Understanding Structural Configuration on the Basis of 3D Seismic Attributes in Dhansiri Valley, Assam

Trishna Saha, B.K.Chowdhury, D.Chakraborthy, S.K.Prusty, B.L. Khatri and G.V.Reddy

ONGC, Jorhat

Abstract :

This paper deals with the role of seismic attributes, such as Event Similarity Prediction (ESP) and Edge Detection and also that of Post Stack merging of 3d seismic volumes at processing stage rather than at interpretation stage, in identifying and firming up the faults which are otherwise difficult to be mapped with the interpretation of conventional Time Slices and vertical seismic sections. The characteristic of ESP slice is that it gives an unbiased view of the features in the seismic volume. The fault patterns thus mapped are in conformity with the surface lineaments mapped through Land Sat Imagery maps. The value addition of these attributes in identifying the faults over traditionally mapped fault patterns through 2D and 3D has exploration significance in terms of formation of up dip fault closures.

Introduction:

Dhansiri valley is a part of Assam–Arakan Basin which represents a classic example of poly-history basin. It is situated in the North-Eastern part of India.(Fig.1)

The area is covered by a number of drilled wells, on the basis of which a generalized stratigraphy (Table-I) has been established. Commercial occurrence of hydrocarbon has been established from fractured basement, Tura, Sylhet, Kopili, Bokabil, Tipam and Namsang Formations.

The area is intensively covered by 2D and 3D seismic surveys which has brought out subsurface structural configuration. Modified structural configuration has emerged with the aid of modern tools/ techniques which could have bearing on the mode of hydrocarbon entrapment. The basic idea of this paper is to demonstrate and understand the interplay between structural configuration and hydrocarbon entrapment in the light of modified structural configuration.

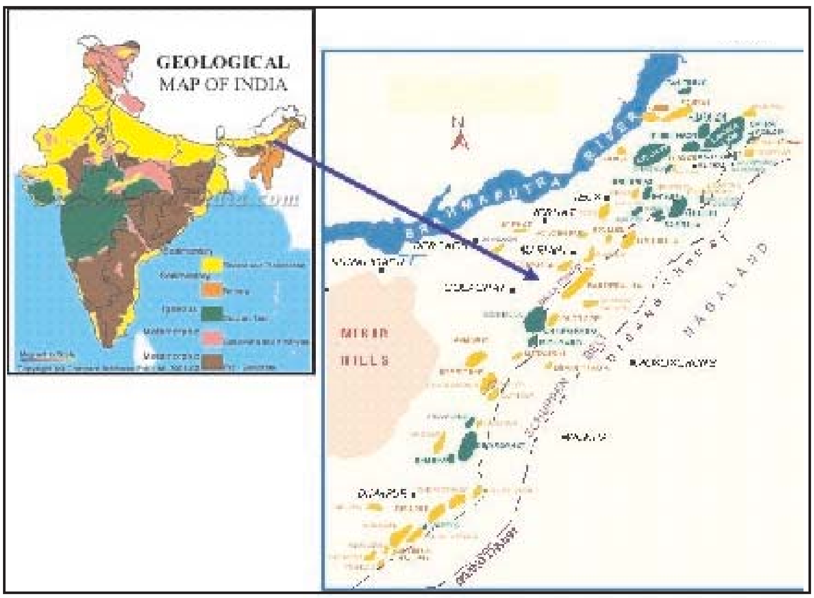

Fig. 1 : Prospect Map of Assam Arakan Basin.

Geology and Tectonics:

The crustal fragment of ancient Gondwana Land, which was block faulted and peneplaned with deposition of Gondwana sediments is the basement complex for next phase of Assam Geology which has passed through four distinct phases.

First phase was when it was the part of Gondwana super continent.

Second phase was when rifting took place and coal bearing fluviatile deposits were deposited during Permo Carboniferous time. After initial rifting erstwhile Gondwana land experienced drifting in Late Triassic/ Early Jurassic from Cretaceous to Early Eocene. This was the **third phase** while the area became open to marine sedimentation. Thus the basinal setup changed into passive margin.

