Prediction of Aeromagnetic System based on Digital Filters by MATLAB and Oasis montaj Software.

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Abstract: - This paper presents the applications of digital filters for prediction of aeromagnetic data signal processing. These data are collected by air graft and digitize using Oasis montaj software. Digital filters are applied to predict the hidden anomalies by eliminate noises and unknown frequencies. these used filters are: gaussian low/high, smoothing, edges of the anomalies in subsurface, derivative and analytical signals. they can be obtained using Potensoft code and Oasis Montaj Software. potensoft are based on MATLAB toolbox of processing, modeling and mapping of aeromagnetic data. Results indicate that Oasis montaj is peter than potensoft. These is due to Oasis montaj has predicted with high resolution and easily to determine anomalies locations and dimensions. Also, gaussian low pass filter give best results and indicate accurate anomalies level. Upwards continuation filters indicate best results for level anomalies. Introduce new derivative technique is useful in edge detection.

Key-words: - prediction, digital filters, Aeromagnetic data, signal processing, MATLAB, Oasis montaj software

1 INTRODUCTION

The digital filters have Some advantages as functionality, stability, noiseless and linearity. The magnetic data is potential field methods and used for a wide range of applications in discover underground structures and materials. the most of filters applying in frequency domain so transforming the data to the frequency domain [1]. The most commonly used frequency domain filters are include: reduction to pole, analytical signals, continuations, gaussian and derivative filters. Convolution methods involve convolving a filter impulse response (filter coefficients) with the dataset. magnetic data processing by many different Filters, the quality of filter related to emphasize boundaries between geological materials, and the magnetic sources show in shallow or deeper. filters procedure can be performing in frequency domain by means of Fourier Transform or in the spatial domain by convolution. The aeromagnetic data convert from Fourier Transform to the wavenumber domain and Inverse Fourier Transformed. frequency domain filter involves converting the dataset into the frequency domain. Digital signal processing (DSP) is based to processing and denoising technique for the recovery of signal contaminated [2]. Digital filters are Gaussian, upward, downward continuation, derivative, analytical signals and smoothing filters.

2 Filters algorithm

2.1 Gaussian filters

Gaussian filters are smoothing filters. high/low noise and investigates the noise free reconstruction property of universal threshold [3]. Gaussian filters are particularly popular in edge detection algorithms because of their ability to smooth edges and edge improve detection as edge position, edges vanishing, and phantom edges [5]. The gaussian filters formula in eq. (1).

$$F(k) = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-k^2}{\sigma}} \quad (1)$$

where f(k) is Fourier transformer of magnetic data, k is wave number = 1/λ.

the gaussian filters have many advantages as smoothing, decay to original signals and simple analytic formula. It is often used for low-pass or high pass applications. the low pass filter is passes low frequency signals but prevent high frequency.

2.2 Low pass filter.

The low pass filter is purpose is removing unwanted high frequencies [6], the formula of low pass filter as in eq. (2).

$$L(k) = \begin{cases} 1 & \leq k_c \\ 0 & > k_c \end{cases} \quad (2)$$

Where k_c cut of frequency.

2.3 High pass filter.

A high-pass filter is the opposite of low-pass filter. It passes all high frequencies and prevent the low frequencies, cut off low frequency. The high pass filter show in fig. 3.

$$L(k) = \begin{cases} 1 < kc \\ 0 \geq kc \end{cases} \quad (3)$$

The gaussian filter use as tilt angle in edge detection [7] & [8].

2.4 Band pass filter

Band pass is use to allowing pass distinct frequencies and it is use to remove corresponding different wavelength.

2.5 Upward and Downward continuations filters

the data set transformations are appearing at different depths. The upward continuation if data set afar from anomalies (sources) the downward continuation if data set being near the anomalies [9].

$$u(k) = (k)_e^{-zk} \quad (4)$$

where f(k) is Fourier transformer of magnetic data, k is wave number = 1/λ.

