Egyptian Geophysical Society
EGS Journal, Vol. 18, No. 1, 47-60 (2020)

DATA CONDITIONING, FREQUENCY DECOMPOSITION AND RGB COLOUR BLENDING AS TOOLS FOR INTERPRETATION RISK REDUCTION, TERTIARY SYSTEM, NORTH EL-AMRIYA, OFFSHORE NILE DELTA, EGYPT

B.M.M. IBRAHIM(1), M.M.F. SHOKRY(2), A.M.A. BAKR(3) and A.M.E. MAHMOUD(2)

(1) Wintershall Dea Egypt BU, Exploration and production petroleum company, Cairo, Egypt.
(2) Geophysics Department, Faculty of Science, Ain Shams University, Cairo, Egypt.
(3) Exploration consultant, Rockserv Company, Cairo, Egypt.

معالجة البيانات ، التحليل الطيفى وخلط النموذج اللونى كأدوات للحد من مخاطر التفسير لخزانات العصر الثلاثى ، شمال العامرية ، دلتا النيل البحرية ، مصر

الخلاصة: تحليل الصفات السيزمية في مدى التردد يعتبر مهما جدا لتوصيف تفاصيل أجزاء وفواصل الخزان الهيدروكربونى، وتعتبر هذه التفاصيل أساسية لتوصيف الخزان بطريقة تفصيلية ودقيقة، وذلك لتقليل مخاطر حفر آبار التى قد تكون جافة. تعتبر طريقة الفصل الطيفي للترددات مع مزج ألوان الترددات السائده هي الأساس لاستنباط معلومات الطيف السيزمى. هذا البحث يختبر نموذج لخطوات عمل تشتمل على تجهيز المعلومات السيزمية لعمل تحليل طيفي للترددات السيزمية لتكوين أبو ماضي الهيدروكربوني لعصر المسينيان المتأخر، دلتا النيل، مصر. أولا تتضمن الخطوة الأولى إلغاء التشوش للبيانات السيزمية باستخدام تقنيات مرحلة ما بعد معالجة الجمع للبيانات السيزمية باستخدام خوارزميات ذات بنية هيكلية وحفاظا على الحافة بالنسبة للمنطقة ذات البيانات السيزمية الأقل جودة بسبب وجود طبقات أو تكوينات ملحية تتبع عصر الميوسين والتى تخفي أي سعات حقيقية ذات صلة، ولذلك تم تطبيق تشتيت أقوى لموجات التشويش يتبعه تطبيع السعة لزيادة استمرارية العاكس وضوحا ولزيادة استمرارية العواكس السيزمية ثم تم عمل إلغاء التشويش للبيانات السيزمية بتقنية أقوى. تم دمج البيانات السيزمية والتي تم فيها إزاحة التشويش منها بالطريقتين لاستخدامهما لتقوية الطيف. حيث تم اختبار عدة محاولات لتحسين الطيف باستخدام طرق مختلفة تضمن إحداهما تقوية الترددات المنخفضة باستخدام مرشح منخفض القطع عالي المستوى، واشتمل الآخر على تقوية كل من الترددات المنخفضة والعالية، والتي تستهدف الطيف السيزمى العريض. تم تطبيق تحليل التردد ومزج الألوان (آر جي بي) على كلتا مجموعتي البيانات المحسنتين، وذلك باستخدام طريقتين مختلفتين: واحدة تتضمن تحويلة فورير السريعة بالطريقة المستندة إلى النافذة والأخرى التي تتضمن خوارزمية مطابقة. تم تفسير الألوان الواضحة التي تمت ملاحظتها في كمؤشر لوجود النفط والغاز والذي يرتبط بطبيعة وعناصر الترسيب الخاصة بالخزان الهيدروكربونى. دعمت نتائج هذا العمل احتمالية وجود الهيدروكربون في بعض القنوات المتعرجة الواضحة تجاه قمة التكوين موضوع الدراسة مما يقلل من خطرعدم تواجد بالخزان بمنطقة شمال العامرية (بئر NEA-2X) .

ABSTRACT: *Analyzing seismic attributes in the frequency domain is quite important for detailing many reservoir intervals. Such details are essential for reservoir characterization and de-risking new appraisal and production drilling locations. Spectral decomposition with color blending is a key attribute for extracting significant components from the seismic spectrum. This paper examines an illuminated workflow which involves data conditioning and frequency decomposition for detecting subtle changes within seismic signals for the late Messinian prolific Abu Madi Formation, Nile Delta, Egypt. Firstly, Post-stack noise cancellation filter is used for enhancing the data by filtering out random noise using a structurally oriented and edge-preserving algorithms. To increase the reflector continuity, in the area of poor-quality data, a stronger noise attenuation workflow followed by an amplitude normalization was applied. This poor-quality area is directed from the presence of Messinian anhydrite which masks any pertinent true amplitude. Both noise cancellations were then combined and this noise cancelled dataset was used as an input for the spectral enhancement. Several spectral enhancements attempts were tested using different methods; one involved the enhancement of the low frequencies using a low-pass high-cut filter, and the other one involved an enhancement of both the low and the high frequencies, aiming for a white spectrum. Frequency decomposition and RGB blending were applied on both enhanced datasets, using two different methods: one involving a window-based Fast Fourier Transform (FFT) and the other one involving an adaptive matching pursuit algorithm. The bright colours observed in the blends were interpreted as an indicator of the presence of hydrocarbon which associated with clear depositional architectures and elements. The results of this work derisked the presence hydrocarbon potentiality at a proposed location of the North El-Amirya Exploration well (NEA-2X). An obvious meandering channel towards the crest of the fault block and along the proposed location is clearly identified.*

INTRODUCTION

Spectral decomposition has been used frequently in seismic data processing by way of spectral analysis, frequency filtering, wavelet characterization, etc., but in recent years it has been applied to 3D seismic data interpretation as well (Partyka et al 1999).

Usually, seismic interpreters work with the amplitude anomalies that are based on the dominant frequency in the seismic data. Spectral decomposition allows interpreters to utilize the discrete components of the seismic bandwidth. Individual frequency components help in interpreting and understanding subtle details of the subsurface stratigraphy. The basic concept behind the technique is that seismic reflections from a thin bed for example have characteristic expressions in the frequency domain – the higher frequencies imaging thinner beds and lower frequencies imaging thicker beds. So, if all the discrete frequency components are available, they can help in observing and discerning the response of the reservoir more accurately. There are several causes for frequency variations in seismic data, both fundamental and apparent; changes in thickness and tuning effects, lithological and fluid variations triggering impedance variation and associated dispersion and attenuation.

Several methods can be used for measuring the frequency content of seismic data, such as, Discrete Fourier Transform (DFT) (Partyka et al 1999), Instantaneous Spectral Analysis (ISA) which is wavelet transform method (Castagna et al, 2003), Matching Pursuit Decomposition and Instantaneous Frequency. Each method has relative advantages and all methods are a trade-off between resolution in time and resolution in frequency according to uncertainty principle.

Once the seismic data has been decomposed into its relative components, each frequency response can be investigated individually or in combination. A common method for combining multiple frequency responses is by colour blending, so that multiple frequency responses can be merged into a composite image. RGB blending is a form of colour blending that uses Red, Green and Blue colour schemes for each frequency channel respectively. The resultant blend shows a variety of colour and contrast that reflects the complex interplay of frequencies and therefore variations in the phenomena that are the cause of the frequency dispersion. Visually, these RGB blends show elements of, and interactions between, geological systems in stark and vibrant details. (McArdle, 2013).

The main objective is to investigate frequency-related phenomena through decomposition and colour blending, so pertaining information can be derived like reservoir geometry, thickness and petrophysical properties.

