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Prospect Analysis of Penumadam in KG Basin With Special Reference To Well Site Geophysical And Geological Techniques.

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INTRODUCTION

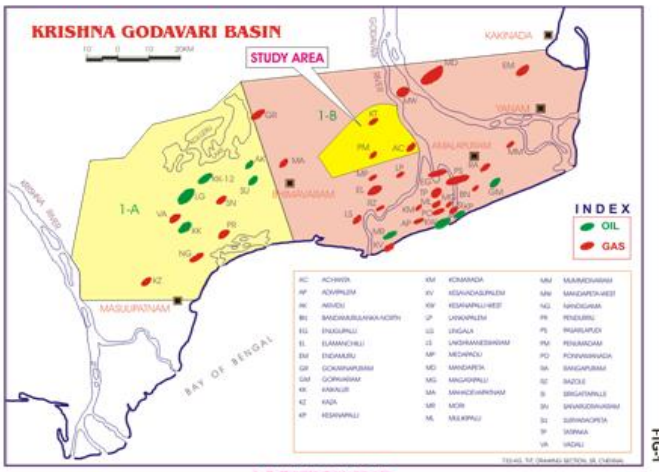
On the East coast of India, Krishna-Godavari Basin is a fairly large sedimentary basin covering an area of 28,000sqkm onland and extends offshore into Bay of Bengal, measuring about 1, 45,000sqkm . The basin is located between 15 to 17.50 N and 80 to 89.50 E.

The basin is divided in the sub-surface into several sub-basins (grabens) and ridges (horsts) running in SW-NE direction along pre-Cambrian Eastern Ghat trend. The different sub-basins from SW to NE are Krishna sub-basin, Baptla horst, Gudivada graben, Kaza-kaikaluru horst, Bantumilli graben and Tanuku-Mhimavaram horst.

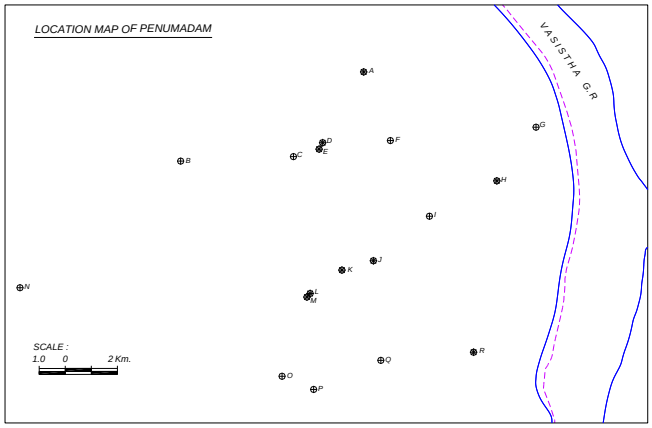
The present study is undertaken with an objective of understanding the sub surface geology and prospectivity of Penumadam area falling in the West Godavari sub basin of Krishna –Godavari Basin.(Fig No. 1). Penumadam area is located on the western side of the Vasista Godavari river in West Godavari District. The study area covers an area of 43.4 sq. kms and extends in NW-SE direction.

- A total of 18 wells were drilled in the study area, of which 9 are GAS wells and the remaining 9 were dry wells.
- The GAS wells are A(3200m), E(3543), H(3000), J(3000), K(2600), M(2600), R(2950).
- The dry wells are B(4520), C(2502),F(2650), G(2650), I(2600), O(4299), P(4500), Q(3100), N(1449).

Among these wells the shallowest well is N(1449m), and deepest well is B(4520m).



LOCATION MAP



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Stratigraphy of study area:

AGE	FORMATION	LITHOLOGY
EOCENE & YOUNGER	Nimmakuru sand stone & younger formation Matsyapuri sandstone	Dominantly sand/sand stone in upper part and alteration of sand stone and clay stone in the lower part.
Middle Eocene	Bhimanapalli Formation	Limestone & sand stone in upper part and dominantly sand stone with subordinate clay stone in lower part.
Lower Eocene	Pasarlapudi formation	Alterations of sand stones and clay stone.
Late Palaeocene	Palakollu Shale	Dominantly clay stone and subordinate sand stone.
Upper cretaceous to Lower Palaeocene	Razole formation	Basalt with intertrappeans Sand stone & clay stone.
Upper cretaceous	Tirupati sand stone	Dominantly sand stones with subordinate clay stone.

