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TEXTURAL ATTRIBUTES OF THE SINGRIMARI SANDSTONES EXPOSED IN AND AROUND SINGRIMARI, WEST GAROHILLS DISTRICT, MEGHALAYA AND DHUBRI DISTRICT, ASSAM, INDIA

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ABSTRACT

Singrimari sandstones are of two types : a basal coarser and younger finer variety. The basal sandstones are poorly sorted, slightly skewed and leptokurtic while the younger units are better sorted, positively skewed and leptokurtic. Finer fractions are dominant in both the distributions, while coarser clasts influence the basal population. Either source control or energy variations is responsible for these features. While energy variation is better applicable to the younger units, both the options may be forwarded for the older unit. A turbid or rapid mode of transportation supports the genesis of the basal sandstones, which seem to refine its characteristics to become graded with time and carry the prelithified detritus of the younger sandstones. Both the distributions show strong tendency of clogging in a riverine environment. While the basal unit shows impact of higher energy and affinity towards a braided zone, the younger variety hints at the influence of a lower energy regime usually impressive in the lower reaches of an alluvial setup. However, field settings nullify these considerations owing to vertical disposition of the lithounit and, in such a case, temporal dynamism of the depositional basin seems to be more vindictive.

Key words: Singrimari Sandstones, textural attributes, Garo Hills (Meghalaya), Dhubri (Assam).

INTRODUCTION

The Singrimari area lies at the western most tip of the Assam-Meghalaya Plateau. A sedimentary blanket of roughly 15 sq. kms. sprawls here upon an eroded Precambrian basement (fig.1) and reflects Gondwanide affinity (Fox 1937; GSI, 1974; DGM-Assam, 1982; Baruah, 2000). Sedimentation here starts with a southerly pinching basal, coarser sandstone having pebbles towards the base. The buff-brown, friable-compact fining upward unit shows pinching and swelling and minor westerly slipping step faults apart from hosting carbonaceous shale. This unit shows two truncated cyclothem-like sequences. Following a hiatus, the next sedimentation resulted in another northerly pinching sandstone. Hosting sedimentary pebbles of the nature of the basal sandstone towards the base, this upper unit is buff-pink, friable-compact and fine- very fine grained. It entombs minor claystones and Fe-laminations which exude a seasonal increament like look. The whole sedimentary column is further intruded by dolerite intrusives. A highly extensive drainage network sheds recent alluvium to sporadically cap the older lithounit and establish itself as the youngest member of the Singrimari lithostratigraphic column which may be summarised in table 1.

Table 1. Lithostratigraphy of the Singrimari area.

AGE	GROUP	FORMATION	LITHOTYPES
Recent			Alluvium
~~ unconformity ~~~~~~~~~~			
Jurassic?			Dolerite
~~ unconformity ~~~~~~~~~~			
L. Permian	Damuda	Barakar	Fine (upper) sandstones, claystone siltstone.
to			~~~~~~~~ hiatus ~~~~~~~~
U. Carboniferous		Karharbari	Pebbly (basal) sandstones with layers of carbonaceous shale and specks of Jhama (?)
~~ unconformity ~~~~~~~~~~			
Precambrian			Quartzofeldspathic gneiss-granite gneiss calc-silicate gneiss amphibolites migmatite granite vein rocks (pegmatitie and quartz vein).

