Seismic Edge Detection by Application of Cepstral Decomposition to Data Driven Modeled Geologic Channel Feature in Niger Delta.

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ABSTRACT

Seismic edge detection algorithm unmasks blurred discontinuity in an image and its efficiency is dependent on the precession of the processing scheme adopted. Data-driven modeling is a ast machine learning scheme and a formal usually automatic version of the empirical approach in existence for long time and which can be used in many different contexts. Here, a desired algorithm that can identify masked connection and correlation from a set of observations is built and used.

Geologic models of hydrocarbon reservoirs facilitate enhanced visualization, volumetric calculation, well planning and prediction of migration path for fluid. In order to obtain new insights and test the mappability of a geologic feature, spectral decomposition techniques i.e. Discrete Fourier Transform (DFT), etc and Cepstral decomposition techniques, i.e Complex Cepstral Transform (CCT), etc can be employed. Cepstral decomposition is a new approach that extends the widely used process of spectral decomposition which is rigorous when analyzing very subtle stratigraphic plays and fractured reservoirs. This paper presents the results of the application of DFT and CCT to a two dimensional, 50Hz low impedance Channel sand model, representing typical geologic environment around a prospective hydrocarbon zone largely trapped in various types of channel structures. While the DFT represents the frequency and phase spectra of a signal, assumes stationarity and highlights the average properties of its dominant portion, assuming analytical, the CCT represents the quefrency and saphe cepstra of a signal in quefrency domain. The transform filters the field data recorded in time domain, and recovers lost sub-seismic geologic information in quefrency domain by separating source and transmission path effects. Our algorithm is based on fast Fourier transform (FFT) techniques and the programming code was written within Matlab software. It was developed from first principles and outside oil industry's interpretational platform using standard processing routines. The results of the algorithm, when implemented on both commercial and general platforms, were comparable. The cepstral properties of the channel model indicate that cepstral attributes can be utilized as powerful tool in exploration problems to enhance visualization of small scale anomalies and obtain reliable estimates of wavelet and stratigraphic parameters. The practical relevance of this investigation is illustrated by means of sample results of spectral and cepstral attribute plots and pseudo-sections of phase and saphe constructed from the model data. The cepstral attributes reveal more details in terms of quefrency required for clearer imaging and better interpretation of subtle edges/discontinuities, sand–shale interbedding, differences in lithology. These positively impact on production as they serve as basis for the interpretation of similar geologic situations in field data.

Keywords: Complex Cepstral Transform, Fourier transform, Gamnitude, Quefrency, Saphe,

1. Introduction

Seismic edge detection algorithm unambiguously unmasks blurred discontinuity in an image and its efficiency is dependent on the precession of the processing scheme adopted. Data-driven modeling is a fast developing machine learning scheme and a formal usually automatic version of the empirical approach in existence for long time and which can be used in many different contexts, i.e. when manual processing and informal observations are used. Here, a desired algorithm that can identify masked connection and correlation from a set of observations or data is built and used.

Geologic models of hydrocarbon reservoirs facilitate enhanced visualization, volumetric calculation, well planning and prediction of migration path for fluid. In order to obtain new insights and test the mappability of a geologic feature, spectral decomposition techniques i.e. Discrete Fourier Transform (DFT), Short-Time Fourier Transform (STFT), etc and Cepstral decomposition techniques, i.e. Real Cepstral Transform (RCT), Complex Cepstral Transform (CCT), etc. can be employed. Cepstral decomposition is a new approach that extends the widely used process of spectral decomposition which is rigorous when analyzing very subtle stratigraphic plays and fractured reservoirs.

This paper presents the results of the application of DFT and CCT to a two dimensional, 50Hz low impedance Channel sand model, representing typical geologic environment around a prospective hydrocarbon zone. A large number of oil and gas fields have been found to be trapped in various types of channel structures. While the DFT represents the frequency and phase spectra of a signal in frequency domain, assumes stationarity and highlights the average properties of its dominant portion, assuming analytical, the CCT represents the quefrency and saphe cepstra of a signal in quefrency domain. The transform filters the field data recorded in time domain, and recovers lost sub-seismic geologic information in quefrency domain by separating source and transmission path effects. Our algorithm is based on fast Fourier transform (FFT) techniques and the programming code was written within Matlab software. It was developed from first principles and outside oil industry's interpretational platform using standard processing routines. The results of the algorithm, when implemented on both oil industry (e.g. Kingdom Suite, Petrel) and general platforms, were comparable.

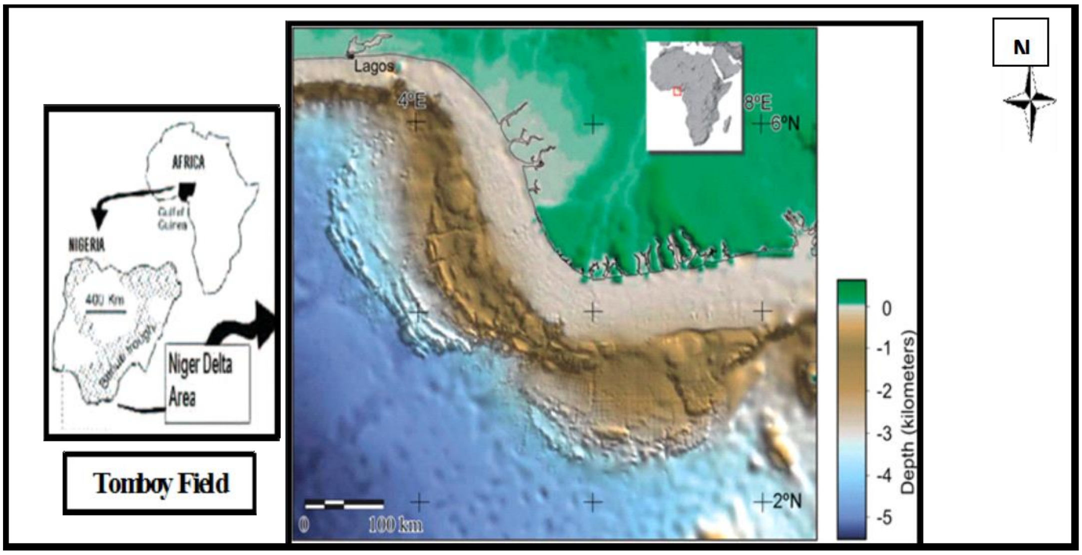
The cepstral properties of the channel model indicate that cepstral attributes can be utilized as powerful tool in exploration problems to enhance visualization of small scale anomalies and obtain reliable estimates of wavelet and stratigraphic parameters. The practical relevance of this investigation is illustrated by means of sample results of spectral and cepstral attribute plots and pseudo-sections of phase and saphe constructed from the model data. The cepstral attributes reveal more details in terms of quefrency required for clearer imaging and better interpretation of subtle edges/discontinuities, sand–shale interbedding, differences in lithology and generally better delineation and delimitation of stratigraphic features than the spectral attributes.

Seismic visibility is enhanced through the change of the seismic data outlook from the standard amplitude measurement to a new domain in order separate fact from artifact in seismic processing and interpretation. Seismic data are usually contaminated by noise, even when the data has been migrated reasonably well and are multiple-free (Satinder et. al., 2011). In frequency and quefrency domains, the technique separates fact from artifact and better geologic picture emerges. This is necessary in hydrocarbon reservoir characterization since a clear knowledge of a reservoir facilitates enhanced recovery. (Ofuyah et al, 2014). The Cepstrum is the Fourier transform of the log of the spectrum of the data.

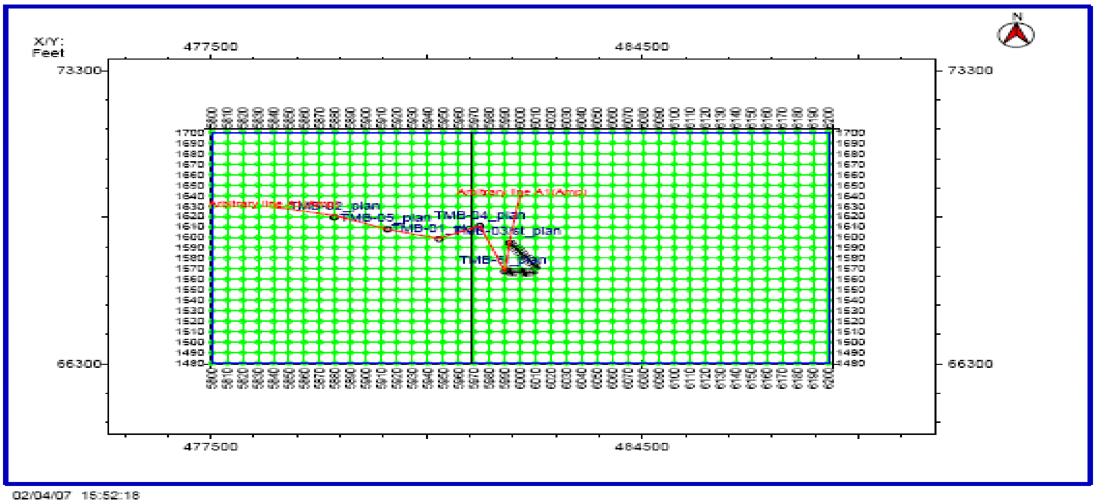
This paper is an attempt to describe aspect of innovative and unconventional methods and new technology developed for application in areas of uncertain data or complex geology such as in deep waters, marginal fields, fractured zones, etc. for the purpose of their development. The presentation outline is as follows: Section one, this section, introduces the concept of edge detection, model types, and interpretation in more resolving domains rather than in time,(natural data acquisition domain), and geology of the study area. In section two, the concepts of Spectral and Cepstral decompositions are addressed, while in section three, the methodology adopted is presented. Section four contains the results and analysis and finally, in section 5, the conclusions of this study are highlighted.