SUBSURFACE GEOLOGIC SETTING

The study area which is North El-Amyria offshore block (Fig. 1) which is part of the Nile Delta basin which represent the SE portion of the large East Mediterranean basin. Tectonics has played a dominant role in the location and the structural as well as depositional history of the Nile delta. The Nile Delta region occupies a key position within the plate tectonic development of the eastern Mediterranean and the Levant. It lies on the northern margin of the African plate which extends from the subduction zone adjacent to the Cretan and Cyprus arcs to the Red sea where it rifted apart from the Arabian plate.

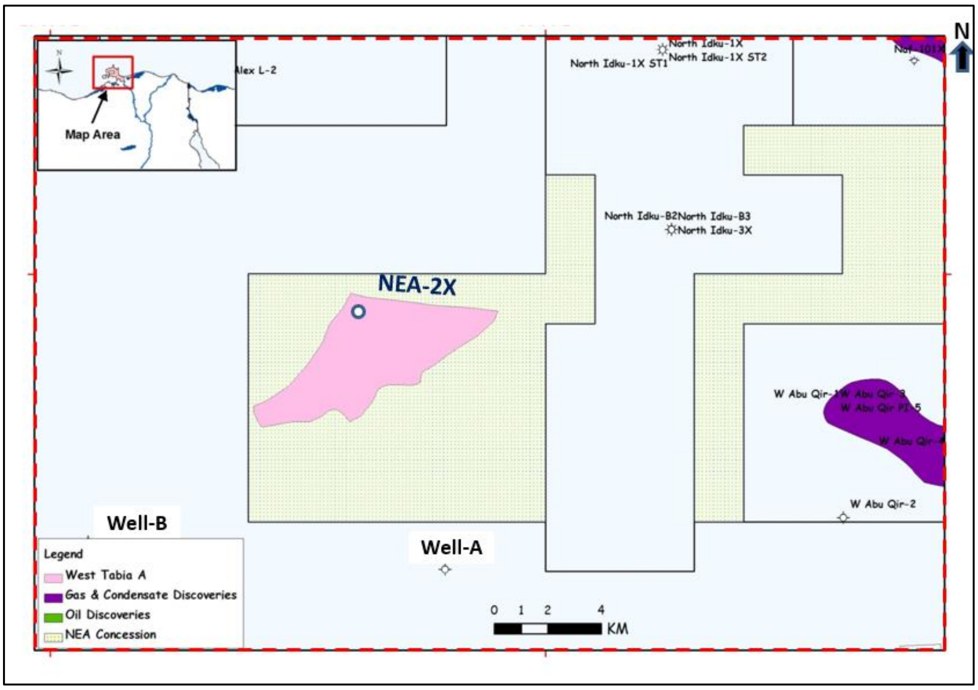


Fig. (1): Location map of the study area.

Abu El Ata (1988) constructed structure contour maps on top Sidi Salem, Qawasim, Abu Madi and Kafr El Sheikh Formations. According to the geological and seismic data, such structure contour maps reveal the diversity of structural patterns of folds and faults that are grouped in three systems of tectonic deformation in the Nile Delta region: thrust, normal and block faults.

The tectonic history of the Nile Delta is interweaved with that of the south-eastern Mediterranean, which was viewed by May (1991) to have passed through three stages of tectonic phases during the Mesozoic. These stages are:

1. An extensional stage from the Triassic to the early Jurassic.
2. A passive margin stage during the middle Jurassic and most of the Cretaceous, and
3. A compressional foreland stage at the end of the Cretaceous.

Abd El Aal et al. (1994) outlined the tectonic history of the Nile Delta into five stages:

1. A cratonic stage after the Caledonian - Hercynian Orogeny.
2. A rift stage combined with the opening of the Mediterranean during the Triassic.
3. A passive margin stage from the late Triassic to the late Cretaceous.
4. An alpine compressional stage from the late Campanian to the mid Eocene.
5. A foreland stage which started in the late Eocene and Oligocene.

The acquired 3D survey, covering an extent area of the Nile Delta, was the most important tool for imaging and delineating the presence of complicated fault pattern which controlled both potential reservoirs distribution and traps generation. (Barsoum et al., 1998).

Zaghloul et al. (2001) summarized the tectonic history of the Nile Delta region into four stages:

1. Rifted foreland of the African Plate with a spreading sea during the Mesozoic. This stage witnessed at least 2 paucity phases in the sea expansion. These two phases were linked to the transition from the Triassic into the Jurassic and from the Jurassic into the Cretaceous.
2. Compressional foreland stage from the late Cretaceous to the end of the Eocene. This stage was accompanied by a transformation of the south-eastern Mediterranean into an emerged land called the Paleo-Levant Microcontinent. The dynamics of forming this microcontinent was thought to be through thrusting and oceanic crust slicing.
3. Vertical movements during the Oligocene resulting in the submergence of the northern Nile Delta and the south-eastern Mediterranean. A probable passive Oligocene rift was formed within the central block of the onshore Nile Delta.
4. The build-out stage from the Miocene to the present.

So according to the geologic and seismic data, it can be concluded that the Nile Delta had been subjected to the general geologic events that affected northern Egypt during the pre-Miocene. The tectonic development of the Nile Delta was clearly affected by the eastern Mediterranean Sea uplifting and subsidence movements together with the Red Sea and Gulf of Suez fracturing mechanisms.

The basin fill itself is essentially a clastic sequence dominated by Highstand Systems Tracts shales, which provide ample sealing potential for both structural as well as stratigraphic traps. During sea level low stands these were incised by submarine canyons, which were then backfilled by the more sandy sediments of the Transgressive Systems Tracts, delivering reservoir lithologies (Samuel et al., 2003). A particular feature of the depositional history of the Mediterranean basin is the massive sea level drop of the so-called Messinian salinity crisis, which lead to widespread deposition of shallow marine sands far out into the basin and evaporates (Fig. 2)

The Area of interest i.e. North El-Amyria block is situated offshore Alexandria, wedged in between West Mediterranean concession in the west, BP’s Alexandria-1 and -2 Development Leases in the North, the West Burullus block and it encircles both WEPCO’s Abu Qir production leases and North Idku development lease. The area of interest close to NEA-2X structure which is three-way dip closure which is relatively away from the active coastal fault which belong to the hinge zone area, two wells were drilled in the same area i.e. Well-A and Well-B and were dry due to reservoir presence issue.

GEOPHYSICAL ILLUMINATION WORKFLOW

In order to identify the extents of the reservoir and its internal variations, a Geophysical illumination workflow was applied to the data. As shown in the chart (Fig. 3), the workflow involved several steps of data conditioning to improve both the signal-to-noise ratio and the frequency content of the dataset; then different methods of frequency decomposition were applied to identify the subtle changes within the seismic signal which can be related to changes in reservoir thickness, fluid content or lithological changes. (Henderson, 2012).

