



Joint analysis and Economic Significance of Lakhra formation in the Vicinity of Khanu Brohi, Jamshoro, Sindh

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Abstract: The detailed joint analysis and economical importance of Lakhra Formation is carried out from the study area which belongs to the southern part of Lower Indus basin and lies in the east of Kirthar range. The present work is carried out from the nine locations existing in the exposed rocks of Lakhra Formation, in the vicinity of Khanu Brohi district Jamshoro, Sindh, Pakistan. The observed joints were analyzed by using the structural techniques and rose diagrams for the purpose to determine the maximum force direction exerted in the formation of joints. In addition to that the entire structure of the studied area was also being focused which is southern most part of the Lakhra Anticline.

The study area represents one major fault in the Lakhra Formation which is a thrust fault and is associated with minor faults. The area of research also displays joints of different types mostly they are oblique, square, parallel and horizontal joints.

The application of structural data through rose diagrams in the studied area shows that the maximum force for the development of the major structures and joints has been generated from the NW direction.

Keywords: Rose Diagrams, Joints, Structure, Lakhra Formation and Khanu Brohi.

1. INTRODUCTION

The area of study lies between the Longitude 68^o, 09', 10'' E and 68^o, 11', 05'' E and Latitude 25^o 25' 24'' N to 25^o 26' 06'' N. It is located about 24 km in the NW of University of Sindh and 16 km in due West of Liaquat University of Medical & Health Sciences (LUMHS), Jamshoro. (Fig. 1) The area where the joints were studied covers the part of Survey of Pakistan Toposheet no 40 C/3. Physiographically this area represents the hilly ridges, flat terrain, well developed drainage patterns. The hills of the area reach up to a maximum height of 500 feet and are dissected by rivers mostly in the east direction. The area has arid climate characterized by high temperature, low precipitation with an average rainfall of 125 mm annually and less humidity. Surface field studies and data from mine shafts show the marine sedimentary rocks ranging in age from Upper Paleocene to Eocene. Recent alluvium overlies these rocks. These rock units has been faulted, folded and jointed into NE-SW trending anticlines and synclines with gentle dipping. Tectonically the studied area lies in the South eastern side of Kirthar Foldbelt.

2. MATERIAL AND METHODS

The latitude-longitude values of the studied area were taken by the direct readings by using the Global Position System (GPS). These values were plotted on index map of Pakistan (Fig. 1) and geological map of the area was prepared by using Global mapper and adobe Photoshop software. The circle inventory

method was used for the collection of data from the field by using the Brunton Pocket Transit for the measurement of dip and strike of the joints present in the area. Data was collected from nine different locations ranging their diameter from 10 to 40 meters. Finally Rose diagrams were prepared by using **Oriana4** software which is a program for Microsoft Windows that analyzes orientations of circular data. It calculates a variety of the special types of statistics necessary for working with data measured in degrees and other circular scales.

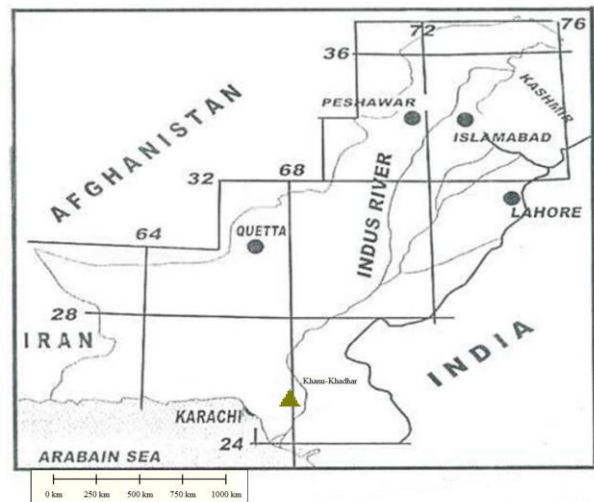


Fig. 1 – Map of Pakistan showing the studied area (After Brohi, 1993)

