VARIABLE CONTRIBUTIONS OF MANTLE VOLATILES TO THE PETROLEUM SYSTEMS ACROSS THE BRAZILIAN SOUTH ATLANTIC MARGIN

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Introduction

The offshore Brazilian sedimentary basins cover an area of more than 1,550,000 km^2, which is subdivided into Cretaceous-Tertiary basins that border the entire coastline (Figueiredo, 1985). Today, these areas are considered as the most promising petroleum provinces in Brazil. The recent discoveries in deep-water plays far from the coast line have shown an excellent potential of gas and oil for future exploration. However, new challenges arise from exploring deepest reservoirs. It can be exemplified by the presence of gases, *e.g.* CO_2, coming from outside the sedimentary system.

This study aims at characterizing the origin of natural gases and identifying the source(s) and sinks of CO_2 at the basin scale and beyond.

Results

Nineteen samples were collected from exploratory oil wells along the Southern Atlantic Brazilian margin. Analyses of molar and carbon isotopic composition of the hydrocarbons and CO_2 were associated to noble gases isotopes measurements.

The geochemical analyses revealed that the main constituent of the natural gases among the hydrocarbons is methane (90.9–76.5 %). Methane carbon isotopic composition ranges between -48.8 ‰ and -29.0 ‰ PDB suggesting a possible presence of gas mixing of thermogenic and microbial methane. CO_2 ranges from 0.4 % to 82.6 % in relation to the total gas composition. Most of the samples show typical mantle-like gas signatures, with $^3He/^4He$ ratios of 2.73–4.67 R_A, $\delta^{13}C_{CO2}$ values of –8.4 ‰ to –2.8 ‰ PDB and $CO_2/^3He$ ratios of 2.3×10^7 to 3.0×10^9. The other samples have significantly lower $^3He/^4He$ ratios (0.02 – 0.84 R_A), lower $\delta^{13}C_{CO2}$ values (<−19.9 ‰) and $CO_2/^3He$ ratios (1.6×10^8–5.6×10^9). The values of the $CO_2/^3He$ ratio are well correlated with the $^3He/^4He$ ratio and CO_2 abundance.

In the ternary plot of CO_2, ^3He and ^4He relative compositions (after Giggenbach *et al*., 1993) the samples present large variability in He and CO_2 systematics, which supports a large scale fractionation of both compounds from an initial mantle volatile end-member for the majority of the samples (Figure 1). Such fractionation may be related to fluid phase equilibrium and/or interaction with crustal rocks during the gas ascension towards the surface. These models provided important information on both the origins and the dynamic behavior of CO_2 between the source and the accumulations in reservoirs.

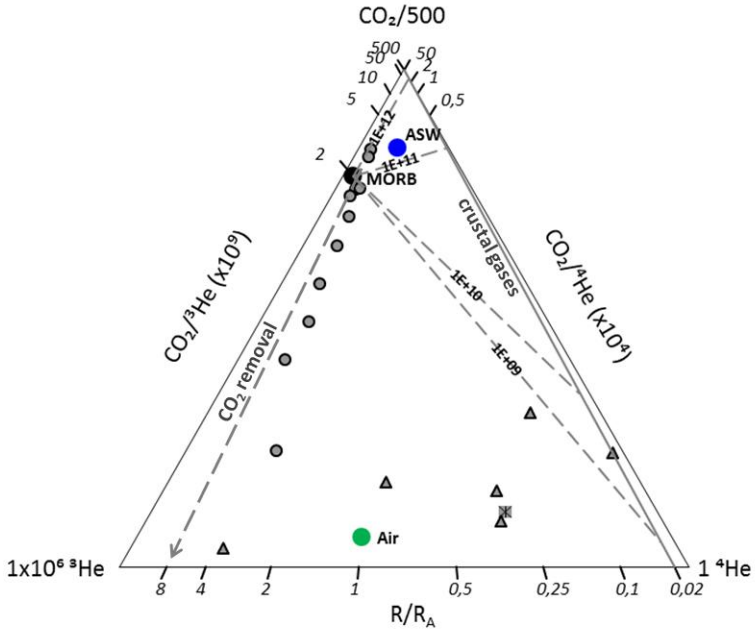

Figure 1 *The CO_2-^{3}He-^{4}He plot generated with HNC-Plot (Karakuş and Aydin, 2016) showing the elemental fractionation effects between He and CO_2. Each symbol represents one sedimentary basin. Air, MORB and Air Saturated Water (ASW) compositions are also represented.*

References

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