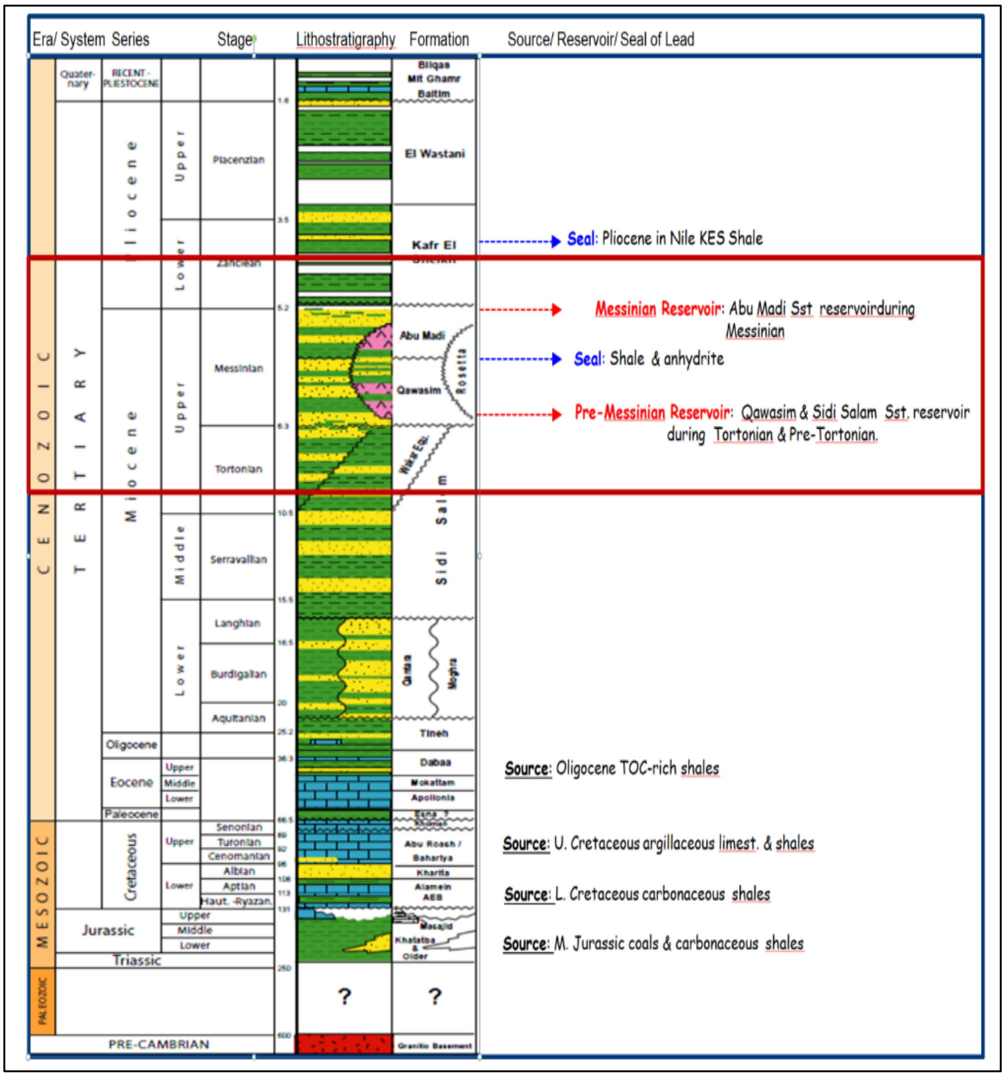
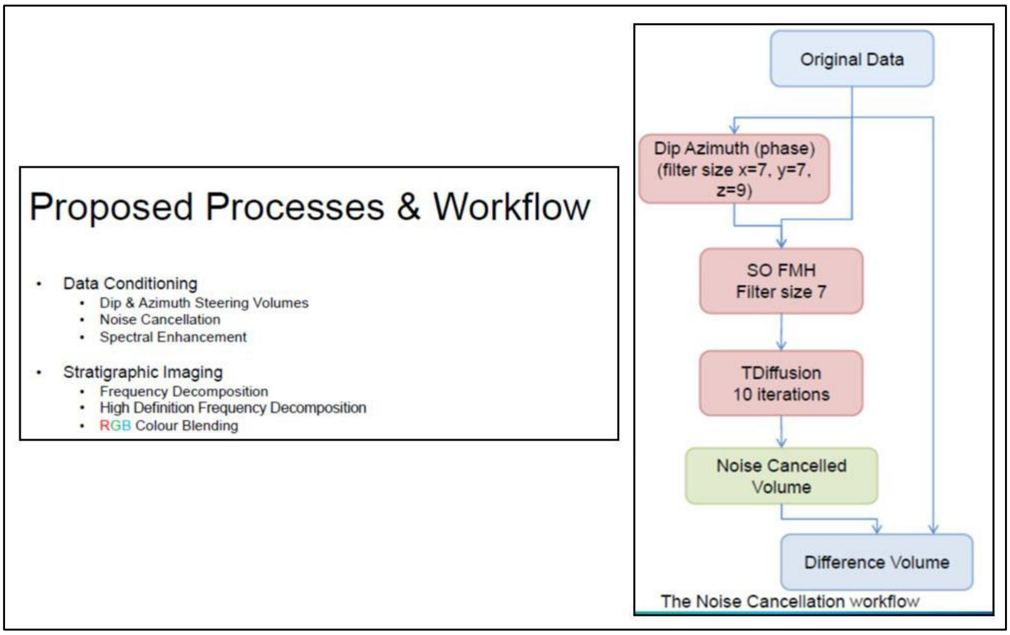


Fig. (2): Stratigraphic column of the offshore Nile Delta basin.



Proposed Processes & Workflow

- Data Conditioning
  - Dip & Azimuth Steering Volumes
  - Noise Cancellation
  - Spectral Enhancement
- Stratigraphic Imaging
  - Frequency Decomposition
  - High Definition Frequency Decomposition
  - RGB Colour Blending

Fig. (3): Geophysical illumination workflow.

1. Noise Cancellation

The noise cancellation workflow involved the application of two noise cancellation filters in succession; a (SOFMH) Structurally Oriented Finite Response Median Hybrid filter and a (TDiffusion) Tensor Diffusion filter. The SOFMH uses Dip and Azimuth steering volumes which aligns the filter along geological structure, rather than a grid. The Dip and Azimuth volumes also need to be smooth enough so that the filter is guided along structure, not the noise. It uses a mean operation to attenuate coherent noise within the data whilst preserving subtle edges associated with the fan bodies and faults.

Detailed Dip and Azimuth volumes were used to ensure that all the structural information was maintained, as well the chaotic (but potentially genuine) seismic character at the interval of interest. If the Dip and Azimuth were too regional, it would risk overlooking structural prints.

TDiffusion filter is a structurally oriented adaptive filter that automatically aligns itself along the dominant structure. It improves reflector continuity whilst preserving faults and subtle discontinuities. TDiffusion is applied iteratively and the amount of noise attenuation as a result of TDiffusion filter is controlled by the number of iterations.

The Difference volume is calculated as a QC process to visualize the noise that has been removed from the data and assess the severity of the filter that was applied. Levels of noise cancellation were tested, and decisions made collectively during the parameter testing procedure. The workflow depicted to the right was considered optimum for attenuating noise and increasing the signal:noise ratio, while preserving structural and stratigraphic information and improving reflector continuity. (Gilani et al., 2016)

An example of comparasion between original & noise cancelled PSTM seismic lines passing through Wells; Well-A & Well-B and proposed location NEA-2X are shown in (Fig. 4) & (Fig. 5).

2. Spectral Enhancement

Several authors (Goloshubin et al., 2002; Burnett & Castagna, 2003; Castagna et al., 2003; Bahal et al., 2007; Yuet al., 2011) have used low frequency effects as a predictive method for identifying and mapping hydrocarbon reservoirs by applying frequency dependent processing.

The vertical resolution and detailed localisation accuracy of seismic data are dependent on the frequency content of the seismic signal. High resolution and accurate localisation are associated with a high mean frequency and a large frequency bandwidth.

