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STRATIGRAPHIC FRAMEWORK AND THE USE OF ACOUSTIC IMPEDANCE, PSEUDO-IMPEDANCE, AND SPECTRAL DECOMPOSITION DATA IN DETAILING THE RO210 DEPOSIT MAPPING IN RONCADOR FIELD, CAMPOS BASIN, BRAZIL

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ABSTRACT. The main oil-producing reservoirs in Roncador field, located in the central Campos Basin-Brazil, are composed of sandy deposits interpreted as turbidites of Campanian to Maastrichtian age, deposited on the contemporary submarine continental slope. Three main grouping of sandy deposits (RO400, RO300, and RO200, from base to top), interpreted as the result of three third-order depositional sequences, comprise the whole sedimentary succession of the Upper Cretaceous Roncador's reservoirs. RO200 is the uppermost sandy deposit grouping composed of RO210 and RO220. This work analyzed, based on some geophysical methods, the RO210. This reservoir is a channel complex composed of at least two individual channels (lower and upper) filled mainly by sandy turbidites. The channel complex direction is N-S, accompanied by the fault plain direction of the main growth fault that separated the field into high and low blocks. The lower individual channel is tectonically controlled by the growth fault and has its axis confined and parallel to the fault plane at its western border. To the east, it can be seen the channel margin and / or the extravasation deposits. The upper channel is not tectonically controlled and shows the character of an unconfined channel, which could be an unconfined deposit such as a turbiditic lobe.

Keywords: turbiditic sandstone, architectural elements, seismic interpretation.

INTRODUCTION

Campos Basin, located on the Brazilian eastern continental margin, holds one of the world's most prolific (considering production / basin area) oil provinces (Winter et al., 2007). Amongst its oil fields there is a giant one known as Roncador. The Roncador oil field was discovered in 1996 by the well 1-RJS-436 drilled by Petrobras in deep waters in the central portion of Campos Basin (Rangel et al., 2003). From there on, geological and geophysical acquired data revealed that the deposits that constitute their reservoirs are composed of nine sandy sequences, interpreted as turbidite deposits, intercalated by layers of shales (Furlan, 2017). The Roncador field turbidites are mainly interpreted as infill of submarine channels, but some unconfined deposits are also identified (Linhares, 2021).

To know the architectural elements, i.e., the exact type of the smaller sandy deposit that assembles with other deposits to form, which in the oil industry is generically referred to as a reservoir, is critical to understand the dynamics of the fluids contained in the pores of the reservoir. This knowledge is essential for a more efficient management. It increases the field's recovery factor since the determination of the hydraulic communication between the wells is strongly influenced by the arrangement and the physical properties of the reservoir existing among the wells (Chaves, 2020).

The architectural elements of sandy deposits like turbidities are commonly at a scale of sub-seismic resolution, despite 3D seismic. Usually, they are only identified by fieldwork at the outcrop scale (Figueiredo et al., 2013).

However, the interpretations of architectural elements have ordinarily been based on the amplitude data (Suarez, 2002). This work steps forward by performing special processing such as spectral decomposition, pseudo-impedance, acoustic impedance, and attribute generation to enhance the original seismic resolution and see smaller depositional sandy bodies. In this research, these techniques were performed to individualize the architectural elements of the deposits known as RO210 in the Roncador oil field.

GEOLOGICAL SETTING

Campos Basin is situated offshore in the north of Rio de Janeiro and south of Espírito Santo states and has an area of c. 100,000 km². It is separated from Espírito Santo Basin in the north by Vitória High, and, in the south, it is separated from Santos Basin by Cabo Frio High (Rangel et al., 1994). The Roncador oil field, the object of analysis of this work, is the northernmost field in the state of Rio de Janeiro, located in the central portion of Campos Basin, 120 km offshore and in water depths ranging between 1500 m and 1800 m, on the current continental slope of the basin (Figure 1).

Like all other Brazilian eastern continental margin sedimentary basins, Campos Basin evolved through 3 (three) main tectonic-stratigraphic phases: Rift, Post-Rift, and Drift (Figure 2). The main producing reservoir in the Roncador oil field is stratigraphically contained in the Drift phase of the Campos Basin. The nine sandy sequences (turbidite deposits) that comprise the actual Roncador oil field are stratigraphically positioned in a sedimentary succession of Campanian and Maastrichtian age. The turbidite deposits and the shales that separate them have an average thickness of about 50 m but can vary from 2 to 250 m per reservoir zone (a chronostratigraphic chart for the age of the Roncador turbidites is shown in the results of this work).

DATA SET AND METHODS

This research was carried out based on seismic and well data acquired from the data bank (BDEP) of the Brazilian Regulatory Agency of Petroleum, Natural Gas and Biofuels (ANP). The dataset comprises: (1) a 3D seismic volume covering the entire area of the Roncador oil field. This seismic volume has a vertical resolution of about 15 m in the Roncador reservoir (the dominant frequency is 42 Hz). Any deposit thinner than this will not have its top and base individualized by seismic reflections at their interfaces. The seismic data used were acquired in 2012, 16 years after field production began, is streamer type, narrow azimuth with East-West direction, Kirchhoff migration and full stack; (2) data from 45 wells (digital files of the geophysical logs; PDF files of the composite logs and geological, geophysical, paleontological, and other reports – Figure 3).

The workflow for the development of this research went through the following steps:

1. Load and quality control of the seismic and well data;
2. Seismic interpretation of key horizons at regional scale: Sea floor, Blue mark (interpreted as a maximum flooding surface); the so-called Seismic Cretaceous (a seismic horizon that marks an erosive unconformity that represents the top of the Cretaceous sedimentary section in Campos Basin and salt top);
3. Seismic well tie. This is necessary to take the wells' geological information (mainly litho- and chronological information) to the seismic interpretation;
4. Seismic interpretation of the key horizons at reservoir scale. Altogether, 10 horizons were mapped: RO400, RO330i, RO330s, and RO320 (only the base of each one, as their tops are difficult to identify); and RO310, RO220, and RO210 (both top and bottom);
5. Attribute extraction. The RMS amplitude of the RO210_top was extracted; the thickness of this deposit was calculated (base level minus the top level); and, finally, the spectral decomposition of the seismic data between the top and bottom of the RO210 was performed.

In addition, other special processing of this 3D seismic volume, such as acoustic impedance and pseudo-impedance, was internally generated at Petrobras and released to be used in this work. These special processing operations were used in this research to improve the imaging resolution to highlight the analyzed deposits' architectural elements, which are deep sandy deposits interpreted as turbidites (Oliveira et al., 2012).