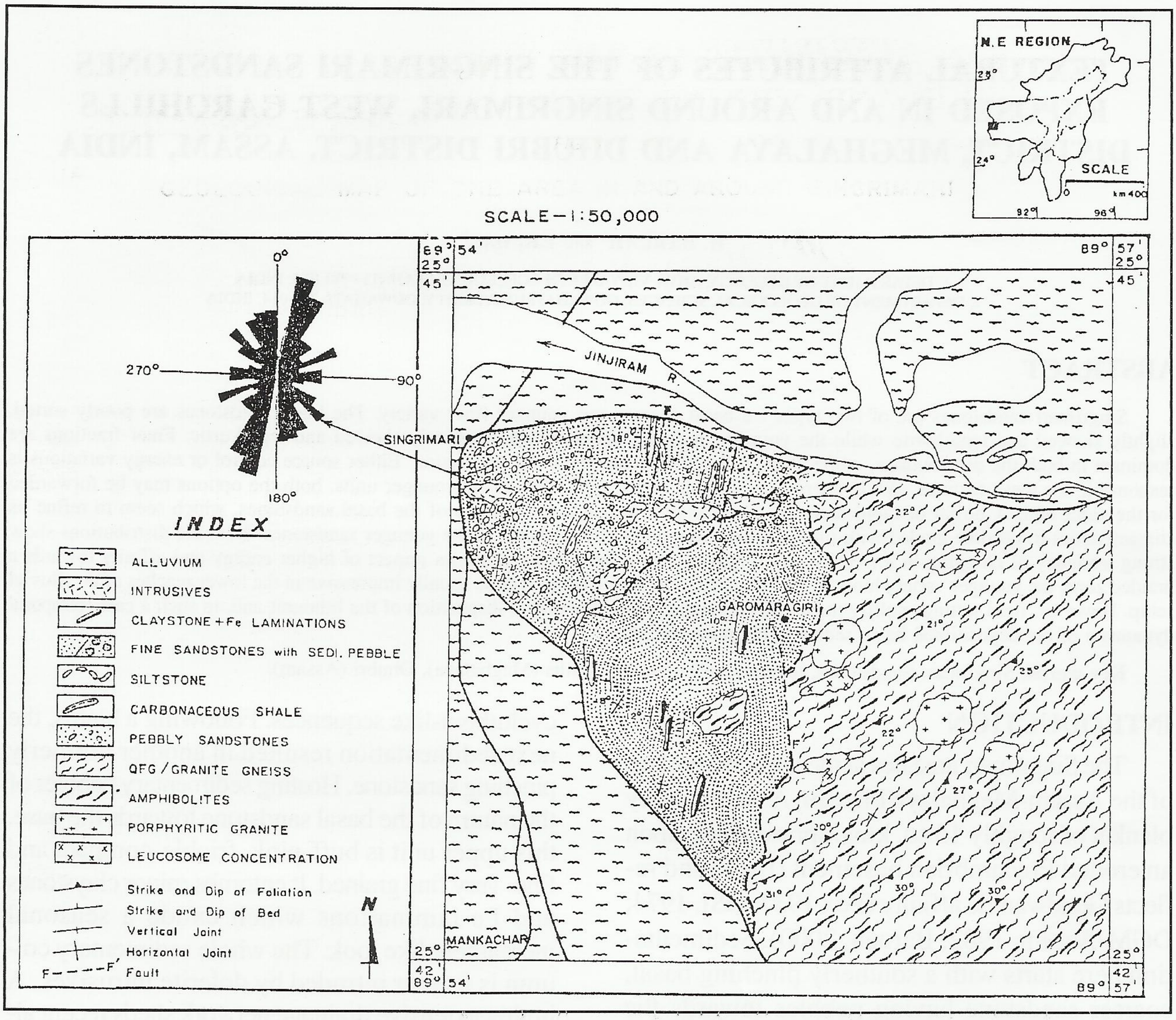

Fig. 1. Geological map of the area in and around Singrimari.

The present paper seeks to find out and discriminate between textural attributes of the two sandstone types. The work plan has been initiated with 75 numbers of disaggregated, representative samples (Carver, 1971) being put to "Composite Sieve and Pipette Method" analysis in 1/2 Q intervals (Krumbein and Pettijohn, 1938). Data obtained from experimentation were plotted as frequency curves and cumulative frequency curves on arithmetic probability paper, and the statistical parameters of mean grain size (Mz), sorting (o1), skewness (Ski) and kurtosis (Kg) were calculated following Folk and Ward, (1957). Afterwards several in-vogue statistical combinations of these basic parameters have been tried out in order to streamline their characteristics into one of the possible realities.

FREQUENCY CURVES

Frequency distributions show that the upper sandstones are distinctly unimodal with 87.3% of the analysed samples showing concentration around the 3Φ class. The basal sandstone curves show bimodality with concentrations around 1Φ and 3Φ-4Φ classes. However, presence of a number of size classes ranging from -2Φ to 8Φ is also seen which

Table 2. Variations grain size parameters.