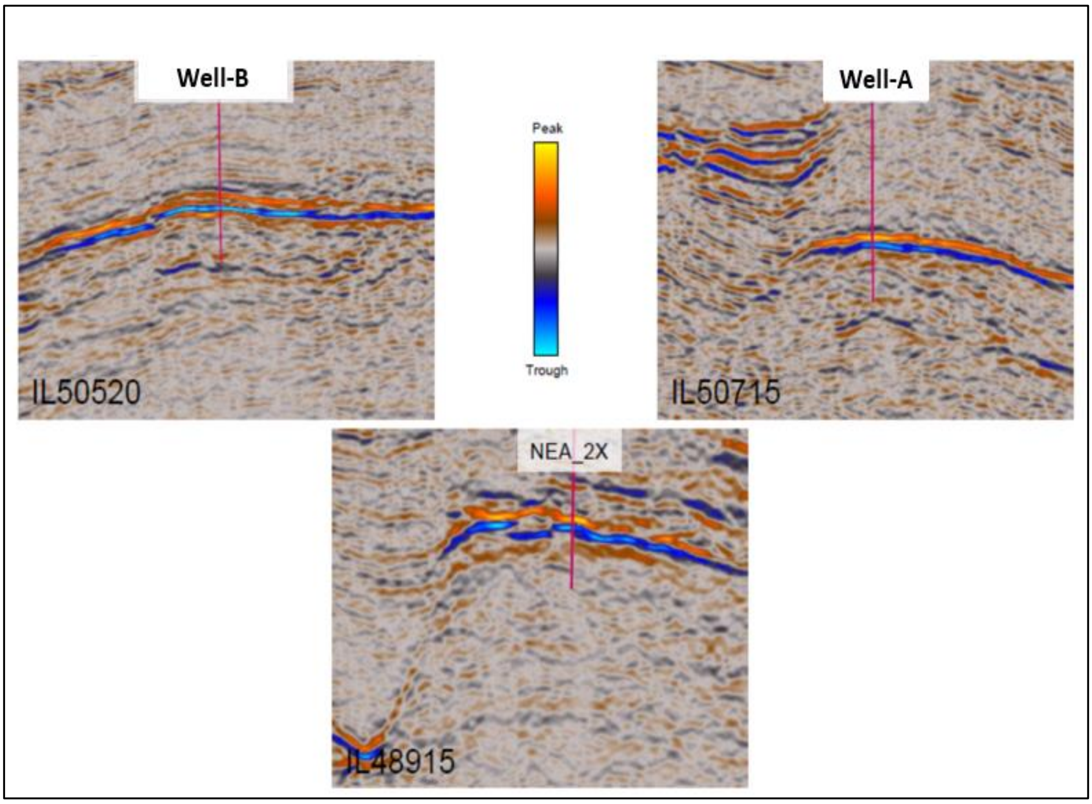


Fig. (4): Original PSTM seismic lines passing through Wells; Well-A & Well-B and proposed location NEA 2X.

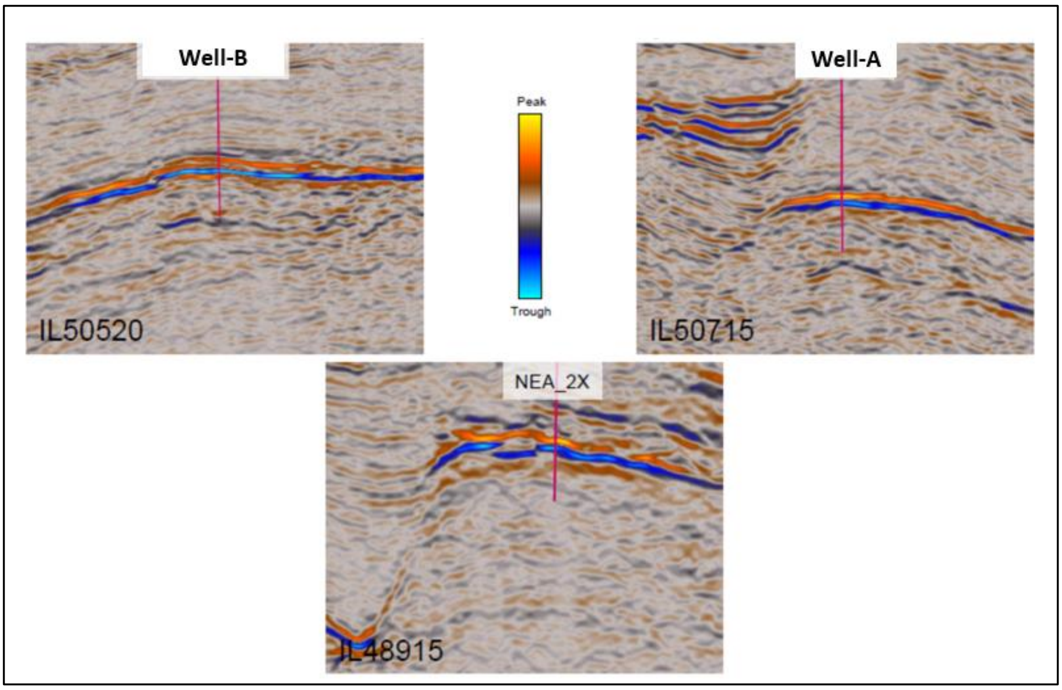


Fig. (5) : Noise cancelled PSTM seismic lines passing through Wells; Well-A & Well-B and proposed location NEA 2X.

Bahal et al. (2007) proposed a low-frequency enhancement of seismic data which involves the application of an amplitude boost in the low frequency range of data, generating an output with an enhanced low-frequency component but still preserving the full bandwidth of the data spectrum. The output low-frequency enhanced data will highlight low-frequency amplitude anomalies potentially indicating hydrocarbon presence.

The aim of the Spectral Enhancement workflow is to maximise the mean frequency and bandwidth of the seismic data by producing a “white” spectrum, i.e. one in which all frequencies contribute equally to the power in the signal. Balancing the spectrum in this way can enable differentiation of previously irresolvable events.

The noise cancelled data was used as the input to the workflow, and the individual frequency bands were noise cancelled prior to enhancement to minimise the impact of noise. Varying levels of Spectral Enhancement can be applied to different intervals and the individual results can then be combined along a chosen horizon using a time volume (Fig. 6). As with the Noise cancellation results, decisions were made during the processing stages and the results applied to the full survey.

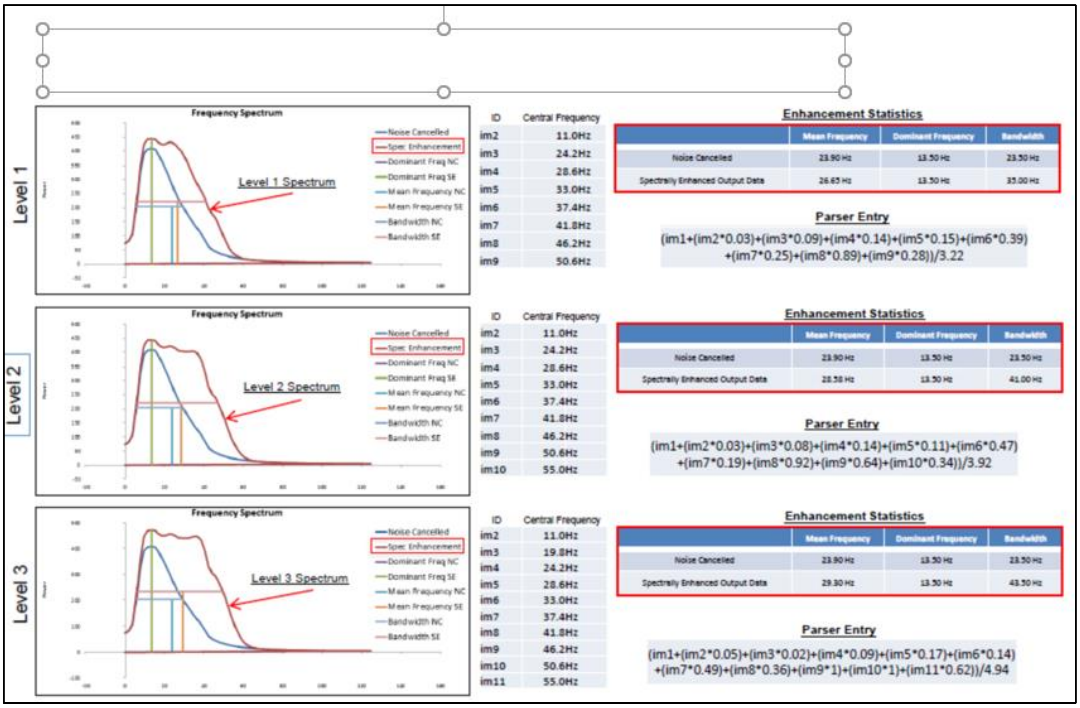
This volume shows improved vertical resolution, distinct feature addition (such as channels) and minimal-to-zero noise introduction at the reservoir interval (Fig.7) & (Fig. 8).

