CONTRIBUTION OF INVERTED SEISMIC DATA IN EXTRACTING ATTRIBUTES TO CHARACTERIZE PLIOCENE AGED CHANNEL LOCATED OFF-SHORE THE NILE DELTA, EGYPT

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ABSTRACT

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Seismic attribute technology can extract information from seismic data and used in predicting, characterizing, and monitoring hydrocarbon reservoirs. Multi-trace windowed extraction method is one of the methods used to extract event attributes. Root Mean Square (RMS) amplitudes and the maximum negative amplitudes of Pliocene aged channel located offshore the Nile Delta, Egypt were extracted using different seismic volumes. The extraction of RMS amplitudes with time window of (−5,5 ms) from the top of the channel using; near, mid, far, and full offset angle stacks volumes, showed the effect of lithology and fluid. Maximum negative amplitudes were extracted between the top and the base of the channel using; reflectivity, Colored Inversion (CI), and Absolute Acoustic Impedance (AAI) near angle stack volumes. Reflectivity and CI near angle stack volumes, showed the difference between the channel complex and the background shale. AAI volume provided detailed description of the reservoir.

KEY WORDS: Pliocene, attributes, reservoir characterization, Colored Inversion (CI), Absolute Acoustic Impedance (AAI), Nile Delta.

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INTRODUCTION

The goal of seismic exploration is to map geologic features associated with hydrocarbon deposition, generation, migration, and entrapment, while the goal of seismic exploitation is to characterize the static and dynamic characteristics of subsurface reservoirs. A good seismic attribute either is directly sensitive to the desired geologic feature or reservoir property of interest, and allows us to define the structural or depositional environment (Chopra and Marfurt, 2005). Seismic attribute technology can extract information from seismic data that is otherwise hidden in the data and which will enhance the use and value of geophysics in an area that is now a prime focus of the petroleum industry: predicting, characterizing, and monitoring hydrocarbon reservoirs (Chen and Sidney, 1997).

Seismic event attributes extracted from the seismic data and associated with a surface provide information about how attributes vary at or between geologic boundaries. Multi-trace windowed extraction method is one of the methods used to extract event attributes. Root Mean Square (RMS) amplitudes and the maximum negative amplitudes of a Pliocene aged channel located offshore the Nile Delta were extracted using different seismic volumes. Worldwide analogs suggest that Pliocene sands are likely to be unconsolidated and have excellent reservoir quality (Aal et al., 2000). The better the quality of the seismic data, the more easily one can determine the characteristics of the reservoir. Another significant seismic attribute contribution was inversion of post-stack seismic amplitudes into acoustic impedance, an important physical property of rocks and an aid in studying the subsurface.

METHODOLOGY

What is a seismic attribute? Seismic attributes are specific measurements of geometric, kinematic, dynamic, or statistical features derived from seismic data. Some are more sensitive than others to specific reservoir environments; some are better at revealing subsurface anomalies not easily detectable; and some have been used as direct hydrocarbon indicators (Chen and Sidney, 1997).

Seismic event attributes extracted from the seismic data and associated with a surface provide information about how attributes vary at or between geologic boundaries. Single-trace windowed seismic event attributes are extracted for "varying windows" (i.e., a window that either changes its length or position on the seismic trace as we move from trace-to-trace). The upper and/or lower bounds of this varying window are defined by interpreted seismic events (Chen and Sidney, 1997). During the mid-1970's, another significant seismic attribute contribution was inversion of post-stack seismic amplitudes into acoustic impedance, an important physical property of rocks and an aid in studying the subsurface. Lindseth (1979) mentioned that the inverted impedance sections yielded useful information about the lateral changes in lithology, because of the ease and accuracy of interpretation of impedance data (Chopra and Marfurt, 2005).

Seismic attributes were extracted using different seismic volumes to study the properties of Pliocene aged channel located offshore the Nile Delta, Egypt. The top of the channel and its base (Fig. 1) were mapped in time. Both horizons helped to understand the architecture of the channel. The extraction of Root Mean Square (RMS) the amplitudes with time window of (−5,5 ms) from the top of the channel using; near, mid, far, and full offset angle stacks volumes, showed the effect of lithology and fluid. Maximum negative amplitudes were extracted between the top and the base of the channel using: reflectivity Rc, CI, and AAI near angle stack volumes.

