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Reinterpretation of the petroleum geochemistry results of Upper Assam Basin, India.

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Abstract: *Reinterpretation of the geochemical data of the published paper became necessary because abnormal variations of source parameters required scientific justifications. Abnormal variations are seen particularly in rock-eval data. Tmax decreasing with depth, S_1 is measured although rock is immature, HI varies from 239 -502 in Barail subsurface samples and 91 – 353 in Eocene samples suggesting abnormal variations of organic facies. Reinterpretation of the results suggests the abnormal variations of the above mentioned parameters are due to the variations of the nature of adsorbed migratory hydrocarbons. The production index and HI variations also support adsorbed migratory hydrocarbons in the assumed Barail & Eocene source rocks. An oil–oil correlation is ultimately made to confirm the migratory hydrocarbon. Saturate GC of the oils suggests Tipam oil is also affected biodegradation. Therefore Kaufman method of GC fingerprint correlation is made that suggests all the three oils are correlatable and therefore confirm all the oils are sourced from another single source and none of the assumed source rocks are true source rock in the basin.*
Keywords: *Upper Assam Oil, Science of Tmax, S1, PI, HI, Oil-Oil correlation.*

I. Introduction

The results of petroleum geochemistry analysis of a part of Upper Assam Basin, India has been published by Mr. S. V.Raju & Mr. N.Mathur of Oil India Limited in Organic geochemistry journal of volume 23 during 1995. Based on the results it has been concluded that the Barail(Oligocene) and Upper-Paleocene to Lower Eocene rocks possess good oil and gas generating potential. It has also been concluded that Barail source rocks are immature throughout the study area and Paleocene – Eocene rocks authors expected to be early mature although six out of fourteen samples of the rock eval results show immature Tmax. Authors have also studied oil-source correlation using GC and GC-MS results and concluded good correlation between Barail and Tipam oils with Barail source rock based on fluorescence and biomarker data. Although oil - source correlation is definitely a technique to prove source of an oil but source character has to be justified first before correlation because the expected source rock if holds migratory hydrocarbon then also the correlation will show positive. In this present work reinterpretation of the source character is made to justify the abnormal variations of rock-eval parameters to evaluate the true source character of the studied samples.

II. Methodology

TOC & Rock-Eval data are reinterpreted particularly using the limitations of the experiments. Oil – oil correlation of Eocene, Barail and Tipam samples are also made using Kaufman et.al (1990) methodology of GC-Fingerprints.

III. Results, Reinterpretation and Discussion

Reinterpretation of the geochemical data of the published paper (Table-1) became necessary because abnormal variations of source parameters required scientific justifications. Variations of Tmax of the samples are not suitable maturity indicators in this study. It is known that Tmax varies with rate of cracking of kerogen which depends on lithology variations of silica, alumina or zeolite and kerogen variations (particularly hydrogen concentration) of organic compounds Hunt(1996) . Here in this work near surface samples show early matured Tmax values but all the Barail borehole samples are immature. Even in the borehole SAR samples of Barail and DKM samples of Erocene show lower Tmax with higher S2 in deeper samples. Because the abnormal variations taking place in the same stratigraphic horizon within a depth variation of nearly 100m it is expected lithology variations are not affecting Tmax variations. Kerogen variations are expected to be responsible for such Tmax and S2 variations.

Earlier authors have not calculated PI [S1/(S1+S2)] which can show contribution of hydrocarbons in the PI range of 0.1 to 0.4. In the near surface samples only one is immature [Tmax <430 (Dil-1)] and rest all are early mature but none of them show PI> 0.1 suggesting no hydrocarbon production contribution from the samples. This is because S_1 is comparatively much lower than S_2 which is very much justified because samples are close to surface. Lower S_1 can also be related to C_{24} and above composition of left over migratory free hydrocarbons(Tarafa,1983).

