ESI(-) FT-ICR-MS ANALYSES OF BRAZILIAN OFFSHORE OILS

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Introduction

The Campos and Santos Basins are part of a series of basins formed along the Brazilian Atlantic margin during the breakup of Gondwana in Early Cretaceous times. This passive margin environment experienced an Early Cretaceous rift phase followed by a thermal subsidence phase during which the main pre-salt reservoirs were deposited (Early to Late Aptian). The Campos Basin has long accounted as largest reserves of Brazil in Late Cretaceous and Tertiary post-salt reservoirs.

Biomarker analyses reveal that the two oils from the Campos Basin are derived from lacustrine and marine, clay-rich source rocks. The oil sample from Santos Basin is clearly of only lacustrine origin.

Geochemical signals like 25-norhopanes suggest that one of the oil samples from Campos Basin (Campos 1) has been affected by biodegradation, which can only be explained with paleo-biodegradation before the reservoir reached temperatures above 80ºC.

In addition to biomarker analyses the three oil samples were measured using a Fourier Transform Ion Cyclotron Resonance Mass Spectrometer (FT-ICR MS) coupled to an electrospray source run in negative ion mode to gain additional information on NSO compounds, whose molecular weight and polarity exceeds the range covered by GC-MS. The focus here is set on the abundance and structure of target compounds, namely the saturated, unsaturated and aromatic acids, unsaturated and aromatic alcohols, carbazoles, and hybrids. The distribution of elemental and compound classes as well as double bond equivalent (DBE) and carbon number distributions are described in detail broadening our understanding of the organic inventory and allowing us to determine differences in facies, maturity and level of biodegradation in the oil samples.

Results

Compound class distribution assessment of the three oils reveals that the Santos 1 oil (API 30.4) is dominated by N_1 compounds. The second most abundant class is the O_1 class. Campos 1 oil (API 43.5) is dominated by N_1, O_1, and O_2 compounds, whereas Campos 2 oil (API 36-37) shows a comparable compound class distribution to oil Santos 1, i.e. domination of the N_1 class (Figure 1).

Within the N_1 class the proportion of carbazoles (DBE9) to benzocarbazoles (DBE12) and dibenzocarbazoles (DBE15) is used to assess the maturity of the oils. The Santos 1 oil has the lowest maturity with a vitrinite reflectance of ~0.9. The two oils from Campos Basin have a slightly higher maturity of ~0.95 – 1.

Within the O_2 class the carbon number distribution of the DBE1 compounds (saturated fatty acids) displays the strongest even over odd predominance in Santos 1 oil which might be related to microalgae *Botryococcus braunii* indicative for lacustrine environments. In the two oils from Campos Basin this strong even over odd predominance is not prevalent. The reason for this difference might be their higher maturity level and/or domination of marine organic matter input.

The abundance of cyclic acids (O_2 class, DBE 2 and 3) in oil sample Campos 1, which are absent in the other samples, is a subtle indicator for biodegradation underlining the idea of paleo-biodegradation.

Conclusions

- Santos 1 oil has the lowest maturity (Rc ~ 0.9) and reveals a strong even over odd predominance which is assumed to derive from fresh water microalgae underlining the lacustrine character of the oil.
- Campos 1 and 2 oils have a higher maturity (Rc ~ 0.95 – 1).
- Campos 1 oil shows higher O_2 compounds intensities and abundance of cyclic acids compared to the other oils hinting to mild biodegradation or paleo-biodegradation.
- Further compositional differences which might help to distinguish between mixed marine/lacustrine and lacustrine facies could not yet be found using ESI(-) FT-ICR-MS.

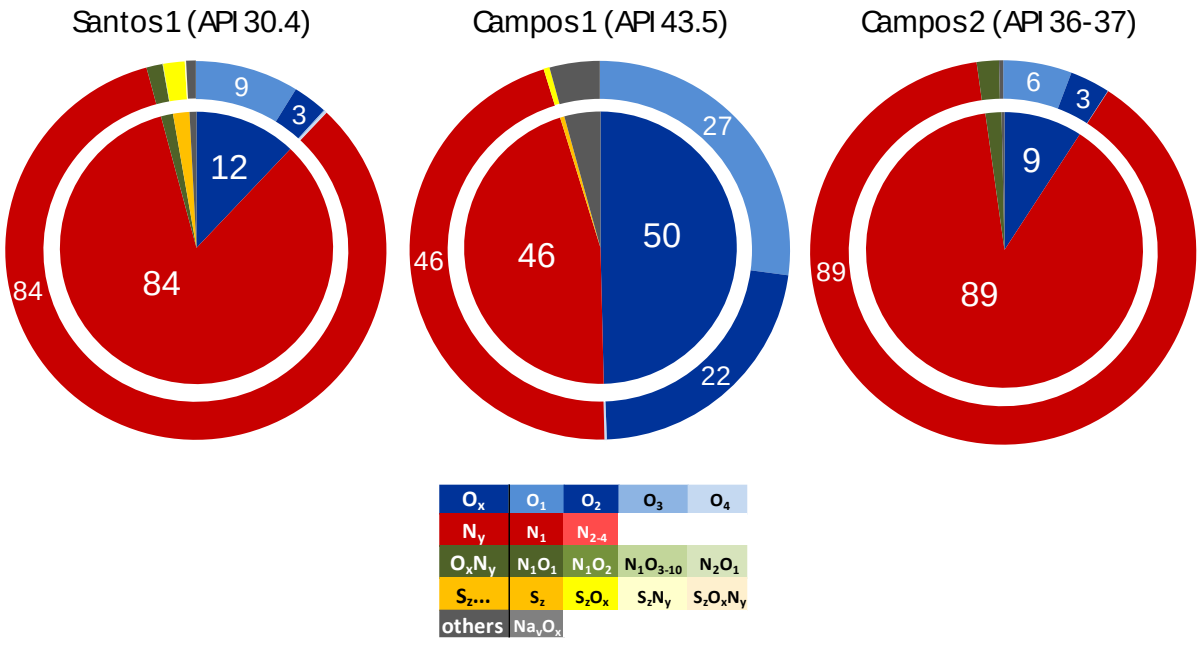

Figure 1 *Elemental and compound class distribution.*