Analysis of the Petroleum System of the Marlim field, Campos Basin, with low reflectivity

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Abstract

A Petroleum System (SP) in its description includes the place of accumulation (*pod*) of the active generating rock, the natural distribution network of the hydrocarbon (paths of its migration) and the occurrences of oil discovered, which have a genetic relationship with such a system. The presence of any occurrence of oil is proof that the oilsystem exists. In contrast to the definitions of *play* and prospectus, which define undiscovered commercial accumulations, an SP includes only occurrences of oil already discovered. If an exploratory well finds any type or quantity of oil, such oil is part of an SP (Magoon, 1995). The Campos Basin, the most important in terms of accumulated production, is located on the southeastern margin of Brazil. Exploratory activity in the Campos Basin began around 1958, withseismic reconnaissance surveys and drilling of the first stratigraphic well (2-CST-1-RJ). The traps are of the structural, mixed and stratigraphic types, and changes in the permoporous characteristics and sudden changes in the thickness of the reservoirs are frequent (Peres & Arso, 1986). The Marlim field is located about 110 km east of Cabo de São Tomé, on the north coast of the state of Rio de Janeiro, in the Campos Basin. The area covered by its *ring fence* covers about 257.6 km², distributed in a water depth that varies between 620 and 1050m (P.D.A. ANP, 2016). Accumulations are considered a complex because they have similar stratigraphic and structural characteristics. Once considered one of the fields with the largest amount of in-place oil in the Brazilian territory, the Marlim field is the target of several studies and applications of new technologies to improve the understanding of the field and to increase production. The turbidite system of the Campos Basin was installed during the Lower Oligocene, in which there was a period of relative high sea level and little sediment was made available for deeper waters, according to Peres (1986). As a consequence, Gamboa (1986) postulates that a vast layer of fossilized pelagic layer was established, establishing acarbonate condensed section called the Blue Mark, belonging to the Siri Member. This section constitutes a seismic guide to the Marlim Field deposits. The Blue Landmark presents itself as a disagreement of the Lower Oligocene in the E74 layer of Winter et al. (2007), being of Upper Repelian age (Johansen et al. 2011). The reservoir of the Marlim field consists of turbiditic sandstones of Oligo-Miocene age, covering an area of 132 km² and reaching thicknesses of up to 120 meters. The campis predominantly located in the distal lobe region of the turbiditic system. The work developed from 3D seismic data and well data (i.e. well profiles, trajectories and completion data). Intended to provide the main in put for the work, the seismic volumes were received in optimal condition. Interpretive tasks with seismic data invariably needdata optimization, as they always have noises that contaminate the primary wave response. One of the best knownis seismic conditioning, which involves, in general, the use of filters, whether static, residual or other processes that tend to improve the signal-to-noise ratio in a data. Unlike conditioning, seismic qualification attenuates specific information, related to noise or seismic signals unwanted to the interpreter's objective, seeks to qualify all the magnitudes existing in the volumes

of data, especially those of background. Coherent noises are most destructive to the signal from a geological target when the energy level of the input data is low, or when the targets causing the reflection are small. One can extend the meaning of seismic qualification to include unwanted signals (Santos et al, 2019). The present work aims to applyseismic ification to obtain accurate perceptions of the Petroleum System of the Marlim field. Initially the original 3D cube of the Marlim field, R0255_MARLIM_ALTA_RES_1A_PSDM.3D, was qualified to show layers with low reflectivity being thefuscade by high energy noise. Finally, an acoustic inversion was made to obtain what will be initially called the DHI Cube. The cube of low reflectivity obtained here will be in many moments of the present work referred to as a DHI BR cube (*Direct Hydrocarbons Indicators in low reflectivity*). Such nomenclature is suggested by Santos *et al*., (2022) for these low reflectivity, because it is an effective indicator of all the elements of the petroleum system, acting according to Bortfeld (1961), where part of the seismic response is due to the factor of saturation of fluids and another part to the factor of stiffness of the rocks. According to the definitions proposed by Santos et al. (2019 and 2022), events with low reflectivity magnitude derived from the DHI BR cubes can indicate layers of very low permeability and thus define the presence of sealing rocks.

