Structural Style and Deformation History of Assam & Assam Arakan Basin, India: from Integrated Seismic Study*

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Abstract

Assam Shelf located in Northeastern part of India has an extent of around 40,000 km^2 of area and belongs to the northeastern prolongation of the Indian Peninsular Shield, bounded in the northwest by the Eastern Himalayan Fold Belt and in the southeast by Naga-Patkai foldbelt. Tectonically, Assam-Arakan basin has been defined as a poly-history basin that evolved synchronous with the other East-Coast basins of India, concomitant with the rifting and subsequent drifting of the Indian Plate from Eastern Gondwanaland. The basin was initiated in an extensional phase and later was modified by different episodes of a compressive phase. Superimposition of compressive phase on extensional regime modified the earlier extensional structures that indicate the poly-phase / poly-history nature of the basin. About 7000m of sediments ranging in age between Cretaceous to Recent are expected to be present in the deepest part of basin.

For the last fifty years of exploration in the basin, considerable geoscientific data has been generated. Structural style and deformation history of Assam Shelf has been an imperative need with the available datasets. In this endeavor efforts have been made to interpret seismic data of thirty-one 3-D volumes and 500 2-D seismic lines, along with sixty or more exploration wells, and their integration with stratigraphic sections has enabled an understanding of 3-D geometry, spatial organization, genesis, and evolution of folds and faults leading to conceptualization, characteristics, and evolution of the structural style of Assam Arakan Basin. Interpretations suggest that two major longitudinal high-angle normal fault systems trending NE-SW and E-W have been identified in addition to the three inverted extensional faults. The transverse system of faults is the result of a youngest episode of compressive movement. The E-W and NE-SW longitudinal faults and the associated structures acted as major areas of entrapment of hydrocarbons. Inter play of extensional, compressive and lateral movement clearly explains the hydrocarbon accumulation pattern in the area. The purpose of this paper is to document an example of the structural patterns resulting from interacting normal and inverted extensional faults, and to

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illustrate the process of iterative seismic interpretation and structural modeling in a complexly deformed basin, based on the interpretation of a 2-D and 3-D seismic dataset.

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Structural style, Deformation history of Assam & Assam Arakan Basin , India.

This Present study was carried out together with a team of ONGC Geoscientists comprising of

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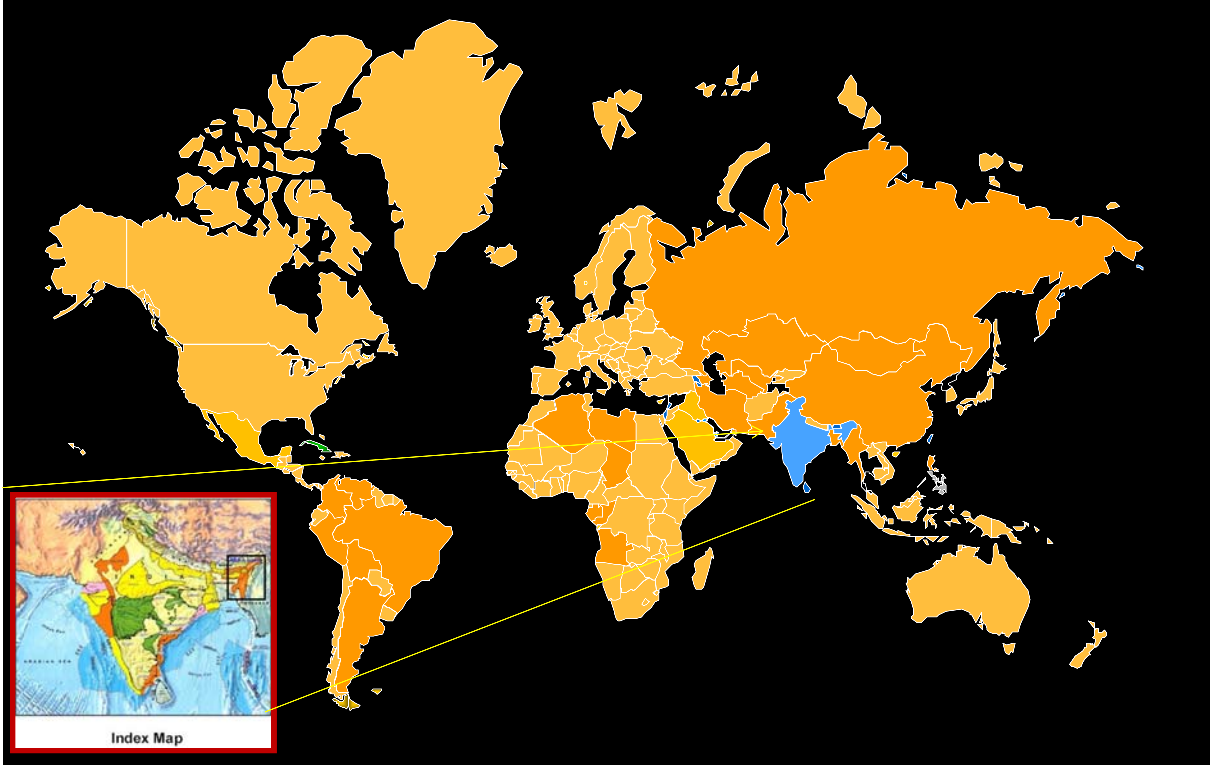
Introduction

Structural style, Deformation history of Assam & Assam Arakan Basin , India.



Presenter's Notes: Among the 76 priority provinces identified by the U.S. Geological Survey World Energy Assessment Team (2000) was the Assam geologic province. Assam-Arakan basin is a poly-cycle basin located in the northeastern part of India. Northeastern India represents the northern part of the Assam-Arakan basin which extends westward beyond Bangladesh and West Bengal to Orissa and includes parts of Burma in the east and south . Assam Valley occupies an unique position in this part of India., It constitutes a vast intermontane basin. Most of its geological features are concealed by the Recent alluvial cover. This is a proven petroliferous basin covering about 116,000 sq.km.

Middle Jurassic (approximately-166 Ma)

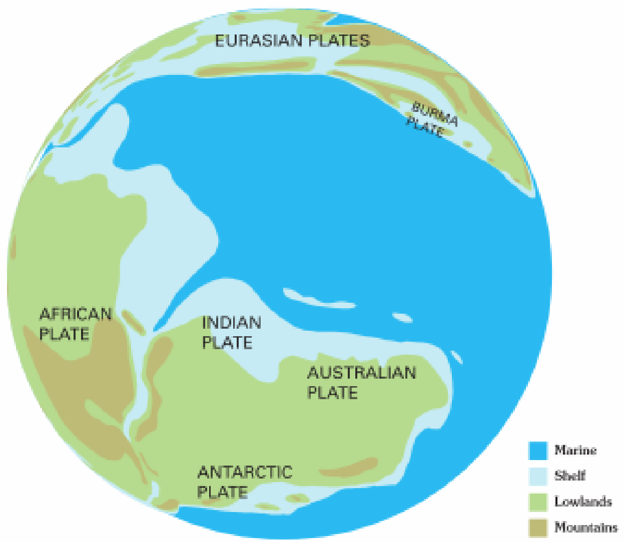


Figure 6. Middle Jurassic (approximately 166 Ma). Perspective lat 20° S., long 68° E. (modified from Scotese and others, 1988, and Scotese, 1997).

The Indian plate was located farther to the southwest, between the African , Antarctic, and Australian plates, making up part of southern Gondwana.

Early Cretaceous (approximately-130 Ma)

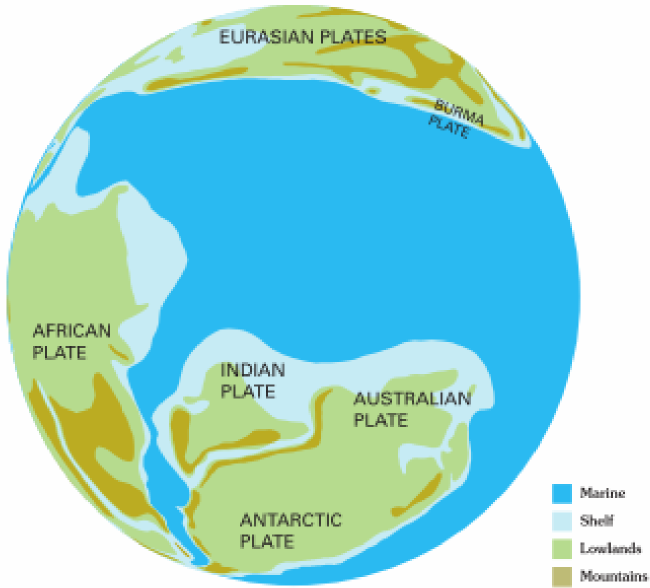


Figure 7. Early Cretaceous (approximately 130 Ma). Perspective lat 20° S., long 68° E. (modified from Scotese and others, 1988, and Scotese, 1997).

The separation of Indian subcontinent from Australia occurred during Early Cretaceous.

Late Cretaceous (approximately-94 Ma)

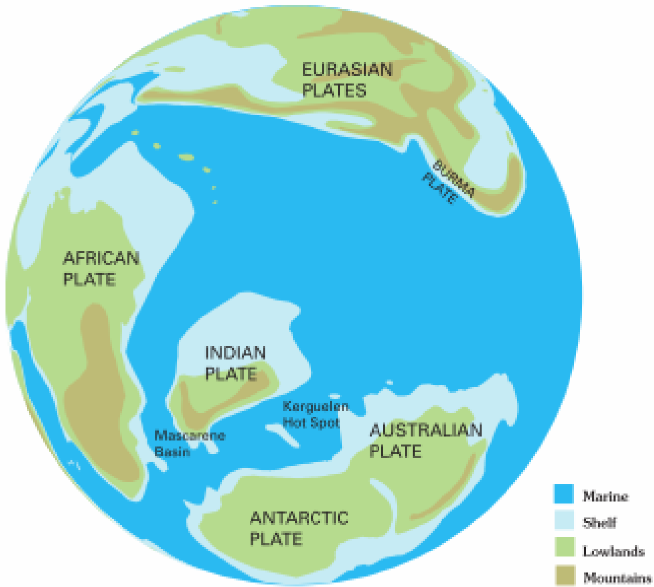


Figure 8. Late Cretaceous (approximately 94 Ma). Perspective lat 20° S., long 68° E. (modified from Scotese and others, 1988, and Scotese, 1997).

The Indian plate drifted from the Indo-Australian plate during the Late Cretaceous, resulting in the formation of horst and graben features.

Cretaceous (approximately- 69 Ma)

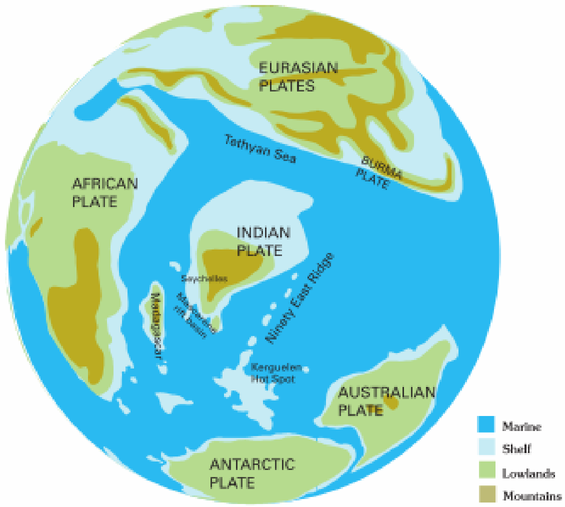


Figure 9. Latest Cretaceous (approximately 69 Ma). Perspective lat 20° S., long 68° E. (modified from Scotese and others, 1988, and Scotese, 1997).

During the Cretaceous, the Indian plate continued to drift northward toward the Burma and Eurasian plates, and by latest Cretaceous time the seafloor of the Bengal Basin began to form (Scotese et al.,1988). **In Assam area, a southeasterly dipping block-faulted shelf developed. Counterclockwise rotation of the Indian plate began** (Waples and Hegarty,1999.).

Middle- Eocene (approximately-50 Ma)

Figure 10. Middle Eocene (approximately 50 Ma). Perspective lat 20° S., long 68° E. (modified from Scotese and others, 1988, and Scotese, 1997).

Initial collision of the northeastern India and Burmese plates occurred during the Eocene, possibly resulting in the coupling of the plates and accelerating the northward movement of the Burmese plate (Pivnik et al., 1998.)

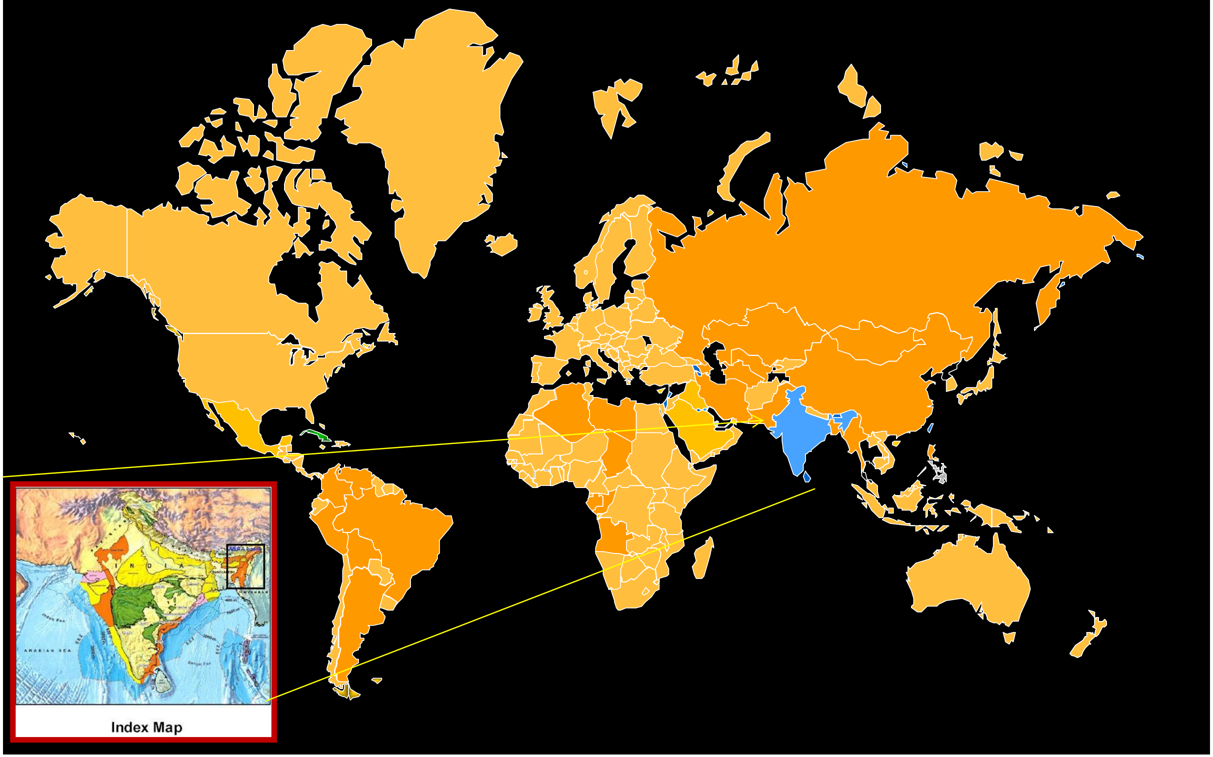
ओएनजीसी ONGC

Late Oligocene (approximately 27 Ma)

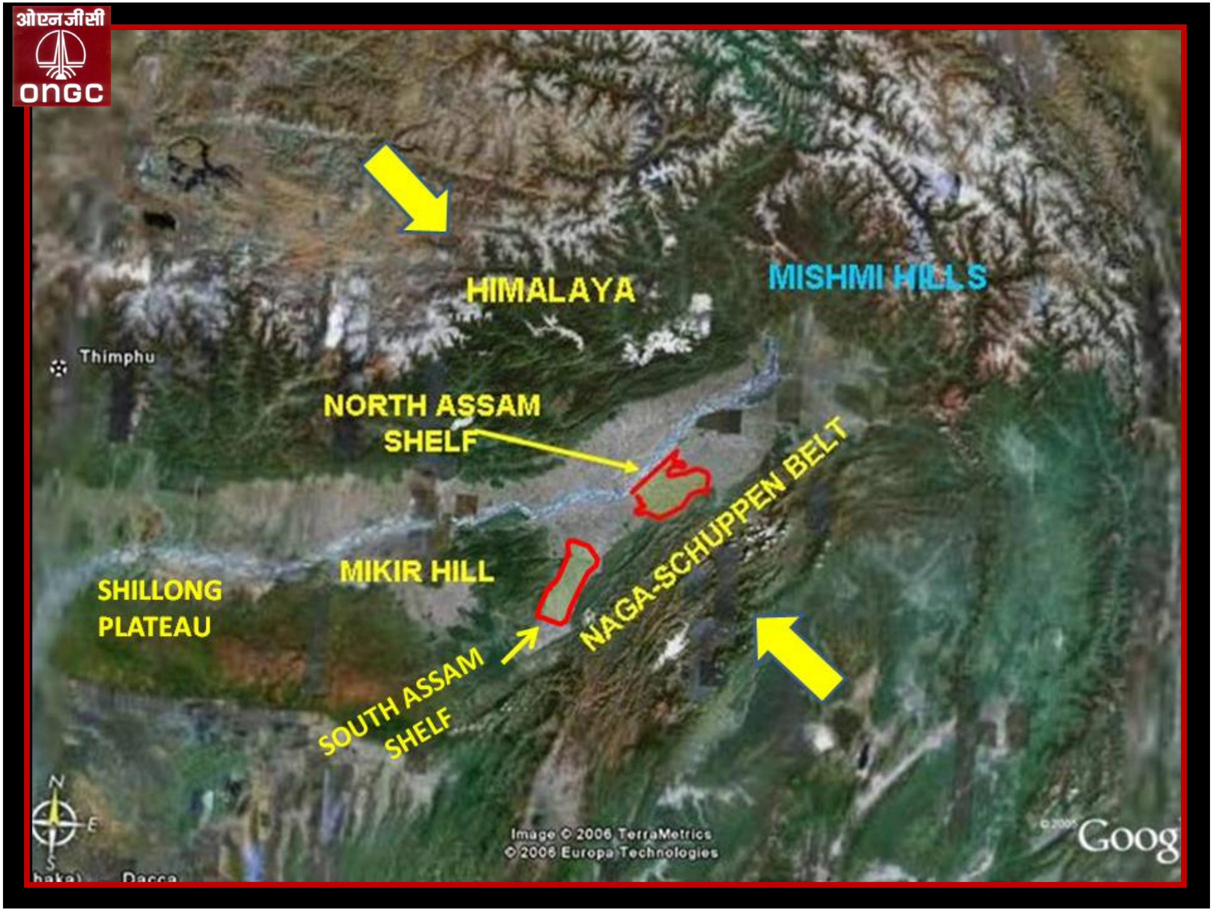
Figure 11. Late Oligocene (approximately 27 Ma). Perspective lat 20° S., long 68° E. (modified from Scotese and others, 1988, and Scotese, 1997).

From Eocene to early Miocene time, tectonic activity increased due to plate collision and rotation. Southward loading of the Assam platform began in the early to middle Miocene, resulting in the development of basal foredeep unconformity which separates the Oligocene passive-margin Barail Series from overlying early to middle Miocene foredeep Surma Group. Northward loading of eastern segments of Himalayan foredeep occurred during Plio-Pliestocene time and resulted in another foredeep unconformity that separates Mio-Pliocene Tipam from the overlying Plio-Pliestocene Moran Group.

