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Research Paper Geology

Textural Variation of the Tipam Reservoir Sandstone of Digboi Oilfield, Assam.

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ABSTRACT

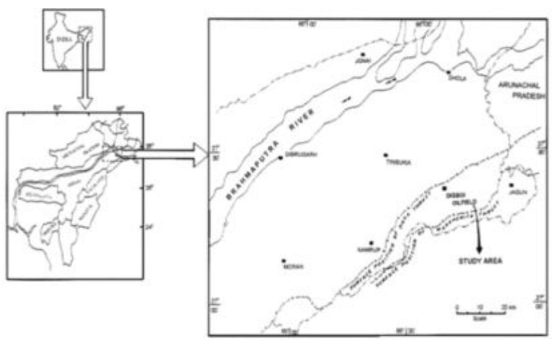
Commercial discovery of oil in India was discovered with the advent of Digboi oilfield in Upper Assam in 1889. The oil bearing horizons of the oilfield belong to the Tipam Sandstone Formation of Miocene age. The textural study reveals the dominance of suspension and saltation populations over the rolling population in the transporting medium at the time of deposition of the sandstones. The sandstones are moderately sorted to poorly sorted with floating type of texture indicating a wide range of fluctuations in the transporting medium. The various interrelationships of size parameters indicate that the sediments were primarily deposited in a fluvial environment under the action of river tractive current. The progressive diagenetic alteration in the sandstone controls its reservoir quality.

Keywords :

Introduction

The Upper Assam Basin in the northeast part of India is one of the oldest petroleum producing basins of the world. The basin is bounded by in the north by the eastern Himalayas, in the east by the Mishimi Massif, in the south by Naga-Patkai Hills and in the west by the Mikir Hills and Shillong Plateau. Exploration for hydrocarbon started way back in 1866 and the first commercial discovery of oil in this basin made with the advent of Digboi oilfield in 1889. Since then the Digboi oilfield is continuously producing oil for more than hundred and twenty years and the present production rate from the oilfield is very low. The Digboi Oilfield is situated in the extreme north-east corner of India, immediately south of Naga Thrust

Figure 1 : Location map for the study area



The area is bounded by latitudes 27°22'N - 27°27'N and longitudes 95°36'E - 95°48'E. A total of 1001 wells had been drilled till 1971 with intermittent interruption (1959-1970). About 90% wells are shallow with a depth less than 1500 m and the deepest being drilled to a depth of 3311m. There are 24 oil/gas bearing productive sands all in the Tipam Sandstone Formation and the underlying thin Surma Group occurring within a stratigraphic rang of 1200 m. Gas occurs also in Girujan Clay Formation, but not in commercial quantities.

Materials and Methods

In this paper primary focus is made on the study of textural variation to find out the depositional history of the oil bearing Tipam Sandstones of Digboi Oilfield. Keeping this view in mind 30 nos. of drill core samples have been collected from the oilfield with due permission from the management of Oil India Limited, Duliajan, Assam for detail textural study. The mechanical analysis has been done in the department of Applied Geology, Dibrugarh University, Assam.

Discussion

In detrital rocks the final texture of the deposit is governed by size, shape, roundness, surface texture, orientation, packing and mineral composition. Grain size is an important textural element which helps to understand the dynamic conditions of transportation and deposition of the sediments in a basin. In the present study, textural analysis with reference to grain size has been undertaken to describe the samples in terms of statistical measures to determine the processes involved in the deposition of reservoir sandstones of Digboi Oilfield. Attention has been given towards interpretation of the individual size parameters, interrelationship of size parameters and the general characteristics of the size frequency distribution. The cumulative curves have been prepared and are found to be bimodal in nature. The slope of the peaks of the curves is gentle but some of them show little steepness in their peaks. The finer and the coarser tail portions of the curves do not extend beyond 5Ø and 0.5Ø respectively.