Briefly, acoustic impedance is a rock property generated by seismic inversion. This special processing uses the verified speed interval of the seismic cube times the density of rocks in the wells (distributed in the area by statistical methods) to generate the physical property of acoustic impedance (Sancevero et al., 2006).

The integrated colored iterdec (also known as pseudo-impedance) is generated from the deconvolution of the seismic amplitude. This special processing results in the reflectivities of the layers. These reflectivities are then convolved with a wavelet that approaches a spike (a Dirac delta), and these amplitudes are then integrated to simulate the acoustic impedance (Da Cunha, 2019). Hence, it comes the pseudo-impedance, given that this method does not involve borehole data, only seismic (Ushirobira et al., 2014). The area of these three data can be seen in Figure 3.

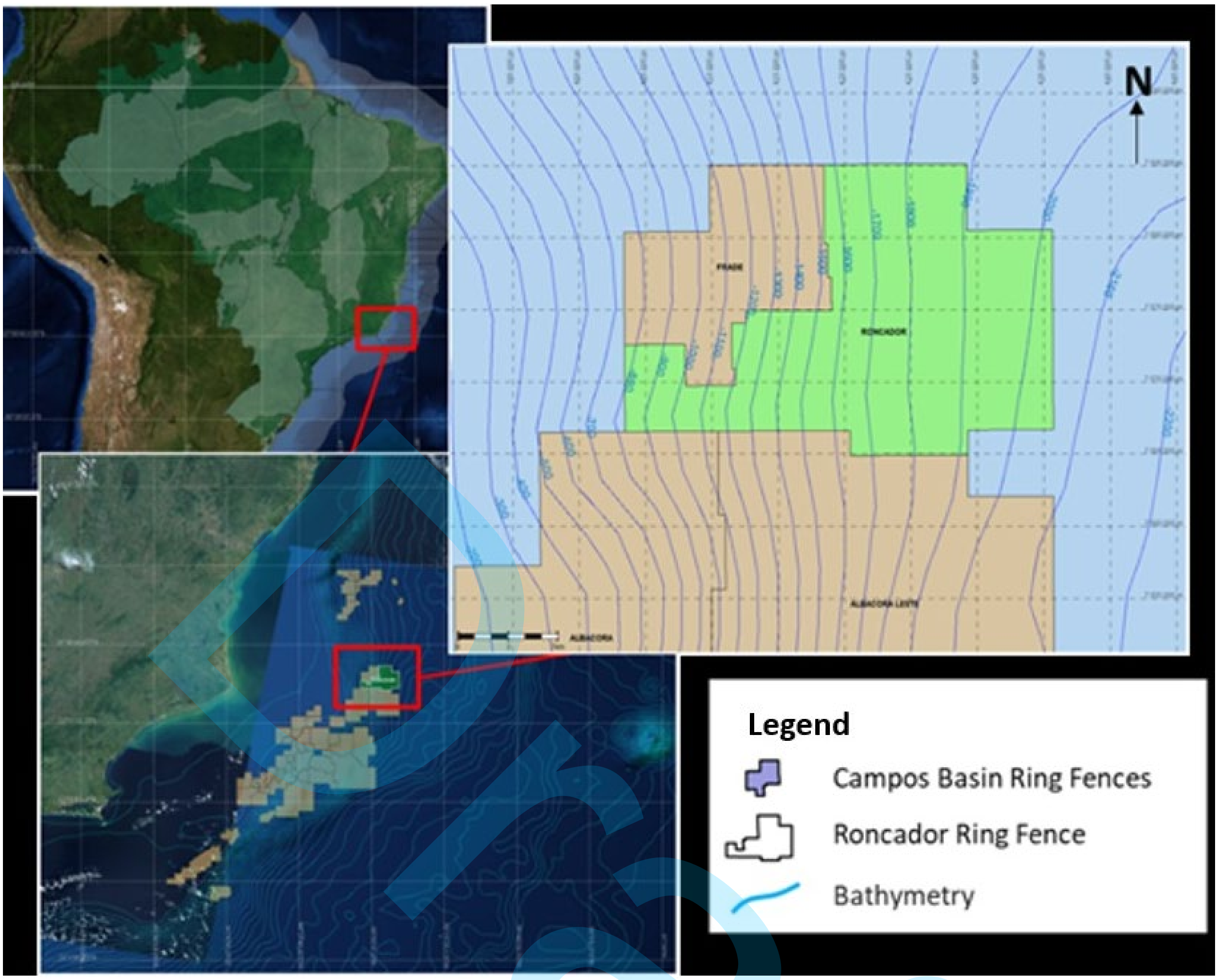

Figure 1: Location map of the ring fence of Roncador Field, in the Campos Basin. Figure generated by the author on VGE, Petrobras' integrated information system.

RESULTS

Stratigraphic framework

The results presented in this article are part of a more comprehensive work related to the Master research project of the first author, Linhares (2021). Although the focus of this article is only one reservoir of Roncador's oil field, the RO210, it is necessary a geological contextualization of this reservoir within the entire stratigraphic section that encompasses the main reservoirs of the Roncador oil field.

A chronostratigraphic chart released by Petrobras for publication in this work shows that the sandy sequences (turbidite deposits) that comprise the current Roncador oil field are stratigraphically positioned in a sedimentary succession of Campanian and Maastrichtian age (Figure 4). This chart details the stratigraphic zonation of the Upper Cretaceous sandy reservoirs of Roncador, placing them in a span of *c.* 10 million years (between 75,4 Ma and 65,9 Ma). This detailed stratigraphic zonation also presents the span time for each major grouping of reservoirs (RO400; RO300; and RO200). As mentioned in the item Geological Setting, those reservoirs are stratigraphically contained in the drift phase of Campos Basin.

The reservoirs RO200 containing the RO210, the target of this work, were deposited between 67,8 Ma and 65,9 Ma. The RO200, specifically the RO210, is stratigraphically positioned within the Upper Maastrichtian.

RO210 Depositional Characteristics

After the seismic well tie, the top and base of the RO210 deposits were defined and mapped according to the amplitude data, i.e., the data representing the interface between layers with different acoustic impedances. This mapping was carried out using a regular grid spacing (120 m x 120 m). Later, the mapped horizons were interpolated to generate the top and base surfaces that encompass the RO210 deposits (Figure 5).

As seen in Figure 6, the maximum thickness of RO210 reaches 60 m. The depocenter has an approximately north-south direction, following the same direction as the normal growth fault that separates the oil field in high (foot wall) and low (hanging wall) blocks.

