



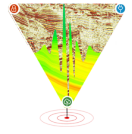
Comprehensive Geological Model of Raghavapuram Play in KG Onland Extension
 environment and facies distribution in a sequence stratigraphic framework

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Summary:

Raghavapuram Shale of Aptian-Turonian age represents a 2nd order sequence which is further subdivided into a transgressive systems tract (TST) representing the Aptian-Albian high gamma-high resistivity (HGHR) Lower Raghavapuram and overlain by highstand systems tract (HST) of Cenomanian-Turonian low gamma-low resistivity (LGLR) Upper Raghavapuram Members. The Lower Raghavapuram has been further sub-divided into 3rd orders TST-HST-TST followed by Upper Raghavapuram into 3rd order HST-TST-HST. A comprehensive geological model is thus attempted by superimposition of depositional facies over paleogeographic maps at 4 levels (Aptian-Albian for Lower and Cenomanian-Turonian for Upper Raghavapuram) in a sequence stratigraphic framework. During Aptian, initially marine transgressions due to breakup of Elan Bank from India led to basal TST-I with prevalence of isolated, restricted marine, anoxic and lagoonal environment. This is followed by middle HST in which coarser clastics were delivered from basin margin (W or NW side) by fluvial processes over innershelf-intertidal sandflat/tidal channels and mixed siliciclastic-carbonate deposition (Kaikalur high). Upper part of Lower Raghavapuram (Albian) indicates further transgression with inundation of horsts (TST-II). In Upper Raghavapuram, initially during Early Cenomanian, increase in sedimentation rate has resulted HST-I with coarser clastics towards western margin. In Late Cenomanian, SE tilting of the basin led to basin-wide transgression (TST). Paleogeographic map at Upper Raghavapuram top (Turonian) depicts seaward shift of paleoshoreline indicating progradation of delta/slope fan (HST-II). The comprehensive depositional model through integrated sedimentological, log signature and other G&G data coupled with high resolution sequence stratigraphic studies will help to identify better reservoir within 3rd order HST and extent of short-term T-R cycles.

Introduction:

The Early Cretaceous (Aptian-Turonian) Raghavapuram play has now been established in onland Krishna-Godavari (KG) Basin and recent success in Penugonda, Turupu and Vipparu areas has provided encouraging exploration leads. Raghavapuram shale serves as source as well as seal and the reservoirs, occurring in both Lower and Upper Raghavapuram Members, are discrete in nature with limited areal extent and thus hydrocarbon bearing sands often come across rapid depletion. The reservoirs are located to the SE of Tanuku horst and extends up to the Kavitam low, encompassing fields namely, Penugonda, Kavitam etc. In view of this, an attempt has been made build up a comprehensive depositional model in a high resolution sequence stratigraphic framework in KG onland up to Matsyapuri-Palakollu fault (MTP-PLK) (Fig. 1a).

Geological Background and Stratigraphy:

KG Basin, located on the eastern passive margin of India, is a pericratonic poly-history basin having commercial quantity of hydrocarbon occurrences ranging in age from Early Permian through Mesozoic and Cenozoic with outcrops near the basin margin in the north (Fig. 1b). The basin extends between Vizag high in the north and the Ongole cross trend in the south. Further south, there exists two passive margin basins viz. Pennar and

Palar basins with similar evolutionary history. Tectonically, the basin comprising of a number of NE-SW trending horst-grabens, can be divided into three sub-basins, namely the Krishna, West Godavari and East Godavari, separated by the two basement highs, Bapatla and Bhimavaram-Tanuku horsts respectively (Fig. 1b). The West Godavari sub-basin is further separated by the Kaza-Kaikalur horst into Bantumilli and Gudivada grabens. The onland part of East Godavari subbasin has been further differentiated into Kavitam-Mandapeta and Narsapur lows by the Poduru-Draksharama-Yanam ridge in the center and Island and Amalapuram blocks in the south. The major tectonic highs and lows trend extend further southwards into offshore region. The pericratonic nature of the basin has resulted the growth fault dominated Tertiary sediments to the east of curvilinear MTP-PLK fault, which is the easternmost limit of the present study.

The Stratigraphy of KG Basin is characterized by thick sedimentary sequences ranging in age from Permian to Recent. The vast and thick sedimentary succession hosts oil and gas accumulations within different stratigraphic sequences ranging from Permian to Plio-Pleistocene age. The generalized stratigraphy of K-G Basin is given in Fig. 2.