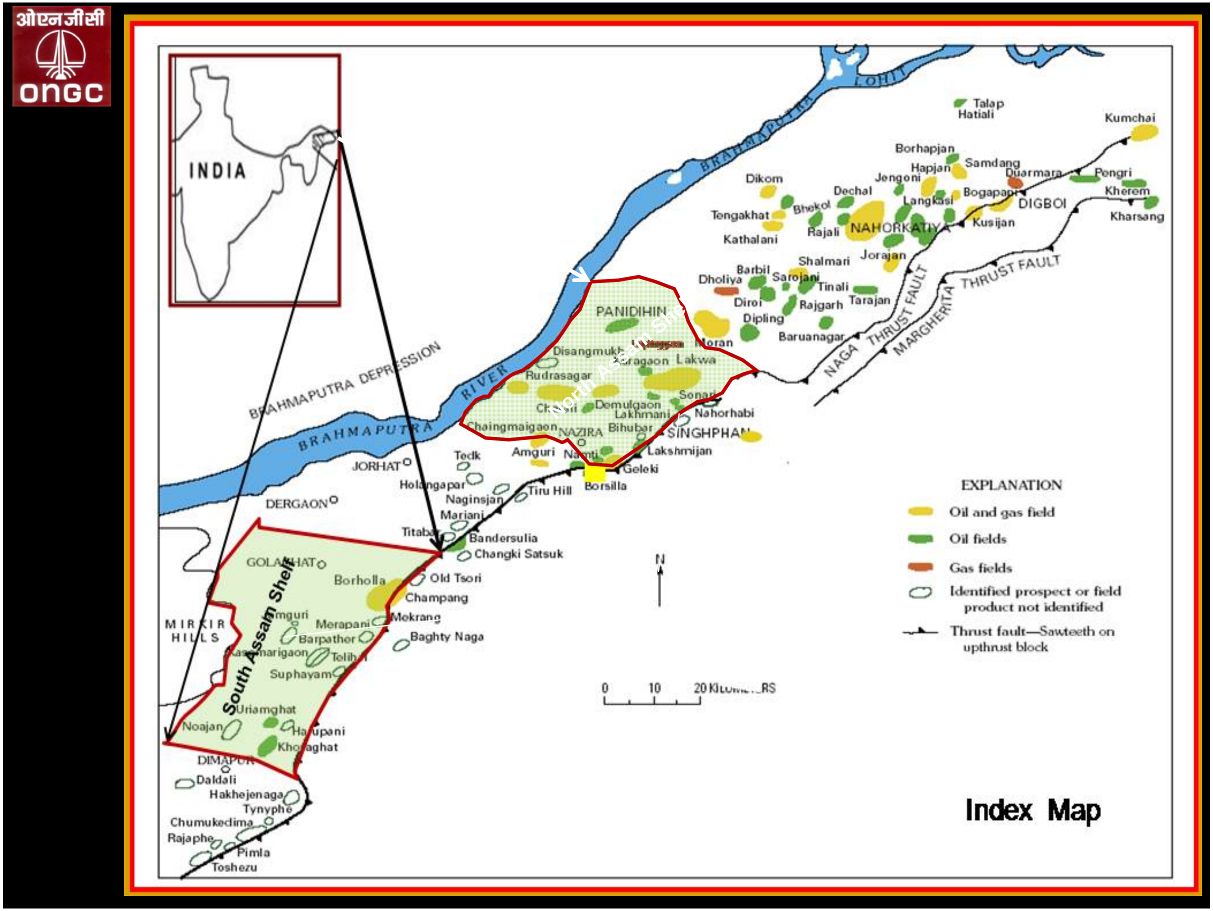
Structural style, Deformation history of Assam & Assam Arakan Basin , India.



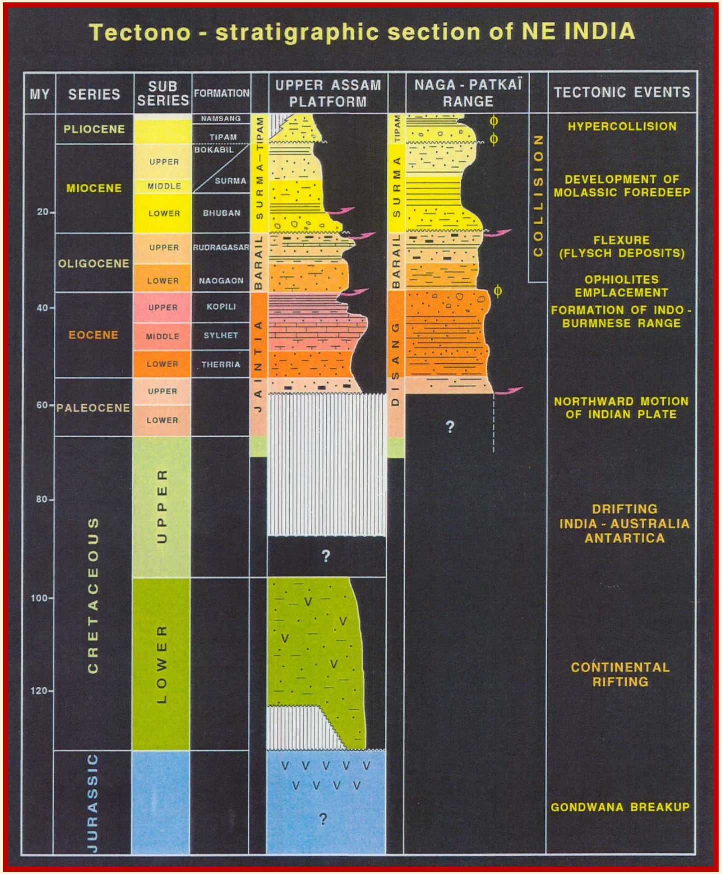
Presenter's Notes: This is the present-day tectonic setup.



Presenter's Notes: The area is bounded in the northwest by the Eastern Himalayas, in the southeast by the Naga-Patkai range, in the northeast by the Mishmi Hills and in the southwest by the Mikir Hills and Shillong Massifs. The central feature of the Assam shelf is the Brahmaputra valley, a stable, foreland shelf.



Presenter's Notes: This is the area of study, North Assam shelf and South Assam shelf are in the ONGC acreage limit.



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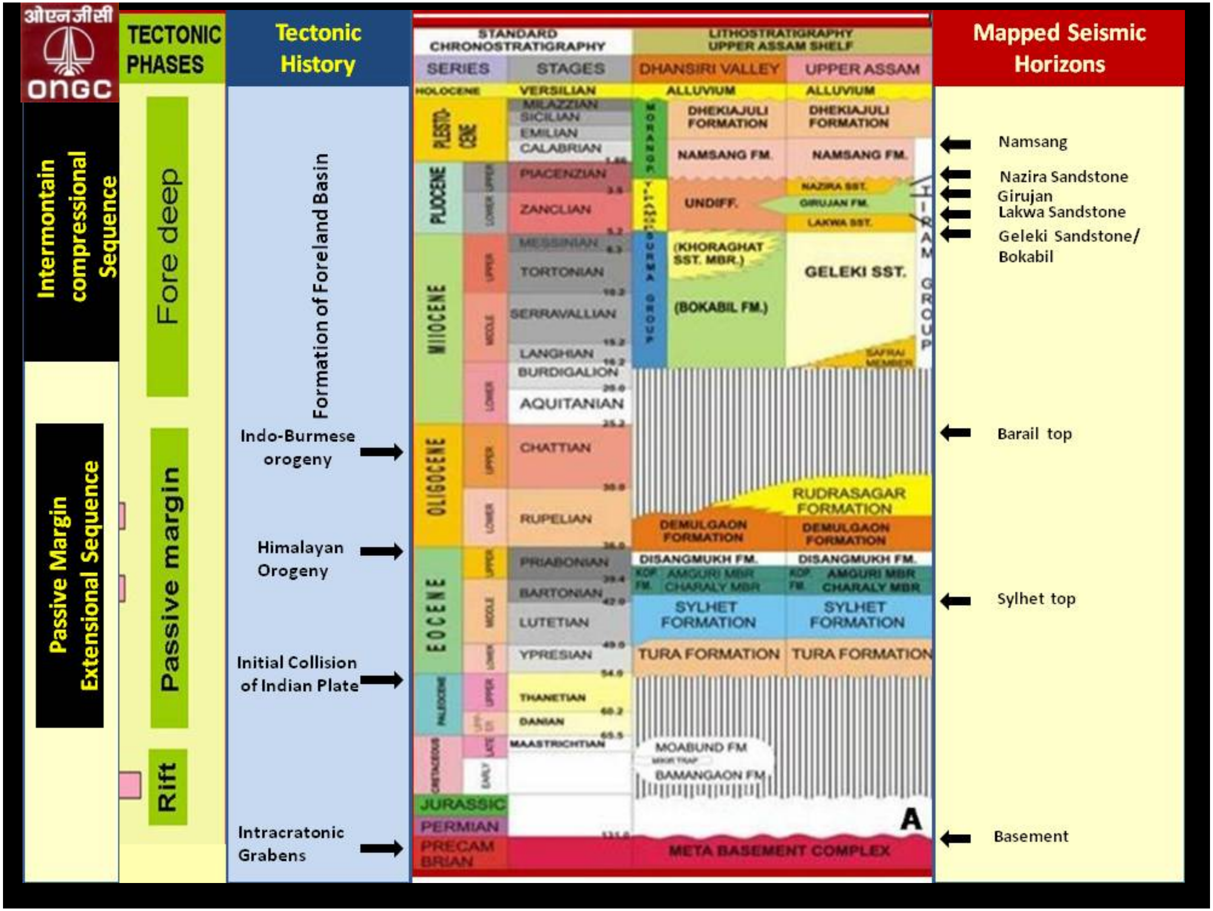
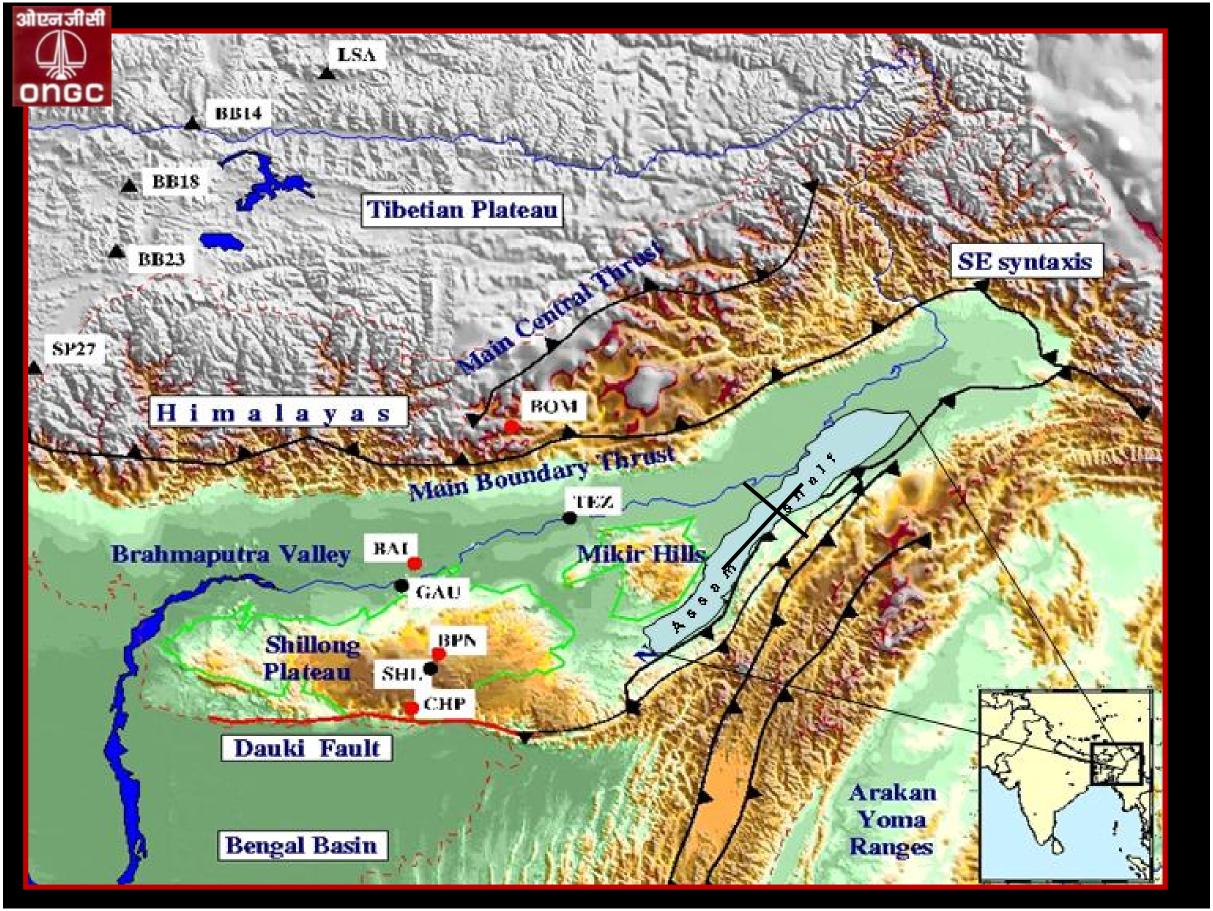
Presenter's Notes: Tectono-stratigraphic section of N-E India depicts the tectonics and stratigraphic relationship of northeastern part of India, particularly Assam Arakan basin.



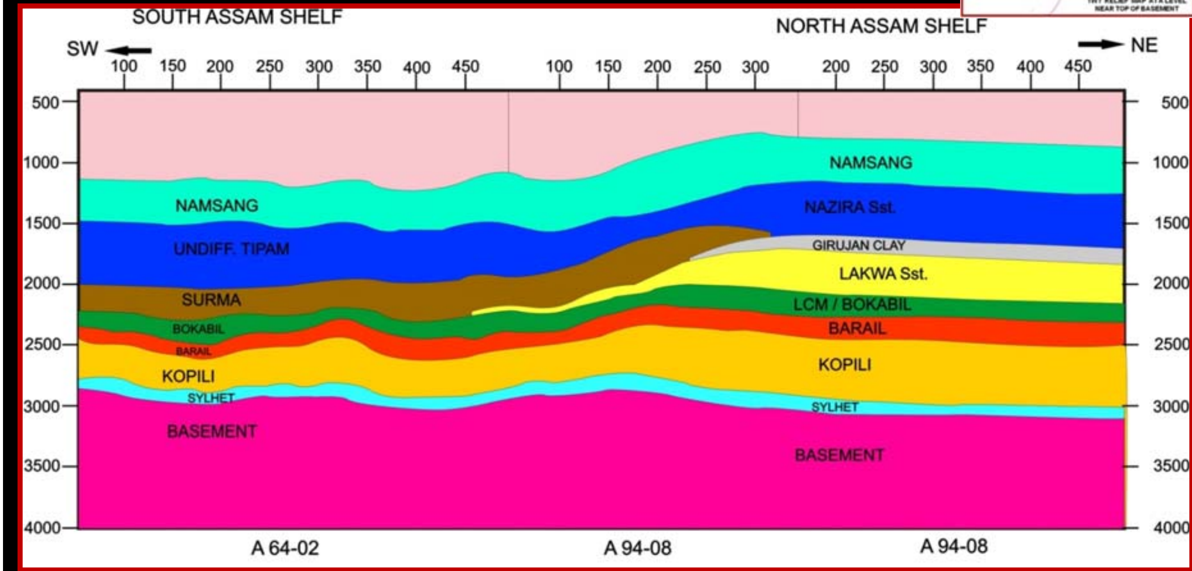
Presenter's Notes: It is pertinent to provide here a brief review of the geology and stratigraphy of this region. About 7000m of sediments ranging in age between Cretaceous to Recent are expected to be present in the deepest part of basin.

Regional Cross Sections

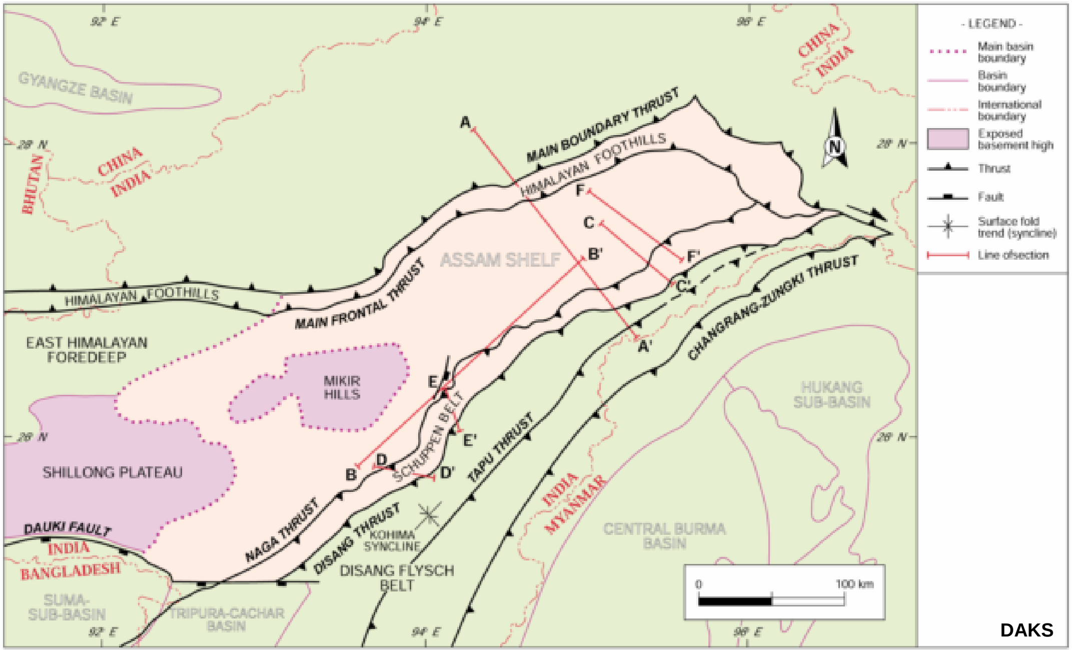


Presenter's Notes: The basin was initiated in an extensional phase and later modified by different episodes of compressive phase. Superimposition of compressive phase over extensional regime modified the earlier extensional structures that indicate the poly-phase / poly-history nature of the basin. About 7000m of sediments ranging in age from Cretaceous to Recent are expected to be present in this part of the Assam & Assam Arakan basin.

S-S’ Regional schematic seismic section showing different depositional systems in North and South Assam shelf



STRUCTURAL FRAMEWORK MAP

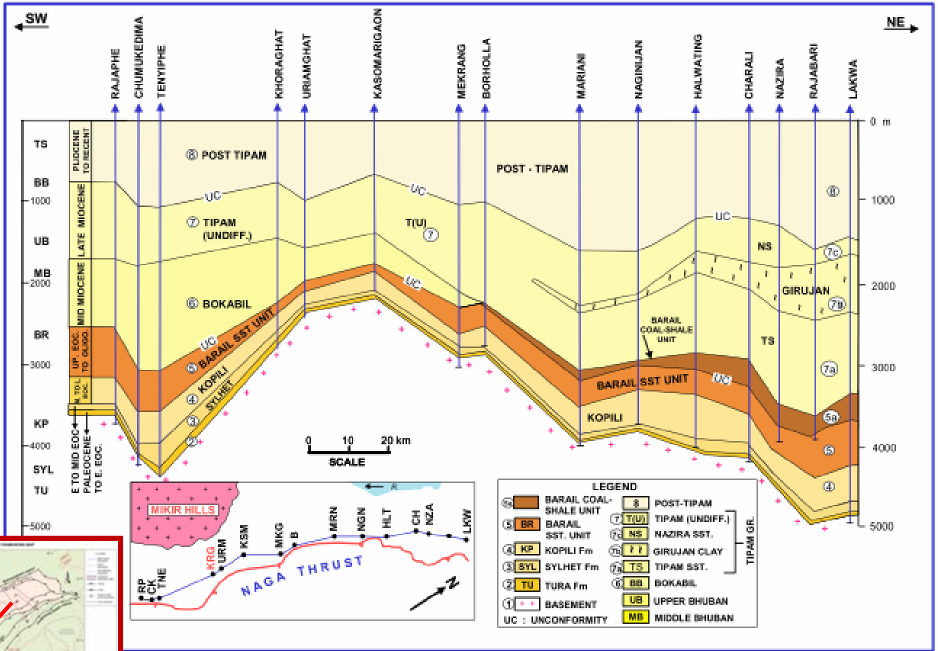


Modified after: Naik, Mishra, Padhy (1993), Mathur & Evans (1964), Hiller (1994)

