IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 5, Issue 2, January 2025

Comparative Strain Analyses in the Lower Aravalli Group using Quartzite Pebbles

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Abstract*: A comparison was made in the strain pattern using quartzite pebbles from basal Aravalli conglomerates of the Lower Aravalli Group. Samples were collected from the conglomerates present at the contact of basement and cover rock sequence of the Lower Aravalli Group and from the same horizons of the Sarara Inlier. It was concluded that the long axis of the pebbles behaves similarly in orientation but has variable strain pattern when plotted on Flinn`s Plot.*

Keywords: The Lower Aravalli Group, strain analysis, Conglomerate, Quartzite

I. INTRODUCTION

In this paper comparative strain analysis study of the Lower Aravalli Group is done using conglomerates of different locations around Udaipur sector of the Aravalli Supergroup (Roy and Jakhar 2002, Roy and Purohit 2018). The Udaipur sector is a type area of the Aravalli Supergroup rocks. The Lower Aravalli Group constitutes Delwara and overlying Jhamarkotra Formation (Table 1). The significance of the study is understanding, distinguishing, and recording strain variation in the Lower Aravalli Group conglomerates. The conglomerate defines an unconformity (Sinha-Roy et. al., 1993). The different strain patterns developed on basement-cover sequence and in the inliers of the same formation are attempted herein

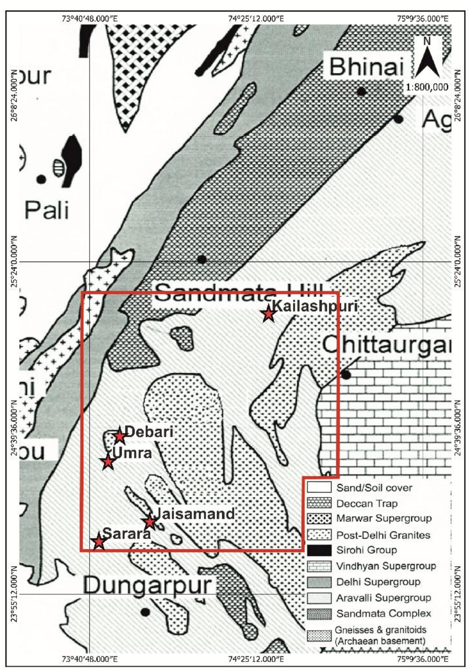

Figure 1- Generalized geological map of the Aravalli Mountains and neighbouring area. (after Roy and Jakhar 2002), rectangle marks the area of study and * marks the sample location.

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II. GEOLOGY OF THE AREA

The rocks of Aravalli Supergroup occur in an intimate association with Archean basement gneisses in large part of central and southeastern part of Rajasthan. The gneiss-metasediment interface truly represents an unconformity between the two major geological formations, the Aravalli Supergroup and the basement rock represented by Mewar Gneiss Complex and granitoids (Berach granite, Ahar River granite etc.) The Lower Aravalli Group consists of Delwara Formation and overlying Jhamarkotra Formation. The base of the Aravalli Supergroup is composed of metavolcanics with thin bands of dolomite/ quartzite, conglomerates, veins of barite units of Delwara Formation. The carbonaceous phyllite and stromatolitic rock phosphate constitutes the Jhamarkotra Formation.

The outcrop transects chosen for study were near Debari, Kailashpuri, Sarara, and Jaisamand, which are parts of Delwara Formation and Umra area which forms a part of Jhamarkotra Formation. The establishment of supracrustals as distinguished entity and being separate from the basement rocks was based primarily, on four factors that involved occurrence of horizons of conglomerate beds, basal metavolcanics with vesicles, quartzite marker horizons, and metamorphosed palaeosol.

