OG01

Hydrocarbon Generation Potential in The Talara Basin, Peru

Liliana López, Sandra Casado, Johnatan Soto and Salvador Lo Mónaco

Instituto de Ciencias de la Tierra. Facultad de Ciencias. Universidad Central de Venezuela

liliana.lopez@ciens.ucv.ve

Copyright 2014, ALAGO.

This paper was selected for presentation by an ALAGO Scientific Committee following review of information contained in an abstract submitted by the author(s).

Introduction

The Talara Basin is located in the NW coast of Peru and includes sedimentary sequences containing rocks from the Paleozoic to the Tertiary ages. The Muerto (COT = 1.0-4.5%) and Redondo (COT < 1.0%) formations from the Cretaceous age, which contain kerogen type II and II-III, have been considered as possible source rocks (Martínez et al., 2005). Moreover, the Heath Formation from the Tertiary (Oligocene) age, which is characterized by the presence of high input of terrigenous organic matter, was also proposed as a possible source rock (Fildani et al., 2005). Although these studies indicated the high potential for hydrocarbon generation in the Talara Basin, it is necessary to further identify the possible source rocks through a detailed evaluation of oil-oil and oil-source rock correlations of different stratigraphic sequences, in addition to establishing the petroleum systems. Here, we present the study of drilling cuttings samples extracted at different depths from four wells in the Talara basin for source rock evaluation and determination of the depth intervals with potential for hydrocarbon generation. The potential of the samples as source rocks was determined through the evaluation of lithology, organic matter type, depositional redox environment, thermal maturity level, and hydrocarbon-generating potential, using a combined suite of rock analyses: (1) mineralogical composition, (2) total organic carbon content, (3) bitumen concentration, (4) SARA (saturated, aromatic, resins and asphaltenes) composition in bitumen extracts, (5) biomarkers in saturated hydrocarbon fractions, (6) aromatic markers in aromatic hydrocarbon fractions, (7) rock-eval pyrolysis, and (8) trace elements (e.g., V and Ni).

Experimental

Forty two drilling cuttings samples from four wells (LA, CO, OL and ZA) from the Talara Basin (Peru) were analyzed. The total carbon (TC) contents were determined using a carbon analyzer (LECO, C-144). The inorganic carbon or carbonatic carbon contents were measured using the Bernard calcimeter method and total organic matter (TOC) was determined by difference. Kerogen type and maturity level were determined on a standard Rock-Eval-6 following basic methods for whole rock analysis. For ten selected samples, mineralogical composition was determined by means of X-ray diffraction (Siemens XD-8 Advance) and sulfur content, vanadium and nickel concentrations by inductively coupled plasma atomic emission spectroscopy (ICP-AES). Bitumen was extracted with dichloromethane in a Soxhlet extractor, and then quantified. In the bitumen extract, after asphaltene precipitation, the malten fraction was separated into its saturated, aromatic and resin fractions by means of adsorption chromatography, using alumina as the stationary phase. The saturated hydrocarbon fractions were eluted with n-hexane, the aromatic hydrocarbon fractions with toluene, and the resin fractions with a toluene:methanol mixture. Detailed analyses of the saturated and aromatic biomarkers were performed by gas chromatography-mass spectrometry (GC-MS) coupling a network gas chromatograph (Model 6890N, Agilent Technologies) to a mass spectrometer (Model 5975, Agilent Technologies). In this case, the GC system was equipped with a type DB-1 or a type DB-5 fused silica capillary column (60 m x 0.25 mm x 0.25 μm) to analyze the saturated and aromatic fractions respectively. The monitored ions were: m/z = 113, 191, 177, 217, 218 for n-alkanes and acyclic isoprenoids (pristane and phytane) terpanes, steranes and diasteranes; m/z = 178, 192, 184, and 198 for phenanthrene, methylphenanthrenes, dibenzothiophene and methyl dibenzothiophenes, respectively.

Results and Discussion

All the samples presented TOC contents in the range 0.9-2.9%, reaching TOC contents > 5% only in a few cases. Lateral and vertical variations in the TOC contents were observed, where the LA and OL wells presented TOC contents in the order of 6% whereas the TOC contents in the CO andZA wells reached maximum values of 2%. This result indicates the wide variability of the organic matter input of the basin. Samples with TOC content ≥ 1% can be considered good source rocks, and those with TOC content > 4% are considered excellent source rocks. The TOC content values obtained suggest that the samples are potentially good source rocks. On the other hand, the samples are characterized by the presence of kerogen type II and II-III, with Tmax value in the range of 443-440°C indicating that these samples are early mature to onset of oil window maturity. The bitumen concentrations in the samples are distributed within a wide range from 300 to 4000 ppm. The hydrocarbon/resin ratios as determined from the SARA compositions are close to 1. Figure 1 shows a typical example of a mass chromatogram for n-alkanes and acyclic isoprenoids (Pr = pristane and Ph = phytane), terpanes and steranes. All analyzed the samples presented Pr/Ph in the range from ≤ 1.0 to 1.9, the high pristane/phytane ratio and plot pristane/n-C17 vs phytane/n-C18 indicate that these source rock contain mixed terrigenous and marine type II-III and terrigenous type III organic matter deposited under suboxic to oxic conditions (Figure 2). Additionally, in homohopanes distribution (C35 < C34), is, typical of suboxic to oxic conditions during source rock deposition. The correlation between dibenzo thiophene/phenanthrene and Pr/Ph ratios suggests that the samples come from marine shale. On the other hand, the regular steranes distributions and the abundance of C27 steranes relative to C29 steranes, as well as the presence of for tricyclic terpanes, suggest a contribution of marine organic matter input. In addition, the presence of 18β(H)-oleanane in some intervals, indicates the presence of oxic conditions during the sedimentation of source rocks from the Cretaceous to the Tertiary ages. The relationship between steranes and C27-diasteranes [C27-diasteranes/(C27-diasteranes+steranes)] suggests the presence of siliclastic lithology...
in the samples, where the main mineralogical phases are calcite, quartz, kaolinite, illite, montmorillonite, plagioclase, and traces of pyrite minerals. Both montmorillonite and illite could be responsible for catalyzing the conversion of steranes to diasterenes (with a rearranged structure), which are then reduced to diasteranes. Thus, in agreement with our findings, oils from clastic source rocks tend to be rich in diasteranes. The concentrations of V (187-3840 ppm) are higher than those of Ni (40-246 ppm), and the values of the V/(V + Ni) ratio are in the range of 0.7-0.9. Sulfur contents are in the range of 0.7 to 1.5%. These results are typical of sedimentation under suboxic conditions with low availability of S.

Conclusions
The core rock samples were identified as possible source rocks with the following overall characteristics: (a) siliclastic lithology, (b) mixed marine-terrigenous organic matter (type II-III kerogen), (c) marine shale depositional environments with suboxic to oxic conditions, (d) early mature to onset of oil window maturity, and (e) regular to very good generating potential.

Acknowledgements
This work was funded by the Consejo de Desarrollo Científico y Humanístico, Universidad Central de Venezuela, under the research grant N° PG-03-8204-2011 and Fondo Nacional para la Ciencia y Tecnología, under the research grant N° 201202299. We thank the Laboratory ChemiConsult of Venezuela for donating the drilling cuttings samples from the Talara Basin. References
