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Sand unit classification and Hydrocarbon potential of Kopili as emerging Play in Lakwa area of upper Assam North shelf

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Abstract

The Kopili Formation forms the topmost part of the Eocene Sequence of Upper Assam North Shelf. This formation is characterized by alternating bands of argillaceous and arenaceous sediments. Kopili Formation was named by Evans (1932) and the Kopili – Khorungma area has been considered as the type section where it attains a thickness of about 500 meters. This formation is best developed in the south eastern part of the Shillong Plateau i.e., Jawai – Badarpur road section in the Jaintia Hills and in the North Cachar Hills (bhuyan.D 2016). The Kopili is defined to contain a shale dominated section occupying a position between the underlying Sylhet Formation and the overlying sand dominated Barail Group (Deshpande et.al. 1993). These rocks are found to occur extensively in the subsurface of Upper Assam Shelf. Based on the faunal content, Kopili Formation has been assigned late part of Middle Eocene to Late Eocene age in most of the areas of the Shelf. Paleogeography during Kopili Sedimentary sequences was associated with a stable to mild unstable shelf littoral to sub-littoral environment deposited during a broad transgressive set up. Rao (1983) also viewed the deposition of Kopili in a brackish water tidal flat environment and doubted if any delta began to form in Eocene time. Hydrocarbon potential of Kopili has been well established in Geleki area wherein number of pay sands has been established. However, full potential of Kopili play is yet to be realized in upper Assam Shelf. The Kopili pay sands in Geleki are established whereas in Lakwa area yet to be establish. Log character seems to be promising and good reservoir facies development in middle and upper kopili of Lakwa area is evident. Sand model also gave strength for future exploration for Kopili sands in this area.

Introduction:

In Lakwa area, in 1986 we struck oil in deeper prospect i.e. Tura play after as follow of that a total of 12 wells have been drilled in Lakwa area for Tura play, out of which three are oil bearing and one well gave oil indication. First time in Lakwa area one of the recently drilled wells produced oil from Kopili formation which opened the Lakwa area for future exploration for Kopili play. The hydrocarbon plays which have been established in upper Assam north shelf are Tipams, Barails, Kopili, Tura, Sylhet and Girujan. In Lakwa area, Tipam and Barails are the most prolific producers and Tipam has reached at matured state of exploration.

Hydrocarbon potential of Kopili has been well established in Geleki area wherein number of pay sands has been established. However, full potential of Kopili play is yet to be realized in upper Assam Shelf. Recent success in one of the well in Lakwa field had once again brought Kopili play in the focus. The corresponding log signatures and identified pay sands in Geleki wells and Lakwa-well is clearly evident. The wells though 29 Km apart are located in regional depositional strike trend during Kopili sedimentation. The drilled well in Lakwa area show encouraging electrolog characters and good reservoir facies development in Kopili section. The ELAN processed results of has also been found to be interesting from hydrocarbon point of view as Kopili pay sands-I & II equivalent intervals have been interpreted to be hydrocarbon bearing.

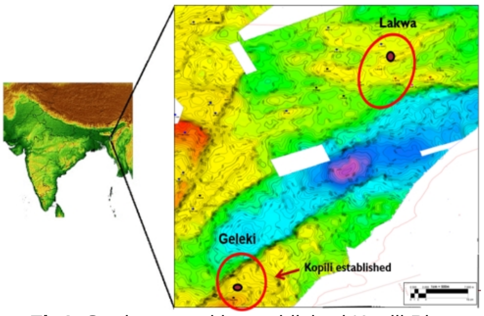

Fig1: Study area with established Kopili Play

Geology and tectonic setting of the area: Assam & Assam Arakan Basin is bounded by the Eastern Himalayan fold belt in the North, the Mishmi hills in the North East and the Patkai – Arakan fold belt in the East. It is a typical poly-history basin having more than one phase of tectonics and sedimentation. The evolution of the basin is essentially influenced by the Northward movement of the Indian plate towards the Eurasian and Burmese plates. In the Assam Basin, extensional tectonics prevailed till Mid-Miocene when the tectonic regime changed to compressional environment during the major phase of Himalayan orogeny. This resulted in reactivation along faults, resulting in reverse faults and inverted structures. The oldest fault trend in the area is NE-SW transacted by the younger E-W to NW-SE trend creating a number of fault blocks.

