Using Modern Multibeam Echosounder and 3-D Seismic Data to Unlock the Petroleum System in Frontier Exploration; A Case Study in Offshore Western Black Sea

Mohammad Fallah[1], Garrett A. Mitchell[2], Jamshid J. Gharib[2], Eric Cauquil[3], Gabor C. Tari[1], and Thomas Eder[1]

[1]Upstream E&P, OMV, Vienna, Austria.
[2]FGCI, Fugro, Houston, TX, United States.
[3]TOTAL, Paris, France.

ABSTRACT

Seafloor to near-seafloor geochemical exploration programs are based on the fundamental idea that hydrocarbons migrating upward from deep source rocks and reservoirs can be sampled from seafloor and near-seafloor sediment and analyzed to evaluate exploration potential based on geochemical signatures. Seafloor features interpreted as hydrocarbon seeps and expulsion features are the primary targets for geochemical exploration because they serve as pathways for upwelling fluids that potentially contain these geochemical signatures. Hydrocarbon seeps may be identified using various types of remotely sensed data, such as 2D and 3D seismic, sub-bottom profiler (SBP), and derivatives of MBES data. Investigations of the subsurface, seafloor, and water column in the Han Asparuh Block, offshore Bulgaria in the Black Sea show evidence of hydrocarbon seepage and methane hydrates. Hydrocarbon fluids forming these abundant seeps can be thermogenically-sourced from vertical gas chimneys and deep faults to shallow fluids originating from the recent biogenic input of organic material in Danube river sediments. Multiple bottom simulating reflectors (BSRs) are evident in 2D and 3D seismic datasets and can be traced as laterally-continuous reflectors over the area of study (AOS). Two clearly-defined BSRs delineate the boundary between free gas accumulation and gas hydrate formation in the shallow part of the AOS at 200-350 m below mudline (BML) for the upper BSR and 250-425 m BML for the lower BSR. Geochemical sampling of the seafloor sediments in the Han Asparuh Block show direct evidence for gas hydrates and hydrate-bearing. These areally-extensive BSRs suggest that the gas hydrate has a biogenic origin. Over 100 gas plumes extending into the water column were mapped with high-resolution MBES data within the block in water depths ranging from 90-1,100 m BSL on the shelf edge and slope. Most of these mapped plumes are located along the fault-bounded channels and the axes of ridges where faults underlying these anticlinal ridge crests serve as pathways for hydrocarbon-rich fluids to reach the seafloor. Integration of these geophysical and geochemical datasets provides a framework for understanding and differentiating thermogenic signals from vertical hydrocarbon fluid migration and distribution, from reservoir to seafloor seepage, and eventual midwater dissolution with influence and masking from shallow biogenic gas input.