# A presalt graben system near the COB imaged by high quality 3D seismic data in Campos Basin, Offshore Brazil

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## Abstract

Seaward-dipping reflectors (SDRs) represent flood basalts rapidly extruded during either rifting or initially subaerial sea-floor spreading (Jackson et al, 2000). Where high-quality seismic data is not available, SDRs can be easily confused with a half graben, when both have reflections dipping seaward and both are near to the Continent-Ocean Boundary (COB). Differentiating SDRs and half graben would have a huge impact to hydrocarbon exploration – a half graben in a rift basin is one of the major exploration targets but SDRs usually indicate that there is no exploration potential. We investigated a recently reprocessed high-resolution 3D dataset in the Campos Basin, and interpreted a presalt graben system where previous workers had interpreted SDRs.

In this paper we present images from the Olho de Boi 3D survey, acquired near the COB from November 2013 to March 2014 and recently reprocessed. The reprocessing workflow was especially designed to image the presalt section, and the interpretation based on the new 3D image and borehole correlation suggests a large graben system in the center of the 3D survey. The improved presalt images and the new interpreted presalt graben systems will greatly help explorationists to analyze presalt sediment architecture and petroleum systems.

## Introduction

The Campos basin, which is located along the passive margin of Brazil, was part of the East Brazil rift system which formed in the Jurassic–Early Cretaceous and led to the opening of the South Atlantic (Meisling et al, 2001). Significant discoveries from presalt areas in Campos and other Brazilian basins have drawn great attention to this new play. We recently revisited a presalt area which had recently been interpreted as SDRs by Norton et al. (2016). With newly acquired and processed high-quality 3D seismic data, we suggest that the presalt sediment package previously interpreted as SDRs is instead a graben filled with seaward-dipping sediments.

The reinterpretation effort includes two interactive processes – seismic depth imaging with better geological constraints based on gravity modeling, and geological interpretation with improved seismic data. An alternative anisotropy model was tested assuming larger anisotropy values between the base of salt and the base of synrift derived from gravity studies. In order to maintain flat gathers, the velocities are expected to decrease when anisotropy increases, therefore the velocities become more compatible with sediment velocities (Figure 1) within the sedimentary section estimated by gravity modeling.

Key technologies, including broadband processing, Tilted-Transverse Isotropic (TTI) model building and imaging, were applied to the processing of the 3D survey. In the following sections we will briefly discuss the salt modeling and then will focus on the interpretation of the graben system.

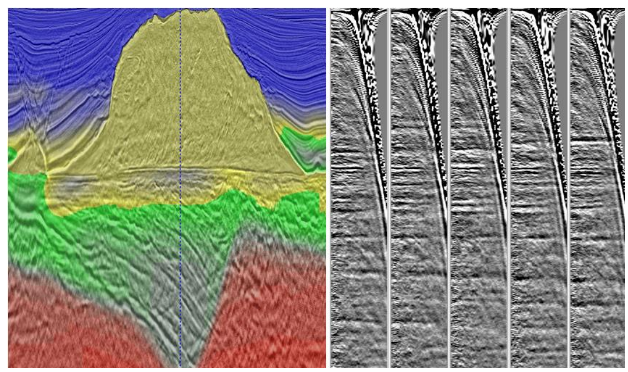

*Figure 1. Sediment velocities constrained by gravity modeling. Gathers are flat in this area.*

## Salt modeling

Because our target is a presalt package, salt modeling is critical for this effort. Detailed salt interpretation including local scenario tests was conducted and multiple iterations of migrations and tomography were done to obtain an accurate salt model. During salt modeling process, we routinely evaluated subsalt images, especially the base of autochthonous salt, to make sure the subsalt image was geologically correct. For example, if we saw any undulations of base of salt we would revisit the salt model to analyze if there were any geological reasons which caused the undulations. If we found that the undulations were caused by model issues, we would fix either the salt model or the sediment model to ensure that the suprasalt model was correct.