The technique of upward continuation is removing the high spatial frequency and highlight regional feature and the downward continuation removing any noise in data. The upward and downward continuation are applied in Fourier transformation multiply in term $e^{\pm 2\pi h\sqrt{u^2+v^2}}$ where h is the required Hight and u/v frequency domain variable. Upward and downward continuation forms are show in figures. 1 and 2, where h is distance and r waver number radian/ground unit.

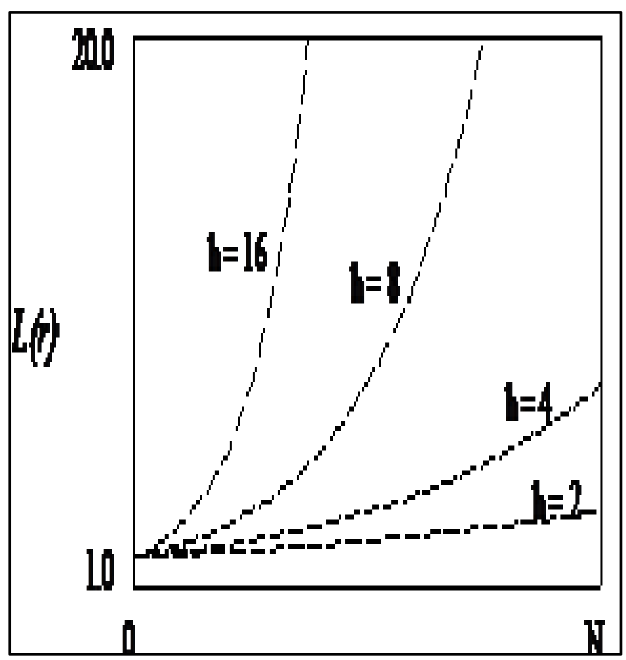

Fig. 1 Upward continuation forms.

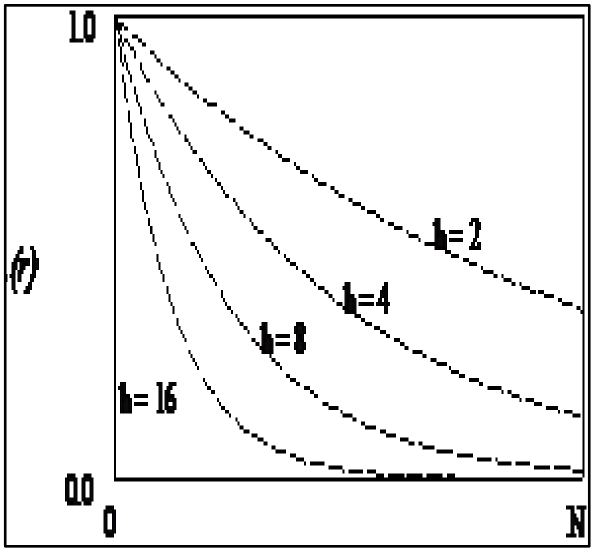

Fig. 2 downward continuation forms.

2.6 Derivative filters

Derivative in x, y and z direction are processing of first and second vertical derivative. The derivative direction is use to edge detection and anomalies boundaries, the data set as f(x, y, z) and derivatives as : ∂nf(x, y & z) / ∂ zn [10]. The derivatives filters are sprouting many filters as first vertical derivative, total horizontal derivative of the tilt angle, analytical signal equation (5) [11], total horizontal derivative and so on. the equations (6) show Total horizontal derivative (THDR), then estimate the tilt angle as show in equation (7)

$$|AS| = \sqrt{\left(\frac{\partial M}{\partial x}\right)^2 + \left(\frac{\delta M}{\delta y}\right)^2 + \left(\frac{\delta M}{\delta z}\right)^2} \qquad (5)$$

$$THDR = \sqrt{\left(\frac{\partial M}{\partial x}\right)^2 + \left(\frac{\delta M}{\delta y}\right)^2} \qquad (6)$$

$$Tilt = \tan\text{-}1\left(\frac{\frac{\partial M}{\partial z}}{THDR}\right) \qquad (7)$$

3 Result and Discussion

In this study: using digital filters to predictions and extract the hidden anomalies in surface and subsurface. obtain digital filters results by Oasis montaj and potensaft (MATLAB environment) software.

