Geological and geophysical interpretation of a 3D seismic section in the Ilha da Caçumba Field (Cumuruxatiba Basin, BA)

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Abstract

Seismology is the study of earthquakes and seismic waves that move through and along the ground. The seismic modeling processes are of great importance in oil & gas exploration because through these methods it's possible to help the subsurface "mapping" on prospection of mineral resources as well as a better understanding of the region's geology. There are in the petroleum industry a range of specific software for displaying and interpreting seismic lines such as Petrel® that was used in this work. With this tool, the integration of geological and geophysical data allowed this work through identification and delimitation of several bodies present within the subsurface.

Introduction

Many computational tools are used to study the subsurface geology and engineering. Among them, we highlight the Petrel®, which applies within the field of Geosciences, featuring as one of the main functions to build consistent and realistic geological models.

Within this function, the interpretation of seismic data integrated with geology is shown in a fundamental way through the characterization of the area formations properties under investigation, such as porosity, permeability and fluid saturation. Through this characterization, it can be identified types of lithology, subsurface structures, result of tectonic activity, etc.

In the present work it will be done the visualization, through Petrel®, of a seismic line of the region of Ilha da Caçumba, located in the extreme south of Bahia, Brazil. Along with these seismic data, the analysis of the stratigraphic chart of Cumuruxatiba Basin will be done, which presents a different geological evolution of its neighbors in the period stretching during the Eocene, where it was under the influence of basaltic spills. Figure 1 identifies the location of the study area.

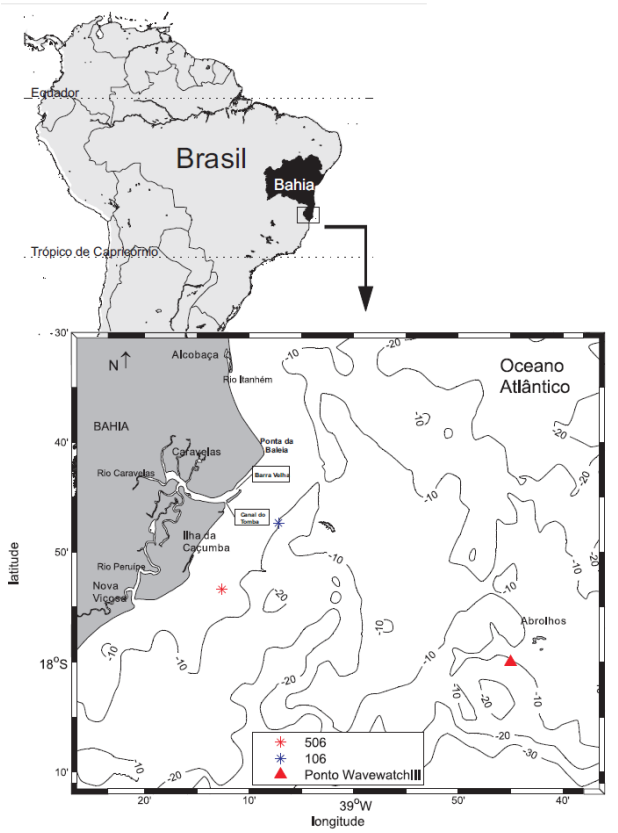

Figure 1: Location of the Ilha da Caçumba Field (modified from Barroso 2009).

Method

For the development of the proposed work, we used a data set belonging to *Petrobras* and *Schlumberger*. This data set work includes: (1) a block of 3D seismic reflection SEGY format, located on the Ilha da Caçumba (2) a well and its logs (3) and a Stratigraphic Charter of the Cumuruxatiba Basin.

The main objective of this study was to correlate the stratigraphic chart with a 3D seismic reflection visualization generated by the software Petrel® (*Schlumberger*), verifying the applicability of the output data of the software in identifying subsurface bodies and structures.

Geological Context of the Cumuruxatiba Basin

It is situated in the extreme south of Bahia state, bordering northwards to the Jequitinhonha Basin by the Royal Charlotte Volcanic Bank, southwards to the Mucuri Basin by the Abrolhos Volcanic Bank and eastwards by the Sulfur Minerva Volcanic Bank. It has an area of approximately 20,500 km², of which about 7,000 km² are on the emerged part, between the cities of Porto Seguro and Alcobaça, and 13,500 km² in the submerged part, to a water depth of 2,000 meters.

The Cumuruxatiba Basin had its tectonic evolution related to the formation of the Neocomian rift, progressing to the opening of the Atlantic Ocean in the Aptian and following the development of a passive margin basin, with similar evolution to its neighboring basins of the eastern brazilian margin. However, the Cumuruxatiba Basin presents a structuration of its stratigraphy, especially in deep water, which it differs from its most distant neighboring basins. At the end of the Paleocene and throughout Eocene the basin was under the influence of basaltic flows and diabase intrusions in its stratigraphic sections.

During this period, the basin was the scene of intense volcanic and tectonic activity, with a very complex lithology association with the presence of igneous rocks, including the interval between 37 and 59 million years, interpreted by Mizusaki (1994) as the period of greatest volcanic activity recognized in the area of Abrolhos complex and adjacent areas. This volcanism alternates periods of subair volcanism, with siliciclastic sediments of the Abrolhos Formation, as shown in Figure 2.