Stratigraphy: In the North Assam Shelf, Tura Formation overlies basement and forms base of Paleogene rocks, followed by Sylhet, Kopili and Barail formations. Tura Formation consisting of alternations of sandstone and shale were deposited during Palaeocene – Early Eocene Period where sedimentation in the Assam Shelf took place in a passive margin setup. End of Tura sedimentation, witnessed a widespread transgression during which carbonate dominated Sylhet Formation and marine pro-delta Kopili Formation were deposited. This in turn is overlain by delta front sandstone of Demulgaon Formation (BMS), which is again succeeded by delta plain interbedded shale and sandstone with thin layers of coal of Rudrasagar Formation (BCS). These delta plain BCS deposits are unconformably overlain by a thick sequence of high energy (braided) fluvial sandstone of Tipam Group. The Tipam Group is unconformably overlain by Namsang Formation of Plio-Pleistocene age.

Depositional environment of Kopili: The end of Tura deposition witnessed a wide spread transgression during Middle Eocene resulting in deposition of carbonates (Sylhet). The depositional regime during Kopili sedimentation relates to prodelta (Lower Kopili sequence) to Delta front sequences (middle Kopili Unit). The sand characteristics have supported tidal influence as well.

Marine shales of Kopili are proven source rocks in the study area. These are mainly characterized by terrestrial type-III kerogen, with some contribution of type-II kerogen. The migration of hydrocarbon is primarily up dip to the northwest with vertical migration occurring through reactivated faults associated with the plate collision.

Most of the wells penetrated Kopili in Lakwa area have hydrocarbon shows while drilling but, this play is yet to be established in this area. The drilled well data suggests that the area on either side of the ENE-WSW trending cross trend is prospective for Tura and Kopili exploration. Wells log correlation shows that sand units are been developed within shale packs of upper and middle Kopili.

The earlier studies by various authors have suggested that broad environmental setting was that of a vast, shallow water sea floor which was slowly changing from a carbonate platform to a relatively muddy deeper water during a period of relative sea level rise. The flat coastal gradient of the stable Assam passive margin, a relative sea level rise and a reduced clastic supply from the mature cratonic source (Indian shield) were probably the favourable factors for the growth of a long and voluminous estuary during the entire sedimentation. Paleogeograpy during Kopili Sedimentary sequences was associated with a stable to mild unstable shelf littoral to sub-littoral environment deposited during a broad transgressive set up Mohan and Pandey (1973),. Rao (1983) also viewed the deposition of Kopili in a brackish water tidal flat environment and doubted if any delta began to form in Eocene time. The model leads support to the views expressed by previous workers which is validated from drilled well data.

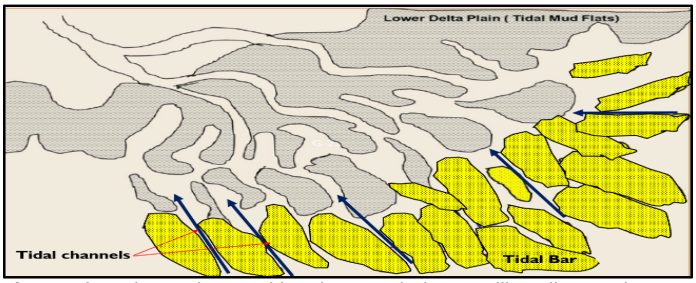

Fig-2: Inferred Broad Depositional Setup during Kopili Sedimentation

Work Flow: The exploration for Kopili is an emerging Play in upper Assam Shelf. So far, success in Kopili was mainly restricted to the Geleki fields where a number of wells have been drilled and total 12 units of Kopili pay sands have been identified. However, in the Lakwa area, one of the recently drilled well has produced oil from Kopili sands. The structural attitude in Lakwa area is demonstrated by number of normal south hading faults Fig-3. The structure thus presents opportunity to probe the potential of Kopili in the fault blocks of Lakwa field. The possibility of entrapment at Kopili pay level also enhances on account of low sand to shale ratio which can be inferred from well log of the drilled well. The Kopili accumulation in hanging wall has already been proved through recently drilled well.