All the 10 borehole samples of Barail however show immature and no production contribution. Immediate question arises what is the source of available S_1 if the rock is immature? Of course the rock has not generated hydrocarbons but possibly it might have adsorbed some migratory hydrocarbon from another source that have made available S1 hydrocarbons. Comparison of the average near surface samples with borehole samples show near surface samples are more matured than borehole samples and S1, S2 and TOC are also comparatively very high. The higher maturity of near surface samples can be possible only if the samples are uplifted from deeper horizons or the kerogens are not same deposits. It is also established that organic carbon always deposit less in deeper bathymetry. Therefore higher TOC in the near surface samples cannot be related to deeper horizons of the measured borehole samples. Even if they belong to the same stratigraphic level but the organic matter is not depository. Therefore the available S1 might have been sourced as adsorbed migratory hydrocarbon from some deeper source. Particularly the surface samples may be rich coaly organic matter which adsorbs more than the low TOC subsurface samples. However it may also be argued that migratory hydrocarbons are known from PI >0.5 but here PI is never exceeding 0.5. This is justified by the fact that PI become >0.5 only when S_1 become more than S_2 which is possible when generated hydrocarbons are mixed with some more similar migratory hydrocarbons or at a very high maturity when S_1 exceeds S_2 but if the rock does not generate hydrocarbon then S_1 and S_2 shall depend on the adsorption of migratory hydrocarbons. Particularly compounds of C_{24} and above will respond as S_2 and lower compounds will respond as S_1. Therefore if the rock is not generative then migratory hydrocarbons are not always expected to exceed 0.5 PI.

In borehole Eocene samples DKM1, 3C, 5A and 5B are deeper wells amongst the six DKM wells which are immature but have high TOC, S1 and S2 results also suggesting migratory hydrocarbon. Of the four DKM samples only DKM3A, the shallowest one is mature and other five deeper wells are immature. Of the four N466 samples all are shown to be matured but the deepest 466D is least mature and N466B and C though matured but show no production contribution because S1 is very low compared to S2. The organic facies for these four samples varies to a large extent showing HI=127.91 to 356.95 suggesting S2 variation is due to compositional variations of adsorbed migratory hydrocarbons. Similarly, in K1 and K2 samples also show the deeper K2 is immature and contributing hydrocarbon production but shallower K1 is mature but do not contribute hydrocarbon production. Therefore these also represent migratory hydrocarbons. The last two samples JEN-1 & N317 although showing matured contribution of hydrocarbons but because they belong to the same stratigraphic horizon it is most possible they also belong to migratory hydrocarbons because of their abnormal organic facies variations which is not possible in sedimentary organic matter. Thus all the rock eval results can be reinterpreted as migratory adsorbed organic matter than to accept them as true source of available hydrocarbons. Attempt is made to confirm migratory hydrocarbon in the Eocene to Barail source rocks using oil-oil correlation. Correlation through use of fluorescence spectrum of oils and assumed source rock extracts made by earlier authors show differences between them are very minor representing minor changes in composition. Fig-1A shows Tipam oil is affected by biodegradation. Correlation is then made following Kaufman(1990) technique to identify reservoir compartmentalization(Table-2). Correlation in Fig.1B show all the oils in different reservoirs are highly correlatable suggesting one migratory oil remained source of all of them.

IV. Conclusion and Recommendation

Based on the above discussions it is concluded that in Upper Assam study area of the authors of published article oils in Barail, Tipam and Lower Eocene – Paleocene horizons are not sourced from Barail source rock or Lower Eocene source rock. The source parameters in the expected rocks are developed due to adsorption of migratory oil from some deeper source which is not yet identified by drilling. It is therefore recommended to drill at least one or two parametric wells down to proved Precambrian basement close to depocentres of the basin. This will definitely help to identify the true source rock in this basin and will also help to identify the basin evolution and seismic interpretation.

