CHAPTER-V

PALAEOCURRENT ANALYSIS

CHAPTER-V

PALAEOCURRENT ANALYSIS

Palaeocurrent analysis was done to assess the direction of transport of the sediments and to locate the position of the source area (provenance) with respect to the depositional site. The trough cross stratifications, asymmetric current ripples, ripple-drift cross-laminations, rib and furrow structures and long axis oriented embedded pebbles were used to reconstruct the palaeoflow pattern of the present area. Sixty locations were studied and a total number of 1188 data were collected to deduce the palaeoflow pattern of the Gondwana succession at local as well as on regional scale.

The plan used for the collection of palaeocurrent data has been described in detail in Chapter-III. The area was segmented into a number of sectors for the collection of palaeocurrent data. Table-V.I sums up the sedimentary structures present, property measured, number of observations recorded at each sector and the arithmetic mean ($\bar{X}a$) and resultant vector ($\bar{X}v$) of each sector. The data of individual sector were grouped at 20^0 class interval and were presented in form of rose diagrams at the centre of each sector to show the sector level palaeocurrent pattern (Fig.5.1A).

To obtain the regional palaeocurrent pattern of each lithostratigraphic unit, the data obtained from individual sectors of a unit were grouped together irrespective of type of structures present and were presented in form of rose diagrams to show the regional palaeoflow pattern (Fig.5.1.B). The statistical parameters like arithmetic mean ($\bar{X}a$), standard deviation (S), variance (S^2), resultant vector ($\bar{X}v$), magnitude of resultant vector (R) and magnitude of resultant vector in percent (L) were computed from grouped data at 20^0 class interval (Table V.II) for each lithostratigraphic unit to show the mean palaeocurrent direction, sediment dispersal pattern and stability of flow.

The sector level and regional palaeocurrent map (Fig.5.1.A and B) indicates that there has been a significant change in the direction of palaeoflow and sediment dispersal pattern from the base of the succession to the top with the palaeoflow direction gradually changing from northeast in the basal part of the succession to north and finally to the northwest in the upper part of the succession.

5.1. PALAEOFLOW PATTERN OF TALCHIR GROUP

Palaeocurrent data were obtained from the directional structures of all the three lithostratigraphic units of the group. For Unit-A, the palaeocurrent data were measured from large scale trough cross-stratifications in two sectors and asymmetric current ripples in one sector. The regional palaeocurrent pattern show a bimodal distribution with the maxima lying between $20^0 - 40^0$ and $80^0 - 100^0$ class intervals. The mean palaeocurrent direction was found to be 32.82^0 which suggests a predominant northeasterly palaeoflow direction. Sector level and regional level polymodal distribution with relatively low value of consistency ratio (77.60%) and high value of standard deviation (44.12) and variance (1946.86) indicate multidirectional currents and rapid shifting of currents over the depositional surface.

In case of Unit-B, the palaeocurrent data were obtained from the asymmetric current ripples, which are extensively developed in the fine-grained sandstones of interbedded sandstone and mudstone sequences. The sector level palaeocurrent patterns show unimodal distribution with radiating pattern of palaeocurrent system fanning out in a northerly direction (Fig.5.1.A). The mean palaeocurrent direction shows a wide range of variation from 326^0 (NW) to 36^0 (NE). The regional palaeocurrent pattern (Fig.5.1.B), however, shows a unimodal distribution with the maxima lying between 340^0 and 360^0 and the mean palaeocurrent direction being 359.37^0 (North). This suggests a predominant northerly palaeoflow (Fig.5.1.B). A regional unimodal palaeoflow pattern with relatively low value of standard deviation (23.91) and variance

(572.11) and a very high value of consistency ratio (91.58%) suggests less scatter of data around the mean and therefore, high stability of the currents.