	UNIVARIANT PARAMETERS	UPPER SANDSTONES	BASAL SANDSTONES
1.	Median (P_{50})	2.6ϕ -4.3ϕ	0.82ϕ -1.75ϕ
2.	Mean size (Mz)	2.59ϕ -4.37ϕ	1.39ϕ -1.83ϕ 100%
	as per Cadigan (1961)	76.4% Very fine sand, rest fine sand, silt	Medium sand
3.	Standard deviation (ϕ)	0.7ϕ -1.22ϕ	1.2ϕ -1.7ϕ
	as per Folk and Ward (1957)	89.1% moderately sorted	100% Poorly sorted
	as per Cadigan (1961)	89.1% Well sorted	85% moderately sorted
4.	Skewness (Ski)	-0.52-0.9	0.163-0.764
	as per Folk and Ward (1957)	89.1% V. positively skewed	98.1% V. positively skewed
	as per Cadigan (1961)	90.9% slightly skewed	100 slightly skewed
5.	Kurtosis (KG)	0.69 ϕ -4.96 ϕ	0.9 ϕ -1.43ϕ
	as per Folk and Ward (1957)	Leptokurtic to V. Leptokurtic	Mesokurtic to Leptokurtic
	as per Cadigan (1961)	81.83% moderately peaked	90% moderately peaked

contribute to the distribution and cloud the modal growths.

GRAIN SIZE PARAMETERS - UNIVARIANT ANALYSIS

A more enhanced way of discriminating between two distributions showing apparently similar nature of curves is through grain size parameters. As such, these genetically statistical indexes are of immense significance. The variations of grain size parameters deduced in this process are compared with the classifications of Folk and Ward (1957) and Cadigan (1961) and shown in Table 2.

Frequency variations of the univariant grain size parameters are significant as they reflect the inherent statistical characteristics of distributions. This leads to a broader level in which the variational aspects of these parameters get reflected and in this process certain features like sediment nature, their mixing, hydrodynamics etc may be projected or envisaged. The present endeavour shows the presence of both coarser and finer tails in the basal sandstone and finer tails in the upper sandstones.

SCATTER PLOTS - BIVARIANT ANALYSIS

Certain scatter plots were made after Folk and Ward (1957); Friedman (1967); Moiola and Weiser (1968) and Glaister and Nelson (1974) to find out the inherent statistical characteristics of the distribution as well as environment of deposition.

Graphic mean size (Mz) vs. Inclusive graphic standard deviation (σ1)

Following Folk and Ward (1957) it is seen that

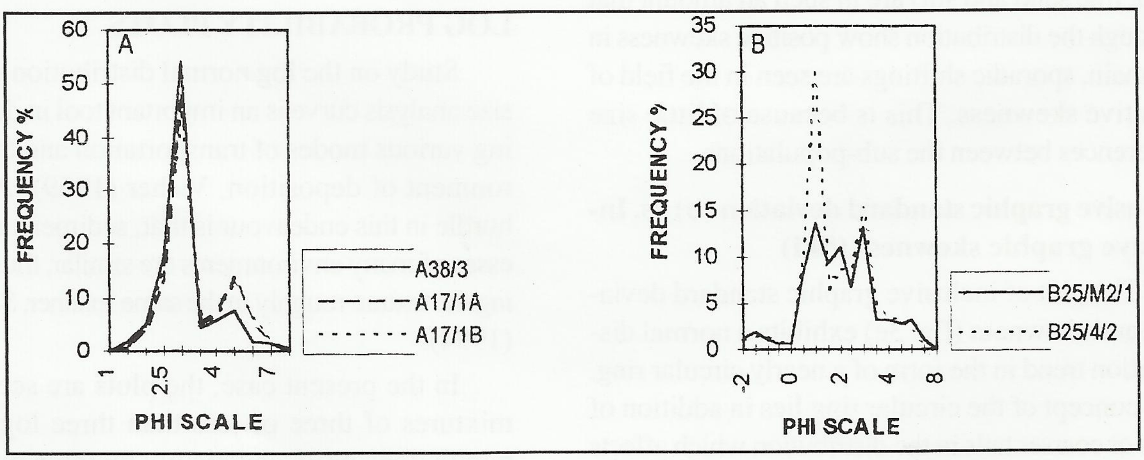

Fig. 2. Frequency distribution curves of the Singrimari Sandstones, Graph 'A' and 'B' are representative of the Upper and the Basal Sandstones