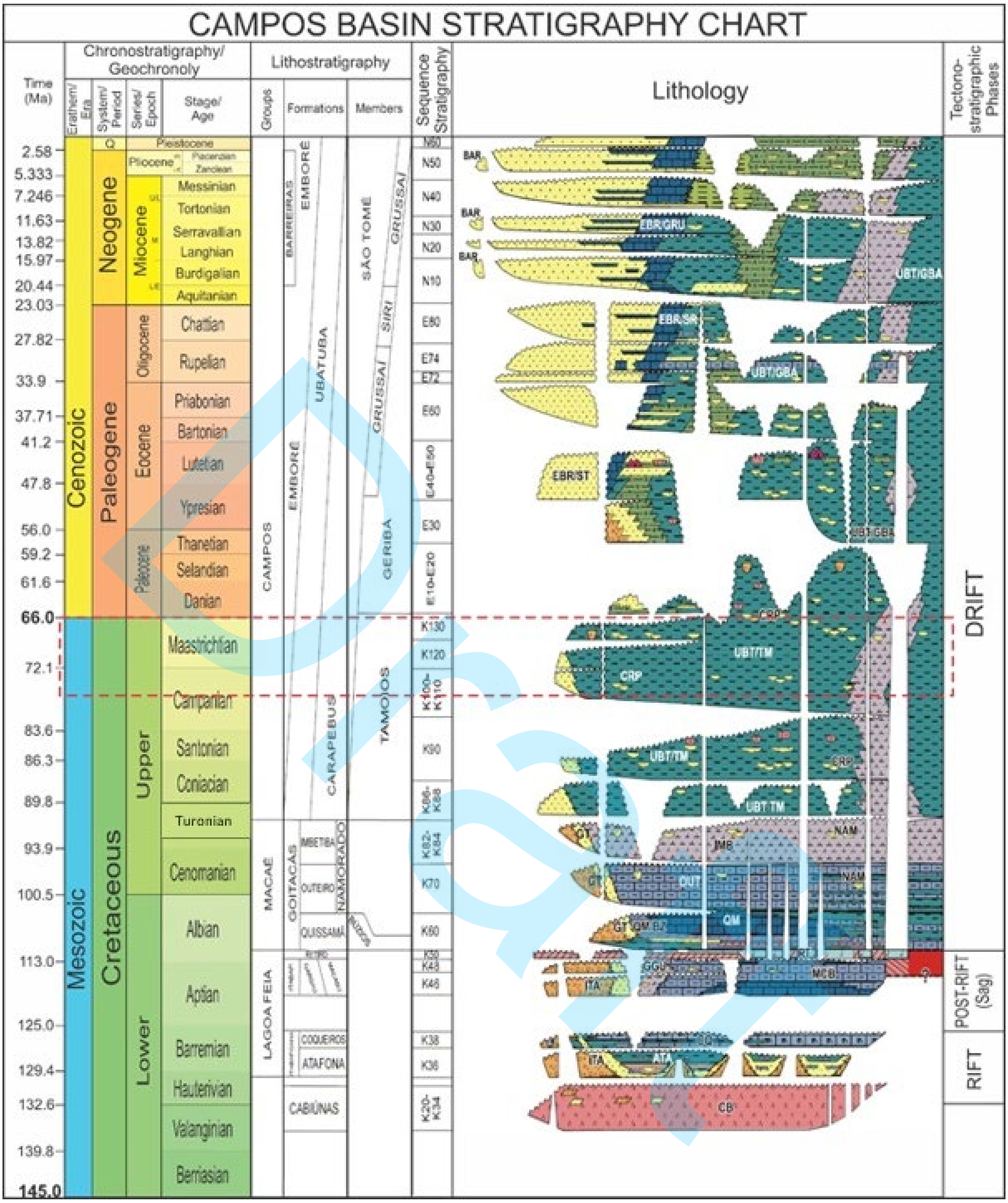

Figure 2: Stratigraphic chart of the Campos Basin, modified from de Winter et al. (2007) and updated based on the last version (v2021/10) of the International Chronostratigraphic Chart published by the International Commission on Stratigraphy (ICS) at the website https://stratigraphy.org/chart. The red polygon marks the stratigraphic interval of the sedimentary section that comprises the Upper Cretaceous sandy deposits (reservoirs) of the Roncador oil field in Campos Basin.

The displacement of this fault reaches up to 300 m, and the reservoir RO210 is syn-depositional to it. The depocenter's geometry suggests two sedimentary paleotransport directions: NW-SE in the northern portion of the field and N-S in the southern one.

RMS amplitude extraction analysis

The impedance contrast (amplitude) is affected by lithology variation, fluid, and pressure at an interface between two layers. The tunning effect can also cause an artifact that initially enhances the amplitude. Bearing this in