For Unit-C, the palaeocurrent data were obtained from the rib and furrow structures, the surface expression of ripple-drift cross-laminations. A slight swing in the regional palaeocurrent direction from north to NNW has been recorded (Fig.5.1.A and B). The sector level palaeocurrent data show both unimodal and bimodal distribution with wide range of variation in mean palaeocurrent direction from 326.48^0 to 355.50^0. This suggests multi directional flow both towards north and NNW. The regional palaeocurrent pattern (Fig.5.1.B), however, shows a unimodal distribution with the maxima lying between 340^0 and 360^0 and the mean palaeocurrent direction being 338.80^0 (NNW). A relatively high value of standard deviation (29.28) and variance (857.56) and low value of consistency ratio (87.50%) suggests fluctuation of currents towards north and northwest within the northwesterly flowing currents.

5.2. PALAEOFLOW PATTERN OF DAMUDA GROUP

The Damuda Group was deposited in a predominantly fluvial environment (Chapter-IV). Palaeocurrent data were collected from trough cross-stratifications, which are extensively developed in the Karharbari and Barakar Formation and from the long axis oriented embedded pebbles of the Boulder gravel bed to deduce the palaeocurrent direction of these sediments. The sector level palaeocurrent patterns of the Karharbari Formation (Fig.5.1.A) show both unimodal and bimodal distribution and a wide range of variation of mean palaeocurrent direction from 11.25^0 to 306.92^0. They regionally describe fan-shaped arcs with multidirectional palaeoflow both towards NNE and NNW (Fig.5.1.A). But the regional palaeoflow pattern (Fig.5.1.B) shows a unimodal distribution with the maxima lying between 340^0 and 360^0 and the mean palaeocurrent direction being towards northwest (339.80^0) paralleling the basin axis. A relatively high value of standard deviation (31.78) and variance

(1009.99) together with low value of consistency ratio (85.72%) suggest fluctuation of the current on either side of the mean direction of flow.

The long axis orientations of the embedded pebbles of the Boulder gravel bed show a northwesterly converging type of palaeoflow pattern. In the east the palaeocurrent pattern is dominantly towards north. In the central part it shifts towards northwest and in the western part the movement is in a north and NNE direction (Fig.5.1.A). Although the regional direction of movement is towards north (359.39^0), the sector level palaeoflow direction shows a wide range of variation of mean palaeocurrent direction from 24^0 (NNE) to 326^0 (NNW). This possibly implies a prominent northwesterly swing of the palaeocurrent direction (Fig.5.1. A and B).

The topmost Barakar Formation has a dominant northwesterly palaeoflow both at sector and regional level (Fig.5.1.A and B) paralleling the basin axis and suggests axial filling of the basin during Barakar sedimentation. While the regional mean palaeocurrent direction has been found to be 327.21^0, the sector level mean palaeocurrent direction ranges from 278.57^0 to 332.72^0. This suggests a high consistency of the northwesterly flowing currents. Unimodal distribution both at sector and regional level, higher value of consistency ratio (88.04%) together with relatively low value of standard deviation (29.20) and variance (852.88) suggests a consistent unidirectional northwesterly sediment transport.

5.3. REGIONAL PALAEOFLOW PATTERN

The sector level and regional palaeocurrent analysis (Fig.5.1) suggests a sinistral swing of the palaeoflow pattern from northeast in the basal part to north in the middle part and gradually taking a turn towards northwest in the upper part of the succession. This implies a transverse filling of the basin during the initial stage of sedimentation which gradually changed over to a northwesterly palaeoflow implying an axial filling of the basin. Since the palaeocurrents are slope controlled in a basin, the palaeoslope might have changed with time from northeast to north and gradually towards northwest resulting in a sinistral swing in the palaeoflow pattern.

A dominant northeast, north and northwesterly palaeocurrent pattern suggests that the sediments were derived largely from a source area that was located towards the south, southwest and southeastern side of the basin.

TABLE-V.I

Summary of palaeocurrent data of various lithostratigraphic units of the Gondwana succession of the investigated area.