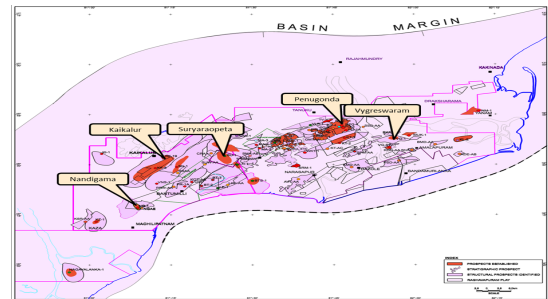


Fig. 1a: Location Map of study area of KG onland

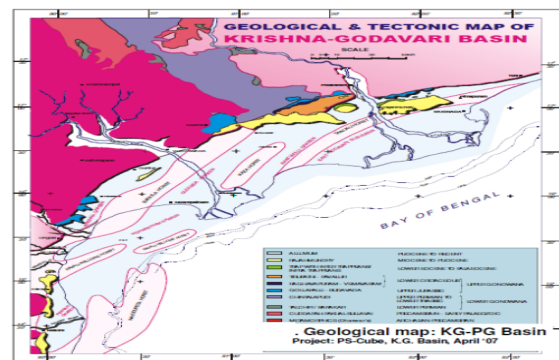


Fig. 1b: Geological map of Krishna-Godavari Basin (Source: Bheemesha et al., 2016)

Materials and Methods:

Cores (30 wells, 48 cores) and cutting samples (20 wells) analysis were carried out for detailed lithofacies characteristics, faunal assemblages and electrolog characteristics to interpret paleoenvironment of deposition. Megascopic, petrographic, XRD and SEM studies have been carried out from cores and

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selected samples to identify and infer facies, microfacies and mineral association, type of matrix/cement, texture and diagenetic imprints. Basic electrolog data (Gamma-Ray, Resistivity, Neutron and Density logs) have been calibrated with lithology and the electrolog motifs were used for identification of lower order units and their correlation.

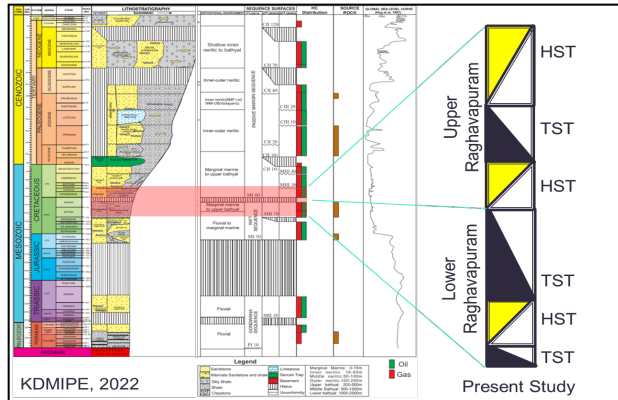


Fig. 2: Generalized stratigraphy of KG Basin (After KDMIPE, 2022) and proposed sequence stratigraphic subdivision of Raghavapuram Shale (Lower and Raghavapuram), KG Onland.

Facies characters of Raghavapuram Shale:

The dominantly argillaceous Raghavapuram Shale overlies the Gollapalli/Nandigama/Kanukollu formations and is exposed at type area near Raghavapuram village, south of Dwarakaturumala of West Godavari District, Andhra Pradesh. It consists of brittle, buff to greyish white coloured clays which are sandy at places. However, the formation is subdivided into Lower and Upper Raghavapuram on the basis of distinctive characters of shale. The sedimentary sequence showing "high gamma-high resistivity" electrologmotif in the lower part of Raghavapuram shale has been known as HGHR Raghavapuram or Lower Raghavapuram deposited during Aptian-Albian age, whereas the Upper Raghavapuram is characterized by low gamma-low or normal resistivity (LGLR) electrologmotif and was deposited in Cenomanian-Turonian age. The Lower Raghavapuram (HGHR) is present in West and East Godavari Sub-basins and is unconformably underlain by Kanukollu Sandstone in West Godavari subbasin and Gollapalli Sandstone in Mandepeta area. The distinct identified lithofacies of Raghavapuram Shale are: dark grey to greenish grey silty shale/claystone; carbonaceous black shale/claystone; grey silty shale; limestone; conglomerate and coarse to granular, massive sandstone; mud-pebble conglomerates with rip-up clasts grading into massive, argillaceous sandstone; massive poorly sorted argillaceous fining-up sandstone; moderate to well sorted, parallel laminated coarsening-up sandstone; slump folded sandstone and sandstone-shale heterolithic facies.

