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Ant-Tracker Attributes: An Effective Approach To Enhancing Faultidentification And Interpretation

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Abstract:*The purpose of this work is to x-ray the use of Ant Tracker Attribute to effectively interpreting faults that are hard to see on a conventional 3D data set. Interpretation of faults in any seismic interpretation process has significant importance during exploration and development stages. On a conventional seismic profile or poor quality data, faults are hard to see or not visible. Seismic attributes provide quick way to visualize the trends of faults. Several attributes enhance clarity of faults on seismic data such as: variance attributes, ant attributes, chaos attributes, curvature attributes etc. among all, ant attributes show better result in delineating faults. The effective implementation of ant attribute can be achieved when the output of other fault sensitive attributes are used as an input data. In this work, the seismic data used was carefully conditioned using structural smoothing to remove residual background noise and to improve the spatial continuity of seismic signal. Then, chaos and variance attributes which are sensitive to faults are applied to the seismic data set; and the outputs from these processes are used as our input data to run the ant attribute with which the faults were clearly seen that were difficult to display on the raw seismic data set. The Ant Tracker Attribute indeed enhances faults and fractures in 3D data set that makes work easier for the interpreter.*
Keywords:*Attributes, faults, chaos attributes, variance attributes, noise, signals*

I. Introduction

The interpretation of faults in any seismic interpretation process has significant importance during the exploration stage or development stage. Faults are important in trapping hydrocarbon into accumulation for drilling; they also serve as a conduit through which hydrocarbons migrate after being generated in the ‘kitchen zone’. The identifying and mapping of fault structures often help in the determination of the size, geometry and the level of compartmentalization of hydrocarbon reservoirs (Jibrin, 2009). This shows that the interpretation of faults structure is paramount in any seismic practice.

According to Ashique and Samiranjan (2010), during the drilling of a well if faults zones are not carefully mapped in the interpretation phase they can cause the loss of drilling mud, as most of the mud would move towards the fault zone, which would lead to the absorption of more drilling mud. This can make the well to be abandoned by the drillers if they do not understand that it was the presence of the fault that was absorbing the drilling mud. Fault interpretation is an important component in determining the structural information of the reservoir. When faults are mapped on a seismic section they can give valuable information about how fluids flow in the reservoir, and the connectivity of the fluid within reservoirs. Faults as geological structures can have significant effects on the permeability of reservoirs which can also have impact on the productivity and efficiency of the reservoir (Neves et al, 2006; Chopra and Marfurt, 2007a and Santosh et al, 2013).

With all these benefits that faults plays in the interpretation phase, interpreting fault comes with challenges. During the picking of fault for structural interpretation, manual picking of fault is tedious, especially when the data quality is poor. The conventional way of interpreting fault is achieved by picking fault on a 3D seismic volume, either by manual picking or using auto-tracking approach. It is most times not suitable in using these approaches to interpret fault since sometimes these faults are not seen clearly on a conventional 3D data due to the presence of noise, or if the data quality is not good as shown in Figure 1. When the data quality is poor due to noise, auto-picking of fault is not reliable and accurate, and one would be compel to interpret the faults manually which is a tedious and cumbersome practice.

Seismic attributes provide quick way to visualize the trends of faults which are hard to see or most times not visible on a conventional seismic profile. Information’s from different seismic attributes are used to form fault geometry, and can generally be used to optimize well locations (Santosh et al. 2013).