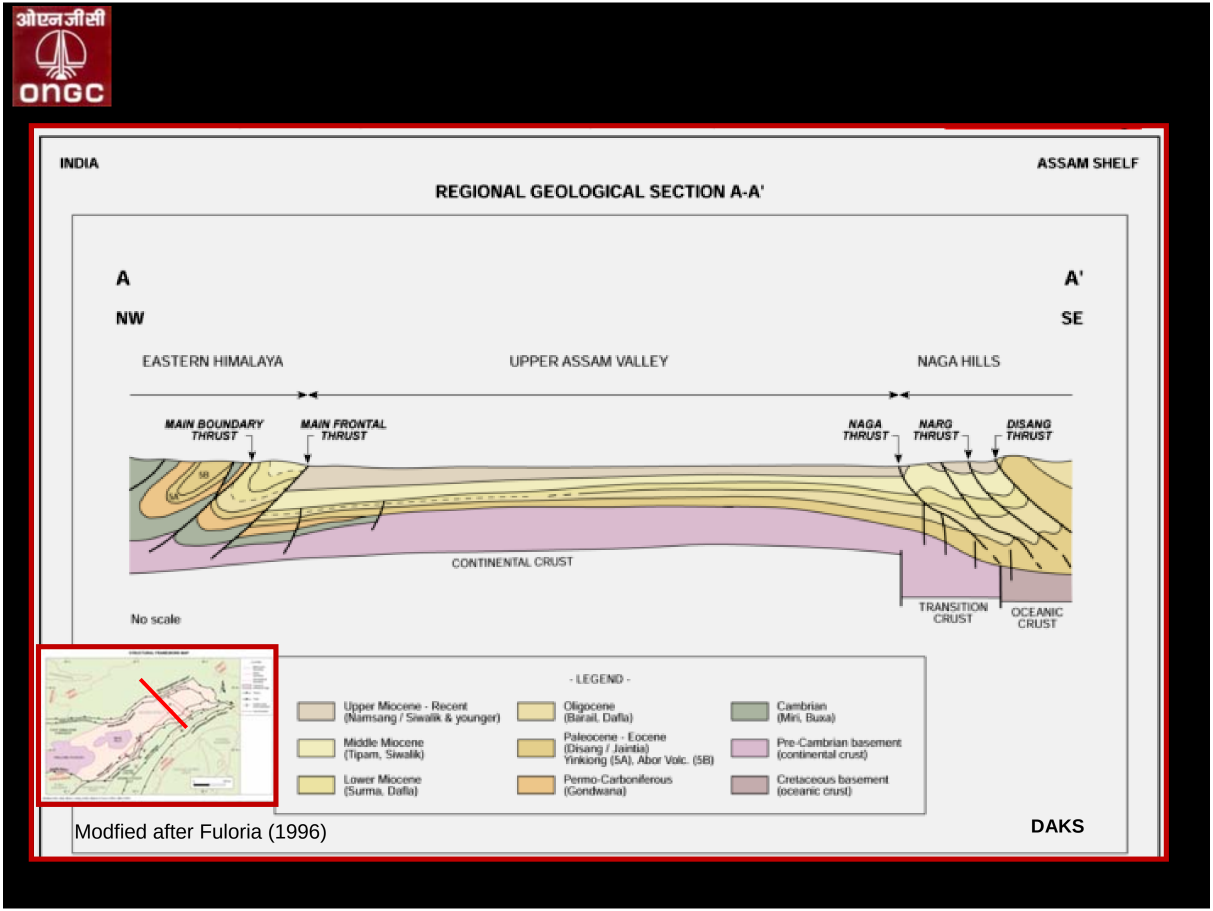
REPRESENTATIVE GEOLOGICAL CROSS SECTION

along the strike of the basin

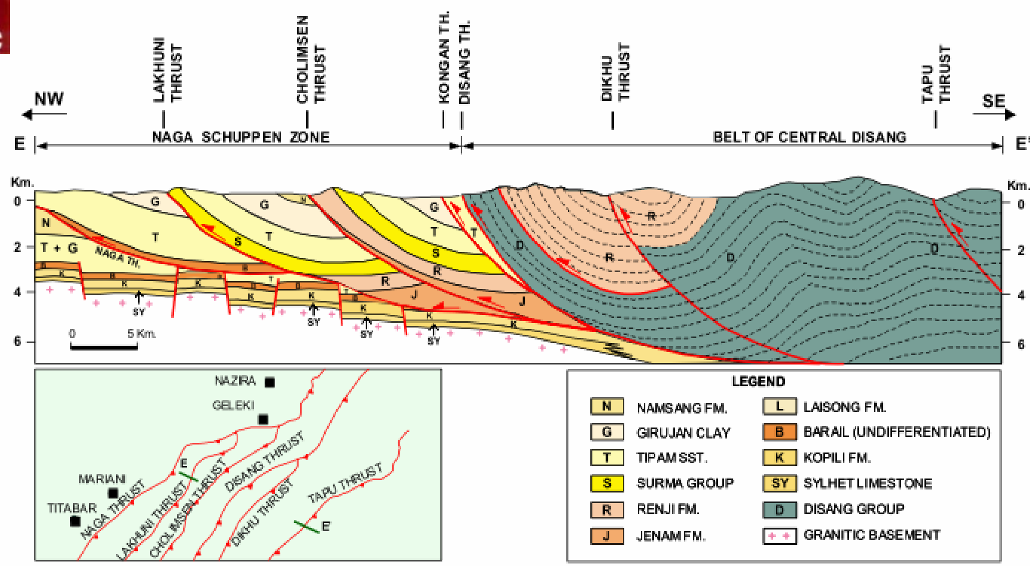
B B'



SECTION THROUGH BRAHMAPUTRA VALLEY-DHANSIRI VALLEY



Presenter's Notes: Assam Shelf exhibits a complex structural pattern, mostly concealed by massive Recent alluvial cover. Subsurface data indicate that the Upper Assam plain forms a broad arch at the basement level, with its apex (south of the present-day Brahmaputra River course) dipping towards the Himalayan foothills in the north and Naga Hills in the south.



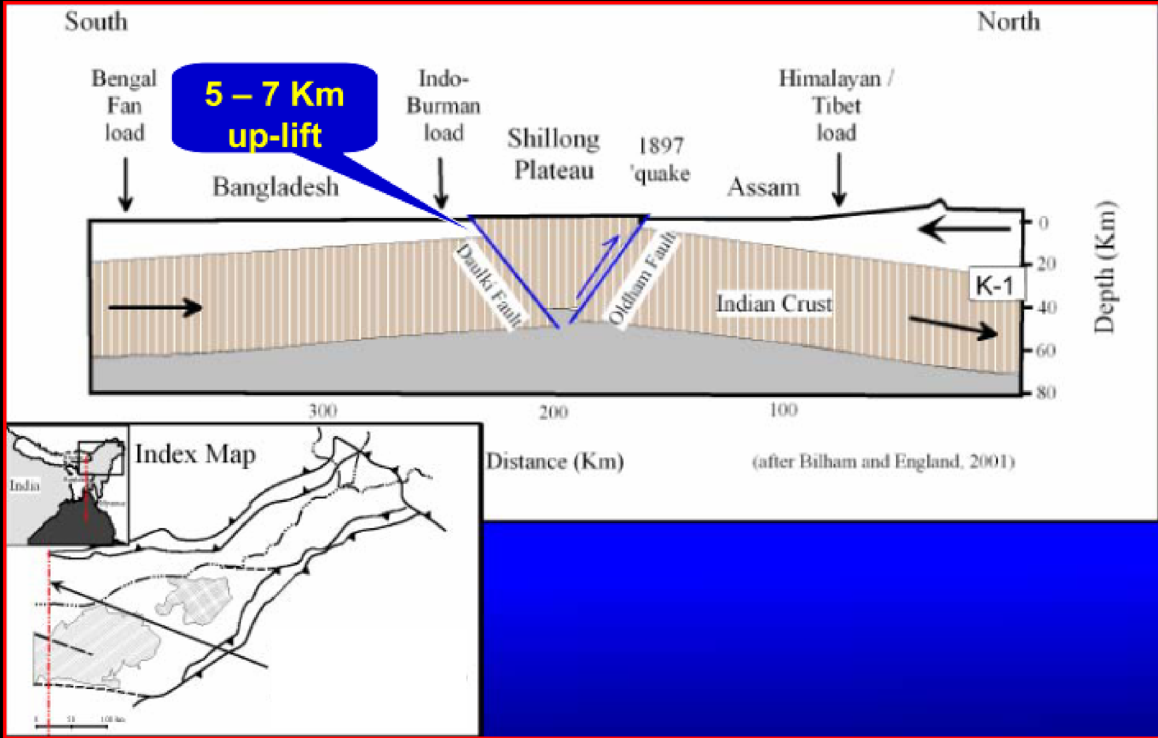
SCHEMATIC GEOLOGICAL SECTION ACROSS NAGA SCHUPPEN ZONE (NSZ) AND THE ASSAM – ARAKAN FOLD BELT (AAFB)

Section shows following structural features :

I. **Extension of Assam shelf beneath NSZ.** This subthrust section is envisaged to contain several potential structural traps.

II. **Imbricate thrust system of NSZ.** Thrust slices are expected to contain oil accumulations as in Digboi & Kharsang fields.

III. **Gentle folding in the belt of Central Disang.** Intra-formational sandstone layers are envisaged to contain hydrocarbons in strati-structural traps.

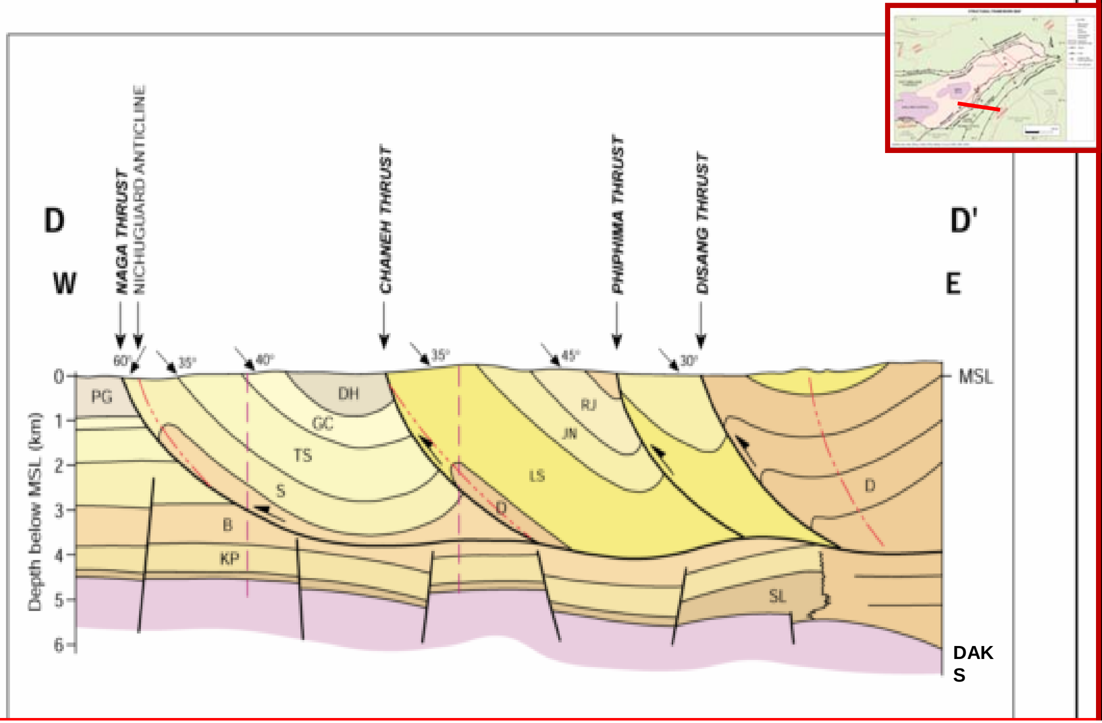


South
North
Bengal Fan load
5 – 7 Km up-lift
Indo-Burman load
Shillong Plateau
1897 'quake
Himalayan / Tibet load
Bangladesh
Assam
Dauki Fault
Oldham Fault
Indian Crust
K-1
0
20
40
60
80
Depth (Km)
300
200
100
Distance (Km)
(after Bilham and England, 2001)
Index Map
India

INDIA

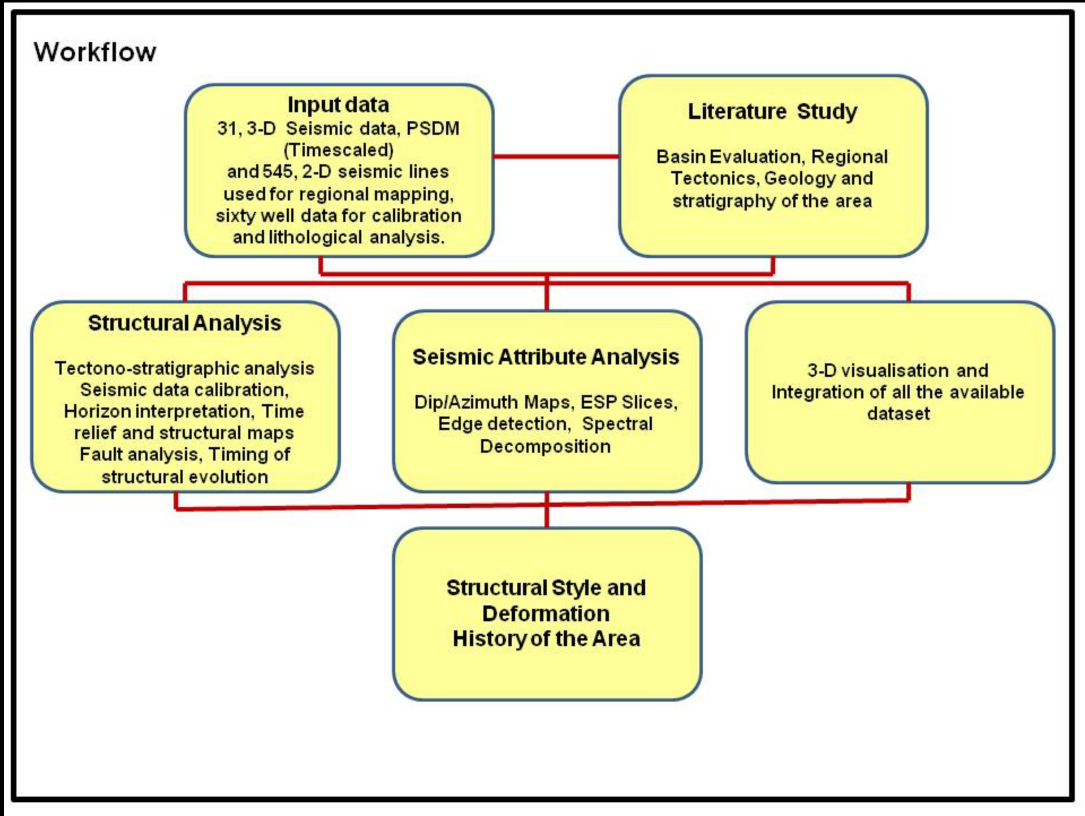
ASSAM SHELF

REGIONAL GEOLOGICAL CROSS-SECTIONS D-D' AND E-E'

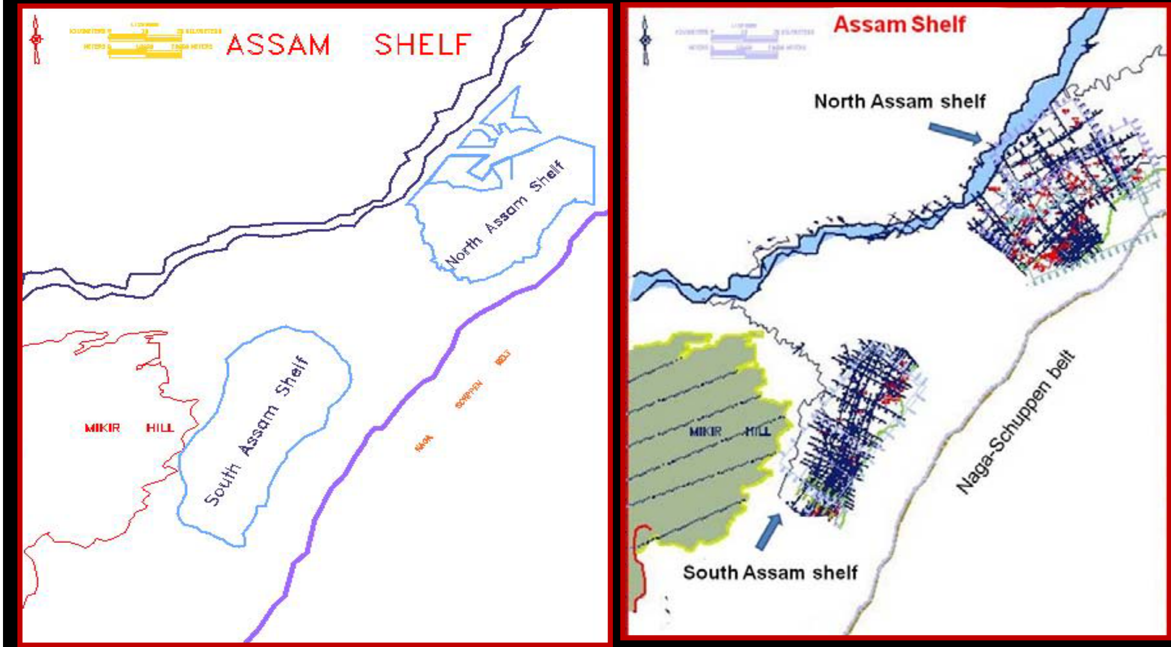


METHODOLOGY

Presenter's Notes: Structural style is a combination of all types of interrelated structures formed under the same stress conditions (Harding and Lowell, 1979). Analyses of structural styles are not only the basis for understanding the properties and deformation behavior and tectono-stratigraphic evolution of the basin, but also the key to forecasting the potential hydrocarbon traps.



Presenter's Notes: To understand the structural style of the area a workflow has been developed. This includes the understanding of structural and stratigraphic framework of the area, well to seismic calibration, structural mapping, surface attribute analysis, 3-D visualization, and integration of available outputs for understanding the structural geometry and deformation history of the area.



Base maps showing area of study and available seismic data

Presenter's Notes:

Seismic data

The seismic data was provided by **Oil & Natural Gas Corporation Limited**, a premier National E&P Company, and is made up of 545 2-D seismic lines and 31 3-D volumes, consisting of 11 PSDM time-scaled volumes also (Figure-03). The data was interpreted with the use of SGI and SUN machines managed by Openworks database and Seiswork, (a seismic interpretation module) software of Landmark Graphic Corp. ZMapplus software for mapping, Syntool for synthetic seismograms, and Stratwork for log-based studies were also used in the project. In order to achieve the objective of this study, significant sequences were initially identified, and horizons have been mapped, from the available seismic data as mentioned below.

Structural and Tectonic Framework

Regarding the nature and the style of faulting three different schools of thought prevail.

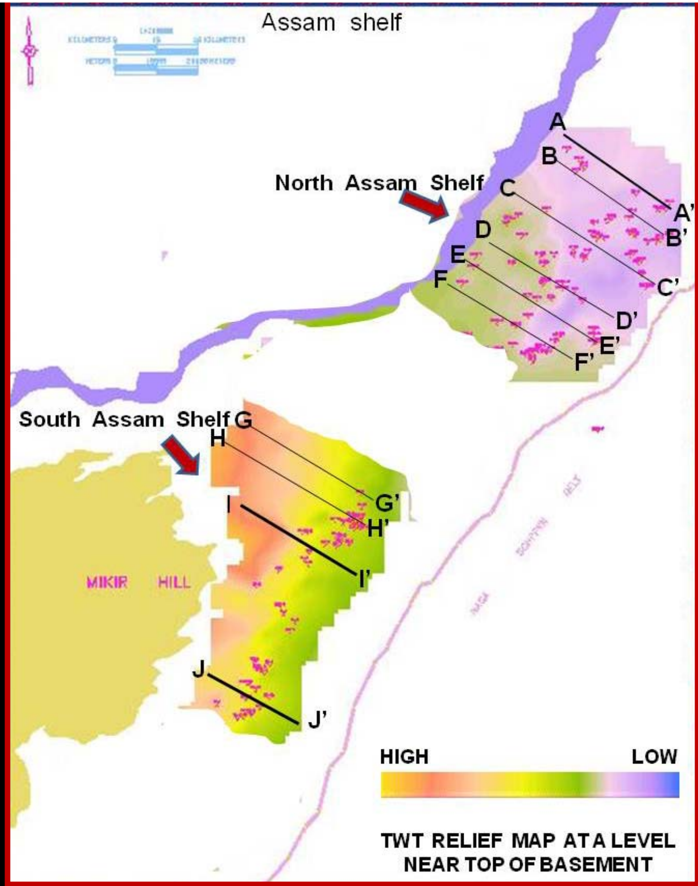
Normal faults/Synsedimentary faults related to extensional/gravity tectonics (Roy et al., 1975, Ahmed et al., 1988.).

Strike-slip faults related to wrench tectonics (Sastry et al., 1989).

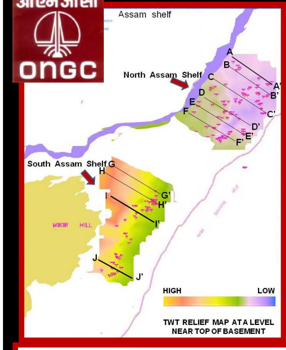
Reverse /Thrust faults related to compressive tectonics.

Normal fault with selected inversion structures.
Bally et al., 1997, **recognized presence of three main types of structures; i.e., early extensional structures, Miocene normal faults with or without Paleogene ancestry and late compressional structures.**

Position of the reconstructed seismic lines examined in study.