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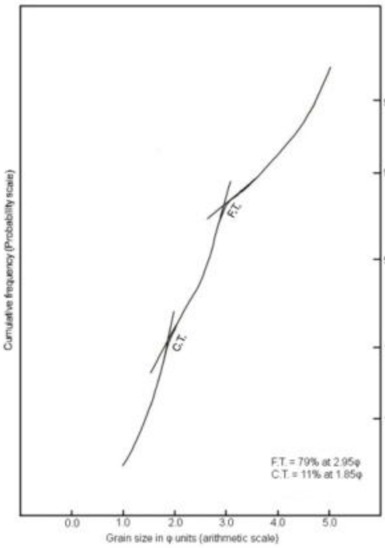
Figure 2: Representative cumulatve curve of the Tipam Sandstone Formation with inflection points.



It indicates the dominance of suspension and saltation populations over the rolling population. The fine truncation point is at 3Ø. Suspension population above this fine truncation point represents the finer materials that are deposited in somewhat quiet environment of deposition. The maximum grain size of sediment that may be held in suspension depends primarily upon the turbulence energy of the transporting medium. It is usually less than 0.1mm. But in the present case the maximum grain size is found to be ≈ 0.13 mm (2.9Ø) and therefore it can be inferred that the turbulence energy of the depositional medium was more than the normal at the time of deposition. The suspension population varies from 55% to 71.5% in the distribution. On the other hand, saltation population varies from 21% to 41.8% and representing materials of medium to fine sands (1.55Ø to 3Ø). There is very little information regarding the maximum grain size which moves in saltation. In the present study the maximum grain size deposited by this population is 0.35mm (1.5Ø) which is indicative of comparatively higher current velocity. The rolling population is not so well developed in the present case and it comprises 3.2% of the size distribution. The maximum size transported by this population is 0.75mm (0.5Ø) which indicates high current velocity.Though cumulative curves have been described in terms of three populations limited by definite size range but in actual practice there may not be any sharp boundary between the populations. Therefore it can be assumed that there existed a transitional zone of intermixing between two populations.

The statistical size parameters of the grain size distribution are calculated from certain critical points on the cumulative curves, following the technique of Folk and Ward (1957). The computed mean size of the sandstone of present study varies from 2Ø (0.25 mm) to 3.35Ø (0.10 mm). The size range of all the samples lay within fine to very fine sand. The sandstones are moderately sorted to poorly sorted indicating a wide range of fluctuations in the transporting medium along with the shape and density of the constituent particles. The sandstones are finely skewed to nearly symmetrical. Positive skewness of the sandstones may point to uni-directional transport or the depositions of sediments in sheltered environment. The sandstones are chiefly mesokurtic to leptokurtic, although few samples are found to be very leptokurtic. From the various interrelationships of size parameters it can be inferred that overall sedimentation took place under fluviatile environment

Figure 3: (a-d). Cross plots of statistical parameters (after Friedman 1961 & 1967).

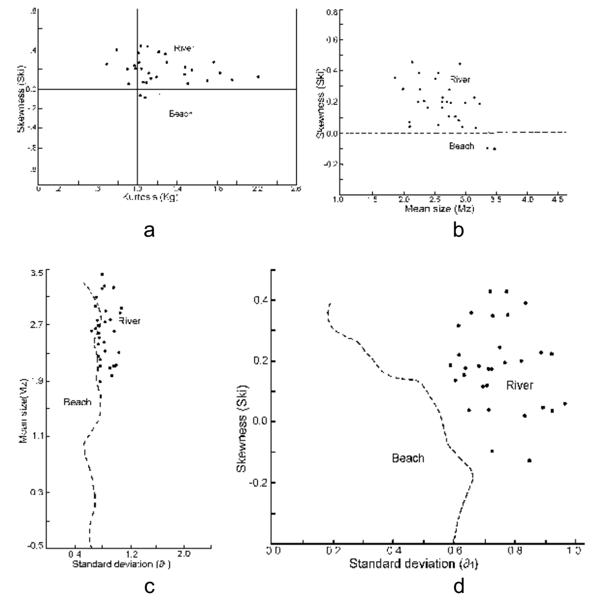


Figure 4 : (a-d). Cross plots of statistical parameters. (a and b) after Moiola, 1968; (c) after Thomas, 1972; (d) after Friedman, 1965.