As part of the research work the data of of all the drilled wells in the area were studied. Lithologically Tirupati sandstone comprises of dominantly Sandstone and appears to have been deposited in a regressive phase in a shallow marine to fluvial environment. The Razole formation comprises of Basaltic eruptive flows with inter trappean sediments. The volcanic phase was followed by a transgressive phase in which the dominantly clay section of Palakollu shale was deposited. This was followed by a regressive phase in which the Pasarlapudi formation comprising of alternations of Sandstone and Claystone were deposited in Shallow marine to deltaic environment. This was followed by a transgressive phsase in which the Bhimanapalli limestone section was deposited. This was followed by regressive phase in which the younger formations were deposited in Shallow marine to fluvial environments.In the study area the Tirupati formation of Upper Cretaceous age is the main Reservoir rock. The under yinf Raghavapuram Shale is yme source rock. The volcanic effusives of Razole formation and the intervening shales of Tirupati formation act as trap / seals for the hydrocarbon pools.

Lithology Identification from Electro logs:

The following gives us, how the various logs respond to the following formations.

Formation	Gamma ray	Resistivity(R_t)	Density(ρ_b)	Neutron-Porosity
Shale	High	Low	Slightly high	High
Sand stone	Low	High	Low	Low
Sand in gas	Low	Very high	Very low	Very low
Sand stone in oil	Low	High	Low	Low
Sand stone in water	Low	Low	Low	Low
Lime stone	Low	High	High	Low
Basalt	Low	High	High	Low

The resistivity curves also show lower resistivity values for shales due to their ion exchange capability and conductive nature. Limestone reads very high resistivity, lower gamma count & higher density.

Basalt (Razole Trap) in KG basin is characterized by very low gamma counts, higher resistivities & higher densities.

By using information what I have been discussed, I plotted lithology from the response of the four logs, by using zeta log

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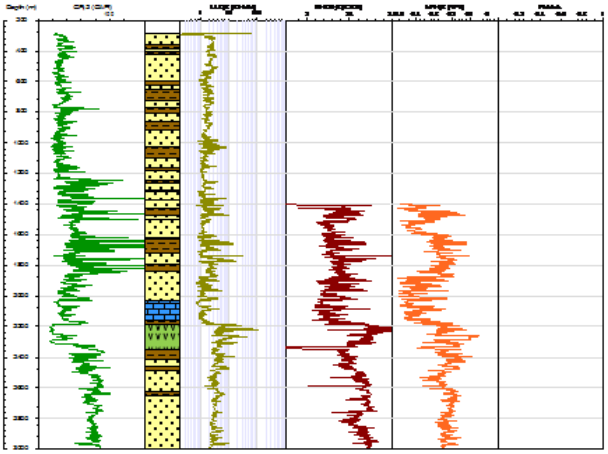
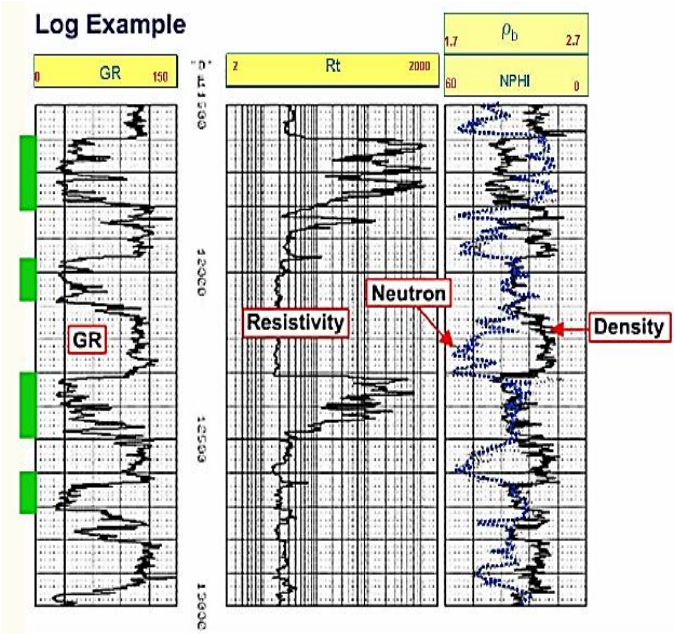
software. Which is an efficient software to draw lithology versus depth and correlate the wells.

