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Hydrocarbon Potentiality of Northern Part of Jaintia Structure, Sylhet, Bangladesh.

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Abstract: *The northern part of Dupigaon prospect in Jaintia structure is one of the remaining undrilled potential structure and suitable for hydrocarbon entrapment in Surma Basin. The exposed rocks of Dupigaon prospect can be classified from older to younger as Barail sandstone, Bhuban, BokaBil, Tipam sandstone, Girujan clay, DupiTila and Dihing formations in southwards direction. Considering Tripura and Assam states of India, now the exploration targets would be along the nose and flanks of major plunging anticlines where prospect area is segmented by some transverse faults. Geology of Fenchuganj gas field is similar to that of other fields situated in Surma Basin and reservoirs are covered with Miocene sediments. In Dupigaon prospect the source rock is probably Oligocene to Early Miocene Renji, Jenum Shale and Bhuban formation, reservoir rock is Middle Miocene to Late Miocene Bhuban & Bokabil sand formation, structural trap may be fold, fault bounded anticlines. Upper Marine Shale is clearly recognized from contour map and supposed to be a regional vertical seal in this area. Intra-formational seals are also recognized from Fenchuganj well data. From the surface geological map & subsurface contour map, the best possible prospects for Dupigaon area might be against transverse faults.*

Keywords- *Dupigaon prospect, Hydrocarbon entrapment, Jaintia structure, Surma Basin, ,Transverse fault.*

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I. Introduction

Dupigaon prospect in Jaintia structure is located on the north-eastern part of Bangladesh in Block 13. It is located between 25^0-$00^/$ to 25^0-$12^/$ north latitude and from 92^0-$03^/$ to 92^0-$14^/$ east longitude of Jaintiapur in Sylhet district. Jaintiapur and its adjacent areas lie in between two contrasting structural set-ups, the uplifting Shillong Plateau in the north and subsiding Sylhet trough (Surma Basin) in the south (Khan et al., 2006). It is surrounded by different gas fields with Miocene reservoirs such as Sylhet, Kailashtila, Fenchuganj in the south, Chhatak in the west and Zakiganj in the east. Previously many works have been done in Surma Basin by use of seismic and well data but hydrocarbon potentiality of this area is not identified yet. The surface geology has been accorded with the subsurface two way time contour map of Dupigaon prospect. The present study mainly focused on structural analysis, correlation of seismic lines with Fenchuganj gas sand distribution and petroleum potential analysis over Sylhet Basin. The objectives of this study are to reveal sub-surface geology of this region and delineation of possible hydrocarbon traps or prospects. 2D seismic lines are covered by Dupigaon prospect in Jaintia structure (Fig 1).

II. Materials and methods

The geological, geophysical and well data used in this paper were collected from some local and International publications. The main target of this study was to decipher the surface geology, subsurface structural configuration and tectonics of the Jaintiapur structure using this data. In order to construct subsurface structural map and to interpret subsurface geologic features, Prakla-Seismos (Petrobangla) carried out 12 fold seismic reflection survey over the Sylhet Basin in 1980. During this survey period, some regional lines were also acquired in this target area. Fenchuganj well data analysis and tie with seismic lines give us useful information about selection of seismic horizons. The structural interpretation of study area has been made by well defined seismic reflectors. Two way reflection times were used to construct time maps. (Banu et al., 2000).
The conversion from velocity to density has been done using the relationship
$\rho=0.31v^{0.25}$
Where, ρ is density in g/cm3.
v is velocity in m/sec (Hossain, 2000).