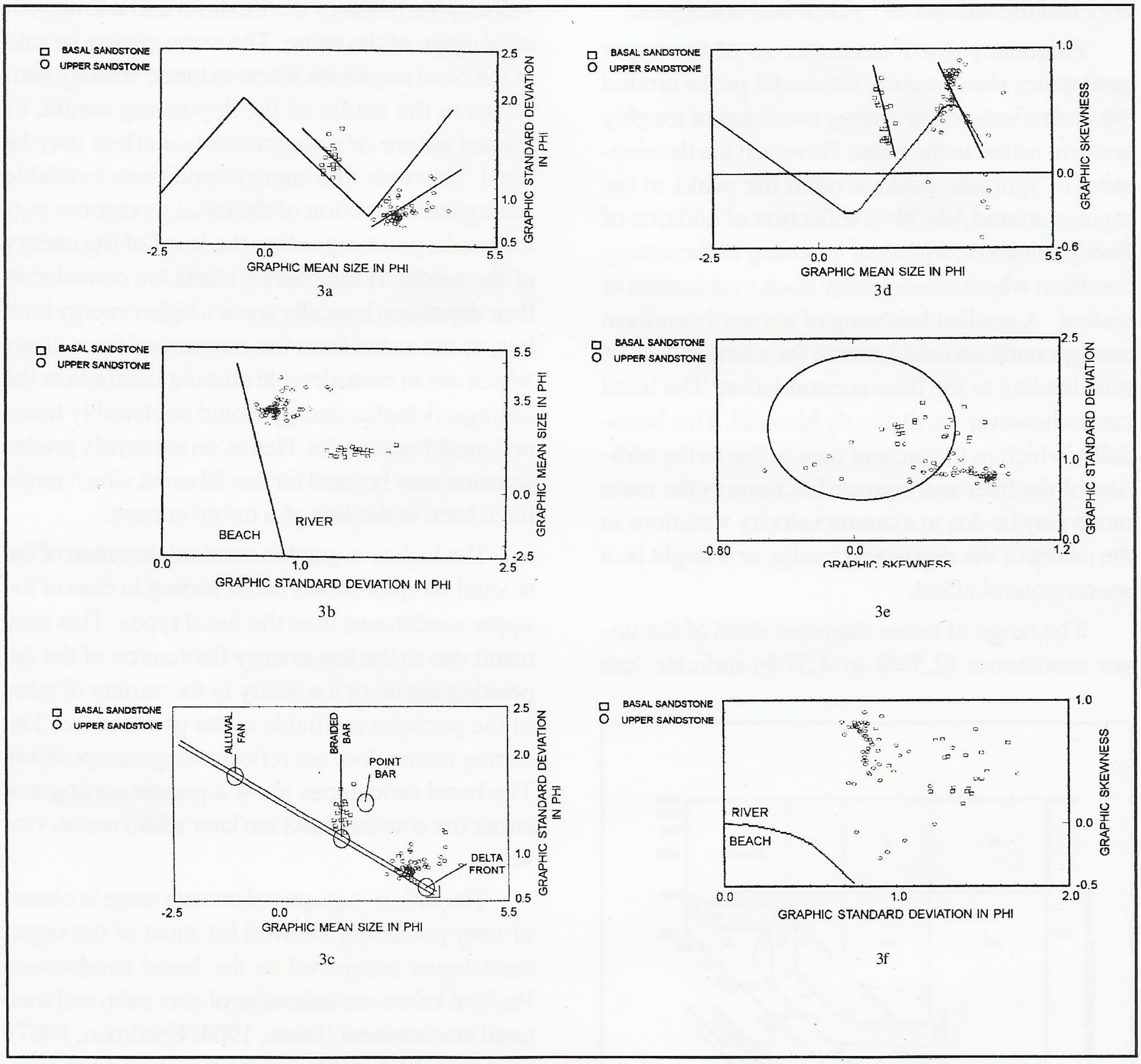

Fig. 3. a. Graphic mean size Vs Graphic standard deviation, (after Folk and Ward, 1957), b. Graphic mean size Vs Graphic standard Deviation (after Moiola and Weiser, 1968), c. Graphic mean size Vs Graphic standard deviation (after Glaister adn Nelson, 1974), d. Graphic mean size Vs Graphic skewness (after Folk and Ward, 1957), e. Graphic skewness Vs Graphic standard deviation, (after Folk and Ward, 1957), f. Graphic standard deviation Vs Graphic skewness, (after Friedman, 1967).

pension. Certain basal plots show two saltation sub-populations. Varying trends of grain probability plots represent inter-mixing of these populations yielding sediments of variable particle size. From the plots, (Fig. 5a, b) it is seen that saltation is the dominant mode of transportation followed by minor traction and suspension.