The following figure represents that plotting the lithology with respect to the depth from the response of the following logs, with in my study area penumadam which belongs to the Krishna-Godavari basin.



Sandstones show lower gamma readings, Sandstones generally show higher resistivity values than shale and lesser gamma counts. shales show higher gamma values.



Isopach Maps:

Isopach maps are prepared for the following formations

- Tirupati sand stone
- Razole top
- Bhimanapalli lime stone

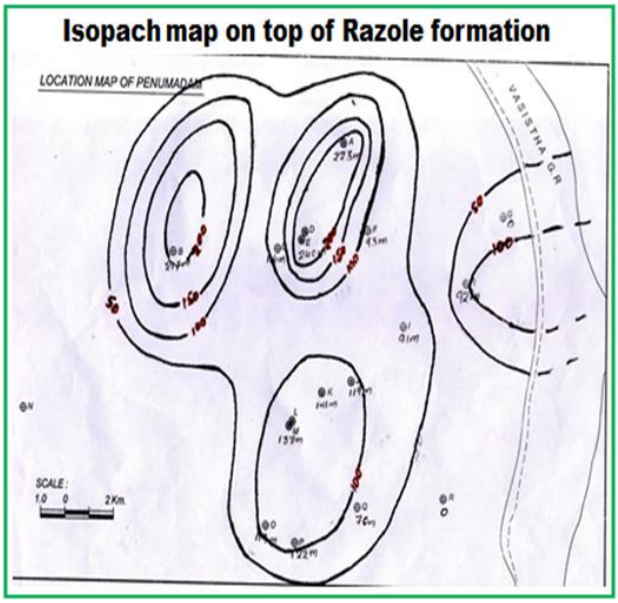
Tirupati Formation:

Isopach map was preared for Tirupati Formation (Fig No.6) by taking the thickness in all the wells in the study area. The map clearly brings out the wedging out of the formation towards East with the maximum thickness observed towards West. A maximum thickness of 1176m was observed in well B and the formation is absent in wells P,Q &R towards East. This clearly shows a regressive or Delta Progradation phase from West to East.

Razole Formation:

Isopach map of Razole unit (Fig No.: 4.4.2) also reflects change in thickness different wells. A maximum thickness of 240m is observed in well E and a minimum of 50m in well Q. As Razole unit is a volcanic eruptive deposit probably in aereal conditions the topography plays a role in the thickness of this unit. In some of the wells the fauting may be the reason for missing / lesser thickness.

Isopach map on top of Razole Formation



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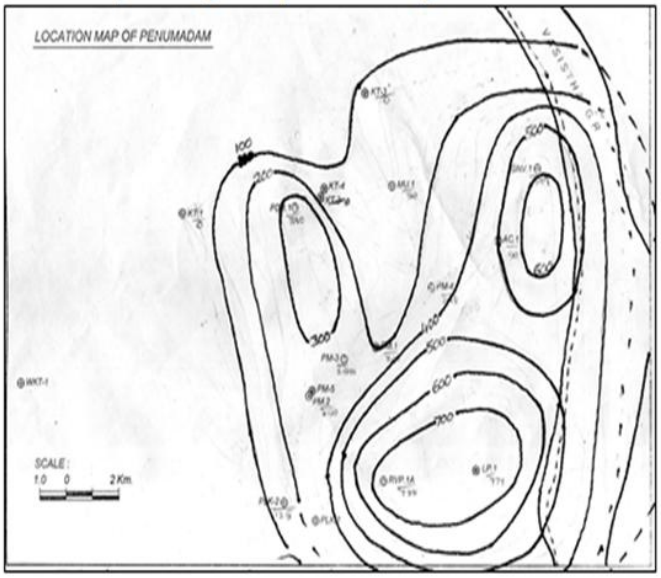
Bhimanapalli Limestone:

