Restricted magmatic manifestations in Almada Basin, offshore Bahia - Brazil

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Abstract

3D seismic data interpretation of Almada Basin for hydrocarbon exploration provided evidences of a magmatic event on Block CAL-M-372 located on deep water region.

According to the interpretation, it is possible to separate intrusive and extrusive bodies positioning this event in Tertiary time, which is probably correlated to several magmatic occurrences in Brazil and worldwide at this time.

Introduction

The Block CAL-M-372 was acquired during the Sixth ANP Round in 2004 by Petrobras (Operator), El Paso and Queiroz Galvão Exploração e Produção. It is located 32 km from Ilhéus City with water depths ranging from 1500 to 2300 m (Fig. 1).

During the exploration program, 3D and 2D seismic data were studied aiming a regional study for the recognition of the structural framework of the basin (Fig 2). Beyond different structural and depositional features, amplitude anomalies were mapped on a restricted region on the southeast part of the study area. The seismic features associated to amplitude anomalies were interpreted as magmatic structures.

Due to the absence of well data in the region, once Almada Basin has only two wells drilled on deep waters (1-BAS-126 and 1-BAS-102), and no well has found igneous rocks.

Dike sheets, sills and plutonic bodies were recognized intruding the tertiary section of the basin, as well as a volcanic manifestation is found associated with them.

Method

This project is part of the regional study performed by Queiroz Galvão Exploração e Produção on Camamu-Almada Basin which is constituted by two phases. The first one, is based on the usage of 2D and 3D seismic data in time. More specifically on the Block CAL-M-372, a PSTM covering about 2000 km^2 was used, which permitted the imaging and recognition of small igneous bodies. The second phase, still ongoing, uses a PSDM for more accurate lead recognitions. Both seismic and well data were loaded on Landmark Geographix platform and interpreted on Seisvision application. During the interpretation process, specific features and seismic attributes were mapped, and then used to track down igneous bodies in the area. They are:

- Strong positive amplitude anomalies (Planke *et al,* 2005) and
- Free reflector zones under strong reflectors (Fig. 3).

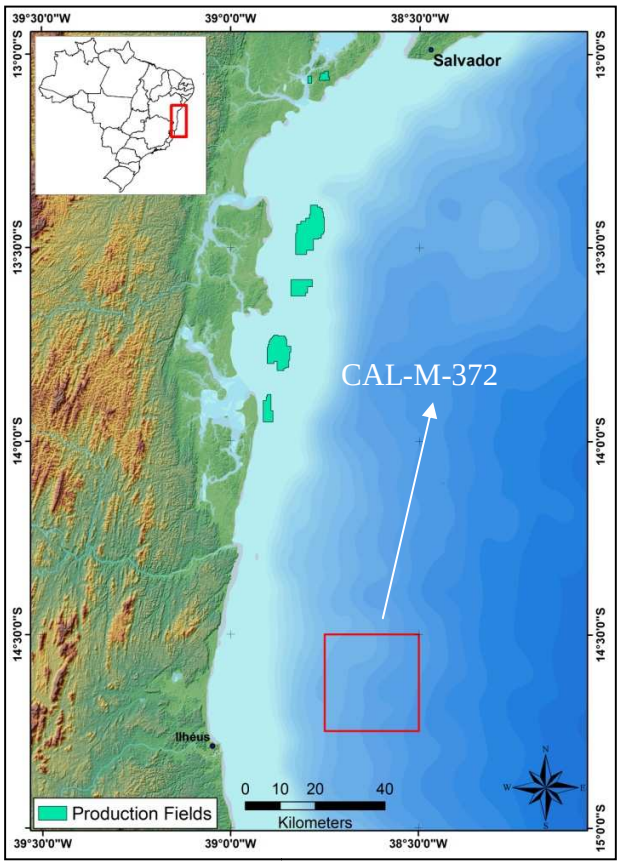

Figure 1 *– Study area location (red square).*

On seismic sections, the differences between sills and lava flows are not well defined, that means they were separated and recognized on structural maps to diminish the uncertainty. Dike sheets were mapped as strong thin unconformable anomalies which caused no displacement on its country rocks, both on seismic sections and on time

slices. Plutonic bodies are characterized by an inner free reflector zone due to high velocities and abrupt contact differing it from salt domes present in the area.