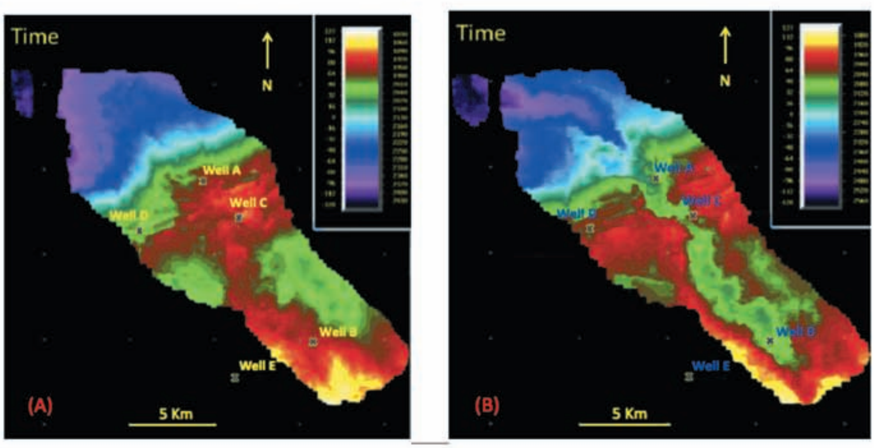
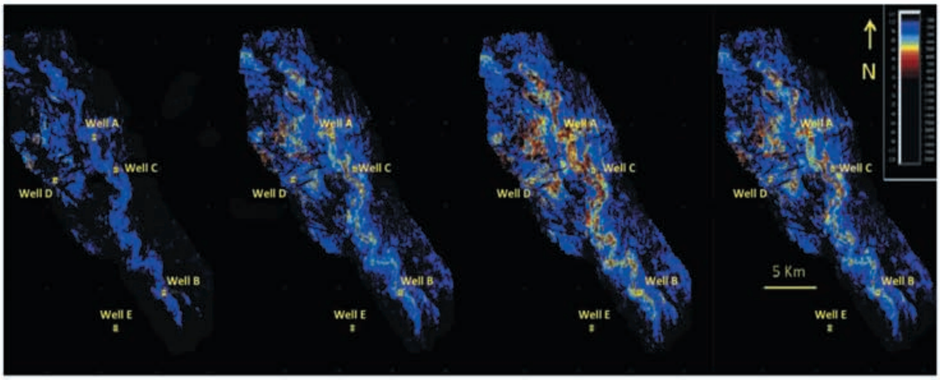


Fig. 1. Structural maps showing the top and the base of the channel in time and depth.

RESULTS

The better the quality of the seismic data, the more easily one can determine the characteristics of the reservoir. In the Pliocene section, there's a significant contrast between the impedances of sands and shale (Avseth et al., 2005), and this characteristic makes it easier to discriminate between the lithologies and different types of fluids. Seismic attribute analysis was used to differentiate between the channel and background shale and to locate the charged segments of the channel. In this section Landmark R5000, Openworks version 0.2, power calculator, were used to generate the following amplitude maps.

Root Mean Square (RMS) amplitudes were extracted using different volumes, near, mid, far, and full offset angle stacks within time window of about [−5,5 ms] from the top of the channel (Fig. 2). The extracted amplitudes from near angle stacks volume showed the contrast between different lithologies, while those extracted from the far angle stacks showed the variation of fluid effect from the south to the north.



Near Mid Far Full offset

Fig. 2. Root Mean Square amplitude extraction maps (−5, +5 ms) from the top of the channel complex. (from left to right; Near, far, mid, full offset angle stacks volumes).

Another attribute extraction was used, which is extracting the maximum negative amplitudes between the top and the base of the channel. This was done using reflectivity Rc, generated CI, and generated AAI (Figs. 3 and 4) near angle stacks volumes. The CI and AAI volumes were generated by using the data of Wells A, B, C, D and E. Reflectivity and CI near angle stack volumes, showed the difference between the channel and the background shale. AAI volume helped in showed the difference between the northern and the southern segments. The generated maps showed that the northern segment is characterized by low impedance due to the presence of clean sandstones and commercial gas while the southern segment is characterized by high impedance due to the absence of clean sandstones (sandstones interbedded with shale) and presence of residual gas and water and showed the gradual variation of the characteristics from north to south. A blind test was applied using the model based inversion technique. Well B has been excluded from the model and the absolute impedance volume, as if it hasn't been drilled. Yet, it showed that the southern segment is completely different from the pay northern segment. It has different properties, than that of the good reservoir.