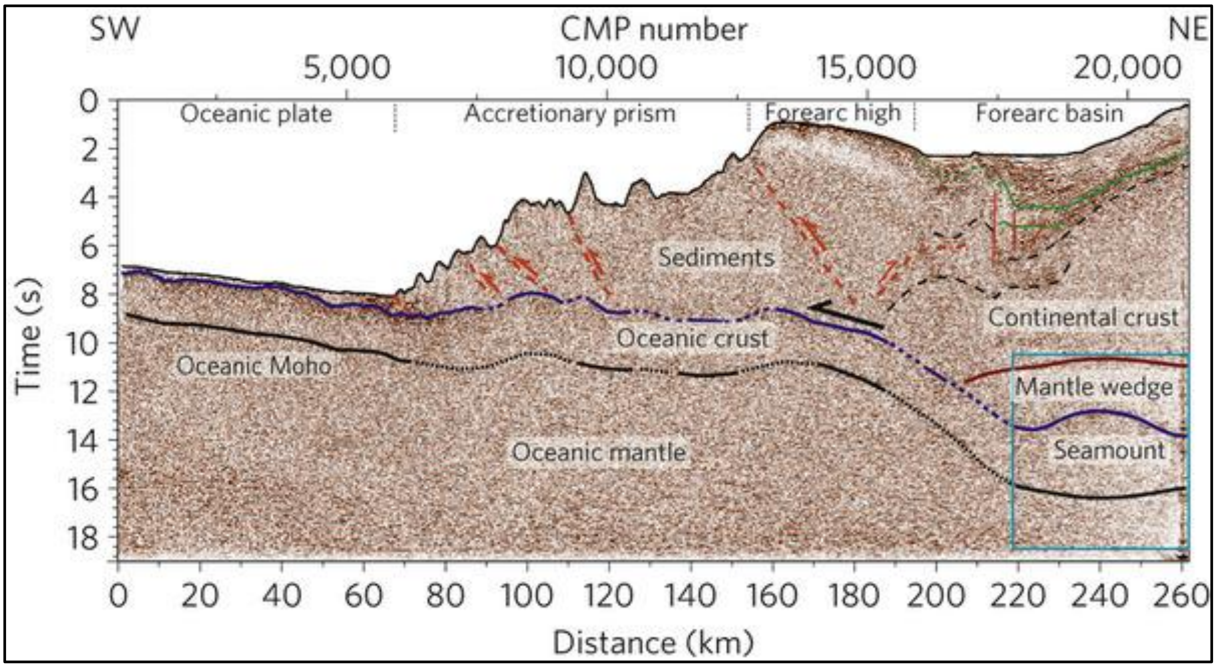

Fig. 1 Data with poor image quality, faults are not seen clearly
(Adapted from, http://www.nature.com/ngeo/journal/v4/n5/images_article/ngeo1119-f2.jpg)

To see faults clearly on a seismic data, seismic attributes are applied on a seismic section. There are several attributes that enhance the clarity of faults on seismic data, this attributes include coherence attributes, variance attributes, ant attribute, curvature attributes and chaos attributes etc. amongst these attributes, the ant attributes always shows a better result in delineating fault. The objective of this research is to use ant attribute to interpret fault that are hard to see on the 3D data set.

Seismic Conditioning

During the processing of seismic data, noises in the data are attenuated, with different processing algorithm depending on the type of noisebefore the interpretation phase. The aim of seismic processing is to have a noise free data before the interpretation stage, but this is most time not achieved as there are residuals noise that still finds their way into the interpretation stage. So the interpreter is face with the challenges of removing this noise types in the data prior to interpretation by applying various filters to remove these residual noise present in the data.

Seismic attributes are often sensitive to noise present in seismic data. It is advisable to run a spatial filtering filter, to remove the noise while retaining the geometrical details on them (Basir et al., 2013). This can be achieved by applying structural smoothing. In Petrel interpretation Software,Structural smoothing is a tool applied to reduce background noise and to improve the spatial continuity of seismic signal. Figure 2 shows the raw data before and after the application of structural smoothing, it can be seen that the data quality has been enhanced, the noise in the data have been attenuated. In structural smoothing the Gaussian weighted Filter parameter is used to attenuate the noise and to sharpen discontinuity in the data set. Since the objective of this research is to interpret fault, we need the faults to be enhanced, so we applied a Gaussian filter to enhance the fault. Figure 3 shows the data with and without applying Gaussian filter parameter in the structural smoothing tool. Figure 3a shows a better result since the faults are more pronounced in the data than in figure 3b.