Shallow regions have inherited a ‘ringing’ character from the higher frequency bandpass volumes due to naturally higher frequencies at shallow depths. As example of spectrally enhanced PSTM seismic lines passing through Wells Well-A & Well-B and proposed location NEA-2X is shown in (Fig. 9).

FREQUENCY DECOMPOSITION AND RGB BLENDING

Frequency decomposition has become a common tool in the oil industry, since it was introduced in the 1990s (Partyka et. al., 1999). RGB blending combines information from three input volumes (in this case three magnitude volumes with different dominant frequencies) into a single output blended volume, and can be used both for looking at stratigraphic and structural features (Henderson et al., 2007).

Red-green-blue (RGB) colour blending is a particularly effective way of displaying multiple frequency decomposition responses (Fig. 10). The interference between different frequency bands can reveal startling details within the colour blend, and can highlight very subtle features of sub-seismic resolution. The colour and intensity apparent in the RGB blend is dependent on a number of variables related to the frequency and amplitude of the signal, which in turn depend on the geometry and rock properties of the subsurface. Although the clarity of geological features imaged using RGB blending can be stark, isolating the overriding influence on the seismic signal that produces



ID	Central Frequency
im2	11.0Hz
im3	24.2Hz
im4	28.6Hz
im5	33.0Hz
im6	37.4Hz
im7	41.8Hz
im8	46.2Hz
im9	50.6Hz

Enhancement Statistics

	Mean Frequency	Dominant Frequency	Bandwidth
Noise Cancelled	23.90 Hz	13.50 Hz	23.50 Hz
Spectrally Enhanced Output Data	26.65 Hz	13.50 Hz	35.00 Hz

Parser Entry

(im1+(im2*0.03)+(im3*0.09)+(im4*0.14)+(im5*0.15)+(im6*0.39)
+(im7*0.25)+(im8*0.89)+(im9*0.28))/3.22

ID	Central Frequency
im2	11.0Hz
im3	24.2Hz
im4	28.6Hz
im5	33.0Hz
im6	37.4Hz
im7	41.8Hz
im8	46.2Hz
im9	50.6Hz
im10	55.0Hz

Enhancement Statistics

	Mean Frequency	Dominant Frequency	Bandwidth
Noise Cancelled	23.90 Hz	13.50 Hz	23.50 Hz
Spectrally Enhanced Output Data	28.58 Hz	13.50 Hz	41.00 Hz

Parser Entry

(im1+(im2*0.03)+(im3*0.08)+(im4*0.14)+(im5*0.11)+(im6*0.47)
+(im7*0.19)+(im8*0.92)+(im9*0.64)+(im10*0.34))/3.92

ID	Central Frequency
im2	11.0Hz
im3	19.8Hz
im4	24.2Hz
im5	28.6Hz
im6	33.0Hz
im7	37.4Hz
im8	41.8Hz
im9	46.2Hz
im10	50.6Hz
im11	55.0Hz

Enhancement Statistics

	Mean Frequency	Dominant Frequency	Bandwidth
Noise Cancelled	23.90 Hz	13.50 Hz	23.50 Hz
Spectrally Enhanced Output Data	29.30 Hz	13.50 Hz	43.50 Hz

Parser Entry

(im1+(im2*0.05)+(im3*0.02)+(im4*0.09)+(im5*0.17)+(im6*0.14)
+(im7*0.49)+(im8*0.36)+(im9*1)+(im10*1)+(im11*0.62))/4.94

Fig. (6) : Spectrum enhancements trials.

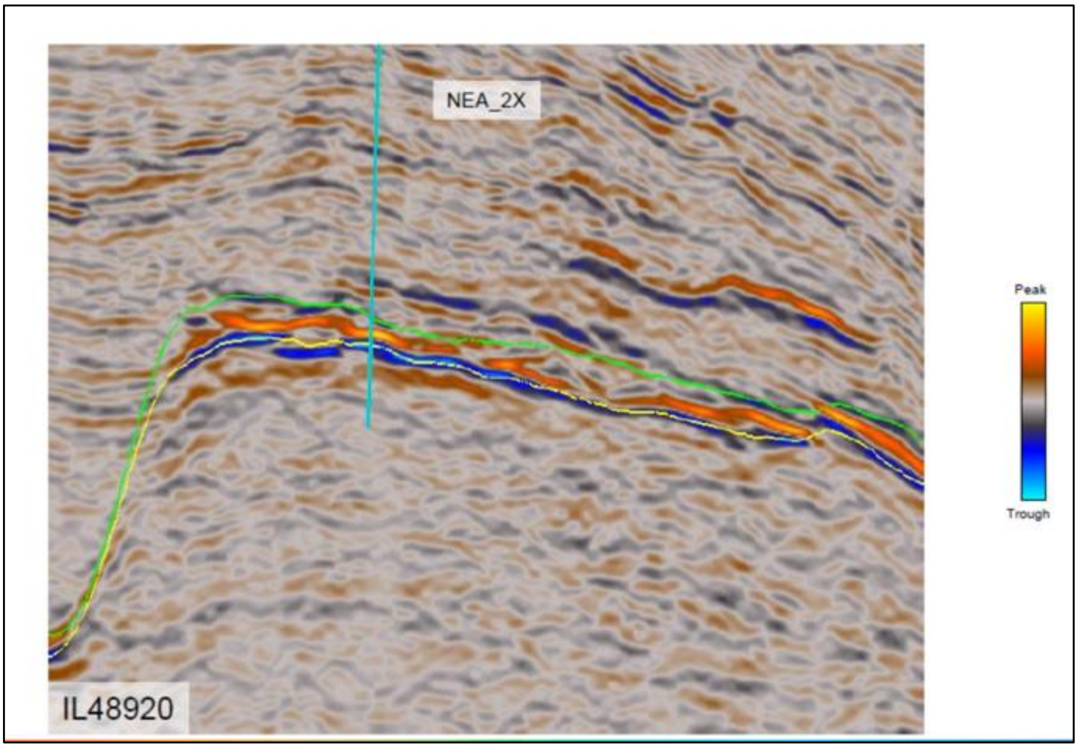


Fig. (7): Noise cancelled PSTM seismic lines passing through proposed location NEA 2X.

