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Identification of discontinuities by attribute analysis and planning of wells for basement exploitation – A case study in Mumbai High Field

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Summary

In this paper we have made an attempt to map the fractured zones by systematic study of different seismic attributes, variance and chaos .The discontinuity volume was used for ant-tracking for predicting the fractured zones at basement level. The study could identify major discontinuities and their orientation which helped in understanding the production of old wells from basement level and planning of new wells for basement exploitation.

The trajectory of the well was planned in such a way that it intersects the fractured zone perpendicularly so as to encounter maximum fractures. The technique used has proved to be quite successful and accurate in locating the fractured zones.

Introduction

Ever since 3D seismic emerged as one of the powerful tools in exploration, the E & P industry has been greatly benefited from its application in the various facets of oil industry. The technology has increased the level of confidence in the minds of the geo-scientists as it proved its capability in accurately planning well locations besides making them economically viable. Seismic attributes are one of many tools used to help in selecting strategic placement of horizontal wells. The placement of landing point and then the modeling of the well path is crucial before the well is released for drilling. The image of the sub-surface can be predicted only by seismic and the meticulous planning can be done only with the help of seismic attributes. Seismic attributes are defined as a mathematical transform of the seismic trace to predict physical properties of the rock.

Normally geoscientists measure petro-physical properties using well logs or core data and then try to interpolate the data between the wells. Seismic data is incredibly rich with the information of the sub-surface in the form of amplitude, frequency, phase, geometry and texture. Each trace in seismic is a composite response of litho-logy, fluid content and other geological factors. Geo-scientists always look for the vital information regarding the rock and fluid content through the seismic traces. The variance and chaos attributes were extracted and further the extent of the discontinuities were mapped using ant-track attribute.

Methodology

Seismic attribute analysis is a broad term that encompasses all geo-statistical methods using more than one attribute to predict some physical property or the other of the earth. In many cases, we can show — using seismic modeling or rock physics — a physically justifiable relationship between a seismic attribute and the reservoir property of interest. When this is true, we are able to greatly reduce the uncertainty of inter-well predictions of reservoir properties.

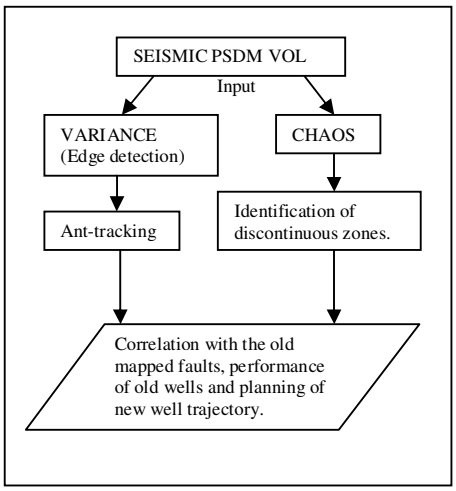

Figure 1 Flow diagram

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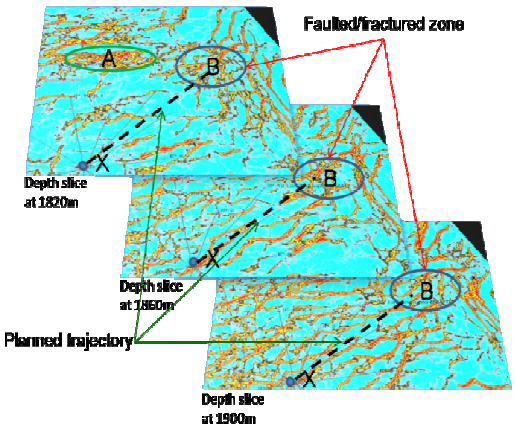

Figure 2 Discontinuities as seen and planned trajectory of the well from platform X to drain hydrocarbon from Zone B