Geologic Background

The source of our data is the ‘Tomboy’ Basin in Niger delta region (Figure 1). The region is a prolific hydrocarbon province formed during three depositional cycles from middle cretaceous to recent in Nigeria. It is located in Nigeria between latitudes 3^0N and 6^0N and longitudes $4^0 30^1$ E and 9^0E and bounded in the west by the Benin flank, in the east by the Calabar flank and in the north by the older tectonic elements e.g. Anambra basin, Abakaliki uplift and the Afikpo syncline. The Niger delta basin is one of the largest subaerial basins in Africa. It has a subaerial area of about 75,000 km^2, a total area of 300,000 km^2, and a sediment fill of 500,000 km^3 (Tuttle, et al, 2015). The region is a large arcuate delta of the destructive wave dominated type and is divided into the continental, transitional and marine environments. In order of deposition, a sequence of under compacted marine shale (Akata formation, depth from about 11121 ft, and main source rock of the Niger delta), is overlain by paralic or sand/shale deposits (Agbada formation, depth from about 7180-11121ft, are present throughout. This is the major oil and natural gas bearing facies in the basin. The paralic interval is overlain by a varying thickness of continental sands (Benin formation, depth from 0-about 6000ft, contains no commercial hydrocarbons, although several minor oil and gas stringers are present) Avbovbo (1978), Merki(1972). Growth faults strongly influenced the sedimentation pattern and thickness distribution of sands and shales. Oil and gas are trapped by roll-over anticlines and growth faults (Weber, 1987). The ages of the formations become progressively younger in a down-dip direction and range from Paleocene to Recent (Merki, 1972). Hydrocarbon is trapped in many different trap configurations. The implication of this is that geological and geophysical analyses must be sophisticated, a departure from the conventional, in order to unmask hidden/by-passed reserves, usually stratigraphic and laden with huge hydrocarbon accumulation.



(a) Tomboy Field, Niger Delta (Smith and Sandwell, 1997, as cited in Corredor *et a*l,, 2005).



(b) Tomboy Field, Niger Delta: Base map of survey area showing the arbitrary line (in Red) in the field.

Figure 2: Tomboy Field, Niger Delta: (a) Bathymetric Sea-floor image of the Niger Delta obtained from a dense grid of two-dimensional seismic reflection profiles and the global bathymetric database showing the location of the Study Area (b) Base map of survey area showing the Arbitrary line(in Red). The Arbitrary line connects the entire six wells (black dots). The well under consideration is TMB 06 is located at coordinates inline 6009 and crossline 1565, right of the vertical line

2. Theory

2.1 Fourier Transform

Fourier analysis decomposes a signal into its sinusoidal components based on the assumption that the frequency is not changing with time (stationary). Fourier transform allows insights of average properties of a reasonably large portion of trace but it does not ordinarily permit examination of local variations) Taner et al, 1979).This is because the convolution of a source wavelet with a random geologic series of wide window produces an amplitude spectrum that resembles the wavelet. To obtain a wavelet overprint which reflects the local acoustic properties and thickness of the subsurface layers, a narrow window as in

STFT can be adopted. In practice, the standard algorithm used in digital computers for the computation of Fourier transform is the Fast Fourier Transform (FFT/DFT).

2.1.2. Discrete Fourier Transform (DFT)

The Discrete Fourier Transform (DFT) is the digital equivalent of the continuous Fourier transform and is expressed as

$$f(w) = \sum_{t=-\infty}^{w-\infty} f(t) \exp(-iwt) \tag{1}$$

While the inverse discrete Fourier transform is

$$f(t) = \sum_{t=-\infty}^{w-\infty} f(w) \exp(iwt) \tag{2}$$

where, w is the Fourier dual of the variable ‘t’ .If ‘t’ signifies time, then ‘w’ is the angular frequency which is related to the linear (temporal frequency) ‘f’. Also, F(w) comprises both real ($F_r(w)$ and imaginary $F_i(w)$ components. Hence

$$F(w) = F_r(w) + iF_i(w) \tag{3}$$

$$A(w) = [F_r^2(w) + F_i^2(w)]^{1/2} \tag{4}$$

$$\phi(w) = \tan^{-1}\left[\frac{F_i(w)}{F_r(w)}\right] \tag{5}$$

Where A(w) and ϕ (w) are the amplitude and phase spectra respectively (Yilmaz,2001).

Cepstral Transform (CT)

Cepstral decomposition is a new approach that extends the widely used process of spectral decomposition. This measures bed thickness even when the bed itself cannot be interpreted (Hall, 2006). While spectral decomposition maps are typically interpreted qualitatively using geomorphologic pattern recognition or semi quantitatively, to infer relative thickness variability Spectral decomposition is rigorous when analyzing subtle stratigraphic plays and fractured reservoirs. The Cepstrum processing technique gives a solution of other signals which have been convolved or multiplied in time domain because the operation of the nonlinear mapping can be processed by the generalized linear system (Homomorphic system). (Jeong.2009). Cepstral analysis is a special case of Homomorphic filtering. Homomorphic filtering is a generalized technique involving (a) a nonlinear mapping to a different domain where (b) linear filters are applied, followed by (c) mapping back to the original domain. The independent variable of the Cepstrum is nominally time though not in the sense of a signal in the time domain , and of a Cepstral graph is called the Quefrency but it is interpreted as a frequency since we are treating the log spectrum as a waveform. To emphasize this interchanging of domains, Bogert, Healy and Tukey (1960) coined the term Cepstrum by swapping the order of the letters in the word Spectrum. The name of the independent variable of the Cepstrum is known as a Quefrency, and the linear filtering operation is known as Liftering. The Cepstrum is useful because it separates source and filter and can be applied to detect local periodicity. There is a complex cepstrum (Oppenheim, 1965) and a real Cepstrum.. In the “real Cepstrum”, as opposed to the complex Cepstrum used here, only the log amplitude of a spectrum is used (Hall, 2006). Complex Cepstrum uses the information of both the magnitude and phase spectra from the observed signal. The complex Cepstrum method is used to recover signals generated by a convolution process and has been called Homomorphic deconvolution (Oppenheim and Schafer, 1968). The applications can be found from seismic signal, speech and imaging processing. Kepstrum was named by Silvia and Robinson in 1978 and used for seismic signal analysis, although the literature on its application is limited. The Kepstrum and complex Cepstrum give almost same results for most purpose.

The Cepstrum can be defined as the Fourier transform of the log of the spectrum. Given a noise free trace in time (t) domain as x (t) obtained by convolution of a wavelet w(t) and reflectivity series r(t) and assuming X (f), W (f) and R (f) are their frequency domain equivalents, then ,Since the Fourier transform is a linear operation, the Cepstrum is

$$F\,[\ln(\mathrm{mod}\ X)] = F\,[\ln(\mathrm{mod}\ W) + F[\ln(\mathrm{mod}\ R)] \qquad (6)$$

To distinguish this new domain from time, to which it is dimensionally equivalent, several new terms were coined. For instance, frequency is transformed to Quefrency, Magnitude to Gamnitude, Phase to Saphe, Filtering to Liftering, even Analysis to Alanysis. Only Cepstrum and Quefrency are in widespread today, though liftering is popular in some fields (Hall, 2006).

3. Methodology

3.1 Field Data Analysis

The 3D seismic and well data used in this study were obtained over ‘Tomboy’ field by Chevron Corporation Nigeria. The field data comprises a base map, a suite of logs from six (6) wells, and four hundred (400) seismic Inlines and 220 Crosslines. Some of the log types provided are Gamma-Ray (GR), Self-Potential (SP), Resistivity, Density, Sonic, etc. Lithologic logs of Gamma-Ray and Self Potential were first plotted to identify the sand (hydrocarbon) unit of interest and then correlated with Resistivity logs .This Interval corresponds to 2648-2672 milliseconds using time-depth conversion. It is important to state that rather than use measured seismic line near the well (TMB 06) under examination for seismic-to-well tie, as is traditionally done, a line (arbitrary) connecting the entire wells was constructed to enhance the seismic data quality for the tie since it integrates the general geologic information in the survey.

3.2 Computation and Decomposition of Channel Model

We computed the frequency attributes of a Channel sand model of low impedance.. The Channel represents spatial variation of the distribution of sediments and rocks in the subsurface and can exist anywhere from river basins to deep-sea environments. Several of the world’s oil and gas fields are developed from channel environments. It was examined with a zero phase Ricker wavelet of 50Hz center frequency using the fast Fourier transform (FFT) convolution technique. The Ricker wavelet was convolved with a four-layer reflectivity series, where the third layer is the channel feature**.** The computed model is presented as Figure 9**.** The acoustic velocity values used are 7926.83 ft/s inside the channel and 9031.45 ft/s outside the channel showing that channel bed, about 35.4 ms thick, is a low impedance layer (Tables 1.0 and 1.1). The computed model is inherently noisy since well data was involved in its computation. Recall that Seismic data are usually contaminated by noise, even when the data has been migrated reasonably well and are multiple-free (Satinder et al., 2011).

The effective offset in Figure 9 is 0 to 2T, where T represents period. The Thickness of the channel is denoted in units of the dominant (center) period corresponding to the dominant frequency of the Ricker wavelet (zero-phase) used in modeling. The center frequency used for simulation is 50Hz implying a period of 20 milliseconds. The spectral and cepstral properties of the model such as amplitude and phase spectra as well as and gamnitude and saphe cepstra highlighting tuning effects are displayed as Figure 10

The model was data- driven and developed to test the resolution capability of the transforms algorithms and to calibrate the model. The transforms employed are the Discrete Fourier Transform (DFT) and theCcomplex Cepstral Transform (CVT). The SEG Y data was loaded into Petrel software and a reconnaissance was performed on the seismic sections of the field. A channel feature was identified between inlines 5880 and 6190 and crossline 1565. Well 06 penetrated the structure around inline 6009. From the log data of Well 06, some model parameters were extracted and then used to compute new parameters necessary for model computation. The Shale reference point was set at 60 American Petroleum Institute (API) units for GR log. Formations with less than (<) 60API units were read as Sands while those greater than (>) 60 API units were read as Shale. Representative model parameters were extracted from Well 06 log data at appropriate depths. The data consist of the GR, RHOB and ITT readings. The logs were correlated with Self Potential(SP) and Resistivity logs. This was followed by the computation of parameters like velocity, acoustic impedance and reflection coefficient used for the modeling of the channel sand structure. The convolutional equation used is given by

$$S(t) = W(t) * R(t) \tag{7}$$

Where S (t) = synthetic seismogram; W (t) = Ricker Wavelet and R (t) = Reflection Coefficient.

The maximum useful frequency or centre frequency was set at 50Hz. This frequency was selected based on apriori information of the general seismic bandwidth of 5-65Hz and the need to capture some structural events. Majority of the stratigraphic traps have structural elements and in some cases the distinction is difficult. Several center frequencies were explored (Figure 7). The channel seismogram consists of 50 seismic traces presented in the wiggle format.

