majority of the offshore transition zone was nonprospective.

However, the offshore area to the east of the island did appear more noteworthy.

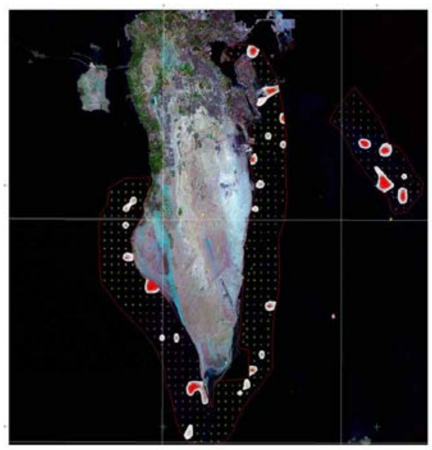

Figure 7.

Nevertheless, the survey did identify a thermogenic gas signature in the area and demonstrated the ability of the AGI method to function in offshore transition zones.

Summary:

- The offshore transition case studies mapped hydrocarbon accumulations in areas **where seismic imaging is very expensive but not very effective**.
- **Geochemical surveys cost ~90% less than seismic surveys** and are minimally invasive to environmentally sensitive areas.
- The geochemical surveys can generate highly accurate hydrocarbon maps in frontier, appraisal, or field development areas with or without model wells.
- Side scan sonar can be used prior to AGI surveys to high-grade sampling points such as mud mounds, pockmarks, seeps, and chemosynthetic communities.
- The surveys can be used to **map the transition of onshore petroleum systems to offshore**.

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