Name of the Group	Name of the Formation	Location No.	Sedimentary structure	Property measured	No. of observations	Arithmetic mean ($\bar{X}a$)	Resultant Vector ($\bar{X}v$)
1	2	3	4	5	6	7	8
Talchir Group	Unit – A	1	Asymmetric current ripple	Direction of steep slope of the ripple	23	55.21^0	55.00^0
		2	Trough cross stratification	Direction of concavity of the arc of the foreset	12	35.00^0	36.00^0
		2A	Trough cross stratification	Direction of concavity of the arc of the foreset	14	350.00^0	350.00^0
	Unit-B	3	Asymmetric current ripple	Direction of steep slope of the ripple	24	340.00^0	341.00^0
		4	Asymmetric current ripple	Direction of steep slope of the ripple	20	353.00^0	354.00^0
		5	Asymmetric current ripple	Direction of steep slope of the ripple	31	356.46^0	358.00^0
		6	Asymmetric current ripple	Direction of steep slope of the ripple	43	23.48^0	24.00^0
		7	Asymmetric current ripple	Direction of steep slope of the ripple	20	34.00^0	36.00^0
		8	Asymmetric current ripple	Direction of steep slope of the ripple	17	353.53^0	354.00^0
		9	Asymmetric current ripple	Direction of steep slope of the ripple	26	34.67^0	343.00^0
		10	Asymmetric current ripple	Direction of steep slope of the ripple	19	344.74^0	347.00^0
		11	Asymmetric current ripple	Direction of steep slope of the ripple	12	345.00^0	344.00^0
		12	Asymmetric current ripple	Direction of steep slope of the ripple	15	356.67^0	358.00^0

1	2	3	4	5	6	7	8
Talchir Group	Unit-C	13	Ripple – drift cross laminations	Direction of concavity of the arc of the foreset laminae	28	336.36^0	337.00^0
		14	Ripple – drift cross laminations	Direction of concavity of the arc of the foreset laminae	24	340.00^0	341.00^0
		15	Ripple – drift cross laminations	Direction of concavity of the arc of the foreset laminae	17	326.48^0	326.00^0
		16	Ripple – drift cross laminations	Direction of concavity of the arc of the foreset laminae	20	343.00^0	344.00^0
		17	Ripple – drift cross laminations	Direction of concavity of the arc of the foreset laminae	40	337.00^0	338.00^0
		18	Ripple – drift cross laminations	Direction of concavity of the arc of the foreset laminae	11	355.50^0	356.00^0
Damuda Group	Karharbari Formation	19	Trough cross – stratification	Direction of concavity of the arc of the foresets	33	316.07^0	316.77^0
		20	Trough cross – stratification	Direction of concavity of the arc of the foresets	20	344.00^0	344.00^0
		21	Trough cross – stratification	Direction of concavity of the arc of the foresets	21	5.23^0	5.37^0

1	2	3	4	5	6	7	8
Damuda Group	Karharbari Formation	22	Trough cross – stratification	Direction of concavity of the arc of the foresets	15	6.00^0	5.99^0
		23	Trough cross – stratification	Direction of concavity of the arc of the foresets	11	317.27^0	317.14^0
		24	Trough cross – stratification	Direction of concavity of the arc of the foresets	15	356.66^0	356.62^0
		25	Trough cross – stratification	Direction of concavity of the arc of the foresets	15	310.00^0	309.99^0
		26	Trough cross – stratification	Direction of concavity of the arc of the foresets	18	354.50^0	354.62^0
		27	Trough cross – stratification	Direction of concavity of the arc of the foresets	16	11.25^0	11.25^0
		28	Trough cross – stratification	Direction of concavity of the arc of the foresets	10	328.00^0	328.42^0
		29	Trough cross – stratification	Direction of concavity of the arc of the foresets	13	306.92^0	306.89^0
		30	Trough cross – stratification	Direction of concavity of the arc of the foresets	15	344.66^0	344.66^0
		31	Trough cross – stratification	Direction of concavity of the arc of the foresets	15	314.00^0	314.15^0
		32	Trough cross – stratification	Direction of concavity of the arc of the foresets	14	317.14^0	317.38^0

