



An Innovative Approach for More Accurate Reservoir Characterization Using the Conventional Attributes

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Summary

The range of frequencies present in the wavelet controls its ability to resolve the layer thickness. As we know that the zero phase processed seismic section is preferred over the minimum phase processed seismic section for the interpretation due to many inherent advantages. A new seismic volume has been created and analyzed by taking the difference of the seismic volume from minimum phase to the zero phase seismic volume. Where, we find that the difference phase (DP) volume is having an increased resolution in the amplitude spectrum in comparison to the minimum and zero phase volume. The seismic analysis on difference volume helps to distinguish the isolated geological features, which were otherwise not mappable or traceable either on minimum or zero phase seismic volume.

Introduction

Seismic data can provide a reasonably good image of the subsurface. However, without knowing the seismic wavelet there are many equally valid geologic interpretations of the actual subsurface geology. It is the wavelet which convolves with the reflection coefficient and gives the seismic trace. For a particular location or area, the reflection coefficients series is fixed, it is the wavelet which determines the type of seismic trace outputs. We have used two types of the 3D seismic volume namely, Minimum and Zero phase of a land area in the southern part of India (Fig.1). The analysis has been carried out on the difference volume (i.e. Difference of Minimum and zero phase volume) in the zone of interest and brought out interesting isolated geological features which are otherwise not possible to be observed on the conventional minimum and zero phase volume.

Brief of the Area.

The area is under Nagapatinam sub basin in the southern part of India. Seismic data is a merged volume of the 13 seismic data sets at the PSTM level

(Fig.1). However, our study is confined to only the NW part of the area as marked by the red block, which is also known as the Nannilam area. Where most of the wells are producing from the Nannilam formation (i.e. below Cretaceous level).The producing sands within Nannilam formation are discrete in nature and distributed randomly.

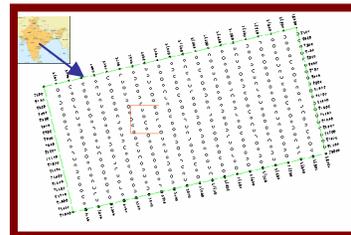


Fig.1. Area of Study.

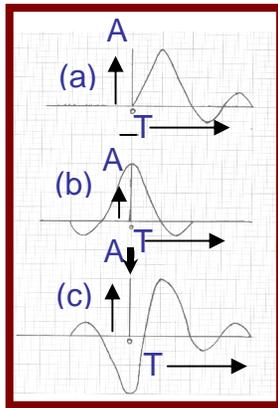


Fig.2 The Concept – Graphical Representation of (a). Minimum ,(b).Zero phase wavelet. Where (c) Difference (i.e (a) – (b)) wavelet. Where A is amplitude and T is Time.

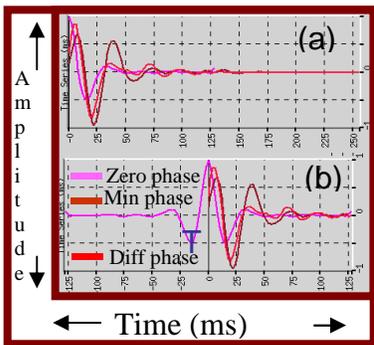


Fig.3 . (a) Minimum, (b) Zero phase equivalent of Minimum, Zero and new(difference) Wavelet.

Methodology

The dominant frequency of the merged seismic volume was ranging from 25 Hz. to 30 Hz. and our target was to map the sand bodies which are from 8 to 26 meters in thickness. With the existing bandwidth, it is not possible to map the discrete sand bodies of such a dimension.

Application of volume subtraction approach has been adopted and shown that how it can be helpful to identify and map the discrete sand bodies. The concept behind the new techniques is that when a minimum phase wavelet is subtracted from the zero phase wavelet, the type of wavelet we get is used for the creation of the seismic traces by convolution. A graphical justification for a very simple technique which can help detect lateral changes in wavelet shape is shown in Fig.2. In other words, the Seismic Volume difference between Minimum and Zero (converting the existing minimum phase to zero phase first) phase has been created. The wavelet analysis of the three volumes namely – Minimum, Zero and Difference phase has been calculated in the same time interval (from 1200ms to 2000ms), in the same area of

the from the respective 3D volumes (Fig.3). Where it is clearly seen in the time series (both in the minimum and zero phase equivalent) that the wavelet in the difference phase volume is little compressed and its side lobes are also reduced.

