Multimicrofossil Biostratigraphic analysis of wells A and B, Krishna -Godavari Basin

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Abstract:

The exploratory wells A and B were drilled in the Krishna-Godavari Deep offshore area off Yanam coast with the objective of exploring the hydrocarbon potential of Cretaceous, Miocene and Basement prospects. The well A has been drilled to a depth of 4155m, encountering Basement at 4115.5m. Although, well A was drilled in rather present day shallower water depth i.e. 16.92m; however, post Oligocene the well section has shown deeper bathymetry with appreciable rates of sediment fills. The microfossil studies on cutting samples provided good yield of microfossils to provide biostratigraphic zonations and correlation of stages. The well B was drilled with the objective of exploring the hydrocarbon potential of Cretaceous sediments up to 4500m depth; in the water depth of 225m. The main targets of the well were reservoir sands below 4107m. Multi-microfossil analysis on cuttings of drilled sections in well A and B was aimed to bring out high resolution biostratigraphy and paleoenvironments. Foraminifera, calcareous nannofossils, spore pollens and dinoflagellate markers (FADs / LADs) were utilized in dividing Cretaceous / Tertiary sections for finer biozones / chrono-units in the study area.

WELL A: MULTIMICROFOSSIL STUDY

The basement was encountered at 4115.5 m. The oldest sediments at 4110-4115 m, yielded nannofossils and rare agglutinated foraminifera. The sediments between 4075 and 4100 were dated Hauterivian – Barremian based on nannofossils. Sediments in this interval suggest probable bathyal environment. Foraminifera recorded from the sediments of pay zone (3924 to 3968) indicate bathyal environment.

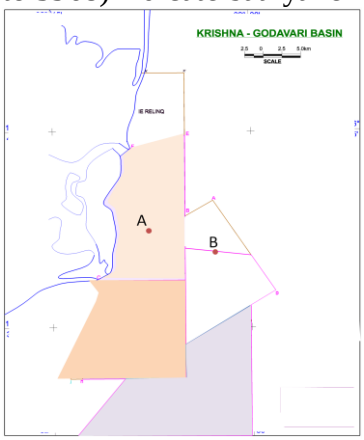

FIG. 1 LOCATION MAP

BIOSTRATIGRAPHIC SUMMARY CHART OF WELL A		
DEPTH	**TOP OF AGES / STAGES**	**CRITERIA**
(-)800	Pliocene	foraminifera
1300	Early Pliocene	foraminifera
1510	Miocene	foraminifera
1750	Late Oligocene	foraminifera, nannofossils
1940	Early Oligocene	foraminifera
2125	Late Eocene	foraminifera
2400	Middle Eocene	foraminifera
2520	Early Eocene	foraminifera
2700	Paleocene	foraminifera
2790	Maastrichtian	foraminifera
2960	Campanian	nannofossils
3275	Santonian.	nannofossils
3500	Coniacian	nannofossils
3550	Turonian	nannofossils
3755	Albian - Cenomanian	nannofossils
3945	Albian	dinoflagellate cysts
4075	Hauterivian - Barremian	nannofossils

In a cutting at 4075m nannofossil assemblage indicates a Hauterivian to Barremian age. Albian top is marked based on dinoflagillate cysts. Cenomanian top is marked at 3755m based on nannofossils.In the overlying section Turonian top is marked at 3550m,Santonian top at 3275m and Campanian top at 2960m based on nannofossils.

Association of *Dicarinella asymmetrica and Dicarinella concaveta* at a depth of 3310m and 3320 m suggest Santonian age. At the uppermost sample level of Cretaceous, *Globotruncana ventricosa* is common and KT boundary could be marked at 2790 metres.

KTB: Late Maastrichtian Planktic foraminifer markers are found. Inference is that the KT boundary in A is represented by hiatus as in case of B, but the duration of the hiatus in A could not be estimated in the present study. *Igorina pusilla* assemblage at 2760-2765 and 2720 m suggests Middle Palaeocene. Based on rare occurrence of *Morozovella velascoensis*, sample at 2700-2705m is dated as Late Palaeocene. Occurrence of *Morozovella formosa* (group) at depth 2610 – 2615m suggests Early Eocene age. Occurrence of *Acarinina pentacamerata and A. soldadoensis* in sample at 2500 m suggest an upper part of Early Eocene. *Hantkenina dumblei* in sample between 2465m and 2440m suggests middle part of Middle Eocene. Occurrence of *Hantkenina trinidadensis and Globigerinatheka spp*. between 2375m and 2320m suggests lower part of Lower Part of Late Eocene. *Turborotalia cerrazulensis cunialensis, Hantkenina alabamensis* and rare *Cribrohantkenina* occur at depth between 2290m and 2140m and suggests upper part of Late Eocene. Top of Eocene is marked at 2290 m and 2140m depth based on LADs of *Turborotalia cerroazulensis s.l.*