3.1 Reduction to Magnetic Pole (RTP)

RTP map is the original data. RTP map display all anomalies with gradually disappear. RTP by Oasis montaj show the anomalies with gradually disappear, but by MATLAB is specific distinct contour. From these results Oasis montaj is peter than Potensoft due to data are gradually.

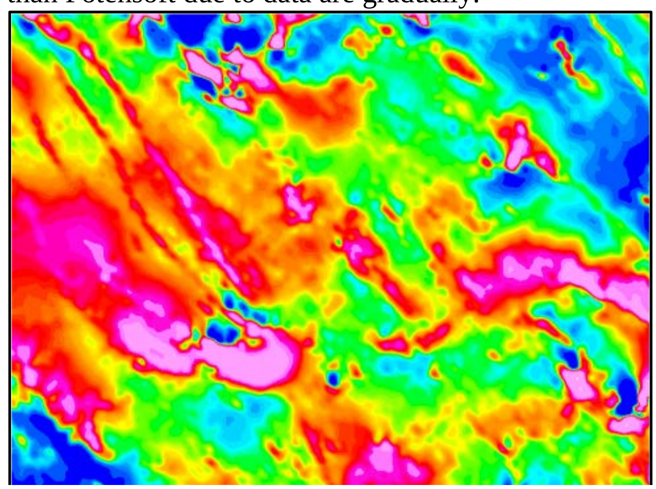

Fig. 3 (a) RTP original data by Oasis montaj.

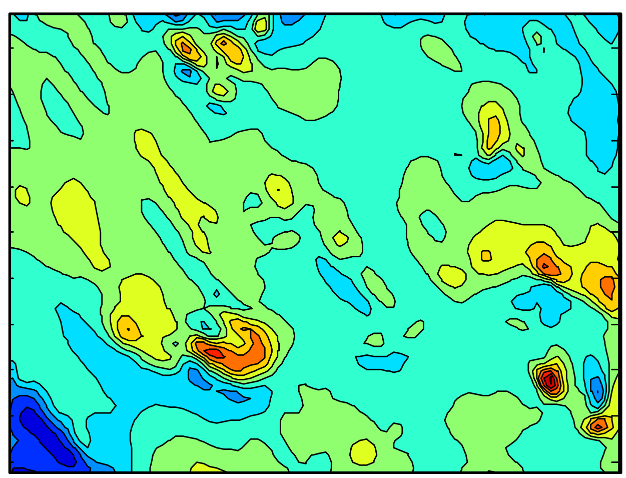

Fig. 3 (b) RTP original data by Potensaft.

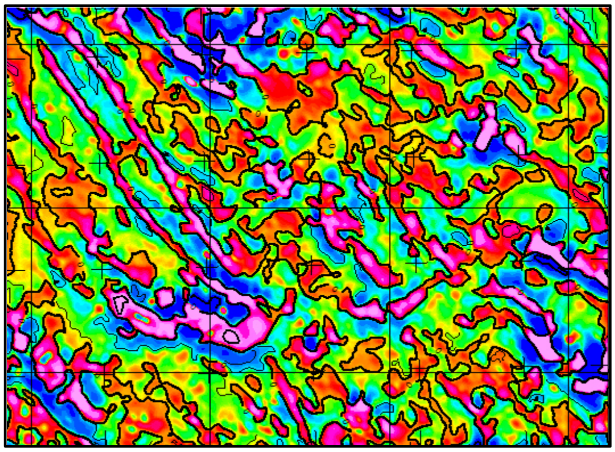

Fig. 4 (a) Oasis Gaussian high filters.