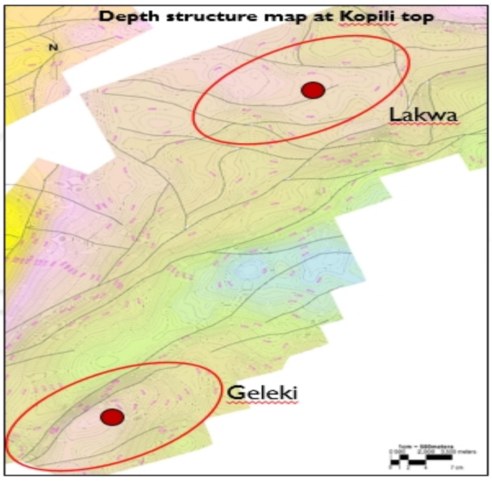

Fig-3: Depth Structure Map at Kopili Top

In the present study Log correlated in two profiles, tracked the Kopili horizon and generated the depth structure map at the top of Kopili formation and prepared the Sand model. Correlated the Geleki sand units with Lakwa sand units by well log correlation. In Geleki area 12 sand units (KSU-1 to KSU-12) are distributed into middle and upper Kopili. Lower Kopili don't have sand units, and is marked by Limestone Streak in both Lakwa and Geleki area. In middle Kopili KSU-12 to KSU-8 sand unit are present whereas upper Kopili KSU-6 to KSU-1 are present. Kopili in Lakwa field is also divided into Lower, middle and upper part, which contains LKS-I to LKS-VII sand units. LKS-1 to LKS-V present in middle Kopili whereas LKS-VI and LKS-VII present in upper Kopili. In Lakwa major seven sand units are developed whereas in Geleki twelve sand packs are present.

The corresponding log signatures and identified pay sands in G-1 and Lakwa-4 are shown in (Fig-4).

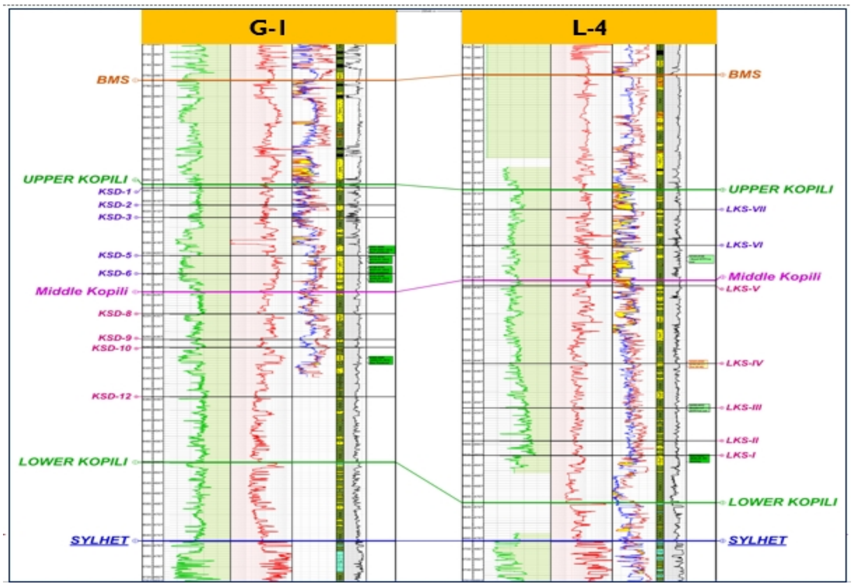

Fig-4: Structural Log correlation of Geleki and Lakwa well showing sand unit classification.