Isopach map of Razole unit also reflects change in thickness different wells. A maximum thickness of 240m is observed in well E and a minimum of 50m in well Q. As Razole unit is a volcanic eruptive deposit probably in aereal conditions the topography plays a role in the thickness of this unit. In some of the wells the fauting may be the reason for missing / lesser thickness.

Isopach map on top of Bhimanapalli limestone



Sand/Shale Ratio Map

Sand /Shale ratio map (Fig. No.: 4.5.1) was attempted for Tirupati Formation for understanding the depositional environment. Sand and Shale thicknesses were noted from the electrologs using Gamma Ray log. The ratios for various wells were plotted and a map was attempted. The map brings out concentration of good sand values in wells J, K & L with an East-West orientation. The data suggests that the environment could be Fluvial (Point Bar or Channel bar) in a meandering phase of the fluvial environment.

Observations:

Based on the isopach maps, thickness levels of each formation are vary at different wells may be due to faulting or tectonic set up of the basin.

Correlation: In order to understand the sub surface Geology of the study area, the following two Litho stratigraphic correlations have been attempted.

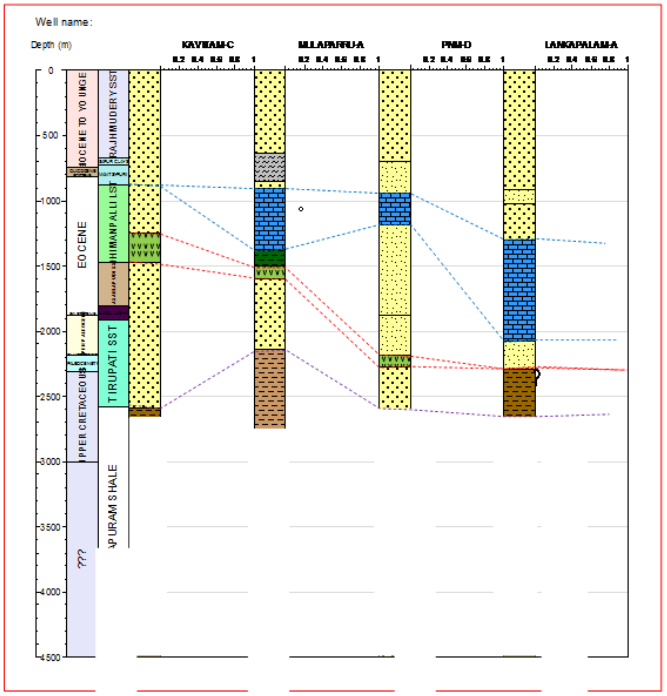
1. Strike direction.
2. Dip direction.

Dip direction:

In the correlation profile in dip direction four wells are plotted i.e. A, F, I & R.

Study of the Correlation profile brings out the following observations:

- Bhimanapalli Limestone is absent in the western most well, A as the well is falling on the updip side of a major fault and the Limestone unit is wedging against the fault and as such is absent in the upside of the fault. Similarly thickness variation in the limestone section may also be because of variation in Bathymetry or missing due to faulting.
- Razole formation is affected by the step faulting and goes down in the dip direction towards East. Also a thickness reduction is observed in the Dip section. This may be due to missing of section due to faulting or due to topographic effect at the time of deposition.
- Tirupati formation is completely drilled in well A. It is thin in wells F & R probably due to missing thickness due to faulting.