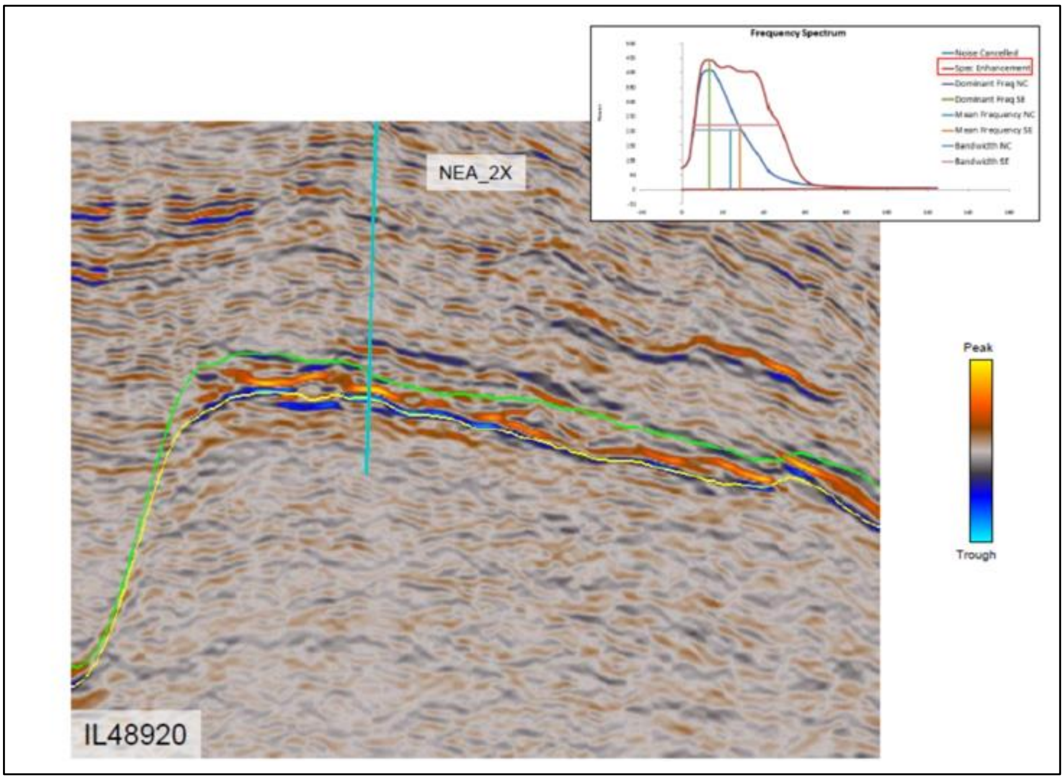


Fig. (8): Spectrally enhanced PSTM seismic lines passing through proposed location NEA 2X.

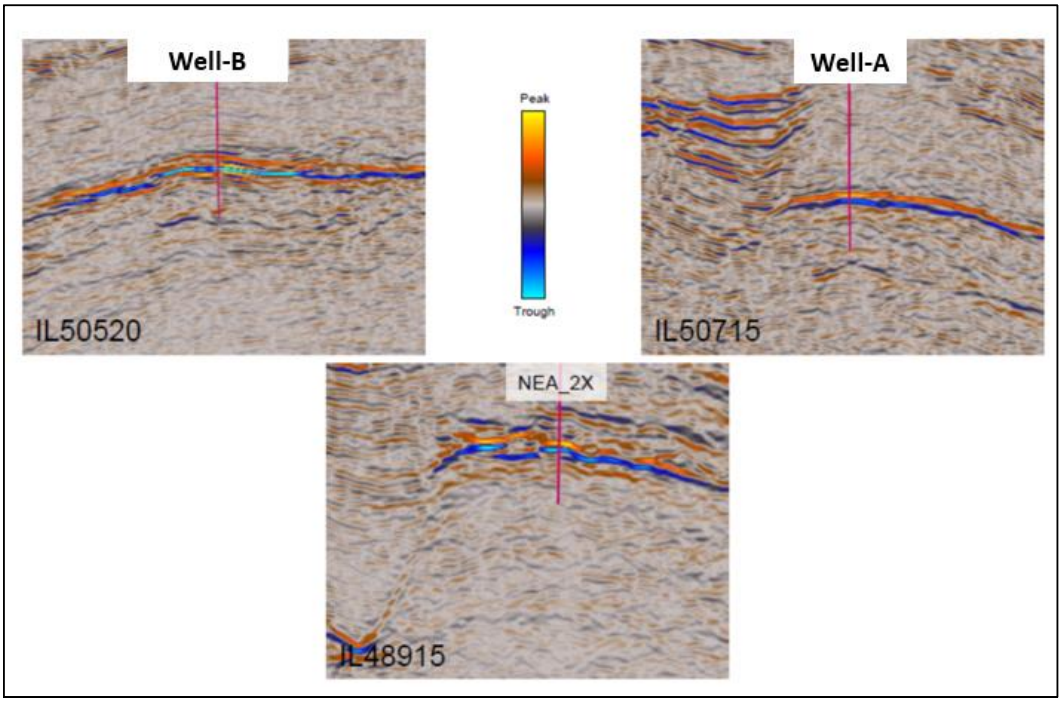


Fig. (9): Spectrally enhanced PSTM seismic lines passing through Wells; Well-A & Well-B and proposed location NEA 2X.

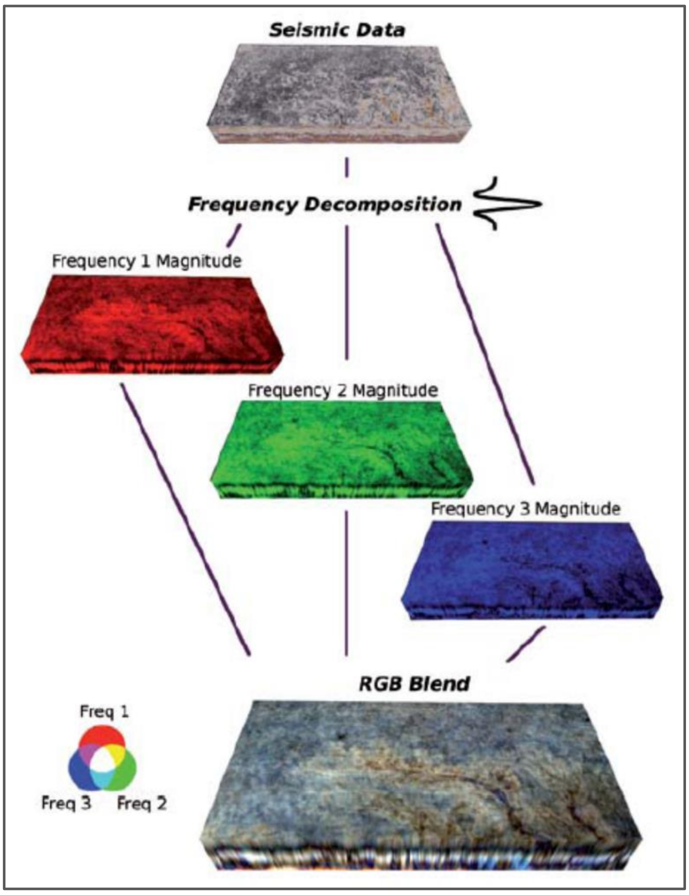


Fig. (10): Frequency decomposition and RGB color blending workflow.

the differences in response, and hence the colours and intensity seen within an RGB blend, is complicated. The Constant Q method is a variable bandwidth method, with bandwidth increasing with frequency so that the proportion of power to bandwidth remains constant between different band-passes (McArdle and Ackers, 2012; Cooke et al, 2014)

The workflow was tested using both the conventionally spectral enhanced data and the low-frequency enhanced data as input volumes. Different frequency decomposition algorithms were tried on the datasets, including the Constant (Q) method analogous to a Continuous Wavelet Transform (CWT) and the High Definition Frequency Decomposition (HDFD) method based on a modified matching pursuit algorithm. (Gilani et al., 2016).

STANDARD FREQUENCY DECOMPOSITION

In the case of standard frequency decomposition, it extracts band limited versions of the data and offers a much more sensitive method of analysing seismic data than the full frequency amplitude response. It can provide information about stratigraphic facies boundaries, structural and stratigraphic geometries, stratigraphic heterogeneity and bed thickness. When three frequency magnitude responses are combined in a RGB (Red-Green-Blue) colour blend, the relationships and interplay between the frequency responses can be investigated.

Frequency magnitude responses have been chosen sensitive to features of interest at the assigned interval. These magnitude volumes are effectively assigned a colour regime within the blend; low frequencies are in the red channel, medium frequencies in the green channel and the higher frequencies in the blue channel of the RGB colour space. Resulting combinations of frequencies present in these blends are depicted in the colour bar below.

Three standard frequency decomposition magnitudes volumes were generated as following: SD_26Hz Magnitude, SD 35Hz Magnitude and SD 45Hz Magnitude respectively (Fig. 11)

Interpretation of RGB blends is a visual task where movement, i.e. scrolling through the 3D volumes, plays a pivotal role. Scanning through the volume gives a useful indication of stratigraphic features present and allows continuous events to be tracked. By reviewing the RGB blend on a horizon, the interpreter can view high resolution stratigraphic information at, and around a specific geological event. Also, stratigraphic features may be more apparent by viewing on or parallel to a horizon.