Geleki	Lakwa
Upper Kopili	
KSU-1	LKS-VII
KSU-2	
KSU-3	
KSU-4	LKS-VI
KSU-5	
KSU-6	
Middle Kopili	
KSU-8	LKS-V
KSU-9	LKS-IV
KSU-10	LKS-III
KSU-11	LKS-II
KSU-12	LKS-I
Lower Kopili	

Fig-5: Kopili Sand unit Classification

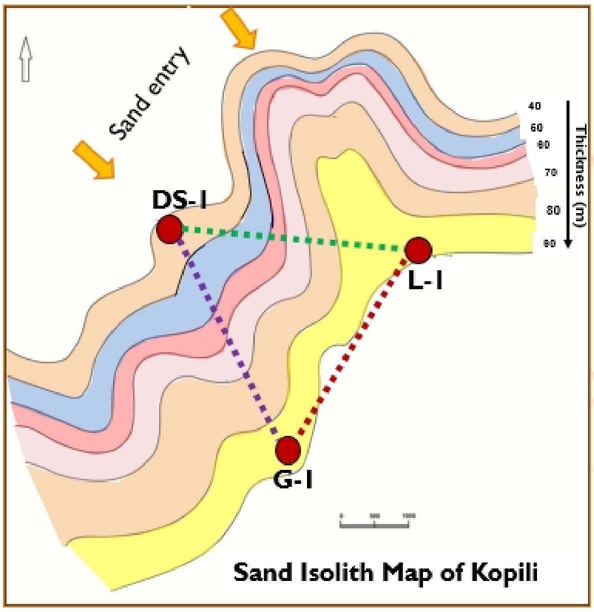

Fig-6: Sand Isolith Map of Kopili formation

The sand units in both the field is tabulated in (Fig-5). Sand isolith maps (Fig-6) indicates minimum of 30m to more than 120m of sand is present in the wells drilled, which suggests that the drilled wells are within prograding delta front area and the prodelta facies lies further South East, probably in Schuppen Belt. The depositional regime during Kopili sedimentation relates to prodelta (Lower Kopili sequence) to Delta front sequences (middle Kopili Unit). The sand characteristics and lab studies (KDMIPE, Dehradun) have supported tidal influence as well. The inferred depositional model seen in Fig-2 is associated with sand isolith map given in Fig.6 would place the major part of G-1 and L-4 in strike trend with Geleki and Lakwa area falls in Tidal bars depositional environment. The representative sequences are shown in Geleki as well as in Lakwa area suggest that Kopili middle and upper part deposit in tidal influence area. The sand model shows that influx of the sediment is from north western side and increases towards south eastern part which is validating from well G-1 & L-4. The Well though are 29 Km apart are located in regional depositional strike trend during Kopili sedimentation.

In NE-SW Log correlation from Disangmukh to Lakwa area shows that the thickness of middle and upper Kopili increases i.e. from DS-1 to L-1, Similarly in other log correlation from Disangmukh to Geleki also shows increase of middle and upper Kopili thickness i.e. from DS-1 to G-1 (Fig-6). Geleki, the upper and middle Kopili sand are hydrocarbon charged and from the recently drilled well in Lakwa area produced hydrocarbon from middle Kopili sand. Lower Kopili in both, Geleki and Lakwa are devoid of hydrocarbon charged sands units.

During drilling, good GYF and positive cut was observed in the cutting samples of Tura, Sylhet and Kopili Formations from the wells of Lakwa area. Few wells are tested in Kopili formation in Lakwa area which produced little Oil with little gas. In the recently drilled wells in Lakwa area in one well hydrocarbon shows were encountered during drilling from Basement, Tura, Sylhet and Kopili. One more well has produced oil from LKS-II sand and the other sand LKS-I is also interpreted to be HC bearing. This well open Lakwa area to explore Kopili play.