Showing dip direction of wells A, F, I and R

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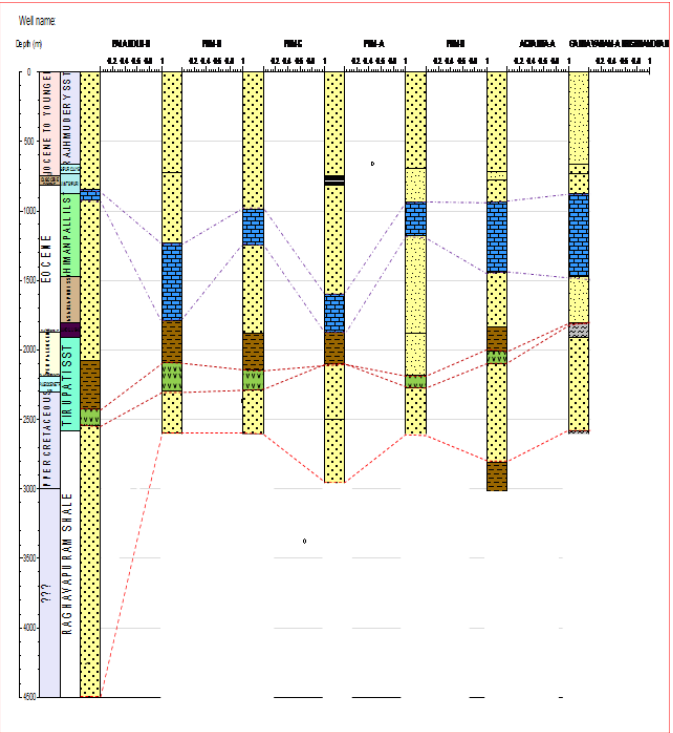
Strike direction:

In strike direction seven wells are drilled those are P, M, K, J, I, H & G.

In the strike profile also variation in thickness, complete absence of some litho units and structural variations are observed. These are probably because of faulting Pasarlapudi, Palakollu Trap & Tirupati formations and due to Bathymetry change and faulting in case of Bhimanapalli formation.

Observations:

- With reference dip direction of studied well it has been observed that deepest well is 'O' and shallowest wells are M, K and I.
- With reference strike direction of studied well it has been observed that deepest well is 'F' and shallowest wells is 'I'.



Showing strike direction of wells P, M, K, J, I, H & G

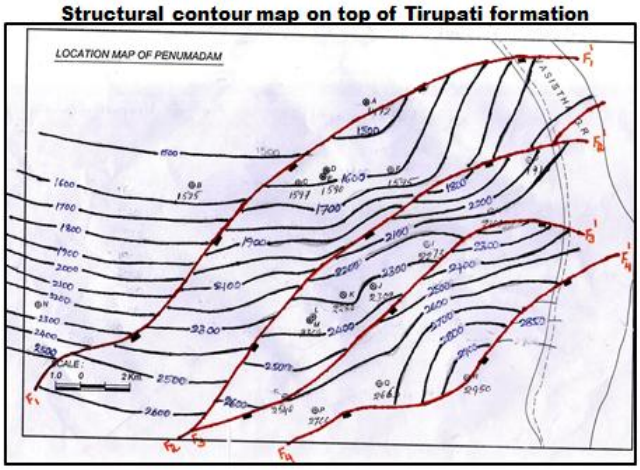
Structure maps:

In order to understand the structural picture at various stratigraphic levels contour maps were prepared at the following levels.

- Tirupati Sandstone
- Razole Top
- Palakollu Shale Formation
- Bhimanapalli Limestone

Tirupati Sandstone

A structure contour map was prepared on top of Tirupati formation.The contour map indicates a gently sloping surface with the slope towards East. The shallowest level of Tirupati is 1472m (in well 'A') towards Wes and the lowest level is 2950m (in well 'R') towards East. The gradient of around 1500 mts in an areal distavce of about 9 Kms with the structure going down towards East.The map clearly brings out curved contours and simple nosing features which when overlayed with the faults in the area form closures for entrapping the hydrocarbons.



Razole Formation

A structure map was prepared on top of Razole Formation. This formation unconformably overlies the Tirupati formation and consists of basaltic trap and intratrapean clay/clay stone and silt stone layers.