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Geotectonic Setting:

In global tectonic perspective, Pakistan is situated at the junction of three lithospheric plates, the Indian plate, Arabian plate, and Eurasian plate (Kazmi and Jan, 1997) (Fig. 2a). The Indus Basin is situated on the northwestern corner of the Indian plate. The Indian plate after separating from the African Plate during Jurassic-Early Cretaceous started drifting in the northeast direction and collided with Eurasian plate in Paleocene – Early Eocene. The collision is characterized by continent to continent collision, obduction and thrusting and is considered the proto type Alpine-Himalayan orogeny (Powell, 1979). Pakistan comprises of two sedimentary basins, the Indus Basin and Baluchistan Basin. These basins, are separated by a major fracture zone (axial belt), collectively occupy an area of about 8, 28,000 sq. km (Shah, 2009). The Indus Basin is divided into large longitudinal oriented parallel tectonic features, which are further subdivided by sub-longitudinal basement highs and transverse uplift into smaller tectonic zones. The main tectonic features of the Indus Basin are the platform and the fore-deep, which comprises depressions i.e. an inner folded zone and the outer folded zone. The platform, known as the Indian platform, coincides with the present Indus plain and is subdivided into the Punjab monocline, Sukkur Rift zone and Sindh monocline. Lower Indus basin includes the Sukkur rift zone, Thar platform, and Karachi trough, Kirthar fore deep, Kirthar fold belt and off shore Indus. During the Paleo-Pliocene times, Himalayan orogeny (continental to continental collision between Indian and Eurasian plates) gave rise to the tectonic pulses generating compressional forces in northeastern direction, which folded the sedimentary layers and gave rise to the ranges in Sindh, including the Khirthar Range. (Fig. 2b)