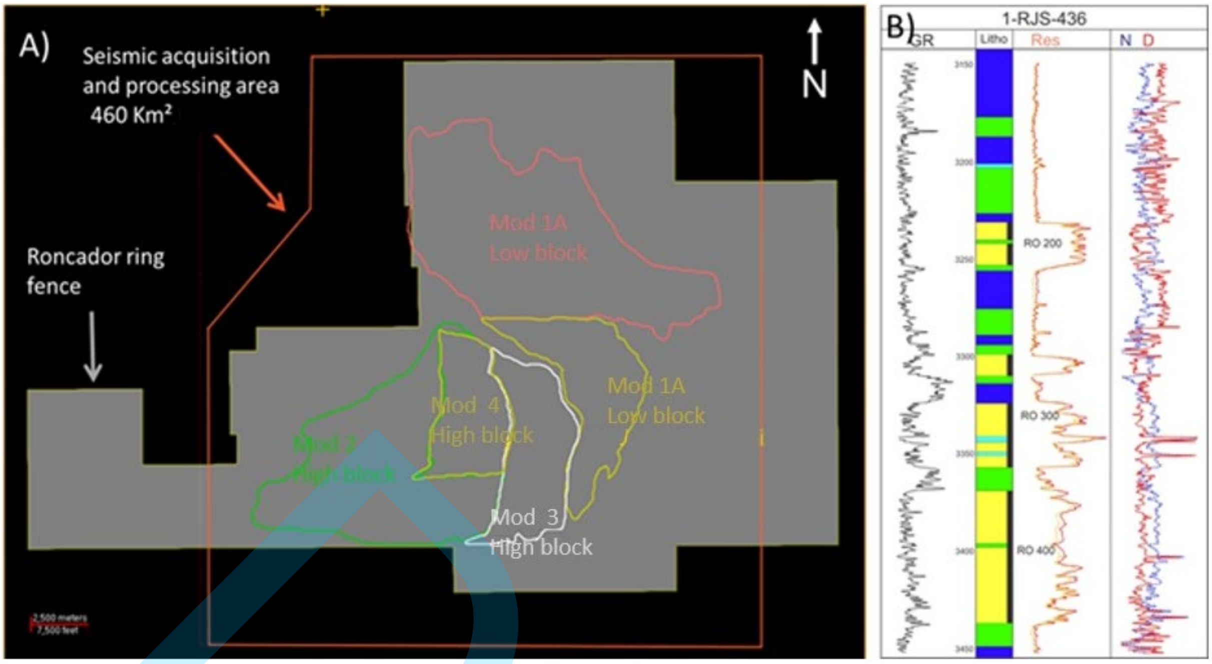

Figure 3: A) Seismic data area provided by ANP to accomplish this study. The gray polygon delimits the ring fence of the Roncador oil field, while the red polygon represents the seismic data coverage, and the green, yellow, white, and magent polygons are the modules from which there is oil production; each one includes an oil-producing platform, this article focuses on module 1A (magent and yellow). B) A PDF file of the composite log of the well 1-RJS-436 (discoverer). The first track (on the left) contains the gamma-ray curve, used to check the clayiness; the second track is the lithology track: in green, shales; in yellow, sandstones; and in blue, carbonates. The third track shows the resistivity log used for fluid analysis. The fourth track contains the neutron log (blue) and density (red).

mind, it is crucial to know the geological context the RMS maps will be extracted once they can reflect any of those variations mentioned above. In the study area, it is well known that the lateral variation in lithofacies is not so remarkable for altering the amplitude content. Neither is the pressure in the reservoir. On the other hand, it is well known that the amplitudes in the Roncador oil field are strongly affected by the fluid content (oil or water) in the pore space of the rock. Based on this background, it is common sense in the reservoir study of the Roncador oil field that cool colors in RMS Amplitude maps represent water; conversely, warm colors represent oil.

As reservoir RO210 contains both light oil and water, this will affect the results of the RMS amplitude extraction on the map. Cool colors such as purple and black represent areas originally filled with water or those that are already depleted. In both cases, the RMS amplitude response is the same. On the other hand, warm colors, like yellow, indicate oil-filled areas. Considering this, it turned out that the RMS amplitude extraction on the map for the RO210 reflects the fluid content in the reservoirs (Figure 7).

Spectral decomposition analysis

The spectral decomposition analysis between the top and the base of the RO210 deposits was also performed in this work. This analysis aims to individualize the architectural elements, *i.e.*, the depositional building blocks, which assemble to form the deposits of the RO210 reservoirs. The knowledge of the geometry of the smallest recognized deposit is of crucial importance for the engineering reservoir once the lithofacies distribution, which is a function of the deposit type, is the main factor in the fluid flow in the rock pores. Therefore, this is very important for reservoir modeling.

As revealed from the thickness map, the depocenters of the RO210 deposits are located in the southern study area. Hence, this is the most appropriate area to perform the spectral decomposition analysis. In this analysis, the decomposition results for the 20 Hz and 40 Hz frequencies, responsible for imaging thicknesses of 32.5 m and 16.25 m respectively, are exposed according to the Widess formula, 1973 (Figure 8). The spectral decomposition analysis suggests that two channels could be partially amalgamated to form a channel complex representing the RO210 deposit represented by the white polygons in Figure 8.

Amplitude x Impedance x Interdec

Other proxies tried in this work to individualize the depositional building blocks were the analyses of the amplitude, impedance, and Interdec data on sections. An arbitrary line was chosen to be shown and discussed in this article. Its location is shown in Figure 9. Figure 10 displays the same arbitrary seismic section performed in these three different seismic processing. Detailed discussion on this and a comparison with the previous related proxies will be provided further in the item Discussion.

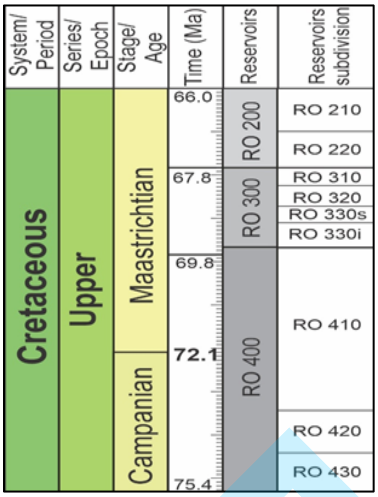

Figure 4: Chronostratigraphic zonation of the sedimentary section that contains the Upper Cretaceous reservoirs of the Roncador oil field in Campos Basin. Provided by Petrobras and updated based on the last version (v2021/10) of the International Chronostratigraphic Chart published by the International Commission on Stratigraphy (ICS, https://stratigraphy.org/chart).

DISCUSSION

Stratigraphic framework of the Upper Cretaceous sandy deposits in Roncador and the RO210 position

The results produced in this work reflect the amount of data used in this research to better understand the depositional architectures of the sandy bodies that form the reservoirs RO210 of the Roncador oil field. Firstly, the RO210 stratigraphic position was defined according to the chronostratigraphic chart shown in Results. It was positioned in the Upper Maastrichtian. Although the stratigraphic evolution of the Upper Cretaceous sandy deposits that are the main reservoir of the Roncador oil field is not the focus of the article, the detailed chronostratigraphic chart allows an interpretation of it. Considering the span time for the entire sedimentary section that comprises the Upper Cretaceous sandy deposits of about 10 million years and taking into account the span time for the depositional sequences proposed by Mitchum Jr. and Van Wagoner (1991), it is possible to infer that all Roncador Upper Cretaceous sandy deposits constitute a second-order depositional sequence.

The RO400 deposits spanned from 75,4 Ma to 69,8 Ma, i.e., 5,6 million years of duration. The RO300 deposits spanned from 69,8 Ma to 67,8 Ma: 2 million years and the RO200 ones spanned from 67,8 Ma to 65,9 Ma: 1,9 million years of duration. From these numbers, it is noticed that RO400 deposits took longer than the sum of the RO300 and RO200 ones.

They showed to be deposited in the period that is considered the span time of all Upper Cretaceous sandy deposits and each significant grouping of sandy deposits (RO400; RO300; RO200). Despite this noticeable difference in duration between RO400 and the others, all of them are still within the age range for third-order depositional sequences, as proposed by Mitchum Jr and Van Wagoner (1991).