The map clearly brings out a sloping surface going down towards East & North East. Here also the shallowest level of Trap is at 1263m (in well 'A') towards West and, the deepest level at 2944m (in well'R') towards East.

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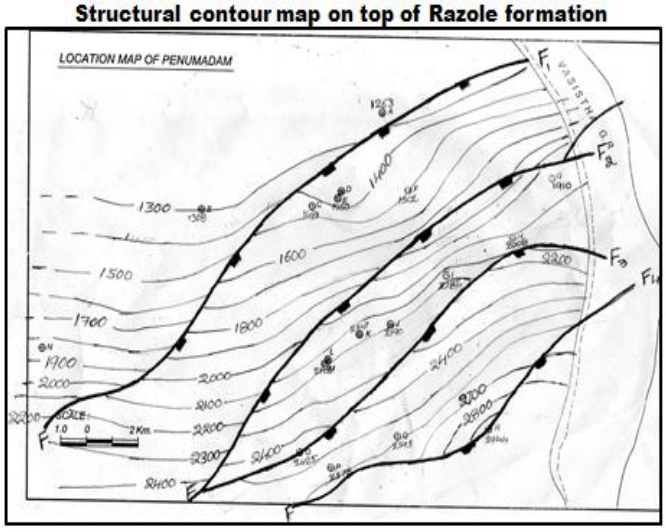
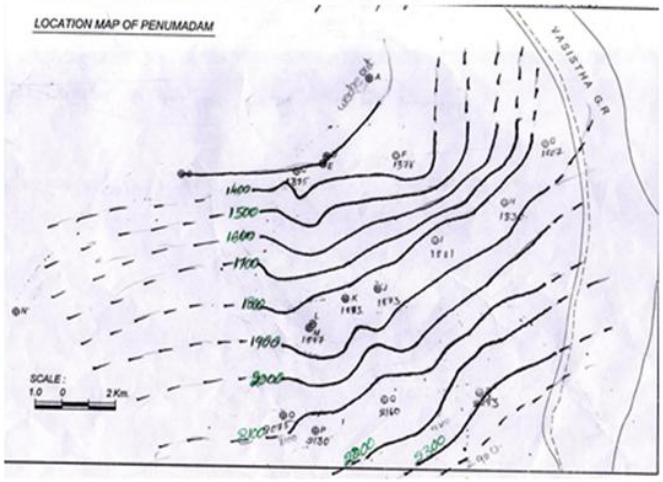
Structural contour map on top of Razole formation



Palakollu Shale Formation:

A structur contour map (Fig. No.: 4.3.3) was prepared on top of Palakollu shale formation .The palakollu shale formation un conformably overlies the lava flows of Razole formation. It consists mainly clay stone /shale with thin beds of sandstone, siltstone and lime stone. The sloping surface observed at deeper levels of Tirupati and Trap level is seen at this level also with the slope towards East.

Structural contour map on top of Palakollu formation



Observations:

- Based on structure contour maps of studied wells almost all the formations are dipping in SSE direction.
- Also observed four major faults are encountered in Tirupati Sandstone and Razole formations.

Bhimanapalli Limestone shows nosily features.

SPECIAL STUDIES

PORE PRESSURE STUDIES:

During drilling mud parameters were critically monitored. These parameters were used for computing and plotting of "D" exponent plot clearly shows the well 'A' was drilled in hydrostatic pressure regime up to depth of 2200m, transitional pressures regime up to depth of 2800m and higher pressure regime up to the drilled depth of 3502m.

