Using Running Sum of AVO Attributes for Improve Albian Carbonates Discrimination on Santos Basin

*C.S.R. Contreras¹, L. Landau¹, P.C. Pereira¹, M.A. Martins¹.
(1. UFRJ/COPPE/LAMCE/Lab2M - Multidisciplinary Modeling Laboratory)

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Abstract

Discrimination of Albian Carbonates is a challenge for seismic interpreters. In this paper, we apply running sum on AVO attributes which can help to discriminate Albian carbonates. In this paper, we intend to present this method on South Santos Basin data.

Introduction

The presence of Albian Guarujá Carbonates on South Santos Basin have been studied in order to find Hidrocarbonates. In consequence, during the last decades were development many production fields like Tubarão, Estrela de Mar, Coral, Cavalo Marinho and Caravelas.

The discrimination of carbonate layers are frequently a complicated objective to achieve for seismic interpreters. This is because porous heterogeneity with respect to complex carbonates formation process. Thus, the carbonates from South Santos Basin were characterized by the presence of oolites calcareous, bioclastic and calcilutite rocks. Additionally, the cyclic sedimentation of guarujá formation, where the Oil and Gas reservoirs are localized, is identified as shallowing upward sequences.

In seismic interpretation, the use of amplitude versus offset (AVO) for reservoir carbonate characterization is a challenge. Because, the method is more complicated than clastics rocks. Furthermore, the application of AVO attributes with running sum of angle traces depends of impedânce. Then, this attributes help to differentiate layers rather than interfaces which are given by conventional data attributes. Thus, these attributes behave as indicators of impedance changes. Applying these AVO attributes in carbonates, using well for a qualitative calibration, can aid in seismic interpretation of the carbonate layers. It's important to remember that the AVO attribute are related to interfaces, so it's possible to see some contacts inside carbonate reservoir, but is difficult to infer characteristics of the layer.

In order to infer some properties of layer we transpose the concept of relative acoustic impedance to AVO attributes through the concept of running sum.

The objective of this work is centered in evaluate the application of AVO attributes and your "integration" to discrimination of albian carbonate from southern part of the Santos Basin.

Method

AVO analyses uses the properties of reflection coefficients which could change with increasing source-receiver offset. So, the amplitude variation on pre-stack offset gathers suit to distinguish different lithologies or fluid contents

Analysis of AVO responses of carbonate rocks has not been well understood yet, but a great effort has been made in the direction of better understanding of relations between their elastic properties, fluid and porosity content. AVO responses have been used successfully to interpret gas-charged dolomites, and to differentiate tight dolomite from porous dolomite (Li et al., 2007). On the other hand, Xu and Payne (2009) discuss strategies for developing carbonate rock physics models.

The most popular AVO attributes for clastic reservoir are: A (Intercept), B(Gradient), AxB(AVO product), aA+bB(Scaled Poisson's Ratio Change), aA-bB(Scaled S-wave Reflectivity). The gradient is related to Poisson ratio contrast between the rocks on the interface and intercept is related to P wave reflectivity. AVO product works very well if you have a Class 3, where low impedance gas sand encased in shale will have larger negative A and B values than the associated non-pay reflectors, AxB will have a positive, classical bright spots response at both top and base. The AVO sum (A+B) is related to Poisson ratio contrast and work well for Class 2 and 3 AVO responses (Ross, 2002) and AVO difference (A-B) is related to Shear Impedance.

We reprocess and generate a set of AVO attributes (A,B, AxB, (A+B)/2, (A-B)/2) from 2D Seismic Line of Coral Field on Santos Basin to investigate whether it is possible to differentiate between fluid content in albian carbonates of Guaruja Formation .

The seismic reprocessing was done creating a true amplitude processing flow. Then, the data after processing follows the characteristics of zero phase, amplitude corrections, noise attenuation, correct moveout velocities, demultiple, no moveout stretch, prestack imaging (Simm, Bacon. 2014). In the case of marine data, the major problem is multiple attenuation because of the presence of seafloor multiples and reverberations which interfere our data, especially on Guarujá formation.