Attributes Analysis

A seismic attribute is any measure of seismic data that helps the geoscientist to enhance or quantify features of interpretation interest that were not possible to detect on a 3D seismic data set (Chopra and Marfurt, 2007a). Any mathematical measurement of interest derived from seismic data is an attribute. They are usually measurements of time; amplitude, frequency, and/or attenuation (Sheriff, 2002).Attributes are powerful aid to seismic interpretation. They allow the geoscientist to interpret faults and channels, recognize the depositional environment, and unravel the structural deformation more rapidly (Chopra and Marfurt, 2007b).

Seismic attribute is grouped into two classes; physical attribute and geometric attribute. Geometric attributes such as dip, azimuth, curvature, coherence , variance, chaos and ant enhances the visibility of the geometrical characteristics or shape of seismic reflectors, while physical attributes such as amplitude, phase, and frequency relate to the lithology of the subsurface (Jibrin, 2009,) In this research our interest is on the geometric attributes. With special focus on variance, chaos and ant attributes.

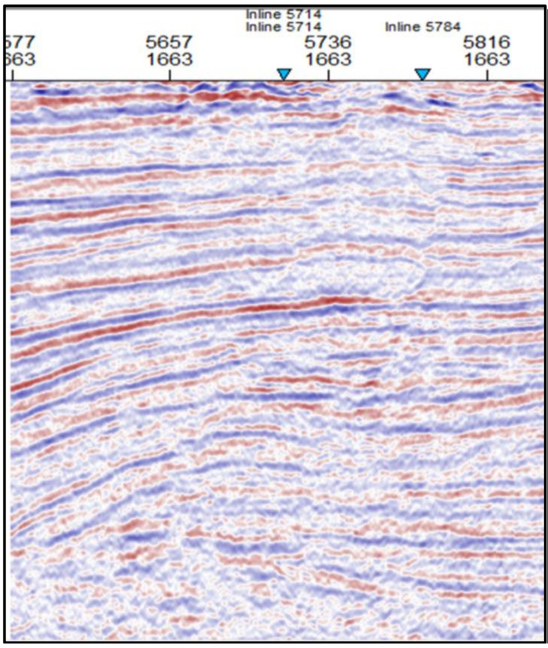

Fig. 2a: Raw Data without applying Structural Smoothing.