Paleo-depositional environment:

Raghavapuram Shale has been deposited as a result of marine transgression into the NE plunging rift grabens during transitional phase from rift to passive margin. During this time, the paleo-slope reversals from NW to SE has taken place and also northward drifting phase of Indian continent resumed (Manmohan and Rao, 1998; Manmohan et al., 2003). Lower Raghavapuram (HGHR) was deposited under a restricted to shallow marine and lagoonal environment with stagnant water conditions and slow rate of sedimentation, thus show typical high resistivity-high Gamma logmotif attributed to presence of

disseminated micaceous silty sediments in the shale, highly carbonaceous nature of shale and also due to organic matter richness of shale (Manmohan et al., 2003). The provenance; i.e. Archean basement being in close proximity resulted in richness of radioactive elements (Th-K-U). Dark grey and carbonaceous-rich shale indicate deposition in an euxinic, innershelf-intertidal-subtidal environment. The massive sandstone with mud pebble conglomerate indicates debris flows within tidal channels. The conglomerate with coarse to granular massive sandstone and slump folded sandstone indicate deposition on a slope fan or fan delta. Tidal signatures are omnipresent in form of flaser, lenticular and wavy bedding and bidirectional ripple cross-laminations. Coarsening-up, parallel laminated to massive sandstone indicate deposition from tidal bars. Conglomerate-rich facies of channel and fan indicate that the sediments are derived from the pre-existing highs and are very close to the provenance.

Upper Raghavapuram (LGLR), on the other hand, was deposited as a transgressive open marine, innershelf to outershelf conditions and thereby exhibits a low gamma low resistivity logmotif. The open marine conditions may possibly be developed after the final rifting (NE-SW) of Southern Gondwanaland followed by drifting of separated Indian plate, as the drifting was accompanied by southeast tilting of the basin that heralded the open sea conditions (Singh et al., 1993). Beyond MTP-PLK fault, the Upper Raghavapuram and the overlying Tirupati Sandstone merge as single argillaceous unit (Chintalapalli shale), represented by prodelta shale (coeval). Towards western basin margin, sands might have been delivered by proto Godavari River along the continental shelf and deposited as channel and slope fans deposits during regressive phase.

Sequence Stratigraphy:

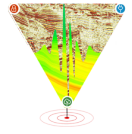
The Raghavapuram Shale belongs to a 2nd order sequence representing a transitional phase from rift to passive margin (Reddy et al., 1998). This 2nd order sequence is divided into a basal TST and an upper HST. These 2nd order TST-HST can be further divided into 3rd order systems tract that are identified and correlated in 29 key wells on the basis of sedimentary facies, logmotif, biostratigraphic data.

Lower Order (3rd order) units within Lower Raghavapuram:

The Lower Raghavapuram is subdivided into TST-I-HST-TST-II units (Fig. 2).

Basal TST (TST-I):

The basal TST corresponds to the lower part of HG-HR Raghavapuram Shale and unconformably overlie the Gollapalli Sandstone (Gudivada graben)/ Nandigama Sandstone (Bantumili graben)/ Kanukollu Sandstone (Kaikalur-Lingala area). The fining-up trend in gamma and resistivity is clear in electrologmotif depicting marine transgressions. This basal TST is cored in wells S-A (CC-3), N-A (CC-1) and KK-B (CC-2), where it is represented by dark grey, carbonaceous shale deposited in subtidal innershelf and lagoonal environment (Fig. 3). The thickness of this TST varies widely, in grabenal part it is maximum represented by dark grey to black carbonaceous shales, while it is considerably reduced over the highs or is completely absent at places. This indicates that the horst-graben nature was maintained after deposition of syn-rift Gollapalli/Nandigama/Kanukollu Sandstone and peneplanation was not achieved completely. This part of Lower Raghavapuram is devoid of any arenaceous unit. The HGHR nature of shale is more pronounced in Gudivada graben and its typical characteristics gradually lost from West to East Godavari



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subbasins. Therefore, it is likely that the marine transgressions might have taken place from south for Gudivada graben bounded by Bapatla Horst (west) and Kaza-Kaikalur horst (East) and from east for East Godavari subbasins.

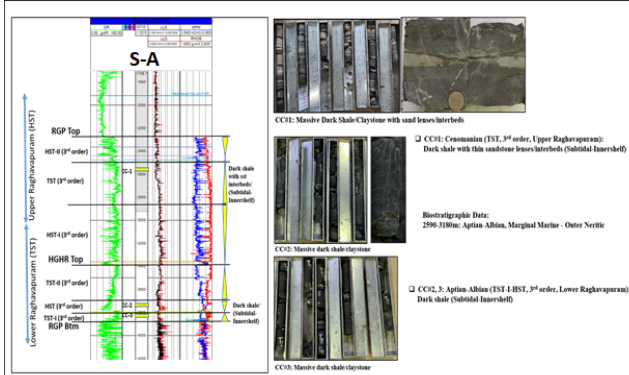


Fig. 3: Identified lower order systems-tract along with paleo-depositional environment of S-A.