Additionally, after obtain our migrated gathers; we have to conditioning them for AVO analysis. Thus, the process consist in fulfill some conditions like conversion to angle gathers, spectral equalization, residual moveout and offset balancing (Simm, Bacon. 2014).

We use the P-wave sonic and density logs from one well, and estimate shear wave sonic log from the P-wave logs in order to build reflectivity series. Using the AVO analysis software Rokdoc we extracted a statistical wavelet from 2D seismic line and correlated the resulting synthetic seismogram with the seismic data. Then we extracted a wavelet from 2D Seismic Line using the entire well log. The algorithm finds the operator which, when convolved with the reflectivity series from the well, results in a synthetic seismogram that closely approximates the nearest seismic trace. We then stack synthetic gather into 3 different angles and use it for amplitude offset scaling on real seismic angle stacks . The amplitude scaling process was done in water saturated carbonate zone. Then, from synthetic gather was generated a set of AVO attributes and that was qualitatively evaluated with well logs (resistivity, density, pressure and impedance) in order to identify different zones of Guarujá reservoir. The relative acoustic impedance attributes is a poststack seismic attribute that is be able to indicate impedance changes (Subrahmanyam, 2008).

Unlike the seismic amplitude that is associated with reflectivity and therefore the interfaces, the acoustic impedance approaches a layer property. This feature is due to the fact that the attribute is calculated from the running sum of the trace to which a low cut filter is applied. In an attempt to transpose this concept to AVO attributes, we calculate the running sum of the attribute A, B, A+B/2, A-B/2 e AxB (Figure 1, 2, 3, 4, 5).

Results

In the upper part of Guarujá Formation, depositional sequences were established, according to well-log patterns. These sequences bear the main reservoirs of the South Pole, named B1, B2 and B3. Attributes A and B appears to feel, at 4955 m, an oil-water contact indicated by pressure analysis, resistivity and density logs .The first attribute is negative and the second positive. In the same way, others contacts also seems to appear in the lower part of B3 zone. The "integration" of the attributes improves the visualization of the contacts and help to discriminate carbonates layer.