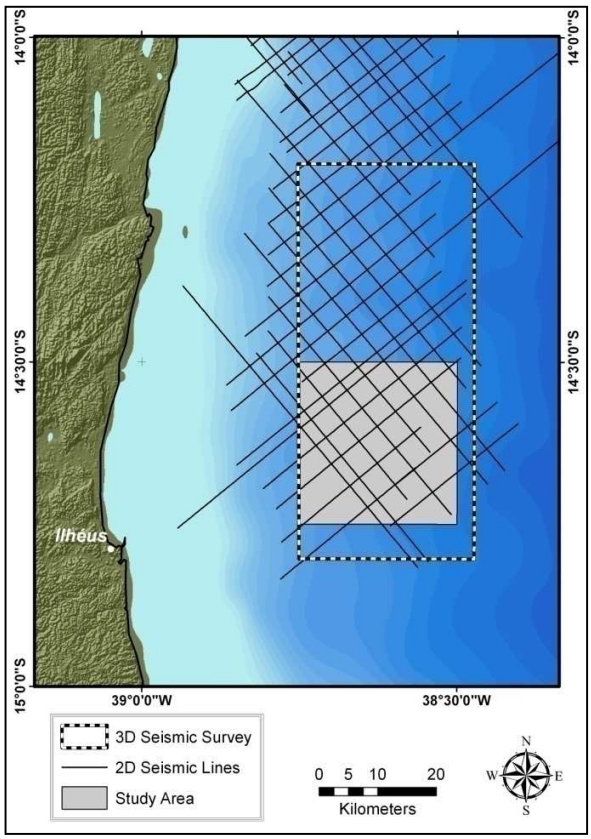

Figure 2 – *Seismic data used on the project.*

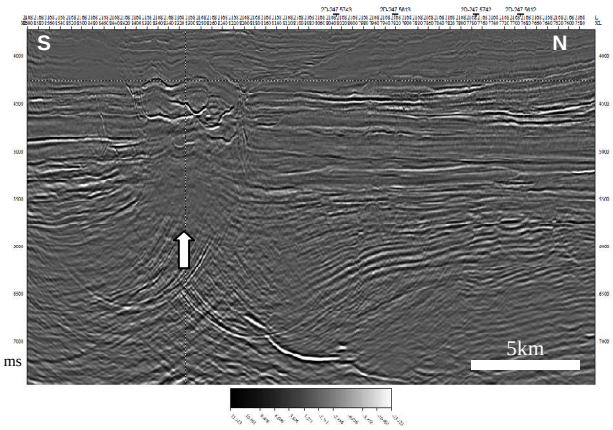

Figure 3 *- Free reflector zone under anomalous high amplitude reflectors in time (white arrow).*

Results

The 3D seismic interpretation led to the recognition of four types of magmatic structures: extrusive rocks (volcanic /volcaniclastic), sills, dikes sheets and plutonic bodies.

All occurrences are concentrated on the southeastern corner of the Block CAL-M-372 occupying an area of 48.5 km^2 following the trend NW-SE (Fig. 4).

The occurrence of extrusive rocks is situated on shallower levels (around 4200 ms - 3200 m). One reflector mapped and observed on map suggested a volcanic construction ranging over 2 km wide with an opening to the southeast, probably a path for lava extrusion (Fig. 5), which probably was subaqueous, once it is conformable to drift phase rocks. Sills are found in contact with the free reflector zones always with close association to dike sheets (Fig 6). They occur in many levels intruding Upper Cretaceous rocks widespread on the magmatism occurrence area. Dike sheets were observed with sub horizontal angles cross cutting Upper Cretaceous and Tertiary rocks.

A plutonic body was recognized intruding Upper Cretaceous rocks. It shows an elliptic section ranging about 1,5 km wide. Country rock folding is observed on its borders, while the roof truncates the reflectors above, possibly indicating a ballooning process for its emplacement (Fig. 7).