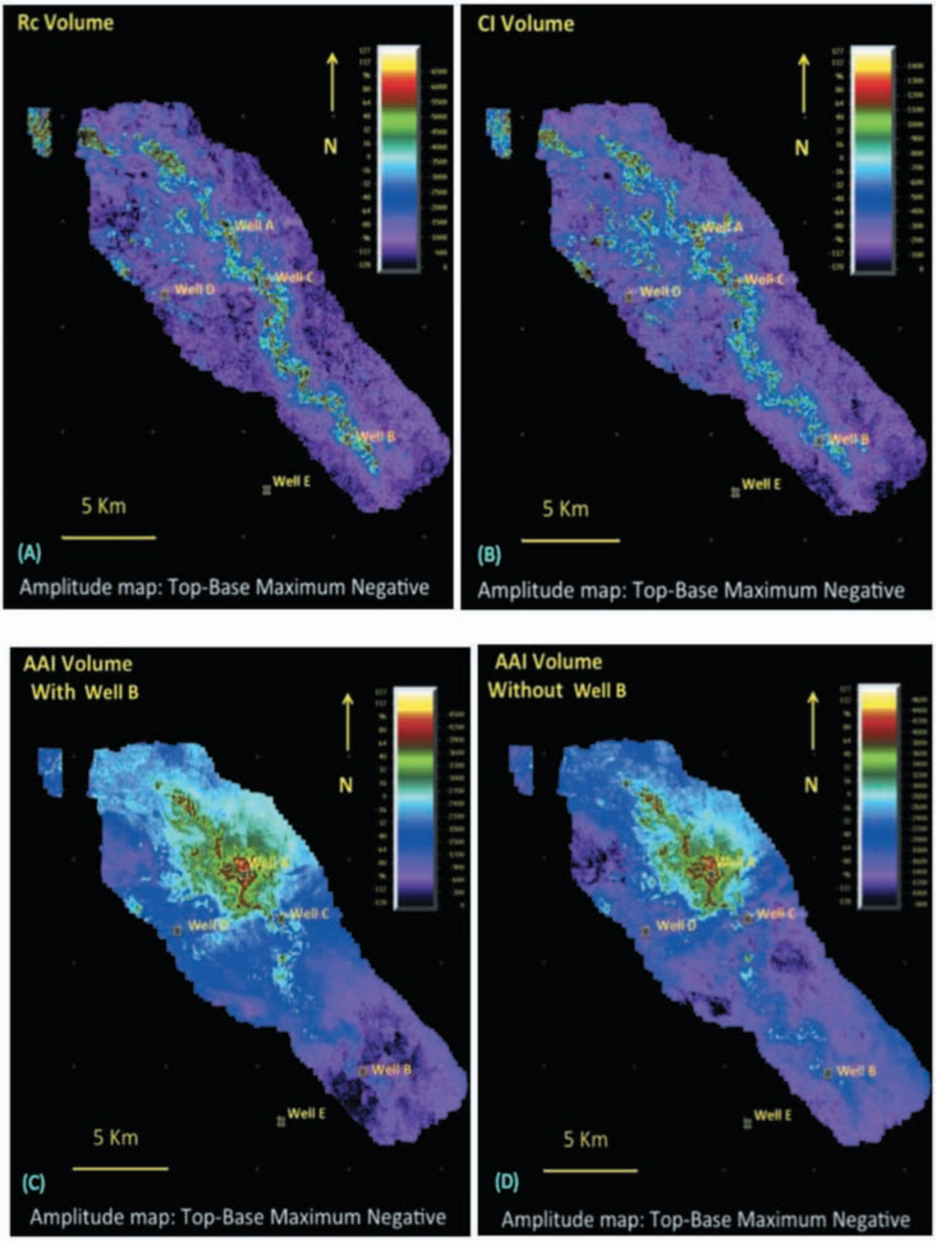
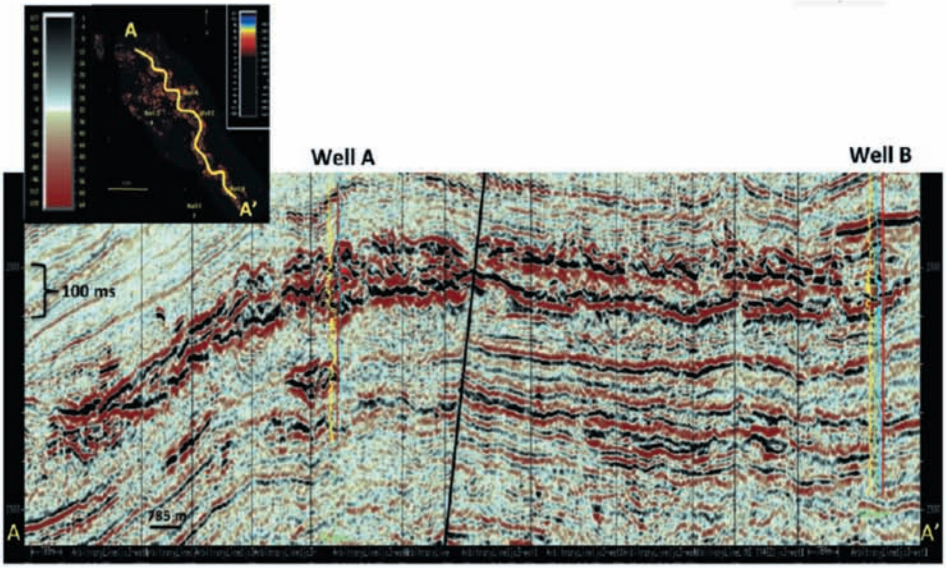