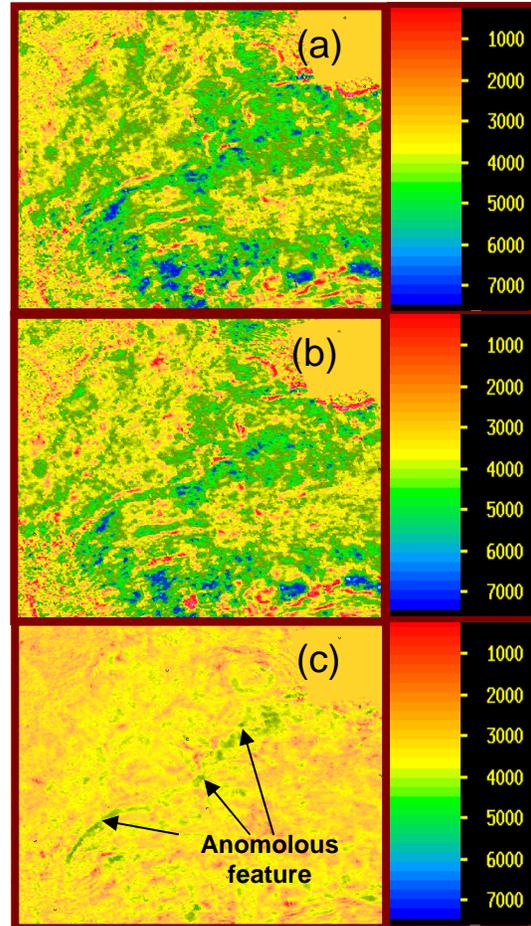


Fig 4. RMS Amplitude at the Cretaceous level from the minimum phase volume (a), Zero phase volume (b), difference phase volume with anomalous feature(c) (in Window -6ms to 6 ms).



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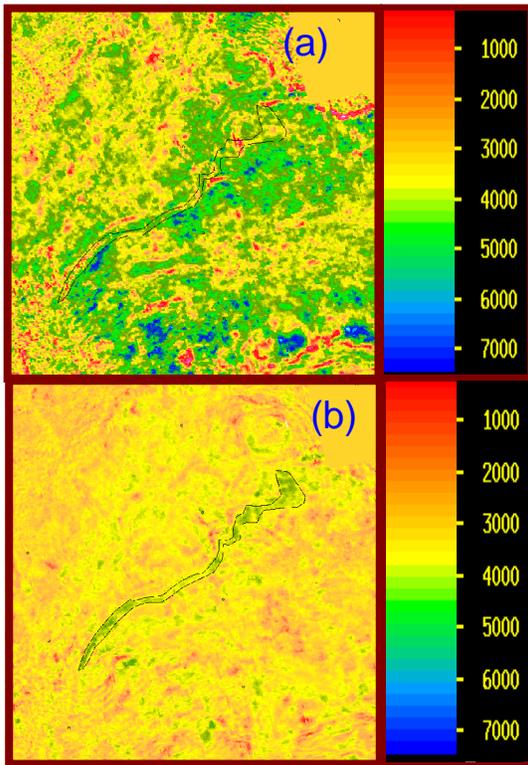


Fig.5. (a).RMS Amplitude from the zero phase volume with the identified Geological body Polygon.(b).RMS Amplitude from the Difference phase volume with discrete Geological body in the polygon. (all at Cretaceous level in Window -- 6ms to 6 ms) .

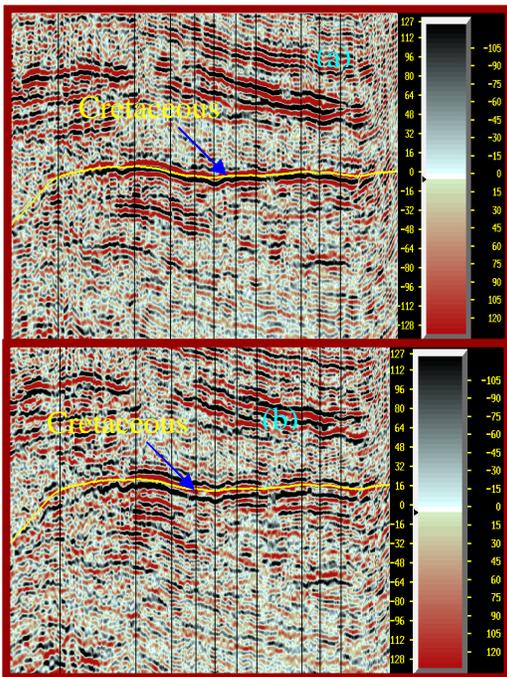


Fig. 6 Arbitrary line along the extracted Geological body (polygon) from the (a) Minimum phase volume.(b) Difference phase volume.