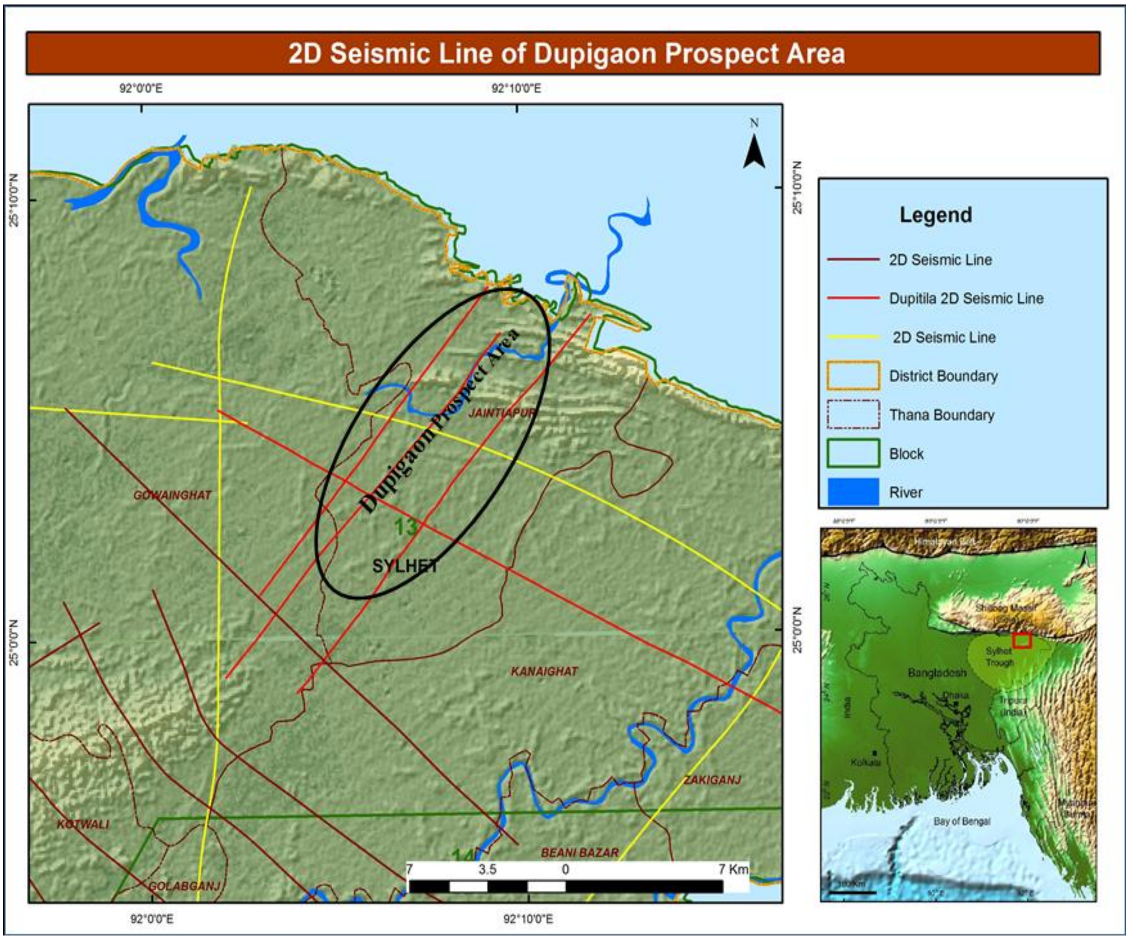

Fig 1. 2D seismic line coverage map of Dupigaon prospect (Baqi et al. 1985).

III. Geologic Overview

Dupigaon prospect lies in a tectonically complex province and is controlled by a very complex fault system, popularly known as the Dauki Fault System (Evans, 1964). It offers excellent topographic features controlled by the structural phenomena and has the maximum number of formations of Tertiary and Quaternary age exposed in Bangladesh. The main rivers of this region are the Sari and the Goyain.

Dupigaon is positioned in the north-eastern fold belt which is the most prolific natural gas province and has been the center of exploration activities in Bangladesh. The basin is bounded on the north by the Shillong Massif, east and south-east by the Chittagong-Tripura fold belt of the Indo-Burman ranges and west by the Indian Shield Platform (Fig 2). Also known as frontal fold belt, this province represents the western and outermost part of the Indo-Burman origin. The fold belt shows sign of diminishing intensity of structures towards the west in which direction it gradually fade away and merge with the central foredeep province (Fig 3) (Alam et al, 2003). The area has been subjected to additional forces from the north and south-east. The north to south stress placed on the Shillong massif following the collision of Indian plate and the Eurassian plate has resulted in reversal of the direction of movement along the Dauki fault. This has resulted in upliftment of Shillong massif and subsidence of the Surma Basin.