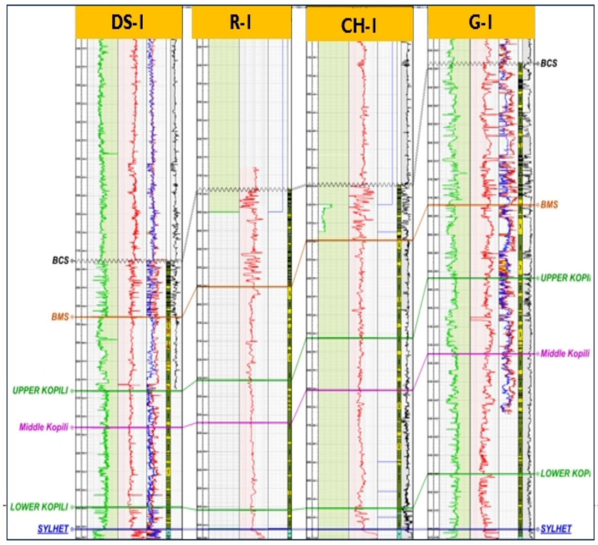

Fig-7: Log correlation in NW-SE direction

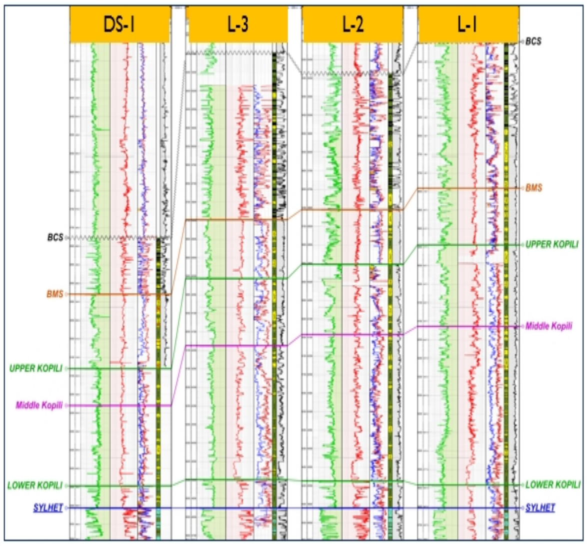

Fig-8: Log correlation in NW-SE direction

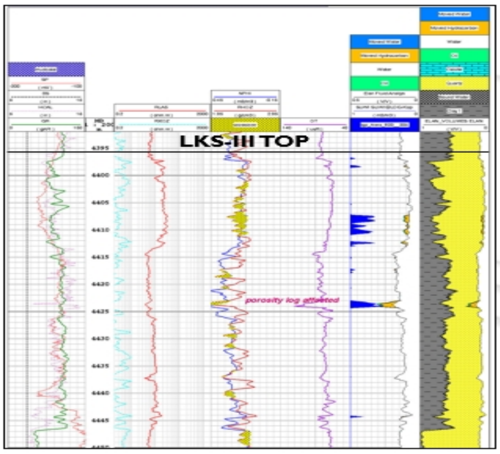

Fig-7: ELAN process Log of drilled well

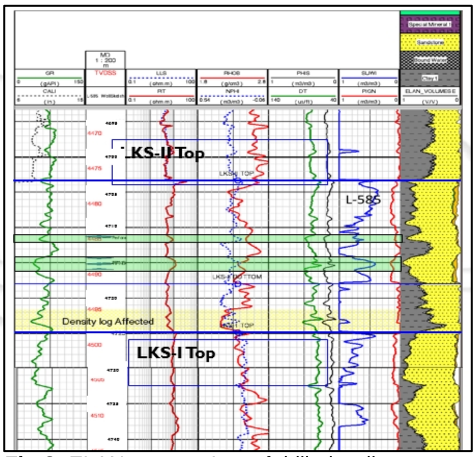

Fig-8: ELAN process Log of drilled well

ELAN processed log of the two wells of Lakwa shows hydrocarbon bearing. ELAN of one well in Fig-7 shows good reservoir facies in LKS-III and promising log character from hydrocarbon point of view, whereas in other well the highlited zone on the ELAN process log in Fig-8 was tested and produced oil from LKS-IIand one zone in LKS-I was kept for testing in future on the merit of the log.