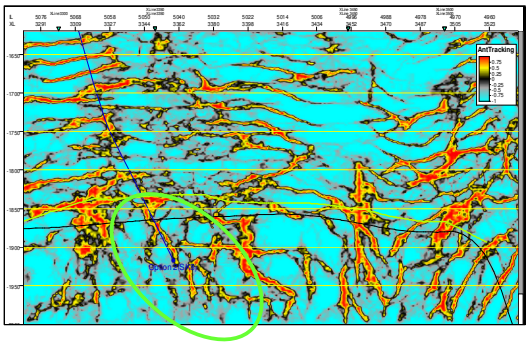

Figure 3 Discontinuities as seen along the intersection plane for the planned well trajectory on "Ant-tracked Variance attribute"

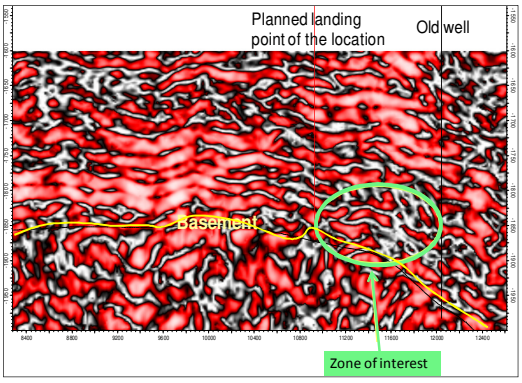

Figure 4 Discontinuities as seen along the intersection plane for the planned well trajectory on "Chaos attribute"

In the paper the authors have extracted three different attributes viz. Variance, Chaos over which further to align the possible discontinuities ant-track attribute was extracted Figure 1, the resultant volume had clear identifiable edges.

At basement level, depth slices were made and the trajectory of the well was planned such that it intersects the discontinuities perpendicularly so that the well path encounters maximum number of discontinuities.

The discontinuity volume was sliced in depth and the depth slices were examined at depth slice at 1820 m, 1860 m & 1900 m. It was verified by the existing basement producers which correlated well with the existing production from basement zone A , Figure 2.On the same analogy well was planned to target the discontinuous zone B .The zone B is in close vicinity to the North-South fault and which has been clearly brought out by ant-tracking. The vertical intersection along the well planned trajectory when overlain on volume of variance attribute Figure 3 and chaos attribute Figure 4 depicts that the trajectory intersects the discontinuities perpendicularly.

We have not only attempted to correlate the physical links between the seismic features and well behavior at basement level, but have also tried to improve the predictive ability of such properties derived from attributes, variance ,chaos and ant-tracking for predicting the fractured zones at basement level .

Discussions and theory involved

Multi attribute analysis comprises of its own a method in which external attributes have been calculated and matched such that they all point towards favorable justifiable relationships with greater certainty. Variance, chaos & ant-tracking have been used to predict the discontinuous zones at basement level.

Theory behind 'Variance attribute' is the estimation of local variance in the signal. One can apply optional vertical smoothing for noise reduction. It is useful for edge detection while in 'Chaos attribute' the chaotic signal pattern contained within seismic data is a measure of the "lack of organization" in the dip and azimuth estimation method. Chaos in the signal can be affected by gas migration paths, salt body intrusions, and for seismic classification of chaotic texture. It reflects physical property contrast and hence discontinuities.

We have also used the ant-track attribute which is proprietary of a company, however but the theory involved is that it joins the discontinuities encountered in the variance volume. Thus it clearly brings out the fracture network and their orientation .This attribute has been used to identify the possible discontinuity trends so that wells can intersect maximum discontinuities.

Conclusions

Application of chaos and variance attributes followed by Ant-tracking applied on 3-D Seismic data of MH Asset is able to identify the discontinuities. They correlate well with the known faults and fractures in the basement level identified by other methods. Thus, the methodology adopted by us leads to better placement of wells, for depletion strategy, injection policies and hence a better reservoir management. Only those seismic attributes that have a physically justifiable relationship with the reservoir property should be considered as candidates for predictors.

The development of a field depends upon how successfully wells are placed in the right position and how best wells are placed in the discontinuous zones so that hydrocarbon if present can be extracted from the basement level. The uncertainty in the well placement in proper fractured zones can be reduced by choosing a proper seismic attribute.

Further Reading

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