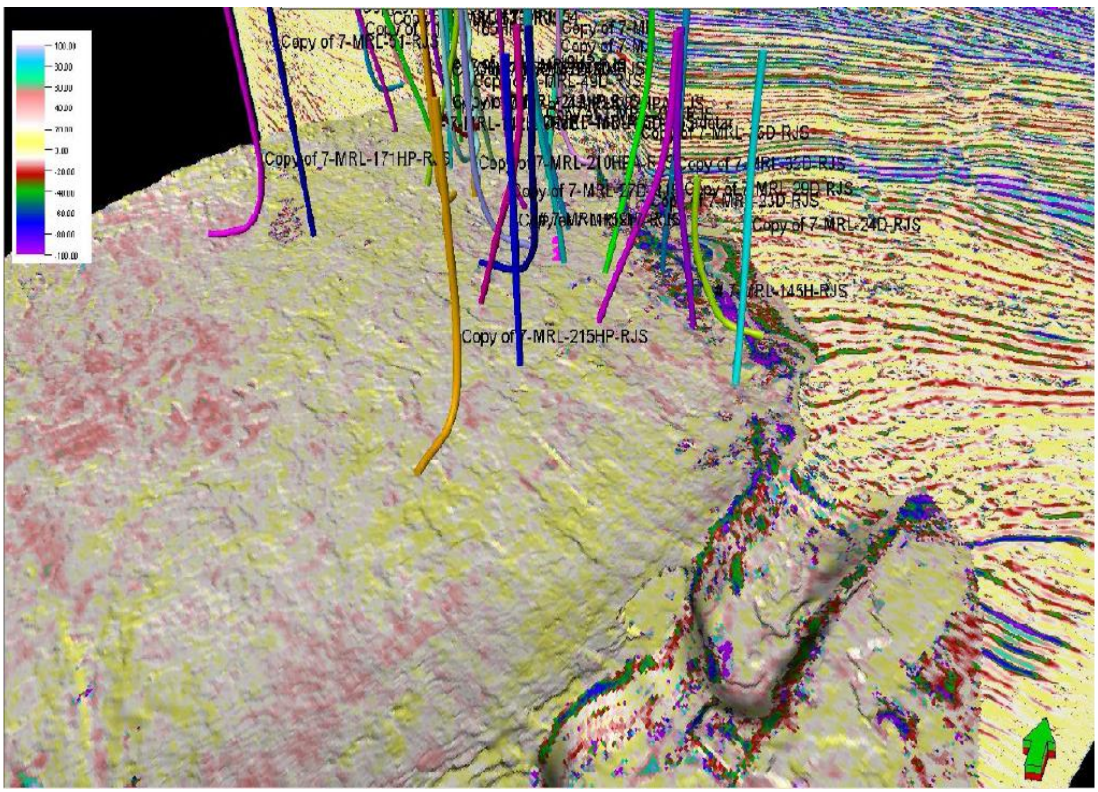

Figure 1: Seismic surface in DHI BR, equivalent to Marco Azul. Important textural homogeneity of the surface, indicating that the sealant is optimal,quite consistent (beige shades). At the eastern edges, erosive processes, in a semi-graben, may have caused the chance of fluid migration at the edges of faults (greenish and blue textures).

Figure 2 illustrates the possible presence of reservoirs suggested in DHI BR data (green to blue tones), and regions of higher concentration in lilac alignments, associable with possible fluid concentrations, in the reservoirs in Marlim.