Presenter's Notes: Structural styles in this part of the basin are differentiated, classified, and illustrated with seismic profiles compiled from regional data. Seismic profiles illustrate a number of structural styles, ranging from step faults of domino type to thrust faults and folds associated with each. A series of interpreted seismic line have been considered to illustrate the structural style of the study area. Of the ten regional 2-D and 3-D composite R-C lines, six in North Assam shelf and four in South Assam shelf area (along the basinal dip direction) are analyzed.



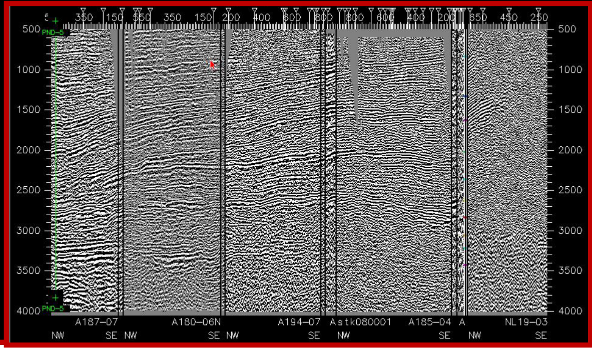
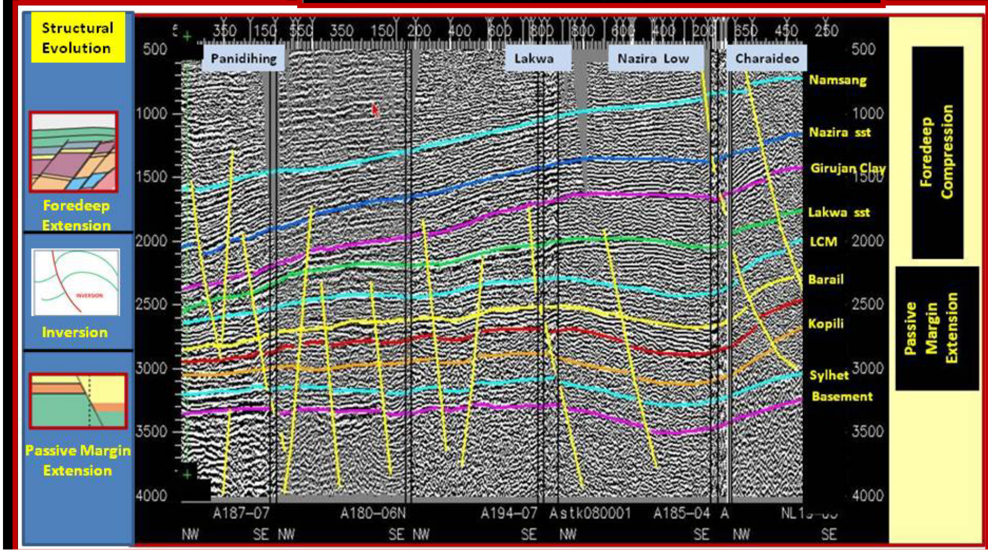
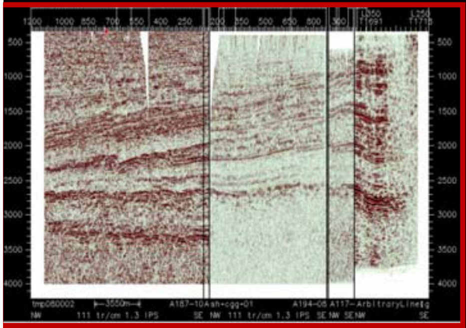


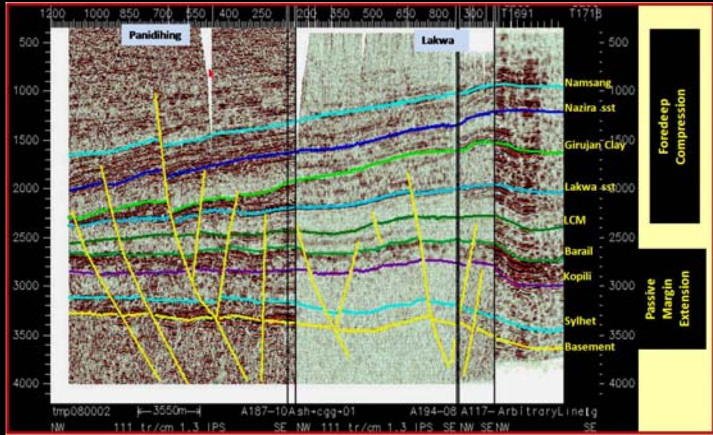
Figure- A-A'

Reconstructed 2-D seismic section showing structural elements of Panidihing, Lakwa Nazira Low and Charaideo area.

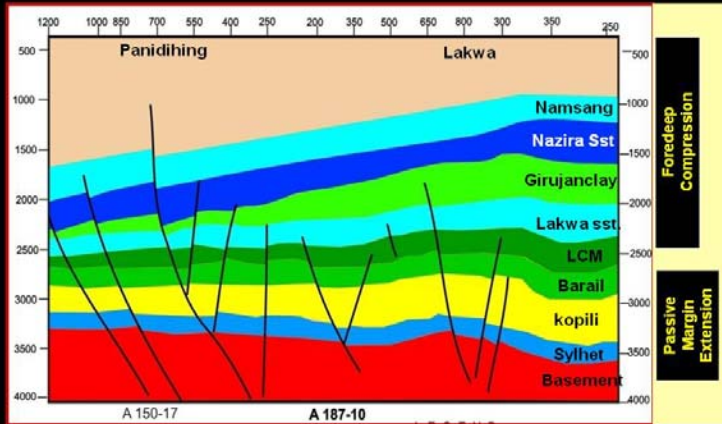


Presenter's Notes: This regional seismic R-C line passes along the Panidihing-Lakwa-Nazira Low-Charaideo area on the NNE side of the basin. Its length of 40 km allows the observation of the major structural features in this part of the basin. Basement top and other reflectors are easily recognized on the NW edge of the line, but it deteriorates as it reaches the other end, especially where the inversion anticlines are located. A high in the central part of the section, up to 1000 msecs, represents the Lakwa structure, which has been a paleostructure that was further accentuated after eastward compression. Quite recent extension is expected by the presence of some shallow extensional faulting in the NW region. The Panidihing structure and the faulting in the area can be seen showing larger displacements and seems to have developed during westward tilting of the basin due to Himalayan orogeny. The reversals observed along younger sections from Mid-Miocene to Namsang are the effect of westward compression. Lakwa sandstone and Girujan Clay thinning towards NW give impression that the western side was uplifted during Miocene time. Also, quite a few faults in NW and central parts are basement-involved and have hades towards NW and SE, showing smaller displacements, and the mode of faulting is mildly affected by tectonic pulses. Most, but not all, faults die-out within Girujan and Nazira sandstone formations of Mio-Pliocene age. The faults shown in the Charaideo area are thrust-related and have been identified as reverse faults. These younger faults are coupled with the compression effect from eastward side. Extending downward from Plio-Pliestocene to Middle Eocene deposits of Kopili Formation, they were responsible for the formation of inverted structures, generating NE-SW-trending inversion anticlines**.** Within this part of the section four important structural elements, such as Panidihing, Lakwa, Nazira low, and Charadeo are visible. They relate to passive-margin extensional setting followed by Mio-Pliocene inversion and late Pliocene-Pliestocene foredeep extension (Panidihing) due to basin tilting towards NW (Figure-A-A').

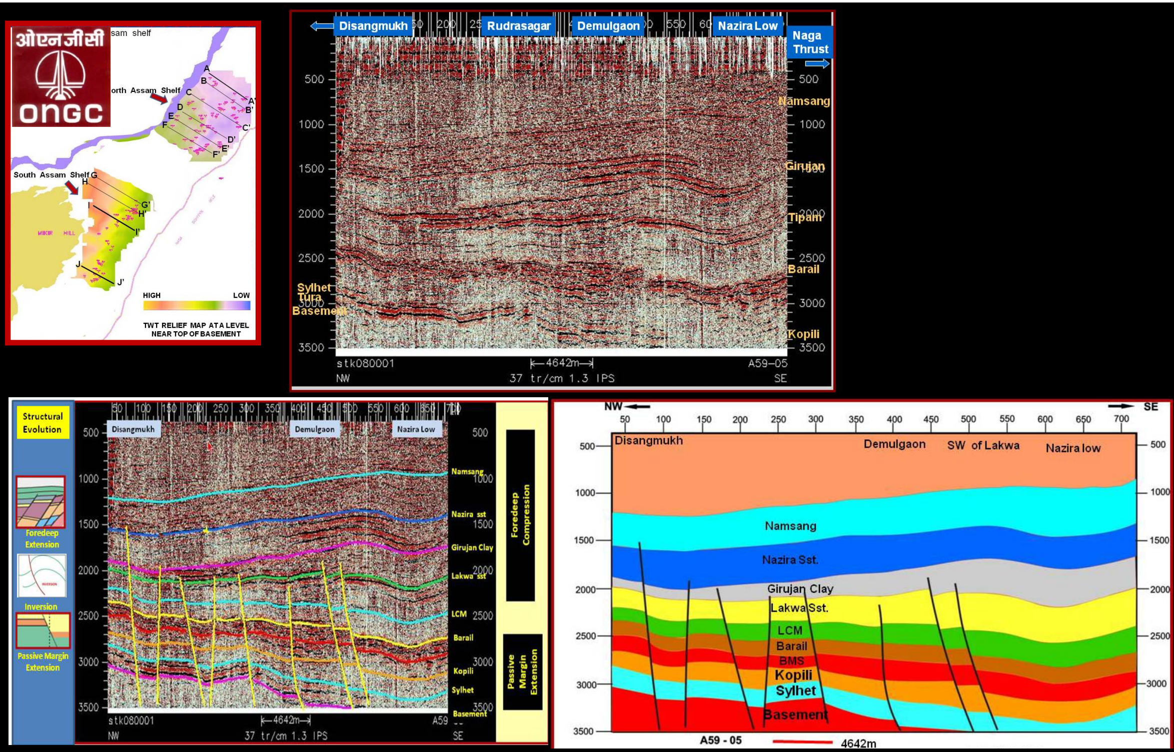



Panidihing
Lakwa
Namsang
Nazira sst
Girujan Clay
Lakwa sst
LCM
Barail
Kopili
Sylhet
Basement
Foredeep Compression
Passive Margin Extension


Assam shelf
North Assam Shelf
South Assam Shelf
HIGH
LOW
TWT RELIEF MAP AT A LEVEL NEAR TOP OF BASEMENT

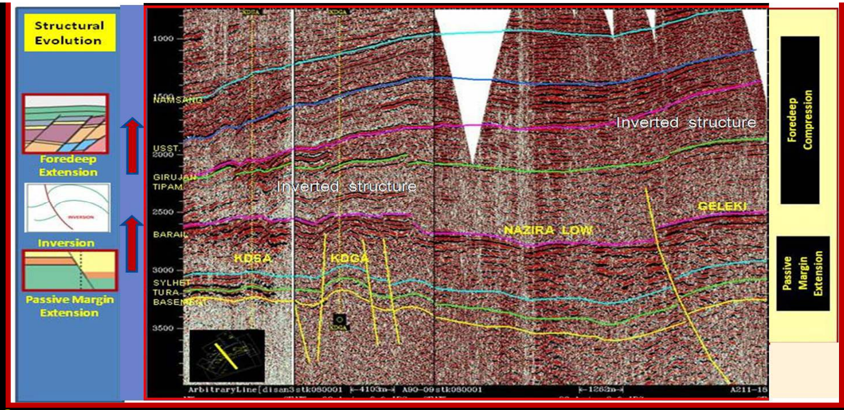

Panidihing
Lakwa
Namsang
Nazira Sst
Girujanclay
Lakwa sst.
LCM
Barail
kopili
Sylhet
Basement
Foredeep Compression
Passive Margin Extension
A 150-17
A 187-10

B-B’ R-C Line

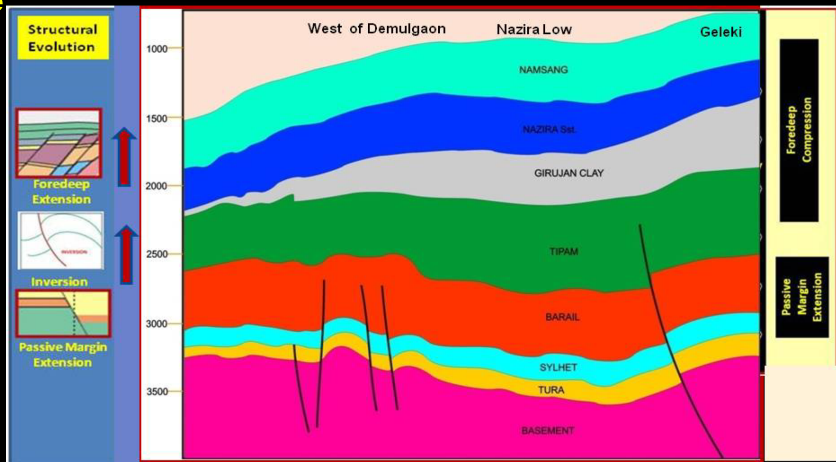


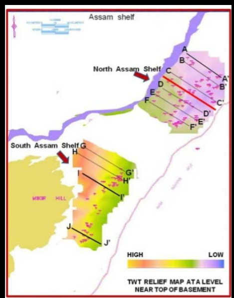
C-C' seismic line showing structural elements of the Disangmukh- Nazira Low areas

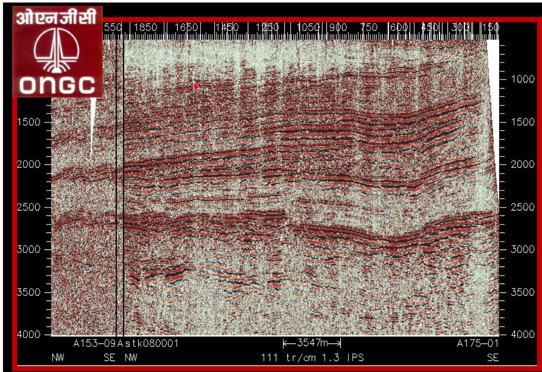
Presenter's Notes: The seismic line C-C' traverses along Disangmukh, Demulgaon and Nazira Low areas as a regional dip section suitable for viewing major structural elements of North Assam shelf. Basement is slightly offset by the presence of southward- and few northwestward-dipping planar faults. Except for the one fault in extreme NW (i.e., Disangmukh-structure-bounding fault) all the faults die out in Girujan Clay; it likely is related to the eastern compressive stress. Two folds can be easily identified, one related to Nazira-Low-bounding fault and another to Disangmukh structure, both have originated quite late, after Mid-Miocene, as a result of the ongoing compression and Naga thrust advancement from the east. Namsang and Nazira Sst have gentle folding near Nazira Low; otherwise they show that tectonic episodes have not affected these formations in this part of the basin.

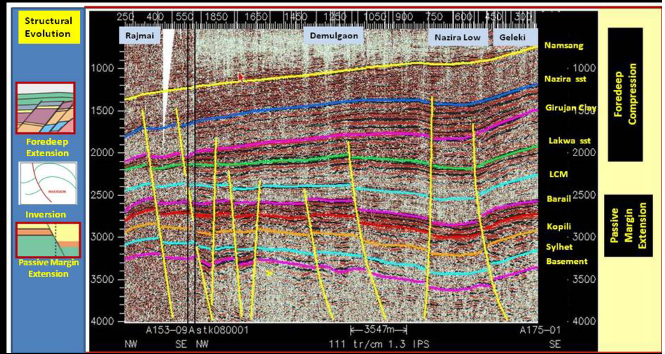


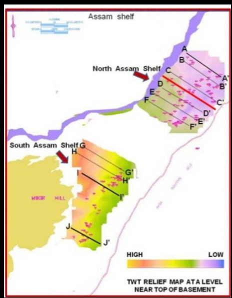
Reconstructed seismic line (Shown in red color) along the basinal dip showing major structural features



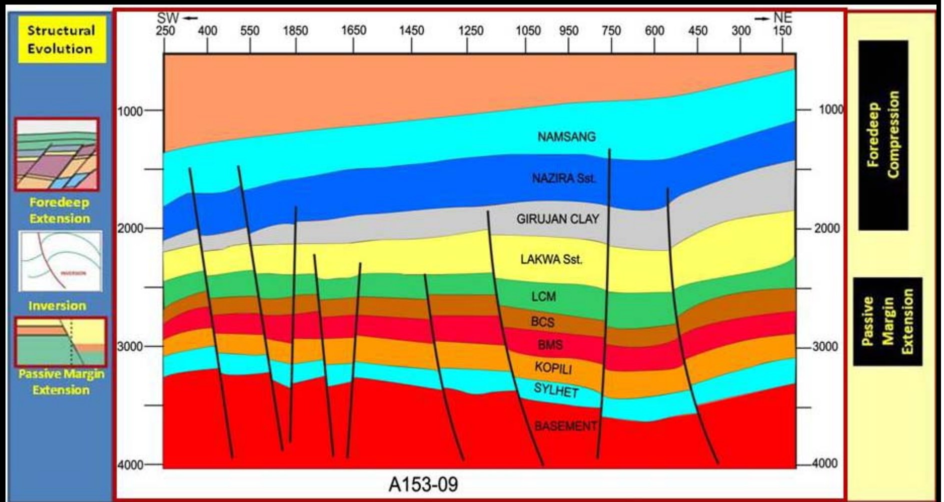


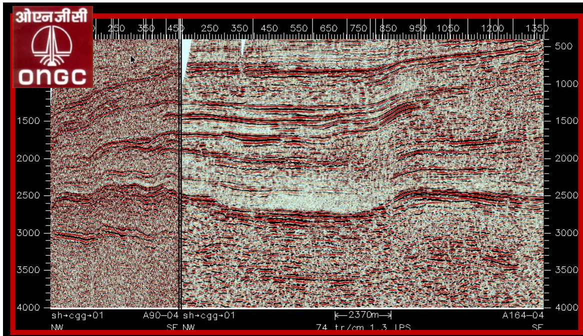


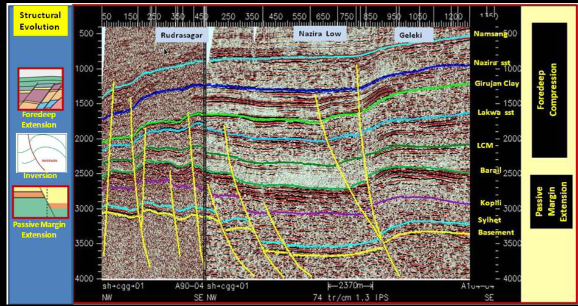


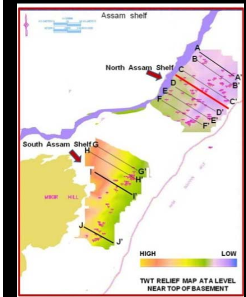


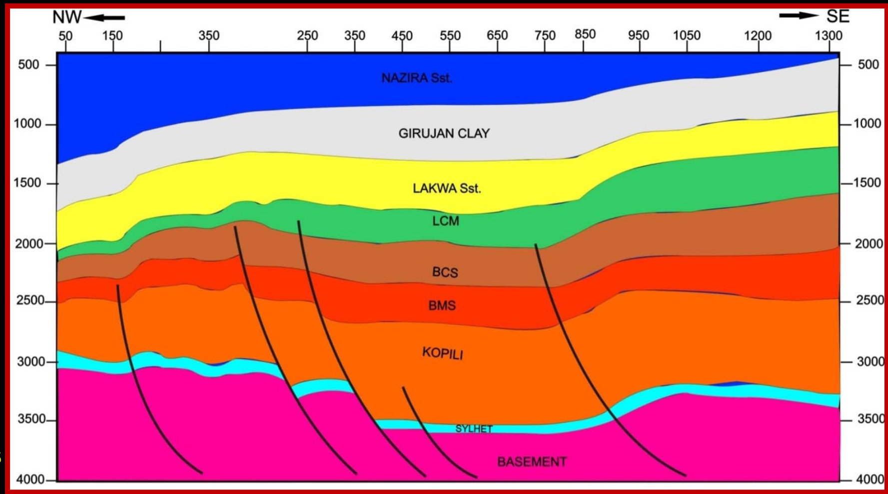
D-D' R-C line Depicting structural trend in Geleki-Rajmai areas