This area forms a narrow east-west elongated strip and is characterized by low rounded hillocks with numerous gullies, spurs, cliffs and scarps (Khan et al., 2006). Tectonically, the whole area has been divided into three zones: zone i -The area between Dauki river in the west and Naljuri bazar in the east, zone ii - The area between Naljuri and Assam para in the east, and zone iii - The area between Jaintiapur in the west and Sari river in the east including Dupigaon (Fig 4).

The effect of displacement of anticlinal axis from Sylhet gas field may result into compartmentalizing the structure which in turn may control entrapment of hydrocarbon along anticline axis (Fig 5).

Dupigaon surface geology & subsurface contour maps show high relief, tighter folds with faults structure (Fig 7, 8). Folding and faulting represents intense tectonic deformation in the area. Structure appears suitable for hydrocarbon entrapment. Earlier drilling in Chhatak, Sylhet, Jalalabad, Fenchuganj structure have already discovered commercial hydrocarbon. In Tripura and Assam states of India, different play types already explored and have been drilled many wells along the crest, nose, syncline, flank etc., Considering hydrocarbon exploration in this region, including Tripura & Assam area of India, the exploration targets would be along the nose and flank of major plunging anticlines where the reservoirs may be segmented by some transverse faults. From Fig 7, it may be indicated that normally the structural trend of this area is along NE direction but in Dupigaon it is slightly shifted to NW from Sylhet gas field. Shari Goyain and other rivers are flowing in the direction of transverse faults. Possibly transverse faults are passed along the rivers and the reservoirs may be segmented by transverse faults. In such a case, there are good chances for trapping of hydrocarbon (Fig 7).

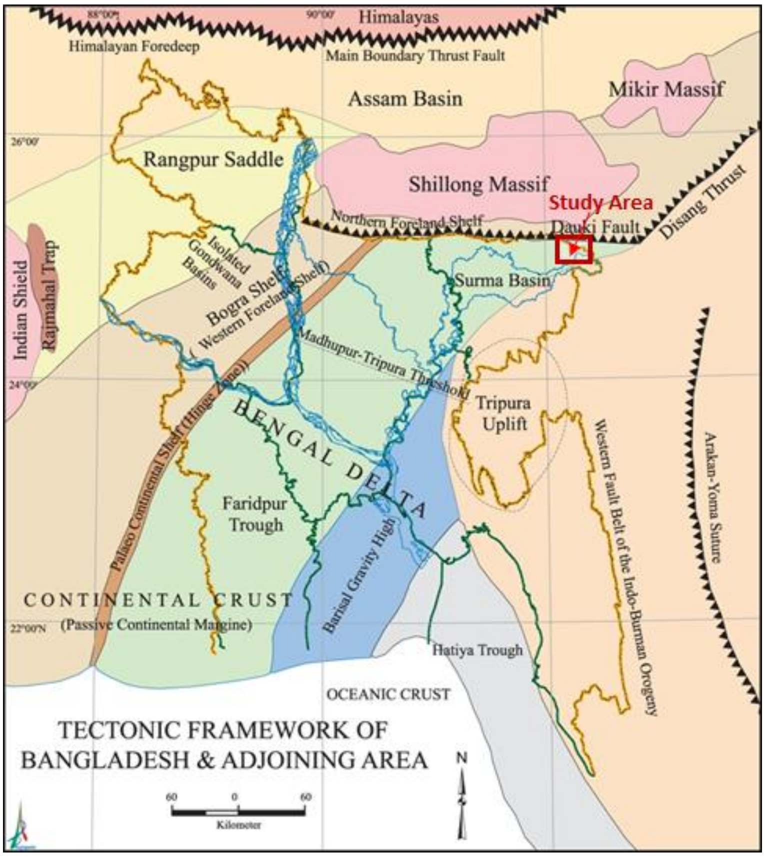

Fig 2. Tectonic Map of Bangladesh (Source: Google Map).