DISCUSSION AND INTERPRETATION

The character of sediments is determined both by the intensity of the formative processes operating upon it, and the time till which these processes continue to act it, reflects the energy conditions of a depositing medium, the nature of the source rock, the distance it travelled, fluctuation of kinetic energy and the number of cycle it had undergone.

Frequency distribution curves of the upper sandstones show mainly unimodal peaks around 3Φ and reflects lower energy condition of roughly uniform nature in the main. However, the development of sporadic peaks around the peaks in the regions around 4Φ-5Φ is reflection of addition of finer particles or, a gradual lessening of the energy condition which subsequently leads to distortion of sorting. A gradual lessening of a roughly uniform energy condition could stretch for a longer span of time leading to the finer accumulation. The basal curves however are distinctly bimodal. This bimodality which in the present case is due to the addition of the finer and coarser fractions in the main mode may be due to extreme velocity variations in the nature of the depositing media, or it might be a source control affect.

The range of mean diameter sizes of the upper sandstones (2.59Φ to 4.37Φ) indicate less

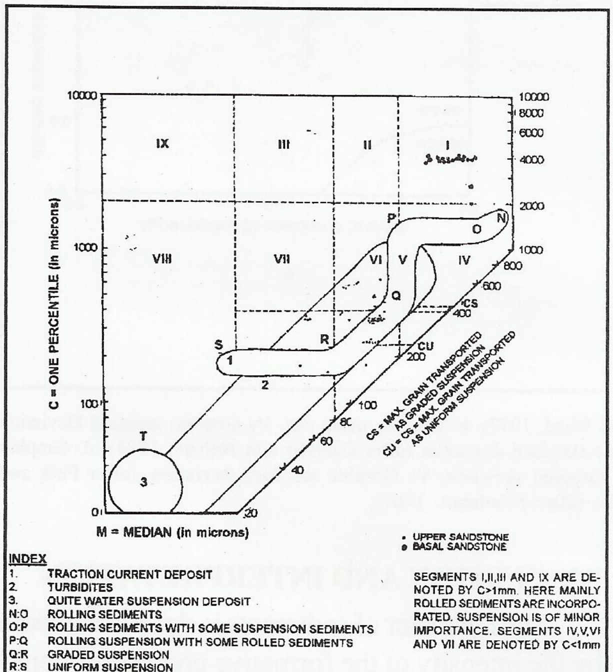

Fig. 4. Complete C-M pattern (after Passega, 1957, 1964; Passega and Byramjee, 1969).

velocity variation of the medium and a lower energy range of the same. The same cannot be said of the basal sandstone where extreme velocity variations in the nature of the depositing media, its graded nature or a source control affect may be cited. However, the energy conditions available during the deposition of the basal sandstones puts forward a point regarding the level of the energy of the media. If the coarser clasts are considered, their deposition basically needs a higher energy level but, at the same time the amount of finer clasts which are in considerable amount contradicts the settings. A higher energy would not feasibly transport such finer modes. Hence, an extremely graded situation may be cited for this lithounit which might have been in the line of a turbid current.

The inclusive graphic standard deviation of the studied samples shows better sorting in case of the upper sandstones than the basal types. This may result due to the low energy fluctuation of the depositing agent, or a scarcity in the variety of sizes of the particles available at the provenance. The sorting nature does not reflect a long transposition. The basal sandstones show a poorer sorting and either the coarser clasts are later additives or, vice versa.

The inclusive graphic skewness range in classes of very positively skewed for most of the upper sandstones compared to the basal sandstones. Positive values are indicative of cool calm and sheltered environment (Dune, 1964; Friedman, 1967). Such may be feasible in a unidirectional transportation system. The slightly skewed nature of the basal sandstones in the main may be due to the mixing of two populations of extreme nature. The finer fraction governs the status of skewness in this case by dominance in the distribution.