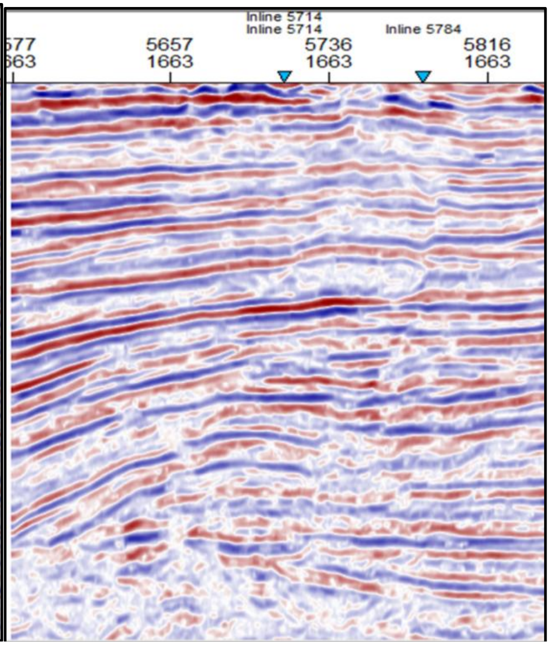

Fig. 2b: Raw Data after applying Structural Smoothing

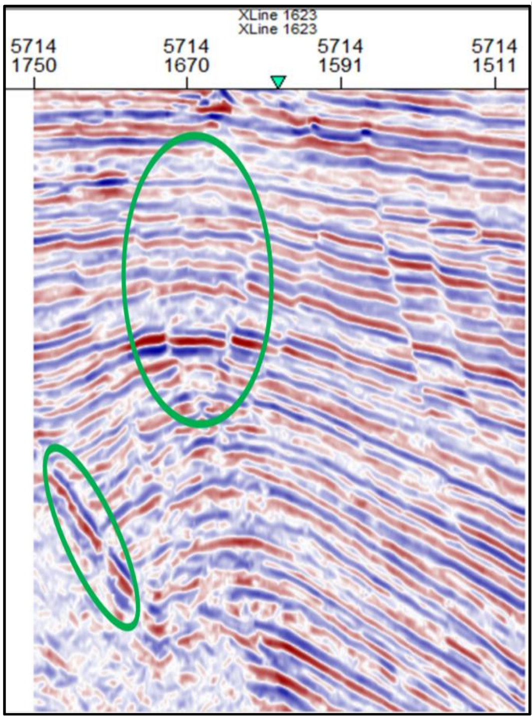

Fig. 3a: Structural smoothing data applied with Gaussian Filter

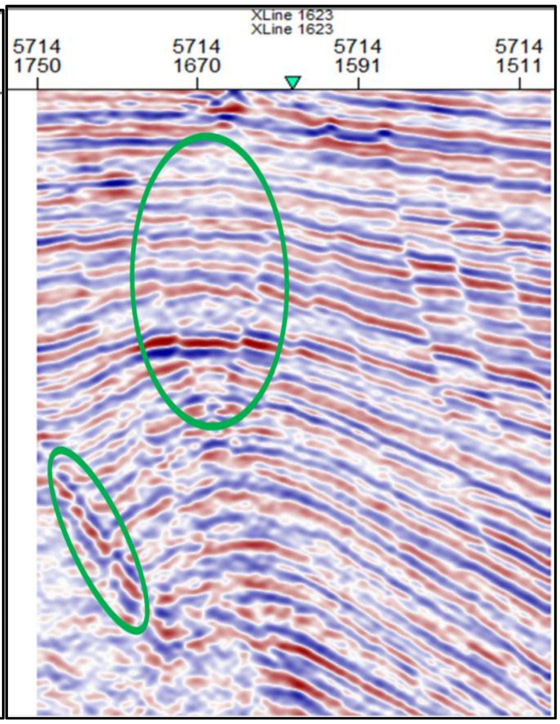

Fig. 3b: Structural smoothing data applied without Gaussian Filter

Descriptions of Ant-Tracker Attribute

Ant attribute was developed based on the concept of ant colony systems to determine discontinuities such as faults in 3D seismic data. This attribute uses the principles of swarm intelligence, which explain the collective behaviour of social insects in finding the shortest path between the nest and a food by communicating via a chemical substance known as Pheromone. When searching for foods ants uses these pheromone trails to direct other colony members to food they have found. Through this process the ants find the most efficient path from the nest to the food (Pedersen et al. 2002; Cox and Seitz, 2007).

The shortest path is marked with more pheromones in the algorithm; ants are more likely to choose the shortest route, and so on. In the ant attribute algorithm, large numbers of electronic ants are distributed in the seismic volume allowing them to move along faults and emitting pheromones. Surfaces that are strongly marked with pheromones are likely to be faults (Randen et al., 2001; Fehmers and Hocker, 2003; Skov et al., 2003; Aguado et al., 2009; Khair et al, 2012).

II. Materials and Method

The effective implementation of ant attribute can be achieved when other fault sensitive attributes are used as an input data in the application of ant attribute. Chaos and variance attribute are sensitive to faults, so these attributes were used as our input data to run the ant attribute separately so as to see faults clearly that where difficult to display on the dataset.

The seismic data used, was carefully conditioned using structural smoothing tool to remove background noise as seen in fig 2b. Ant attribute is a CPU- intensive algorithm and it takes time to run, knowing this, we first worked with a small cropped data size to test the various parameters of the ant attribute. When we had achieved a successful result we then applied the ant algorithm to the entire data set. The time taken for this attribute to run completely also depends on the number of faults in the data, and the parameters used.

