Multimicrofossil Biostratigraphic Analysis of Wells A and B, Krishna - Godavari Basin*

Q. A. Ali[1], D. S. N. Raju[1], S. Shukla[1], R. K. Saxena[1], B. Prasad[1], M. H. B. Raju[1] and M. Shanmukhappa[1]

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[1]No Affiliation (asadaliqaziin@yahoo.com)

Abstract

The exploratory wells A and B were drilled in the Krishna-Godavari Deep offshore area off Yanam coast (Figure 1) with the objective of exploring the hydrocarbon potential of Cretaceous, Miocene and Basement prospects. The well A has been drilled to a depth of 4,155m, encountering Basement at 4,115.5m. Although, Well A was drilled in rather present day shallower water depth i.e. 16.92 m; 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. Well B was drilled with the objective of exploring the hydrocarbon potential of Cretaceous sediments up to 4,500 m depth; in the water depth of 225 m. The main targets of the well were reservoir sands below 4,107 m. Multi-microfossil analysis on cuttings of drilled sections in Wells 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/chronounits in the study area.

Well A: Multimicrofossil Study

The basement was encountered at 4,115.5 m. The oldest sediments at 4,110-4,115 m, yielded nannofossils and rare agglutinated foraminifera (Table 1). The sediments between 4,075 and 4,100 were dated Hauterivian – Barremian based on nannofossils. Sediments in this interval suggest probable bathyal environment. Foraminifera recorded from the sediments of pay zone (3,924 to 3,968) indicate bathyal environment.

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 3,755m based on nannofossils.In the overlying section Turonian top is marked at 3,550 m, Santonian top at 3,275 m and Campanian top at 2,960 m based on nannofossils.

Association of Dicarinella asymmetrica and Dicarinella concaveta at a depth of 3,310 m and 3,320 m suggest Santonian age. At the uppermost sample level of Cretaceous, Globotruncana ventricosa is common and KT boundary could be marked at 2,790 m.

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 2,760-2,765 and 2,720 m suggests Middle Palaeocene. Based on rare occurrence of Morozovella velascoensis, sample at 2,700-2,705 m is dated as Late Palaeocene. Occurrence of Morozovella formosa (group) at depth 2,610 – 2,615 m suggests Early Eocene age. Occurrence of Acarinina pentacamerata and A. soldadoensis in sample at 2,500 m suggest an upper part of Early Eocene. Hantkenina dumblei in sample between 2,465 m and 2,440 m suggests middle part of Middle Eocene. Occurrence of Hantkenina trinidadensis and Globigerinatheka spp. between 2,375 m and 2,320 m suggests lower part of Lower Part of Late Eocene. Turborotalia cerrazulensis cunialensis, Hantkenina alabamensis and rare Cribrohantkenina occur at depth between 2,290 m and 2,140 m and suggests upper part of Late Eocene. Top of Eocene is marked at 2,290 m and 2,140 m depth based on LADs of Turborotalia cerroazulensis s.l.

Top of Zone P20 (which falls within upper part of Rupelian) is marked at 1,940 m based on LAD of Globigerina ampliapertura. Occurrence of Globorotalia Opima, which is restricted to zone P21, occurs at 1,850 m, LAD of G.opima and falls within lower part of Chattian. The top of Oligocene is marked at 1,750 m based on LAD of Globigerina ciperoensis. Occurrence of Ammonia umbonata at 1,510 m suggests an age not younger than N8 zone. Early Pliocene is marked at 1,500-1,505 based on the occurrence of Globorotalia incisa. Submarine unconformity with the duration of hiatus probably from N9 to N17 (9.1 Ma) is marked 1,510 m. During the interval of Palaeocene to Early Pliocene sediments were deposited under bathyal environment. Palaeowater depth greater than 900 m can also be inferred for some intervals. Pliocene sediments at 960 m appear to have been deposited under a palaeowater depth of about 900 m. The present water depth at the well site is 16.92m. Two alternative interpretations are possible. The sediments have gradually filled the site from 900 m to 16.92 m water depth during Pliocene to Holocene; there also could be uplift/subsidence.

Paleobathymetric Indicators

Present water depth at the site of A is 16.92 m. 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. However, 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 and illustrated in Table 2.