The **fourth phase** started during Early Eocene when it collided with Myanmar. Since then the entire landmass was caught-up between two collision zones; Myanmar to the East and Tibet to the North. Apart from this the Mishmi Hills added third compressional force from North East.

Structural setup:

Till the onset of 3D data acquisition and subsequent interpretation in the year 1988-89, understanding of structural disposition and fault pattern was largely based on 2D seismic data coupled with GM survey.

3D seismic data acquired in different phases reveal structural disposition and fault pattern which was by and large similar to that of the earlier one. The earlier NNE-SSW trending down to basin normal faults accompanied with their antithetic mode are the major fault system established in the area (Fig.2).

Table 1: Standard stratigraphic succession in Dhansiri Valley

Depth (m)	Age	Formation / Unit	Lithology	Environment of deposition
0	Pleistocene to Recent	Alluvium		
	Plio-Pleistocene	Dhekiajuli		Fluvial
		Namsang		
1000	Pliocene	Tipam (Undifferentiated)		Fluvial (Braided stream to Flood plains)
2000				
	Middle–Upper Miocene	Bokabil		Shallow-marginal marine (Tidal influence)
	Oligocene	Barail		Deltaic
	Eocene	Upper Kopili		Shallow marine (Tidal channel & Tidal bar)
3000		Lower Kopili		
		Sylhet		
	[illegible]	[illegible]		[illegible]
	Early Cretaceous	U.Gondwana		Non marine
	E.Permian	L.Gondwana		[illegible]
3800	Pre-Cambrian	Basement		

The occurrence of Hydrocarbon in the area suggests that they are all fault controlled. Some deep seated faults extending further into the Schuppen belt (the kitchen) appear to play an important role as possible conduit. Therefore, correct understanding and mapping of fault pattern in the area may lead to the exploratory success. The fault patterns mapped earlier in the area have been re- looked in terms of their genesis and subsequent reactivation.

Analysis of merged 3D seismic data:

3D data set amounting to 550 SKM was merged in post stack mode to facilitate seamless interpretation of the area in holistic manner. The interpretation of the merged data has enabled us to bring out better structural disposition of the area.

It has been observed that ENE-WSW trending cross faults offset NNE-SSW trending main faults at different places. Analysis of fault patterns indicate that the NNE – SSW trending faults take a NE-SW swing at different places. Such fault trends together with the contour pattern suggest the development of cross trends in the area north of Merapani, Uriamghat and in between Borholla – Mekrang. Conventional Time slices and horizon based attributes such as Edge Detection (Fig.3) faintly suggest the existence of cross faults trending ENE-WSW. However, the volume based attributes from event similarity prediction (ESP) Volume (Fig. 4) suggest beyond doubt the existence of such cross faults. ESP volumes are essentially a measure of trace-to-trace similarity, so the discontinuities in the seismic data are brought into better focus. Regions of seismic traces cut by faults result in sharp discontinuities of trace-to-trace coherence, producing delineation of low coherence along fault planes. Since the three-dimensionality is an essential ingredient of coherence computation, faults or fractures in any orientation are revealed equally. Faults exhibit the greatest amount of trace-to-trace dissimilarity. The Land Mark Software measures the data continuity by trace-to-trace cross correlation. The algorithm

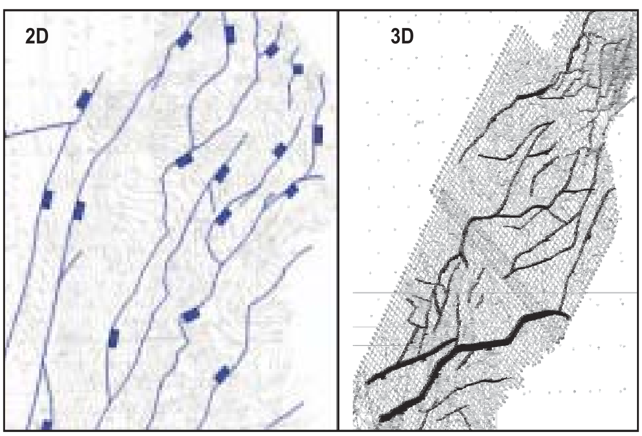

Fig 2. Map showing fault pattern based on 2D (on the left) & 3D (on the right)