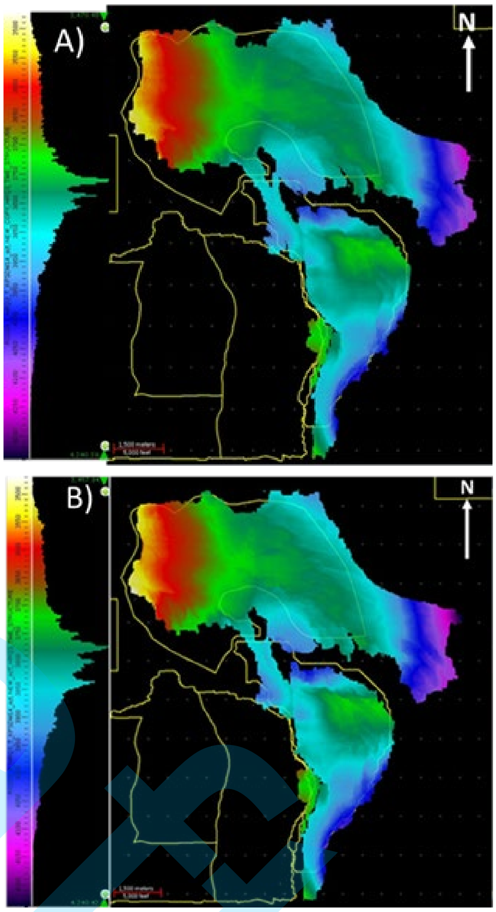

Figure 5: A) Top of the reservoir RO210 generated from regular grid interpolation. The color bar shows depth variation, which in this case ranges from -3400 (white/yellow) to -4100 (purple/black). Negative depth values mean vertical depth below sea level. B) The same for the base of RO210, with ranges between -3500 (white/yellow) to -4200 (purple/black).

It is observed a reasonable correlation of geological events when comparing the chronostratigraphic zonation of the Roncador's Upper Cretaceous sandy deposits with the Stratigraphic Chart of Campos Basin by Winter et al. (2007). The Campos Basin's Stratigraphic Chart suggests 3 (three) depositional sequences from the middle Campanian up to the top of Maastrichtian deposits, named K100-110, K120, and K130, all of them separated by unconformities. The elapsed time of each sequence proposed in the Stratigraphic Chart of the

Campos Basin is different from those of the Chronostratigraphic Chart of the Upper Cretaceous sandy deposits. However, they still show the same pattern, i.e., K100-110 was longer than K120, which was longer than K130.

The chronostratigraphic zonation of the sandy deposits at the Roncador oil field also suggests that higher frequency events (i.e., fourth-order) of relative sea-level rise and fall might be ascribed as the responsible for the deposition of sandy deposits, which are a subdivision of RO400, RO300, and RO200, such as RO210 and RO220.

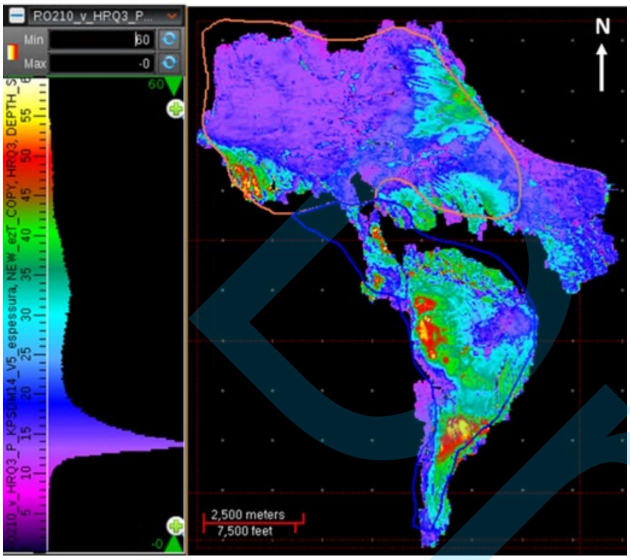

Figure 6: Thickness map of the RO210 deposits and your histogram. The depocenters (red to yellow) are aligned approximately NW-SE in the northern and N-S, the same direction of the growth fault that sectioned the field in high and low blocks. The maximum thickness is 60 m and there is a lot of values at 15 m because this is the vertical resolution data, below these values the tuning effect occurs.

According to Moraes et al. (2006), the Upper Cretaceous sandy deposits of Roncador are turbidites mainly deposited within channels on the continental slope of the basin. Considering that the turbidites are preferentially deposited during the relative sea-level fall, the Roncador's sandy deposits are genetically linked to the unconformities proposed in the basin's Stratigraphic chart.

Individualization of the architectural elements (depositional building blocks) within RO210 using different seismic approaches

As shown in Results, several proxies were used to individualize the depositional building blocks that congregate on the seismic data to form the so-called reservoir RO210 in the Roncador oil field. Firstly, it was shown on the isopach map the rough geometry of the RO210. In this case, it was seen that the depocenters are located close to the main growth fault that sectioned the Roncador oil field, generating the called high and low blocks. This evidence makes it clear that the deposition of the turbidites that compose the RO210 reservoirs were tectonically controlled, at least for the basal sandy deposits of the RO210, as will be discussed further.

When comparing the isopach map for the entire RO210 and the RMS amplitude map, it seems that there is no coincidence between the main depocenters, the area with more sand content, and the area with higher values of a high-resolution RMS amplitude. It suggests that the RMS amplitude, in this case, shows the fluid content of the rocks rather than the rocks themselves.

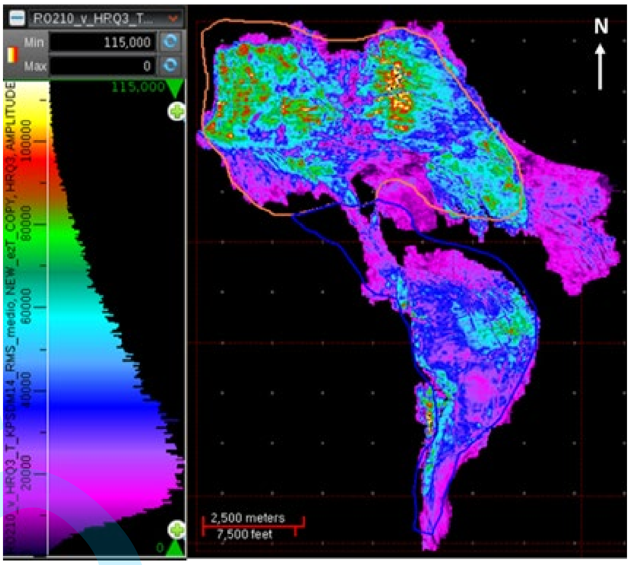

Figure 7: RMS amplitude extraction between top and base of RO210. Color bar in RMS amplitude. Cool colors (purple and blue) represent water; warm colors (red and yellow) represent oil (unpublished internal information).

On the other hand, the 20 Hz spectral decomposition map, which has a resolution of about 32.5 m, shows a very fair coincidence with the isopach map suggesting that the thickest deposits are concentrated within the channelized depression tectonically controlled by the growth fault mentioned above. Nevertheless, on the 40 Hz spectral decomposition map, which images thicknesses of about 16.25 m, the presence of thinner deposits is not close to the fault as seen in the 20 Hz map. The geological implication of this will be discussed later.