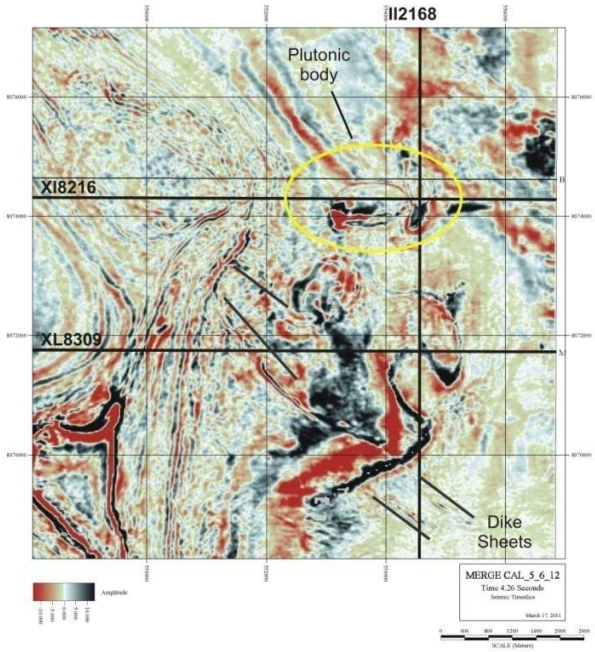

Figure 4 *- A timeslice on 4260ms (3245 m) showing the occurence of dikes (indicated by the lines), plutons (XL8216) and the volcanic construction.*

All occurrences are distributed along a basement lineament which corresponds to a huge fault that seems to have worked until the Upper Cretaceous (Fig. 8). The inflection of this fault on the area follow the same trend of the dike sheets with a NW-SE direction.

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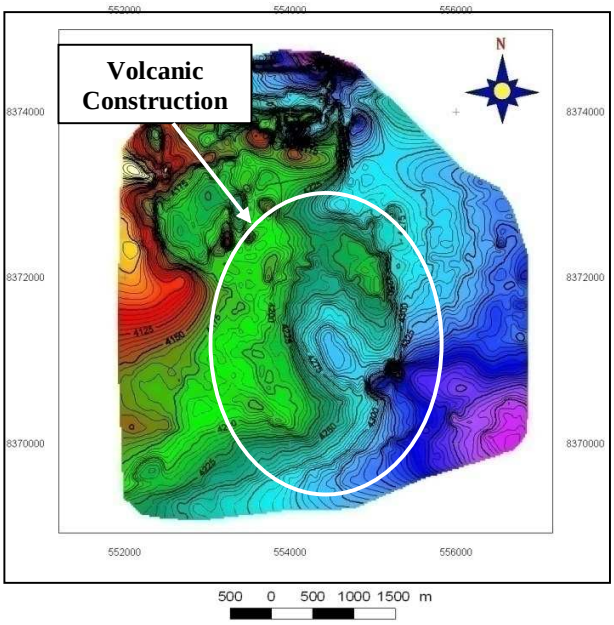

Figure 5– *Volcanic construction in time.*

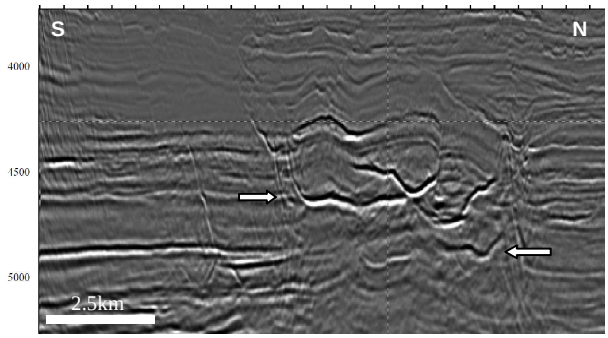

Figure 6*- Inline 2168 - Sills and dike sheet intrusions emerging from the free reflector zone (white arrows).*

Discussions

The area distribution and the elements mapped points out to an intraplate alkaline magmatism related to hot spot activity, probably during Eocene time like some occurrences described by Misuzaki (2002), that separated the magmatism of the South Atlantic Margin in 3 groups: Lower Cretaceous rocks (tholeiitic magmatism), Upper Cretaceous rocks (basic and intermediate) and Eocene alkaline rocks. The restricted distribution associated to the structural framework of the basin indicates a possible reactivation of the basement fault system which acted as weak zones, becoming natural paths for magma rising.