III. Results and Discussions

The data set shown in Figure 3a (inline 5714) was used to generate the variance and chaos attribute. Structures that were not seen clearly in the amplitude data and chaos attributes were seen clearly in the variance attribute (green circular loop,) as shown in figure 4 (inline 5594). Within the green arrow in figure 4c, the quality of the variance attributes was better than the chaos attributes.

The variance and the chaos attributes (Figure 4) were used as our input data to run the ant tracking attributes as shown in Figure 5. We observed that the major faults not seen in the amplitude data (Green loop in Figure 4a) and, chaos attributes (red loop in Figure 5b)where seen clearly in the variance attributes (Figure 5a).The variance attributes Figure 5a shows clearly the major faults than the chaos attributes, Figure 5b.

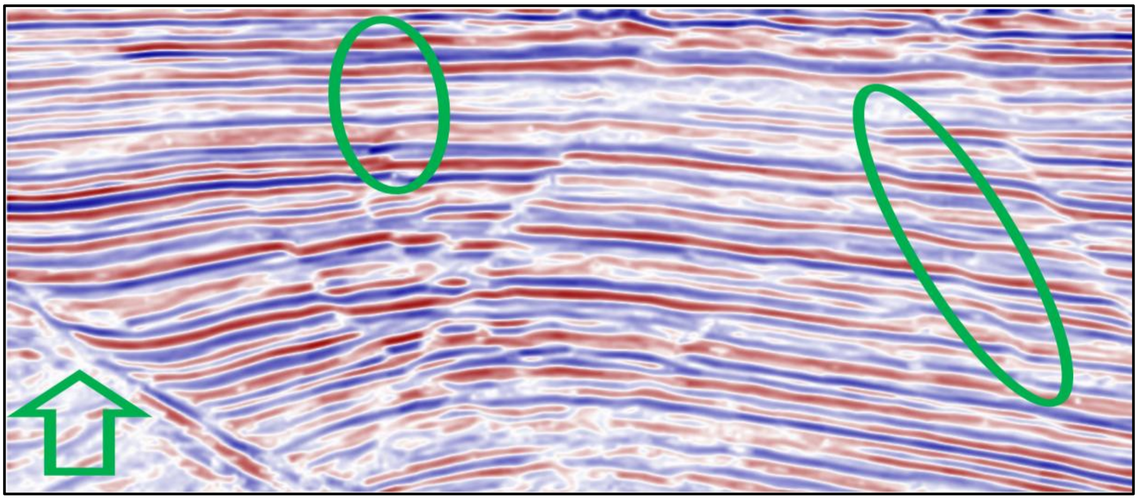

Fig. 4a: Structure in green circular loop not clearly seen in amplitude data

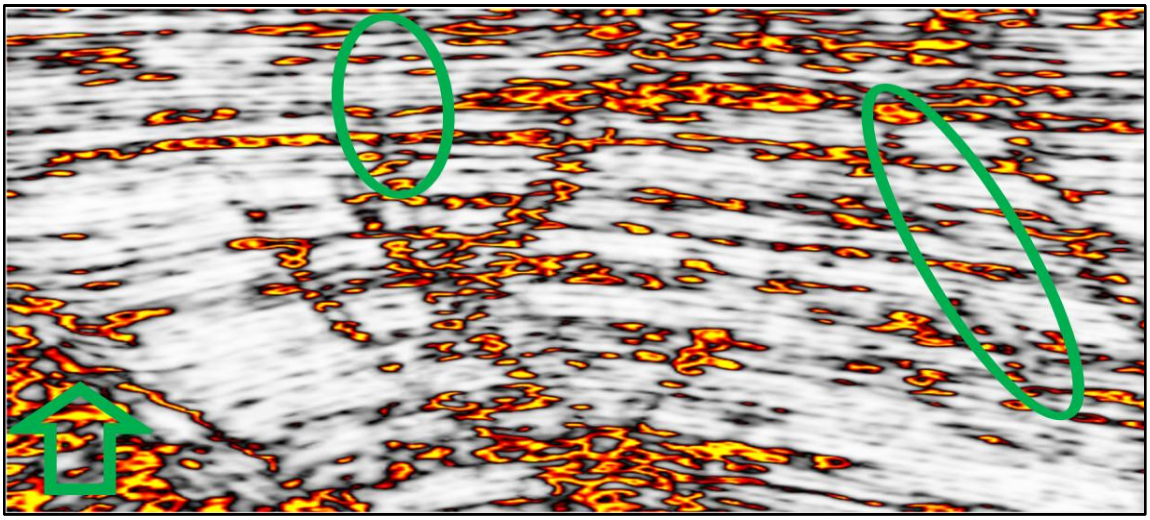

Fig. 4b: Structure in green circular loop not clearly seen in chaos attribute

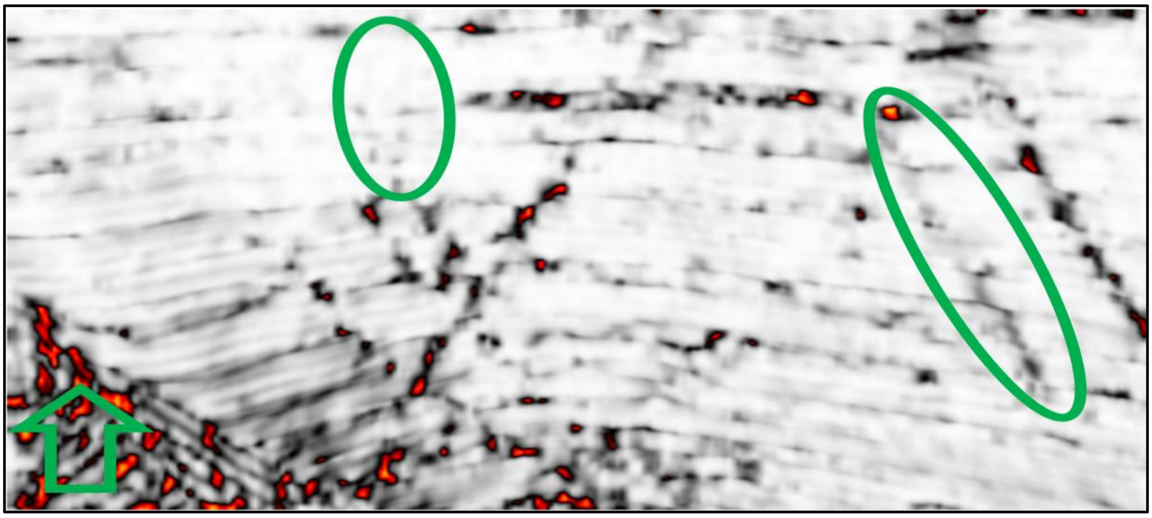

Fig. 4c: Structure in green Circular loop is clearly seen in variance attribute.