Middle HST:

The basal argillaceous unit (TST) is followed by the deposition of highstand limestone and sandstone with shale (Fig. 4), characterized by an abrupt increase in resistivity and decrease in gamma values. Core data are available from these HST in wells NK-A (CC-1), MK-A (CC-2), G-A (CC-3), L-A (CC-3), SL-A (CC-3), WP-A (CC-2), WK-A (CC-1), KK-I (CC-2, 3) and N-A (CC-4) (Fig. 4,5). In NK-A (CC-1), MK-A (CC-2), towards the western basin margin, it represents basin margin channel sandstone. In Kavitam low, SL-A (CC-3) this HST is represented by intertidal (sandflat-mixedflat) and tidal bar, while in WP-A (CC-2), WK-A (CC-1), the core facies represents innershelf-intertidal-tidal channel deposition. In Bantumili graben, N-A (CC-2) and S-A (CC-2), this HST is represented by intertidal (sandflat-mixedflat-mudflat) and further northward into subtidal deposits. This HST is present in wells KK-I, VN-A, KK-J, KK-F, KK-S, KN-A, L-A, LG-I and KK-L. In KK-I (CC-2, 3), mixed clastic-carbonate facies in core shows gradual transition into carbonate ramp over Kaikalur High with gradual decline of sand supply from CC#2 to CC#3. In L-A (CC-3), the core facies represents prograding tidal bar. In G-A (CC-3), coarsening-up log motif along with core facies shows progradation of innershelf-intertidal-tidal bar sequence with slump folded sandstone (Fig. 4). The sandstone and limestones, though developed locally within the HST, form excellent wedge-shaped reservoirs on the fringe of the horst and slope-fans in further deeper bathymetry. These units are expected to be better developed and would be interesting exploratory targets.

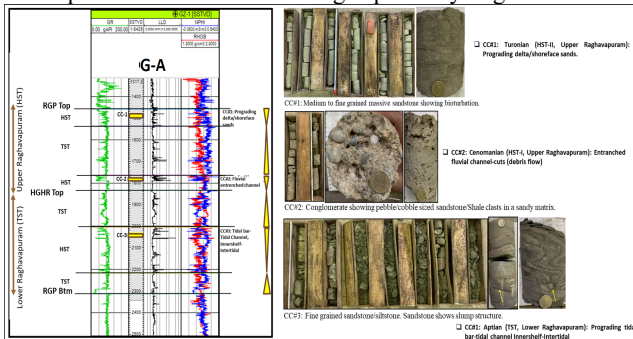


Fig. 4: Identified lower order systems-tract along with paleo-depositional environment of G-A.

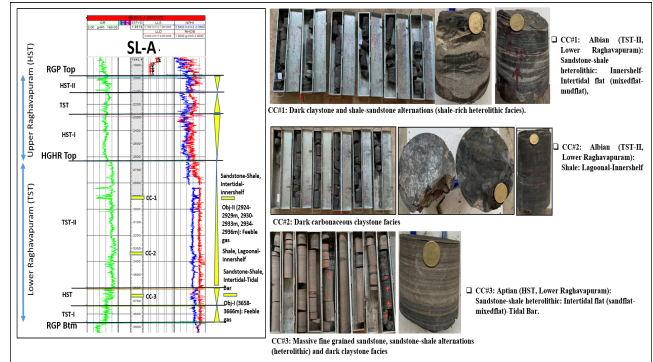


Fig. 5: Identified lower order systems-tract along with paleo-depositional environment of SL-A.

Top TST (TST-II):

The top TST is also characteristically represented by HG-HR log motif, is made up of claystone with thin lenses and laminations of very fine-grained sandstone (Fig. 3.1), deposited under anoxic, shallow marine-middle neritic realm, representing the upper transgressive sequence. Generally, the unit is devoid of good reservoir facies. Core data are available in the following wells with paleo-depositional environments: SV-A (CC-2, Shoreface-Intertidal-Tidal channel), K-A (CC-2, Supratidal-Lagoonal), E-A (CC-3, Innershelf-Intertidal to Subtidal) M-A (CC-1, 2; Innershelf-subtidal-lagoonal), SL-A (CC-1, CC-2; Innershelf-intertidal-lagoonal) L-A (CC-2, Intertidal-subtidal), MS-H (CC-1, 2, 3; Innershelf-intertidal-mixedflat-mudflat) KK-I (CC-1, Innershelf-intertidal) and N-A (CC-3, Retrograding Tidal bar-Tidal Channel, Innershelf-Intertidal) (Fig. 5).

Lower Order (3rd order) units within Upper Raghavapuram:

This has been subdivided into 3 systems tract, viz. HST-I-TST-HST-II (Fig. 2). Foraminiferal studies suggest that the Upper Raghavapuram is deposited under more than 100m bathymetry.