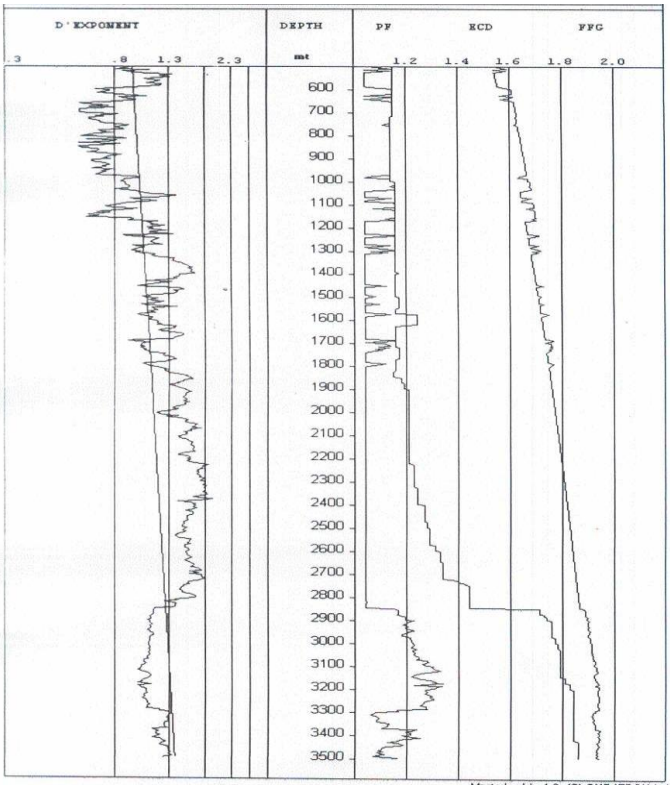


Fig.: D-Exponent plot of well 'A'

SHALE DENSITY STUDIES:

Shale density values were measured from 1250—3500m during drilling and the corresponding values were plotted against depth. The shale density range from 2.0 g/cc to 2.2 g/cc in the interval 1260m—2150m indicates normal pressure regime, 2.25g/cc to 2.5 g/cc in the interval 2150m to 2800m indicates overpressure zone and a major anomaly in the trend of density.

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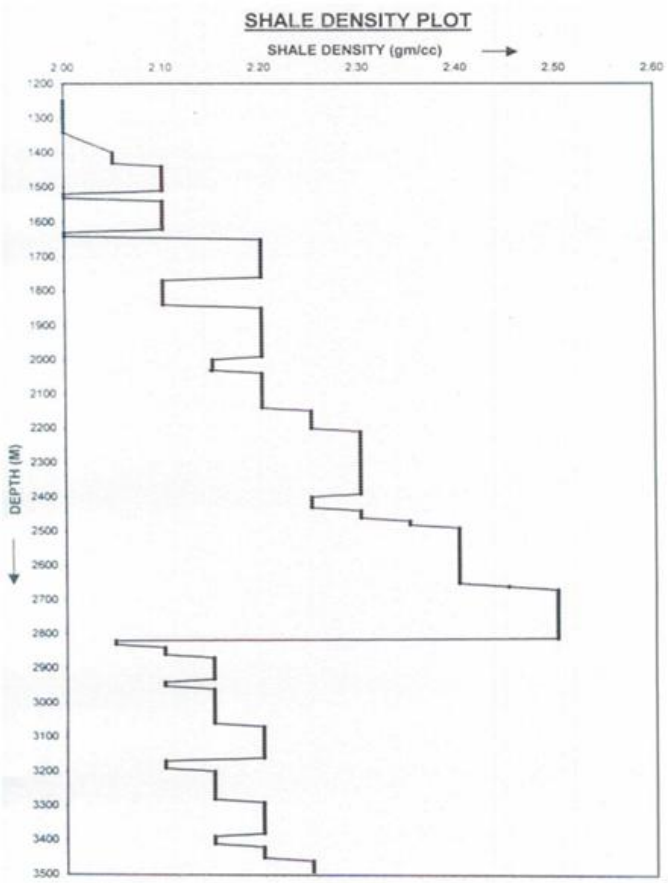
SHALE FACTOR STUDIES:

The shale factor studies were carried on shale samples from 1250—3500m. The study indicates that the Cat ion exchange capacity (CEC) value range from19.5 meq/100gm to 11.80meq/100gm in the interval 1260m to 2090m indicates normal pressure regime 11.80 mec/100gm to 16.0mec/100gm in the interval 2090m to 2520mover pressure transition zone. Two different over pressure zone were identified in shale factor range 13.80meq/100gm to11.40 meq/100gm in the interval 2520m to2800m and range 16.20 meq/100gm to 8.80meq/100gm in the interval 2800mto 3500m. The section 2800m to 3500m is least compact, high over pressure zone in the well.