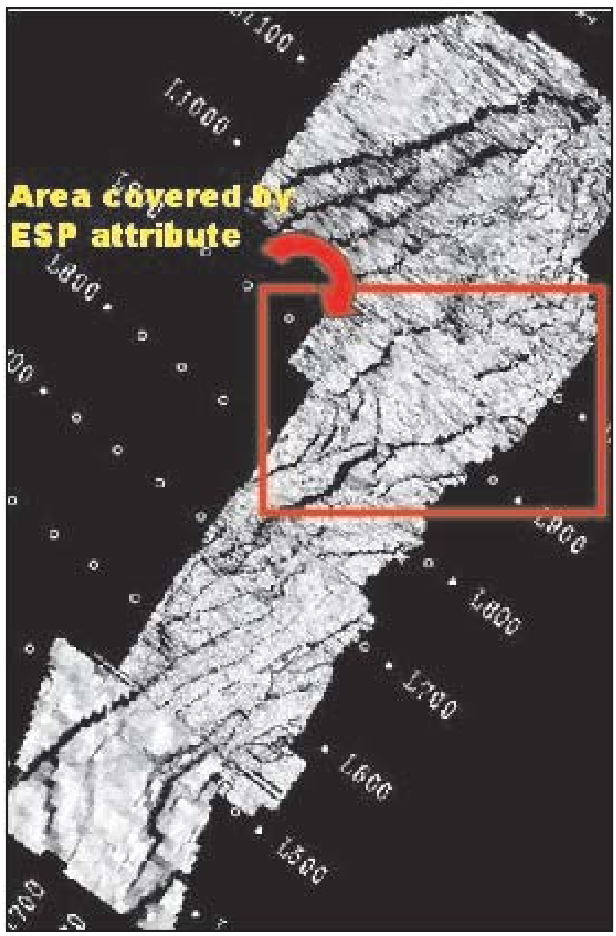

Fig.3 Edge Detection Attribute

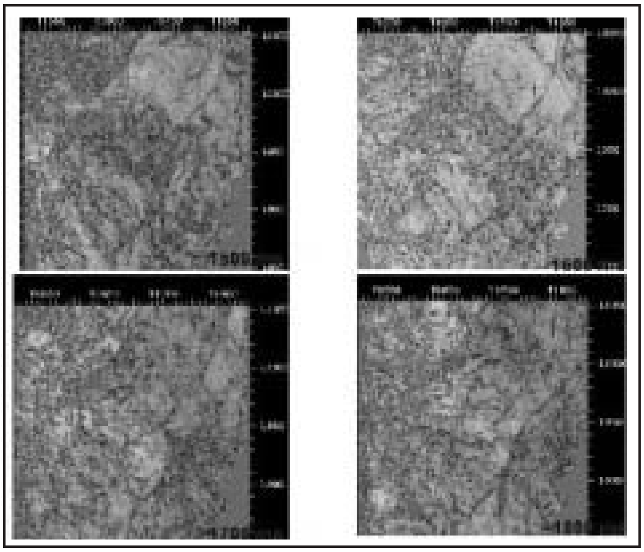

Fig.4 Time Slices of ESP attribute at different time levels bring faults into better focus.

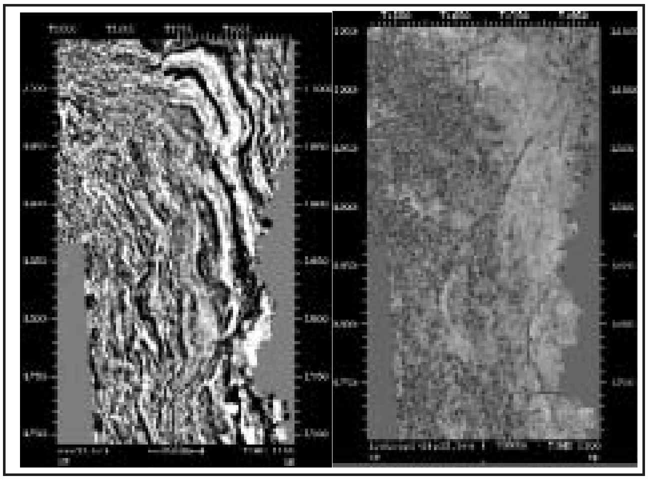

Fig. 5 Comparison of Conventional Time Slice with ESP time Slice. ESP brings faults into sharp focus.