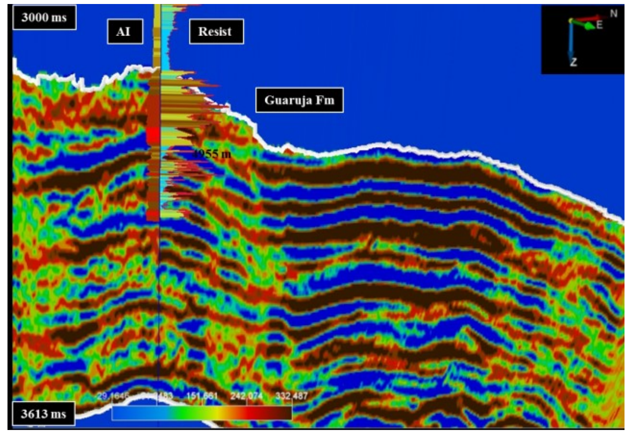

Figure 1 – *Running Sum of the attribute A with Impedance and Resistivity logs.*

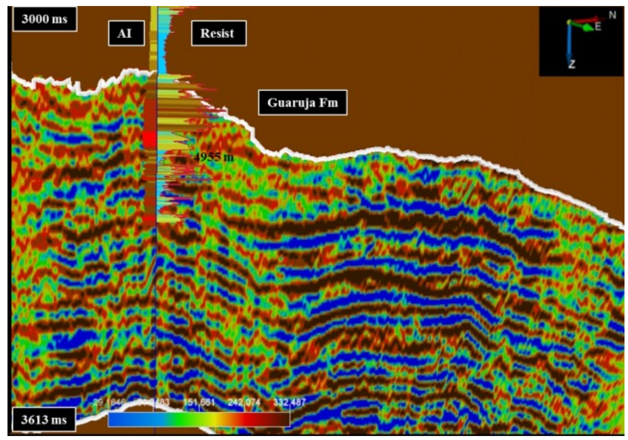

Figure 2 – *Running Sum of the attribute B with Impedance and Resistivity logs.*

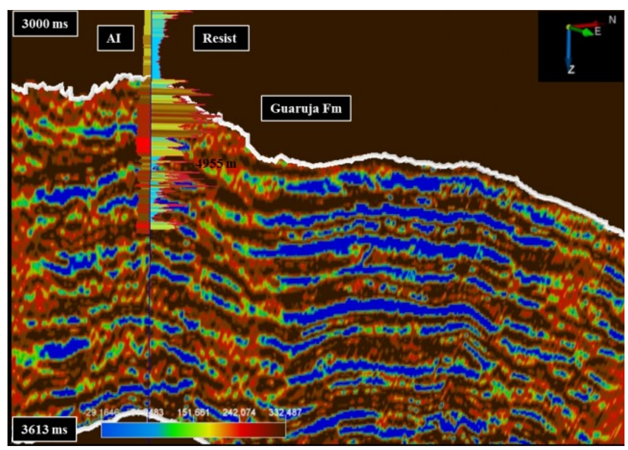

Figure 3 – *Running Sum of the attribute AxB with Impedance and Resistivity logs.*

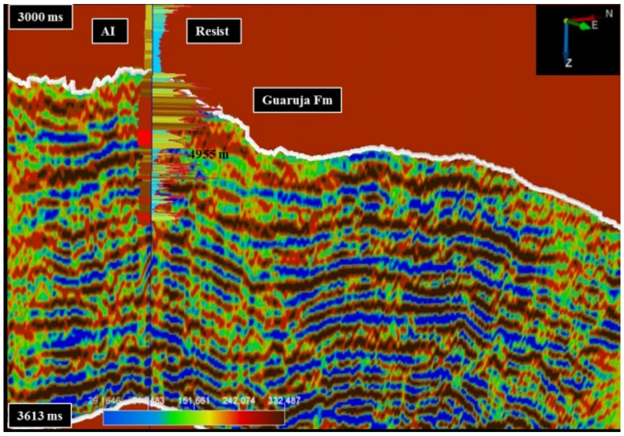

Figure 4 – *Running Sum of the attribute (A+B)/2 Impedance and Resistivity logs.*

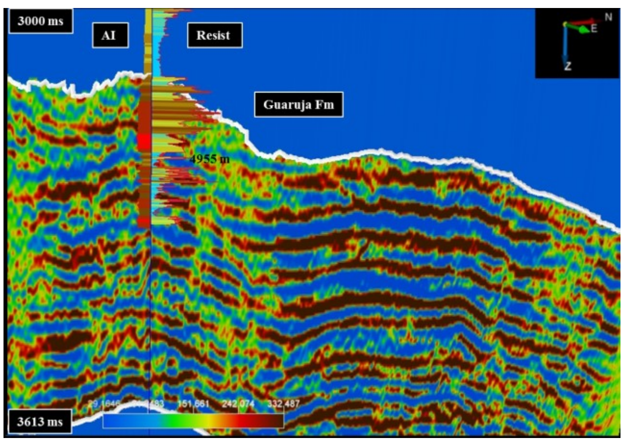

Figure 5 – *Running Sum of the attribute (A-B)/2 Impedance and Resistivity logs.*

Conclusions

We present the improvements that have the application of running sum on AVO attributes. In consequence, we transform a conventional attribute, which represents interfaces, into layer attribute through running sum. This application helps on qualitative interpretation of Albian Carbonates. Future work will include modeling AVO response into different saturation conditions.

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