Origin and maturity of crude oils and oil seeps from Falcón Basin, Western Venezuela

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Introduction

Falcón Basin is a secondary oil and gas basin in Venezuela (Figure 1). Recent discoveries of excellent quality crude oil offshore Falcón, have reactivated the exploration and the interest for the basin; therefore a better understanding of the active petroleum systems is necessary.

Numerous studies have taken place in the basin with the main goal of characterizing crude oils and oil seeps. However, many of them have focused on analyzing individual samples or making correlations with a limited amount of data. The differences of this work from the others is that a regional scale study was applied in order to show the family distribution of crude oils in the basin and obtain the characteristics of the possible source rocks; therefore the main goal of this work was to compile all the existing geochemical information related to crude oils and oil seeps in the basin and carry out an oil-oil correlation study. That way similarities and differences among these oils could be established and their origin and level of maturity determined.

Experimental

Information from 24 crude oils and 63 oil seeps was collected. The available analyses were API gravity (19), SARA composition (78), %S (52), V/Ni (26), GC (25), GCMS (69) and isotopes (14). This information was used for oil-oil correlation and compared with information from Maracaibo’s Basin crude oils. Results were represented in graphic, tables and classification maps according to correlation parameters.

Results and discussions

Falcón Basin’s crude oils are characterized for having an API gravity between 25° and 55°. The sulfur content is low (<0.5%). Oils can be classified as paraffinic, and oil seeps are paraffinic-naphthenic product of alteration by microorganisms.

Vanadium (V)/ Nickel (Ni) and Pristane (Pr)/ Phytane (Ph) correlations allowed differentiating crude oils and oil seeps according to the depositional conditions of the source rock. Important differences were identified amongst the available information. These dissimilarities suggest that, there is more than one source rock in Falcón Basin. Figure 2 shows the relation Pr/Ph vs. Dibenzothiophene (DBT)/ Phenanthrene (PHEN) (Hughes et al., 1995) where a group of crude oils originated from a fluvial/deltaic source rock is observed followed by other group derived from a siliciclastic marine source rock. Maracaibo’s Basin oils are located in the zone of anoxic- euxinic conditions associated to marine carbonate and lacustrine source rocks.

Figure 3 shows the spatial distribution of the redox conditions of the sedimentary environment were source rock was deposited, according to the crude oils and oil seeps studied. To the North of the basin, crude oils are associated to a source rock deposited in a disoxic sedimentary environment. Another group is related to a source rock deposited in a suboxic-anoxic sedimentary environment at the northeast and west of the basin. Finally a third group was evidenced associated to a source rock deposited in an anoxic environment in the Agua Salada Sub-Basin at the Southeastern part of Falcón.

Figure 2. Pr/Ph vs. DBT/PHEN for crude oils from Falcón and Maracaibo Basin.

Another parameters used like n-alkane distribution, oleanane index, steranes distribution and isotopes suggest that some crude oils and oil seeps were generated from a type III kerogen, others from a type II-III kerogen and southeast crude oils from a type II kerogen. A similar distribution as Figure 3 was acquired for source rock kerogen type.
Conclusions

Based on the available information the existence of more than one source rock for Falcón Basin’s crude oils and oil seeps is evident. Six crude oil families were identified. A1 and A2 generated by a type III kerogen fluvial-deltaic source rock differentiating each other in the maturity level. B1 and B2 families generated by a type II-III marine siliciclastic source rock also with maturity level differences. Finally C1 and C2 families originated by a type II marine anoxic source rock with differences in the maturity level being the first generated at early oil window and the second at the oil peak (similar for the other families).

References
