

Surface geochemical prospecting and integration with geophysical data of KG OSN 2004/1 area, KG Offshore.

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Abstract

Petroleum Geochemistry is an effective tool for reducing exploration risk and Surface Geochemical Prospecting helps in search for indirect near surface hydrocarbon expressions of the deeper accumulations. KGOSN 2004/1 geochemical prospecting data is statistically evaluated and integrated with Geological horizons and fault data. Poor correlation between C1 & C2 and C3 compositions indicate plurality of origin of gases and usually biogenic gases correlate poor than the thermogenic gases. Based on C3/C1x 1000 parameter the accumulations from which the seepage occurred might be gas/ gas condensate pools. Methane anomalies integrated with faults indicated a boundary fault and faults in the area may be serving as preferential migratory path ways.

Introduction

The Krishna-Godavari Basin is located on the east coast of India. It covers an area of over 22,480 sq. km Onland and extends offshore into the Bay of Bengal over 183,700 sq. km. The basin is a passive cratonic rift margin and is bounded by northeast-southwest faults which separate it from the Pranhita-Godavari Graben to the northwest and the Cuddapah Basin in the west. The northern and southern boundaries are characterised by northwest southeast cross trends, which separate the basin from the Vishakhapatnam and Palar basins respectively.

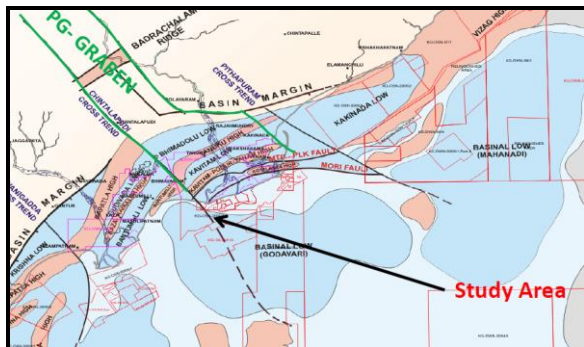


Figure 1: Study area highlighted in red for current study
The study area is sub-divided into number of fault blocks and sedimentation pattern was influenced with

tectonic activity. The most significant tectonic elements passing through the block are the NE-SW trending Matyapuri-Palakollu and the curvilinear Mori fault and Ravva structure building growth faults. Loading of the shelf areas leads to progressive collapse and growth within the detached normal faults. These normal faults typically sole out as listric faults. Two to three phases of growth and toe thrusting is seen in the block, possibly during Eocene, Miocene and Pliocene times.

In this area the Plio-Pleistocene sedimentation is dominated by slope shales and associated slope channel and fan systems. Sedimentation is locally controlled by accommodation developed by major gravitational growth faults. Shale diapirism and compression tectonics are commonly associated with these growth faults. (Fig 2).

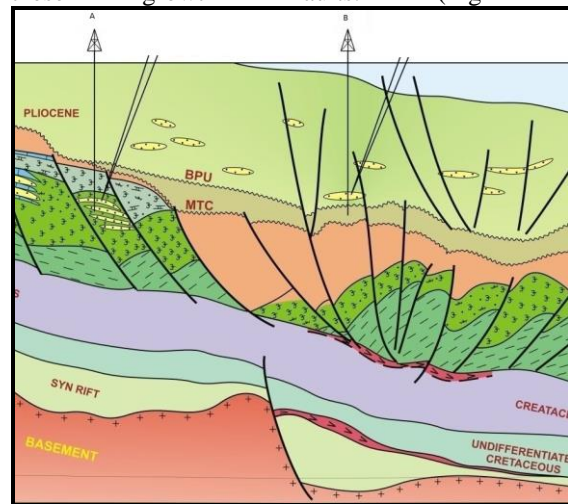


Figure 2: Study area tectonic elements
The generalised stratigraphy of the area is given in Fig. 3.