## Presalt interpretation

Two critical horizons were mapped and analyzed: base of presalt (Figure 2, Figure 3) and base of autochthonous salt (Figure 2, Figure 4). From the map of the base of autochthonous salt (Figure 4), we can see that this horizon is very smooth on the NW side of the survey and becomes more rugose to the SE. From seismic cross sections (Figure 2) we can see that from NW to SE the base of autochthonous salt changes from trough-dominated, to peak-dominated, and finally to rugose chaotic. We interpret this trend to indicate that salt was deposited on postrift slow-velocity sediments to the NW, on synrift high-velocity sediments in the middle of the survey, and directly on oceanic crust to the SE.

Thickness of presalt sediments (Figure 5) was computed from base of autochthonous salt and base of presalt. The base of presalt surface map (Figure 3) and the thickness of presalt sediments map (Figure 5) show that a major graben trends NNW, and that sediment thicknesses in the graben exceed 4000 m over a large area. Because this graben is under salt, hydrocarbon traps can be very large. The biggest growth package is on west side of the graben, producing seaward sediment dips that give the appearance of an SDR sequence. However the narrowness of the basin, the apparent termination of reflections against a steep fault, and the existence of a reflection-free basement block just downdip all lead us to reject an SDR interpretation in favor of a graben model.

We also correlated units in the graben to the nearby Pão de Açúcar well, using a regional 2D seismic grid and the 3D seismic data (Figure 6). The Pão de Açúcar well is the third discovery in BM-C-33 block after Seat and Gávea, and found a presalt hydrocarbon column of 500 m, one of the thickest to date in Brazil. The seismic data clearly show that the presalt sediments discovered in Pão de Açúcar well can be correlated to the graben system observed in the 3D data.

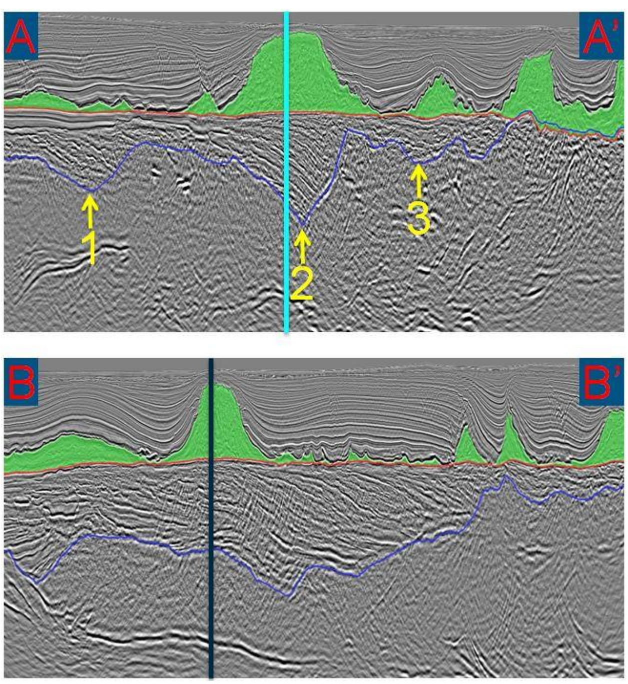


*Figure 2. Base of autochthonous Salt (red) and Base of presalt (blue) on two seismic sections. The locations of the seismic sections are shown in Figure3, 4 and 5.*

**Conclusions**

Based on interpretation of a new high quality 3D seismic data and a well tie, we conclude that a package of presalt reflections that could be confused with SDRs is instead a presalt graben. Further study of the new 3D data will greatly improve the industry's understanding about the exploration potential in this area and will be likely open a new territory for hydrocarbon exploration.

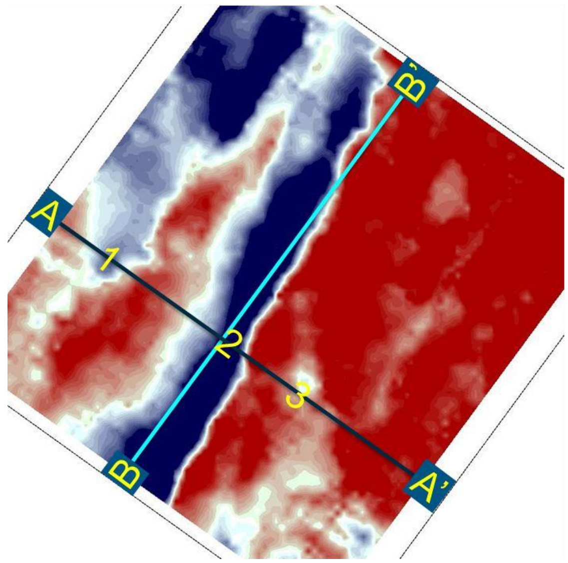


*Figure 3. Base of presalt surface map. The map shows that a major graben (blue area in the center of the survey) trends NNW.*