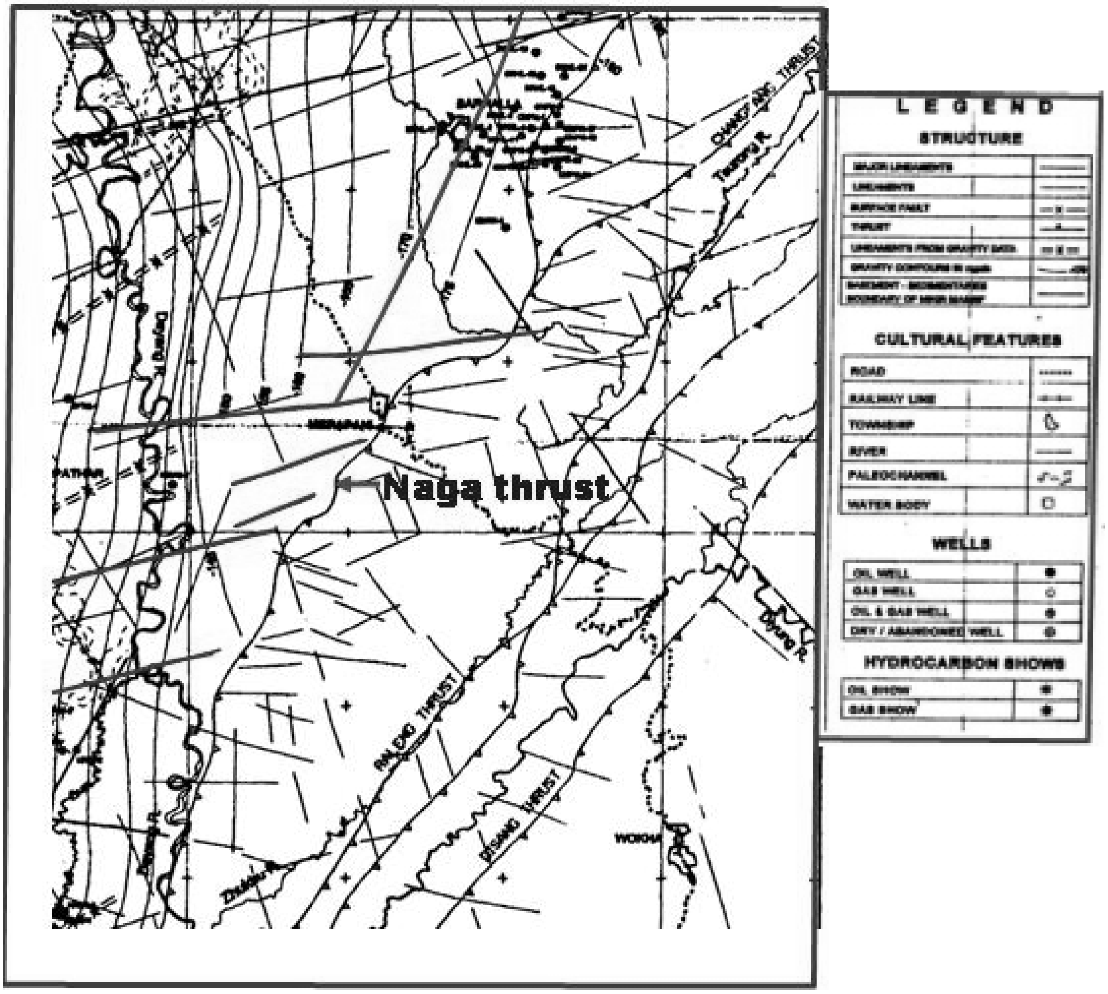

Fig.6 Land Sat Imagery map showing the lineaments in Dhansiri Valley.

performs cross correlation of seismic trace with its neighbouring two, four or eight traces. The cross correlation values are averaged and normalized to compute a continuity attribute. Fig. 5 depicts an example where faults apparently difficult to interpret on the conventional Time Slice, show up clearly on the ESP slice. The additional characteristic of ESP slice is that it gives an unbiased view of the features in the seismic volume.