4. Results and Interpretation

In seismic attribute analysis, amplitude or magnitude, or envelope indicates local concentration of energy, bright spots, gas accumulation, sequence boundaries, unconformities, major changes in lithology, thin bed tuning effects, etc; phase measures lateral continuity/discontinuity/edge) or faulting, shows detailed visualization of bedding configuration and has no amplitude information. In the case of the phase attribute, there is a flip owing to sign reversal (Jenkins and Watts (1968). The frequency attribute reflects attenuation spots, indicates hydrocarbon presence by its low frequency anomaly, shows edges of low impedance thin beds, fracture zone indication-appears as low frequency zones, and also indicates bed thickness. Higher frequencies indicate sharp interfaces or thin shale bedding, lower frequencies indicate sand rich bedding, sand/shale ratio indicator (Subrahmanyam and Rao, 2008). In Cepstral domain, the Gamnitude, Saphe and Quefrency are interpreted in a similar manner to Magnitude, Phase and Frequency in the Spectral domain. Saphe highlights discontinuity/edge and lithologic changes, while Quefrency indicates fracture zone, hydrocarbon presence by its low values.

WELL TMB 06

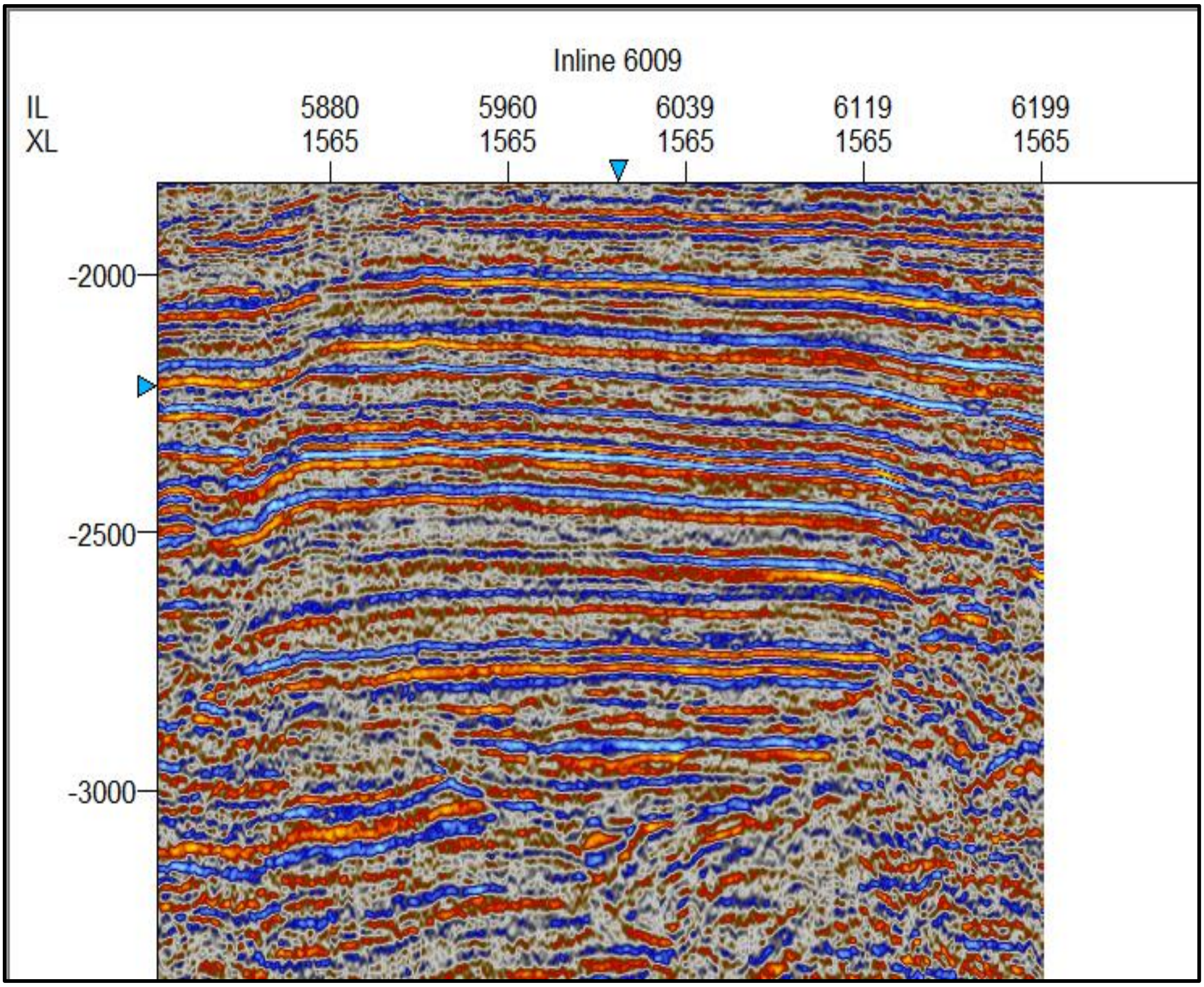
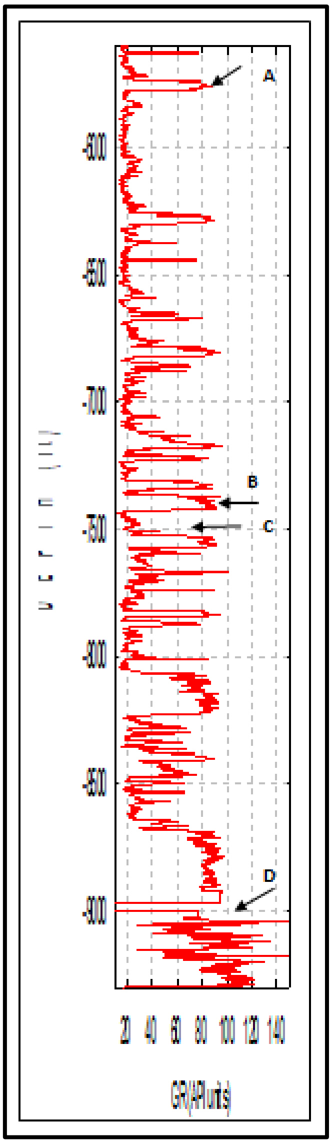
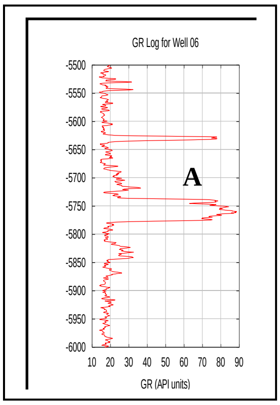
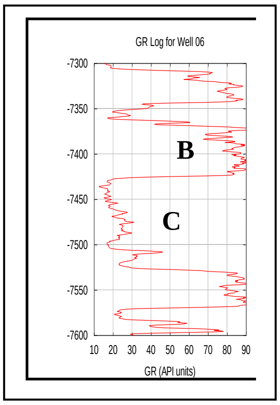


Figure 3: Tomboy Field, Niger Delta: Seismic Section showing Channel feature. (Petrel Platform).

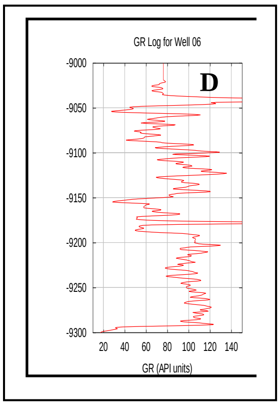






3.5i – At Depth 5738.0ft – 1st layer (A) of Channel Model (Z1)

3.5ii – At depth 7368.0ft & 7435.0ft – 2nd(B) & 3rd (C) layers of channel Model (Z2)& (Z3)



3.5iii– At Depth 9105.0ft – 4th layer (D) of Channel Model (Z4)

Figure 4: Well log analysis**:** Gamma Ray Log of Well 06 showing picked horizons for model computation. (Plotted using Gnuplot)

TABLES OF MODEL PARAMETERS

Table 1.0: Extracted Values of Some Well Parameters of Well 06

s/n	Depth (ft)	Layer		H (ft)	TWT (ms)	TWT (AVE) (ms)	GR (API units)	SP (mV)	RHOB 'δ' (g/cm^3)	TT (μsec/ft)
1	5738.0	A	Top	37.5	2217.92	2225.16	70.30	346.42	2.17	115.56
	5775.5		Base		2232.41		63.75	325.56	2.25	123.86
2	7368.5	B	Top	56.5	2855.23	2866.25	59.92	299.66	2.23	110.41
	7424.0		Base		2877.28		67.99	283.10	2.32	111.04
3	7435.0	C	Top	90.5	2881.39	2899.09	14.11	306.86	2.18	129.64
	7525.5		Base		2916.80		29.85	289.31	2.08	122.85
4	9105.0		Top	187.5	3534.57	3571.13	96.25	-49.12	2.40	110.85
	9292.5	D	Base		3607.70		76.38	-32.58	2.21	103.50
5	9675.0		Top		3757.14		94.68	-20.81	2.26	102.84

Table 1.1: Computed Values of Some Well Parameters of Well 06

s/n	Depth (ft)	Layer	H (ft)	TWT (AVE)	RHOB 'δ' (g/cm^3)	Velocity 'V' (ft/s)	AV E 'δ'	AV E 'V'	Z = δV		Zb-Za
1	5738.0	A	37.5	2225.16	2.17	8653.51	2.21	8363.57	18483.48	Z 1	Z2-Z1
	5775.5				2.25	8073.63					2017.91
2	7368.5	B	56.5	2866.25	2.23	9057.15	2.27	9031.45	20501.39	Z 2	Z3 –Z2
	7424.0				2.32	9005.76					-3617.25
3	7435.0	C	90.5	2899.09	2.18	7713.66	2.13	7926.83	16884.14	Z 3	Z4-Z3
	7525.5				2.08	8140.00					4601.33
4	9105.0	D	187.5	3571.04	2.40	9021.19	2.30	9341.51	21485.47	Z 4	Z5-Z4
	9292.5				2.21	9661.83					497.18
5	9675.0				2.26	9726.84	2.26	9726.84	21982.65	Z 5	

Where h = Interval Thickness; Z =Acoustic Impedance; R_C= Reflection Coefficient; AVE = Average Values; TWT = Two Way Travel Time; TT = Transit Time; ϕ = Porosity; Vsh = Volume of Shale;

Velocity 'V' = $\frac{10^6}{t}$ where t = Sonic Transit time or Wave Slowness (μsec/ft)

And $$R_C = \frac{Z2-Z1}{Z2+Z1}$$

A schematic diagram incorporating all model parameters of the channel is shown in Figure 5