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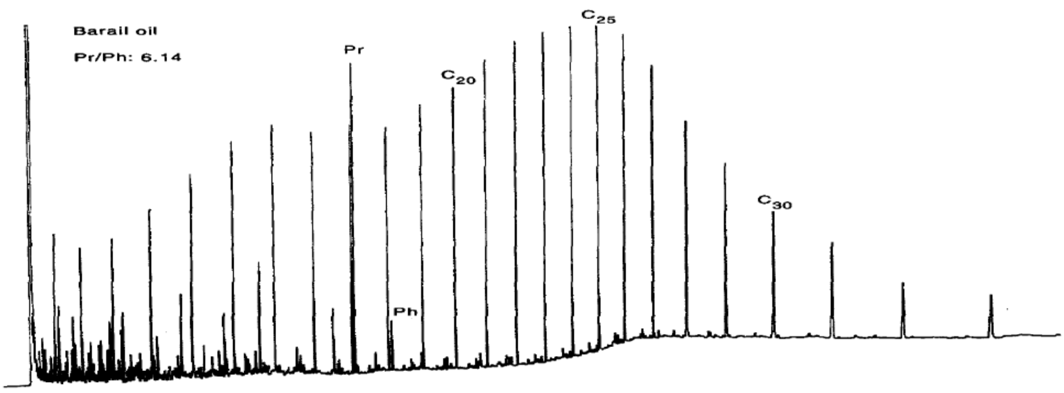

Fig. 9. Gas chromatogram (saturate fraction) of Barail crude oil.

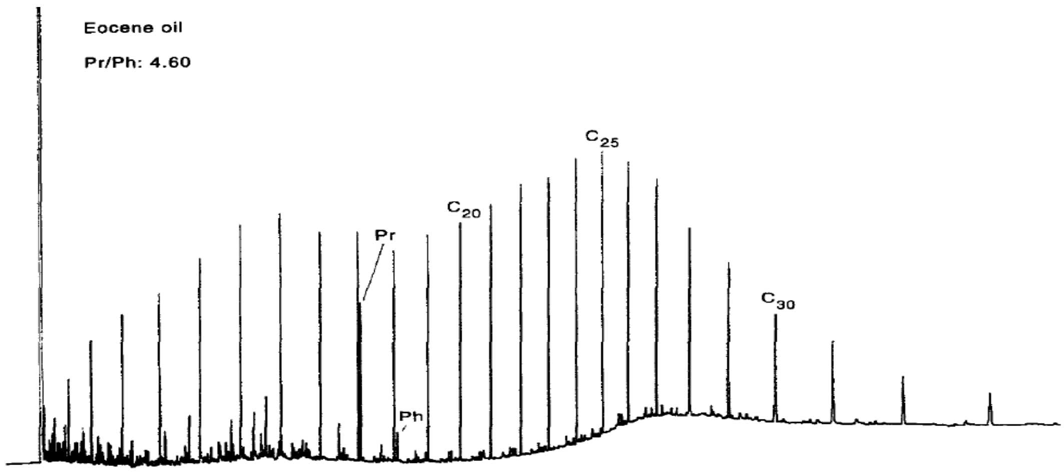

Fig. 12. Gas chromatogram (saturate fraction) of Eocene oil.

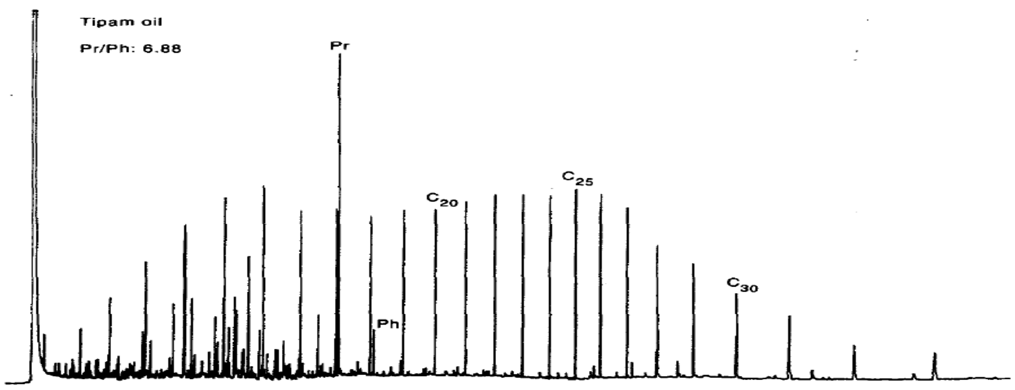

Fig. 10. Gas chromatogram (saturate fraction) of Tipam crude oil.

