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The petrogenesis of the Lower Rewa Sandstone, Karauli State, Rajasthan

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Abstract

The Lower Rewa Sandstone is medium to fine grained, moderate to well sorted, mature, symmetrical to positively skewed, mesokurtic to leptokurtic, quartz-arenite. Ripple marks are present whereas cross-stratifications are not common. Vector analysis indicates a north-westerly palaeocurrent direction. From the study of the petrological characters, elongation quotient of the quartz grains, C-M pattern distribution of the quartz grains and palaeocurrent azimuthal pattern, a beach environment of deposition with a steady supply of sediments from a granitic source area is postulated.

Introduction and Geologic Setting

The two NE–SW trending ridges composed of Lower Rewa Sandstone form the two limbs of a major syncline, near Kela Devi, Karauli State, Rajasthan (Heron, 1922). The sandstone is white in colour, medium to fine grained, moderate to well sorted, bedded to massive, profusely rippled and commonly cross-stratified. At places two sets of vertical or subvertical joints give rise to cubical or sub-cubical blocks.

Both the upper and lower stratigraphic contact of the Lower Rewa Sandstone with Jhiri Shale and Panna Shale are concealed by soil cover and vegetation.

Petrography

Quartz is the main constituent of the sandstone and the minor constituents are clay pellets, chert fragments and a few rounded grains of tourmaline, zircon and muscovite flakes.

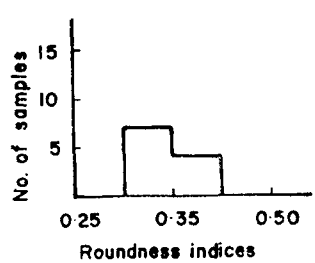

Figure 1. Frequency distribution of the roundness of the quartz grains

Quartz grains show a little variation in roundness and sphericity. The roundness indices determined from eleven systematic samples lie in the range 0.30–0.40. (Fig. 1). Although inclusion-free quartz grains are present, quartz grains with dusty inclusions are common. The dusty inclusions are mostly clustered along the margin of the grains though at places they are arranged in planes within the grains. Besides this type of inclusion, needle shaped, bubble shaped and micaceous inclusions are rarely present.

Quartz grains show both normal and wavy extinction, the normal one being more common. Quartz grains are generally welded with concavo-convex or sutured contact with a little silica cement which is present as overgrowth and as vein quartz. In a few samples a low amout of Fe-cement is present. Modal analysis shows that the sandstone is rich in quartz (83 to 97% in nine samples) and feldspar is totally absent. Out of eleven samples only in three samples the percentage of quartzitic rock fragments was high (14.08%, 30.46%, 30.68%). The sandstone can be recognised as quartz arenite.

Size Analysis

Microscopic size analysis (Krumbein and Pettijohn, 1938) of eleven samples of the sandstone has been carried out. Among the eleven cumulative curves six approach straight lines, two distinctly bimodal and others show only slight bimodality. Most of the curves are symmetrical to positively skewed and mesokurtic to leptokurtic. The range of variations of the size parameters (studied directly from cumulative curves; Folk and Ward, 1957) are grouped in Table I and frequency distribution of the size parameters are shown in Fig. 2.

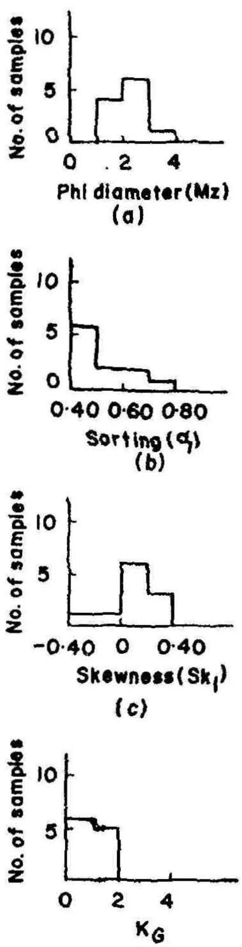

Figure 2. Frequency distribution of different parameters obtained from size analysis.