Table 1: Precambrian rock stratigraphic sequence in Rajasthan

Purohit et. al., 2012		
Delhi Supergroup		
ARAVALLI SUPERGROUP	UPPER	Lakhwali Group Jharol Group Kabita dolomite Debari Formation
	MIDDLE	Tidi Formation Bowa Formation = Machlamagra Formation Mochia Formation = Zawar Formation Udaipur Formation
	LOWER	Jhamarkotra Formation Delwara Formation Conglomerates, Quartzites etc
Mewar Gneiss- Gneisses, Amphibolites etc		

III. CONGLOMERATE AS STRAIN MARKERS

In all the conglomerate horizons bedding plane occurs parallel to the strongly developed S_1 cleavage. Because of this the shortest axis of flattened pebbles invariably lies perpendicular to the bedding schistosity. Accordingly, the longest axis of pebbles defines the L_1 lineation on the bedding schistosity.

IV. METHODOLOGY

It is well known that the finite axial ratios of the strain markers such as vesicles, ooids, pebbles, fossils etc. and orientation of the strain ellipsoid are due to the combined effects of the nature of the pre-tectonic shape factor and the subsequent superimposed strain.

Passive strain markers deform along with their surroundings, active strain markers respond differently, leading to varied strain patterns and providing deeper insights into the deformation process. This understanding is crucial for geoscientific studies of rock deformation and structural geology (Bhattacharyya and Hudleston, 2001). Data from active strain markers, such as those collected from a deformed polymictic conglomerate, can be used to estimate three-dimensional strain. By analyzing different clast types within the same rock and locality, we can understand the varied strain responses and the mechanics of deformation in greater detail. Quartz or quartzite conglomerates with a quartzite matrix are frequently utilized for strain analyses. The closer the mineralogy and grain size of the matrix matches with that of the pebbles, the less deformation partitioning occurs, resulting in more accurate strain estimates (Hossack, 1968)

Five transects were selected of intraformational and basement relation lying along inlier and basement outcrops, of these Sarara, and Jaisamand are the inliers and Debari, Umra, Kailashpuri lies close to the basement. The research

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technique involves measuring major, intermediate, and minor principal strain axes x-y, y-z, x-z from conglomerates of different locations of the study area to understand strain variation using Flinn graph after (Figure 2 and Figure 3)