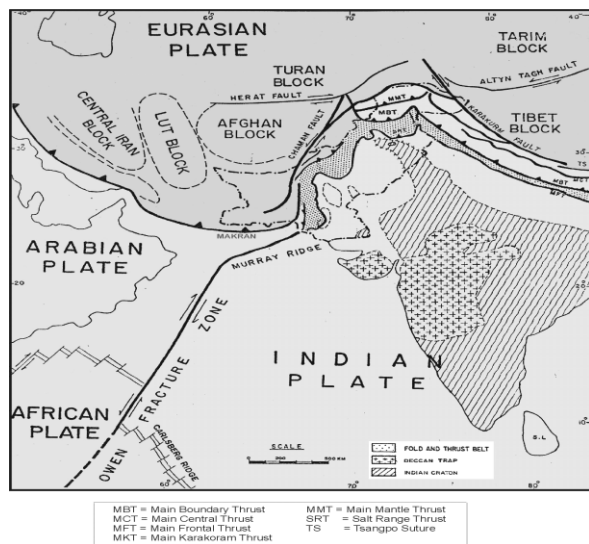


Fig. 2a- Tectonic Map of Indian Plate

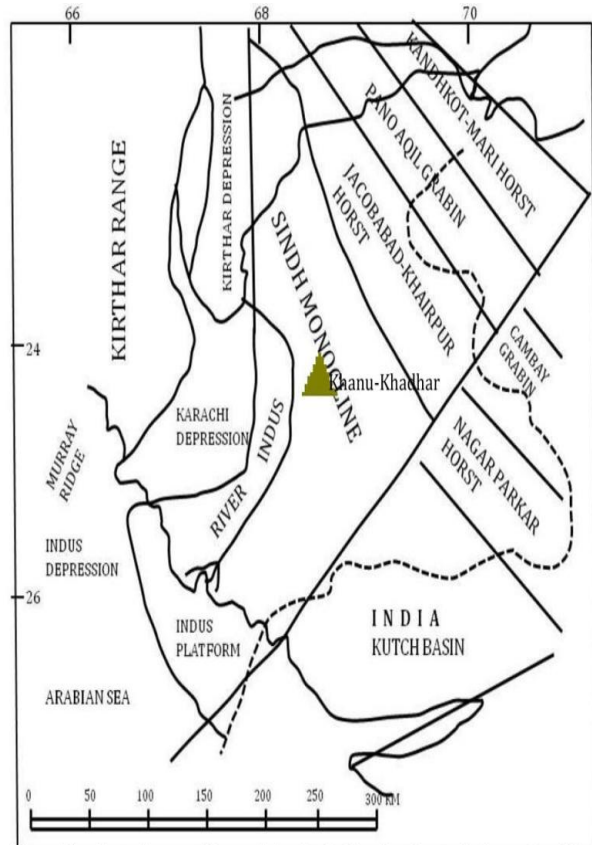


Figure 2b - Tectonic map of Lower Indus Basin Showing the studied area, (modified after Raza et al. 1990)

Fig. 2b- Tectonic map of Lower Indus Basin Showing the studied area

Geology and Stratigraphy:

Stratigraphically the area depicts the two Formations namely Lakhra and Laki, ranging in age from Paleocene to Eocene. Ahmed and Ghani (1971) have proposed the name Lakhara formation, after Lakhara, Laki range, for the “Upper Ranikot (limestone)” of Vredenburg (1906) and “upper Ranikot” of later workers. The Lakhra formation of the present report also represent the “upper Ranikot formation” and upper parts of the “bad Kachu”, “Rattaro” and “Thar” formations and lower part of the “Jakker Group” of Hunting survey Corporation (1961).

The Formations consists of interbedded non clastic rock (limestone) and clastic rocks (shales), containing the frequent occurrence of gypsum beds ranging from 2.5 to 7.5 cm. The Shale is flaky, thinly bedded and Khaki in color. Whereas the limestone is medium hard to hard, it is pinkish yellow to yellowish brown in color and is well jointed and fractured in the area. (Fig. 3 and 4).