Basal HST (HST-I):

The basal unit is progradational and is very important from hydrocarbon accumulation point of view in KK-A, E, G, I, J, V-B and VN-A. The overlying transgressive shales cap these accumulations. In G-A (CC-2), MA-A (CC-1), VK-B (CC-1) and N-A (CC-3), the core facies depicts sandy slump, channel-cut, fluvial entrenched channel, while the core facies in LL-A (CC-1), WK-A (CC-1) and BS-A (CC-1) indicate Innershelf Intertidal/Tidal Bar, Innershelf-Intertidal-Subtidal and Innershelf-Subtidal deposition (Fig. 4, 6).

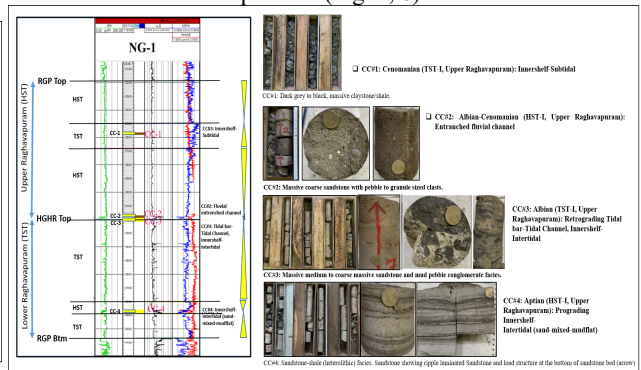


Fig. 6: Identified lower order systems-tract along with paleo-depositional environment of N-A.

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Middle TST:

This middle TST (Cenomanian age) in the area is made up of shale, as evident from fining-up logmotif with increasing gamma directly overlying the underlying HST (Fig. 2). The Lower part of this TST consists of high gamma shale, dark grey in colour, interbedded with lenses of siltstone/sandstone. Sandy beds are very few showing coarsening-up or fining-up tidally reworked bar or channel/intertidal flats. The studied cores from this TST with paleo-environments are as follows: S-A (CC-1, Innershelf-Subtidal), N-A (CC-1, Innershelf-Subtidal), A-A (CC-1, Innershelf-Intertidal/Tidal Channel), P-A (CC-2, 3, Innershelf-Intertidal/Subtidal) and MH-A (CC-1, Innershelf Subtidal) (Fig. 3, 7).

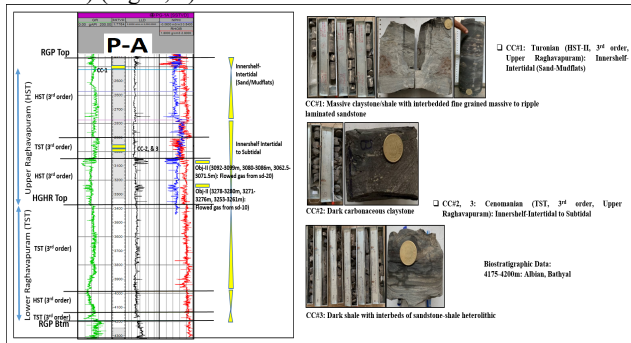


Fig. 7: Identified lower order systems-tract along with paleo-depositional environment of P-A.

Top HST (HST-II):

The upper part of Upper Raghavapuram (Turonian age) is characterised by relative abundance of coarser clastics (sandstones) with aggradational to progradational cycles corresponding to HST (Gupta et al., 1997; Fig. 2). The topmost HST is represented in wells VK-A (CC-1), G-A (CC-1), MA-C (CC-1), P-A (CC-1), MK-A (CC-1) and SMA-1 (CC-1) (Fig. 4,7,8). In VK-A (CC-1), the core facies represents Fluvial Slope fan, while G-A (CC-1) is deposited in a prograding lower delta plain and tidal bar (Fig. 4) and in MA-C, CC-1, the core represents a supratidal-lagoonal setting. In P-A (CC-1) and SM-A (CC-1), core facies indicates Intertidal flat and Supratidal-Lagoonal deposits Fig. 7). In MK-A, CC-1 represents a fluvial entrenched channel cut on innershelf (Fig. 8). Foraminiferal and dinoflagellate cyst studies suggest that the sequence was deposited under marginal marine to inner neritic environment. Upward decrease in faunal frequency suggest rapid shallowing of the basin and unconformably overlain by Tirupati Sandstone.

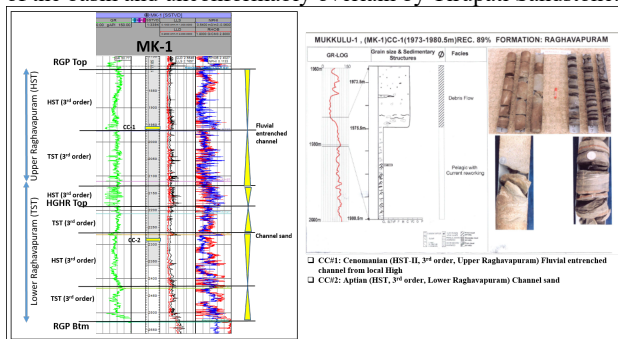


Fig. 8: Identified lower order systems-tract along with paleo-depositional environment of MK-A.