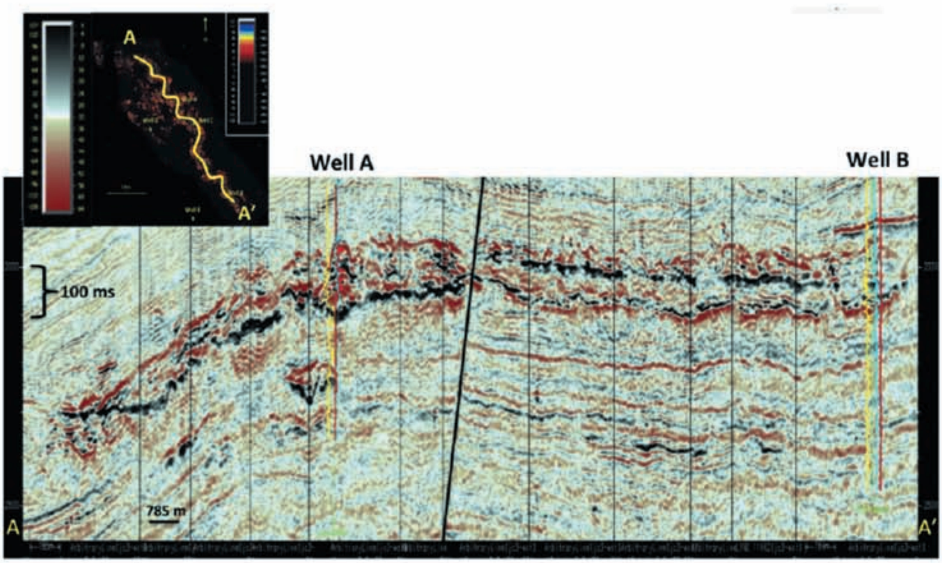