Fig.1A: Oil-Oil correlation using saturate GC

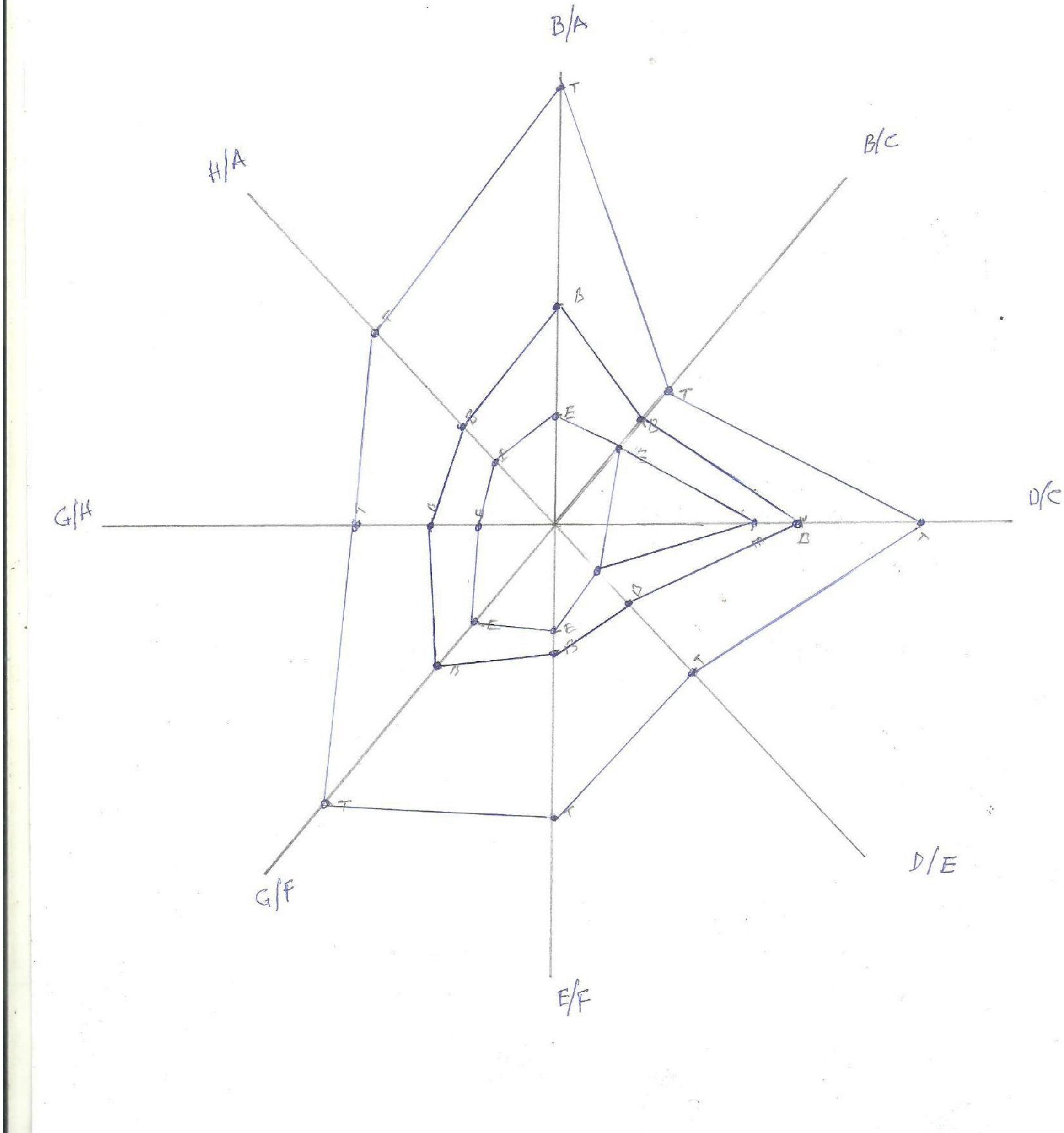

Fig.1B: Oil-Oil Correlation

Table-1: Rock-Eval Results of Raju & Mathur (1995)

