Palaeocurrent Analysis of the Tertiary Rocks of Changkikong Range, Mokokchung District, Nagaland, Northeast India

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DOI: 10.29322/IJSRP.8.8.2018.p8046
http://dx.doi.org/10.29322/IJSRP.8.8.2018.p8046

Abstract: Tertiary rocks of Changkikong Range constitutes a part of belt of Schuppen- a most prominent morphotectonic unit of Naga Hills. The palaeocurrent patterns for the Barail Group (Tikak Parbat Formation) , Changki Formation and Tipam Group (Tipam Sandstone Formation) have been studied . Interpretation reveals polymodal, bimodal , bimodal-pipolar palaeocurrent patterns in the study area.

Key words: Palaeocurrent analysis, Belt of Schuppen, Changkikong Range, Naga Hills, North east India.

Introduction

The Changkikong Range one of the majestic hill ranges in the Mokokchung District of Nagaland. To its west lies a parallel range named Japukong Range. These are manifestations of thrust slices in the belt of Schuppen – the western most morpho-tectonic unit of NE-SW trending Naga Hills. The study area covers nearly 125 square kilometres bounded between north paralles of 94^{O}20' and 94^{O}30' east meridians of 26^{O}24' and 26^{O}30' of the Topographic Sheet No.83 G/7 of Survey of India.

The Tertiary succession (Evans,1932; 1964) of the study area preserves well developed cyclic pattern and normal stratigraphic succession except along the western face of the Changkikong Range where the thrusted contact between the successive litho-units has been recorded. The succession comprises of coal bearing Tikak Parbat Formation of the Barail Group (Oligocene), the Changki Formation and Tipam Sandstone Formation of the Tipam Group (Miocene).The Tipam sandstone Formation is in turn overlain by Dihing Formation. During recent years, increasing attention has been paid towards interpretation of dispersal patterns and depositional environments of clastic sedimentary rocks on the basis of measurement of directional sedimentary structures and dimensional fabrics. In the present area of investigation, palaeocurrent data have been collected from the field through the measurement of small and large scale cross-stratifications, ripple marks and channels.

Methods of investigation

The following methods were used for determining the palaeocurrent directions .

Cross-stratifications

Cross-stratifications encountered in the Tertiary rocks of the study area are mostly trough and planar varieties (Michelson and Dott, 1973). Foresets of these units are essentially plane or concave upwards and meet the overlying and underlying 'normal' bedding either at sharp angle or erosional base (Photo no.3&4). Pebbles and granules are commonly concentrated along the forests or parallel to the bedding plane . Cross-stratification generally occurs as a single sedimentation unit overlain and underlain by normal bedding planes.In some vertical profile sections, it occurs as co-sets or grouped sets (McKee and Weir, 1953).

For the cross-stratifications, the following measurements were made and recorded in the field.

(i) Dip and strike of the 'normal' bedding.
(ii) Dip and strike of foresets beds.
(iii) Dip and strike of trough cross - strata, measured according to the procedure outlined by Slingerland and Williams (1979).

(iv). Thickness or scale of cross-bedded units according to the classification proposed by Miall (1974), large scale cross-beds > 25 cms. Medium scale cross-beds 5-25 cms. Small scale cross-beds <5 cms.

(v). Length of foreset beds.

The area was arbitrarily divided into 3 square kilometres sectors following approximately 'nested' or hierarchical sample design (Olson and Potter, 1954). However , the cross-bedding measurements were made keeping in view availability of exposures. Nearly 100 readings were taken for each Formation from approximately fifteen exposures of Tertiary rocks under study. The thickness of cross-beded units in Tikak Parbat , Changki and Tipam Sandstone Formations range between 5 to 20 cm, 15 to 60 cm and 10 to 25 cm respectively. The cross-bedding inclination or dihedral angle between the plane of foreset beds and plane of bedding ranges respectively between 5^{o} to 25^{o}, 5^{o} to 15^{o} and 5^{o} to 10^{o}. The inclination of a foreset bed is a function of angle of repose of the sedimentary particle at the time of deposition. According to McKee (1940) and others, eolian sandstone has inclination of 33^{o} or more where as it is upto 28^{o} for water –laid sandstones. In the present case , almost all the data on foreset inclinations fall within water-laid deposits.

Ripple Marks

Both asymmetrical and symmetrical ripple marks were observed in the Tertiary sediments of the study area. Linguoid small ripples and sinuous, bifurcating wave ripples with ripple index ranging from 4 to 5 are commonly associated with calcareous sandstones of Tipam Sandstone Formation . Both current and wave modified ripples are prevalent in Tikak Parbat and Tipam Sandstone Formations. Well preserved straight crested dunes (L=2.75m, H=0.4m) with succession of tidal bundles containing reactivation surfaces were also recorded from Tikak Parbat.