Fig. 3. Maximum negative amplitude extraction map from the top and the base of the channel, using near angle stacks volumes. (A) Reflectivity Volume. (B) CI Volume. (C) AAI Volume, Well B is included in the model. (D) AAI Volume, Well B is excluded in the model.

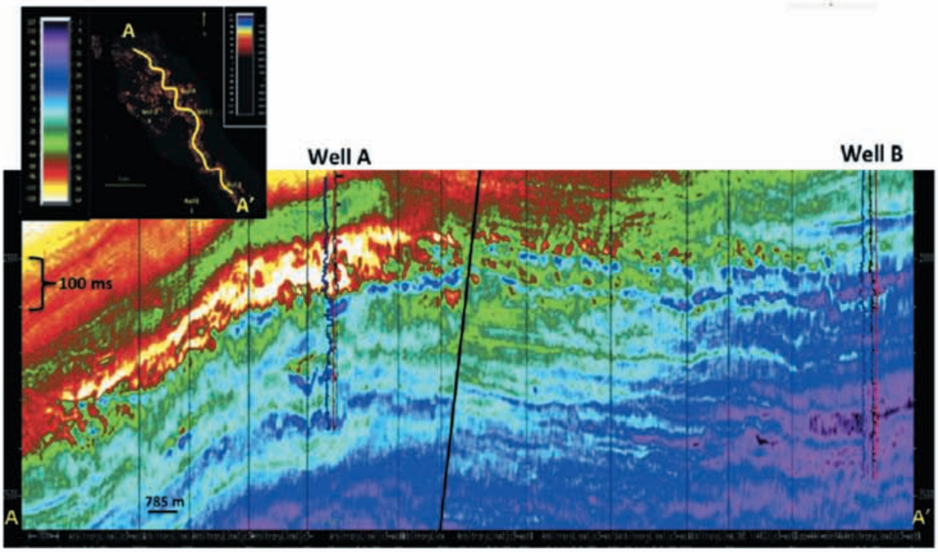


(A) Axial seismic line across the channel complex using; Reflectivity near angle stack volume

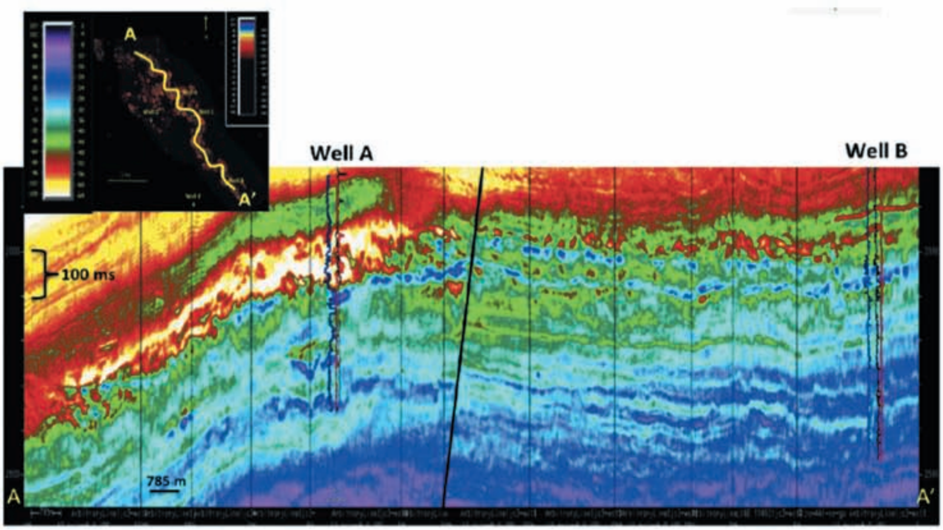


(B) Axial seismic line across the channel complex using; Color inversion near angle stack volume

Fig. 4. Axial seismic line across the channel, using the near angle stacks volumes.
(A) Reflectivity Volume. (B) CI Volume.



(C) Axial seismic line across the channel complex using; AAI, near angle stack volume (Well B is included)



(D) Axial seismic line across the channel complex using; AAI, near angle stack volume (Well B is excluded)

Fig. 4. Axial seismic line across the channel, using the near angle stacks volumes. (C) AAI Volume. Well B is included. (D) AAI Volume. Well B is excluded.

CONCLUSIONS

Seismic attributes were extracted using different seismic volumes to study the properties of Pliocene aged channel located offshore, Nile Delta, Egypt. The extraction of Root Mean Square (RMS) the amplitudes with time window of (−5,5 ms) from the top of the channel using; near, mid, far, and full offset angle stacks volumes, showed the effect of lithology and fluid. Maximum negative amplitudes were extracted between the top and the base of the channel using; reflectivity, CI, and AAI near angle stack volumes. Reflectivity and CI near angle stack volumes, showed the difference between the channel and the background shale. AAI volume helped in discriminating between the northern and the southern segments. The map confirmed that the northern segment is characterized by low impedance due to the presence of clean sandstones and commercial gas while the southern segment is characterized by high impedance due to the absence of clean sandstones (sandstones interbedded with shale) and presence of residual gas and water and showed the gradual variation of the characteristics from north to south. Also, the attribute maps generated by using the results of the blind inversion test, showed that the northern segment is different from the southern segment. The impedance of the southern segment is not as low as that of the northern segment.

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