Barail Near surface samples :								
	Depth(m)	TOC%	S1	S2	Tmax	HI	OI	PI
Mta-1		77.02	8.76	288.38	435	374.42	5	0.029
Mta-2		64.74	8.15	255.24	431	394.25	22	0.031
Mta-3		66	7.91	268.03	433	406.11	12	0.029
Mak-1		15.99	1.19	34.37	436	214.95	59	0.033
Dli-1		38.96	6.89	222.43	425	570.92	43	0.030
Trp-1		12.75	2.62	44.73	436	350.82	43	0.055
Borehole samples:								
Sar-1A	3170	5.25	0.05	4.8	425	91.43	29	0.010
Sar-2A	3260	14.16	0.88	32.15	415	227.05	15	0.027
Sar-2B	3220	13.46	0.38	27.29	422	202.75	12	0.014
BBL-1A	3096	41.3	4.18	98.3	418	238.01	43	0.041
DBL-1D	3160	16.73	1.13	33.45	420	199.94	59	0.033
BBL-1C	3230	2.45	0.1	2.55	423	104.08	44	0.038
DHL-								
1A	3140	12.72	1.5	35.53	420	279.32	23	0.041
DHL-!B	3220	38.85	1.85	59.76	426	153.82	20	0.030
TNL-7A	3240	38.85	2.98	76.72	419	197.48	27	0.037
TNL-7B	3320	7.93	0.72	28.01	422	353.22	41	0.025
Borehole Eocene samples:								
DKM-1	3558	65.85	31.96	254.2	423	386.03	3	0.112
DKM-3A	3477	2.01	0.71	4.8	435	238.81	11	0.129
DKM-3B	3488	3.22	1.12	9.7	428	301.24	7	0.104
DKM-3C	3546	6.71	3.86	25.8	425	384.50	9	0.130
N-466A	4492	3.98	1.71	10.2	441	256.28	7	0.144
N-466B	4496	3.9	0.88	11.7	442	300.00	7	0.070
N-466C	4499	3.67	0.92	13.1	441	356.95	10	0.066
N-466D	4542	2.58	0.95	3.3	432	127.91	13	0.224
K-1	3538	3.64	1.02	14.7	431	403.85	8	0.065
K-2	3601	4.26	3.62	12.5	423	293.43	9	0.225
JEN-1	4135	6.22	4.1	15.5	437	249.20	4	0.209
N-317	4426	10.5	6.6	54.5	445	519.05	4	0.108
DKM-5A	3540	5.86	1.4	29.42	428	502.05	7	0.045
DKM-5B	3650	4.85	1.35	17.3	427	356.70	5	0.072

Table-2: Ratio Values of Parameters measured for correlation

	Bar	Tip	Eoc	Bar	Tip	Eoc
A	2.5	2 2	2			
B	10	9 5	5			
C	4	5	2			
D	18	19	9			
E	9	9	6			
F	4	3	2.5			
G	13	11	7			
H	6	5.5	4			
B/A	4	4.5	2.5	4.384	8.672	2.213
B/C	2.5	1.8	2.5	2.74	3.469	2.21
D/C	4.5	3.8	4.5	4.932	7.32	3.982
D/E	2	2.1	1.5	2.192	4.047	1.327
E/F	2.25	3	2.4	2.466	5.781	2.124
G/F	3.25	3.66	2.8	3.562	7.053	2.478
G/H	2.16	2	1.75	2.367	3.854	1.549
H/A	2.4	2.75	2	2.63	5.299	1.77

Note: In the earlier published paper GC figures are plotted but intensity measure Y-axis scale is not given. Intensity variation factors are now calculated using Pr/ph given data:
Barail: 1.096, Tipam: 1.927 & Eocene: 0.885.
Parametric ratios are finally calculated based on the above factors.