Comparativey, the ripple marks are fairly common in Tipam Sandstone Formation, moderate in Barails and rare in Changki Formation. Approximately ten, fifteen and five measurements of ripple crest Azimuths were recorded in Tikak Parbat, Changki and Tipam Sandstone Formations respectively (photo no.2).

Channel Structures

Erosional sedimentary structures , measuring approximately 0.5 meters across; concave up in cross section and showing cross cutting relationship to underlying sediments, were recognised as channels, These are usually infilled with coarser sediments than that below or adjacent, and there is commonly a basal conglomeratic layer. Cross bedded sandstones infill most of these channels. Such channel structures are fairly common in Changki Formation and not very uncommon in Barails and Tipam Sandstone Formation.All together approximately ten readings on orientation of channels were made depending on their availability in respective Formations (photo. no.1).

Conclusion

Palaeocurrent patterns

Empirical studies on palaeocurrents have shown that for structural dips more than 25 degrees , a tilt correction is necessary (Carver, 1971; Sen Gupta, 1994) to ascertain the correct direction of palaeocurrents. In the area of investigation, the average amount of dip for various litho-units ranges between 24^{o} to 54^{o} and hence the possibility of tilt induced error between measured and original Azimuths become more likely. The orientation data on measurements of linear and planar sedimentary structures were treated to the tilt correction technique after Potter and Pettijohn (1977), before they were analysed for palaeocurrent patterns. Palaeocurrent measurements , thus corrected were grouped into compass intervals (i.e.0^{o} to 29^{o}, 30^{o} to 59^{o} and so on) and then plotted on a rose diagram (Table 4.8 Fig. 44) following Nemec (1988). For data from structures giving current Azimuths, the rose diagram was conventionally constructed showing the current to sense, the directions . Calculations for Vector mean and dispersion were omitted as none of the palaeocurrent patterns were unimodal (Tucker, 1996; p.124). Accordingly , palaeocurrent patterns obtained may be grouped into three types , namely, bimodal bipolar, bimodal (oblique) and polymodal (Fig. 44). The polymodal pattern characterise the Changki Formation , where as , Barail Group and Tipam Sandstones display bimodal (oblique)- polymodal and bimodal (oblique)- bimodal bipolar patterns respectively. As a whole, the palaeocurrent patterns characterise a near-shore, beach environment having mixed wave –tide influence. All the three major litho-units viz. Barail Group, Changki Formation and Tipam Sandstone Formation , appear to have been deposited parallel to palaeoshore line. This is further substantiated by their overall shoestring type of geometries (Tucker, 1996).

Transport mechanisms and dispersal

The transport mechanisms and dispersal patterns of the Tertiary sediments in the area appears to be rather complex. Detritals were transported from various source terranes mostly through fluvial process and reworked under marine conditions before they were finally deposited. The dispersal pattern , as revealed by dominant palaeocurrents, appear to be mostly longitudinal. During Barail sedimentation the dispersal took place from the Naga Hills ophiolite to the east as well as Mishimi Hills , Himalayas and Trans-Himalaya to the north . The Changki and the Tipam Sandstone Formations received detritals mostly from the east i.e. Naga Hills Ophiolite with subordinate contribution from the north. The nature and scae of sedimentary structures together with maximum clast size reveal general dominance of bed load during the deposition of Changki Formation , where as saltation and suspension dominated during the deposition of Barail and Tipam Sandstone Formation. All the petrofacies were influenced by frequent changes in energy conditions mostly due to storm induced wave dominated depositional environtments. This is further substantiated by the polymodal, bimodal , bimodal-bipolar palaeocurrent patterns in the study area.

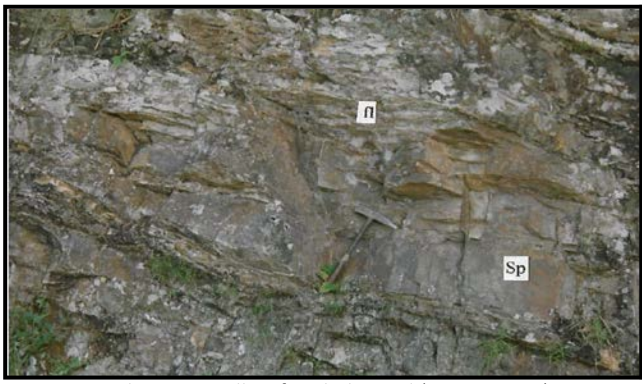

Photo 1: Well Defined Channel (0.5m across)

Photo 2: Linguoid small ripples (arrowhead) and sinuous bifurcating wave ripples.