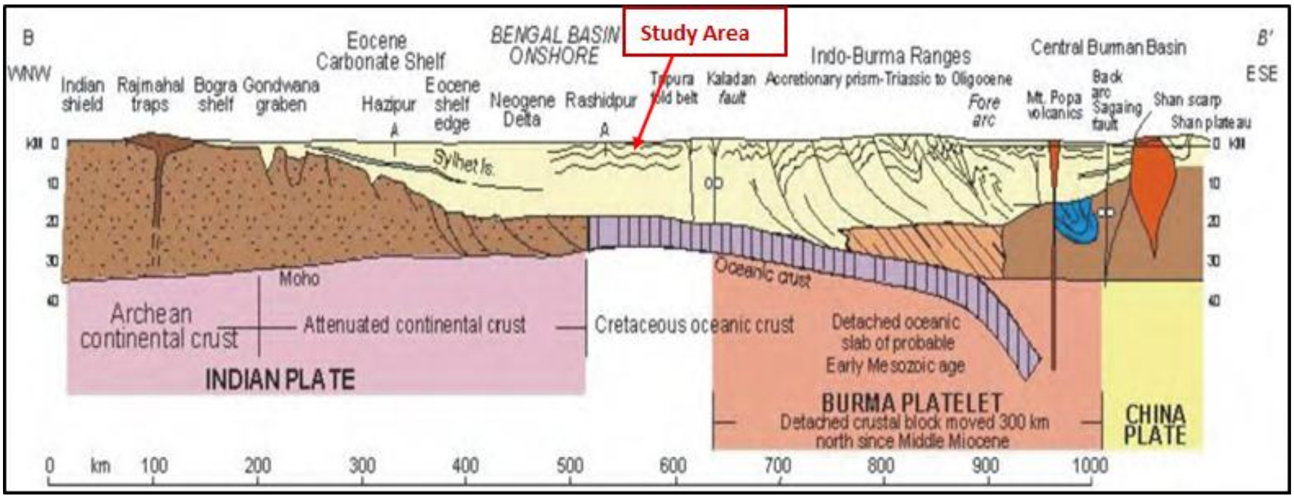

Fig 3. Scematic west-east cross section showing major tectonic province and sedimentary units in Bangladesh. The Bengal Basin evolved into a major depocentre after the late Eocene-Oligocene when the Northward-drifting Indian plate collided with thne Eurasian plate resulting in the initial uplift of the Himalayas (Petrobangla, 2000).