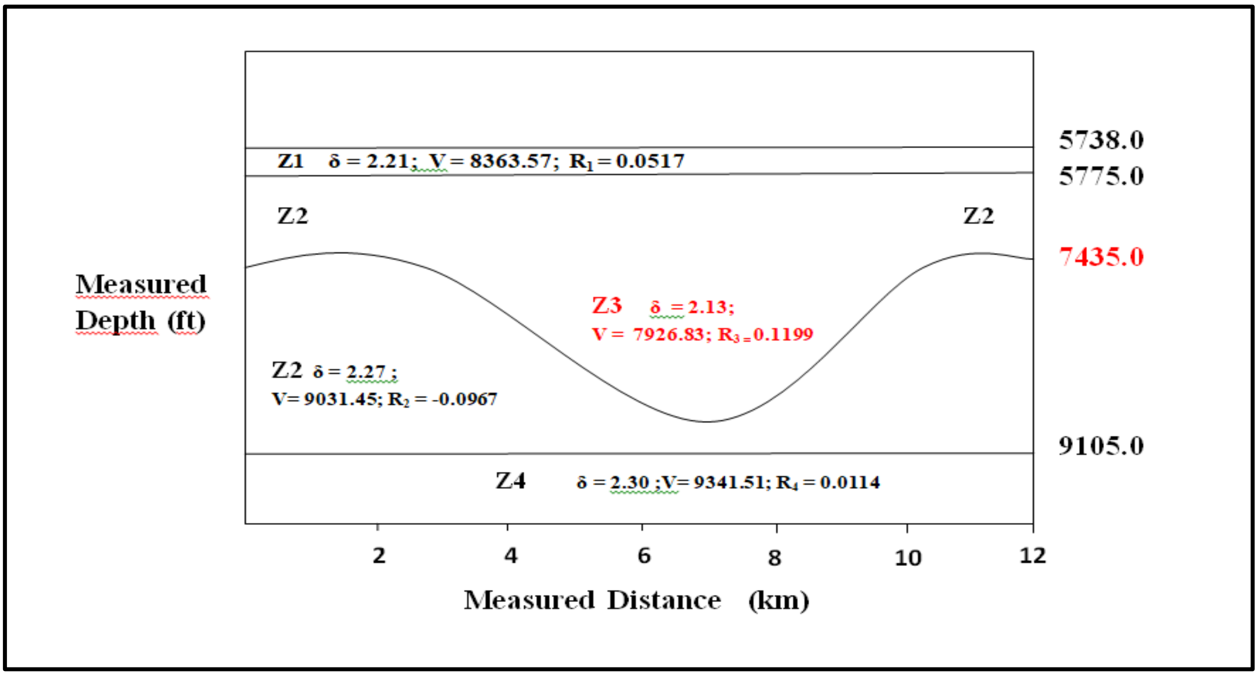


Figure 5: A Schematic diagram of the Channel Feature (in red)

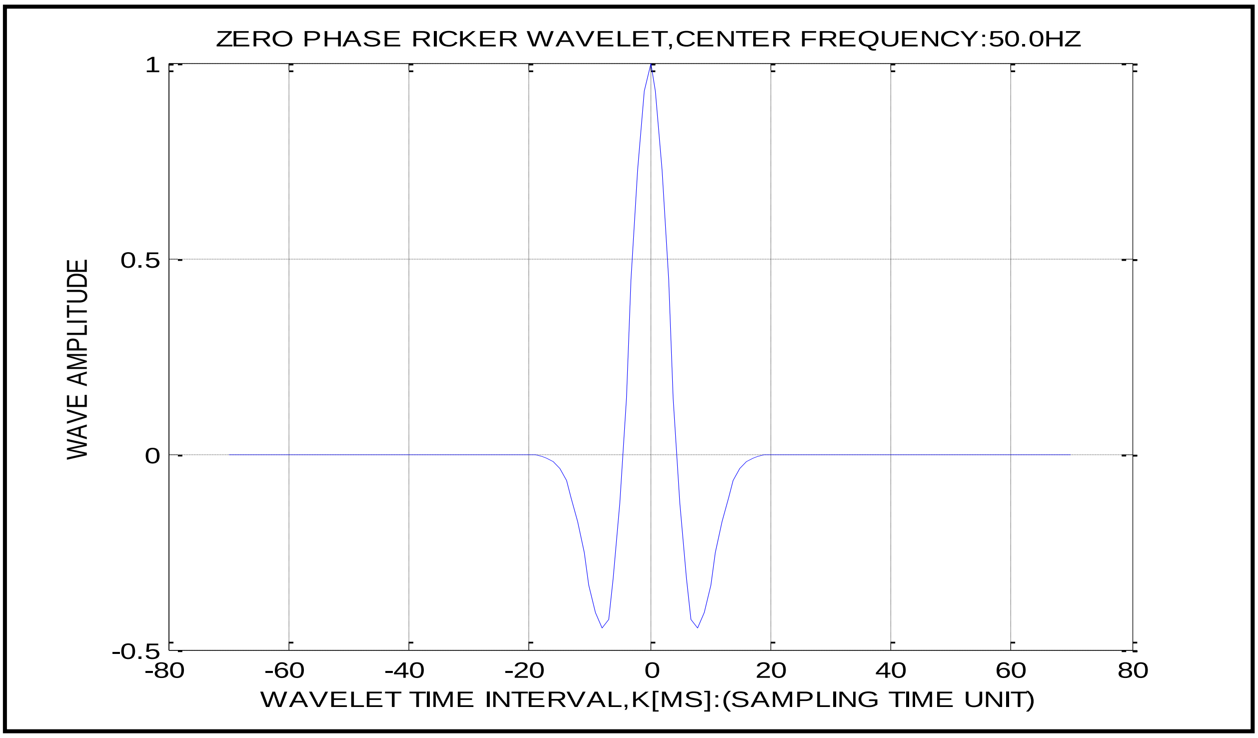
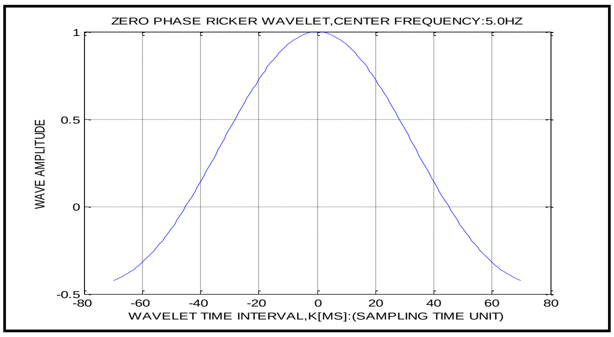
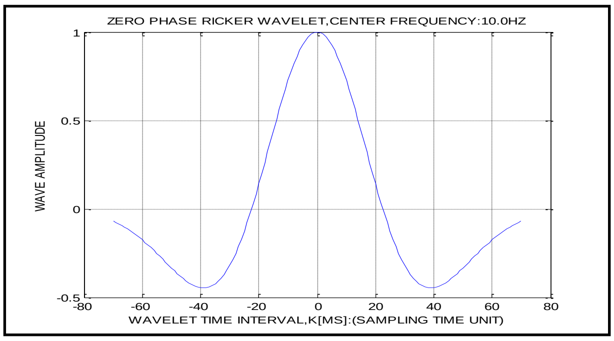


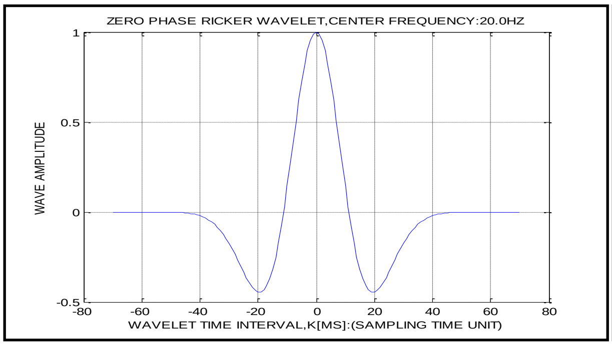
Figure 6: Zero Phase Ricker Wavelet for Channel Sand Model with Centre Frequency of 50Hz



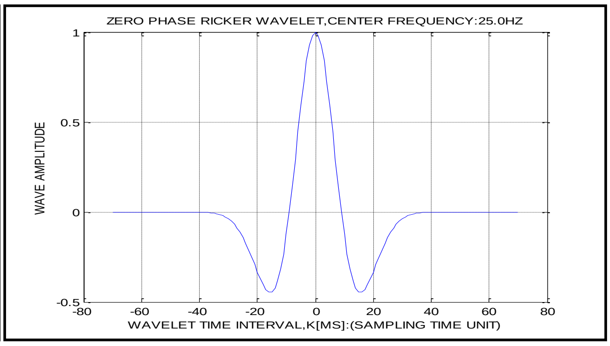
(a) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **5Hz**



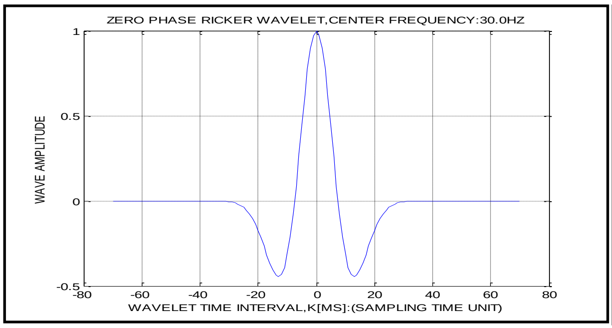
(b) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **10Hz**



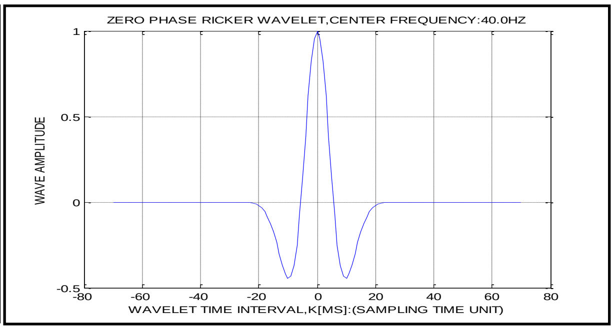
(c) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **20Hz**



