Investigating a Cambrian-Ordovician source rock in the Parnaíba Basin, Brazil

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Introduction

The hydrocarbon generation in the Parnaíba Basin, located at the northeastern of Brazil, is well known as an atypical petroleum system, which consists in the intrusion of basic igneous rocks inside the rich organic matter shale of the Pimenteiras Formation (Devonian), as like others Paleozoic sedimentary basins in Brazil, such as Amazonas, Solimões and Paraná basins. In the Parnaíba Basin it is so long recognized the presence of the pre-Silurian sedimentary packages, which are inside in several graben structures aligned with the Transbrasiliano Lineament (northeastern-southwestern). Those pre-Silurian sediments were already described and cored in several oil wells drilled by PETROBRAS in Parnaíba Basin, they were named as Riachão Formation (Cambrian to Ordovician) and Mirador Formation (Late Proterozoic). In the basement at northeastern portion of the Parnaíba Basin outcrops several Early Paleozoic grabens structures, being the most expressive the Jaibaras Graben. As like as the grabens under the Parnaíba Basin, those outcropping grabens are either aligned with Transbrasiliano Lineament (Figure 1).

Those grabens are interpreted as an Early Paleozoic rift stage2, preceding the intracratonic sedimentary depositional phase of the Parnaíba Basin. In the Jaibaras Graben, the Cambrian-Ordovician sedimentary package is named as Jaibaras Group, subdivided in three formations: Massapê, Pacujá and Aprazível. There are several citations in the bibliography about the occurrence of dark shale in the Pacujá Formation 3,4. In such way, in this research were collected some sample of the dark shale of Pacujá Formation near Santana do Acaaru City (northwestern of the Ceará State), to evaluate its generation potential. These samples were submitted to organic geochemistry and mineralogical analyzes.

Experimental

Six collected outcrop samples from Pacujá Formation were all crushed and pulverized. To geochemistry analysis, they were submitted to extraction with a dichloromethane solvent using the Soxhlet system. Then, the extracts from the rock samples were fractioned into saturates, aromatics, and polar compounds by successive elution with hexane, hexane/dichloromethane (8:2, v/v), and dichloromethane/Methanol (9:1, v/v) on silica gel columns, respectively. The saturate hydrocarbon fraction was analyzed by Gas Chromatography/Mass Spectrometry (GC/MS). TOC analyses were made in the Geochemistry Lab of the Stratigraphy and Paleontology Department of UERJ. Equipment: LECO SC – 444 Carbon Sulphur Analyzer.

For mineralogical analysis, the pulverized rock was reduced to 0,53 mm (280 Tyler series). Then, was made a tablet with 2,5g of the sample and analyzed in a equipment D2 Phaser (Bruker) with configuration 2Theta (Couple Two Theta/Theta) Wl=1,54060.

Results and Discussion

The TOC values were very low, reaching the maximum value at 0,23%. This low value is attributed to the heat from basic igneous intrusive rocks of the Parapuí Suite inside Pacujá Formation or from de Meruoca granite. In the GC/MS analysis were identified n-Alkanes (C17 to C33), revealing there was a thermal maturation for liquid hydrocarbon generation and suggesting a good quality organic matter (Figure 2).

Figure 2 - Mass chromatograms (m/z 85 and 191) of saturated hydrocarbons in a outcrop sample from Pacujá Formation. nC17 to nC33 = n-Alkanes; Tri23 = C23 Tricyclic terpanes; C31-C35 = Homohopanes; G = Gammacerane.
Gammacerane is present, which is an indicator of the depositional paleo-environment salinity. The S/R ratio Homohopanes (C31 to C35) shows a good level organic matter thermal maturity. The relative abundance of the Tricyclic Terpanes over Pentacyclics Terpanes characterizes algalic organic matter from Cambrian-Ordovician. In the mineralogical analysis was identified the garronite, a mineral of the zeolite group, which suggest a very low grade of metamorphism.

Conclusions
The samples of the Pacujá Formation collected around Santana do Acaraú City are in a senile stage of maturity, because of the very low grade of metamorphism caused by coeval igneous rocks intrusions. But the good quality of the bitumen extract can put some good expectative about the possibility to have a good generation potential inside the grabens subjacent to the Silurian-Devonian sedimentary package of the Parnaiba Basin.

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References