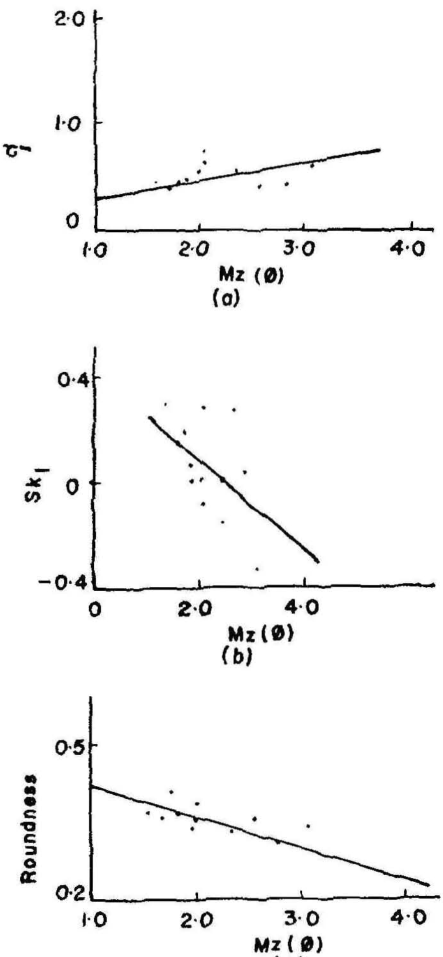

Figure 3. Graphical presentation of the relations between different size parameters.

The plot of σ_1 values against M_Z values shows a linear pattern which indicates *an increase of sorting with increase in size* (Fig. 3a). But the correlation coefficient of these two variables is not significant (r = 0.18).

M_Z *verses* SK_1 *diagram* (Fig. 3b) shows a linear pattern. The relation between two variables (r = 0.13) is inverse i.e. SK_1 decreases with increase in M_Z.

A linear relationship is obtained by plotting roundness values against M_Z

TABLE I. Range of variation of size parameter.

Size parameters	Range of variation
Mz	1.57 to 3.08
σ_I	0.400 to 0.741
SK_I	−0.068 to +0.294
K_G	0.869 to 1.398

TABLE II. Quantitative and Statistical analysis of ripple marks

No. of observations	Profile & ground plan	Scale	Wave length (L) in cms & amplitude (h) in cms	Vertical form index (L/h)	Vector mean direction	Depth of formation (as per Allen's 1968) regression equation $H=0.08\,6d^{1\cdot19}$)
68 (out of which 39 observations are used in vector analysis)	Parallel, symmetrical & asymmetrical mainly sinuous, also. Caternary. Bifurcating, interference and slightly curved ripples rare	Small Scale	2–11.5 (Fig. 4a) 0.2 – 1.6 (Fig. 4b)	2–15 (Fig. 4c)	291° (Fig. 5a) (Consistency ratio : 32.82%)	12.87 cms

TABLE III. Geometrical and statistical data of cross-stratification (Geometrical terminology as per McKee & Weir, 1953)

No. of observations	Type of cross stratification	Length & thickness of cross stratification	Dip of foreset	Nature of the lower bounding surface	Shape of the foreset	Vector mean direction	Depth of formation (as per Allen's 1968) regression equation log Dm=0.8901 + 0.8271 log Hm)
21 (out of which only 10 observations are used to calculate the depth of formation)	Tabular	Small Scale to medium (20 cm to 1.8 m). 5–20 cm. bedding interval 1.5 cm – 2.5 cm	8° – 42° (Fig. 6)	Planar surface of erosion	Commonly tangential (asymmetric) and some straight angular (symmetric)	306°28′ (Fig. 5b) (Consistency ratio : 28.52%)	1.171 m

(Fig. 3c). A reverse relationship is found here, such that roundness decreases with the increase of size (r = 0.66, up to 5% level of significance).

Primary Structures

The geometrical and statistical analysis of the ripple marks and cross-stratifications present in the sandstone are furnished in Tables II and III respectively.