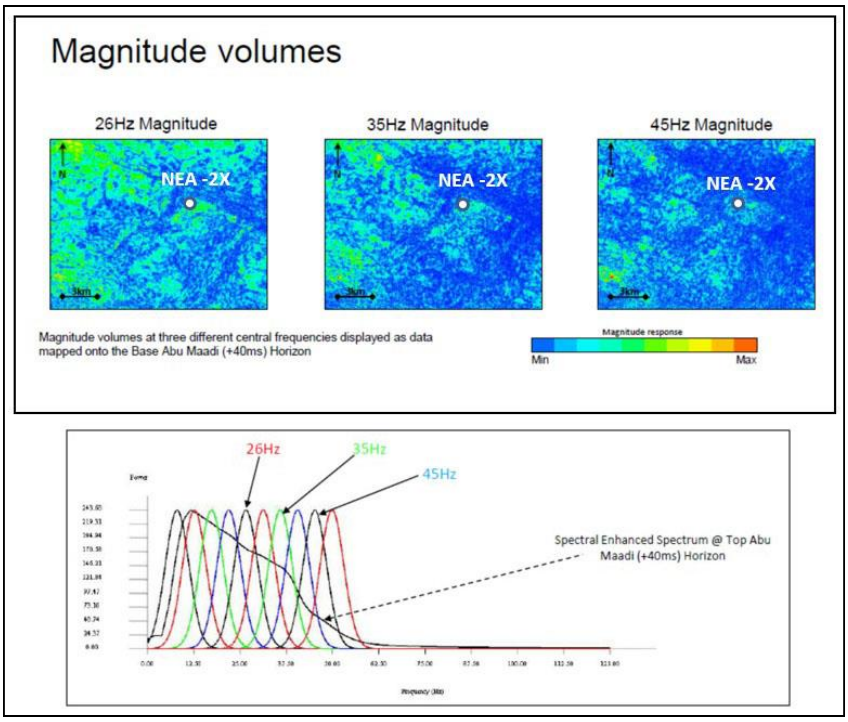


Fig. (11): Standard Frequency Decomposition workflow.

The blend of the magnitude volumes has revealed great contract in the frequency response of the geology of the area as meandering channel feature towards the crest of the fault block can be interpreted as illustrated in (Fig. 12), in this case a dominant southeast-northwest trend of mid frequency (green) responding packages can also be seen arrows). This horizon is taken below the anhydrite and when used alongside other attributes it is evident there is vert little/no response from the overlaying anhydrite.

HIGH DEFINITION FREQUENCY DECOMPOSITION

High Definition Frequency Decomposition (HDFD) uses an algorithm which reconstructs the original signal from a dictionary of synthetic Gabor wavelets chosen to approximate the seismic waveform. The technique is based on matching pursuit (Mallat et al., 1993), which means that every point in the data is matched to a number of different Gabor wavelets so that the misfit to the reconstructed seismic event is minimised. After the seismic signal has been successfully matched, an entire trace can be reconstructed at a given frequency simply by reconstructing and summing all wavelets with this central frequency.

Unlike other standard bandpass frequency decomposition, there is minimal vertical smearing, due to the high temporal localisation of this technique. HDFD techinque does not utilize uniform filter sizes, it precisely matches the wavelets to each seismic reflection so that no vertical averaging occurs. It does not have any window effects and this allows it to deliver the highest resolution frequency decomposition available for 3D seismic, therefore more accurate localization of features. Three high definition magnitude volumes were generated as following: HDFD 15Hz Magnitude, HDFD 22Hz Magnitude and HDFD 30Hz Magnitude, (Fig. 13).

The trend is still visible in the blend, however represented by blue (high frequencies). The colour map is adjusted according to the frequency inputs, therefore blues in this blend represent response from the 30Hz magnitude volume and greens in the standard RGB blend represent a response from the 35Hz magnitude. This opens up avenues for further work by confirming this trend has a dominant response from around the 30-35HZ range and additional workflows can be targeted at this frequency range.

Like the standard frequency decomposition, the low frequency trend which crosspond to same depositional architectures and elements which is fluival meandering channels are also be imaged in the HDFD blend (Fig.14), which decreae the risk of finding the reservoir in the prospect area.

Time slice through color blend volume along the potential reservoir level (Fig.15) show white ampiltude anolmly, where the white colour is the common of the RGB scheme i.e. Red-green-blue colors, this is defintely increases the possibility of presence of reservoir sand in the prospect area which is controled faulted compartment.

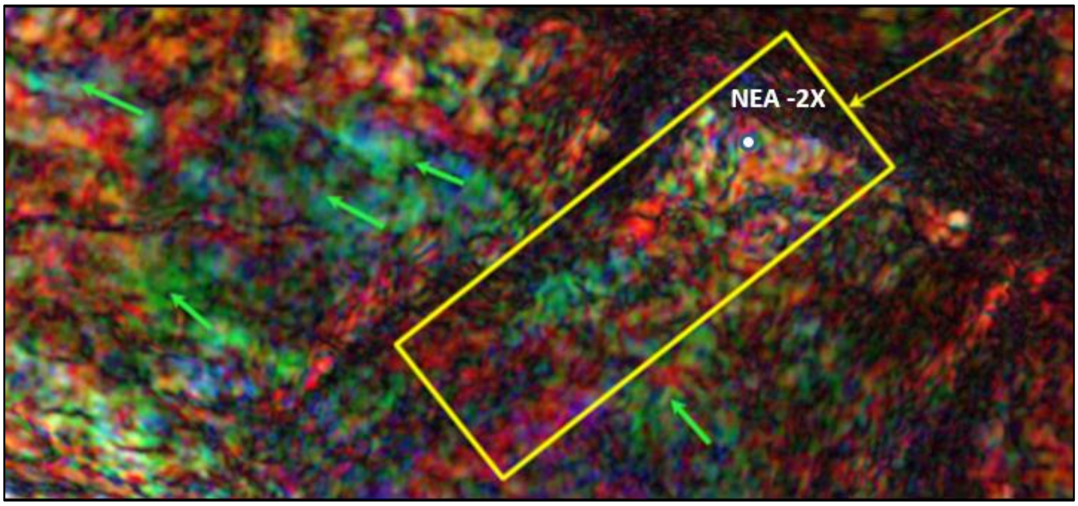
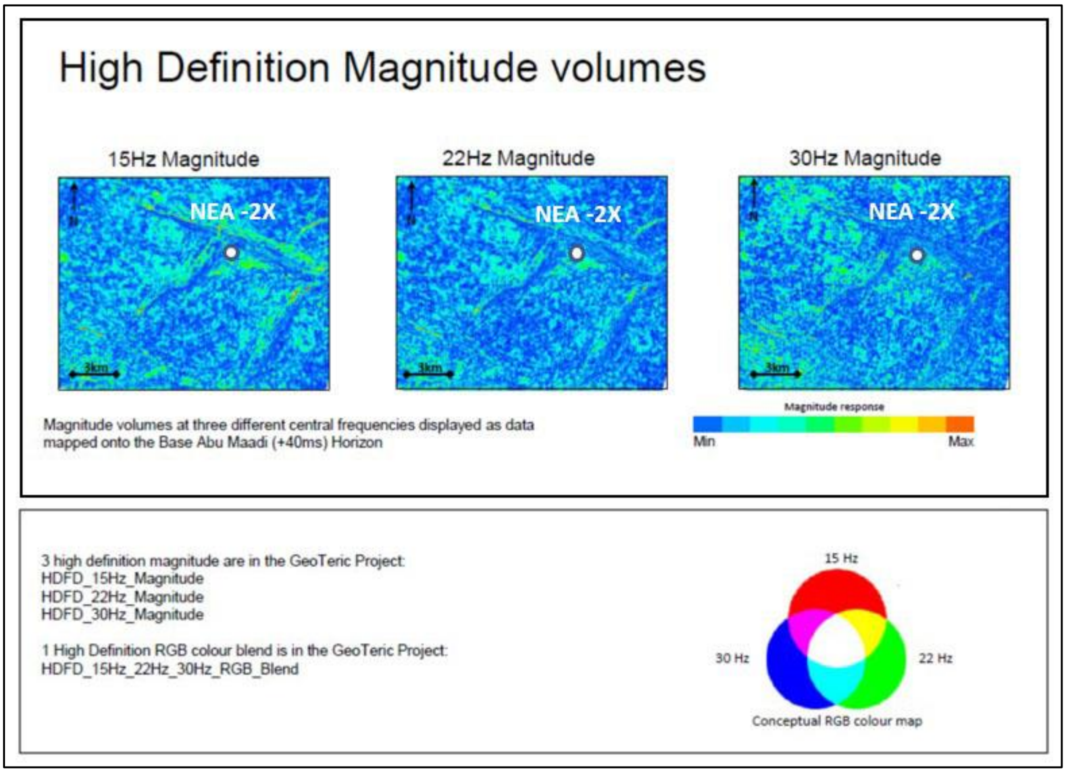