Photo 3: Trough –Lenticular Cross- Bedding

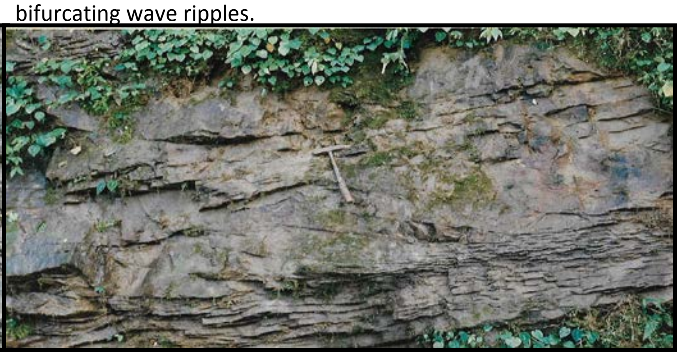

Photo 4: Ripples seen towards lower side of the photograph while in the upper part major channels are. Straight crested dunes with succession of tidal bundles containing reactivation surfaces are seen in the middle.

Table 1: FREQUENCY DISTRIBUTION (IN PERCENT) OF CROSS- BEDDING DATA MEASURED AT DIFFERENT LOCALITIES IN CHANGKIKONG RANGE.

CLASS INTERVAL IN DEGREES

LOCALITY	0-29	30-59	60-89	90-119	120-149	150-179	180-209	210-239	240-269	270-299	300-329	330-359
BARAIL GROUP												
West of Changki	0.00	0.00	0.00	66.66	0.00	0.00	33.33	0.00	0.00	0.00	0.00	0.00
North east of Longnak	10.00	0.00	0.00	15.00	37.00	0.00	0.00	0.00	10.00	10.00	10.00	0.00
CHANGKI FORMATION												
Changki	12.50	0.00	25.00	12.50	0.00	0.00	12.50	37.50	0.00	0.00	0.00	0.00
Mangkolemba	0.00	0.00	0.00	0.00	0.00	9.00	0.00	22.72	22.72	45.45	0.00	0.00
TIPAM SANDSTONE FORMATION												
Chungliyimsen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00	50.00	0.00	0.00
Khar	0.00	0.00	0.00	25.00	25.00	0.00	0.00	0.00	0.00	0.00	50.00	0.00

