Predicting the Quality of Petroleums Generated by Lower Paleozoic Source Rocks, MENA Region

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Abstract

The composition of reservoired petroleum is controlled by the physical, chemical and biological processes that have acted on the source-carrier-reservoir system over geological time. Because phase behaviour in carrier systems has been identified as the major control of gas-oil ratio in many of the World's petroleum provinces, we established the PhaseKinetics modelling protocol that can be applied in advance of drilling as part of a risk reduction strategy. It begins with the organofacies concept, which states that kerogen abundance and composition are relatable to depositional settings. Our facies, five in all, are based on potential petroleum type and are determined by open system pyrolysis of kerogens or asphaltenes. Having used this as a secondary screening tool, coming after the usual Rock-Eval primary screening procedure, bulk kinetic parameters are then calculated to determine generation characteristics. Petroleum compositions are then assigned to the activation energy distributions using MSSV pyrolysis, a method whose utility has been proven by regional calibrations, including mass balance modelling studies in Canada and Mexico. The pyrolysis data is essentially ready as it is for direct import into PVT models, except for gas composition which has to be tuned in order to take account of the different radical reactions occurring within gas-forming intermediates in nature versus in the laboratory.

Here we contrast the lateral variability in PhaseKinetics behaviour (GOR, Psat) of Silurian source rocks in Jordan and Libya, with reference to the occurrence of photic zone euxinia during source rock deposition, and its manifestation in GOR values. A contrast is drawn with the Devonian, and illustrated using a 2-D petroleum system model for the Ghadames Basin., as well as the predicted carbon isotopic composition of gases from primary and secondary cracking reactions. The late gas potential of the Silurian is high, because of a high contribution of dry gas precursors inherited from the unusual biota associated with photic zone euxinia, as well as the presence of neoformed entities that are the last vestiges of live carbon at high thermal maturity (Rm > 2%). The formation of dead carbon from live carbon in some Silurian source rocks and its ramifications for petroleum yield calculations is also discussed.