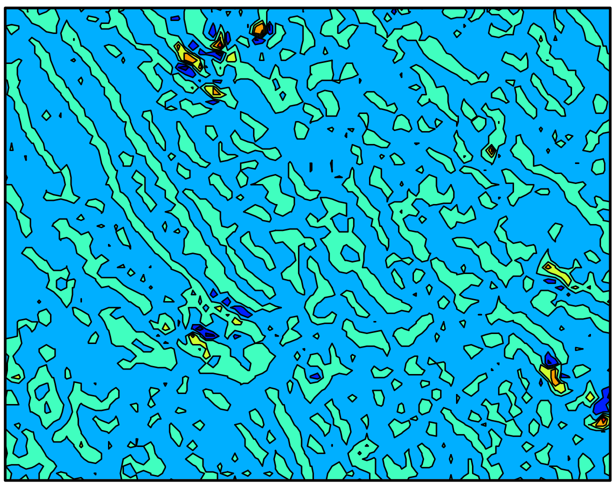

Fig. 4 (b) Gaussian high filters.

3.2 Gaussian Filter

Gaussian filter that include high and low-pass filters were applied to recognize the shallow and deep sources responsible for the residual and regional fields. Isolating of the regional and residual magnetic anomalies. Gaussian high pass filter recognize deeper (subsurface) anomalies. Gaussian high pass filter can be obtained anomalies level from power spectrum curve by slop divid to 4π. Oasis montaj show deeper anomalies and are clearly more than Potensoft. Power spectrum fig. 4 (e) The residual (low-pas fig. 4 (c)) map focuses attention on the weaker features, which are obscured by Reginal component at 3.5km show in fig. 4(a) and resdual component at 0.6km show in fig. 4(c) and the magnetic modeling proved, show in fig 4. (f, j). two modeling show in fig. 4 recognize hidden anomalies reginal and residual components at shallaw and deep anomalies as high/low pass filters. Two main average interfaces, at depths of 0.6 km and 3.5 km respectively below the measuring level, were revealed through the application of local power spectrum Fig. 4 (e). the stronger regional fig. 4 (a) high pass effects on the original map.

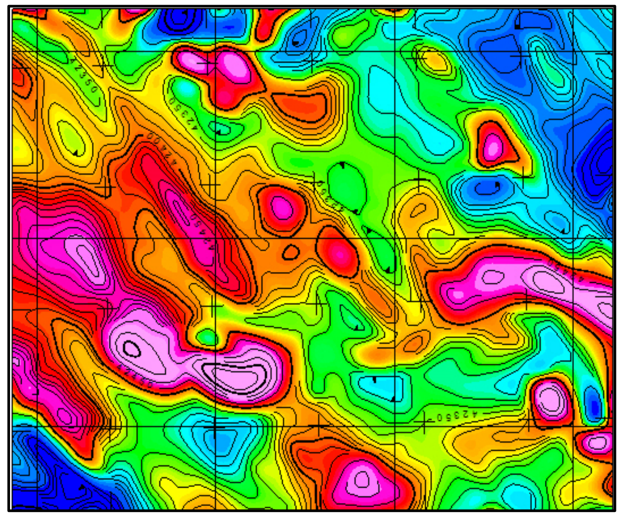

Fig. 4 (c) Oasis Gaussian low filters.

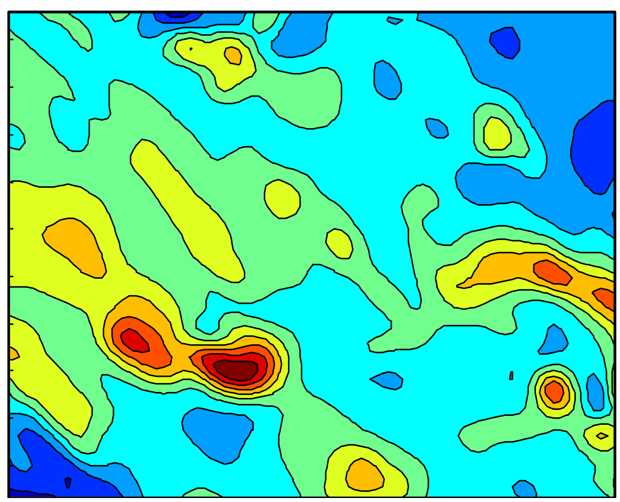

Fig. 4 (d) Gaussian low filters.