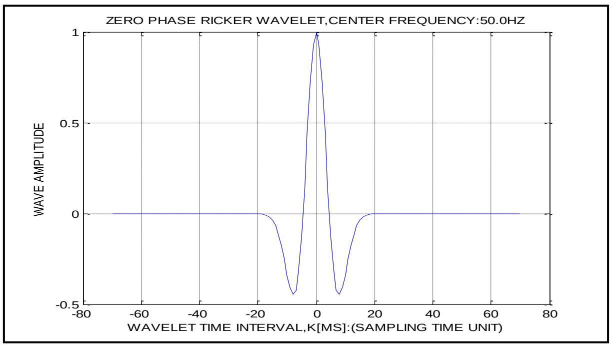
(d) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **25Hz**



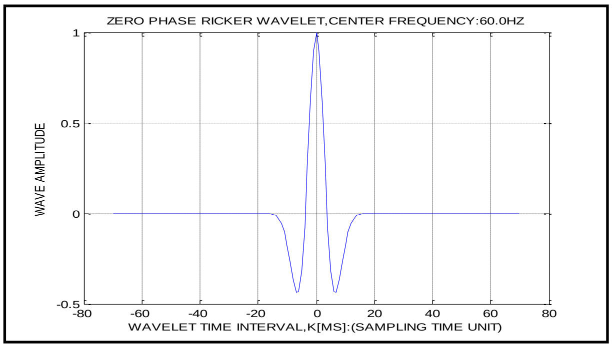
(e) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **30Hz**



(f) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **40Hz**

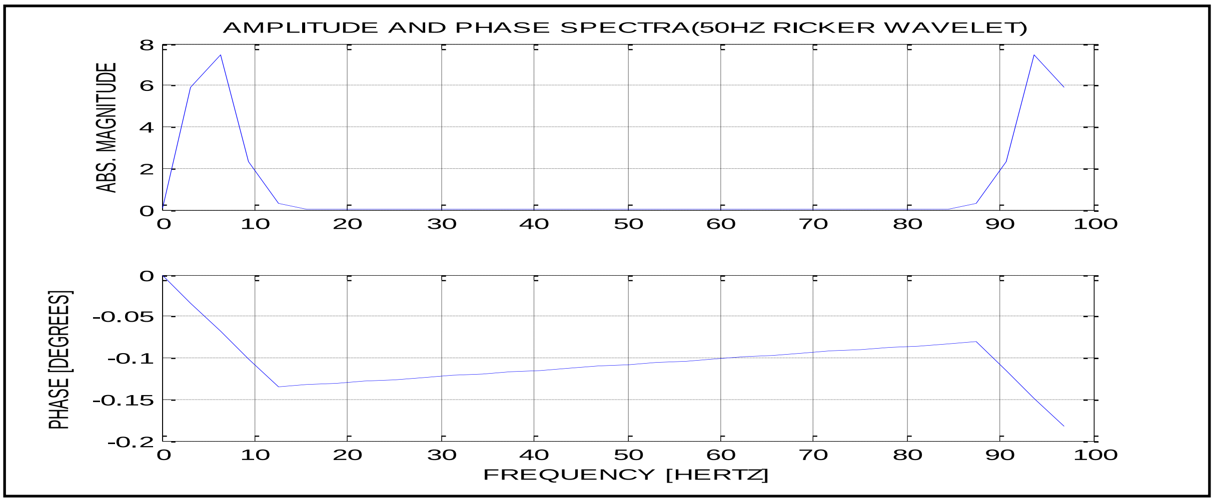


(g) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **50Hz**

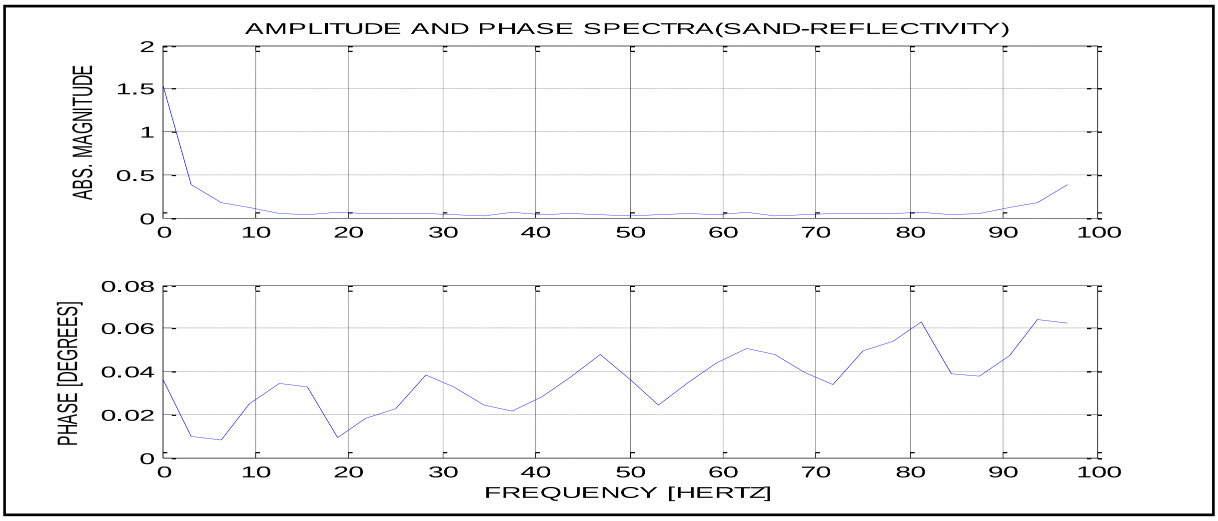


(i) Zero Phase Ricker Wavelet for Channel Sand Model at Centre Frequency of **60Hz**

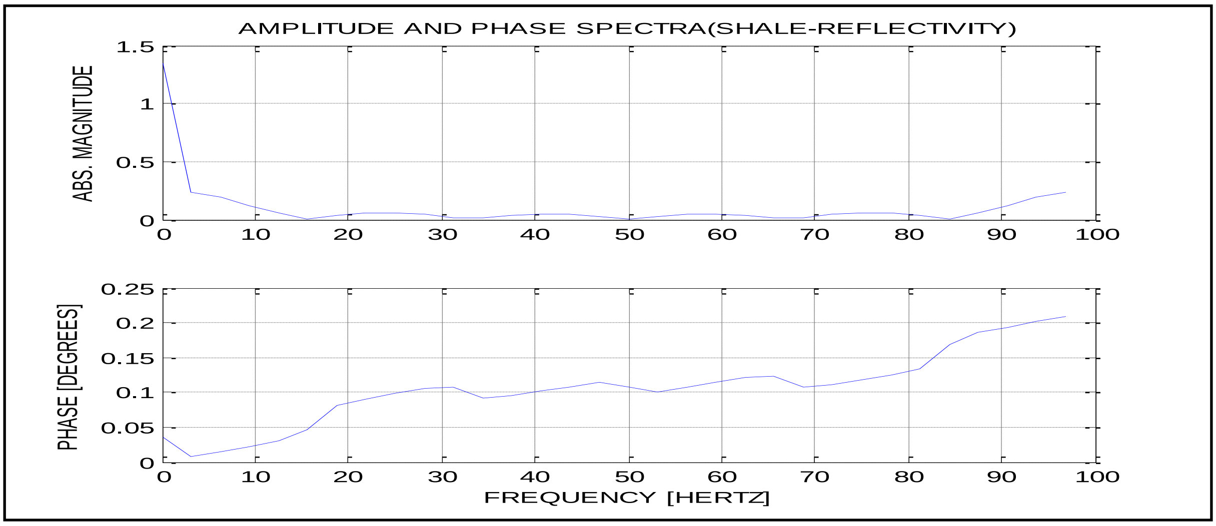
Figure 7: Zero Phase Ricker Wavelet Analysis at Various Center Frequencies and Time Breadths



(a): Amplitude and Phase Spectra (50Hz Ricker Wavelet)



(b) Amplitude and Phase Spectra (Sand-Reflectivity)



(c) Amplitude and Phase Spectra (Shale-Reflectivity)

Figure 8: Amplitude and Phase Spectra (Shale-Sand Shale Reflectivities)