Log characters are promising in the wells penetrated upto kopili and seems to be promising and good reservoir facies development in middle and upper kopili of Lakwa area. Though a number of hydrocarbon shows were encountered in most of the wells in Lakwa area, this play is yet to be established in this area. Log data and drill cutting data suggest that Kopili play is prospective for future exploration in Lakwa area.

Conclusion: The Kopili Formation consists of alternations of sands and shale and sand thickness varies from 140m to more than 200m thick sands within Kopili in the drilled area of upper Assam north Shelf. The Kopili formation is divided into three units: Lower, Middle and Upper with distinct sand units in middle and upper Kopili. The Lower unit is dominantly shaly with occasional limestone streak which demarcates it from the above Middle unit which is comparatively more argillaceous with alterations of thin sand beds. The Upper unit is also argillaceous with thick alterations of sand bodies. These shale exhibits tidal flat bedding which comprises of sand bodies with good reservoir facies for Hydrocarbon accumulation. In view of the recent success in two wells in Lakwa area gave boost to the exploration of Kopili Play and emerging as a new play in Lakwa area. Regional correlation the corelatable sand units in Geleki and Lakwa area Fig-9.Geological cross section shows structural disposition from NE-SW direction (Fig-10).

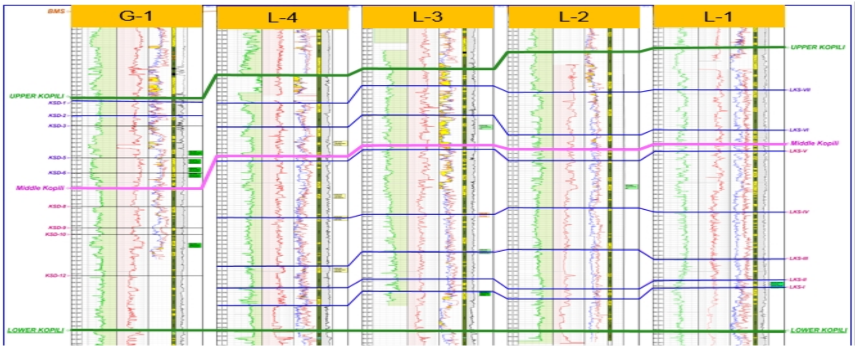

Fig-9: Log Correlation of wells of Geleki and Lakwa field (Flattened at Lower Kopili)

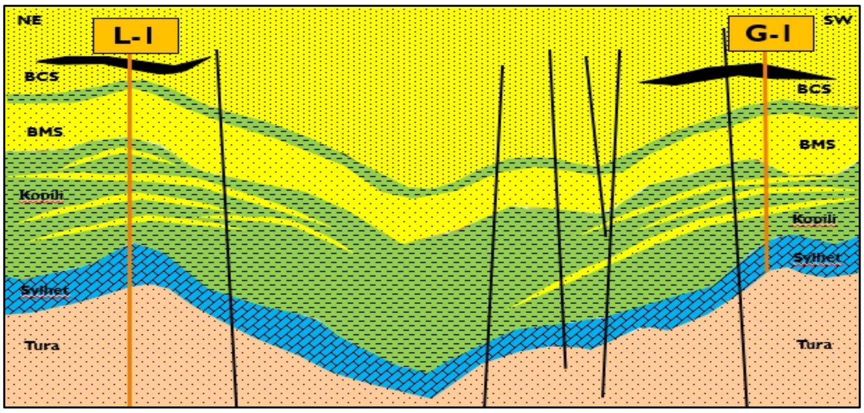

Fig-10: Geological cross section showing structural disposition along NE-SE direction

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