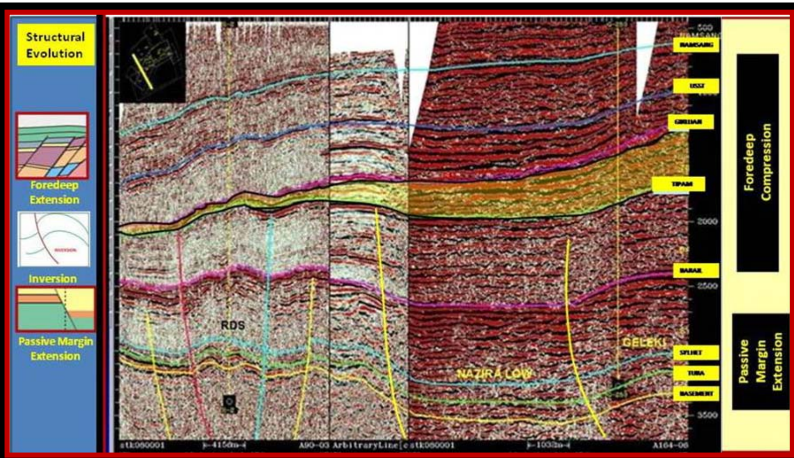


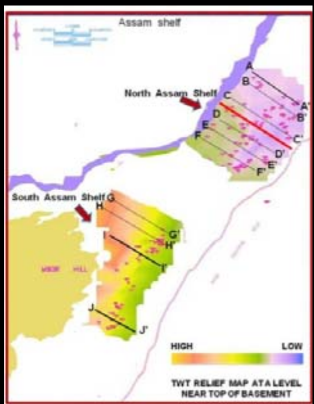


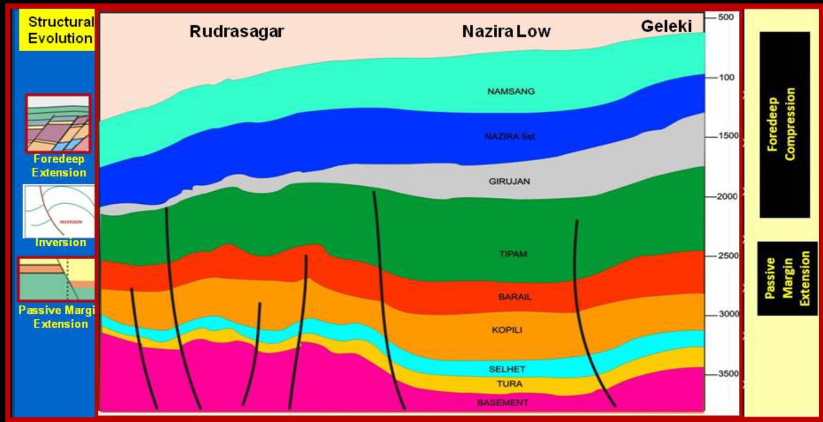


E-E' Reconstructed seismic section showing major structural features

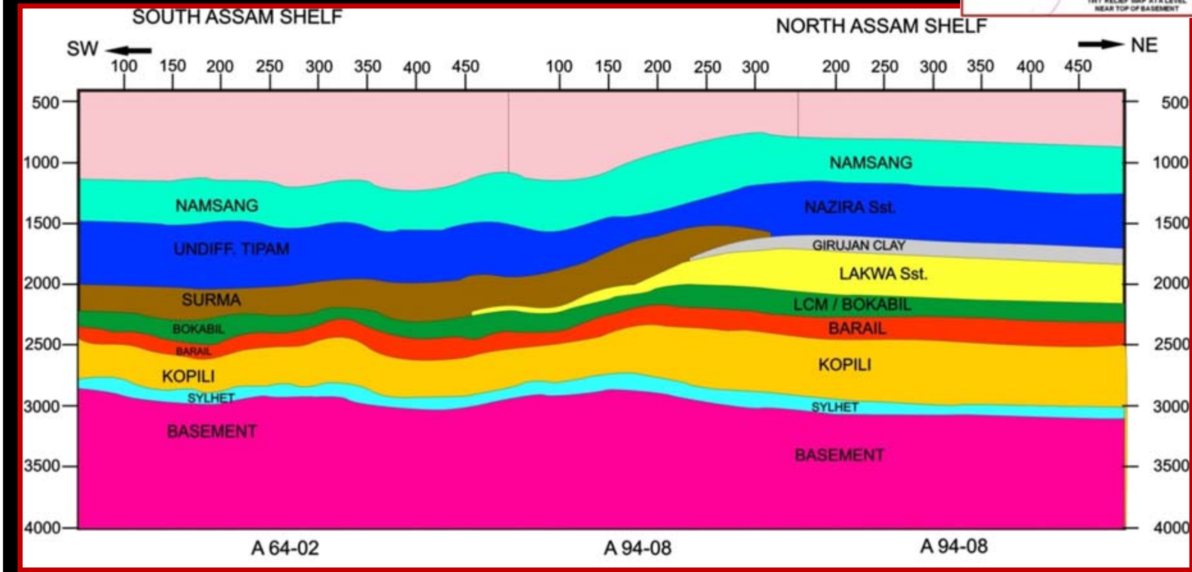
F-F'
NW-SE seismic section Showing a combination of normal and inverted structures

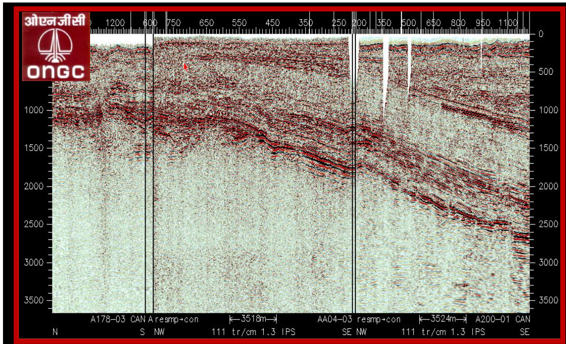


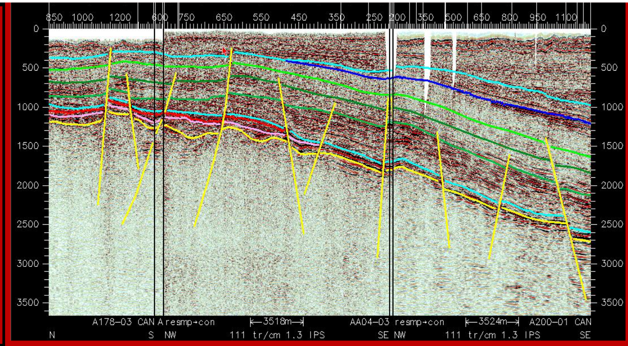


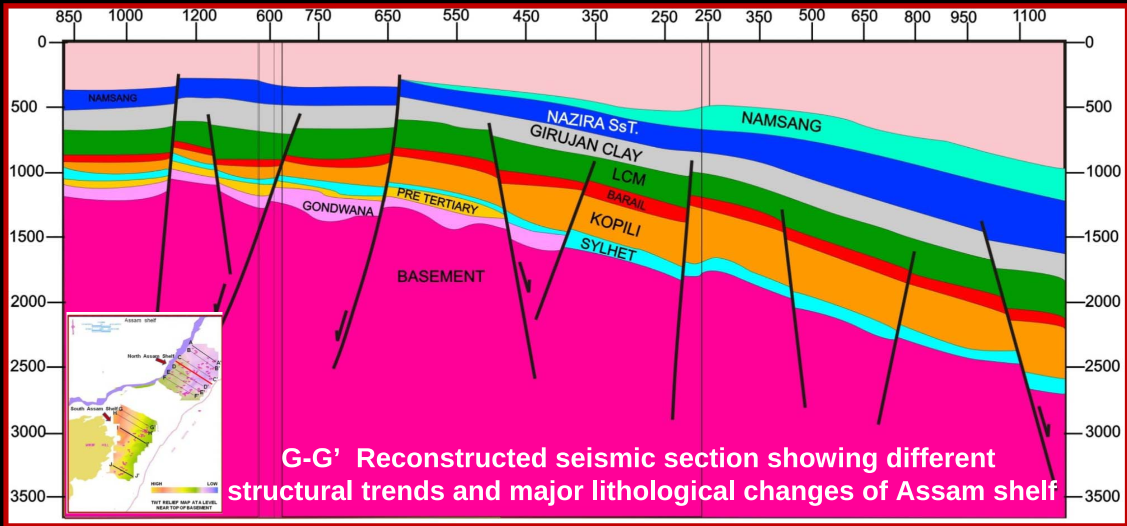


S-S’ Regional schematic seismic section showing different depositional system prevailed in North and South Assam shelf



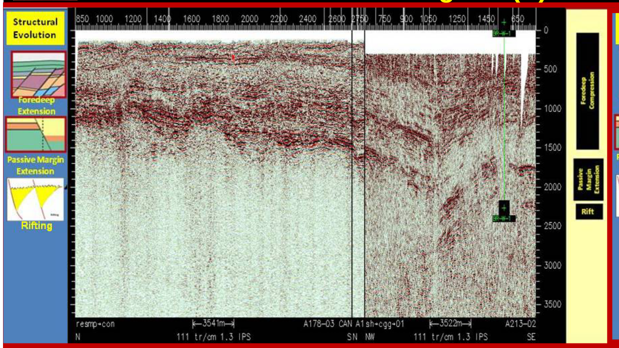


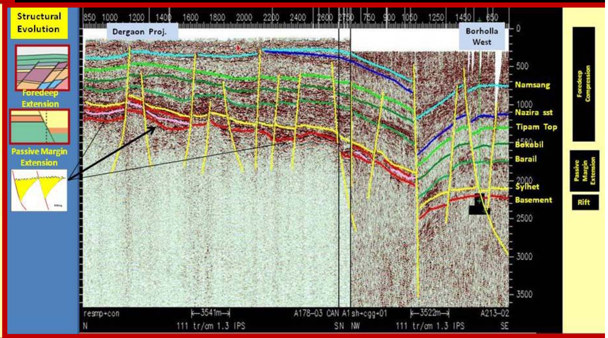


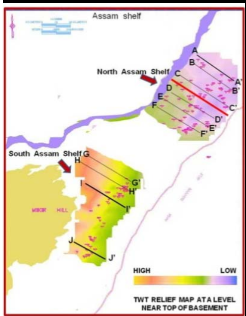


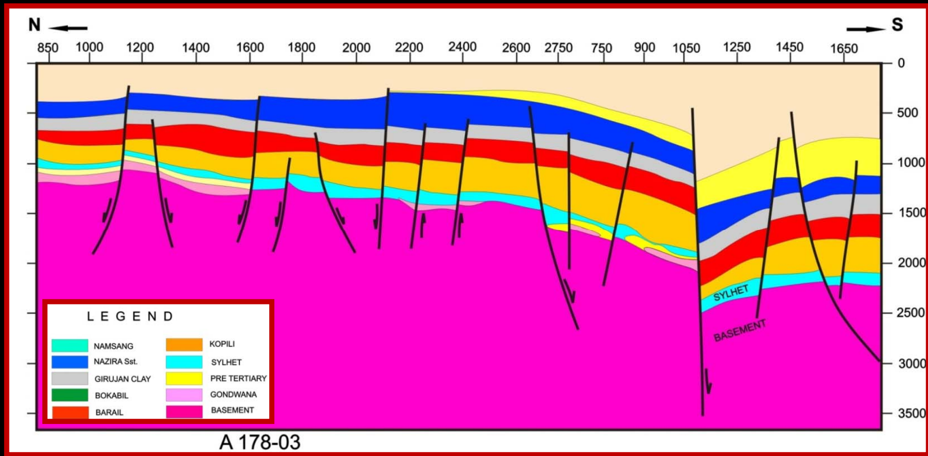
G-G' Reconstructed seismic section showing different structural trends and major lithological changes of Assam shelf

H-H’ Reconstructed seismic section passing through Borholla and Dergaon (P) structures.

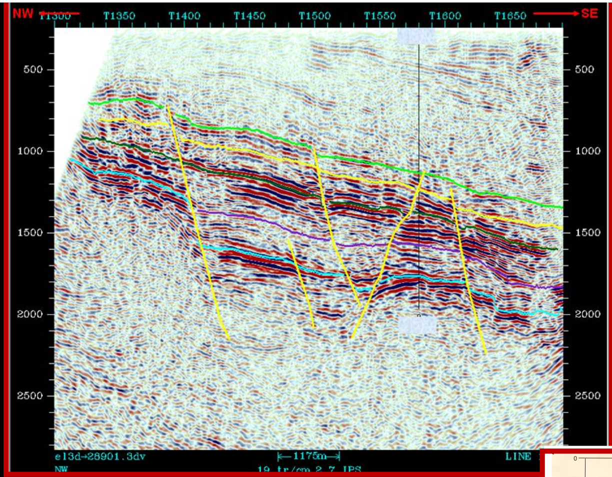


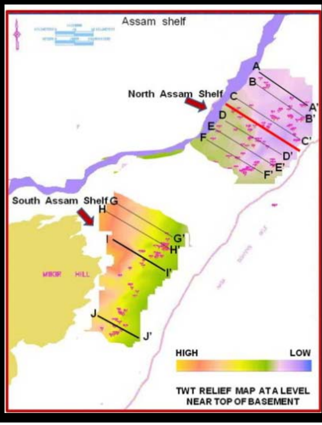


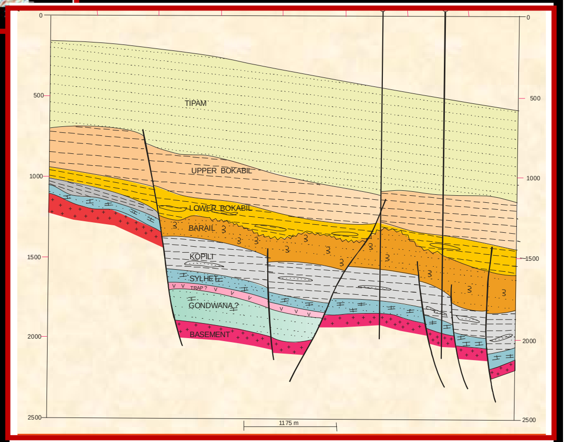


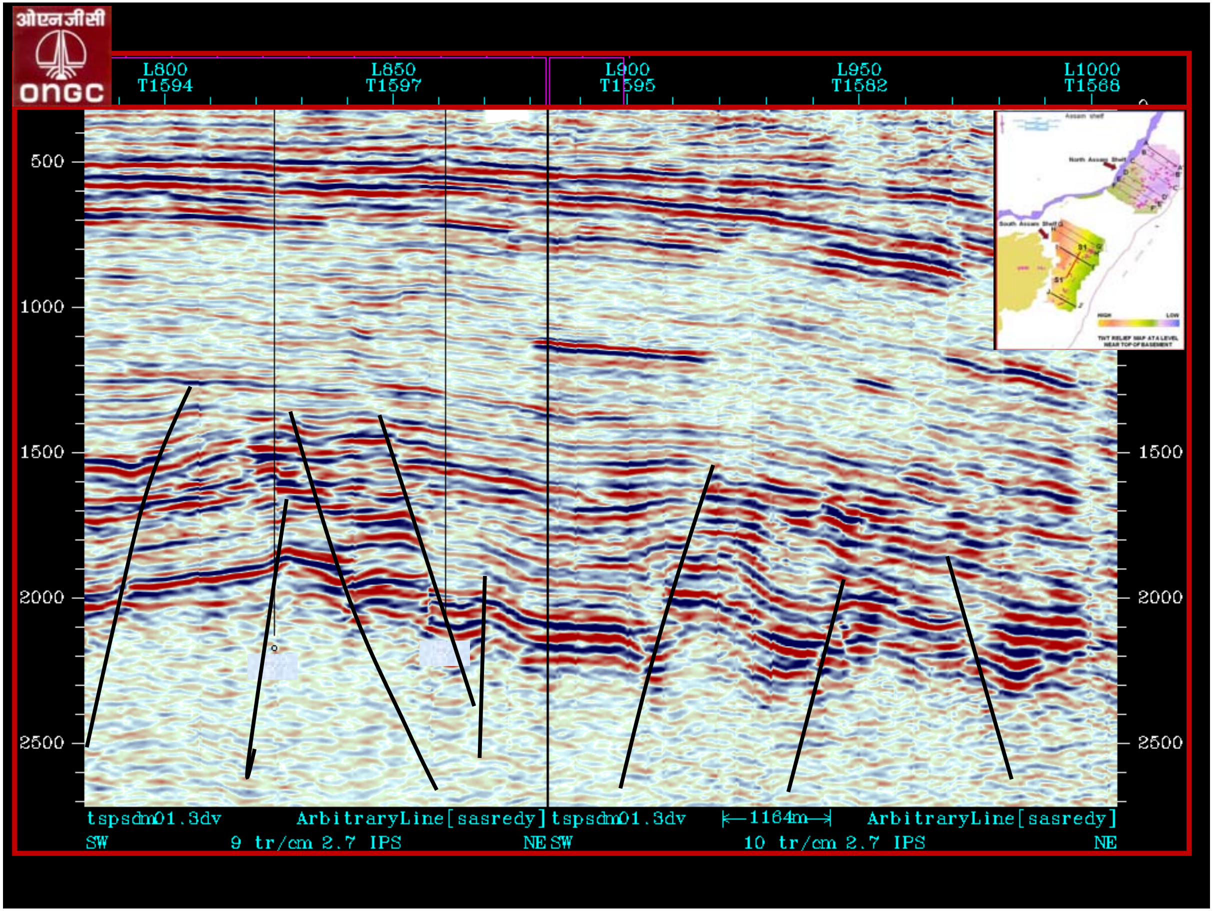


I-I' Seismic line from 3-D data Showing rift and extensional features of Southern part of Assam shelf





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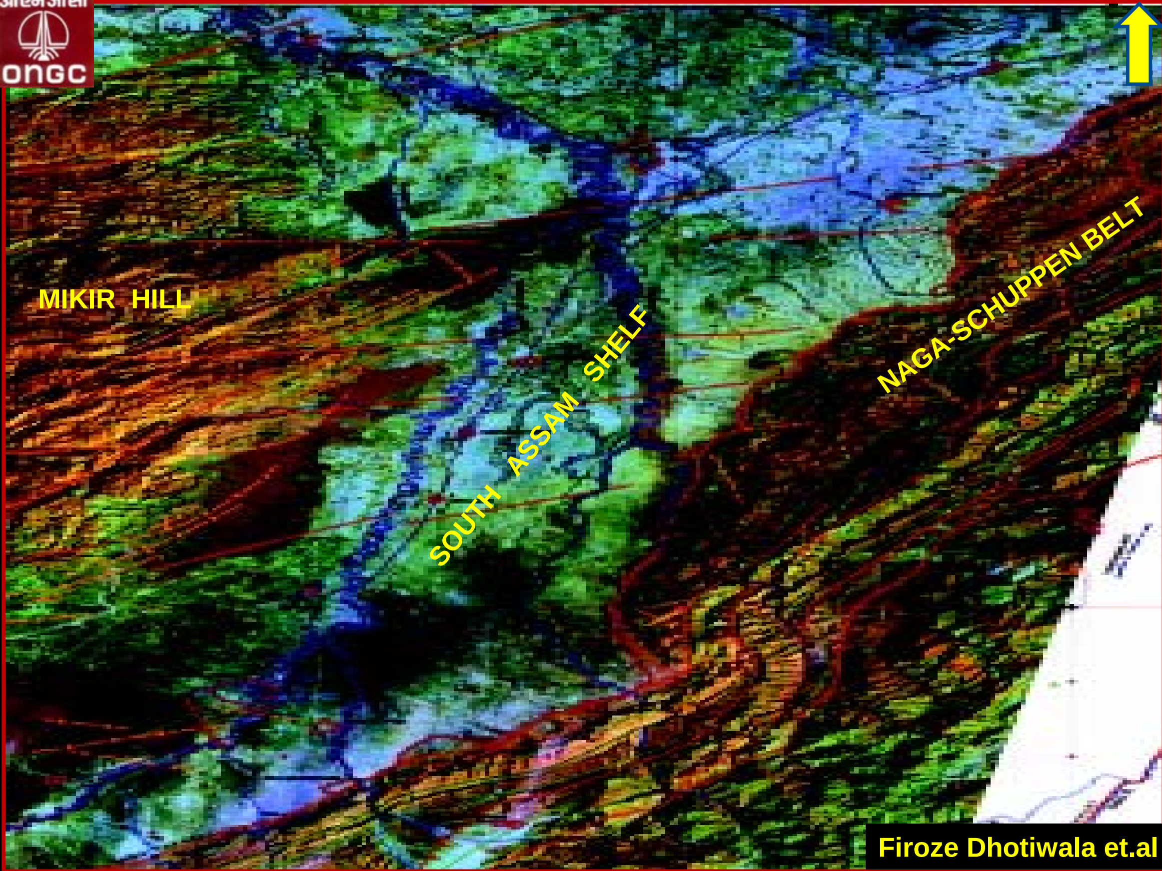
ONGC
L800
T1594
L850
T1597
L900
T1595
L950
T1582
L1000
T1568
500
1000
1500
2000
2500
tspsdm01.3dv
ArbitraryLine[sasredy]
tspsdm01.3dv
1164m
ArbitraryLine[sasredy]
SW
9 tr/cm 2.7 IPS
NE
SW
10 tr/cm 2.7 IPS
NE