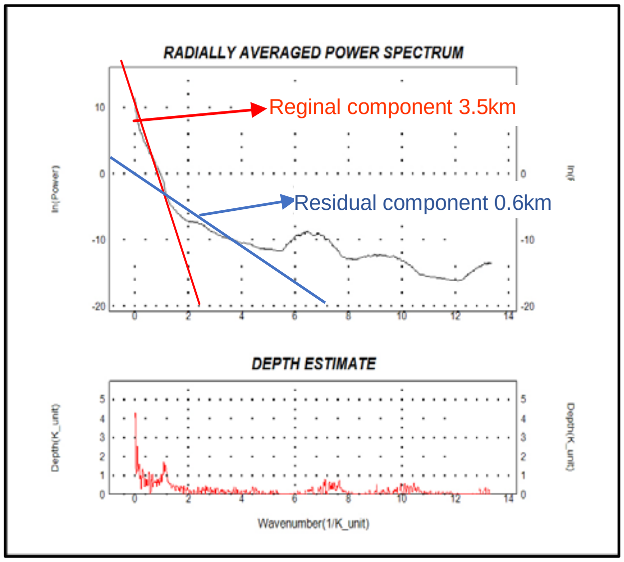

Fig. 4 (e) power spectrum of gaussian high pass filter.

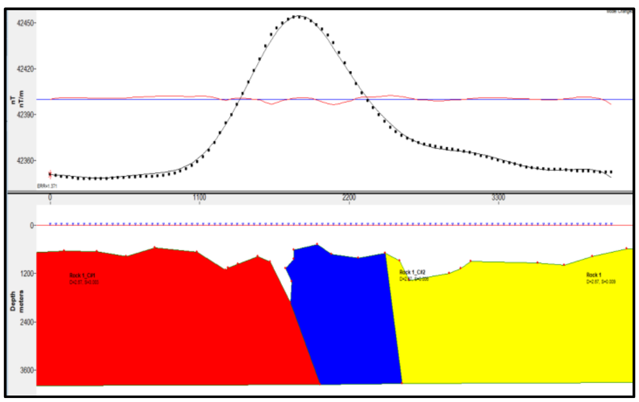

Fig. 4 (f) Magnetic modeling show shallaw anomalies.

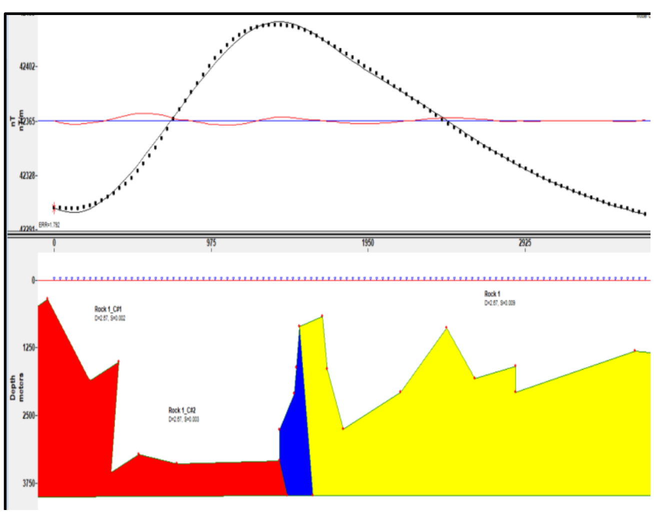

Fig. 4 (j) Magnetic modeling show deeper anomalies.

3.3 The upward continuation

Up ward maps Fig. 4 (a) attenuate these shallow source anomalies and emphasizes the deeper ones. The upward continued process at level 2000m show hidden anomalies clearly in Oasis and Potensoft. But in potensoft not recognized all anomalies as show in previous figure.

