Characteristics of the Biomarkers from Nonmarine Crude Oils in China —— A Review

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Abstract

The present paper deals with the biomarker characteristics of crude oils and source rocks from different environments (fresh, fresh-brackish and salt waters) of nonmarine depositional basins of different ages in China. Their characters are summarized as follows: 1) Source rocks and crude oils derived from fresh-water lacustrine facies have an odd/even predominance of n-alkanes and high pristane/phytane ratios. Oils from the fresh-water lacustrine facies differ from typical marine oils in the relative contents of total steranes and terpanes, the concentrations of hopanes and organic sulphur compounds and the values of methylphenanthrene indices and C,H,S stable isotopes. 2) The source rocks and crude oils derived from saline lacustrine facies possess an even/odd predominance of n-alkanes and high phytane/pristane ratios. There are also some differences between saline lacustrine oils and freshwater lacustrine oils in the concentrations of steranes, tricyclic terpanes and organic sulphur compounds, as well as in the values of methylphenanthrene indices and C,H,S stable isotopes. 3) Oils derived from fresh-brackish water lake facies differ from oils from fresh-water lacustrine or saline lacustrine environments in respect of some biomarkers. According to the various distributions of these biomarkers, a number of geochemical parameters can be applied synthetically to differentiating and identifying the nature of original depositional environments of crude oils and source rocks and that of organisms —— primary source materials present in those environments.

Introduction

Mesozoic and Cenozoic nonmarine sedimentary basins are well developed in China and they are noted for vast distribution and a long development history. During the geological history, different climates and various depositional environments provide the grounds for the formation of oils and source rocks in these basins. Therefore, these nonmarine basins present exceptionally good opportunities to investigate systematically the characteristics of biomarkers of nonmarine crude oils. For comparison, some typical marine crude oils were selected from some other countries such as America, Indonesea, etc.

Since 1981 the authors have published some papers on biomarkers as indicators of depositional environments, which have attracted increasing attention of many scientists and contributed to the development in this field. Therefore, the classification of source rocks and crude oils as well as the analytical methods concerned (Fan Pu et al., 1980, 1985, 1988; Fan Pu, 1988) are not described again in detail here. The present paper focuses on the biomarker characteristics of crude oils and source rocks from different environments of nonmarine depositional basins in China (Mello et al., 1988).

Characteristics of Normal Alkanes and Isoprenoids

Source rocks and crude oils from saline lacustrine facies show an even/odd
predominance (EOP) of \( n \)-alkanes and high phytane/pristane ratios (Fig. 1). The EOP values of \( n \)-alkanes are apparently higher within the \( n\text{-C}_{22} - C_{30} \) range, varying from 1.01 to 2.18. Evidently, in saline sedimentary basins, rapid deposition and strong reducing environments promoted the hydrogenation of bacterial monomers (Chappe et al., 1980), waxy esters, alcohols and fatty acids (\( C_{20} - C_{30} \)). \( \text{H}_2\text{S} \) in sediments is the source of hydrogen involved in hydrogenation

Fig. 1. GC chromatograms of saturated hydrocarbons in Eocene saline crude oils from the Jianghan Basin at different depths.
1. Pristane; 2. Phytane.