Top of Zone P20 (which falls within upper part of Rupelian) is marked at 1940m based on LAD of *Globigerina ampliapertura*. Occurrence of *Globorotalia Opima* which is restricted to zone P21 occurs at 1850 m, LAD of *G.opima* and falls within lower part of Chattian .The top of Oligocene is marked at 1750m based on LAD of *Globigerina ciperoensis*. Occurrence of *Ammonia umbonata* at 1510m suggests an age not younger than N8 zone.Early Pliocene is marked at 1500-1505 based on the occurrence of *Globorotalia incisa.*Submarine unconformity with the duration of hiatus probably from N9 to N17 (9.1 Ma) is marked 1510

m. During the interval of Palaeocene to Early Pliocene sediments were deposited under bathyal environment. Palaeowater depth greater than 900m can also be inferred for some intervals. Pliocene sediments at 960 m appear to have been deposited under a palaeo-water depth of about 900m. The present water depth at the well site is 16.92m. Two alternative interpretations are possible. The sediments have gradually filled the site from 900m to 16.92m water depth during Pliocene to Holocene, There could be uplift / subsidence.

PALEOBATHYMETRIC INDICATORS

Present water depth at the site of A is 16.92m. One interpretation could be that from Early Pliocene to Holocene, the site of A is rapidly filled up with little subsidence. Very high rate of Deposition during Pliocene to Holocene was earlier recognized in offshore area of KG-Basin**.** Foraminifera suggest that the palaeowater depths during Cretaceous at the site of A are relatively shallower than at the site of B .but Cenomanian to Early Maastrichian sediments in both the wells were deposited under bathyal setup. As in case of B, there was a hiatus at KTB in A. The Late Miocene unconformity was in bathyal setup**.**

WELL B: MULTIMICROFOSSIL STUDY

Foraminiferal, nannofossils, dinoflagellate and spore pollen data was integrated to arrive at fine time slicing between Early Cretaceous to Neogene sections penetrated in the studied well B. Efforts are made to integrate multi-microfossil information to arrive at a common precise age boundaries. However, using multi-microfossil criteria, the different age boundaries are suggested and discussed below:

BIOSTRATIGRAPHIC SUMMARY CHART OF WELL -B

DEPTH	AGE/STAGE	CRITERIA
1705 m	**early – Mid. Miocene**	**Dinoflagellate**
2080 m	**Early Miocene**	**Foraminifera**
2195 m	**Oligocene**	**Foraminifera**
2500 m	**Late Eocene**	**Foraminifera**
2660 m	**Middle Eocene**	**Foraminifera**
2820 m	**Early Eocene**	**Foraminifera**
3040 m	**Late Paleocene**	**Foraminifera**
3520 m	**Maastrichtian**	**Forams, Nanno, Dinof.**
3645 m	**Campanian**	**Foraminifera**
3660 m	**Santonian**	**Dinoflagellate cysts**
3830 m	**Coniacian**	**Dinoflagellate cysts**
3865 m	**Turonian**	**Foraminifera**
4015 m	**Cenomanian**	**Dinoflagellate cysts**
4125 m	**Albian**	**Dinoflagellate cysts**
4210 m	**Aptian**	**Dinoflagellate cysts**
4265 m	**Barremian - Hauterivian**	**Nannofossils**

The section from 4210 -4275 m is dated as Aptian based on dinocysts and spore pollens and a marginal marine to shallow marine environment is interpreted. The section from 4260-4275m is devoid of foraminifera but has yielded nannofossils indicating a marine environment. In a cutting at 4265 to 4270m the nannofossil yield indicates a Hauterivian-Barremian age. This section has yielded only a few agglutinated foraminifera. The section from 4125-4210m is referred to Albian age based on dinocysts and spore- pollen studies. However the nannofossil study of cutting sample at 4125 to 4160m indicates a Hauterivian-Albian age. The Albian / Cenomanian boundary is marked at 4125m based on dinocysts and spore pollen study. The foraminiferal yield comprises mainly agglutinated forms. The overlying section from 4030 - 4125m is referred to Cenomanian age based on dinocysts / spore pollen study. Cutting sample at 4080-85m has yielded nannofossils indicating Upper Albian to Cenomanian age. Section from 3830 -3865m is referred to Coniacian age based on dinocysts and spore- pollen study. Nannofossil yield at 3790-95m also suggests a Santonian age. The Santonian top is marked at 3660m based on dinocysts and spore- pollen study. Campanian top is marked at 3645m based on foraminifera. The section based on dinocysts and spore- pollen study indicates a late Campanian / Early Maastrichtian age for the interval 3520-3570m. A cutting at 3530-35m yielded rich nannofossil assemblage of Campanian age. Whereas, the section from 3520 -3625m is referred to Maastrichtian based on foraminifera and dinocysts / spore - pollen study. Cutting at 3450-55m contains rich nannofossil assemblage of Late Paleocene age. The Early Eocene age (2820 -3040m), Middle Eocene (2660 - 2820m), Late Eocene(2500- 2660m), Oligocene(2195 to 2500m), Early Miocene(2080 to 2195m), Early - Middle Miocene(1705 to 2080m), Middle to Late Miocene(1365 to 1705m), Late Miocene Early Pliocene(1160 to 1365m) and 1000 to 1160m to Pliocene and younger age has been assigned based on foraminifera, dinocysts, spore-pollen and nannofossil studies.