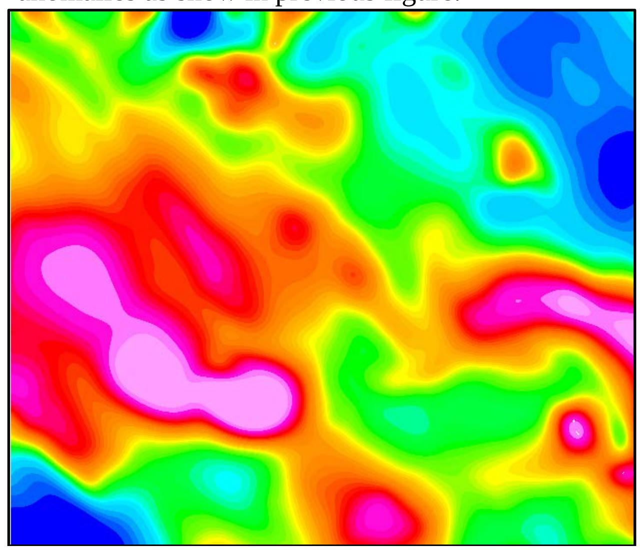

Fig. 5 (a) Oasis upward continuation at 2000m.

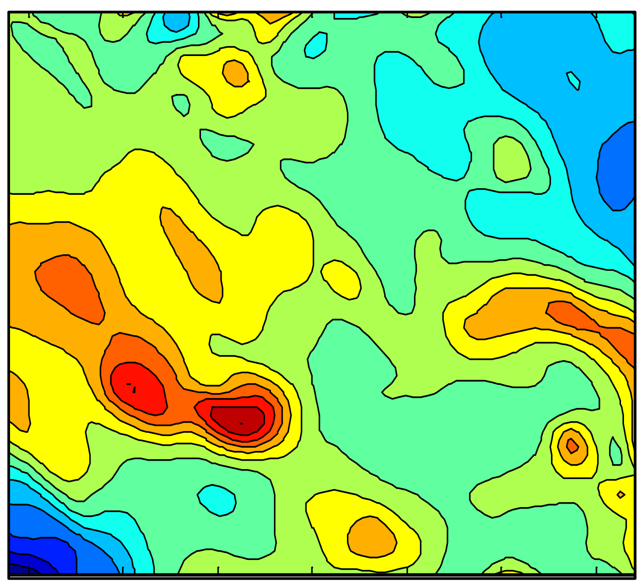

Fig. 5 (b) MATLAB upward continuation at 2000m.

3.4 Derivative filters

Derivative filters first derivative in x direction fig. 6 (a, b), Oasis result show anomalies in x direction is clearly with anomalies extended. Derivative in y direction show in fig. 6 (c, d) also Oasis has specific results. Derivative filters have enhanced detail and sharpen hidden anomalies as edges detection. Derivative filter introduces tilt derivative and analytical signals and other technique based on derivative.

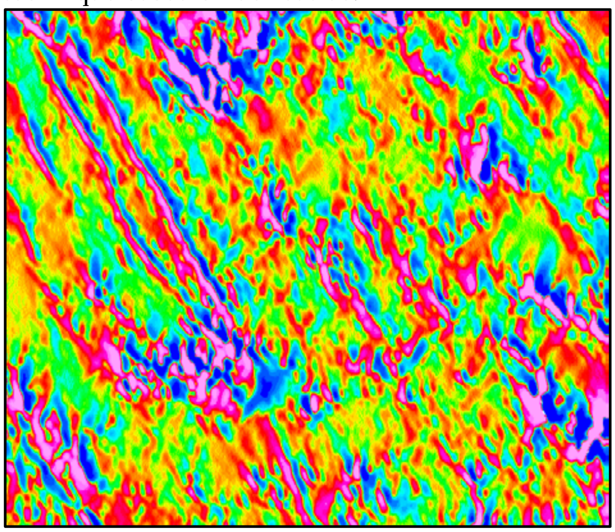

Fig. 6 (a) Oasis derivative in x direction.