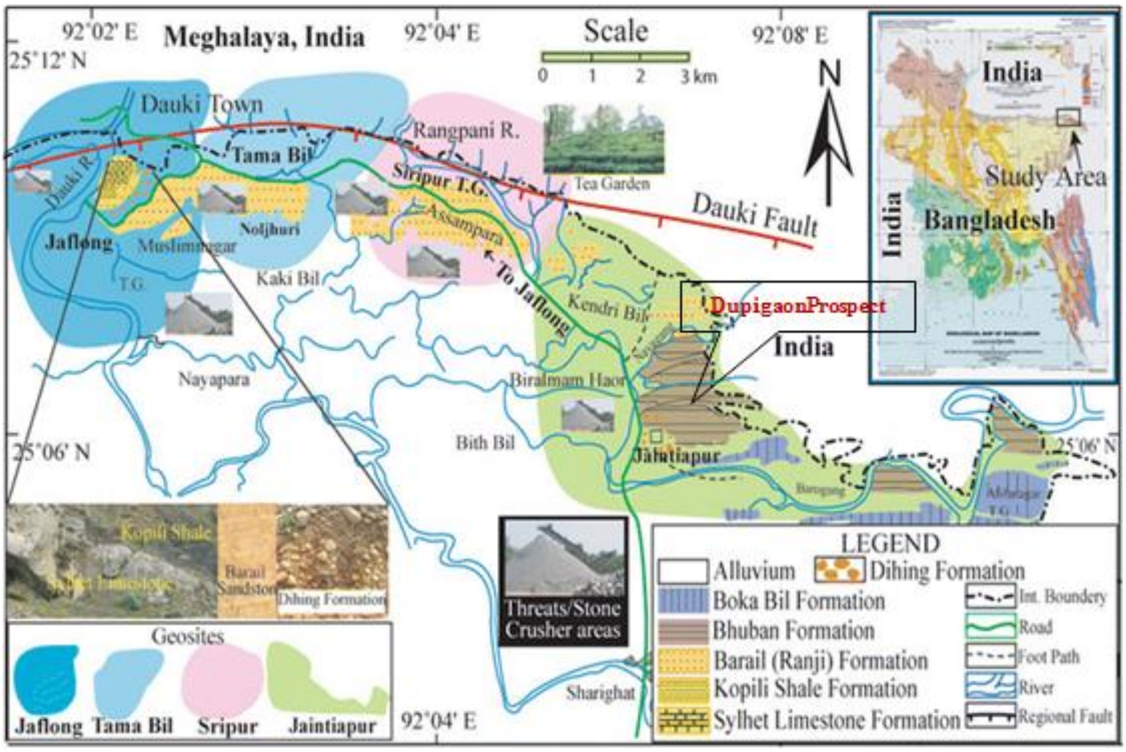

Fig 4. Exposed formation of Dupigaon and its surrounding area in Jaintiapur (Source: Google Map).

Fig 5. Structural orientation of Sylhet and its surrounding area (Source: Google Earth).

The Dupigaon area covers nearly all the Tertiary sediments in Bangladesh and is exposed as southward dipping strata, south of the Dauki fault system (Johnson & Alam, 1991, Worm et al., 1998 and Biswas., 2005). This huge thickness of sediment is a result of tectonic mobility or instability causing rapid subsidence and deposition in a relatively short geological time.

The stratigraphy of this area is related to the stratigraphy of the Surma basin and is based on lithological correlation with rocks in the Assam oil fields. The area exposes nearly all Tertiary stratigraphic units of the Surma Basin (Fig 6). The stratigraphic succession of Fenchuganj gas field is based on geological, seismic and well data. Stratigraphic succession with a brief lithological description of Fenchuganj gas field is given in Table 1. It should be noted that the best reservoirs have been found in the Miocene sediments, mainly composed of alternating grey to dark grey clay, very fine to medium grained sandstones (Islam et al, 2014). Based on drilling results from Fenchuganj well the Dupigaon is composed of alternating clay, sandstone and shale beds and deposited in the fluvial, delta plains to delta front to inner delta environment.

Table1: Lithostratigraphic succession of Fenchuganj Gas Field (Islam et al, 2014).

Age	Formation	Depth(m)	Thickness(m)	Lithology
Recent	Alluvium	0-30	30	Unconsolidated sand, silt and clay
Late Pliocene	DupiTila	30-298	268	Mostly sandstone and minor clay
Middle Pliocene	Tipam	298-1150	85	Sandstones are light to off white, medium, ferruginous, poorly consolidated and composed of mainly quartz with few mica & dark color minerals
Miocene	Upper Bokabil	1150-1466	316	Grey to bluish grey shale, soft to moderately hard and compact and also laminated
	Middle Bokabil	1466-1766	300	Sandstone and shale alteration
	Lower Bokabil	1766-2236	470	Mostly shale with minor sandstone
Early Miocene	Upper Bhuban	2236-down to 4977	914-2741(Vary)	Alteration of Sandstone and shale with minor calcareous siltstone