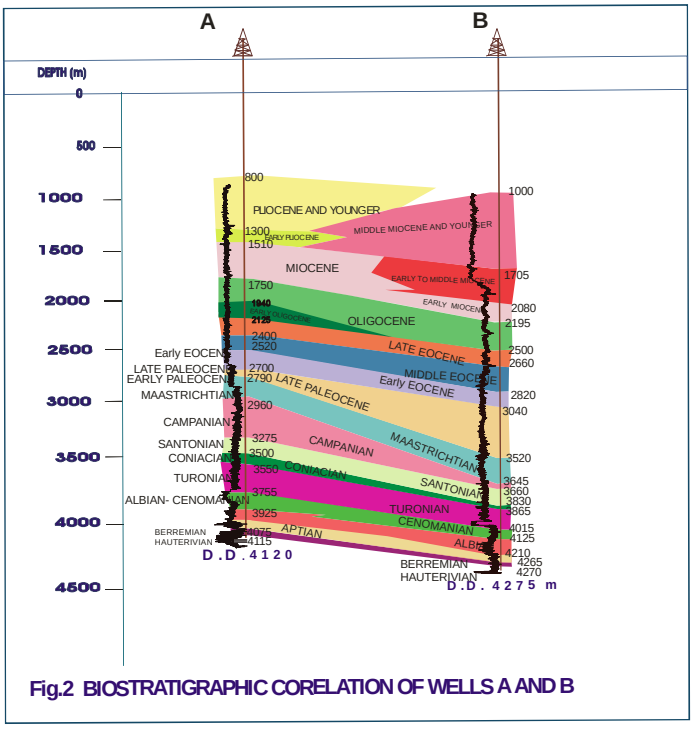

Fig.2 BIOSTRATIGRAPHIC CORELATION OF WELLS A AND B

DATA INTEGRATION:

The oldest sediments in both the deep wells: A and B are assigned Hauterivian-Barremian age while the youngest is Pliocene and younger age. Most of the stage tops in the well A are at shallower level as compared to the well B which is conforming to the basinal paleo-geometry. Ideally in well sections, where only cutting samples are available, the first down-hole record (LAD) of the microfossil is important and taken into consideration to define the zonal / age boundary. However, in the absence of recognizable LADs of nannoplanktons, dinoflagellates and planktic foraminifera, FADs of different diagnostic microfossils may also be used to define stages and age boundaries. Such stages and age boundaries will certainly have an element of approximation therefore while integrating multi-microfossil information to arrive at a common precise age boundary the normal convention of youngest bio-chronohorizon / bioevent is considered in the present study. This avoids unnecessary and compulsory matching of different chrono-levels by varied criteria. The tertiary boundaries also show a similar trend on the dip line. The age units upto Oligocene show almost similar thicknesses on the strike line.

CONCLUSIONS:

- The finer stages and age boundaries are demarcated in Cretaceous and Tertiary sections on the basis of foraminiferal and nannofossils, dinoflagellate cysts and spore – pollen study.

- In well A foraminiferal studies indicate deeper environment for the Cretaceous section. Palaeocene to Early Pliocene sediments were also deposited under bathyal environment. Palaeowater depth greater than 900m can also be inferred. Pliocene sediments at 960 m appear to have been deposited under a palaeo-water depth of about 900m, whereas in Well B, foraminiferal studies indicated a bathyal and deeper environment for the Cretaceous section. The dinoflagellate cysts data suggests an inner to outer shelf environment for the Cretaceous and Tertiary section.

- The foraminifera between 3000-3005 and at 4115.5 are dark coloured or often black. High temperature regime during the deposition of these sediments is inferred. This may be related to higher temperature generated during Rajmahal volcanism.

- Submarine unconformity with the duration of hiatus probably from N9 to N17 (9.2Ma) is marked 1510 m. Top of Cretaceous is also marked by unconformity however the hiatus at this level is not conformative.