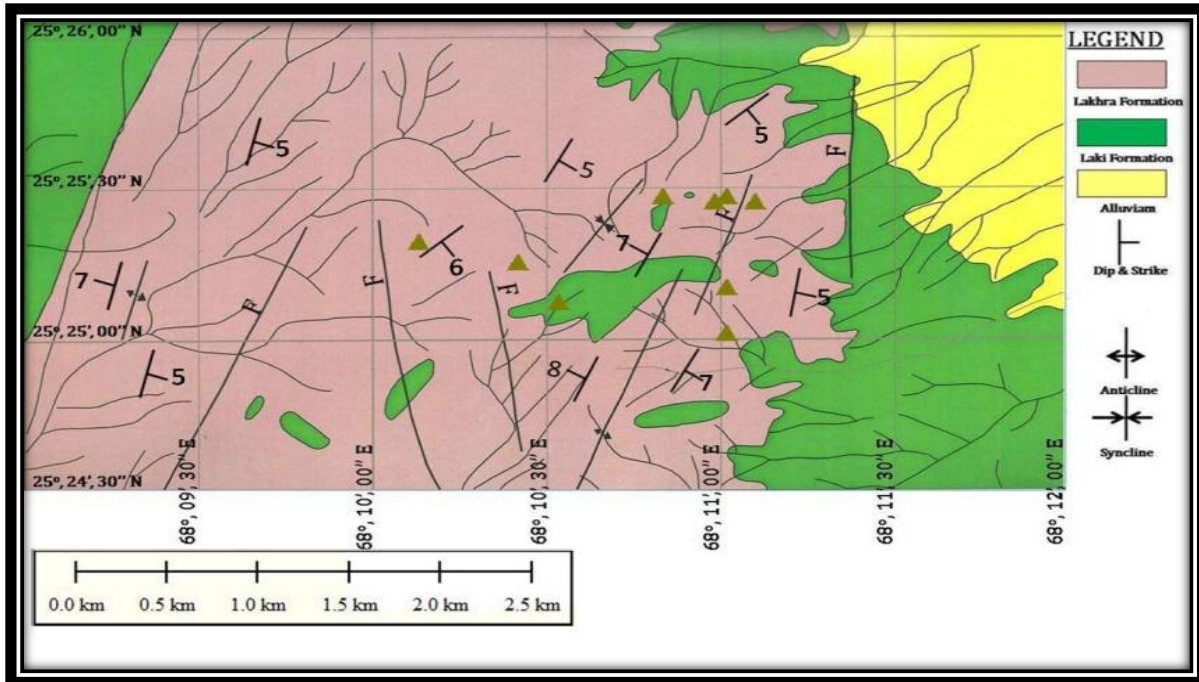


Fig. 3- Geological map of the studied area (modified after Solangi and Brohi, 2008)

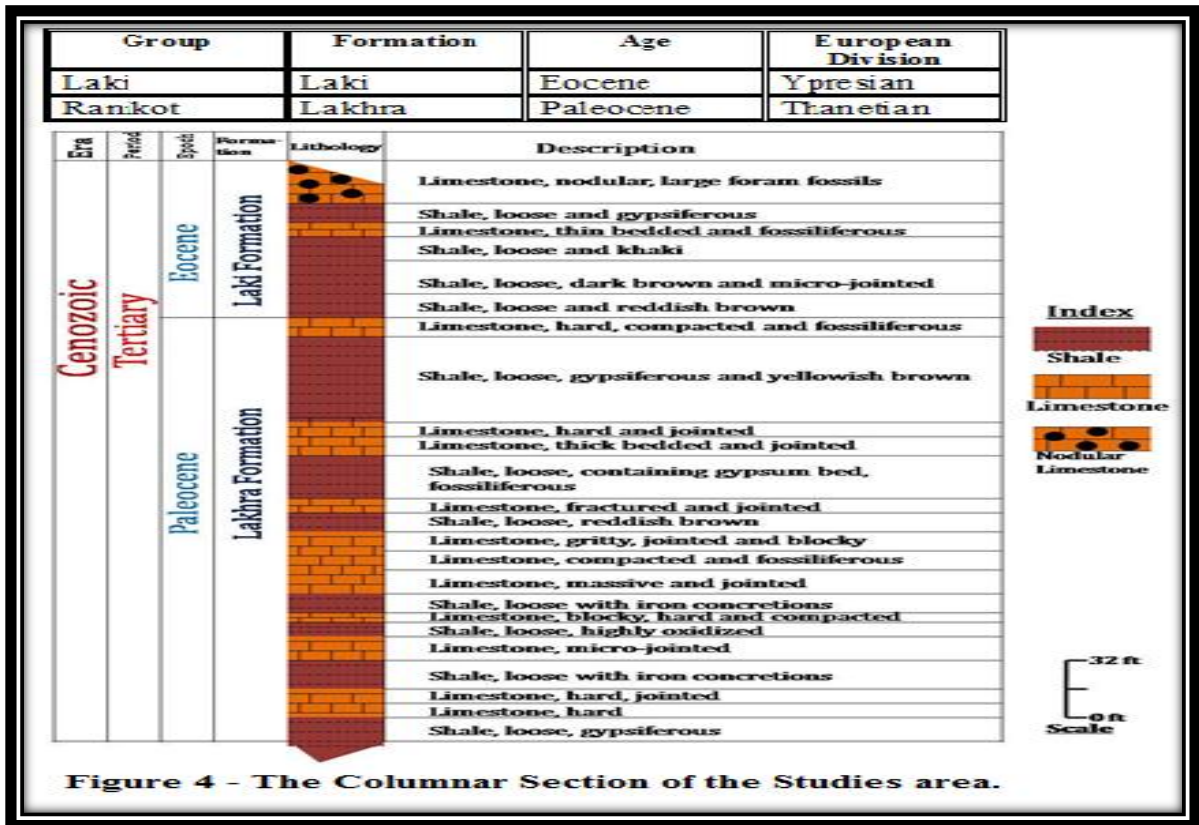


Figure 4 - The Columnar Section of the Studies area.