Remote Sensing and Surface attributes



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ONGC
N
HIMALAYA
NORTH ASSAM
SHELF
NAGA-SCHUPPEN BELT
SOUTH ASSAM SHELF
Google
Pointer 27°10'37.27" N 94°32'40.19" E
Streaming |||||||||| 100%
Eye alt 93.63 mi

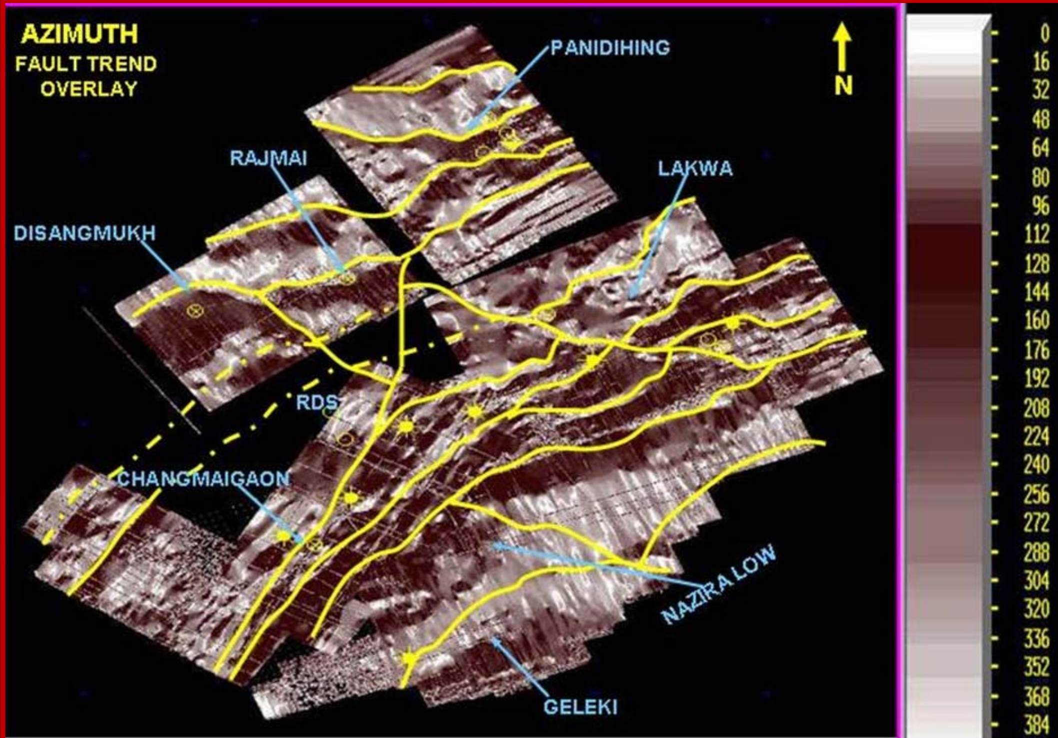
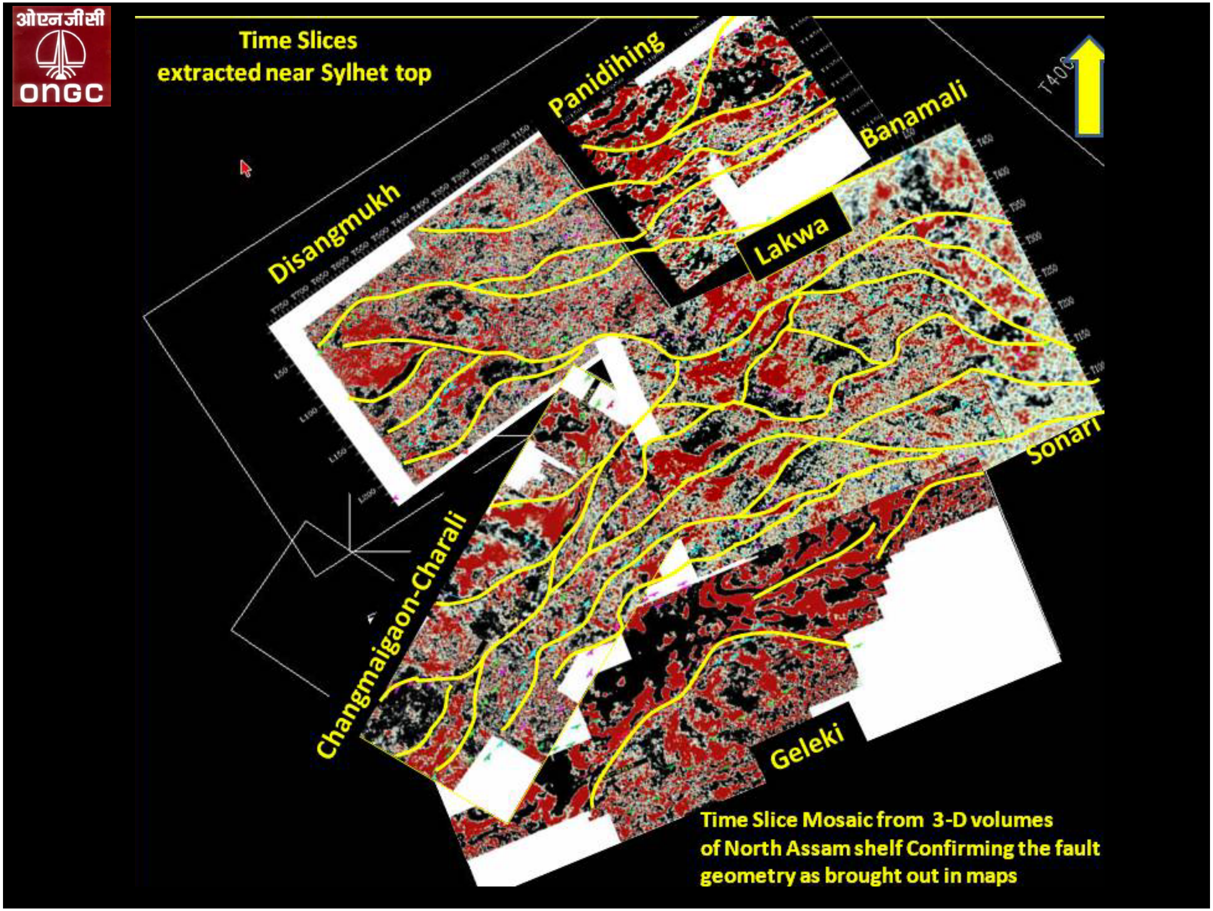


FIGURE- AZIMUTH MAP (NEAR KOPILI TOP)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Time Slices
extracted near Sylhet top
Panidihing
Banamali
Disangmukh
Lakwa
Sonari
Changmaigaon-Charali
Geleki
Time Slice Mosaic from 3-D volumes
of North Assam shelf Confirming the fault
geometry as brought out in maps

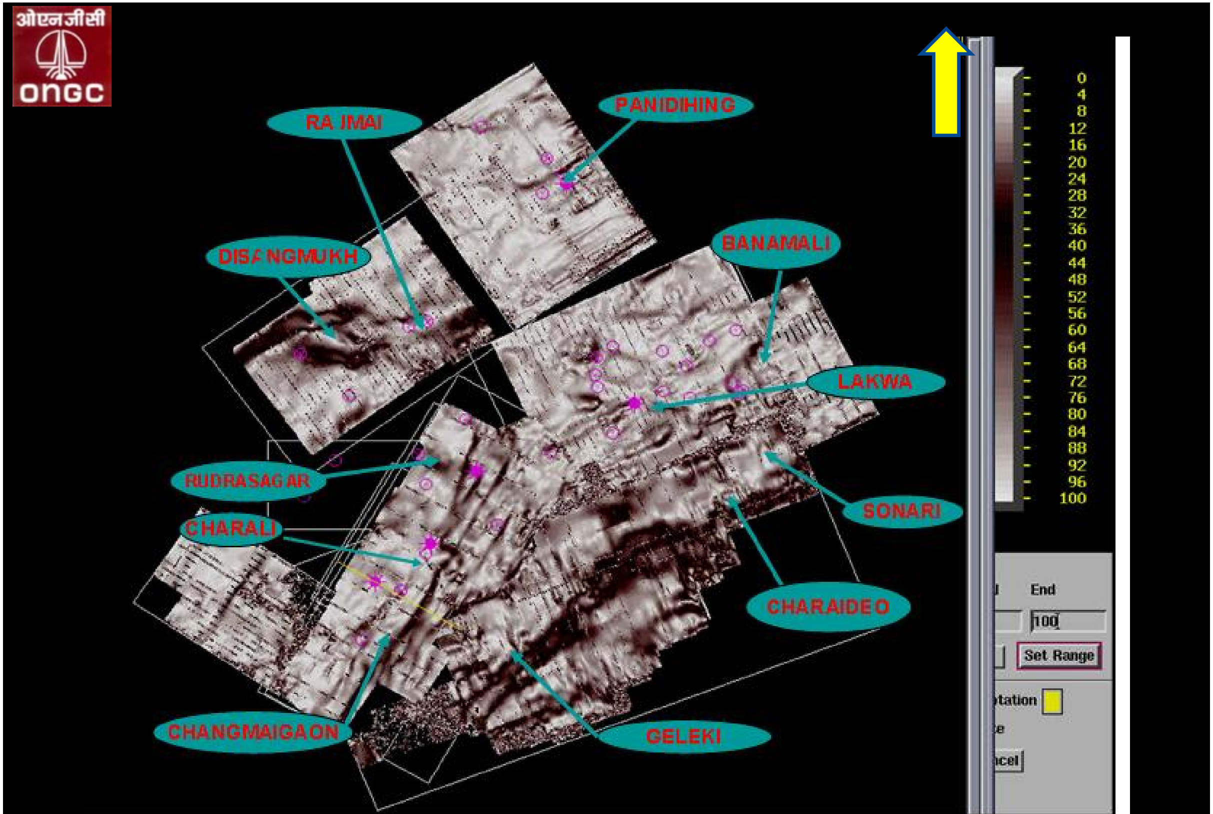

FIG: EDGE DETECTION MAP AT SYLHET LEVEL


South Assam Shelf
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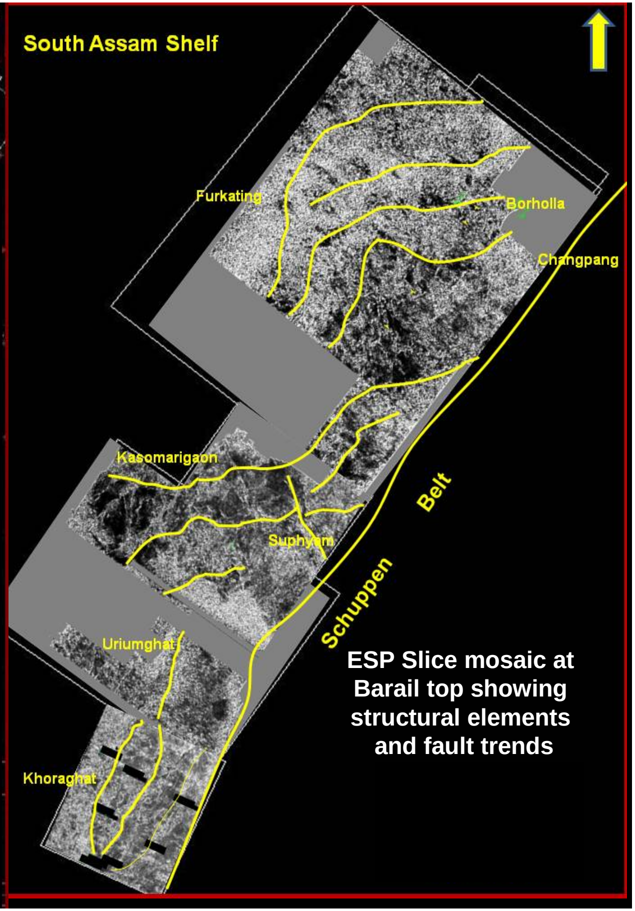
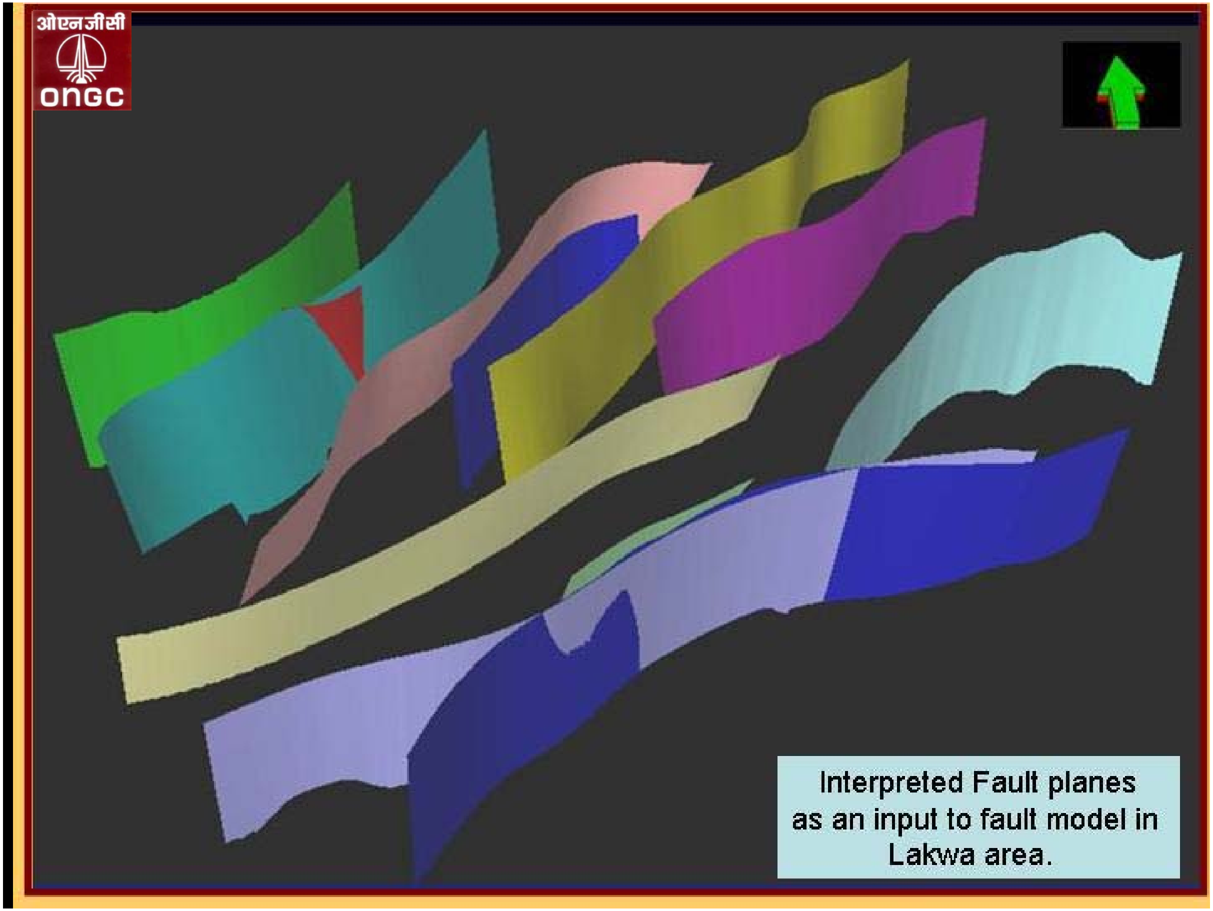
Edge Detection Map
Showing major and minor faults


South Assam Shelf
Furkating
Borholla
Changpang
Kasomarigaon
Suphyam
Uriumghat
Khoraghat
Schuppen
Belt
ESP Slice mosaic at
Barail top showing
structural elements
and fault trends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ONGC
Interpreted Fault planes
as an input to fault model in
Lakwa area.

MAPS

Time structure maps need critical analysis in order to have better understanding of the tectonic evolution of the region. To facilitate the description of the structural setup in the area, eight correlated horizons, Basement, Sylhet, Barail top, LCM, Bokabil, Lakwa Sst., Girujan top and Namsang top have been mapped.

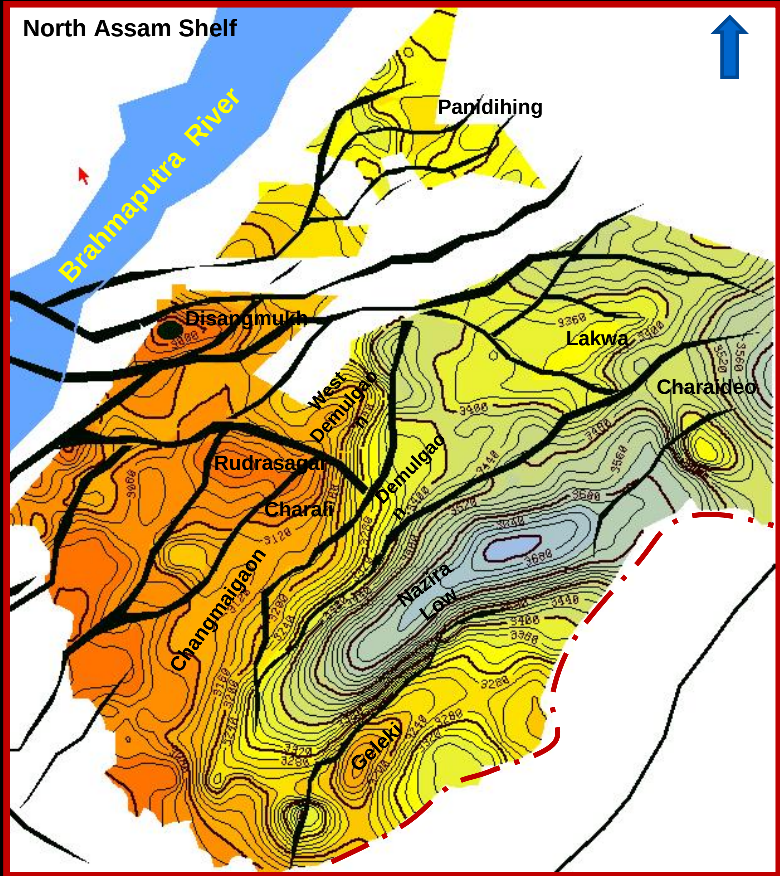
A basement top time structure map is useful to recognize the regional faults and some observations about the inversion that has occurred in the basin. Maps generated for North Assam and South Assam shelf have been examined separately.

The map clearly shows dominant ENE-WSW, NE-SW (sub-parallel to Naga thrust) trending longitudinal faults and NW-SE to W-E trending transverse faults in the area. The major faults in ENE-WSW and NE-SW directions show variable throw along the faults with a southerly hade. These faults along the Naga trend are younger in the regional structural framework but appear relatively older to the cross faults, trending NW-SE and W-E, which also show strike-slip component. The area is compartmentalized into several smaller fault blocks.

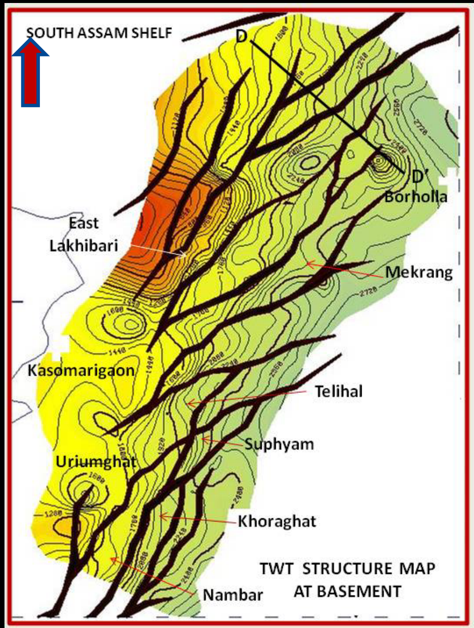
Most of the ENE-WSW and NE-SW trending faults follow a curvilinear geometry particularly in Rudrasagar and Geleki area and appear to have been generated due to Early Tertiary extensional tectonics and further reactivated and reoriented due to later tectonic pulses causing the present-day fault system.