Still, in the search for the individualization of the depositional building blocks within the RO210 reservoirs, it was carried out a comparison between seismic sections based on amplitude, impedance, and pseudo-impedance, as shown in Figure 11.

On the amplitude seismic section, it was only possible to individualize the base and top of RO210; even though, in the depocenter, the RO210 thickness reaches about 60 m. It is important to recall that the vertical resolution of the seismic data at this depth is about 15 m, as reported in the section Data Set and Methods of this article.

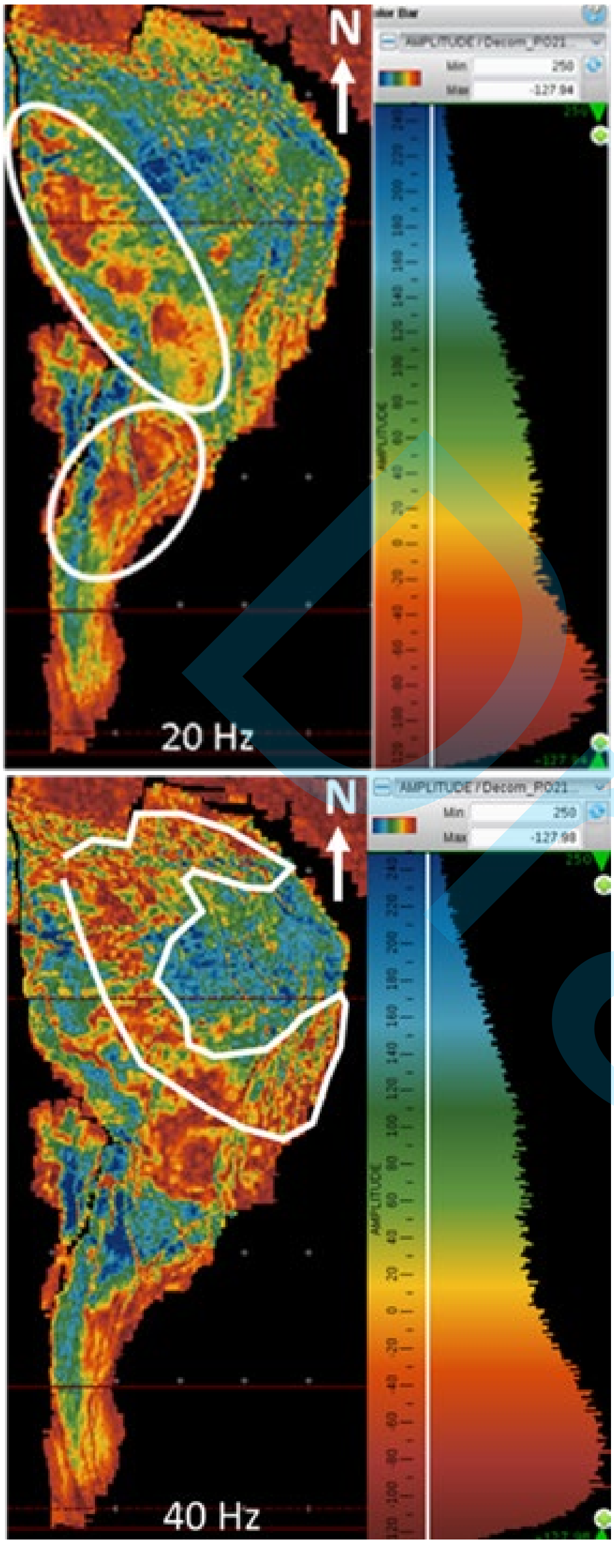

Figure 8: On the left, an amplitude map of the 20 Hz spectral decomposition, which has a resolution of 32.5 m. Its color scale was normalized by the program's algorithm and therefore varies from -128 (red) to +250 (blue). The two white ellipses highlight areas where amplitudes match thicknesses. On the right, the same is true for the amplitudes of the 40 Hz decomposition, which image thicknesses on the order of 16.25 m.

Most of the works, if not the total, that use seismic data for stratigraphic analysis trying to identify depositional bodies perform their analysis on amplitude data, even though high resolution amplitude data like the analyzed ones in this work do not deliver, in a practical way, the actual geometric configuration and the architecture of the depositional building blocks, which for the siliciclastic reservoirs are sandy deposits. This is why several works published in the geoscientific literature, such as Mayall and Stewart (2000), Sprague et al. (2005), Mayall et al. (2006), McHargue et al. (2011), Figueiredo et al. (2013), suggest that it is not possible to individualize on seismic data the depositional building blocks of the channel complexes developed on the continental submarine slope.

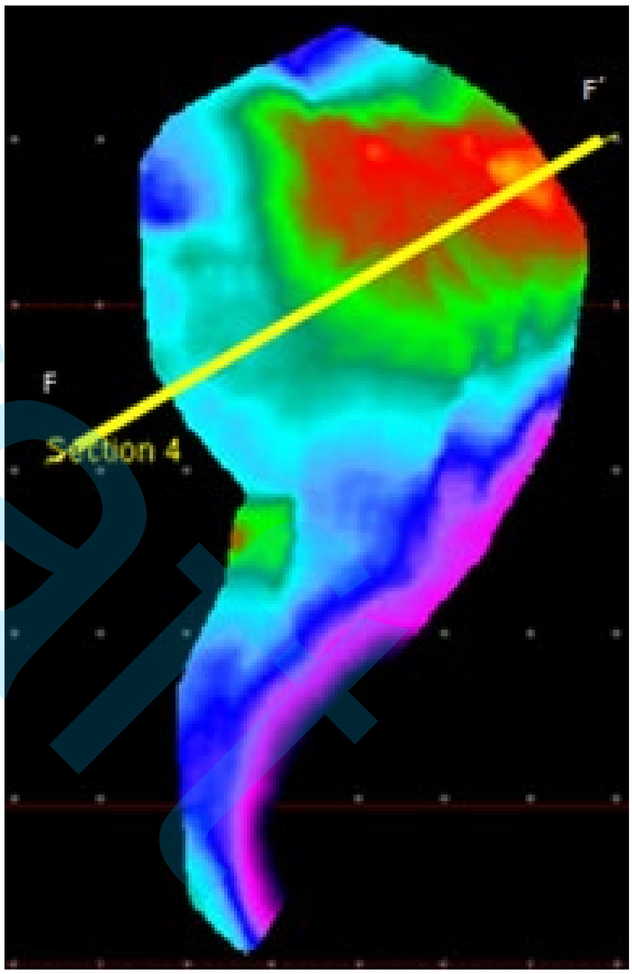

Figure 9: Location map of Figure 10 sections.