Land Satellite imagery map also shows presence of NE-SW, E-W trending lineaments (Fig.6) which supports the presence of such cross trends. ESP attributes, considered together with the other attributes, enabled mapping of cross faults which could not be mapped through earlier studies. The 3D time map incorporating these cross faults is placed at Fig. 7. These cross faults cutting across the main fault system results in the formation of fault blocks that could have exploration significance.

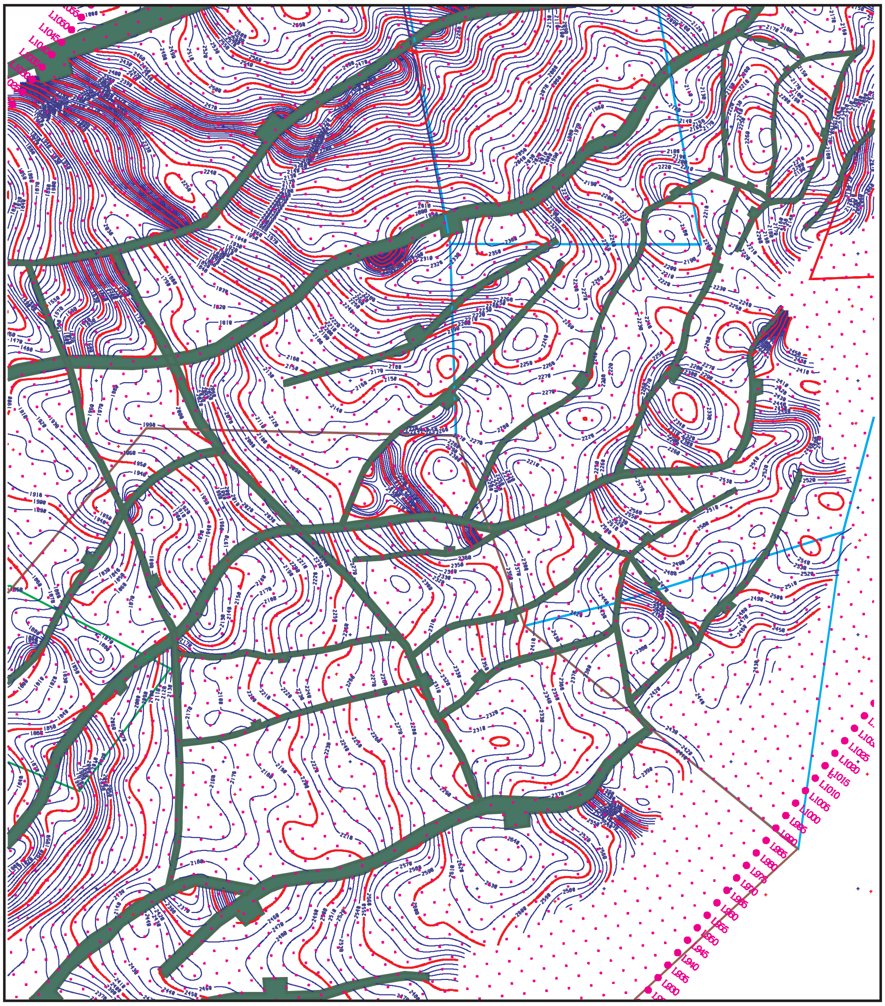

Fig.7 Time map showing resultant fault pattern emerged after considering various attributes.

Conclusions:

1. Seismic attributes such as ESP and Edge detection helped identifying fault patterns that are otherwise difficult to be identified through section based interpretation.
2. Post Stack merged data offered interpretative advantage over the merging of different data sets at interpretation level as far as the fault mapping is concerned.
3. In this modified structural set-up several favorable locales for HC accumulation can be identified. These cross faults are expected to offer entrapment to the hydrocarbons moving up dip direction.

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