Geochemical Characterization of Families of Lacustrine Oils in Recôncavo Basin, Brazil
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Abstract

The aim of this study was to perform the geochemical characterization of a representative group of oils from the Recôncavo Basin, Brazil. The lacustrine oils in this basin share similar geochemical features, so their grouping in families was based on a thorough study of their molecular parameters. Three major oil families were recognized, as well as few minor groups. The main geochemical characteristics of each oil group were identified and their geographic and stratigraphic distributions examined.

Keywords:
Recôncavo Basin, lacustrine oils, gas chromatography, biomarkers, oil groups

Introduction

The Recôncavo Basin covers an area of approximately 11,500 km² in the state of Bahia, in northeastern Brazil. The formation of the basin is related to the rifting process that led to the breakup of the Gondwana continent in the Early Cretaceous (Neocomian). The basin has the shape of a half graben, with regional dip towards its eastern depocenters (Figueiredo et al., 1994). During its pre-rift phase (Late Jurassic), eolian, fluvial, deltaic and lacustrine sediments were deposited in a continental setting. An assymetric rift valley was developed during the rift phase (Neocomian), when a heterogeneous fluvial and lacustrine sedimentation took place in an environment characterized by deep lakes (Netto & Oliveira, 1985). The source rocks of the oils in the Recôncavo Basin are the shales of the Candeias Fm. (Tauá and Gomo members) deposited in lacustrine fresh to brackish water environments (Gaglianone & Trindade, 1988). These oils are paraffinic (percentages of saturates between 48 and 84%), with low contents in resins and asphaltenes (7 to 34%), and API gravities ranging from 17 to 40°.

Methodology

Two hundred oil samples were selected from 47 fields in the Recôncavo Basin. Whole-oil samples were analyzed by gas chromatography. Saturates, aromatics and polar compounds were separated by medium pressure liquid chromatography (MPLC). The saturates fraction was analyzed by gas chromatography coupled to mass spectrometry to obtain the m/z 191 and 217 fragmentograms (terpanes and steranes, respectively). API gravities and the carbon isotopic compositions were also measured for the whole oils.
Results and Discussion

The geochemical characteristics of the oil samples suggest an origin from source rocks deposited in a lacustrine environment. Such an origin is evidenced by carbon isotopic values from -32.1 to -27.6‰, and features in the gas chromatograms such as an abundance of paraffins of high molecular weight (n-C_{25} to n-C_{33}), and a predominance of pristane over phytane. Among biomarkers, one can observe a high proportion of hopanes compared to steranes (hopanes/steranes > 9), Ts>Tm, low to medium gammacerane index (<0.4), C_{34}>C_{35} homohopanes, tricyclics/pentacyclics <0.3. C_{28} steranes are low compared to their C_{27} and C_{29} counterparts, and C_{30} steranes are lacking. With a few exceptions, oils do not present evidences of biodegradation.

Among the 200 oil samples, 163 belong to three major oil families, henceforth named groups 1, 2 and 3. Mass chromatograms m/z 191 and 217 of representative samples from each of the three major oil families can be seen in Fig.1.

The steranes configuration was the principal criterium for the differentiation of the oil families (m/z 217 fragmentograms in Fig.1). Maturation levels are quite distinct in the oils. Oils of group 1 are characterized by a low relative concentration of rearranged steranes (diasteranes) and a predominance of C_{29} steranes. A group of samples pertained to the group 1 from a particular oilfield have a high level of thermal maturity, as indicated by the low concentrations of steranes, high tricyclics/pentacyclics ratios, abundance of extended tricyclics and higher gammacerane index. In the group 2 oils, diasteranes are relatively more abundant, and C_{27\alpha\alpha R} and C_{29\alpha\alpha S} are the most common isomers. A low relative concentration of diasteranes, a predominance of C_{27\alpha\alpha R} and C_{29\alpha\alpha R} among steranes, and a low abundance of αββ steranes compared to their ααα counterparts are the main features of the group 3 oils. Whereas hopanes are not particularly useful for grouping, group 3 oils stand out for their higher gammacerane indices and for their greater abundance of normal and extended tricyclics.

High API gravities (25-42^0) and tricyclics/pentacyclics ratios suggest that the group 3 oils are very mature. However, steranes isomerization ratios (C_{29αββ}/(ααα+βββ) andC_{29S}/(S+R)) indicate a low thermal evolution. This inconsistency might be due to a contamination of a highly mature oil with low concentrations of biomarkers by bitumen. The incorporation of biomarkers from bitumen or from a relatively less mature oil could occur during secondary migration or, most probably, from contamination of reservoired oils by surrounding potential source rocks.

Samples from groups 1 and 3 encompass several oilfields spread throughout the basin. Most reservoirs are found in rocks of the pre-rift or early syn-rift sequences. On the other hand, oils from group 2 are mostly located in oilfields in the northeastern compartment of the basin in early syn-rift reservoirs.

Conclusion

The integration of organic geochemical data from liquid and gas chromatography, gas chromatography coupled to mass spectrometry and stable carbon isotopic determinations allowed the identification of three major families of lacustrine oils in the Recôncavo Basin. However, oil groups are differentiated basically by their steranes fingerprints. The group 1 oils have low concentrations of diasteranes and a predominance of C_{29} steranes; it comprises 134 oils, with 38 presenting higher thermal evolution. The
group 2 oils show higher relative abundances of diasteranes and a predominance of C_{27}αR and C_{29}αS steranes. The group 3 oils are characterized by low concentrations of diasteranes and a predominance of C_{27}αR and C_{29}αR steranes. The inconsistency between high API gravities and steranes maturity parameters indicative of low thermal evolution in group 3 oils is probably due to a contamination by bitumen. Source-rock extracts will be analyzed in order to verify whether the oil compositional differences are linked to lateral variations in organic facies of the Tauá and Gomo members (Candeias Fm.) or to distinct geochemical features observed vertically along the source-rock sequences.

References


Fig 1: Mass chromatograms m/z 191 (hopanes) and m/z 217 (steranes) of families of lacustrine oils in the Recôncavo Basin: (a) group 1, (b) group 2, (c) group 3.