Fig. 4. The columnar section of the Studies area.

Economical Importance:

Though the studied area does not contain the other valuable economic deposits but it contains very rich deposits of limestone, dimension stone, cut stone, coal and minor occurrence of gypsum which cannot be included in economic deposits because of its less development.

Limestone:

The area comprises thick to massive bedded occurrence of limestone belonging to upper Paleocene age, hard and compact which are white, off-white, pinkish yellow and gray in color. This limestone can be a good source for cement factory and building material.

Dimension stone:

This stone is also known as marble in the market and is used for building floor and decoration. Dimension stone is economically valuable.

Cut stone:

This stone is also economically valuable and is used in building construction.

Gypsum:

In the studied area the gypsum occur as Lenticular lenses 2.5- 5.0 cm in the layers of grayish brown colored shale of Lakhra Formation belonging to upper Paleocene age, which is not economic in this area.

Coal:

At a depth of 61.5 m, 2.6 m thick horizon of Bituminous type of coal is present in Lakhra Formation and is being mined locally. This coal is used for the various purposes in the industries.

3.**RESULTS**

The type of joints in the area are cross-parallel, parallel-horizontal, vertical and cross-strike and strike-parallel (**Fig. 5**). Space between joints varies between 6 to-10 inches. The rose diagrams of all nine locations (**Fig.6**) and composite rose diagram (**Fig.7**) prepared by plotting the data taken from all locations in the studied area (**Table 1**) shows the high concentration of joints in NW direction which were formed because of the tectonic forces from NW direction.

4.**CONCLUSION**

The detailed joint analysis study suggests that the maximum force that caused in the formation of joints was from W-NW direction. The study area suggests that the research area is economically important with reference to dimension and cut stones. In Studied area 10 feet thick bed of Limestone is of Good quality for dimension stone and other units from medium to high quality of cut stones are present.

Table 1 - Data collected from field showing the density of joints in NE, SE, SW & NW directions

Frequency Interval	NE		SE		SW		NW	
	Number of Joints	Percentage	Number of Joints	Percentage	Number of Joints	Percentage	Number of Joints	Percentage
1 to 10	18	8.61244	11	6.547619	7	3.365385	15	2.890173
11 to 20	23	11.00478	20	11.90476	23	11.05769	35	6.743738
21 to 30	33	15.78947	25	14.88095	39	18.75	46	8.863198
31 to 40	31	14.83254	22	13.09524	30	14.42308	52	10.01927
41 to 50	40	19.13876	17	10.11905	23	11.05769	71	13.68015
51 to 60	24	11.48325	21	12.5	19	9.134615	65	12.52408
61 to 70	17	8.133971	31	18.45238	21	10.09615	101	19.4605
71 to 80	19	9.090909	17	10.11905	35	16.82692	98	18.88247
81 to 90	4	1.913876	4	2.380952	11	5.288462	36	6.936416
Total	209	100	168	100	208	100	519	100

Table 1 - Data collected from field showing the density of joints in NE, SE, SW & NW directions