In the present case, sorting of both the distribution is found to better in the central portion compared to the tails which further indicate constancy in the impact of the energy of the media irrespective of its level. Although energy fluctuations were there towards the tails in the both the cases, the

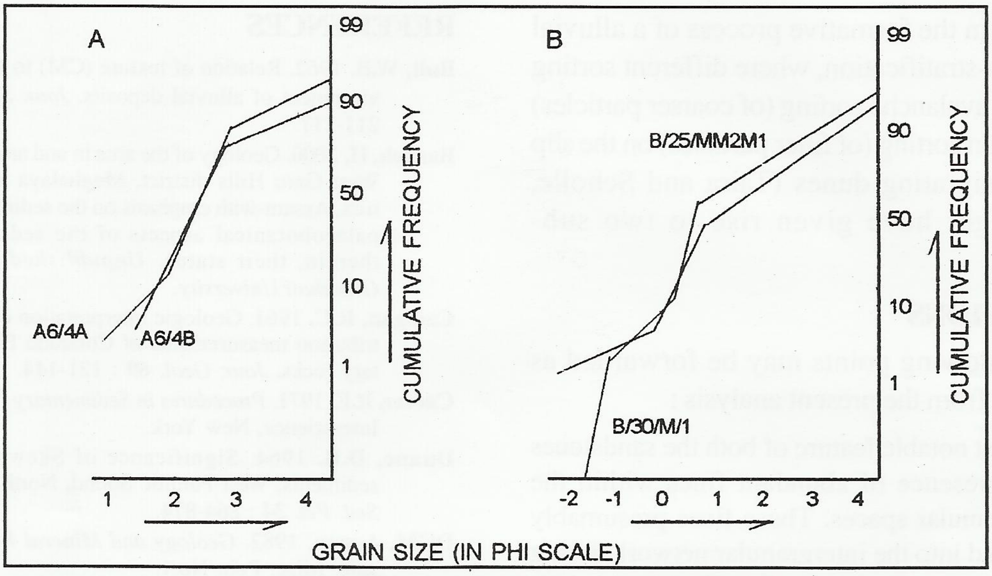

Fig. 5. Log Probability plots of the Singrimari Sandstones (Graph 'A' and 'B' are representative of Upper and Basal sandstones.

finer/coarser fractions could not disrupt the internal sorting of the distributions.

Finer fractions in the upper sandstones and, both coarser and finer tails in the basal sandstones govern their statistical characteristics. While the energy factor seems to control the upper sandstones source control seems to have an additional influence on the basal units.

All the statistically biased bivariate plots indicate the presence of a finer fraction in case of the upper sandstones which tend to disrupt the natural settings of the mixture particularly in terms of sorting but, is unable to do so by virtue of their lesser size difference and abundance. The same in case of the basal sandstones slightly deviate the sorting as well as the skewness. However, in case of the basal units, from the abundance point of view, whether the finer fraction or the coarser clasts are parasites in the host is a matter of doubt. The environmentally biased plots show concentration of the points mainly in the river field for both the distributions irrespective of the combinations. The slight deviations may be ignored. Maturity wise, the upper sandstones seem to be more matured.

About 65.45% of the upper sandstone curves and whole of the upper sandstone curves show considerable traction population which are typically shown to be absent in deposits transported by a typical fluvial process (Visher, 1969) and are, on the other hand, characterised by a system of turbulent, continuous current. High traction load can, however, be expected in a distributary network of river and can be attributed to a relatively shallow deposition within the channel having lower current velocity (Visher, 1969), and according to Gomez (1991), sediment transport on the stoss side of a dune occurs primarily in the form of bed load in an alluvial channel. The upper sandstone saltation loads commonly exhibit steeper probability plots. The amount of saltation population depends upon the stability of moving bed layer and the rate of deposition. The high degree of sorting of the saltation population suggests grains that logically would be deposited from the moving grain layer or traction carpet. Two saltation subpopulations (exhibited by 25% of the basal sandstone are believed to be related to swash and backwash transport in a foreshore beach deposits, (Visher, 1969). However, such subpopulations can also be attributed to mixing of particles in different sizes under variable flow conditions of density stratified turbulent current, (Moss, 1962). Mixing of particles may have taken place in the formative process of a alluvial trough cross-stratification, where different sorting tendencies - avalanche sorting (of coarser particles) and projection sorting (of finer particles) on the slip face of a migrating dunes (Taira and Scholle, 1979a) might have given rise to two sub-populations.