This work steps forward on seismic analysis looking for ways to recognize those smallest depositional elements from seismic interpretation. In this sense, an acoustic inversion of the seismic data was carried out to obtain data based on impedance. The geophysical characteristics of the impedance data are set up to represent on seismic section sandy deposits with warm colors and shaly deposits with cool colors such as the one depicted in Figure 11.

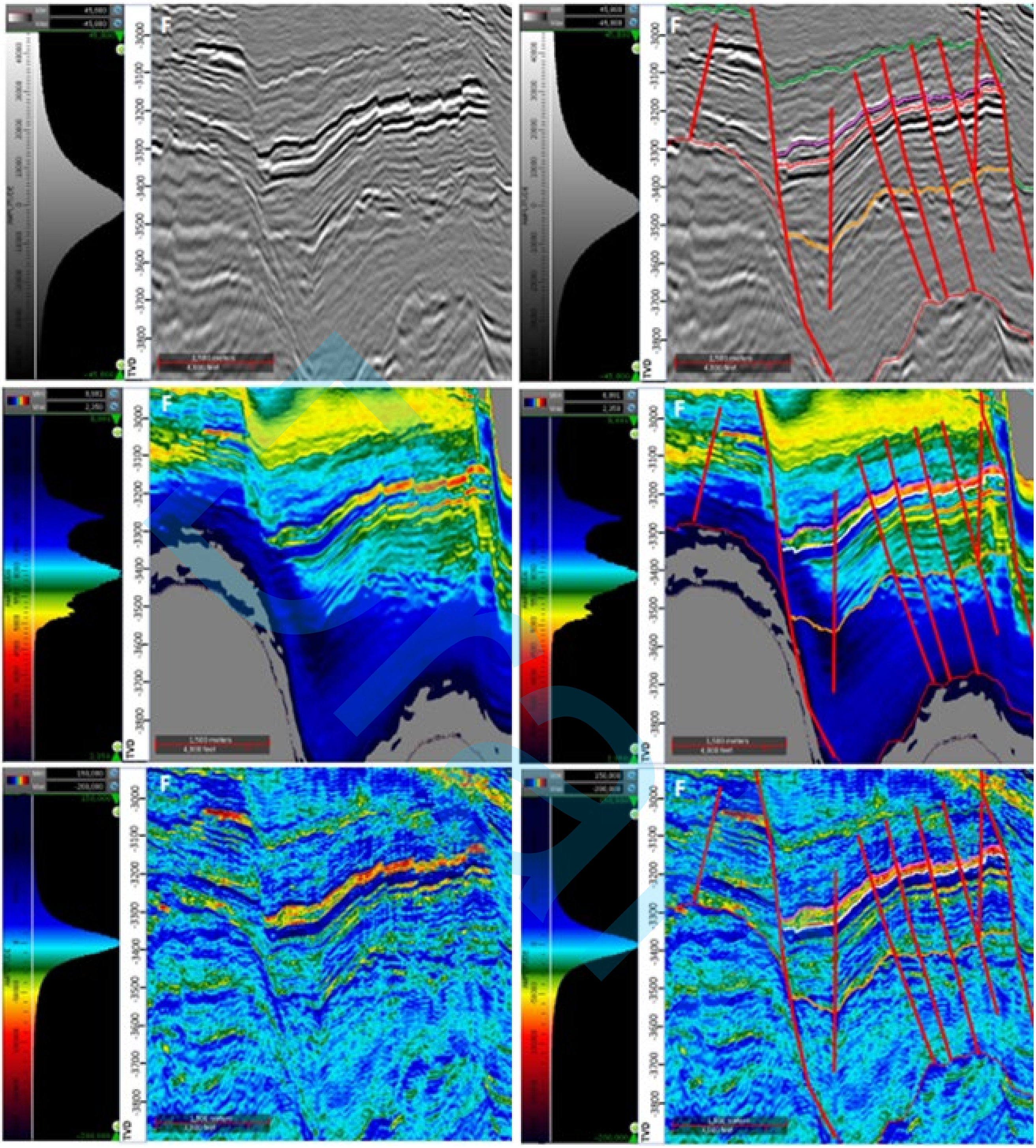

Figure 10: SW-NE oriented arbitrary seismic section (for location see Figure 9). A.1 non interpreted amplitude seismic section; A.2 interpreted amplitude seismic section. B.1 non interpreted impedance seismic section; B.2 interpreted impedance seismic section. C.1 non interpreted interdec seismic section; C.2 interpreted interdec seismic section. The RO210 is depicted on A.2 encased within the red (base) and purple (top) horizons. In Figures B.2 and C.2, base and top of RO210 are drawn in white and red, respectively. The so called "International Pattern", on the amplitude section black reflectors represent negative impedance contrast, and the white reflectors, positive impedance contrast. On the impedance section, warm colors, such as red and yellow, are low impedances, that is interpreted as sandy rocks with good permoporous characteristics; cold colors, such as green and blue, are high impedances, interpreted as shaly rocks. Vertical exaggeration: 6x.