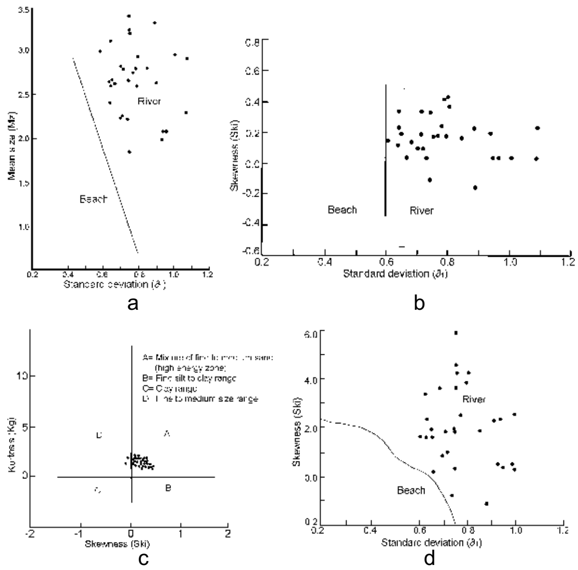
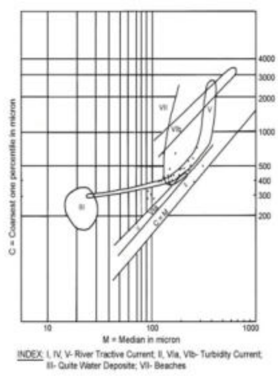


Figure 5 : C-M plot of Tipam Sandstones of present study area.



The C-M pattern indicates that the sediments were primarily deposited in a fluvial environment under the action of river tractive current.

Conclusion

The textural study reveals the dominance of suspension and saltation populations over the rolling population in the transporting medium at the time of deposition of the Tipam Sandstones of Digboi Oilfield. The turbulence energy was more than the normal at the time of deposition. The sandstones are moderately sorted to poorly sorted and deposited in a fluvial environment under the action of river tractive current.

Acknowledgements

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Table 1: Modal analysis data of the Tipam Sandstones of Digboi Oilfield.