The section from 4,210 -4,275 m is dated as Aptian based on dinocysts and spore pollens and a marginal marine to shallow marine environment is interpreted (Figure 2). The section from 4,260-4,275 m is devoid of foraminifera but has yielded nannofossils indicating a marine environment. In a cutting at 4,265 to 4,270 m, the nannofossil yield indicates a Hauterivian- Barremian age. This section has yielded only a few agglutinated foraminifera. The section from 4,125-4,210 m is referred to Albian age based on dinocysts and spore-pollen studies. However, the nannofossil study of cutting sample at 4,125 to 4,160 m indicates a Hauterivian-Albian age. The Albian/Cenomanian boundary is marked at 4,125 m based on dinocysts and spore pollen study. The foraminiferal yield comprises mainly agglutinated forms. The overlying section from 4,030-4,125 m is referred to Cenomanian age based on dinocysts / spore pollen study. Cutting sample at 4,080-4,085 m has yielded nannofossils indicating Upper Albian to Cenomanian age. Section from 3,830-3,865m is referred to Coniacian age based on dinocysts and spore- pollen study. Nannofossil yield at 3,790-3,795 m also suggests a Santonian age. The Santonian top is marked at 3,660 m based on dinocysts and spore-pollen study. Campanian top is marked at 3,645 m based on foraminifera. The section based on dinocysts and spore-pollen study indicates a late Campanian/Early Maastrichtian age for the interval 3,520-3,570 m. A cutting at 3,530-3,535 m yielded rich nannofossil assemblage of Campanian age whereas the section from 3,520-3,625 m 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 (2,820-3,040 m), Middle Eocene (2,660-2,820 m), Late Eocene(2,500-2,660 m), Oligocene (2,195-2,500 m), Early Miocene (2,080-2,195 m), Early-Middle Miocene (1,705-2,080 m), Middle to Late Miocene (1,365-1,705 m), Late Miocene Early Pliocene (1,160-1,365 m) and 1,000-1,160 m to Pliocene and younger age has been assigned based on foraminifera, dinocysts, spore- pollen and nannofossil studies.

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 paleogeometry. 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 biochronohorizon/bioevent is considered in the present study. This avoids unnecessary and compulsory matching of different chronolevels by varied criteria. The tertiary boundaries also show a similar trend on the dip line. The age units up to Oligocene show almost similar thicknesses on the strike line.

Conclusions

- The finer stages and age boundaries are demarcated in Cretaceous and Tertiary sections based on 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 900 m can also be inferred. Pliocene sediments at 960 m appear to have been deposited under a palaeowater depth of about 900 m, 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 3,000-3,005 and at 4,115.5 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 (9.2 Ma) is marked 1,510 m. Top of Cretaceous is also marked by unconformity however the hiatus at this level is not conformative.