CONCLUSIONS

The following points may be forwarded as conclusions from the present analysis :

I. The most notable feature of both the sandstones is the presence of abundant fines within the intergraunular spaces. These fines presumably infiltrated into the intergranular network during various stages of sedimentation and is responsible for distortion of their sorting and skewness characteristics.

II. The upper sandstones are finer in nature, better sorted, positively skewed and leptokurtic. The basal sandstones are coarser, poorer in sorting, slightly skewed and leptokurtic.

III. The energy conditions leading to their deposition was lower in case of the upper sandstones. The basal types were deposited by a higher energy level than the former. However, the nature of the depositing media seem to be turbid in this case.

IV. Finer fractions play a decisive role in formulating the statistical character of the distributions. While energy variation seems to be better suited with the upper sandstones, in case of the basal mixture, both source control and energy variations were active.

V. Both the distributions show a strong tendency of clogging in the riverine environment in a broad spectrum where besides the typical fluvial process, various other formative processes, in varying degree were in operation during the different stages of sedimentation. While the basal sandstones show affinity towards a braided zone, the upper sandstones show more maturity and inclination towards a delta front zone which seems to be influenced by the size factor, energy level and sorting.

REFERENCES

Bull, W.B. 1962. Relation of texture (CM) to depositional environment of alluvial deposits. *Jour. Sed. Petrol.* **32** : 211-217.

Baruah, H. 2000. Geology of the area in and around Singrimari, West Garo Hills district, Meghalaya and Dhubri district, Assam-with emphasis on the sedimentological and palaeobotanical aspects of the sedimentary rocks therein, their status. *Unpublished Ph.D. Thesis, Guwahati University*.

Cadigan, R.C. 1961. Geologic interpretation of grain size distribution measurements of Colarado Plateau sedimentary rocks. *Jour. Geol.* **69** : 121-144.

Carver, R.E. 1971. *Procedures in Sedimentary Petrology*. Wiley Interscience, New York.

Duane, D.B. 1964. Significance of Skewness in Recent sediments, West Pamllic Sound, North Carolina. *Jour. Sed. Pet.* **34** : 864-874.

DGM, Assam. 1982. *Geology and Mineral Resources of Assam*. Misc. Pub. No.1.

Fox, C.S. 1934. The Gondwana system and the related Formations. *Memoir. Geol. Surv. India,* **LVIII** 1-241.

Folk, R.L. and Ward, W.C. 1957. Brazos River Bar-A study on the significance of grain size parameters. *Jour. Sed. Petrol.* **27** : 3-26.

Friedman, G.M. 1967. Dynamic processes and Statistical Parameters Distribution of Beach and River sand. *Jour. Sed. Petrol.* **37** : 327-54.

Glaister, R.P. and Nelson, H.W. 1974. Grain size distribution: an aid in facies identification. *Bull. Can. Petrol. Geol.* **22** : 203-240.

Geological Survey of India, 1974. *Geology and Mineral Resources of the States of India, Part-IV*. Misc. Publ. No. 30.

Gomez, B. 1991. Particle size variation in bed load over dunes. *Sed. Geol.* 75 : pp.5-8.

Krumbein, W.C. and Pettijohn, F.J. 1938. *Manual of Sedimentary Petrology*. Appleton Century Crofts, New York.

Moss, A.J. 1962. The physical nature of common sandy and pebbly deposits: Part.1. *Amer. Jour. Geol.* **260** : 337-373.

Moiola, R.J. and Weiser, P. 1968. Textural Parameters: An Evaluation, *Jour. Sed. Pet.* **8** : 43-45.

Passega, R. 1957. Texture and characteristics of clastic deposition. *Bull. Amer. Assoc.Pertol. Geol.* **41** : 1957-1984.

Passega, R. 1964. Grain Size Representation by C-M Pattern as a Geological Tool. *Jour. Sed. Petrol.* **34** : 830-847.

Passega, R. and Byramjee, R. 1969 Grain Size Image of Clastic Deposits. *Sedimentology*, **13**(3) : 233-252.

Sengupta, S. 1994. *Text-book on Sedimentology*. Oxford Publication, New Delhi.

Taira. A. and Scholle, P.A. 1979a. Origin of bimodal sand in some modern environments. *Jour. Sed. Petrol.* **49** : 777-786.

Visher, G.S. 1969. Grain size distribution and depositional processes. *Jour. Sed. Pet.* **39** : 1074-1106.

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