Jaintiapur and adjoining areas are very important in stratigraphic context as the area exposes nearly all the Tertiary stratigraphic units of geosynclinals facies of Bengal Basin (Fig 6). Geomorphological investigations suggest that the gravel beds were deposited by the flash water derived from the rising Shillong Plateau and deposited as alluvial fans on paleo drainage systems of the area. As the study area is relatively small, the climatic influence on sedimentation might be homogenous; but the local tectonics might have played the key role in depositing the gravel beds with different thickness. Dauki fault has changed its directions just in the east of Sripur Tea Garden. The fault bounded on SE from EW which indicated a change of fault kineamatics in the area (Khan et al., 2006). On the basis of gross lithology, sedimentary structures and petrographic characteristics, the exposed rocks of Jaintiapur and adjoining areas can be classified into nine litho-stratigraphic units, e.g., limestone unit, greyish-black shale unit, pinkish sandstone unit, silty shale unit, sandy shale unit, yellowish sandstone unit, mottled clay unit, loose yellowish sandstone unit, gravels with silty and sandy matrix unit, which are equivalent to Sylhet Limestone formation, Kopili Shale, Renji formation (Barail Sandstone), Bhuban formation, Bokabil formation, Tipam formation, Girujan clay formation, DupiTila formation and Dihing formation respectively (Khanam, F., 2017).

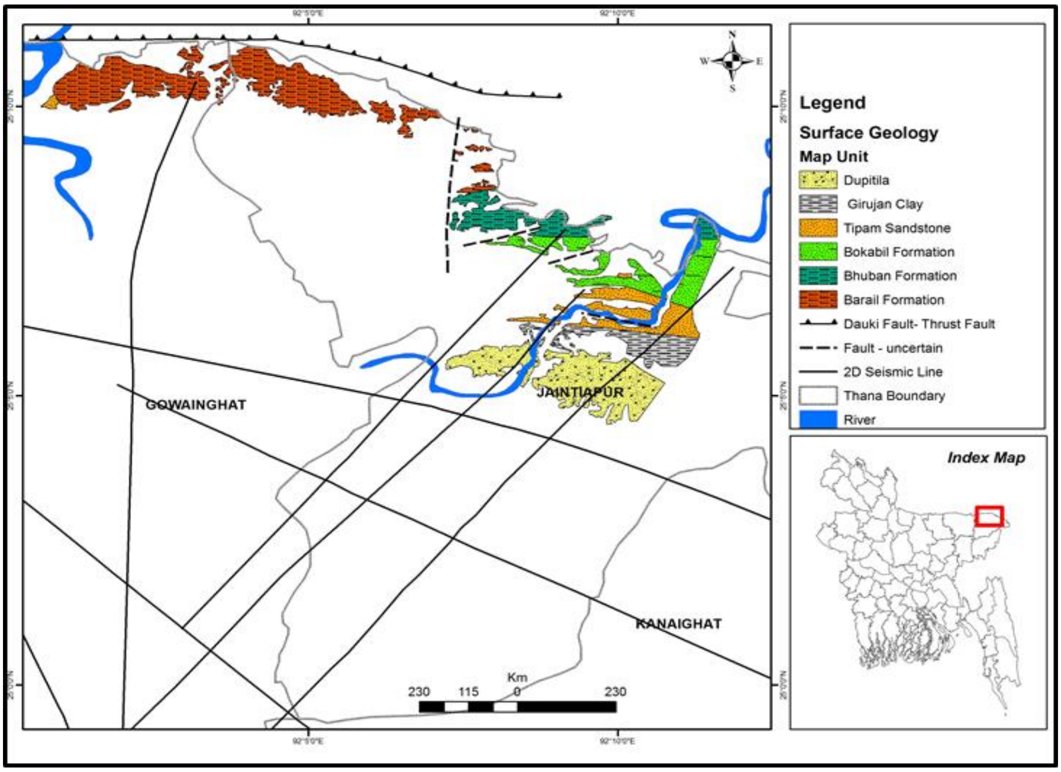

Fig 6. Surface Geology Map of Dupigaon Prospect (Source: Khan et al. 2006).

