Geochemical evaluation of oil migration in Stromatolites Samples: influence of water formation salinity

Rafael C. Pachecoa*/ Eliane S. DeSouzaa/ LeonamBragaa

PETROLEUM ENGINEERING AND EXPLORATION LABORATORY (LENEP/UENF), MACAÉ, BRAZIL.

costinharaael@hotmail.com

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 compositional fractionation of petroleum accompanying the migration process can be potentially used to infer distances petroleum may have travelled and the ratio of oil in the reservoir to that lost in the carrier beds1. Several researches have examined the interaction oil components, mineral surfaces in reservoir rocks2 and the salinity of formation water that can have influence on wettability and oil recovery3. Therefore, the purpose of this study was to investigate the distribution of petroleum compounds during the migration in recent analogues of Albian carbonate rocks of the Brazilian pre- salt stromatolites, and to highlight the effect of the salinity level of synthetic formation water during the compositional fractionation.

Experimental
Initially, it was realized a mineralogical characterization of stromatolites samples through X-ray diffraction. They were saturated with synthetic formation waters of different salinities: W1- 143 g/L and W2- 286 g/L (post and pre-salt Brazilian water formation, respectively). The migration process was performed by gravitational ascension, in duplicates. It was used API gravity of 26° oil and four rocks samples saturated with different types of formation water, W1 and W2. After 60 days of migration in carbonate rock samples, at room condition, the four stromatolites samples were divided into 3 parts (Bottom, Middle and Top), and the oils were removed by a Soxhlet extractor. Each extracted sample (free Oil) was fractionated by liquid chromatography to obtain saturated and aromatic hydrocarbons. The fractions were analyzed by Gas chromatography/ mass spectrometry, to investigate the oil compositional fractionation through n-alkanes (m/z 85), polycyclic terpanes (m/z 191), steranes (m/z 217) and methyl-phenanthrenes (m/z 192), as result of salinity level influence.

Results and Discussion
The result of stromatolite mineral characterization was Magnesian Calcite, Quartz and Aragonite, respectively, 95.9%, 3.0% and 2.6% in the Top; 86.0%, 8.9% and 5.1% in the Middle; and 70.3%, 20.1% and 9.6% in the Bottom.

It was observed the compositional fractionation of the n-alkanes, when it content decreased from Bottom to the Top. Moreover, the n-alkanes content in the free oil of the subunits (Bottom, Middle and Top) saturated with synthetic formation water W1 was higher than obtained from stromatolites subunits saturated with synthetic formation water W2 (Figure 1).

Figure 1: Compositional fractionation of n-alkanes through simulated migration in stromatolites samples.

It was detected changes in the values of phytane/n-C18 along the carrier bed, as consequence of the preferential migration of phytane with respect to n-C18. Moreover, the ratio C21S/ (C21 + ΣC29)S increased, about 50%, along carrier bed independently of formation water salinity level (Table 1).

The steranes ratios, C27DIA/C27S and αββ/(ααα+αββ), have been recognized as sensitive indicators for oil migration, based on field observation for PAN et al. (2005) and SEIFERT & MOLDOWAN (1981). However, in this present research in carbonates rock these ratios did not demonstrate the compositional fractionation of oil during simulated migration (Table 1).

Table 1: Saturated and Aromatic hydrocarbons ratios.
According PAN et al. (2005), the selective adsorption oil components on clay minerals in sandstones reservoir could also induce the variations of the (C23TTR+C30H)/C23-TTR. However, in the results obtained in this present research in carbonates rocks didn’t show variations in this ratio during simulated migration independently of the salinity level of formation water (Table 1).

During the simulated migration, the effect of salinity of the formation water could be observed through the ration-C17/2-MP (Table 1). This ratio showed lower variations along the carrier bed saturated with synthetic formation water W2 when compared with subunits stromatolites saturated with synthetic formation water W1. Thus, it might have occurred the preferential migration of 2-MP when compared to n-C17 and the decreasing the interaction of 2-MP with minerals surface and synthetic formation water (W2, of more salinity), principally.

Conclusions
The study of geochemical tracers to migration monitoring showed a slight compositional fractionation of the oil during the simulated migration as was observed in the behavior of n-alkanes and ratios: phytane/n-C18, C21S/(C21 + ΣC29) Sand n-C17/2-MP.

The ratios C27DIA/C27S, αββ/(ααα + αββ) S and (C23TTR+C30H)/C23-TTR couldn’t be recognized as sensitive indicators for oil migration in this present research. Moreover, these ratios weren’t affected by the salinity level of formation water.

The salinity of formation water can have proportionated different water films (W1 and W2) on the rock. This can have caused different interactions with oil compounds, influencing mainly the migration of 2- methyl phenanthrene.

Acknowledgements
The authors thank Petroleum Engineering and Exploration Laboratory (LENEP/UENF), CAPES, FAPERJ, PETROBRAS/REDE DE GEOQUÍMICAAand Agência Nacional do Petróleo (ANP) for the fellowships and financial support.

References