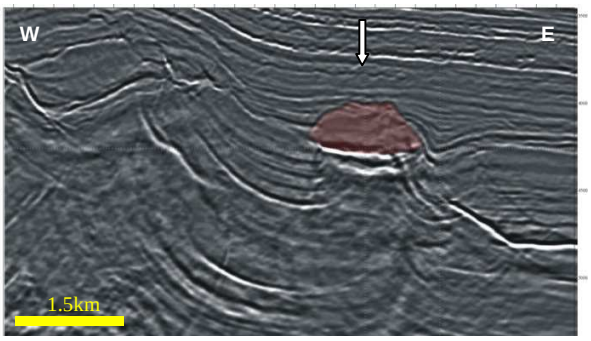

Figure 7 - XL8216 - *Plutonic body (white arrow) deforming adjacent layers.*

The inline IL2168 shows those components acting together, once the free reflector zone is situated over a huge basement fault (Fig. 9). The distribution of dike sheets following the same trend as the basement faults is another point that shows the basement structural control in the area. Those elements resulted in a distribution of magmatic rocks over an area similar to other alkaline occurrences all over the Atlantic continental margin like Fernando de Noronha, Trindade and Abrolhos.

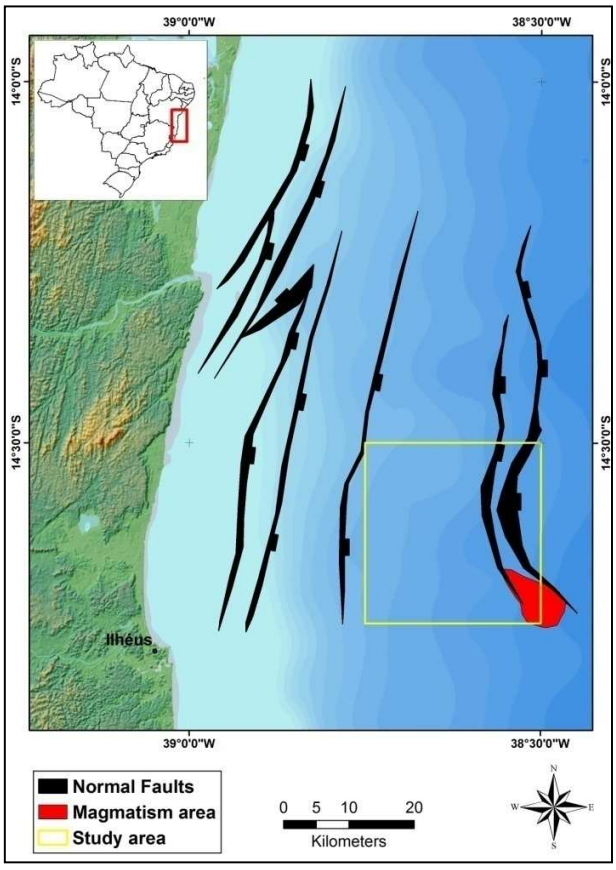

Figure 8 – *Basement structural map in time showing the occurrence area.*

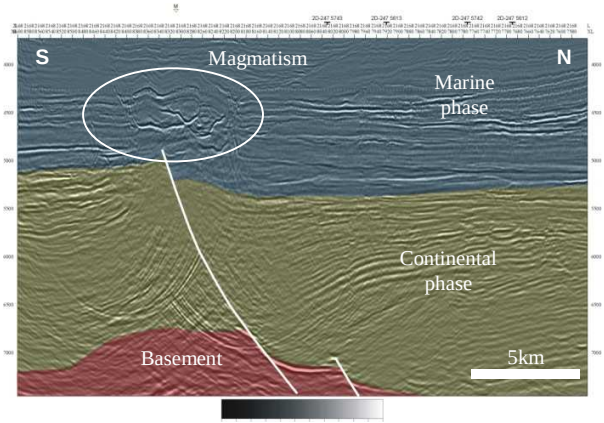

Figure 9 - *Basement faults probably acting as a path for magma rising.*

Conclusions

According to the data provided by the seismic interpretations it is possible to identify a magmatic event occurred on Almada Basin that might be correlated to other occurrences on Tertiary time all over the Atlantic continental margin during the Eocene.

Considering the distribution of alkaline magmatic occurrences along Campos, Espírito Santo, Sergipe-Alagoas and Potiguar basins it is possible to consider that other occurrences might exist along offshore Bahia.

The restricted area and distance from the coast, are limiting factors to find such occurrences. 3D seismic data is a key tool in order to achieve the recognition of those bodies and reveal their distribution on space and time.

Acknowledgements

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