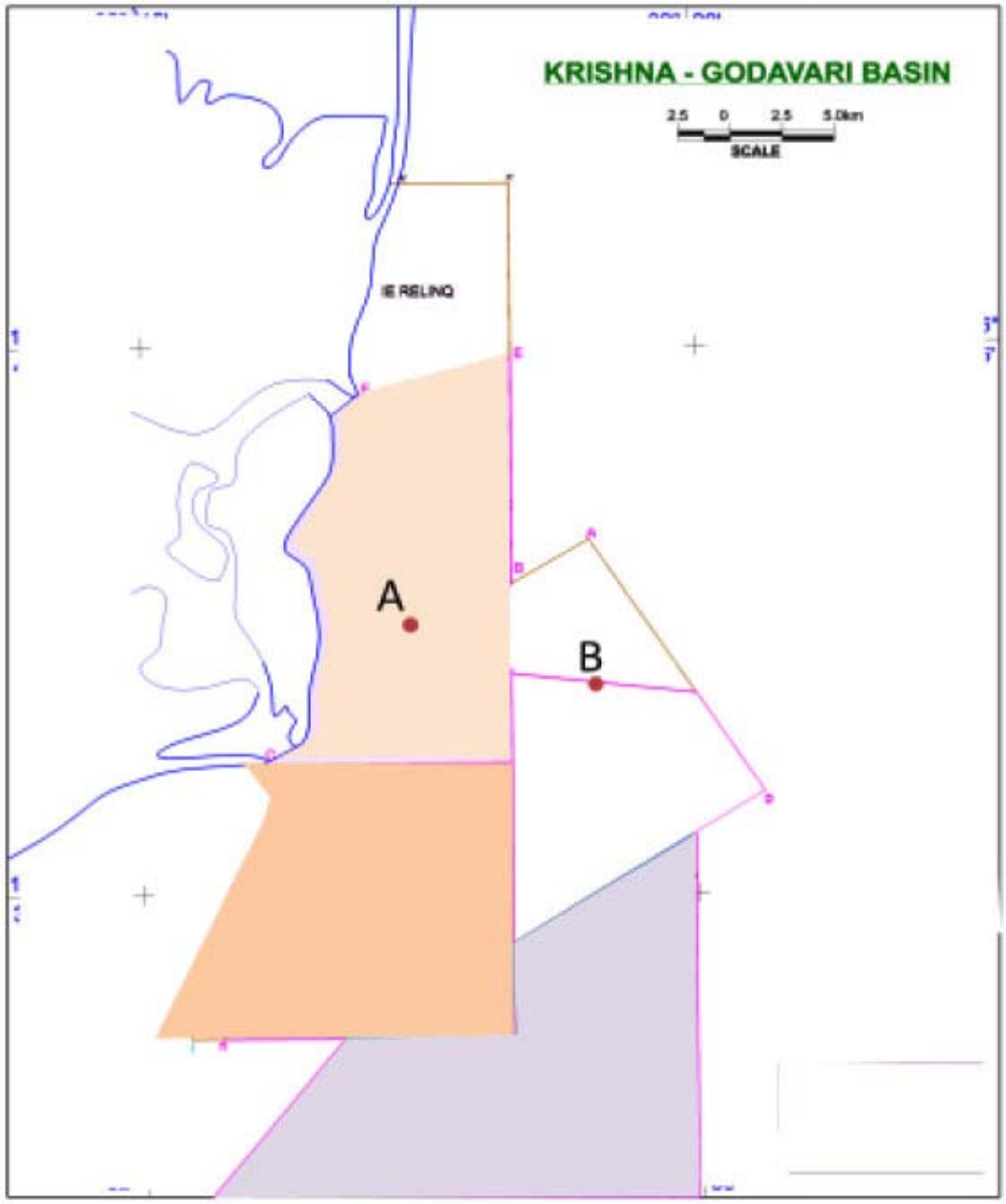

Figure 1. Location map.

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

Table 1. Biostratigraphic summary chart of Well A.

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

Table 2. Biostratigraphic summary chart of Well B.

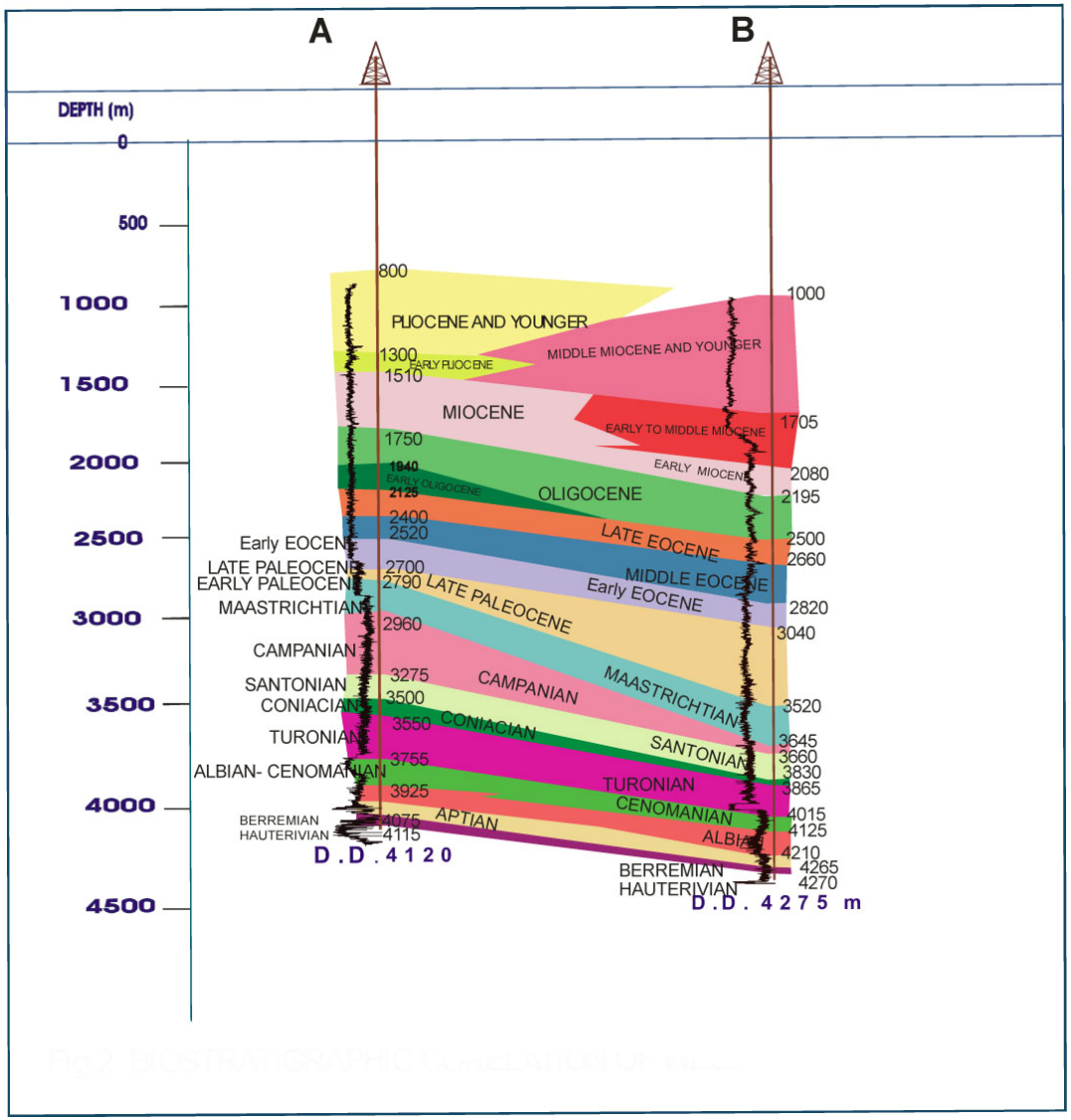

Figure 2. Biostratigraphic correlation of Wells A and B.