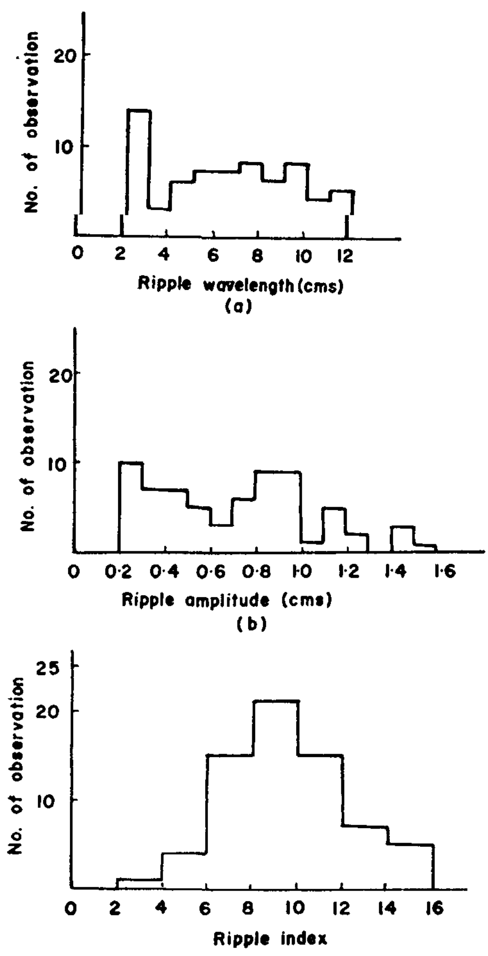

Figure 4. Frequency distribution of different parameters of ripple marks.

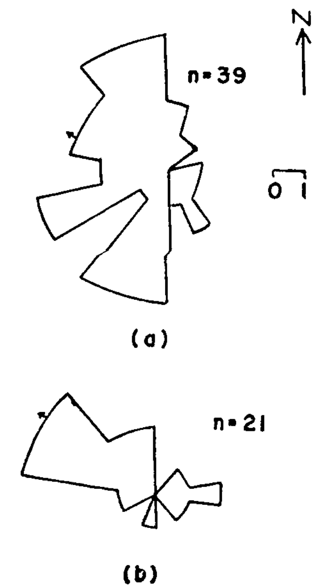

Figure 5. Palaeocurrent azimuthal pattern from (a) ripple marks (b) cross stratification.

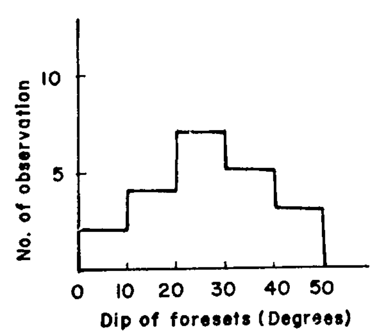

Figure 6. Histogram presents the distribution of dip of foresets.

For vector analysis, the foreset dip data are corrected for tilt as the beds of the Lower Rewa Sandstone are highly dipping (exceeding 20°). The mean vertical form index of the ripples suggests an aqueous origin of the ripples and the average inclination of the foresets of the cross-stratification also suggests their aqueous origin. A linear relationship is observed from the ripple height *vs.* ripple wave-length diagram (Fig. 7) and indicates the non-fluctuating condition of the depositional basin.

Provenance and Environment of Deposition:

Microscopic study of the detrital grains suggests a granitic provenance for the Lower Rewa Sandstone. The points in favour of granitic provenance are: (i) Presence of (a) inclusion free quartz grains having normal extinction & (b) tourmaline, zircon and muscovite flakes—indicating igneous source rock. (ii) The elongation quotient of the quartz grains (mean e.q. of the quartz grains 1.47) (Fig. 8) (Bokman, 1952), the palaeocurrent direction from primary structures and the geographical position of Bundelkhand Granite, suggests that this granite massif is the source rock for the Lower Rewa Sandstone.