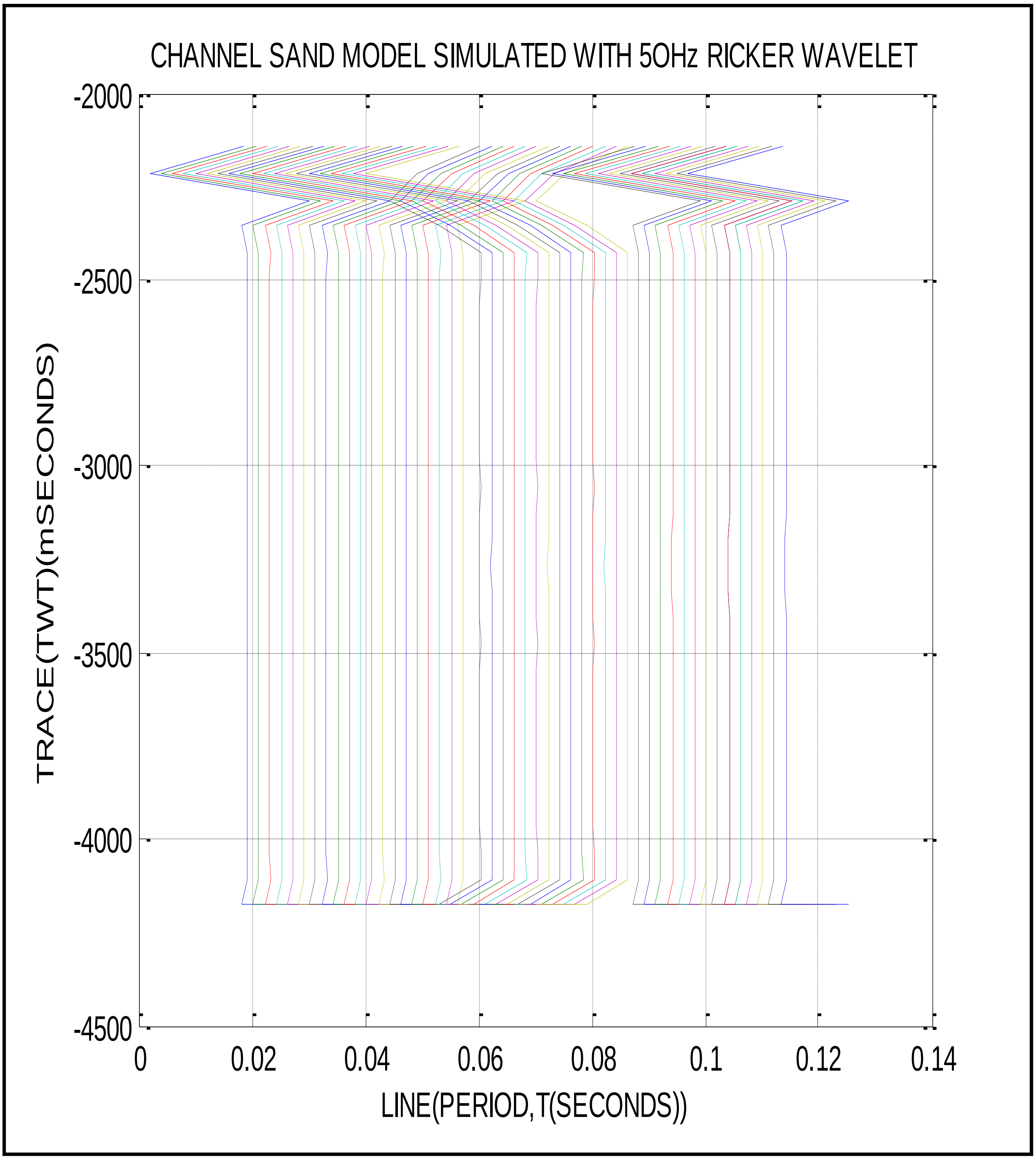
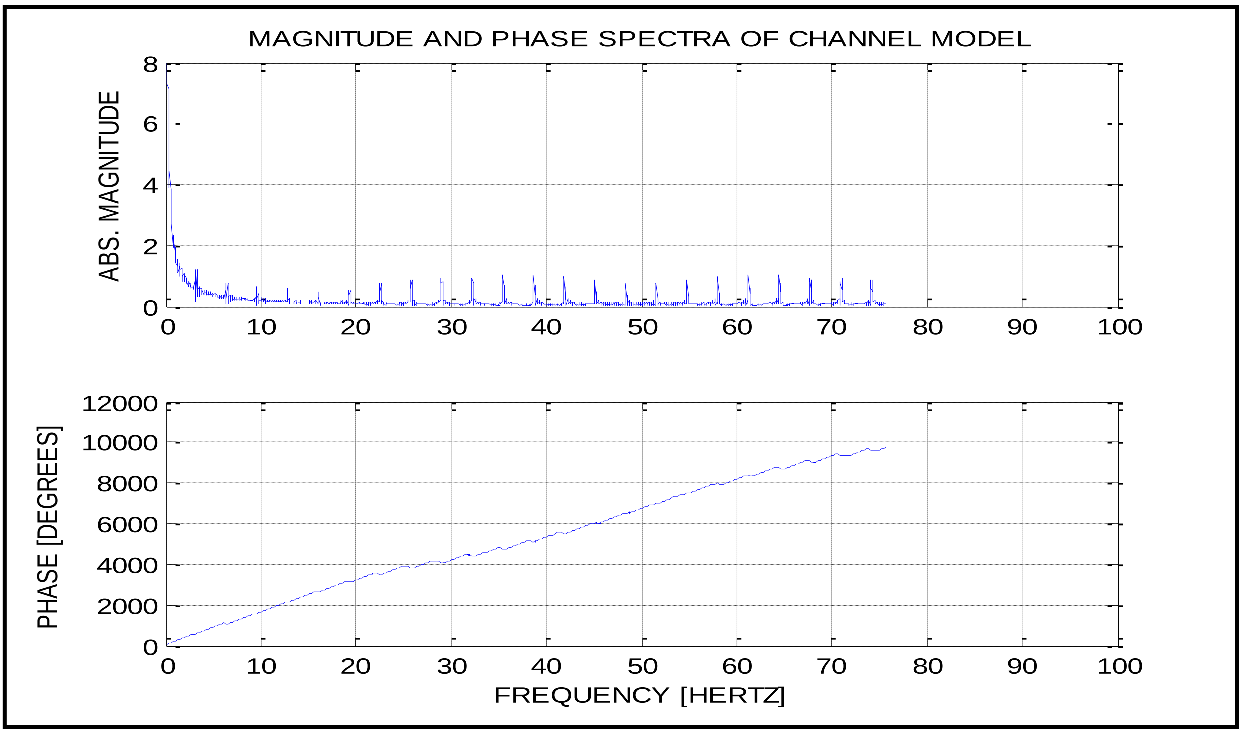


Figure 9: 50-Trace, 50Hz Field Data-Derived Channel Model: Original amplitude



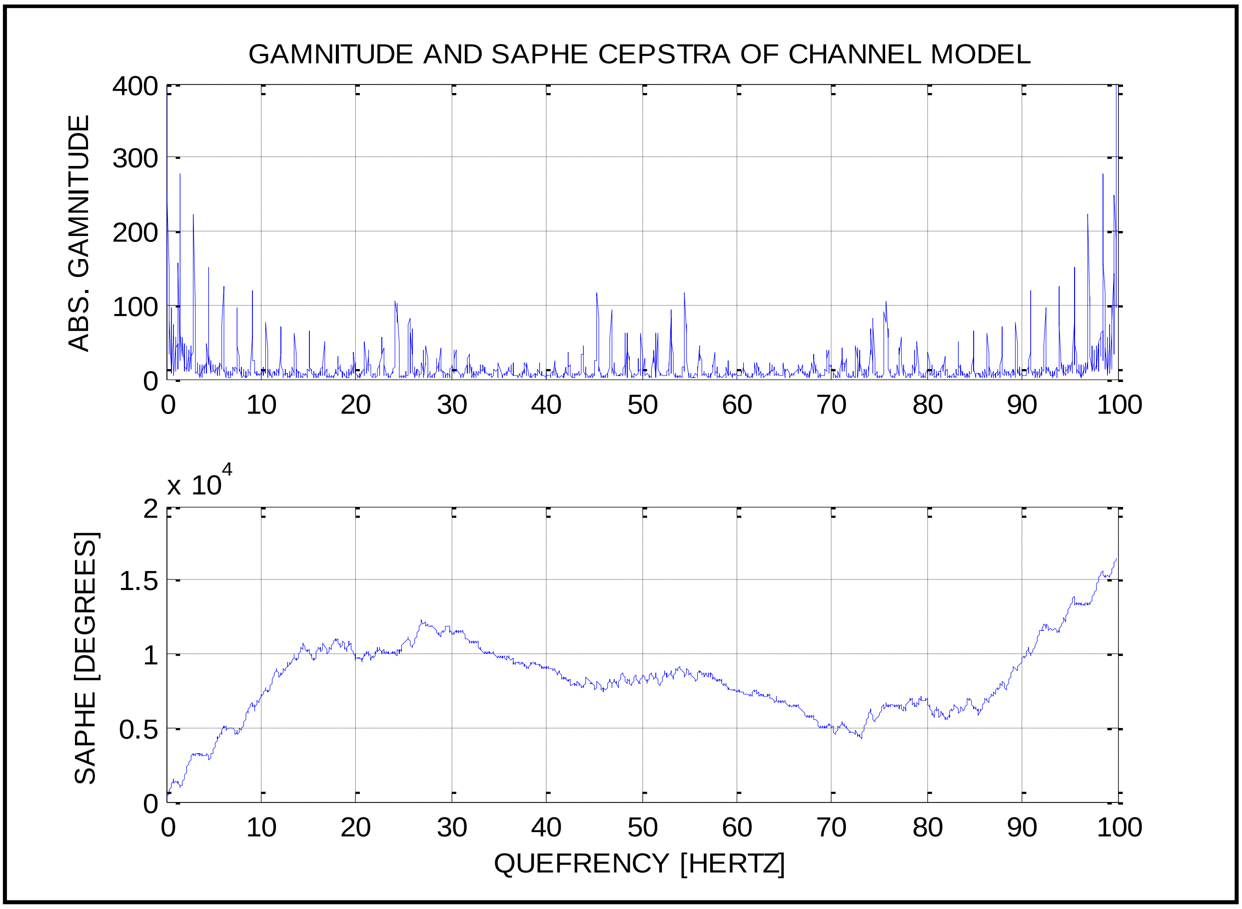


Figure 10: Spectra and Cepstra of 50Hz Field Data-Derived Channel Model. There is more information recovery in the Cepstra plot.