Sample No.	Quartz								Feldspar	Rock fragments	Mica	Cement	Matrix
	NU	U	2-3 units per grain	>3 units per grain	chert	Qm	Qp	Q=(Qm+Qp)					
1	16.00	11.00	6.00	8.50	4.00	27.00	18.50	45.50	5.50	7.50	6.50	35.00	-
2	18.00	11.50	4.00	4.50	6.00	29.50	14.50	44.00	8.50	9.00	1.50	37.00	-
3	12.00	15.00	21.00	14.00	3.00	27.00	38.00	65.00	3.00	7.00	11.00	6.00	8.00
4	15.00	12.00	6.00	9.00	3.00	27.00	18.00	45.00	7.50	6.50	6.00	35.00	-
5	12.00	10.00	15.00	13.00	4.00	22.00	32.00	54.00	6.00	7.00	12.00	5.00	16.00
6	18.00	10.00	8.00	9.00	11.00	28.00	28.00	56.00	1.00	13.00	3.00	9.00	18.00
7	13.00	17.00	19.00	7.00	4.00	30.00	30.00	60.00	6.00	10.00	6.00	11.00	7.00
8	12.00	13.00	10.00	16.00	6.00	25.00	32.00	57.00	4.00	10.00	8.00	16.00	5.00
9	13.00	20.00	8.50	7.00	5.00	33.00	20.50	53.50	10.00	9.00	9.00	6.00	12.50
10	19.50	21.00	7.50	7.50	5.00	40.50	20.00	60.50	7.00	11.00	9.00	4.00	8.50
11	14.00	23.00	13.00	10.00	3.00	37.00	26.00	63.00	2.00	6.00	6.00	3.00	20.00
12	7.00	18.00	4.00	18.00	4.50	25.00	26.50	51.50	3.00	10.00	15.50	5.00	15.00
13	10.00	11.00	6.00	18.00	3.00	21.00	27.00	48.00	7.00	6.00	15.00	4.00	20.00
14	22.50	20.50	3.50	10.50	5.00	43.00	19.00	62.00	5.50	11.00	5.00	4.00	12.50
15	11.00	15.00	10.00	17.00	3.00	26.00	30.00	56.00	1.00	7.00	8.00	-	28.00
16	24.00	12.00	2.00	4.00	4.50	36.00	10.50	46.50	2.00	7.00	4.50	19.00	21.00
17	17.00	14.00	6.00	11.00	3.00	31.00	20.00	51.00	8.00	8.00	12.00	-	21.00
18	15.00	24.00	4.00	10.00	5.00	39.00	19.00	58.00	6.00	6.5.00	4.50	21.00	4.00
19	28.00	11.00	4.00	10.00	6.00	39.00	20.00	59.00	3.00	10.00	5.00	23.00	-
20	15.00	14.50	6.50	18.50	5.00	29.50	30.00	59.50	1.00	11.50	2.00	22.00	4.00
21	7.00	22.00	18.00	13.00	3.00	29.00	34.00	63.00	2.00	5.00	8.00	4.00	18.00
22	17.00	12.00	11.50	17.50	5.00	29.00	34.00	63.00	2.00	10.00	5.00	2.00	18.00
23	5.00	26.00	16.00	12.00	3.00	31.00	31.00	62.00	2.00	7.00	9.00	1.00	19.00
24	15.00	16.50	4.50	17.00	5.50	31.50	27.00	58.50	3.50	12.00	3.00	23.00	-
25	12.00	17.00	6.00	6.00	4.00	29.00	16.00	45.00	4.00	8.0	7.00	33.00	3.00
26	10.50	13.00	9.50	20.50	4.00	23.50	34.00	57.50	4.00	7.50	8.00	23.00	-
27	11.00	5.50	11.00	23.00	4.00	16.50	38.00	54.50	2.50	13.00	4.00	25.00	1.00
28	13.00	15.00	5.00	16.00	5.00	28.00	26.00	54.00	3.00	11.00	6.00	18.00	8.00
29	18.00	13.00	10.00	14.00	5.50	31.00	29.50	60.50	3.00	8.50	4.00	20.00	4.00
30	13.00	18.00	8.00	12.00	5.00	31.00	25.00	56.00	2.00	9.00	6.00	23.00	4.00

NU, None undulose, Qp, Polycrystalline quartz, U, Undulose, Qm, Monocrystalline quartz

Table 2: Graphic size parameters of the Tipam Sandstones of Digboi Oilfield

Sample no	Mean size (Mz)	Standard deviation (δi)	Skewness (Ski)	Kurtosis (kg)
1	3.20	0.75	0.05	1.10
2	2.96	0.81	0.45	1.03
3	3.26	0.76	0.19	1.10
4	2.96	1.05	0.07	1.08
5	3.35	0.89	-0.11	1.14
6	2.28	0.71	0.20	0.93
7	2.41	0.67	0.16	1.10
8	2.59	0.80	0.04	0.79
9	2.63	0.63	0.17	1.81
10	2.11	0.93	0.07	1.95
11	2.85	0.71	0.12	2.20
12	2.00	0.95	0.23	0.98
13	3.40	0.75	-0.08	1.08
14	1.88	0.75	0.36	1.21
15	3.01	0.61	0.18	1.57
16	2.78	0.72	0.12	1.20
17	2.25	0.70	0.38	1.00
18	3.18	0.64	0.24	1.00
19	2.65	0.65	0.20	1.49
20	2.56	0.64	0.35	1.28
21	2.60	0.68	0.05	1.48
22	2.80	0.86	0.20	1.13
23	2.66	0.91	0.24	1.11
24	2.70	0.75	0.20	0.97
25	2.13	0.96	0.05	1.67
26	2.34	0.08	0.21	1.56
27	2.93	1.09	0.04	0.88
28	2.30	1.09	0.28	1.24
29	2.18	0.77	0.46	1.10
30	2.78	0.78	0.28	1.76

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