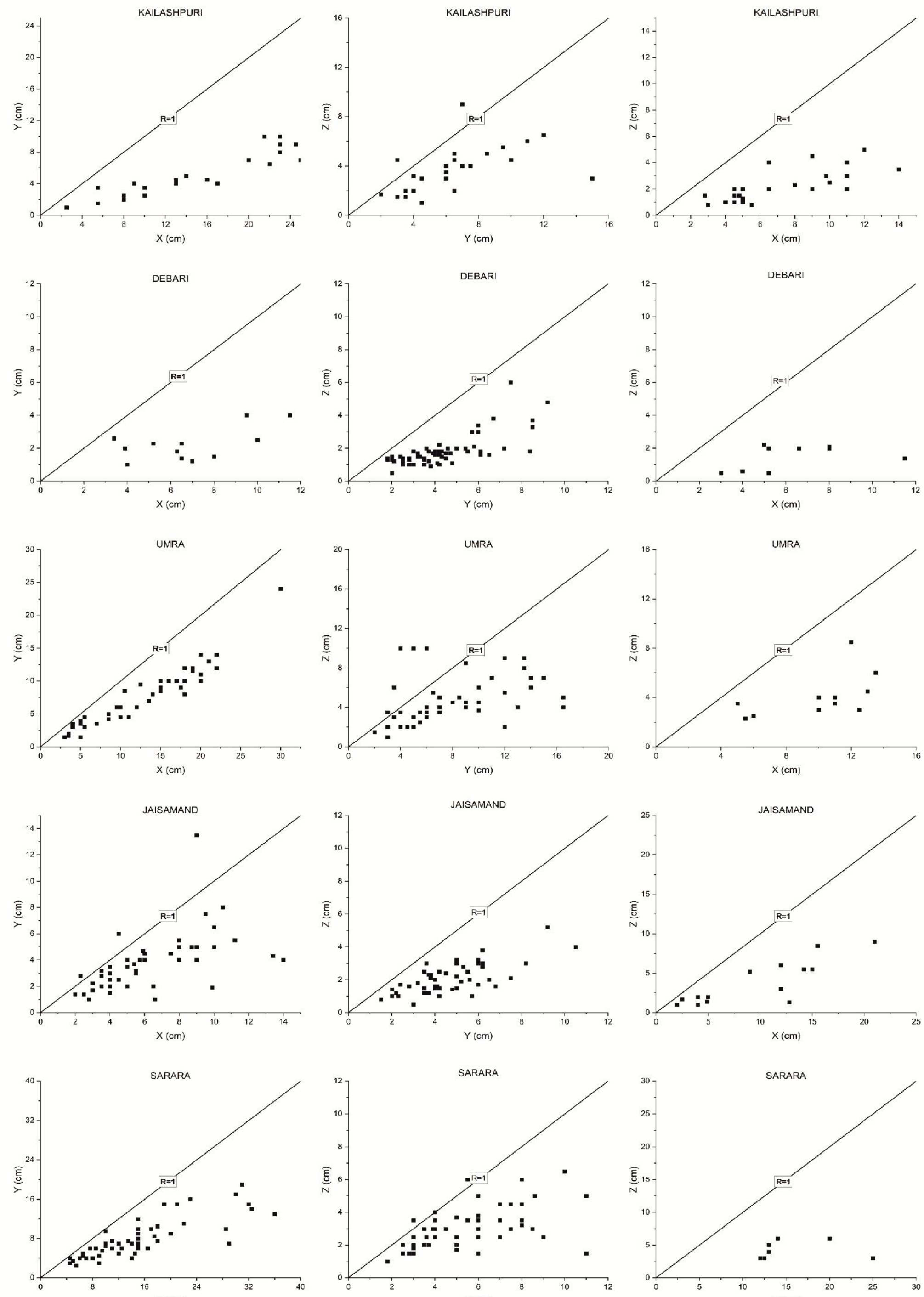

Figure 2- Plot of major, intermediate, and minor semi axes (x-y, y-z, x-z)-of the quartzite pebbles.

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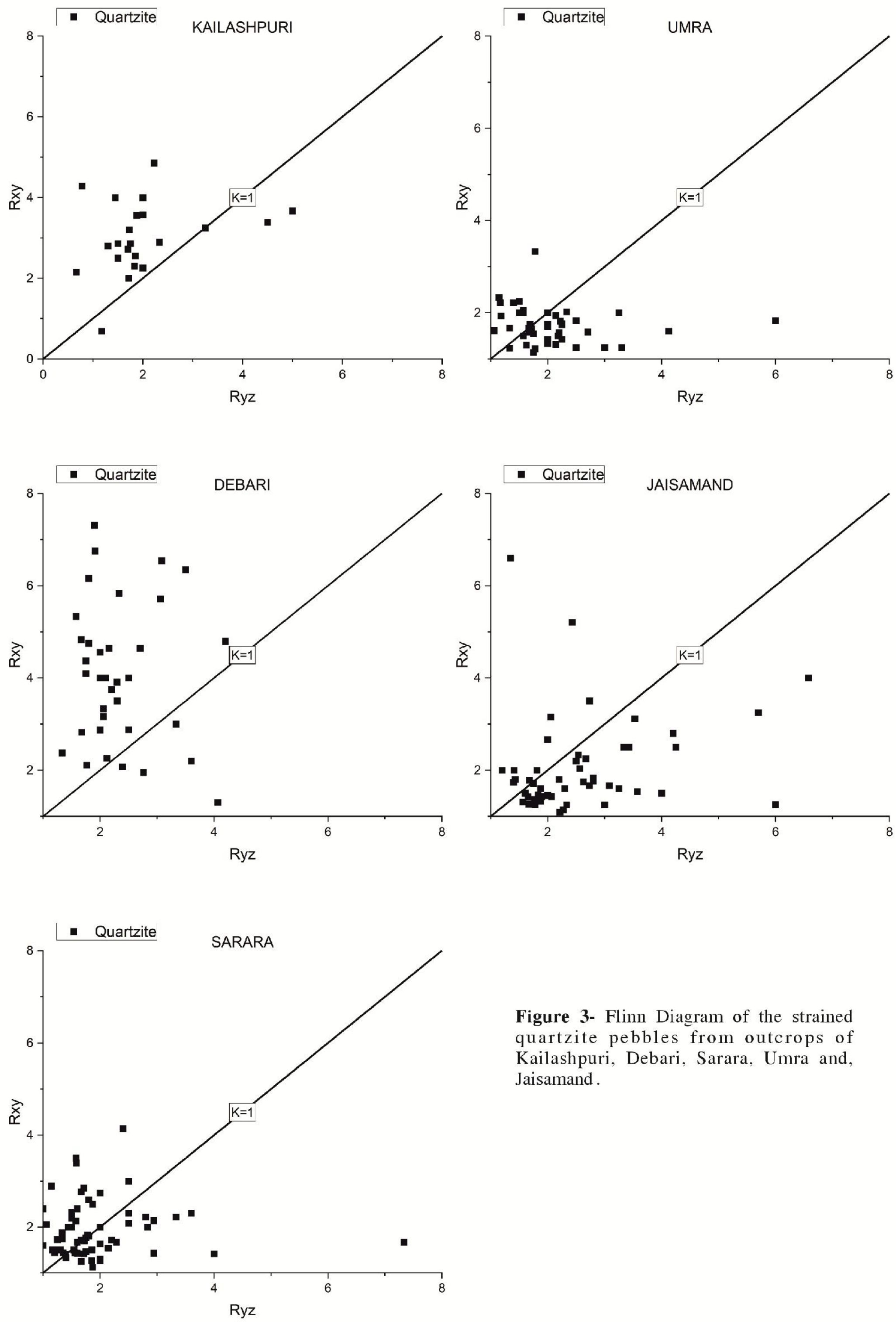