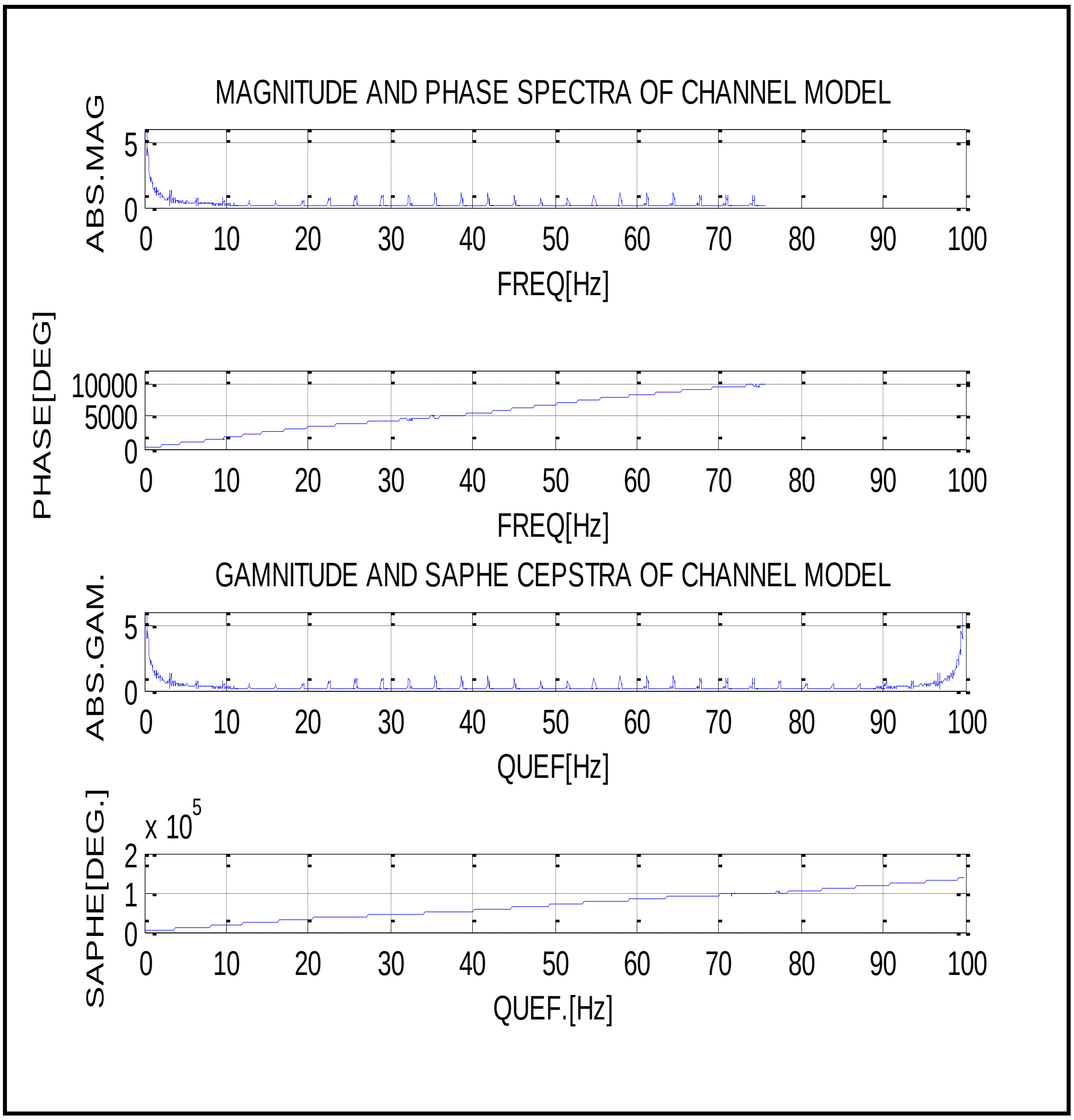


Figure 11: 50 Hz Field Data-Derived Channel Model: Comparison of resolving capabilities of Spectral and Cepstral attributes integrated in a plot

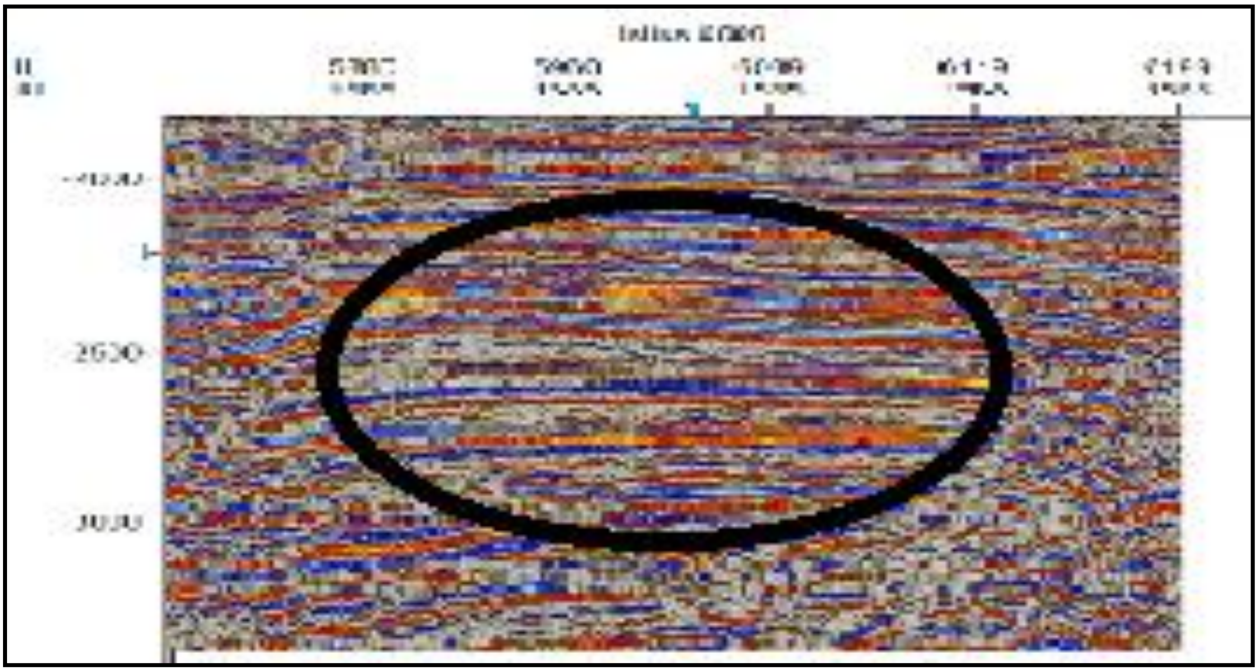


Figure 12: Seismic Section showing channel feature. (Petrel Platform)

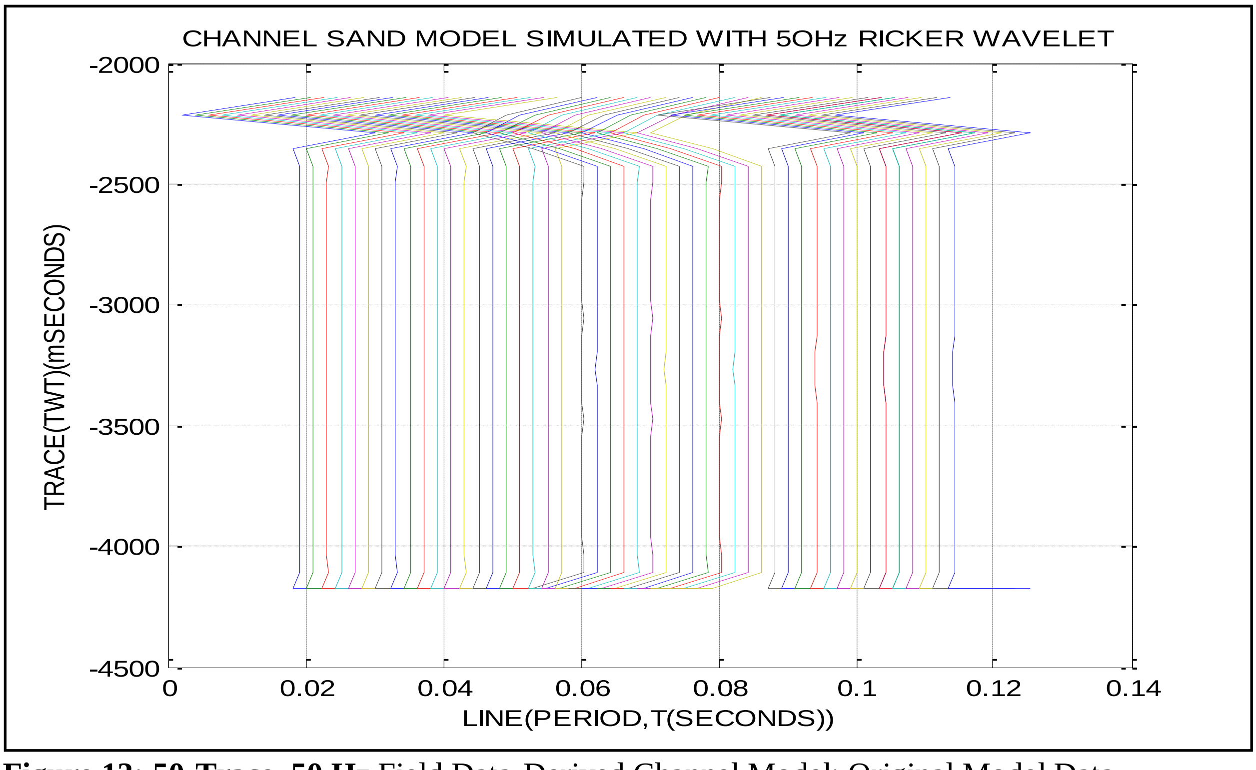
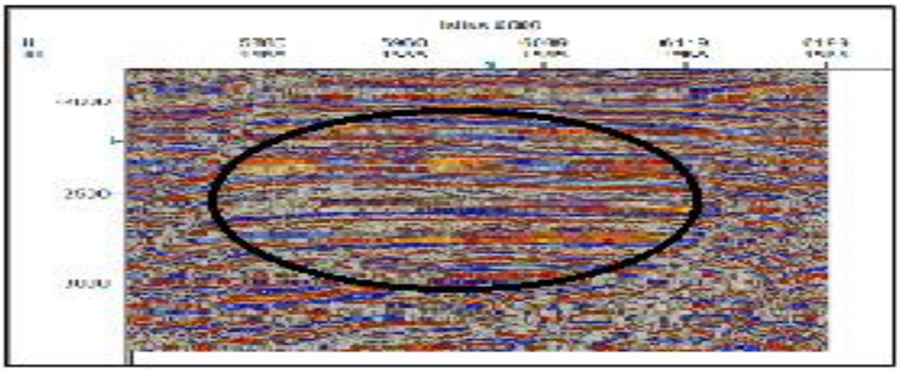
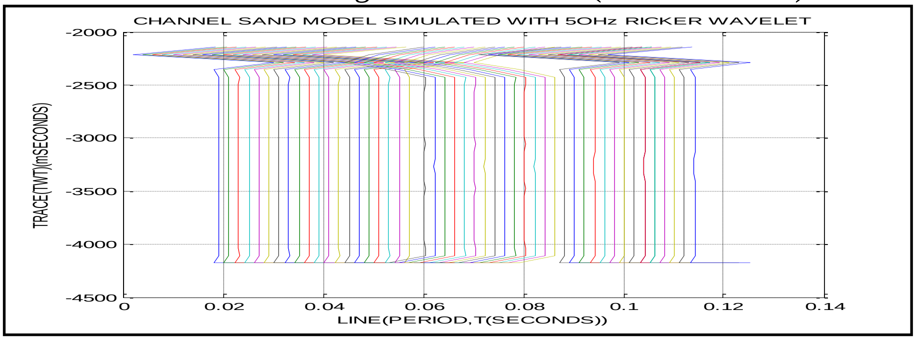


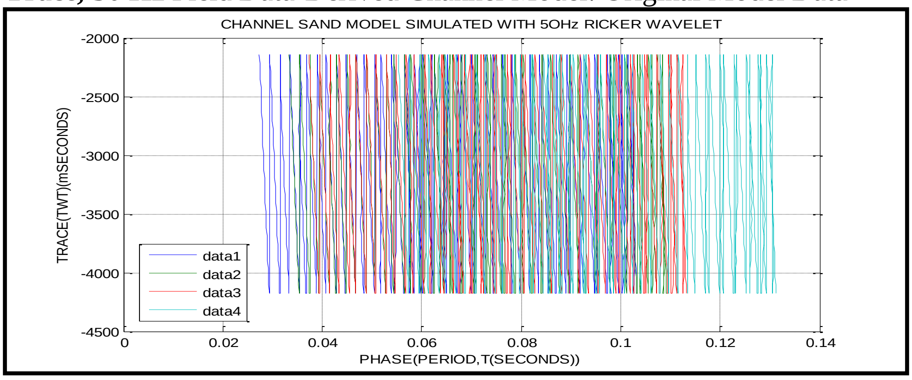
Figure 13: 50-Trace, 50 Hz Field Data-Derived Channel Model: Original Model Data