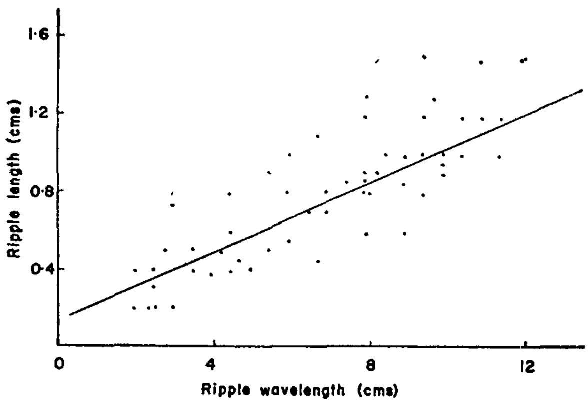

Figure 7. Graphical presentation of relationship between different parameters of ripple marks.

The rare occurrence of double overgrowth in quartz grains and rounded clay pellets and well rounded grains of tourmaline and zircon are due to reworking of the sediments.

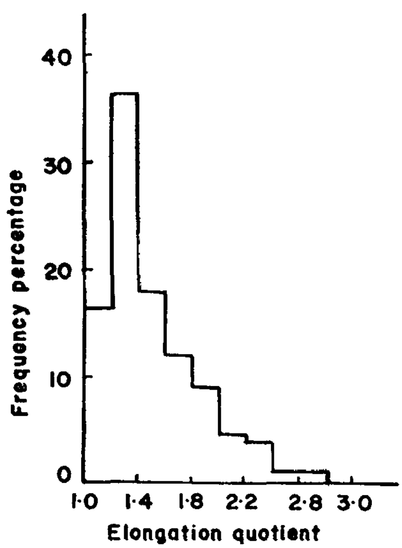

Figure 8. Elongation quotient distribution of quartz grains.

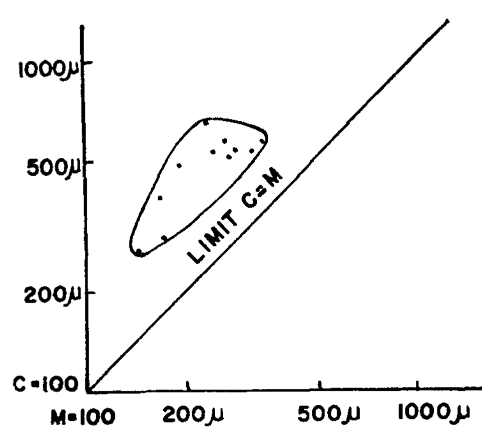

Figure 9. C=M pattern distribution of the quartz grains.

Environment of deposition has been deduced from the following observations: (i) the medium grained, moderate to well sorted, mature, nearly symmetrical, mesokurtic to leptokurtic nature of the sandstone strongly suggests a beach environment (Folk and Mason, 1958). The Rewa Sandstone fulfils these criteria; (ii) the tabular cross-stratification with nearly straight or concave foreset planes of varying scales and occasional high dip (40° to 50°) of the foreset beds favours a beach environment

(Dunbar and Rodgers, 1957). This statement holds good in the Lower Rewa Sandstone of the present area; (iii) the study of the C–M pattern of the Lower Rewa Sandstone (Fig. 9) of the present area and its similarity with the type VII of Passega (1957) basic C–M patterns suggests a typical beach pattern for the sediments; (iv) comparison of the palaeocurrent azimuthal pattern (bimodal bipolar type) with Selley's (1968) palaeocurrent models suggests onshore deposition in presence of fluvial currents. But in the present case, as no evidence of fluvial action has been found, it is supposed that this azimuthal pattern represents interaction of two opposing longshore drifts, i.e. a slight modification of Selley's fourth pattern where instead of one longshore drift there were probably two opposing longshore drifts.

Synthesising all the evidences, a beach environment has been postulated for the Lower Rewa Sandstone exposed in the Karauli State, Rajasthan, and the basin of deposition as a tectonically stable one.

Conclusion

From the above discussion of petrological characters, provenance, environment of deposition and tectonic set up of the basin, the Lower Rewa Sandstone in the present area may be catagorised as pure quartz type and quartz-iron-oxide type of the platform blanket deposits (Dapples, 1947).

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