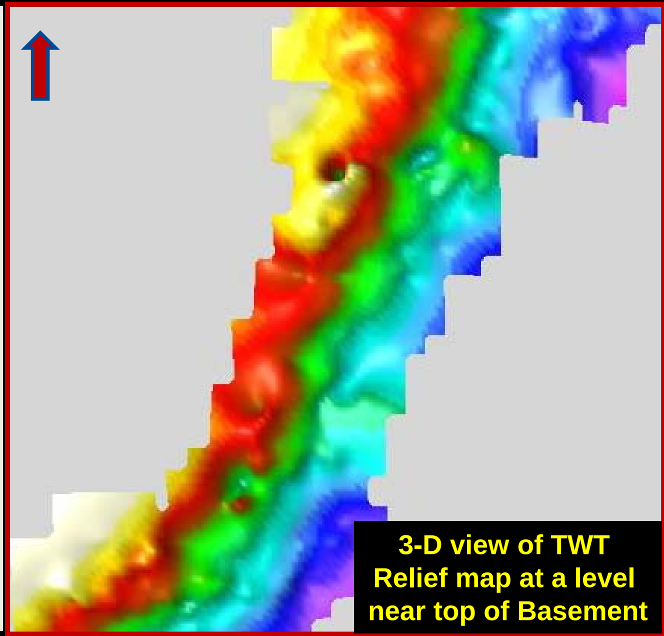
The present-day fault system consists of Domino type cascading normal faults, inverted and reverse faults and strike-slip trends in all of Assam shelf. Two main trends can be recognized from the most important faults, and another trend can be observed in minor faulting. The first mode has an ENE-WSW direction, whereas the second one is approximately E-W.

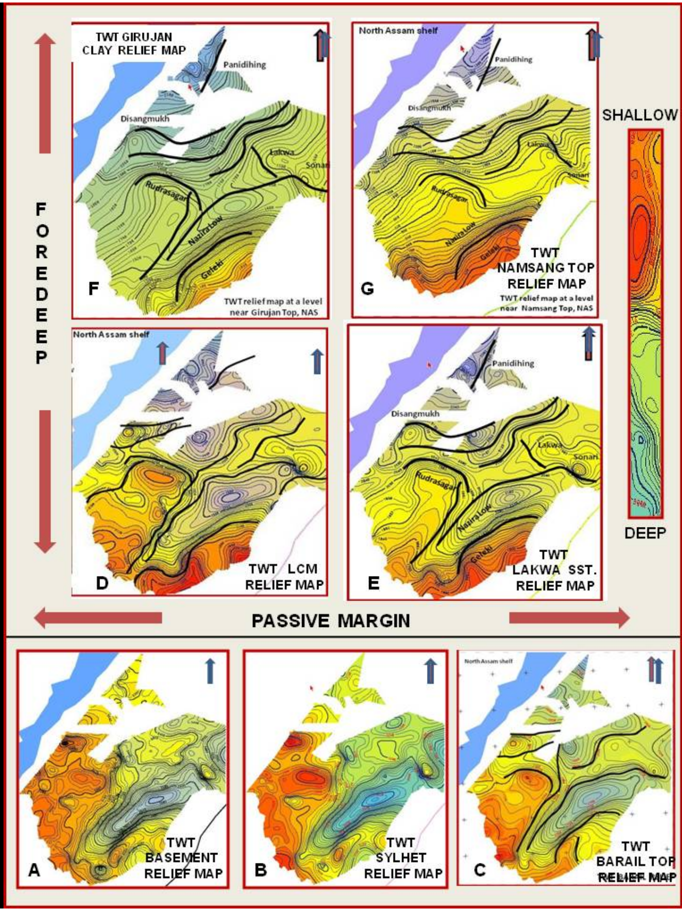
In Assam basin the extensional faults have an important role within inversion stages, and they are the ones that have been mostly affected by the compressive episodes. Small faults are located in the southwestern part of the region and are normal faults related to the initial stage of extension; they usually do not propagate significantly upward into the sedimentary column and they have not been inverted.

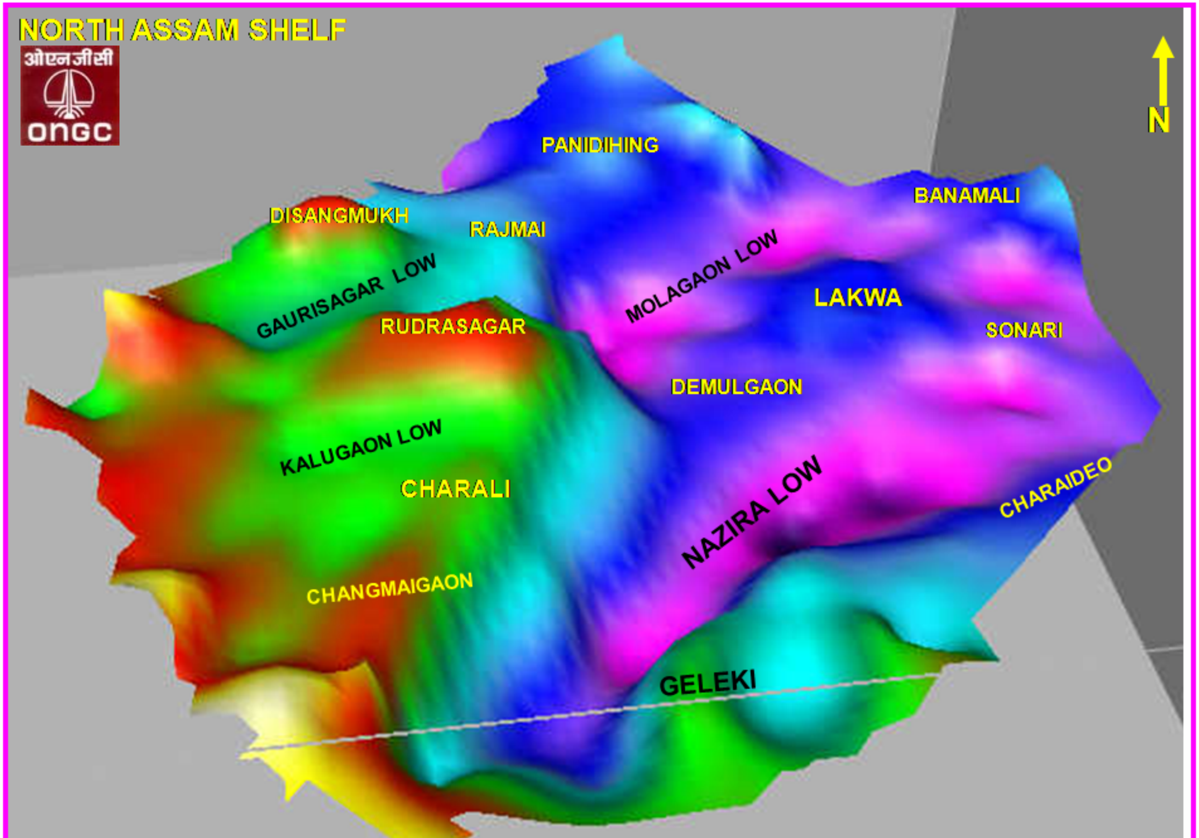


TWT Structure Map at level near top of Basement

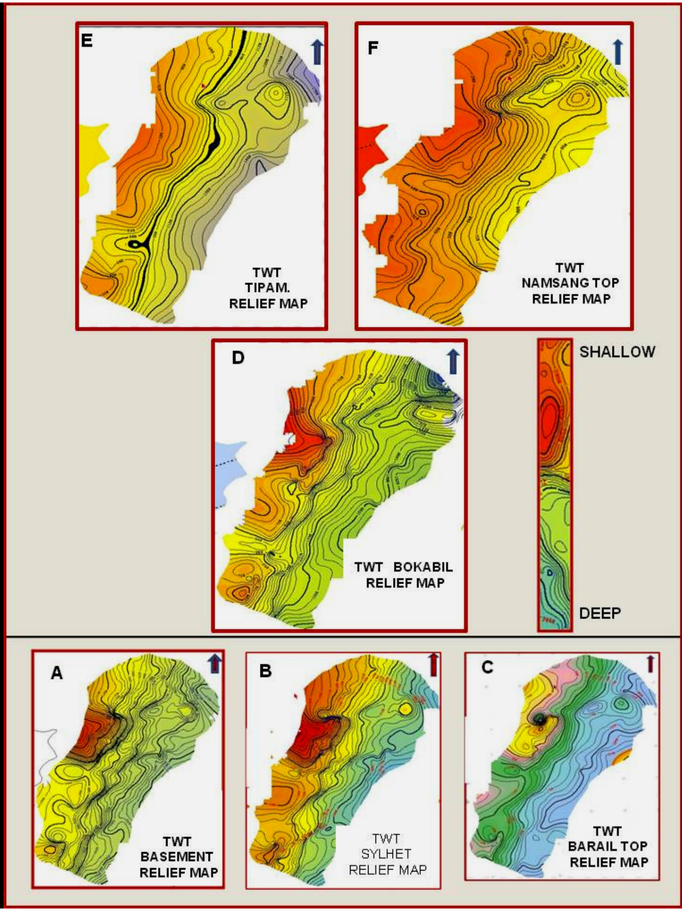

SOUTH ASSAM SHELF
D
D'
Borholla
East
Lakhibari
Mekrang
Kasomarigaon
Telihal
Suphyam
Uriumghat
Khoraghat
Nambar
TWT STRUCTURE MAP
AT BASEMENT


3-D view of TWT
Relief map at a level
near top of Basement


TWT GIRUJAN CLAY RELIEF MAP
Panidihing
Disangmukh
Lakwa
Sonari
Rudrasagar
Nazira Low
Geleki
F
TWT relief map at a level near Girujan Top, NAS
North Assam shelf
G
TWT NAMSANG TOP RELIEF MAP
TWT relief map at a level near Namsang Top, NAS
SHALLOW
DEEP
FOREDEEP
D
TWT LCM RELIEF MAP
E
TWT LAKWA SST. RELIEF MAP
PASSIVE MARGIN
A
TWT BASEMENT RELIEF MAP
B
TWT SYLHET RELIEF MAP
C
TWT BARAIL TOP RELIEF MAP



3-D VIEW OF THE KOPILI TOP (RELIEF)


E
TWT
TIPAM.
RELIEF MAP
F
TWT
NAMSANG TOP
RELIEF MAP
D
TWT BOKABIL
RELIEF MAP
SHALLOW
DEEP
A
TWT
BASEMENT
RELIEF MAP
B
TWT
SYLHET
RELIEF MAP
C
TWT
BARAIL TOP
RELIEF MAP

Thickness distribution trend

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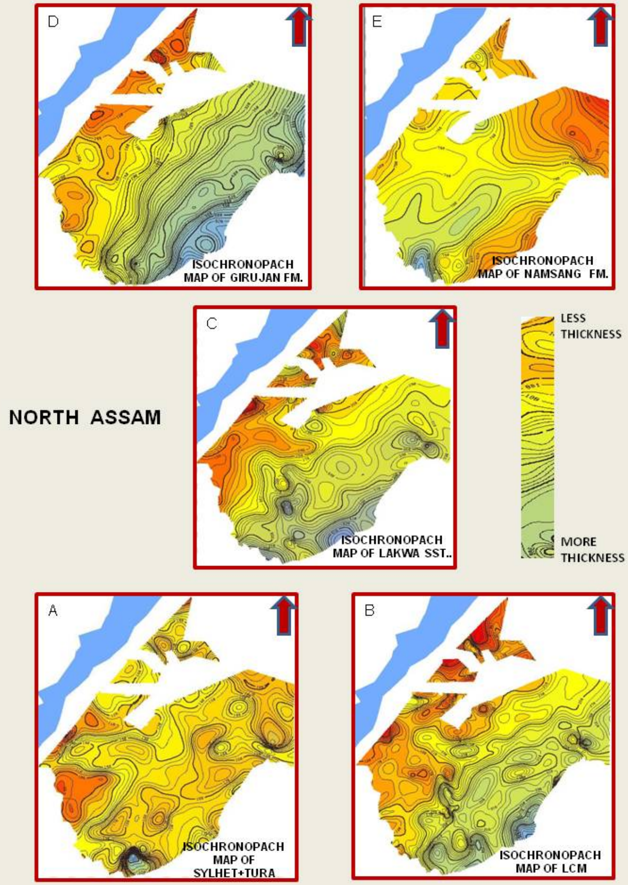

D
ISOCHRONOPACH
MAP OF GIRUJAN FM.
E
ISOCHRONOPACH
MAP OF NAMSANG FM.
NORTH ASSAM
C
ISOCHRONOPACH
MAP OF LAKWA SST..
LESS
THICKNESS
MORE
THICKNESS
A
ISOCHRONOPACH
MAP OF
SYLHET+TURA
B
ISOCHRONOPACH
MAP OF LCM

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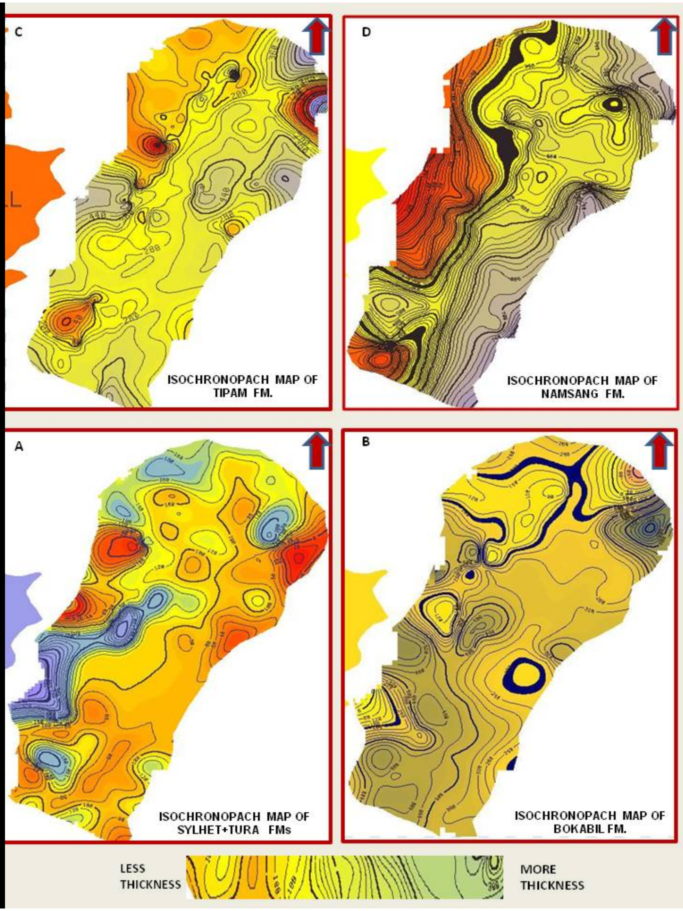
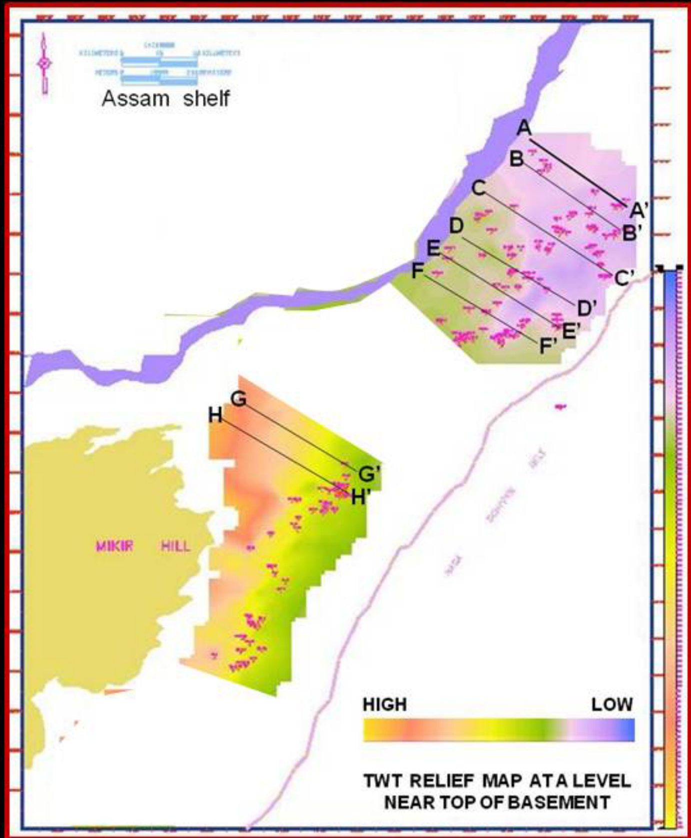
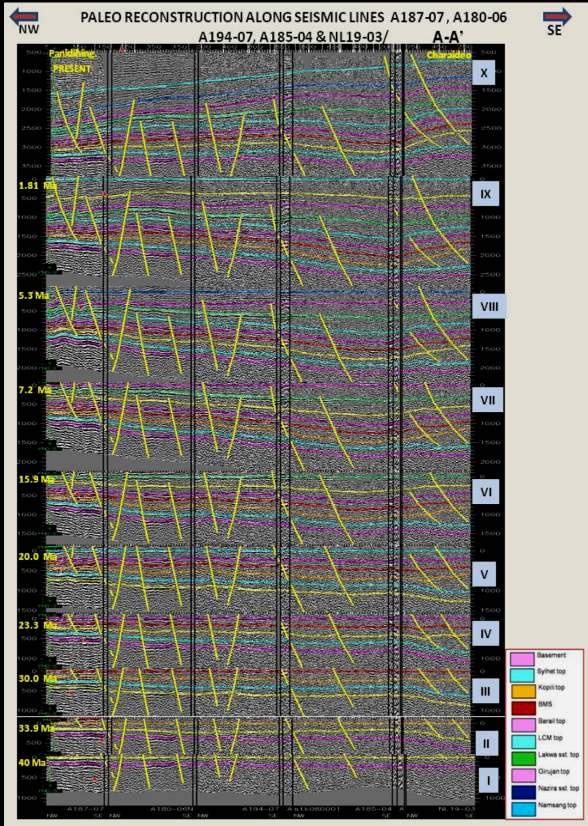
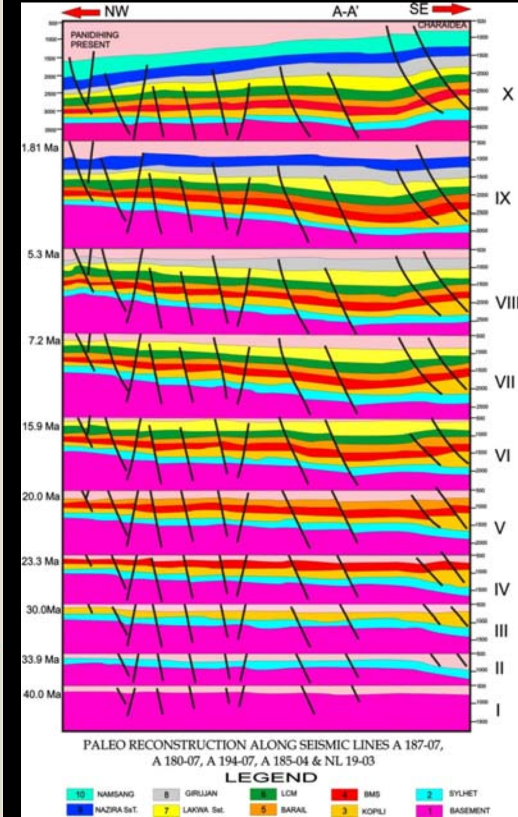

C
ISOCHRONOPACH MAP OF TIPAM FM.
D
ISOCHRONOPACH MAP OF NAMSANG FM.
A
ISOCHRONOPACH MAP OF SYLHET+TURA FMs
B
ISOCHRONOPACH MAP OF BOKABIL FM.
LESS THICKNESS
MORE THICKNESS