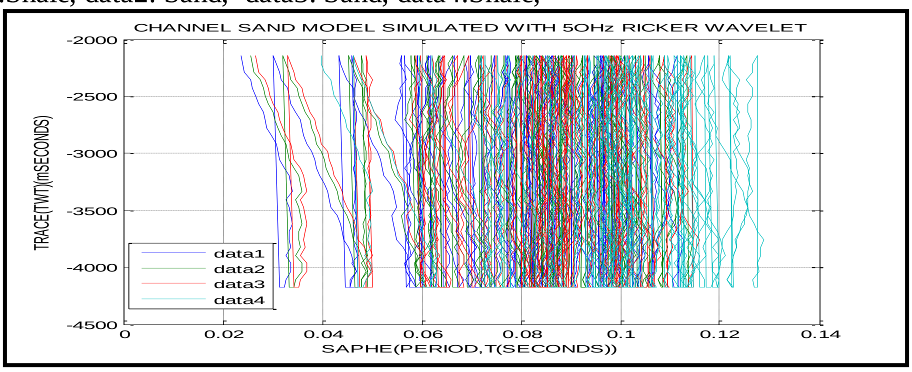
(a) Field Seismic Section showing channel feature. (Petrel Platform)



(b) 50-Trace, 50 Hz Field Data-Derived Channel Model: Original Model Data

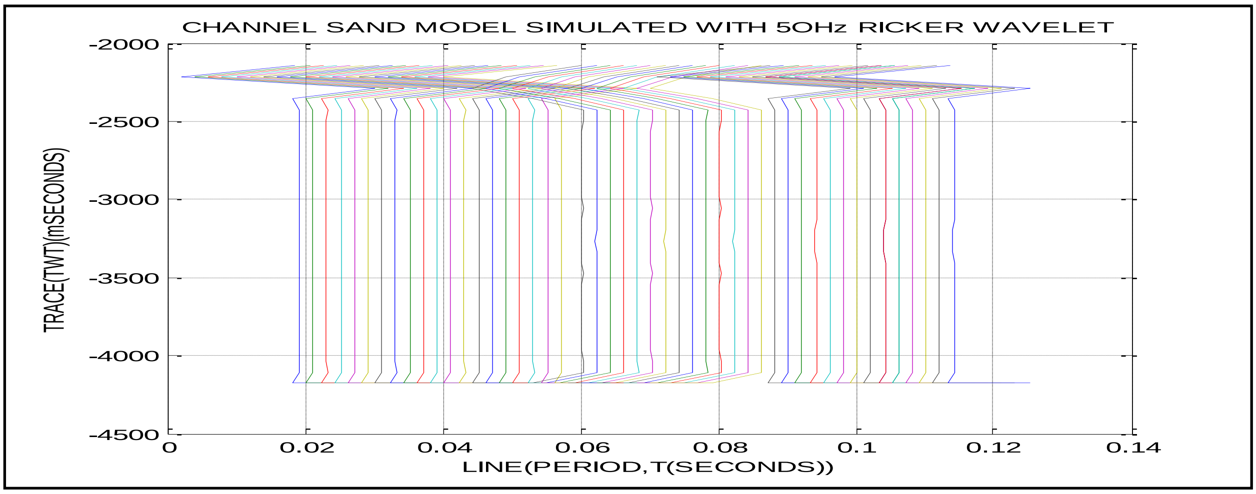


(c) An abridged Phase Attribute Section by Discrete Fourier Transform to indicate improved lithologic change/segmentation and comprising four (4) traces namely data1:Shale, data2: Sand, data3: Sand, data4:Shale,

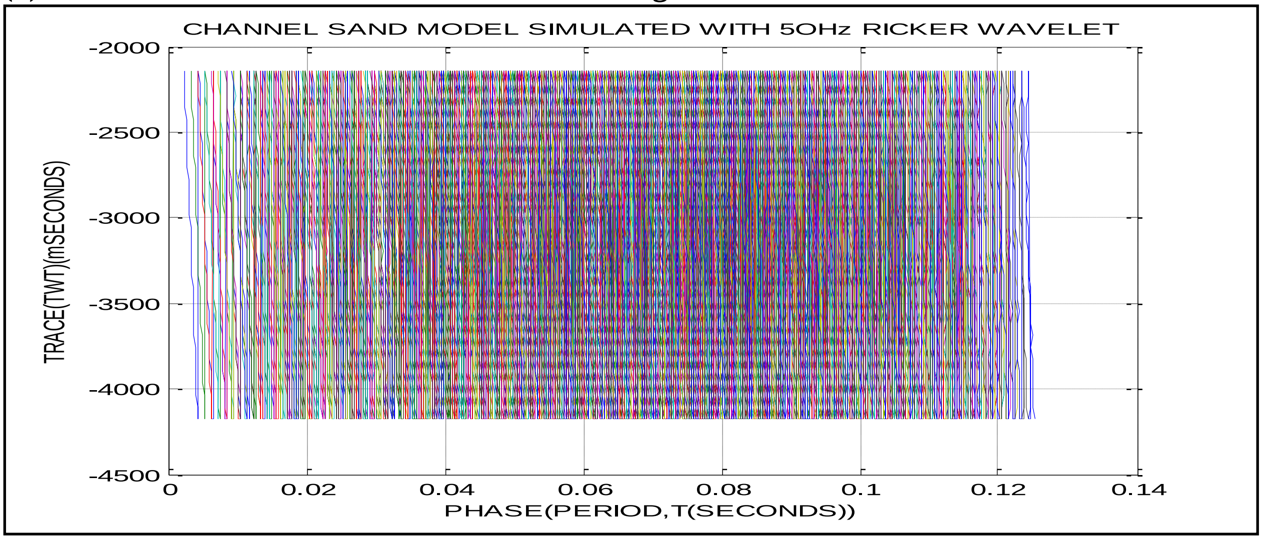


(d) An abridged Saphe Attribute Section by Cepstral Transform to indicate enhanced Lithologic change/segmentation and comprising four (4) traces namely data1:Shale, data2: Sand, data3: Sand, data4:Shale,

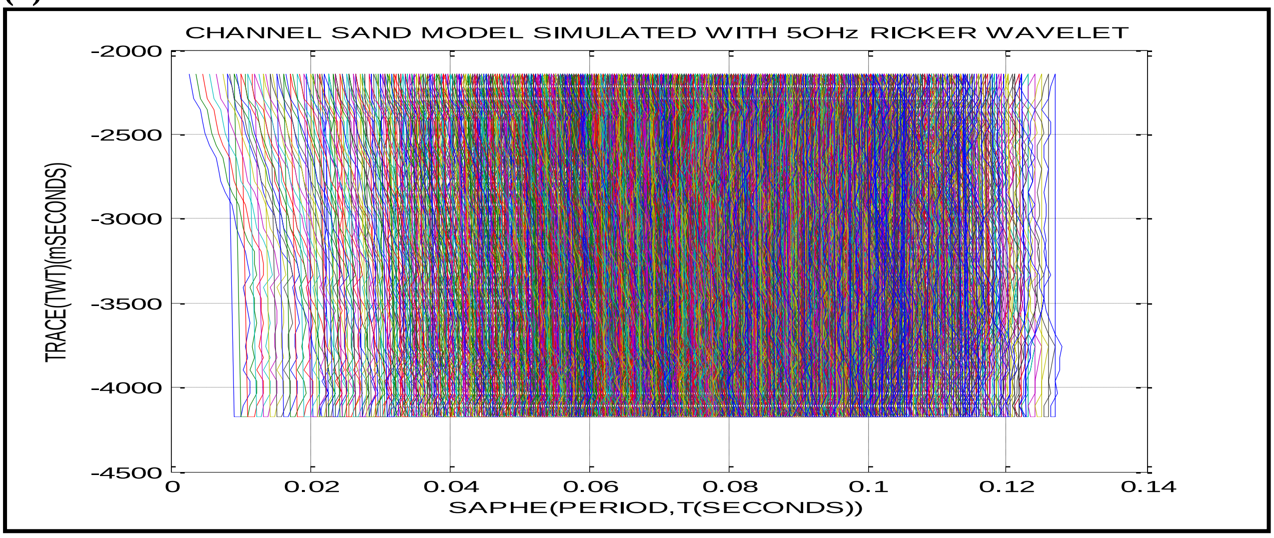
Figure 14: 50 Hz: Comparative display of Field Seismic Section, Data-Derived Channel Model, An abridged **Phase** and **Saphe** Attribute Sections



(a) 50 Hz Field Data-Derived Channel Model: **Original Model Data**



(b) 50 Hz Field Data-Derived Channel Model: **DFT Phase Section**



(c) 50 Hz Field Data-Derived Channel Model**: CT Saphe Section**

Figure 15: Comparative display of Field Data-Derived 50Hz Channel Model, DFT **Phase** and CT **Saphe** attribute

Conclusions

We have investigated spectral and cepstral decomposition of data driven geologic channel sand ,about 35ms thick obtained by convolution of a 50 Hz zero phase Ricker wavelet with a four-layer reflectivity series, where the third layer is the channel bed. The Discrete Fourier and Complex Cepstral transforms were used to highlight the channel's average/response and precise attributes. Our aim was to develop a practical method for processing and mapping of stratigraphy which is usually masked after normal data interpretation. The DFT and CCT were used to calibrate and analyze a computed channel model with respect to subtle signal variation as obtained in field stratigraphic works.

The results obtained(from the samples presented) show the resolution capability of the Complex Cepstrum in separating source and filter and the detection of local periodicity which are critical geological parameters in understanding stratigraphic details and hydrocarbon fairways which impact on enhanced recovery. We implemented it on both standard and general platforms and found the match, on comparison to be convincing. This technology has application in the delimitation, delineation and characterization of subtle geologic targets such as thin-bed reservoir, areas of uncertainty in data and time such as in complex geologic environments as in deep waters, marginal fields, etc and and similar geologic situations.

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