IV. Prospect Analysis

Hydrocarbon generation and accumulations depend on four elements; a source rock, migration path, a reservoir rock and a trapping mechanism/seal. In Dupigaon and Fenchuganj structure, the source rock is probably Oligocene to Early Miocene Renji and Jenum shale, Bhuban formation. The probable reservoir rock in the prospect area is Middle Miocene to Late Miocene Bhuban and Bokabil formation (Imam, B., 2013). These formations have good to excellent reservoir quality. From the Google surface map (Fig 7) and subsurface contour map (Fig 8), it may be noticed that the structural trend of this area is along NE direction and prospects are segmented by transverse faults. In such a case, there are good chances for trapping of hydrocarbon. On figure 9, it is observed that all traps are mostly structural and anticlinal to fault bounded in Surma Basin. The Upper Marine Shale is clearly recognized from contour map and supposed to be a regional vertical seal in the Dupigaon and Sylhet area. Intra-formational seals are also recognized from Fenchuganj well data.

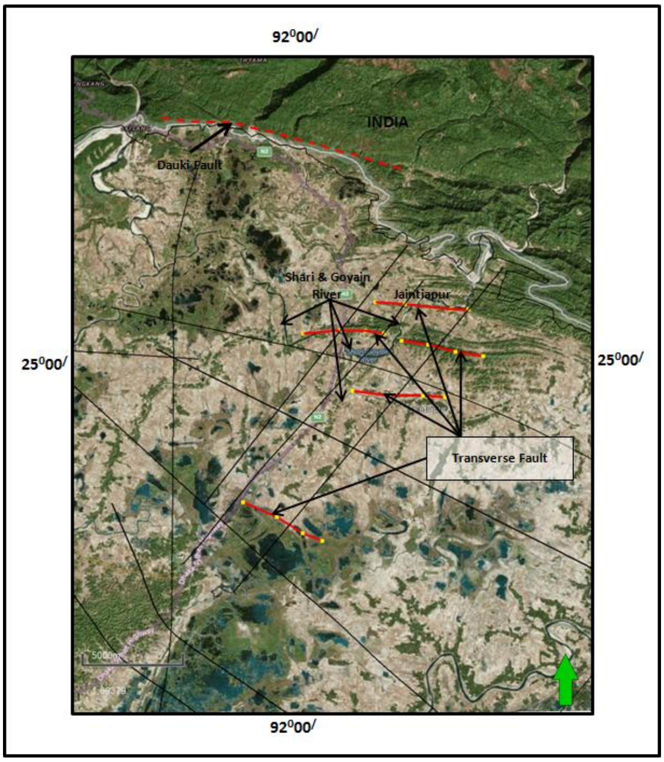

Fig 7. Surface Geology Map of Dupigaon Prospect (Source: Google Earth).

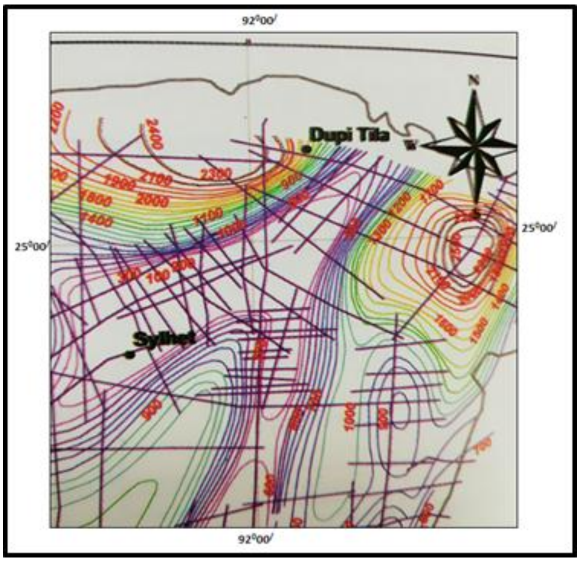

Fig 8. Sub Surface Contour Map of Upper Marine shale in Dupigaon Prospect (Source: Assmann et al. 1983, Baqi et al. 1985 and Biswas et al., 2005).