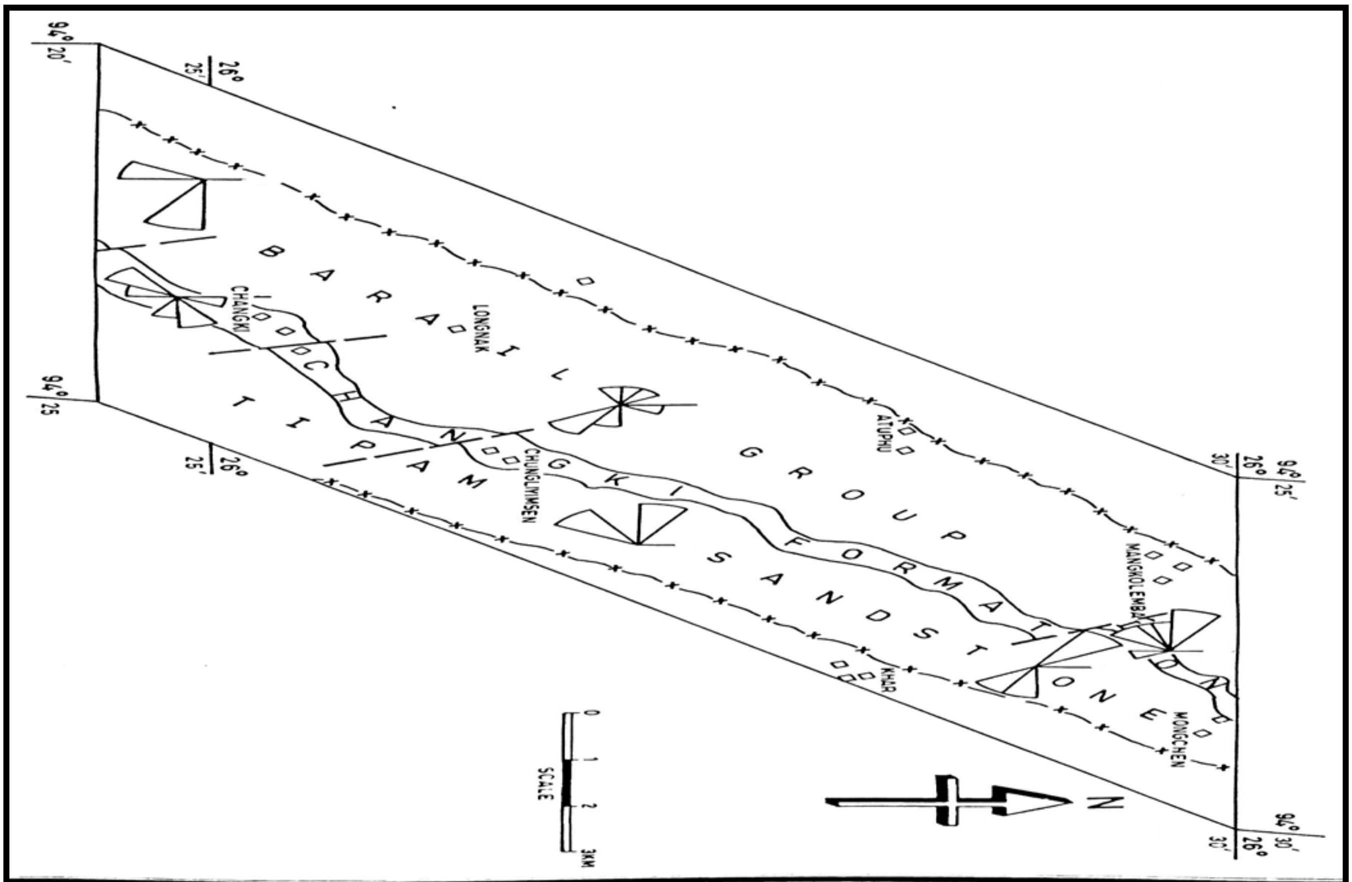

Fig. 1 : Current rose diagram based on cross-bedding data of Barail Group, Changki and Tipam Sandstone Formations.

REFERENCES

Acharyya, S.K. , Srisvastava, R.K. , Bhattacharya, S. , Venkataraman, P. , Ghosh.S, Vidyadharan, k.T. and Jena, SK., 1984 a : Geology and tectonic frame of Naga Hills ophiolite Northern Indo-Burmese Range. India, 27th Int. Geol. Congr., 7, vol. 3, 89-90 (Abst.)

Allen, J.R.L., 1982 : Sedimentary structures, their character and physical basis . In : Developments in sedimentology. V. 1 and 2, 515 p and 645 p. Elsevier.

Carver, R.E., 1971 : Procedures in sedimentary Petrology. 653p. Wiley-interscience. facies. P.20-62, Black Well Scientific Publications.

Debadhikari, B., 1968 : Geological mapping and investigation for coal in the Changkikong and Japukong ranges of Nagaland. Unpublished Progress Report of the G.S.I. for the F.S. 1967-68.

Evans, P., 1932 : Tertiary succession in Assam. Trans.M.n. Geol. Inst. India, 37, pp. 155-260.

Evans, P., 1964 : The Tectonic framework of Assam Jour. Geol. Soc. India, 5,p.80-96.

Folk, R.L. , 1974 : Petrology of sedimentary rocks. 170 p. Hemphill's Austin : Texas.

Mckee, E.D., 1940 : Three types of cross- lamination in Palaeozoic rocks of northern Arizona. Am. Jour. Sci., V. 238,p. 811-824.

Mckee, C.E. and Weir,G.W., 1953 : Terminology of stratification and cross- stratification. Geol. Assoc. Am. Bull., V.64, p. 381-390.

Miall, A.D., 1974 : Palaeocurrent analysis of alluvial sediments- a discussion of directional variance and vector magnitude. Jour. Sediment . Petrol., V.44, p. 1174-1185.

Michelson, P.C. and Dott, R.H., Jr., 1973 : Orientation analysis of trough cross- stratification in Upper Cambrain sandstones of Western Wisconsis. Jour. Sediment. Petrol., V. 43, p. 784-794.

Nemec,W., 1988 : The shape of rose . Sediment .Geol., 59 : 149-152.

Olson, J.S. and Potter, P.E., 1954 : Variance component of cross-bedding direction in some basal Pennsylvanian sandstones of the eastern Interior basin: Statistical methods. Jour. Geol., V.62, p. 50 73.

Potter, P.E. and Pettijohn, F.J., 1977 : Palaeocurrents and Basin Analysis . 425p. Springer-Verlag : New York.

Sengupta, S.M., 1994 : Introduction to sedimentology . 314p. Oxford & IBH publishing co.

Slingerland, R.L. and Williams,E.C., 1979 : Palaeocurrent analysis in light of trough cross-stratification geometry.Jour. Geol., V.87,p. 724-732.

Tucker, Maurice. E. , 1996 : Sedimentary rocks in the field. 153p.