1	2	3	4	5	6	7	8
Damuda Group	Karharbari Formation	33	Trough cross – stratification	Direction of concavity of the arc of the foresets	22	350.00^0	348.91^0
	Boulder Gravel bed	34	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	32	5.62^0	9.75^0
		35	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	33	18.48^0	19.39^0
		36	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	16	358.12^0	358.08^0
		37	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	46	354.35^0	354.34^0
		38	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	24	331.88^0	331.57^0
		39	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	06	326.66^0	326.93^0
		40	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	20	24.00^0	24.00^0

1	2	3	4	5	6	7	8
Damuda Group	Boulder Gravel bed	41	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	16	348.75^0	348.75^0
		42	Long axis orientation of pebbles	Direction of elongation of the long axes of pebbles	25	354.80^0	354.95^0
	Barakar Formation	43	Trough cross-stratification	Direction of concavity of the arc of the foresets	21	314.76^0	314.63^0
		44	Trough cross-stratification	Direction of concavity of the arc of the foresets	20	319.50^0	318.94^0
		45	Trough cross-stratification	Direction of concavity of the arc of the foresets	21	278.57^0	277.65^0
		46	Trough cross-stratification	Direction of concavity of the arc of the foresets	22	332.72^0	332.93^0
		47	Trough cross-stratification	Direction of concavity of the arc of the foresets	27	315.92^0	315.46^0
		48	Trough cross-stratification	Direction of concavity of the arc of the foresets	15	319.33^0	319.40^0
		49	Trough cross-stratification	Direction of concavity of the arc of the foresets	14	328.57^0	328.57^0
		50	Trough cross-stratification	Direction of concavity of the arc of the foresets	15	323.33^0	323.38^0

1	2	3	4	5	6	7	8
Damuda Group	Barakar Formation	51	Trough cross-stratification	Direction of concavity of the arc of the foresets	10	324.00^0	323.94^0
		52	Trough cross-stratification	Direction of concavity of the arc of the foresets	10	308.00^0	307.99^0
		53	Trough cross-stratification	Direction of concavity of the arc of the foresets	30	314.00^0	314.11^0
		54	Trough cross-stratification	Direction of concavity of the arc of the foresets	18	314.45^0	314.07^0
		55	Trough cross-stratification	Direction of concavity of the arc of the foresets	20	313.00^0	313.22^0
		56	Trough cross-stratification	Direction of concavity of the arc of the foresets	32	326.88^0	327.42^0
		57	Trough cross-stratification	Direction of concavity of the arc of the foresets	18	314.45^0	314.51^0
		58	Trough cross-stratification	Direction of concavity of the arc of the foresets	20	319.00^0	318.96^0
		59	Trough cross-stratification	Direction of concavity of the arc of the foresets	18	313.50^0	316.87^0

TABLE – V.II

Statistical parameters of the palaeocurrent data collected from various lithostratigraphic units of the present area.

Name of the Group	Name of the Formation	Structure	No. of observations	Arithmetic mean ($\bar{X}a$)	Standard deviation (S)	Variance (S^2)	Resultant Vector ($\bar{X}v$)	Magnitude of resultant Vector (R)	Magnitude of resultant vector in percent (L)
1	2	3	4	5	6	7	8	9	10
Talchir Group	Unit-A	Trough cross bedding Asymmetric current ripples	49	32.04^0	44.12	1946.86	32.82^0	38.03	77.60
	Unit-B	Asymmetric current ripples	227	359.51^0	23.91	572.11	359.37^0	207.90	91.58
	Unit-C	Ripple-drift cross-laminations	140	338.43^0	29.28	857.56	338.80^0	122.59	87.50
Damuda Group	Karharbari Formation	Trough cross bedding	253	339.17^0	31.78	1009.99	339.80^0	216.87	85.72
	Boulder Gravel bed	Long axis orientation of pebbles	218	359.26^0	38.07	1450.03	359.26^0	174.15	79.88
	Barakar Formation	Trough cross bedding	301	326.84^0	29.20	852.88	327.21^0	265.00	88.04