Figure 3- Flinn Diagram of the strained quartzite pebbles from outcrops of Kailashpuri, Debari, Sarara, Umra and, Jaisamand.

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V. RESULTS

Data points of strain ellipsoids plot in the field where both the axes are deformed as shown in figure 2. The Flinn diagram of the strain patterns are as shown in figure 3. Strain analysis study of Debari and Kailashpuri lie within prolate field ($k = \infty$) and shows uniaxial extension, while Umra, and Jaisamand lie in the oblate field ($k = 0$), showing dominantly uniaxial flattening. The samples from Sarara Inlier, lies on the boundary of prolate-oblate ellipsoid ($k = 1$), showing bimodal strain variation. Results of strain analysis from Debari, Kailashpuri, Umra, and Jaisamand are suggestive of directed forces whereas that from Sarara are indicative paired forces.

VI. DISCUSSION

Results of strain pattern as shown in figure 2 plot in the field which can form during a single deformation of flattening type, or it can develop as a result of the superposition of two or more phases of non-coaxial deformation (Ramsey and Huber 1987). Furthering the strain variation analysis using Flinn plots reveal distinct deformation patterns across different locations. The Debari and Kailashpuri outcrops, part of the Delwara Formation, exhibit uniaxial extension, while Umra, and Jaisamand show predominantly flattening strains. Interestingly, the Sarara Inlier demonstrates bimodal strain variation, suggesting a complex interplay of geological forces.

The findings indicate that the strain patterns in Debari, Kailashpuri, Jaisamand, and Umra are influenced by directed forces that have caused elongation at the first two and flattening at the latter three locations.

VII. SUMMARY

This study focuses on comparative strain analysis of the Lower Aravalli Group rocks, particularly conglomerates, from different locations around the Udaipur sector, a key area for understanding the Aravalli Supergroup. The study reveals distinct deformation patterns. Debari and Kailashpuri show uniaxial extension. Umra, and Jaismand exhibit flattening, and Sarara Inlier displays bimodal strain. These findings suggest that different regions of the Udaipur sector have experienced varying tectonic forces, providing insights into the tectonic evolution of the Lower Aravalli Group.

VIII. ACKNOWLEDGEMENT

Praveen Sharma and Pranjal Gothwal want to express their sincere gratitude to, Head Department of Geology, Mohanlal Sukhadia University, Udaipur for their unwavering encouragement, support, and direction during this research.

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