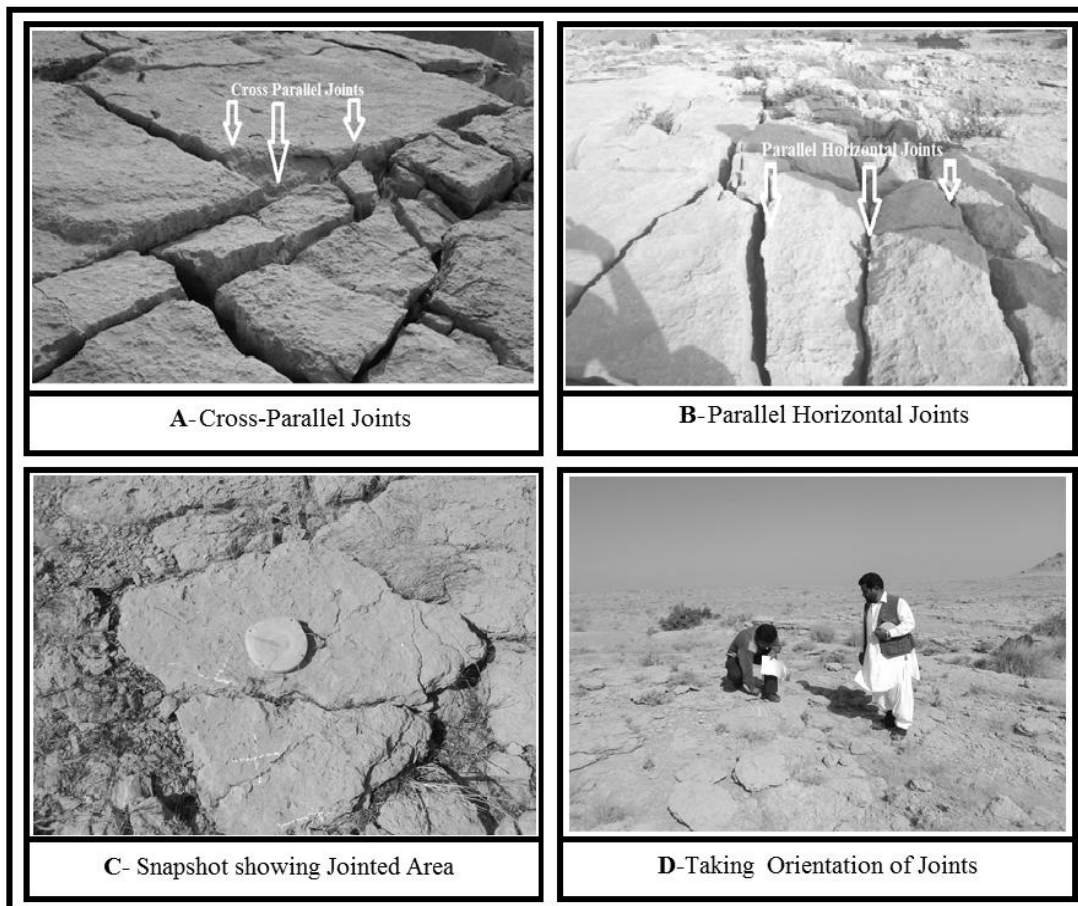


Fig. 5 - Photographs showing the different types of joints in the studied area

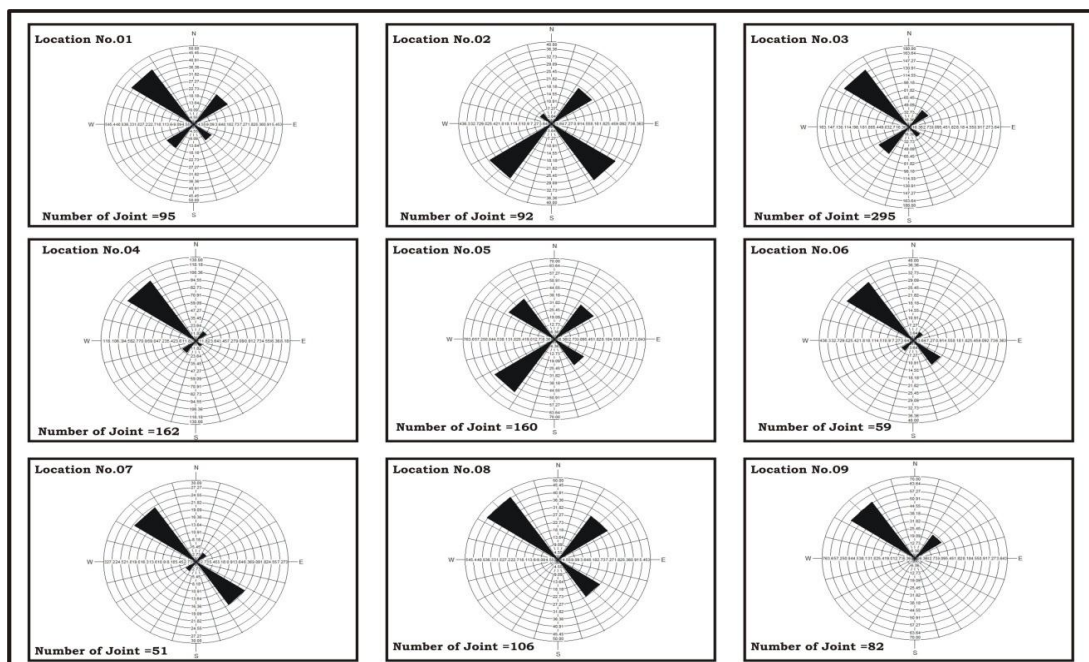


Figure 6 - Rose diagrams of the different Locations with in studied Area

Fig. 6. Rose Diagrams of the Different locations With In Studies area

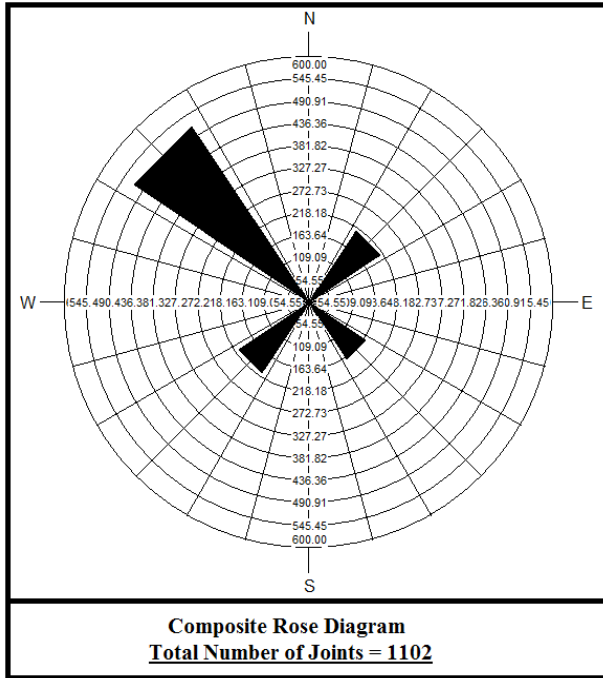


Fig. 7- Composite rose diagram of the studied area

REFERENCES:

Hunting Survey Corporation, (1960) Reconnaissance Geology of Part of West Pakistan Toronto, Canada, 1-150.

azmi, A. H. and Q. Jan (1997) Geology and Tectonics of Pakistan, graphic publishers, Karachi, Pakistan.

Powell, C. and A. Mc. (1979) Speculative Tectonic History of Pakistan and Surroundings: Some Constraints from the Indian Ocean. In: A. Farah and A. De. Jong (editors), Geodynamics of Pakistan, Geol. Surv. Pakistan. 5-24.

Raza, H. A., S. M. Ali, and R. Ahmed, (1990) Petroleum geology of Kirthar sub-basin and part of Kutch basin. Pak. J, Hydroc. Res., 2 (1): 68-76.

Shah, S. M.I., (2009) Stratigraphy of Pakistan. Mem. Geol: Surv. Pak. Vol. (22): 71-72.

Vredenburg E. W. (1906) The Classification of Tertiary system and Sindh with response to the zonal distribution of the Eocene echinoids describe by Dunca n and Slanden India Geol: Surv; Recs. Vol. (34): 172-198.