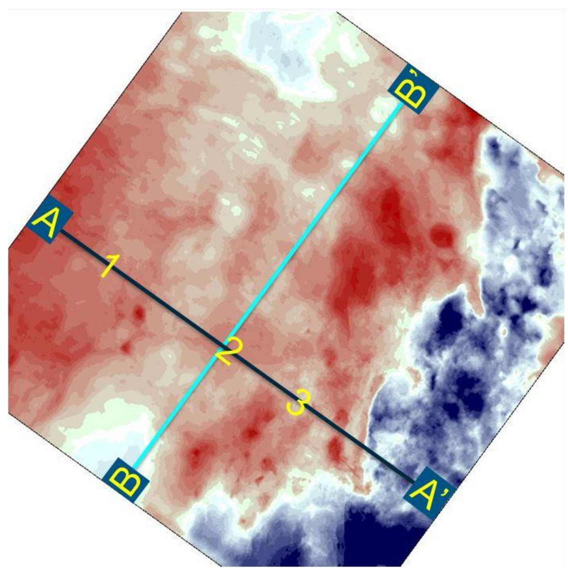


*Figure 4. Base of autochthonous salt surface map. It shows that the surface is very smooth on the NW side of the survey and becomes more rugose to the SE.*

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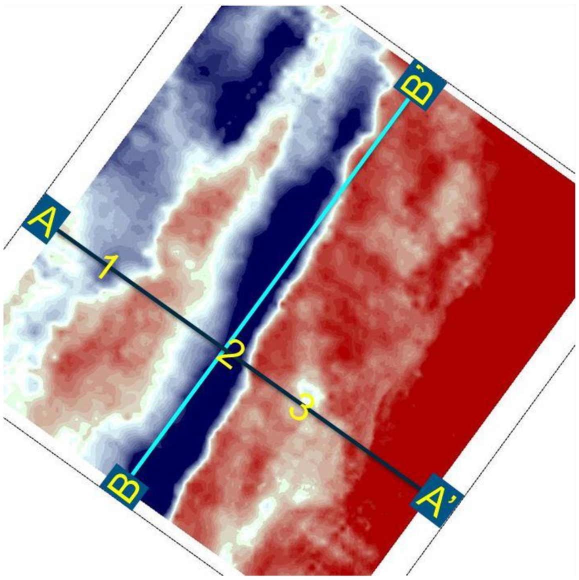


*Figure 5. Total thickness of presalt sediments. It shows that a major graben (blue area in the center of the survey) trends NNW, and that sediment thicknesses in the graben exceed 4000 m over a large area.*

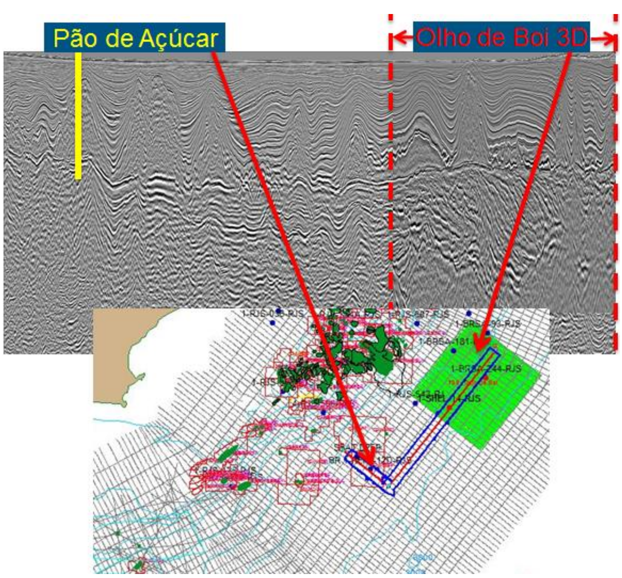


*Figure 6. Well-2D-3D correlation. A presalt sediment package can be correlated continuously from Pão de Açúcar well to the graben in the 3D area.*

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