The analysis on the difference volume has been carried out in different windows and the results have been compared to the results of Minimum and Zero phase volume by doing the same analysis.

Horizon slice of RMS amplitude has been taken along the Cretaceous horizon in -6 to +6 ms window (Fig.4). It has been extracted in all the three volumes, namely- Minimum, Zero and Difference phase volume. One anomalous feature (Fig.4(c)) has been clearly observed, which may be embedded in Minimum and Zero phase volumes (Fig.4 (a) & Fig.4 (b)). It is found to be an isolated Geological event. One polygon has been drawn (Fig.5 (b)) over the anomalous feature observed at the Difference phase volume. When the Same poly is overlain on Zero Phase volume slice(Fig.5 (a)),in the same slice window, it is found that the anomalous feature is embedded in the Zero phase ,however, difficult to identify.

An arbitrary line on the anomalous feature (along the poly) has been drawn using minimum and difference phase volume (Fig.6(a) & Fig.6(b)). It is clearly seen that there is clear-cut around half cycle time shift in the Cretaceous horizon, which has to be there as per our concept used (see the wavelet form Fig.2). However, in the outset, the quality of seismic data of minimum phase data and difference phase data is not very different (Fig.6 (a) and Fig.6(b)).

Most of the wells, as known fact, in the Nannilam area are producing hydrocarbons below Cretaceous horizon (mostly around 100ms).

The RMS amplitude distribution (below Cretaceous horizon from 70 to 130 ms) has been taken in the Nannilam area, on Minimum, Zero and difference phase volume(Fig.7). The spectral decomposition slice (below Cretaceous horizon from 70ms to 130ms window) has also been taken on Minimum, Zero and difference phase volumes (Fig.8).

Discussion

Due to the compression and reduction in the side lobes of the wavelet in the difference volume (Fig.3), the resolution of the data has increased which enables us to map the isolated seismic event (Fig.4). Three wells, namely 'x','y','z' are producing gas ,while well z1 is dry (Fig.7), are existing in the same window (below Cretaceous top from 70ms to 130ms).The RMS amplitude in the desired window clearly shows that the sand body (that is in red & yellow in colour as marked) does not extend to 'x' and but to y ,z, and z1 wells (Fig.7(a) & Fig.7(b)), which means that the 'x' well should be dry. However, It is found that well 'x' is producing, which is not being confirmed through the analysis on Minimum and Zero phase volume. Although it is found that sand is present in the well'z1',by Log data, but not charged. Moreover ,the



sand distribution in well 'z1' is evident in Fig.7.(a),(b) & (c)). When the RMS analysis, on the difference volume, is carried out in the same window, it clearly indicates the distribution of the sand at 'x' well, thus confirm its status along with the status of well 'z1','y','z'(Fig.7(c)). The spectral distribution at the tuning frequency of 38 Hz., clearly shows that the sand body distribution (yellow in colour, as marked) does not extend to 'x' producing well but the sand shows its presence at the 'y' producing well, (Fig.8(a) & Fig. 8(b)) both in the minimum and zero phase volumes. While it clearly shows the sand bodies at 'x' well as well as at 'y' well on the difference phase volume (Fig.8 (c)). The distribution of the sand body ,which are discrete in nature, are shown very prominently in the Nannilam area(Fig.8(c) on the difference phase volume in comparison to the Minimum and Zero phase volume(Fig.8 (a) &(b)).The same type of pattern of the discrete sand body distribution (Fig.8 (c)) is to be found as per the Geological , Petrophysical and Geochemical study of the area.