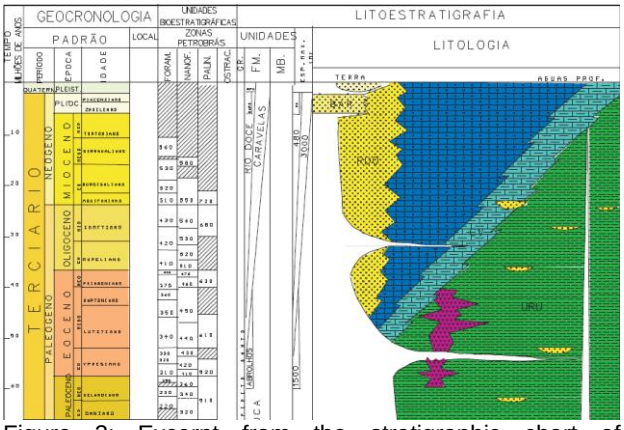

Figure 2: Excerpt from the stratigraphic chart of Cumuruxatiba Basin (modified from Santos 1993).

There are also recognized normal and inverse faults reactivations and formation of significant volcanic mountains, of which high density volcanic rocks overburden probably changed the depositional dynamics of Eocene sediments. This caused halokinetic movements resulting in significant deformation of the post-salt section in this period.

Results

The 3D seismic reflection data loaded into the software Petrel® was visualized as shown in Figure 3:

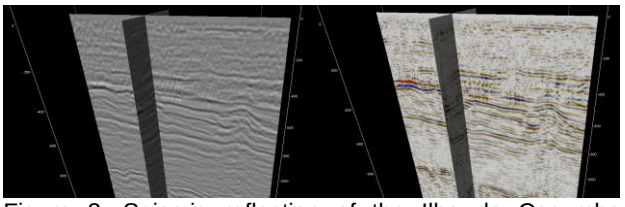
Figure 3: Seismic reflection of the Ilha da Caçumba region with color variations scale for best visualization of anomalies.

Depth density variations are observed. In 600 meters there is a most noticeable anomaly indicating a significant variation of density between the upper and the subsequent layer. From this depth there are still some anomalies observed up to 800 meters deep, where there is a significant difference in density across the horizontal extent of the region. In Figure 4 we see a zoom in the region studied.

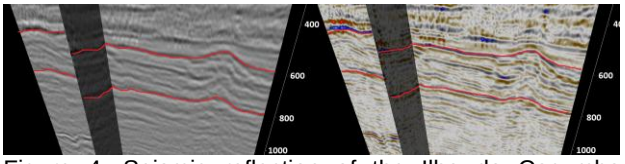

Figure 4: Seismic reflection of the Ilha da Caçumba region with variations in color scale for best visualization of anomalies, emphasizing density anomaly between depths from 600 to 800 meters.

The geological and geophysical interpretation that can be done with this seismic reflection is that there is a significant difference in density between the layer contained in the interval 600 to 800 meters and its host rocks. It's known there is an igneous intrusion caused by the basaltic Eocene spills that can probably be this layer. The anomaly is caused by the higher density of the formation igneous rocks comparing to sedimentary ones.

To confirm the higher density of this formation compared to the others it was observed the Sonic log of a well in the area, shown in Figure 5. The responses are low travel times for the studied range that indicates a more compact rock. Further confirmation that this body has volcanic origin is its low clay concentration which is indicated by the Gamma Rays log.

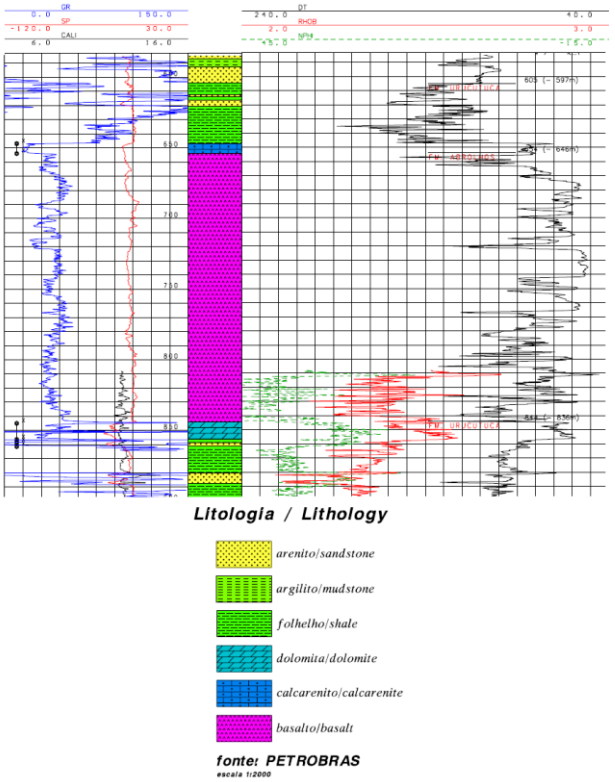

Figure 5: Geophysical logging of the well "1ICA0001BA" in the Cumuruxatiba Basin. The basaltic body is found between depths from 650 to 850 meters (modified from *ANP* 2003).

Based on the stratigraphic chart of the basin, it's identified in the study region of about 600 to 800 meters deep as being the Abrolhos Formation. This igneous intrusion appears between layers of sedimentary rocks and, due to that, its detection in seismic reflection was possible.

Conclusions

Using the Petrel® software was possible to identify subsurface disagreements and structures by the 3D seismic block visualization for the Ilha da Caçumba area.

Integrating well logs and stratigraphic chart of the Cumuruxatiba Basin in which the well "1ICA0001BA" is inserted, it was recognized that two major inconsistencies identified on 3D seismic belong to the basaltic spills of the Abrolhos Formation. This could be confirmed by analyzing the responses of Sonic and Gamma Rays logs.

The software Petrel® proved to be a useful tool in the visualization and interpretation of seismic data. These achievements were only possible due to the integration of geophysical data (seismic reflection and well logs) and geological data (basin stratigraphic chart).

Acknowledgments

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