Electrolog Correlation and Correlation of Key wells:

A Total 4 Dip profiles have been prepared correlating these different units to understand the vertical and lateral facies

variation/distribution and relative structural disposition of identified sequences/systems-tract.

Dip profile-1: This profile passes through Endamuru-Draksharama high in east to Kavitam-Mondepeta low to Bhimadolu low and Bapatla high in west with wells E-A, MH-A, M-A, K-A and SL-A (Fig. 9).

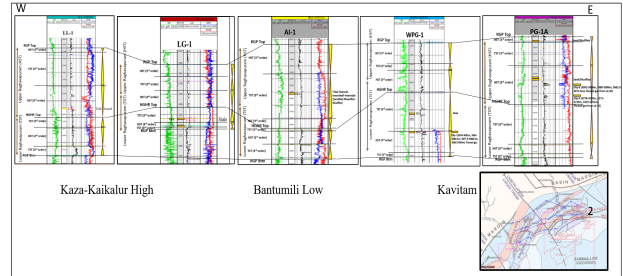


Fig. 9: Correlation Profile 2 showing subdivision of Raghavapuram sequence (Lower and Upper Raghavapuram).

Dip profile-2: This profile passes through Kavitam-Poduru-Yanam high in east to Kavitam-Penugonda low to Bantumili high to Bantumili low to Kaza-Kaikalur high passing through wells P-A, WP-A, A-A, L-A and LL-A.

Dip profile-3: This profile passes through Godavari low in east to Kavitam-Poduru-Yanam high to Kavitam low to Bantumili high to Bantumili low to Kaza-Kaikalur high passing through wells KK-B, VW-A, S-A, KK-I and G-A.

Dip profile-4: This profile passes through Kavitam-Poduru-Yanam high in east to Kavitam low to Bantumili high to Bantumili low to Kaza-Kaikalur high passing through wells BS-A, MS-H, NS-A, N-A and K-A.

Paleogeography and Depositional Model with Sediment Dispersal:

Depositional models for Raghavapuram Shale are prepared at 4 levels from Aptian to Turonian. The process based depositional facies, as envisaged from core data, were superimposed over paleogeographic maps show the mode of sequence evolution of Raghavapuram Shale.

Lower Raghavapuram (Aptian Level):

Paleogeographic map clearly shows existence of horst-graben at this stage. In Gudivada graben towards southwestern part, cores from wells NK-A (CC-1) and G-A (CC-1) show presence of fluvial slope fan/washover fan during sea-level lowstands (Fig. 10). The cores from KK-I (CC-2, 3) indicates mixed siliciclastic-carbonate deposition over Kaikalur high, while in LL-A (CC-3) and SL-A (CC-1), prograding tidal bars and innershelf-intertidal deposition is observed (Fig. 10). In Bantumili and Kavitam lows, the core data shows sand reworking by tidal processes in form of innershelf-intertidal sandflat and tidal channels (N-A, CC-1, WK-A, CC-1, WP-A, CC-2; Fig. 10). In northern part, sand supply by slope fan is observed (E-A, CC-4). Therefore, it can generally be assumed that the coarser clastics is delivered from basin margin (west or northwest side) by fluvial processes and deposited as slope-fan or entrenched channels that extended towards the grabenal lows over innershelf-intertidal sediments during sea-level lowstands. Also, in Aptian level, the remaining horst played an important role for provenance and sediment dispersal from where sediment was delivered in basinal lows, where enough accommodation space was available. The short distance transportation is envisaged for this HST phase. The highs might have possibly acted as barrier for sediments to spill over to other grabenal lows (Fig. 10). Laboratory data suggests that the coarser clastics are of channel and fan deposits (Fig. 10).

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Isolated, discontinuous depocentres are observed in the SW part of Gudivada and Bantumilli grabens, while a continuous NE-SW trending low is observed in Penugonda-Kavitam-Mandapeta Low. This may indicate the role of axial drainage in sediment transportation in this area.