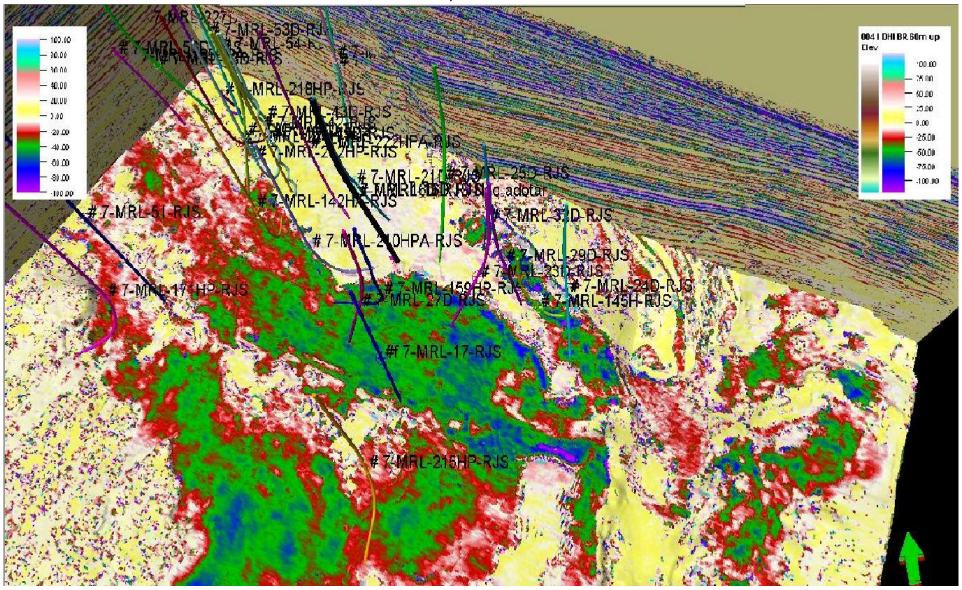

Figure 2: Possible presence of detected reservoirs associated with fluids directly indicated in the Marlim reservoirs. The blue hues suggest higher concentrations of fluids.

Figure 3 shows the excellent discrimination of reflectivity generated by the DHI BR inversion process in textures (bluish green tones) of migration indicators of salt windows where the fluid could migrate through the salt base (a) and the salt top (b).

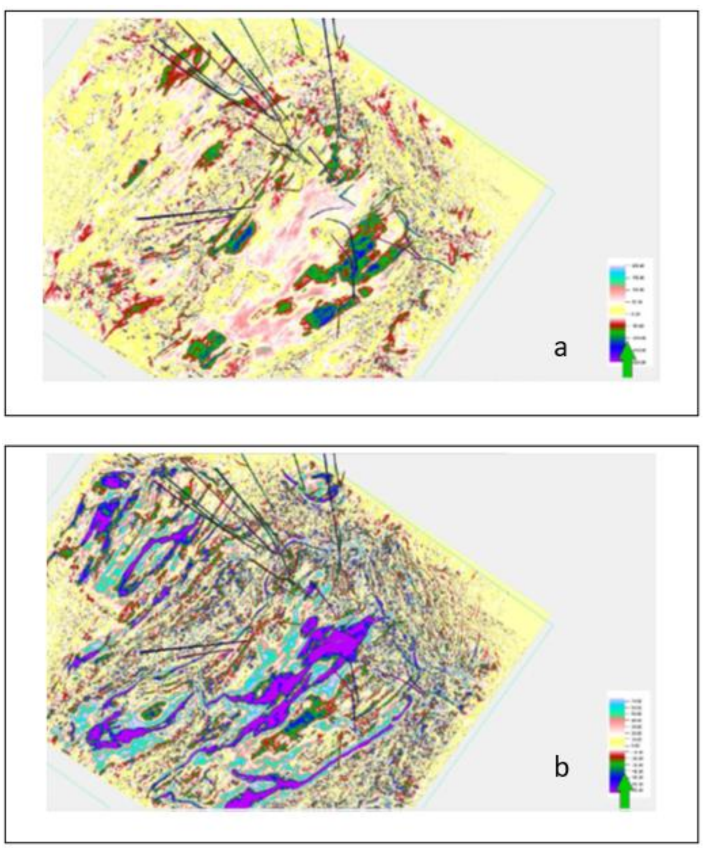

Figure 3: Discrimination of reflectivity generated by the DHI B R inversion processin textures (bluish green tones) of migration indicators of salt windows where the fluid could migrate through the base of the salt (a) and the top of the salt (b).

Conclusion

This work successfully demonstrates the importance of the study of low reflective events and shows theability of similar studies to contribute to the oil industry, being in its exploration phase, for the discovery of new plays, or development, to better understand the Petroleum System and optimize production.

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