AAPG Datapages/Search and Discovery Article #90254 ©2016, GEO-2016, 12th Middle East Geosciences Conference & Exhibition, Manama, Bahrain, March 7-10, 2016

Geochemical Approach for Characterizing Shale Formations

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ABSTRACT

Shale formations, usually the source rock for conventional hydrocarbon plays, retain gas within micropores and fissures in addition to gas adsorption on the clay surface, even after the expulsion of hydrocarbon into more permeable reservoir rocks, therefore forming an unconventional reserve of hydrocarbon. However, the potential for generating economically viable hydrocarbon is the prerequisite for shale gas exploration.
Adapting a conventional methodology [i.e., three-dimensional (3D) surface seismic data] to evaluate a shale gas formation fails to provide a comprehensive understanding because exploring shale with a depleted hydrocarbon generating capacity is not economical.
Determining geochemical characteristics [e.g., total organic content (TOC), kerogen type, thermal maturity, biological source input, and palaeodepositional condition] by means of a complete set of laboratory analyses with actual formation rock samples is essential. In the present study, organic-geochemical analysis was performed using rock-eval pyrolysis and gas chromatography/mass spectrometry (GC-MS) method on three shale samples.

Overall, the organic matter of the shale samples can be classified as Type III kerogen with potential to produce gas. Further, detailed aliphatic biomarker investigation of soluble organic matter of the representative shale samples was performed to reveal the biological source input and reconstruct its palaeodepositional (palaeoenvironmental and palaeoclimatic) conditions. The assemblage largely consisted of n-alkanes, acyclic isoprenoids, and C_{29} to C_{32} hopanes, with several hopenes, oleanenes, ursenes, and some des-A-triterpenoids. Overall, the assemblage suggested an angiosperm contribution, with some microbial and pteridophytic input and a terrigenous depositional environment.

Conventional approaches using seismic data are limited to a broad overview of TOC in terms of geochemical characterization. Laboratory testing with actual rock samples, to the contrary, provides detailed information on kerogen type, TOC, thermal maturity and, in turn, hydrocarbon potential.

The present study demonstrates the influence of geochemical characterization for shale exploration. The results obtained from analysis of shale rocks indicate the influence of different geochemical parameters for designing an appropriate exploration method. Therefore, the geochemical approach explained here can help in unconventional, marine, as well as continental shale evaluation.