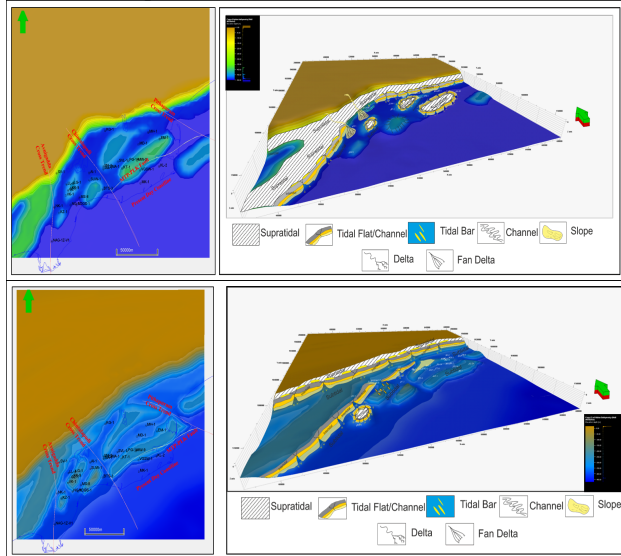


Fig. 10: Depositional model of Lower Raghavapuram Member at HST (Aptian) and TST-II level (Albian).

Lower Raghavapuram (Albian Level):

The depositional model at Albian level depicts the topmost transgressive phase (TST-II) of Lower Raghavapuram with dominance of finer clastics, i.e. shale with HGHR character (Fig. 10). Paleogeographic map clearly shows submergence/peneplanation of subbasinal horsts at end of Albian period due to transgression and resultant landward shift of peloshoreline. Transgressive paleoshoreline will promote reduced coarser clastic supply from land through channels/slope fans. The coarser clastics are thus very much limited during this TST phase, as are indicated from core data. However, tidally reworked sands are distributed/deposited on intertidal flats/tidal channels. In landward part of Gudivada graben (southwestern part), cores from wells SV-A (CC-2) show presence of shoreface and intertidal channel sands (Fig. 10), while towards northern side in K-A (CC-2) supratidal lagoonal facies in form of dark grey to black carbonaceous shale is observed (Fig. 10). Towards basinal side, limited sands are present as innershelf-intertidal (LG-A, CC-2; KK-I, CC-1) and innershelf-intertidal channel-retrograding tidal bars (N-A, CC-3). Further basinward, sand is not present and the core data show existence of innershelf-intertidal (mixed flat-mudflat)-subtidal-lagoonal shale (MS-H, CC-1, 2, 3; S-A, CC-2; SL-A, CC-1, 2; M-A, CC-1, 2; KK-B, CC-2).

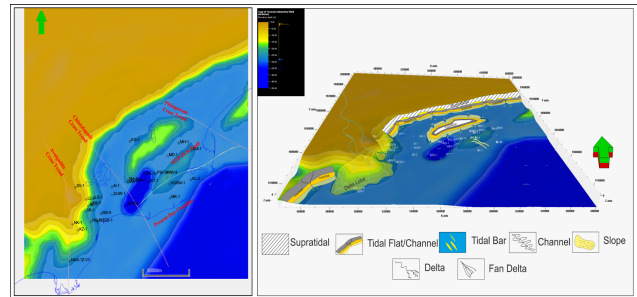
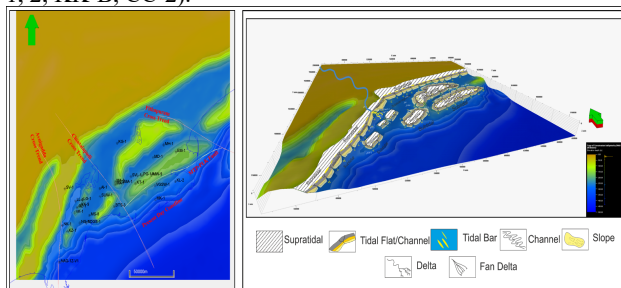


Fig. 11: Depositional model of Lower Raghavapuram Member at HST-I (Cenomanian) and HST-II level (Turonian).

Upper Raghavapuram (Cenomanian Level):

Initially during Early Cenomanian, there is an increased sedimentation rate with supply of coarser clastics towards western basin margin. This resulted basin ward shift of paleoshoreline or progradation (marked as HST-I), as can be seen in paleogeographic map (Fig. 11). In Gudivada and Bantumili grabens, towards southwestern part, the effects of regression are more prominent. Cores from G-A (CC-2), MA-A (CC-1) and N-A (CC-3) show presence of entrenched channel sand over HGHR TST-II unit indicating relatively rapid fall in relative sea-level. In these areas, chances of getting such channel sands are more. This may indicate existence of lowstand channels. In LL-A (CC-1), innershelf-intertidal-Tidal bar is present. Towards basinal part, in Bantumili South (BS-A, CC-1) and Kavitam low (WK-A, CC-1) innershelf-subtidal and innershelf-intertidal to subtidal facies are present (Fig. 3.62).

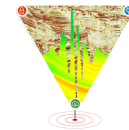
After the initial sea-level fall, the Cenomanian transgression is reflected by TST unit indicating again a landward shift of paleoshoreline. Sediment supply from western basin margin is reduced considerably and the available clastics are reworked by fair-weather waves and tides. As the basinal horst-graben is already submerged, wave action also played a major role in sediment redistribution.