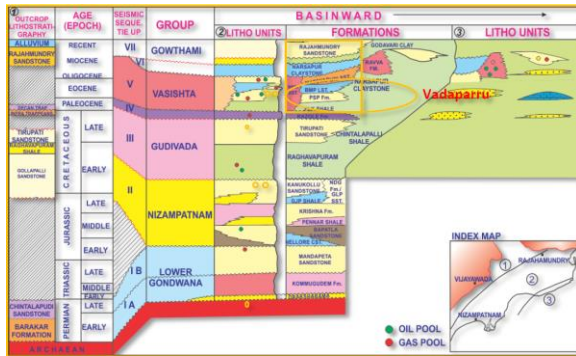
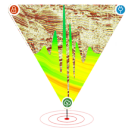


Figure 3. General Stratigraphy of KG basin

Data Sets and methodology

Surface geochemical prospecting data of 560 seabed cores for methane, ethane and propane was generated by Bhrumaji et al was used to carry out statistical output along with integration with the fault system present in the study area.

Frequency histograms of the gases C₁, C₂ & C₃ along with cross plots of C₂ vs C₁ and C₃ vs C₂ were plotted. Distribution pattern of the C₂₊ hydrocarbon in the study area is presented and anomaly maps were generated to understand their preferential concentrations. Seepage pathways from the subsurface accumulations are envisaged by overlaying the fault map on the anomaly maps.

Result and discussion

Surface geochemical techniques target the trace amounts of hydrocarbons that might have migrated from the subsurface accumulations. Various factors affect the abundance and seepage such as, microbial activity, rain, water table etc. Statistical tools are necessary to interpret the data sets to arrive at logical conclusions. Common tools are mean, standard deviation and correlation coefficients. The statistical summary is below.

Variable	Min	Max	Mean	Std. deviation
C ₁	31.05	340.40	109.60	44.96
C ₂	2.49	32.22	9.55	4.12
C ₃	0.16	11.58	2.28	1.34

The large difference in mean and standard deviation of C₁ distribution indicates that there are data sets of anomalous

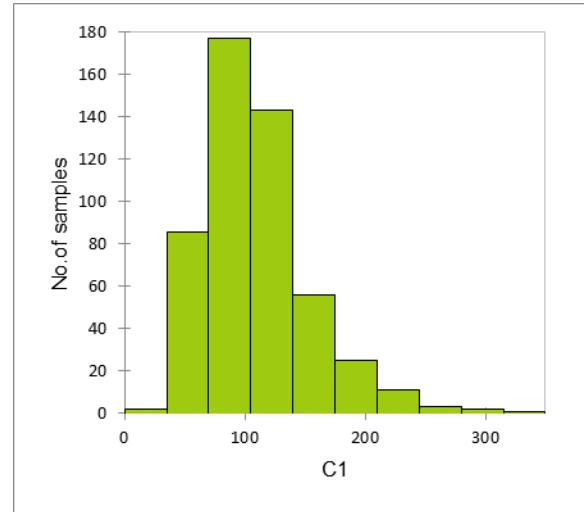


Figure 4. Frequency of C₁ Concentration

population. The frequency histograms of the data set indicates the positive skewness for ethane and propane anomalies.(Fig.4-6) The cross plot of C₁ vs C₂ indicate the poor correlation coefficient between them indicating that they are not related to each other which is an example of bacterial sourced gas. This is further corroborated by the cross plot between C₃ and C₂ that again indicated very poor correlation R²= 0.53 indicating that there is a high chance of mixing of hydrocarbons from either two sources or gases from mixed origin like biogenic and thermogenic (Fig 7-8)

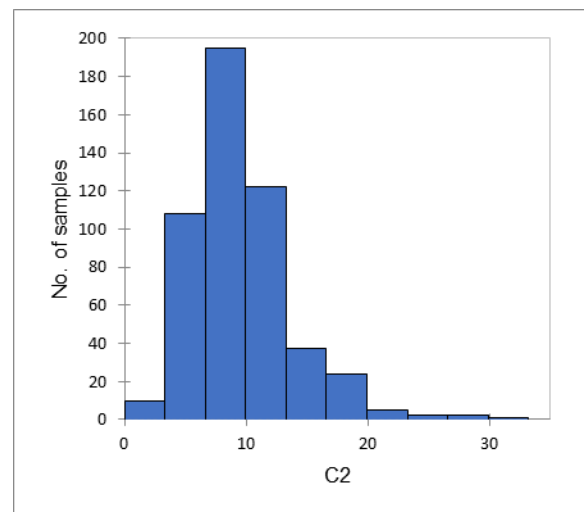


Figure 5. Frequency of C₂ Concentration

The type of source of gas is known by C₃/C₁ x 1000 and if it is in the range of 20-60 suggests the presence