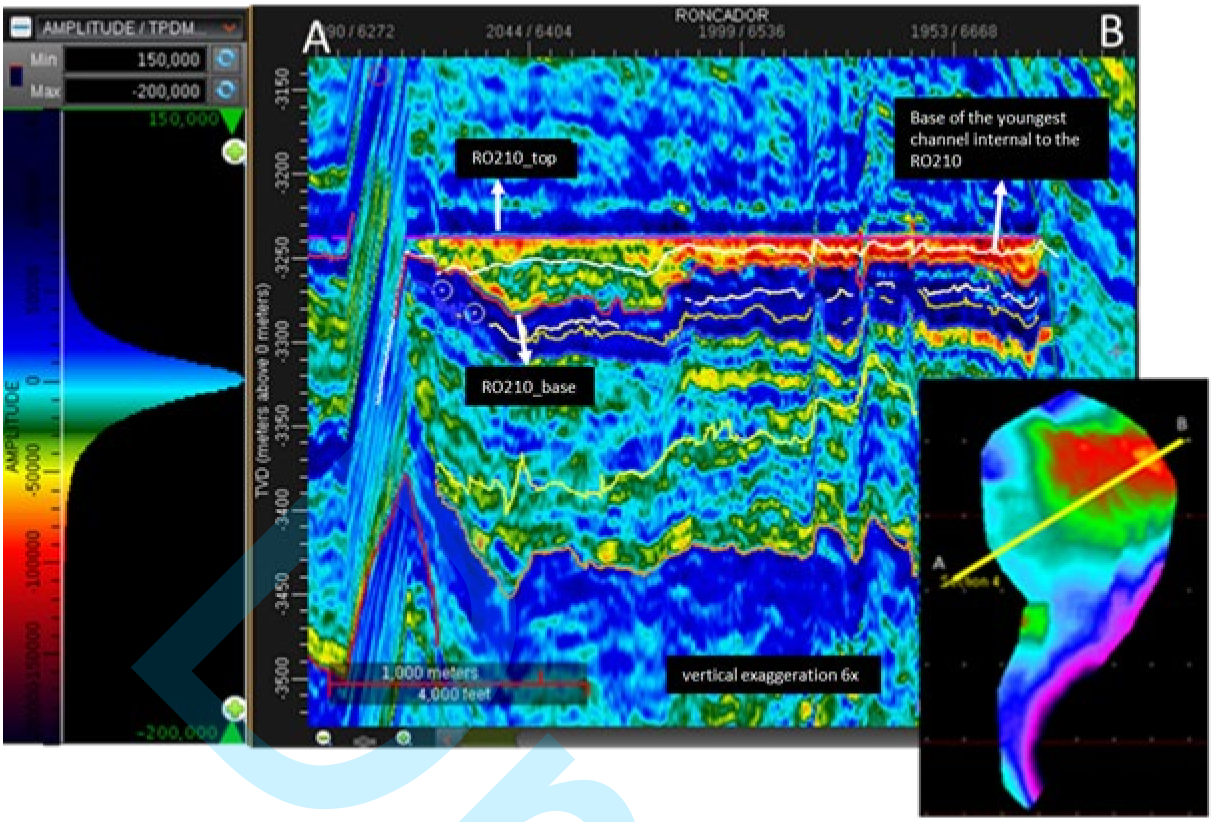

Figure 11: The same section of Figure 11, in pseudo-impedance data, with horizontalization of RO210 top to show the depocenter to SW and the channel edge to NE. The white line delimited the channel 1 and 2 intern of RO210.

The tectonic structuration put the thinner portion of RO210 up-dip. In this position, this portion is more suitable for oil accumulation; however, the water / oil contact in the Roncador oil field is much below the RO210 base. Therefore, all sandy deposits and reservoirs are saturated in oil. This condition gives robustness to the performed interpretation in this work once there is no interference of the fluid effect with the analyzed sandy deposits.

At first sight, it can be noticed that the impedance section in Figure 10 (B.1 and B.2) is significantly better in imaging the internal depositional elements within RO210 than the amplitude section. In the depocenter, vertical intercalation of layers of warm-cool-warm colors is discernible from base to top. Considering the geophysical characteristics of the data, it can be interpreted as an intercalation between sandy-shaly-sandy deposits. The possibility of impedance data allowing this interpretation puts this type of data in a much-advanced position compared to amplitude data for interpretation of depositional elements within channel complexes developed on submarine continental slopes.

However, in the eastern portion of RO210, the impedance data show only one layer. By the color pattern, it is interpreted as sandy deposits. In this case, there is no difference between impedance and amplitude data for individualization of the depositional elements once both suggest just one depositional body. At this point, this work steps forward by introducing pseudo-impedance processing as a proxy to individualize depositional elements that are not discernible on the impedance data. As seen in Figure 10 (C.1 and C.2), the eastern portion of RO210, the one interpreted on the impedance data as only one sandy deposit, shows, on the interdec data, a tenue color variation suggesting a stratification from base to top of the sandy deposit overlain by a thin layer of shale, and other sandy deposit at the top. This is better seen on the flattened section at the top of RO210, as shown in Figure 11. Therefore, the interdec data show to be valuable to discrete deposits thinner than the vertical seismic resolution. Back to the discussion on the tectonic control of RO210, revealed by the isopach map, and the distribution of the sandy deposits, as shown on the spectral decomposition map, and integrating this with the impedance and interdec data, it is possible to propose the following interpretation:

The analyses on the maps (isopach and spectral decomposition) suggest the channel geometry for all RO210 deposits, which is corroborated by the data shown in the sections (amplitude, impedance, and interdec).

The isopach map suggests that RO210 is syn-tectonic. It was controlled by the main growth fault that sectioned the entire Cretaceous sedimentary section of the drift phase sectioning the sandy deposits that comprise the Roncador oil field in two distinct structural compartments called high and low blocks.

The spectral decomposition map suggests two settings of sandy deposits with two different thicknesses. These deposits are thicker and off to the depocenter, thinner within the depocenter. At this point, it is already possible to infer that RO210 is a channel complex composed of at least two individual channels, two depositional elements, or two building blocks for this kind of deposit. This interpretation is ratified by the interdec seismic section (Figure 11).

The flattened interdec section also sheds light on the tectonic control of the channel development. It ratifies the isopach map suggestion. However, as it allowed us to visualize at least two individual channels within the RO210 channel complex, it shows that the tectonic control is accurate for the basal channel since it is seen in the thickening of the channel fill in the depocenter. Nevertheless, the interdec section does not suggest tectonic control on the upper individual channel once its thickness is quite even over the whole channel complex width.

What was discussed so far allowed us to infer that the basal individual channel in the RO210 channel complex is confined. Its axis accompanied and was controlled by the fault plane. Off-axis, to the east, the thinner sandy deposits, as interpreted from the spectral decomposition map and the interdec seismic section, might be interpreted as channel extravasation deposits.

On the other hand, the upper individual channel does not share the same characteristics like the lower one. Unlike the latter, the former did not get a clear depocenter, meaning that the fault did not have or had only little control over its development. The upper channel's even thickness, revealed by the interdec data integrated with the interpretation of the sandy deposits performed on the spectral decomposition map, suggests that the upper channel is unconfined. This conclusion questions the character of the so far interpreted upper individual channel in the RO210 channel complex, making it possible to consider it an actual channel or a complete unconfined deposit such as a lobe. The data interpreted in this work did not allow a conclusion on it.

CONCLUSION

The analyses, integration, interpretation, and discussion of the dataset presented in this work allowed the following conclusions:

- The Upper Cretaceous sandy deposits that compose the Roncador oil field reservoirs developed throughout c. 10 million years and are the product of 3 (three) third-order depositional sequences.
- RO200 dates back to the Maastrichtian age and represents the last third-order depositional sequence developed over a time of c. 1.8 million years.
- RO210, the uppermost set of sandy deposits within the Roncador's reservoir, is a channel complex composed of at least 2 (two) individual channels.
- The lower RO210 individual channel is tectonically controlled and has its axis roughly N-S oriented. Its confined axis is located in the western direction, and its margin and / or extravasation in the eastern one. As a result, this channel is asymmetric in the orthogonal section.
- The upper RO210 channel does not show evident characteristics of a confined channel and can be either an unconfined channel or an unconfined deposit like a turbidite lobe.

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