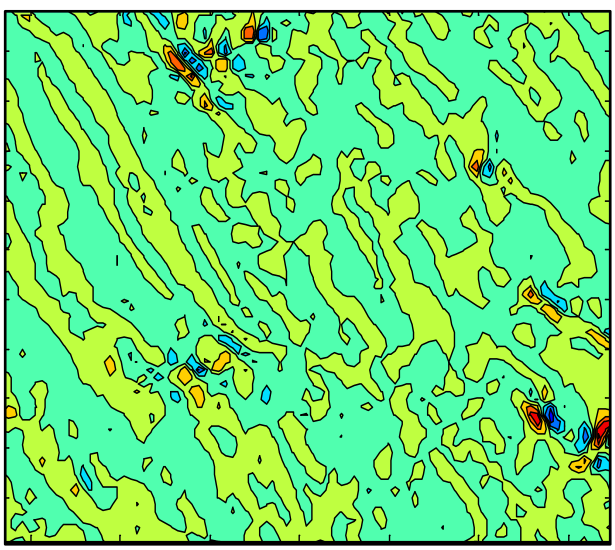

Fig. 6 (b) MATLAB derivative in x direction.

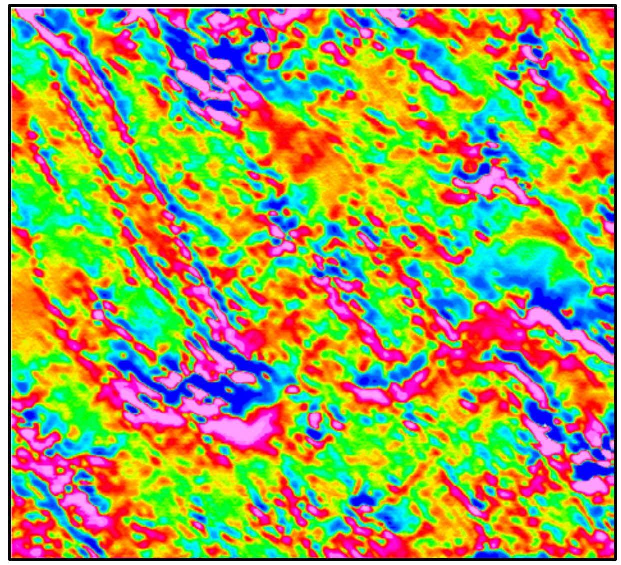

Fig. 6 (c) Oasis derivative in y direction.

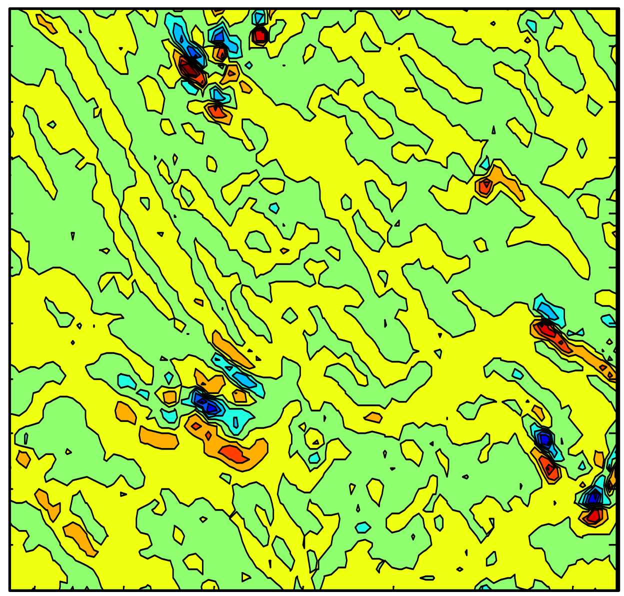

Fig. 6 (d) Oasis derivative in y direction.

