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Regional Multibeam Surveys for Seep Hunting and Geochemical Sampling in Frontier Areas

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Summary

H ydrocarbon-rich gases and fluids seep through the seafloor in many regions of the world. If these hydrocarbons are generated from leaking reservoirs, then there is much information to be gained for frontier oil and gas exploration. These seeps can physically modify the seafloor and create topographically-distinct features such as mud volcanoes, pockmarks and depressions, methane hydrate deposits, characteristic patterns of seafloor faulting, and other interpretable seabed morphology. Additionally, cold seeps have associated mineral deposits and aggregations of organisms, like cold seep clams and mussels, that are relatively hard and/or rough compared to the softer clay-rich seafloor around them. Finally, some seeps have gas bubbles and oil droplets migrating through the water column to form bubble plumes and oil slicks on the sea surface.

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The seafloor morphology and character (hardness and roughness) of the seafloor, water column anomalies, and subsurface indicators of hardgrounds and shallow gas, are primarily detected through their acoustically-reflective geophysical signatures in remotely-sensed datasets. Interpreting these geomorphologic and reflective patterns using multibeam echosounder data (bathymetry, backscatter, and water column) integrated with exploration seismic and subbottom profiler datasets is a fundamental component of seep hunting and geochemical exploration surveys in frontier regions. Integration of these data sets allow for precise targeting of piston cores near enough to hydrocarbon seeps to collect sediment samples for geochemical analysis. However, many of these seeps can be small or otherwise difficult to discern in the geophysical datasets, especially in deep water, which requires that the data be high-quality and of superior resolution and geologic resolvability to prevent inconclusive or erroneous interpretations.

Multibeam mapping and experienced geological interpretation allow for characterization of seep-related features through analysis of several terrain variables to constrain the geologic controls of seafloor seep distribution on a regional scale. These features then need to be sampled with both good accuracy and good repeatability (precision), usually by means of an armored drop coring system with a well-calibrated USBL for navigation. Seep samples recovered to the vessel through the coring operations need to be sampled properly, with an understanding of the geochemical reactions and physical outgassing that these samples will undergo if not effectively processed and stored, as well as avoiding or at least minimizing the potential variables that can cause contamination to the geochemical signatures.

Since the adoption of this methodology: using high-resolution multibeam mapping, integrated with existing seismic data, interpreted by experienced seep geoscientists, and then sampled with strict protocols to optimize the geochemical signal, the success rates in the surface geochemical exploration programs being conducted has improved by over an order of magnitude, with 10X and greater increases in statistical confidence. This translates directly into tremendous commercial savings and tremendous reduction in the risk footprint of an exploration program.

A regional multibeam dataset would not only provide information on seeping hydrocarbons, but could also be used for hydrographic charting, habitat characterization, proactive environmental baseline studies, interpretation of geotechnical conditions and data for selecting geotechnical samples, and geohazard assessments such as optimal pipeline routing and other infrastructure development. Here we will discuss methods for the utilization of frontier multibeam data for regional studies in general and seep studies in particular.