Carbonate Sedimentary Rocks and the Origin of Heavy Crude Oils

Irving A. Breger[1]
U.S. Geological Survey
Reston, Virginia

Questions concerning the origin and constitution of so-called heavy crude oils have multiplied immensely with escalating interest in recovery of these oils. Although defining the term *heavy crude oils* presents a major and as-yet-unsolved problem, substances such as naturally occurring *tars, asphalts,* and *bitumens* are all considered to be expressions of heavy crude oils and are so treated in this presentation. Much evidence indicates that some heavy oils are residues of biodegraded conventional oils or are conventional oils from which the light ends have been stripped. On the other hand, such observations do not readily explain the origin of all heavy oils, among which are those found at great depth where neither biodegradation nor evaporative stripping is a likely mechanism.

The association of vanadium and sulfur with heavy crude oils also suggests that many such oils may have been formed by mechanisms other than those thought to be basic to the origin of conventional oils. In particular, evidence has recently been accumulated to show that carbonate rocks may be source beds for many heavy crude oils and that mechanisms leading to the direct formation of heavy oils are probably unlike those by which conventional oils are formed. Moreover, oil formed in carbonate sequences may have accumulated in source-bed reservoirs if conditions of porosity and permeability were appropriate.

[1]Now deceased.

Recurrent Appearance of Source-Rock Facies in Cretaceous to Eocene Carbonate Series of Tunisia

B. Tissot and R. Pelet
Institut Français du Pétrole
Rueil Malmaison, France

B. B. Furollet and J. L. Oudin
Compagnie Française des Pétroles Total
Paris, France

Oil production in Tunisia is obtained from a carbonate series of mainly shallow-water facies comprising Middle to Upper Cretaceous, Paleocene and Eocene formations interbedded with the reservoirs. Several organic-rich beds with good petroleum potential appear in the series; however, they are of limited geographic extent, which results in poor chronostratigraphic correlation from well to well. The deposition of these beds seems to have depended on the local appearance of anoxic conditions in an otherwise constant environment. The most plausible model, consequently, is a shallow, consistently oxygen-depleted basin with eutrophic planktonic growth in which anoxic conditions could occur in slightly depressed topographic hollows that varied both in place and time.

The character of the organic matter of these beds exhibits features that correspond well with the model suggested. The chloroform extract, rich in NSO (nitrogen, sulfur, and oxygen) compounds and especially in resins, generally shows a strong, even predominant, n-alkane distribution and a high phytane-pristane ratio. In some interesting but uncommon cases this picture is reversed, however. The chemically isolated, chloroform-insoluble fraction, studied by Rock-Eval pyrolysis, exhibits characteristics typical of type II organic matter that originates from marine planktonic remains. All these features show little variation with geologic age. Correspondingly, the oils in the reservoirs are all of similar composition independent of reservoir age. The composition of the oil is compatible with the concept of generation from the organic beds previously considered. Consequently, a single oil type appears to have been generated by distinct source beds corresponding to the recurrent appearance of the same organic facies.