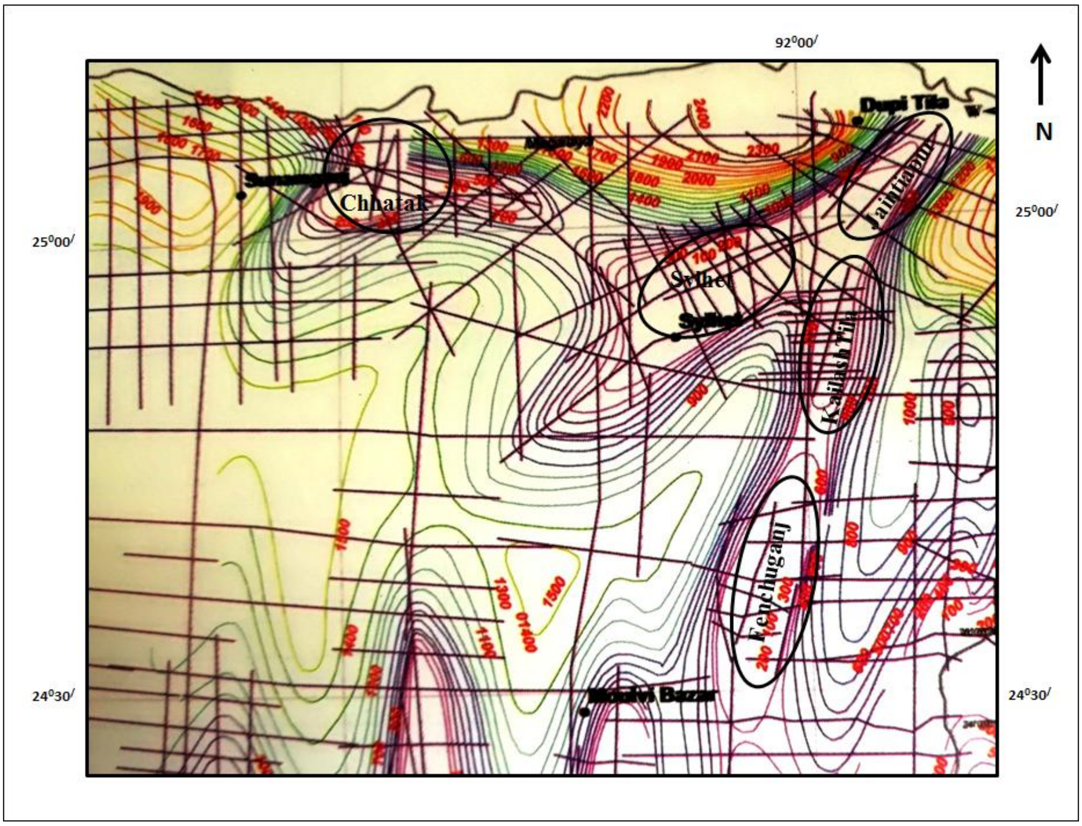

Fig 9. Two way time contour map for Upper Marine Shale in Sylhet Basin (i,e. Top Bokabil Formation; modified from the data Assmann et al. 1983, Baqi et al. 1985 and Biswas et al., 2005). The available seismic grid has been overlain on the time contours in order to mark the density of seismic investigation in Basin.

V. Conclusion

The main stratigraphic sequences observed in Fenchuganj wells can be correlated to the Dupigaon prospect area confirming that both areas share the same basic geology. It can therefore be inferred that the formation of NE to SW Dupigaon and surface geology with sub surface contour maps indicates the possibility of gas/oil in the equivalent sedimentary sequence, since Dupigaon area being more closer and down dip towards the kitchen area both in the east and west. The best possible trapping areas might be against transverse faults which indicate good chance to trap hydrocarbon. The Upper Marine Shale is recognized from contour map and supposed to be a regional vertical seal in the Dupigaon prospect and Sylhet Basin. From overall interpretation, Dupigaon anticline displays multiple prospects separated by transverse faults. Further improvement could be achieved by generating AVO, 3D seismic and well data and other factors of petroleum system (e.g. reservoir property, seal capacity, fluid substitution model) review in more detail with referring near field property.

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