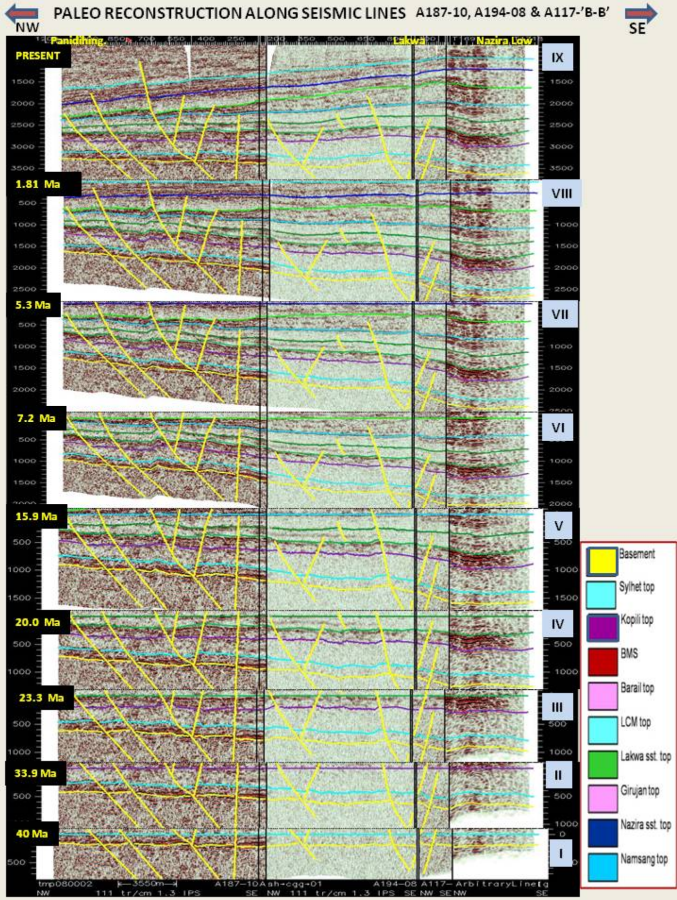
Deformation History


Assam shelf
A
A'
B
B'
C
C'
D
D'
E
E'
F
F'
G
G'
H
H'
MIKIR HILL
HIGH
LOW
TWT RELIEF MAP AT A LEVEL
NEAR TOP OF BASEMENT


PALEO RECONSTRUCTION ALONG SEISMIC LINES A187-07 , A180-06
A194-07, A185-04 & NL19-03/
A-A'
NW
SE
Panidihing PRESENT
Charaideo
X
1.81 Ma
IX
5.3 Ma
VIII
7.2 Ma
VII
15.9 Ma
VI
20.0 Ma
V
23.3 Ma
IV
30.0 Ma
III
33.9 Ma
II
40 Ma
I
Basement
Sylhet top
Kopili top
BMS
Barail top
LCM top
Lakwa sst. top
Girujan top
Nazira sst. top
Namsang top


NW
A-A'
SE
PANIDIHING PRESENT
CHARAIDEA
X
1.81 Ma
IX
5.3 Ma
VIII
7.2 Ma
VII
15.9 Ma
VI
20.0 Ma
V
23.3 Ma
IV
30.0Ma
III
33.9 Ma
II
40.0 Ma
I
PALEO RECONSTRUCTION ALONG SEISMIC LINES A 187-07,
A 180-07, A 194-07, A 185-04 & NL 19-03
LEGEND
10 NAMSANG
9 NAZIRA SsT.
8 GIRUJAN
7 LAKWA Sst.
6 LCM
5 BARAIL
4 BMS
3 KOPILI
2 SYLHET
1 BASEMENT

PALEO RECONSTRUCTION ALONG SEISMIC LINES A187-10, A194-08 & A117-'B-B'



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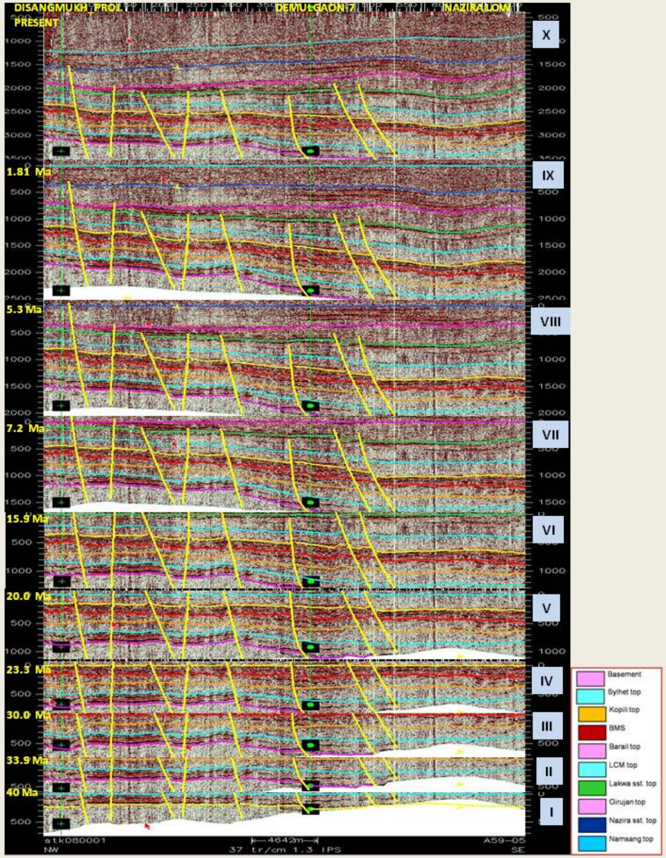
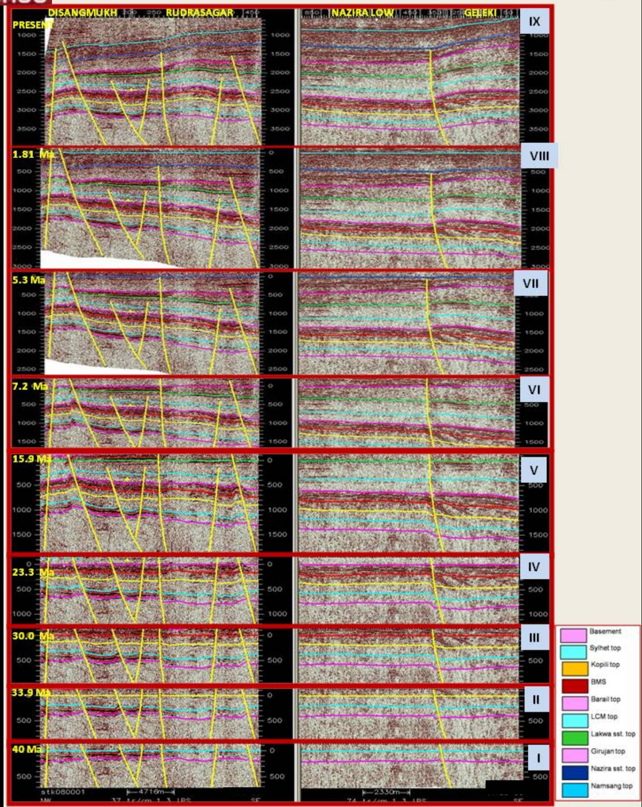
NW

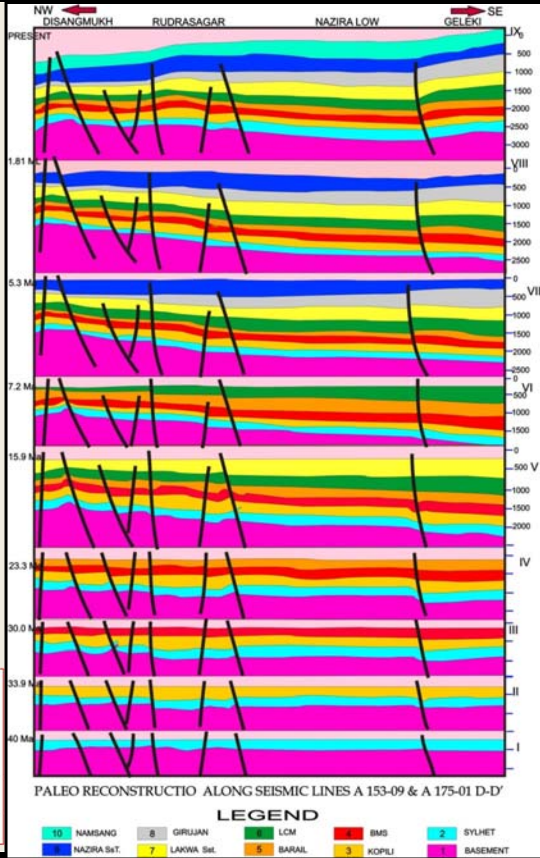
PALEO RECONSTRUCTION ALONG SEISMIC LINES A59-05 C-C'

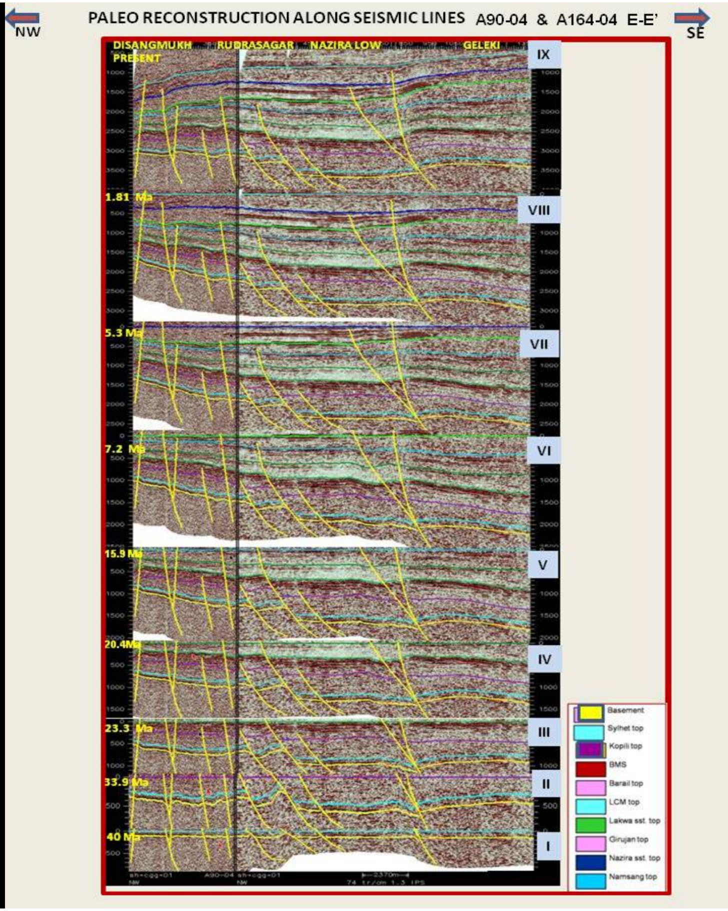
SE



PALEO RECONSTRUCTION ALONG SEISMIC LINES A153-09 & A175-01 D-D'







PALEO RECONSTRUCTION ALONG SEISMIC LINES A90-04 & A164-04 E-E'
NW
SE
DISANGMUKH
RUDRASAGAR
NAZIRA LOW
GELEKI
PRESENT
IX
1.81 Ma
VIII
5.3 Ma
VII
7.2 Ma
VI
15.9 Ma
V
20.4Ma
IV
23.3 Ma
III
33.9 Ma
II
40 Ma
I
Basement
Sylhet top
Kopili top
BMS
Barail top
LCM top
Lakwa sst. top
Girujan top
Nazira sst. top
Namsang top

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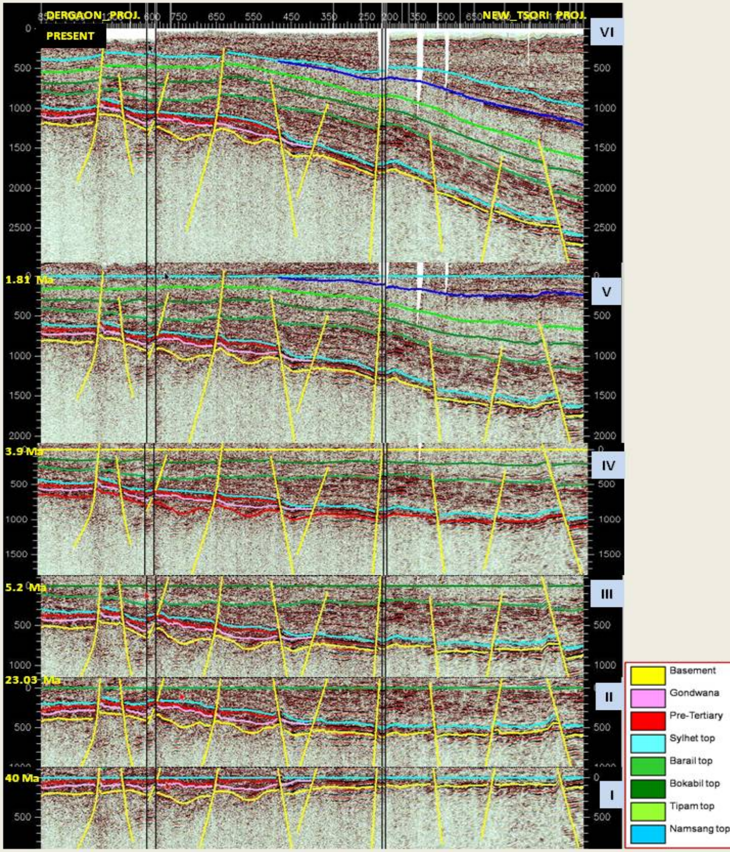
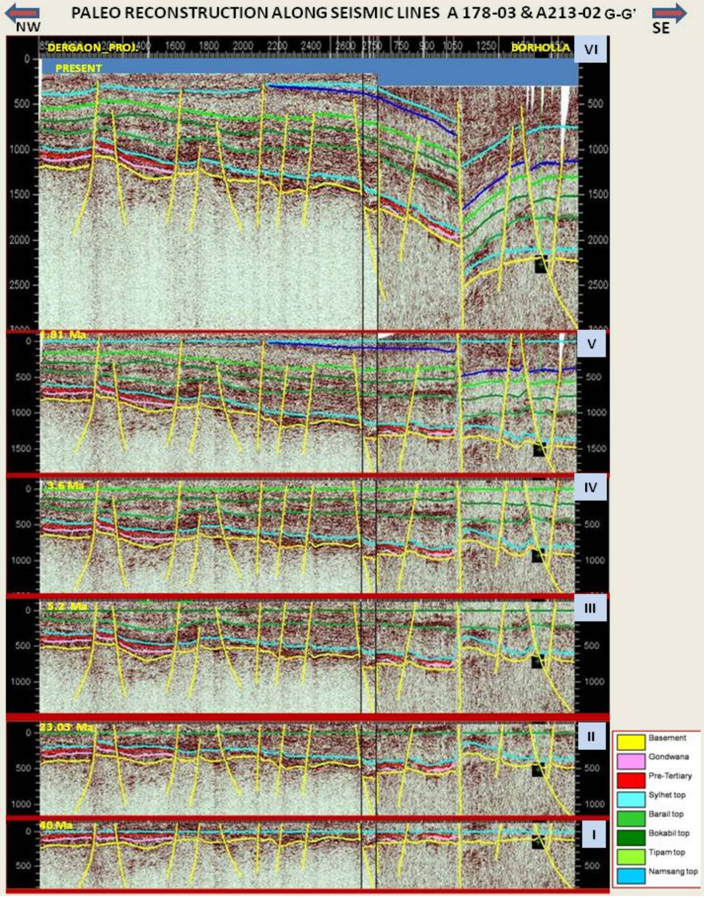
NW PALEO RECONSTRUCTION ALONG SEISMIC LINES A178-03, AA04-03 F-F' & A200-01' SE



PALEO RECONSTRUCTION ALONG SEISMIC LINES A 178-03 & A213-02 G-G'



To work-out the deformation history of the area, detailed paleostrctural analysis has been carried out on basinal scale. Two reconstructed dip profiles across the basin were chosen for the study). These profiles were analyzed by way of flattening nine horizons (Sylhet, Kopili, BMS, BCS, LCM, Bokabil (South Assam) Lakwa Sandstone, Girujan clay, Nazira Sandstone & Namsang); the following observations have been recorded:

A poly-phase history of deformation is responsible for the development of the present-day structural setup of Assam shelf. At least three tectonic episodes were involved. An Early Cretaceous rifting created horst and graben in extensional setting superimposed by a compressive episode in early Miocene resulted inversion/compressional structures. The third phase of another compressive episode of Plio-Pliestocene modified the earlier structural setup.

2. The North Assam shelf can be divided into three mega-tectonic blocks. One block comprising Nazira low, Geleki-Charaideo high trend including Nahorabi and Sonari area is highly influenced by the compressive stress from southeast direction and is also largely influenced by the Naga-Schuppen orogeny.

3. The second mega-tectonic block exists in southwest of Rudrasagar structure, where intensity of deformation appears to be less .The third tectonic mega-block exists north-east of Rudrasagar structure. Intensity of deformation in this block is relatively higher.

4. The major deformation and structuring of the whole area occurred between early Miocene to middle Miocene time in a compressive episode.

5.The longitudinal normal faults of extensional setting were reactivated and reoriented due to younger compressive episodes, and the associated structures formed due to re-activation and re-orientation of these normal faults.

6. The majority of the structures in North Assam shelf have been formed due to tectonic inversion and reactivation of the major longitudinal fault systems. The structures formed mainly on the pre-existing normal fault bounding longitudinal horsts due to tectonic inversion. The early extensional structure superimposed by the late inversion mode in younger tectonic sequences. Specific example: Rudrasagar, Lakwa- Charali, Changmaigaon and Demulgaon trends.

7.The formation of majority of structures in Assam shelf are basement-involved inversion of pre-existing paleo-highs, and major deformation of the younger Tertiary sequences are genetically related with the formation of Naga-Schuppen zone.

Figure- Paleo-reconstruction along seismic lines E-E'

8.The formation of Geleki-Charaideo high trend system developed along with the formation of Nazira low during the same episodic compressive effect of Naga- adjoining fold movements. 9. The lateral movements along the cross faults offsets the hinges/axes of the structures. A clear indication of lateral block movements can be depicted in some of the seismic sections showing outright changes of reflection pattern and drastic variation of thickness against these cross faults.

Figure 20: Paleo-reconstruction along seismic lines D-D'

10.The Rudrasagar and Charali – Changmaigaon structures are younger structures and formed in late Miocene to early Pliocene. The areal extent of Rudrasagar structure in Sylhet level is relatively small, and the extension of the structure gradually increases in the younger Tertiary sequences (Figure 20).

Conclusions

Assam-Arakan basin represents a classic example of a poly-history basin which developed as a passive margin and later changed into a foreland basin in a peripheral position with respect to the major Naga schuppen belt and the contiguous Indo-Burma orogenic front. Probably three phases of tectonic regimes prevailed in the Assam Arakan basin: (I) Rift (2) Passive Margin Extensional, and (3) Foredeep compressive regimes.

Analysis of the seismic reflection sections and detection of seismic horizons that bound the seismic units illustrates the geological-geostructural evolution of the basin. The different tectonic phases recognizable on the seismic sections testify to the complexity and poly-phase character of the entire study area. The longitudinal fault system represents the foundered extension of the basement lineaments and fractures and evolved in extensional setting. The major deformation and structuring of the area initiated during early Miocene time in a compressive episode, resulting in creation of a basal foredeep unconformity separating Barail series from the overlying Tipam Group.

During this compressive episode of late middle Miocene time some of these longitudinal faults re-activated and re-oriented. The transverse systems of faults are the result of youngest episode of compressive movement. Normal down-to-basin Domino style of faulting, trending ENE-WSW to NE-SW, has been interpreted in this area. However, selective reactivation of some of the down-to-basin normal faults, such as west-bounding Geleki fault, northwest-bounding Charaideo fault, north-bounding Rudrasagar fault and north-bounding Demulgaon fault, has resulted into the inversion structures.

A younger transverse fault system trending NW-SE and N-S dissects/offsets the longitudinal NE-SW, ENE-WSW trending faults. Strike-slip movements cannot be ruled out in the area.

The majority of the structures of the area are parallel/sub-parallel to the longitudinal faults. The axis /hinges of these structures are offset by the cross faults due to lateral movements along the transverse faults. These criss-cross fault patterns compartmentalize the area into different fault blocks, resulting in development of a number of high and lows.

Two extreme models can be applied to the interpretation of structural style of Assam Arakan basin: one states that the sedimentary cover is detached from the underlying basement along fault planes with ramp-flat geometries (thin-skinned model). The alternative one states that the basement is also involved in the deformation along crustal-scale ramps (thick-skinned tectonic model). Recent work from the seismic data has shown that thick-skinned tectonic interpretations can readily be applied to the shelf part of the Assam Arakan basin. A thin-skinned model still fits well for thrust foldbelt in the Naga-Schuppen area. The structural style of the Naga-Schuppen belt can be categorized as a decollement thrust-fold type. The main decollement lies in the coal-shale sequence of Barail (Rangarao & Samanta et.al.,1987.) but for the shelf part it can be basement-involved as well. The Rudrasagar, Demulgaon and Disangmukh structures can be ascribed to as younger splays originating from the westward advancement of Naga thrust.

The integration of all the available data allowed us to trace the interplay between thin and thick skinned structural styles in the basin.

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THANK YOU