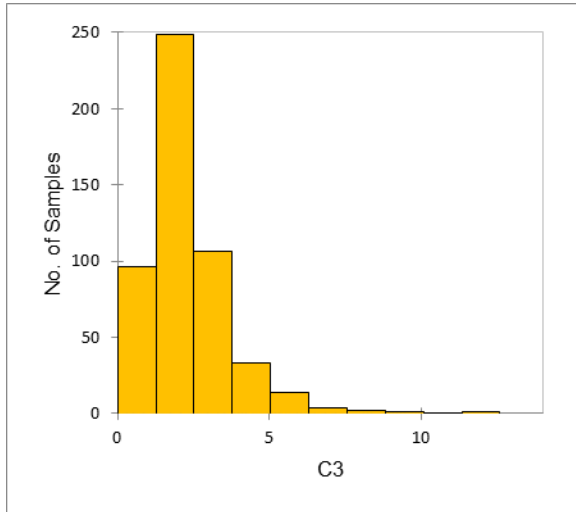
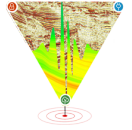


Figure 6. Frequency of C₃ Concentration of gas condensate and if it is from 60-500 it indicated oil. The present data set from the Fig.9 indicate that gas/gas condensate type hydrocarbon in the

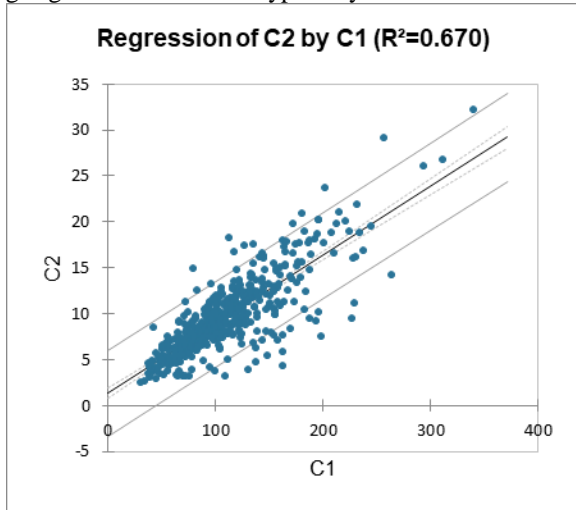


Figure 7. Cross Plot of C₂ vs C₁

accumulation. Gases produced from the drilled wells Fig. 10 further validate this observation as most of the wells produced biogenic/mixed gases

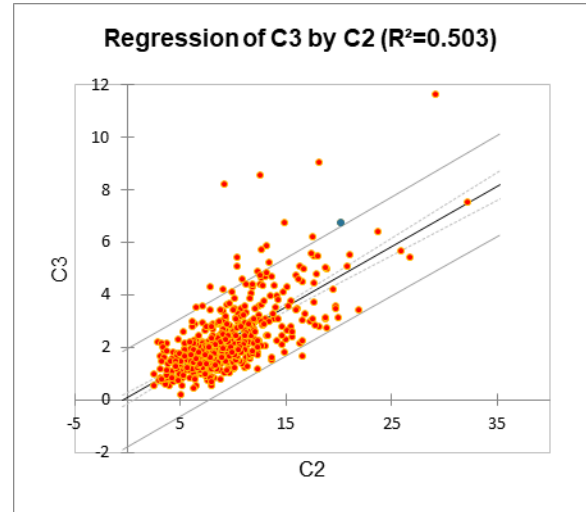


Figure 8. Cross Plot of C₃ vs C₂

with meagre higher homologues.