Fig. (12) : Standard Frequency Decomposition RGB Blend 26Hz, 35Hz & 45 Hz at top Abu Maadi reservoir.



Magnitude volumes at three different central frequencies displayed as data mapped onto the Base Abu Maadi (+40ms) Horizon

3 high definition magnitude are in the GeoTeric Project:
HDFD_15Hz_Magnitude
HDFD_22Hz_Magnitude
HDFD_30Hz_Magnitude

1 High Definition RGB colour blend is in the GeoTeric Project:
HDFD_15Hz_22Hz_30Hz_RGB_Blend

Fig. (13): High Definition Frequency Decomposition workflow.

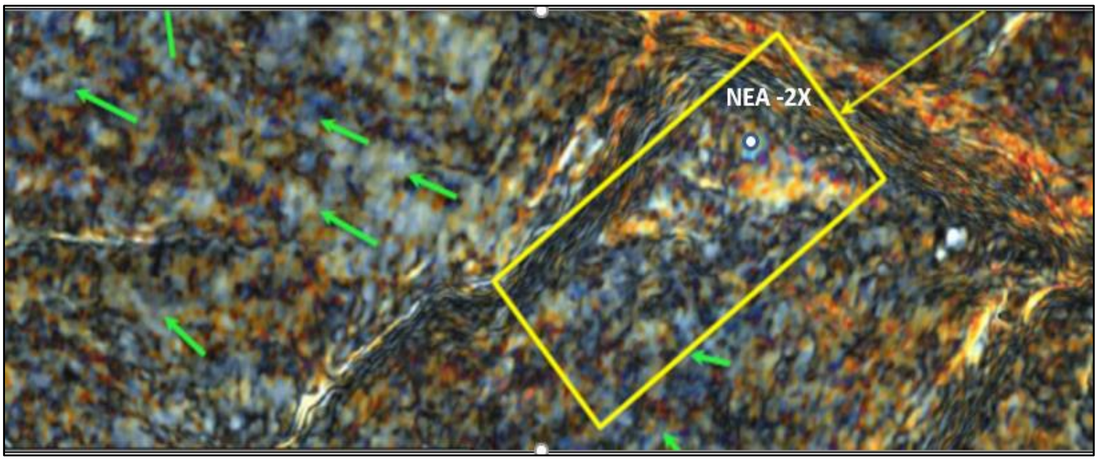


Fig. (14): High Definition Frequency Decomposition RGB Blend 15Hz, 22Hz & 30 Hz at top Abu Maadi reservoir.

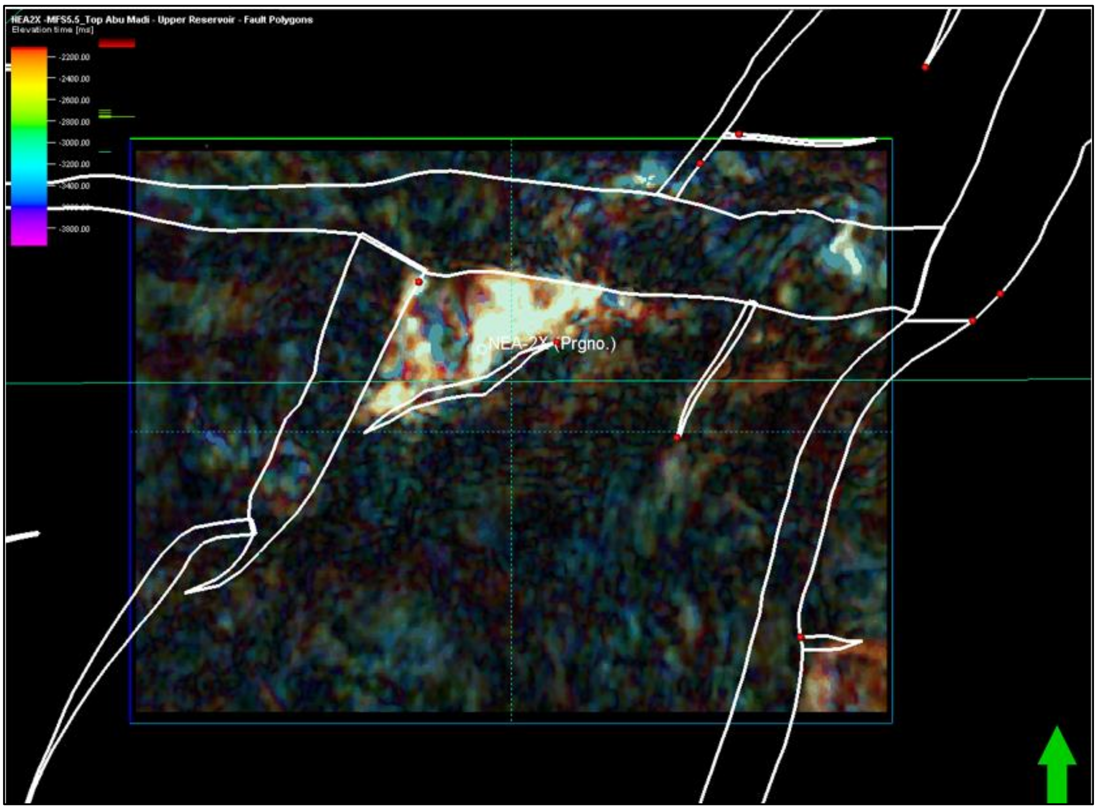


Fig. (15): Color blend time slice @ top top Abu Maadi reservoir.

CONCLUSIONS

Data conditioning, including both noise cancellation and spectral enhancement, optimised the input data to be used for further interpretation and frequency studies. The noise cancellation increased the signal-to-noise ratio while preserving the subtle edges and fault breaks, and the spectral enhancement brought a white spectrum to the data improving the vertical resolution. The amplitude in these areas was corrected using an adaptive amplitude normalisation workflow, which adjusted the amplitudes that were attenuated because of the presence of the Messianian anahydrite, recovering a similar amplitude range to the surrounding un-affected areas.

The frequency decomposition workflow analyzed the subtle frequency variations in the seismic signal which were interpreted as changes in reservoir thickness, lithology or fluid content. This technique has been used mainly as a qualitative approach for identifying those reservoir variations. The brighter RGB blend colours observed within the reservoir were interpreted as an indicator of the presence of hydrocarbons. Different approaches of frequency decomposition and colour blending techniques were tested in the dataset, and all of them showed a brighter colour response within the reservoir, which could be an effect of the presence of hydrocarbons.

Acknowledgments:

Great appreciation and gratitude present to Wintershall Dea Egypt BU, EGAS and EGPC for providing us with the needed data set.

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