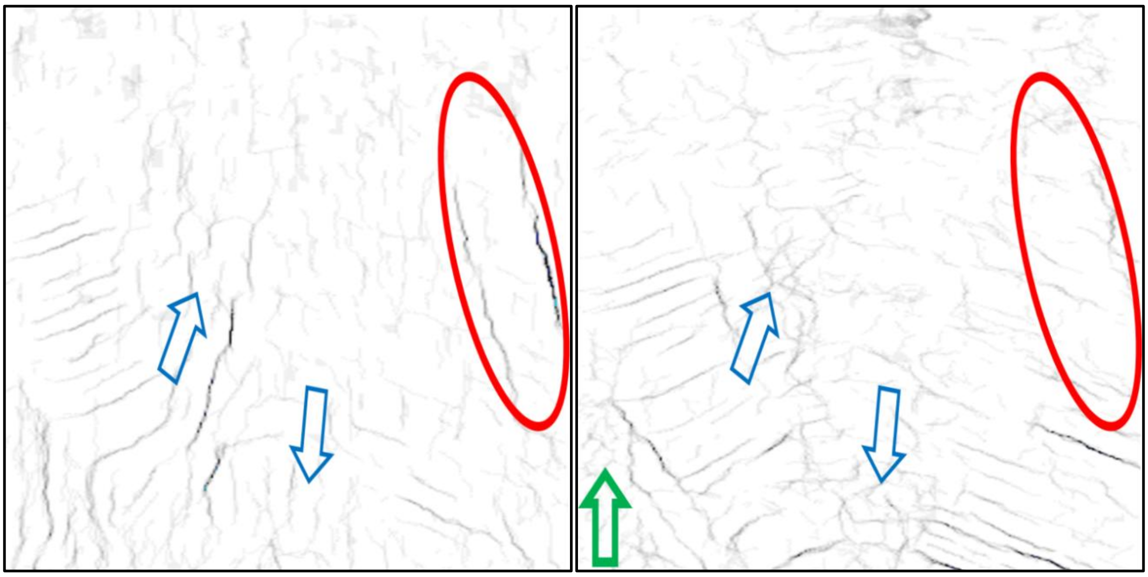

Fig. 5a; Major faults shown in red circular loop using variance attribute.

Fig. 5b; Major faults not seen clearly in red circular loop using chaos attribute.

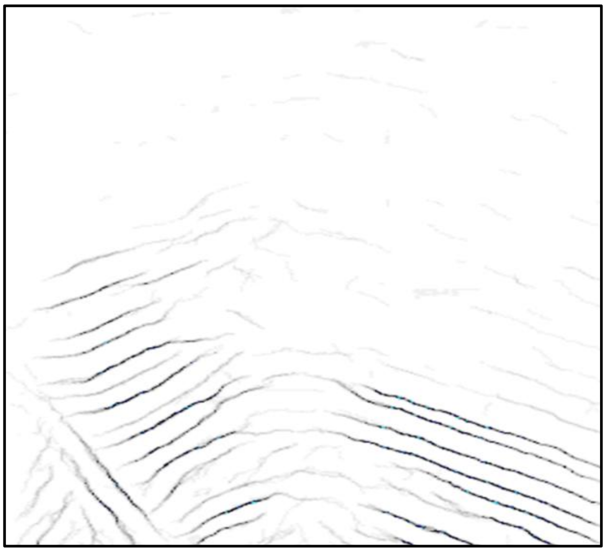

Fig. 6; Ant track using structural smoothing data as input for ant attributes.

Faults and fractures that were poor to see in the chaos attribute; green arrow in Figure 4b were seen clearly when we used it as input data to run the ant track attributes; green arrow in Figure 5b. Within a given area in Figure 5, the chaos attributes shows more fractures than the variance attributes.

The result from Figure 6 shows the ant attribute result without applying variance or chaos attribute. The outcome of the result is poor when compared to figure 5a and 5b. The input used in generating figure 6 was the structural smoothing data (Figure 3a); it shows that in order for the ant attribute to work effectively, variance attributes or any other fault sensitive attributes need to be applied on the data first. Both Figure 5 and Figure 6 are from inline 5594, we noticed that the major faults seen in the variance attributes where not seen using only ant tracker attributes as shown in Figure 6.

IV. Conclusions

The work has shown that the use of Ant Tracker attribute is an effective tool suitable to enhanced fault interpretation in 3D seismic data set, the research also shows that for ant tracker attributes to work effectively; one has to apply a fault sensitive attribute such as chaos and variance attributes before the application of ant tracker attribute and the interpreter has to apply signal enhancing filters to remove residual noise so as to have an optimal result. Different fault sensitive attributes have both their strength and weakness. The research shows that variance attributes is more suitable to show major faults that are not seen in the amplitude data than the chaos attributes, also within a given area, chaos attributes can show more fractures than the variance attributes. The outcome of the research shows a satisfactory result, since it is in line with the objective of the research.

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