Upper Raghavapuram (Turonian Level):

It is quite evident from the paleogeographic map that during this final HST phase (HST-II), progradation has resulted basinward shift of paleoshoreline (Fig. 11). The depositional processes indicate that towards southwestern basin margin, progradation of delta/slope fan is evident in wells K-A (CC-1), G-A (CC-1) and VK-A (CC-1). In MA-C (CC-1) and SM-A (CC-1), towards basin margin supratidal-lagoonal facies are present, while in P-A (CC-1) intertidal-sandflats are developed. In KG basin during this phase (i.e. end of Raghavapuram), delta building and progradation of lower delta initiated. The reason is during this stage continental shelf-system has been developed, the slope adjacent to basin margin has reduced considerably and instead of slope fan-washover fan and fan-delta, full deltaic sequence is developed. Some entrenched channels are delivered sediments basinward in MK-A, CC-1 due to this progradation (Fig. 11).

Summary and Conclusions:

1. The Raghavapuram Shale belongs to a 2nd order sequence representing a transitional phase from rift to passive margin. This 2nd order sequence is divided into a basal TST (Lower or HGHR Raghavapuram) and an upper HST (Upper or LGLR Raghavapuram). The Lower Raghavapuram is inferred to be deposited in restricted, lagoonal, shallow marine setting, while Upper Raghavapuram is deposited in open marine innershelf-outershelf (intertidal-subtidal) to bathyal setting.



Comprehensive Geological Model of Raghavapuram Play in KG Onland Area to understand depositional environment, facies distribution in a sequence stratigraphic framework

2. Lower Raghavapuram is further subdivided into 3rd order basal TST-I, followed by HST and finally TST-II at top. Upper Raghavapuram is sub-divided into 3rd order basal HST-I, middle TST and top HST-II. These lower order sequence stratigraphic units are identified/correlated in different wells.

3. The basal TST (Early Aptian) in Lower Raghavapuram varied in thickness, maximum in grabenal part, represented by dark grey to black carbonaceous shales, while it is considerably reduced over highs or completely absent at places. This indicates that the horst-graben nature was maintained at this stage. Middle HST is represented by limestone and sandstone with shale. Wedge-shaped reservoirs within the HST are developed locally. The top TST with HGHR log motif, consists of dark grey, black shale/claystone with thin sandstone lenses.

4. Base of Upper Raghavapuram represents a progradation (HST-I) followed by a dominantly argillaceous transgressive unit (TST) and finally interbeds of siltstone and sandstone showing progradational cycles (HST-II). The basal HST-I unit appears to represent shallow marginal marine sandstone and is important from hydrocarbon point of view. The middle TST with LGLR character (Cenomanian age) consists of shale, while the top HST-II (Turonian in age) is characterised by relative abundance of coarser clastics (sandstones) with progradational cycles. The foraminiferal and dinoflagellate cyst studies suggest that the sequence was deposited under marginal marine to inner neritic environment.

5. Integrated analysis of the G&G data including laboratory data has led to a comprehensive understanding of facies distribution, paleogeography, depositional model and sediment dispersal of lower order stratigraphic units. Depositional models for the Raghavapuram Shale are prepared at 4 levels from Lower to Upper Raghavapuram, based on facies architecture and order of sequence stratigraphic units.

6. In Aptian Level, paleogeographic map depicts that during HST, coarser clastics are delivered from basin margin (west or NW side) by fluvial processes and deposited as slope-fan/washover fan or entrenched channels that extended towards the grabenal lows over innershelf-intertidal sediments. Presence of mixed siliciclastic-carbonate deposition over Kaikalur high (KK-I, CC-2, 3), prograding tidal bars, innershelf-intertidal deposition (LL-A, CC-3; SL-A, CC-1) and innershelf-intertidal sandflat and tidal channels (N-A, CC-1, WK-A, CC-1, WP-A, CC-2) are observed during this HST. Paleogeographic map in Albian indicates further transgression with bathymetric conditions of 100-200m. The positive areas remained as horsts was inundated as a result of this transgressions.

7. In Early Cenomanian, paleogeographic map revealed basinward shift of paleoshoreline due to increased sedimentation rate (HST-I). Then Cenomanian transgression is reflected by TST that continued till early part of Turonian. Paleogeographic map at Turonian top depicts seaward shift of paleoshoreline indicating progradation manifested by the final HST (HST-II). Delta progradation also initiated from northwest to southeast direction. The continental shelf-system has been developed, the slope adjacent to basin margin has reduced considerably and instead of slope fan-washover fan and fan-delta, full deltaic sequence is developed.

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