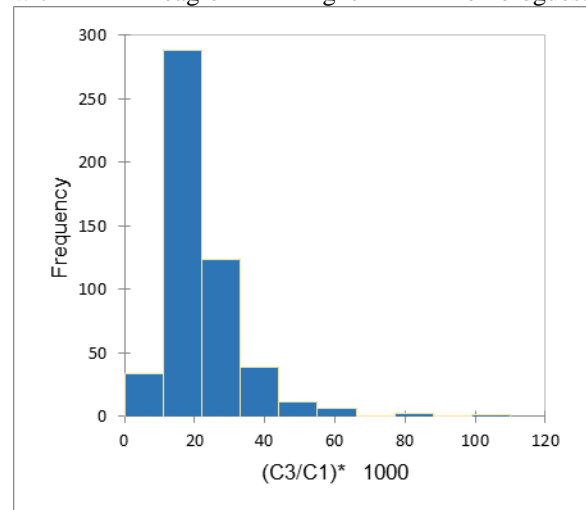
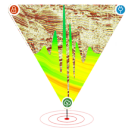


Figure 9. Frequency Plot of C₃/C₁x 1000



A bubble scatter plot with different concentrations of C_2+ with dry and gas wells is plotted in the studied

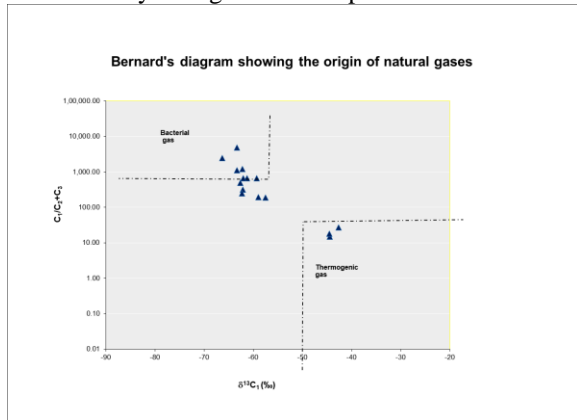


Figure 10. Bernard's Diagram area that indicated a clear demarcation of ethane plus concentration less than 15 ppm and greater than 15 ppm in the North East side as compared to the North West side respectively.

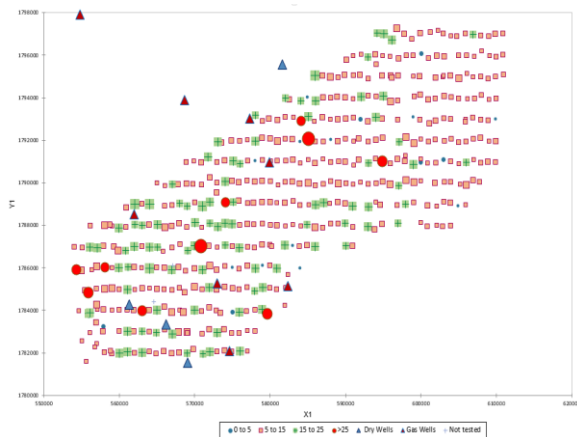


Figure 11. Scatter Plot of C_2+ Concentration

Methane anomaly map is generated and is superimposed on Base Pliocene unit level. Anomalies of C_1 concentration of 140-200 ppm are plotted and found that they are prominent toward the West of Fault C. The concentrations of the seeped hydrocarbons are marginal on the east of the Fault C. Fault C can be inferred as the bounding fault or there are meagre accumulations towards east side. Anomalies 'c, e & f' within Fault A and Fault B are near to the gas wells drilled in the region. Further

anomaly

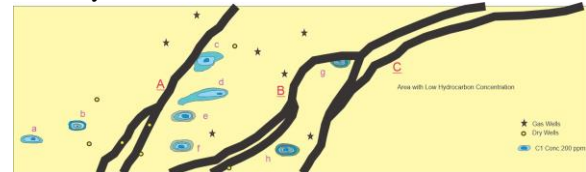


Figure 12. Methane Anomaly map with Faults at Base Pliocene Unit.

'h' is near to the gas well between Faults B & C.

Conclusions.

Though hydrocarbon composition trend $C_1 > C_2 > C_3$ supports the thermogenic origin and petroliferous nature of seeping hydrocarbon gases non-linearity in cross plots indicates these hydrocarbons are genetically not correlated and may be emanating from different petroleum accumulations. Characterization of hydrocarbons through frequency distribution of hydrocarbon gas ratios, predict the seeping hydrocarbons to be from gas and condensate type of hydrocarbons. Integration of the geophysical data indicated probable risk free areas that can further be explored in the study area for new pools.

References

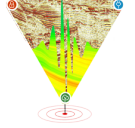
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