3.5 New technique

Now: prove the derivative in x direction multiply in y derivative and divid on z derivative have advantages in edges anomalies technique. the mathematical expression as in this equation $\frac{\partial x * \partial y}{\partial z}$ the result are show fig. 6(e).

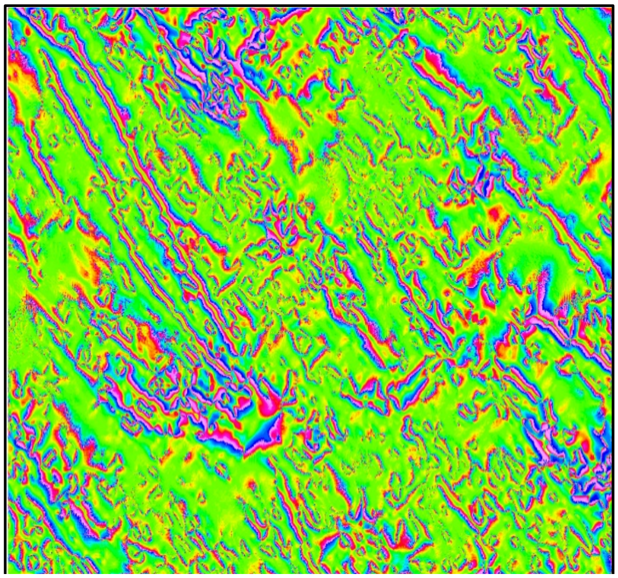

Fig. 6 (e) Oasis result of $\frac{\partial x * \partial y}{\partial z}$.

3.6 The analytical signal

Analytical signal results show the boundaries of hidden anomalies. It useful in boundaries anomalies. Analytical signal has advantage enhance the amplitude is positive and not need assumption of anomalies directions and structure of magnetic anomalies.

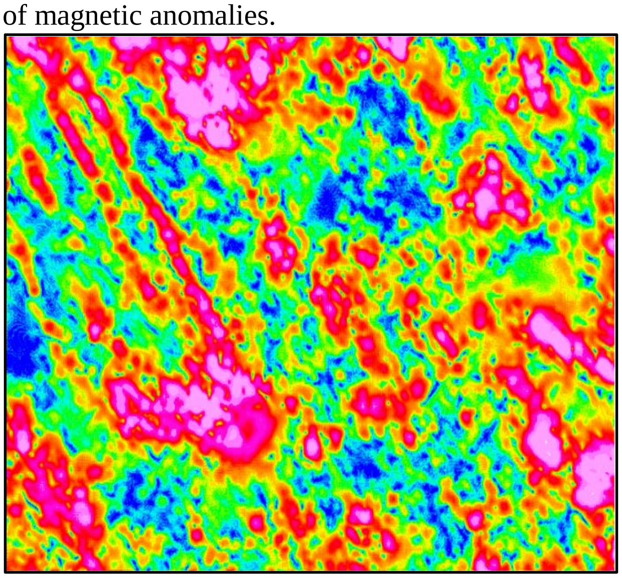

Fig. 6 (f) Oasis Analytical signal.

4 Conclusion

This paper present Prediction of Aeromagnetic System based on Digital Filters by MATLAB and Oasis montaj software. these used filters are: gaussian high/low, upward, downward continuations, smoothing edges of the anomalies in subsurface, derivative, new derivative filter and analytical signals. results from Oasis montaj and MATLAB packages prove the Oasis montaj is very distinct on aeromagnetic data processing and preforming any process easily. The MATLAB codes are useful in some processing as upward continuation at any level. In Oasis results the hidden anomalies are extended, we can apply the smoothing filter to cut this extended. The power spectrum show anomalies level by divided the slop to 4π. two modeling show lower and deeper anomalies. Upward continuation shows the anomalies depth and structure. Derivative filters have advantage in edge detection and emphasizes the hidden anomalies and introduce new derivative technique. Analytical signal is useful in boundaries anomalies. The oasis montaj software is specific in aeromagnetic data processing.

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