CALCIMETRY:

Calcimetry analyses were carried out in the interval of 1030—1480m in Razole Formation. It is shown in graphical form.

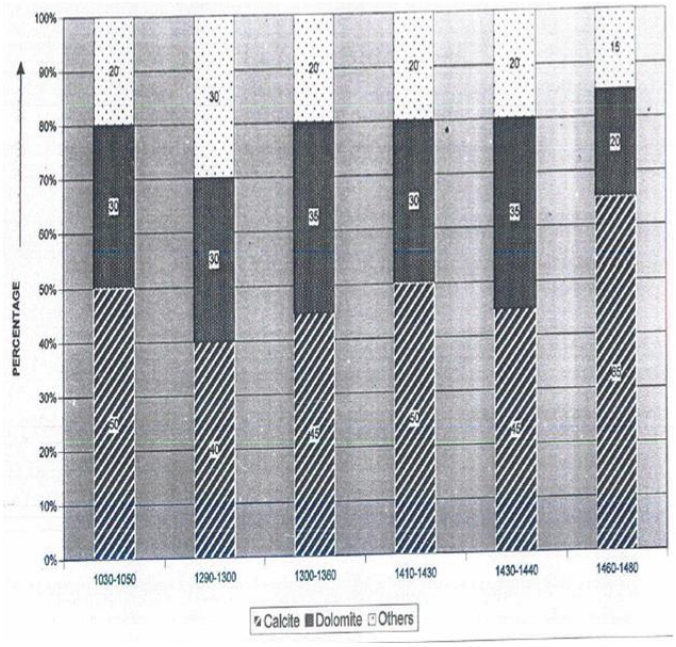


Fig.: Calcimetry plot of well 'A'

OBJECTIVE VS ACHIEVEMENT:

The location 'B' and 'E' was released as an exploratory step out "B" category location, Tirupati Sandstone and sands within Raghavapuram shale. The location was drilled as well 'A' vertically down to a depth 3502m.

Recent commercial gas production from a sand pack within Raghavapuram Shale in the well 'E' and from a number of sands in upper part of Tirupati Sandstone in well 'M' leads to evaluate area for further exploration. Accordingly two time structure map have been prepared at the Raghavapuram Shale and Tirupati Sandstone levels, which has been identified a new prospect to the NE of well 'E' with well defined fault closure at both the levels. The location 'B' and 'E' was released on the above prospect at structurally favourable position to the drilled well 'C' at both the mapped levels. The location was drilled as 'A'.

The drilling of the well 'A' indicates several gas shows in sands within Raghavapuram shale and Tirupati Sandstone. Although sand are less developed in both the formations but some new reservoir facies are well developed towards upper section of Raghavapuram Shale in the interval 2689m to 3413m and towards the bottom part of Tirupati Sandstone in

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the interval 2519m to 2642m depth. Testing of object – III in the interval 2825m to 2822m has proved the commercial accumulation of new gas pool in Raghavapuram Shale. The well is completed in object – III. The object within Tirupati Sandstone is also tested.Therefore the objective of the well is fulfilled.

CONCLUSIONS

Study area "Research on prospect analysis of Penumadam area – Krishna Godavari Basin with special reference to Geology of Penumadam Area. All the wells are exploratory wells and drilled in recent to upper cretaceous age. Correlation were attempted to understand the formation boundaries.

The wells penetrated Recent sedimets-mainly sands and clays, Bhimanapalli Carbonate rocks, Paleocene shales, Paleocene igneous flows (Razole formation), Tirupati deltaic sandstone and Raghavapuram shale.

Structure contour maps show that Regional strike is almost in the NE-SW strike direction and dip is in SSE direction.

Four major faults are observed in Tirupati Sandstone and Razole formations. The throw across the faults vary 50-100m. Isopach study states that, thicknesses vary in different wells may be due to faulting or tectonic set up of the basin.

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