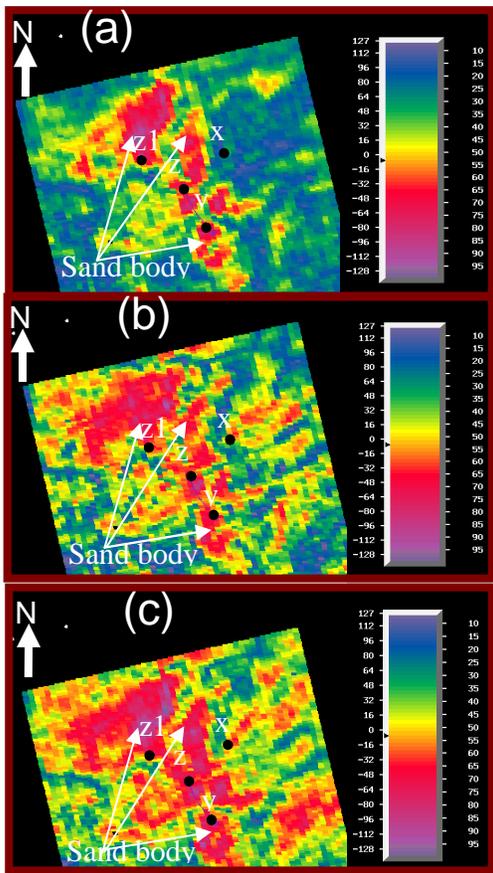


Fig.7 RMS Amplitude shows Discrete sand body distribution in the nannilam area in (a). Minimum (b).Zero (c) Difference Phase Volume (below Cretaceous from 70 to 130ms).

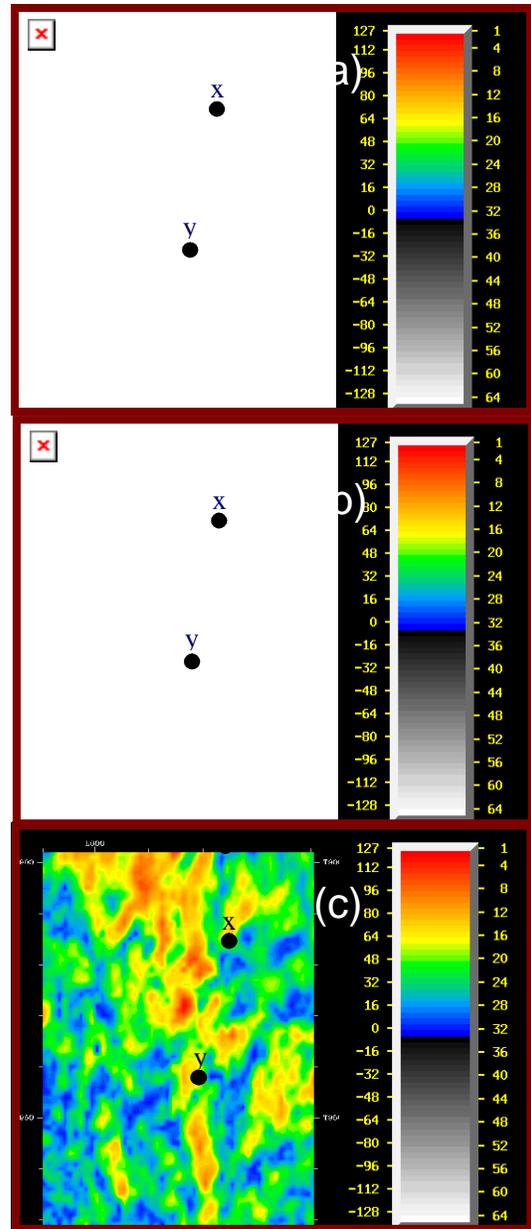


Fig.8 Spectral Decomposition at 38 Hz at(a).Minimum phase Volume (b).Zero Phase volume.(C) Difference Phase volume.(below Cretaceous(From 70 to 130 ms))



Conclusions

When interpreting seismic data it is important to realize that the actual subsurface geology is always being viewed through the filter of the seismic wavelet. In this newly developed method, where the increase in the resolution of the newly developed seismic data enables us to map the isolated geological events, which we are unable to map through the other conventional methods. The technique's most attractive feature is that it's easy to use from the interpreter's viewpoint. Moreover, many commercial interpretation packages allow the computation of the requisite difference (New) volume.

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Views expressed in this paper are that of the author only and may not necessarily be of ONGC.

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