# SEDIMENTARY ROCKS OF LADHIYA FORMATION, NAINITAL DISTRICT, KUMAON HIMALAYAS (A PART OF THE NAINITAL BASIN)

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ABSTRACT

The observations suggest that the sedimentaries of the Nainital basin south of the Almora Crystallines are normal in position. Palaeocurrent direction in the Talari section is SSE. Rhythmicity of stable and unstable shelf conditions was due to the uprising of the Almora Crystalline mass.

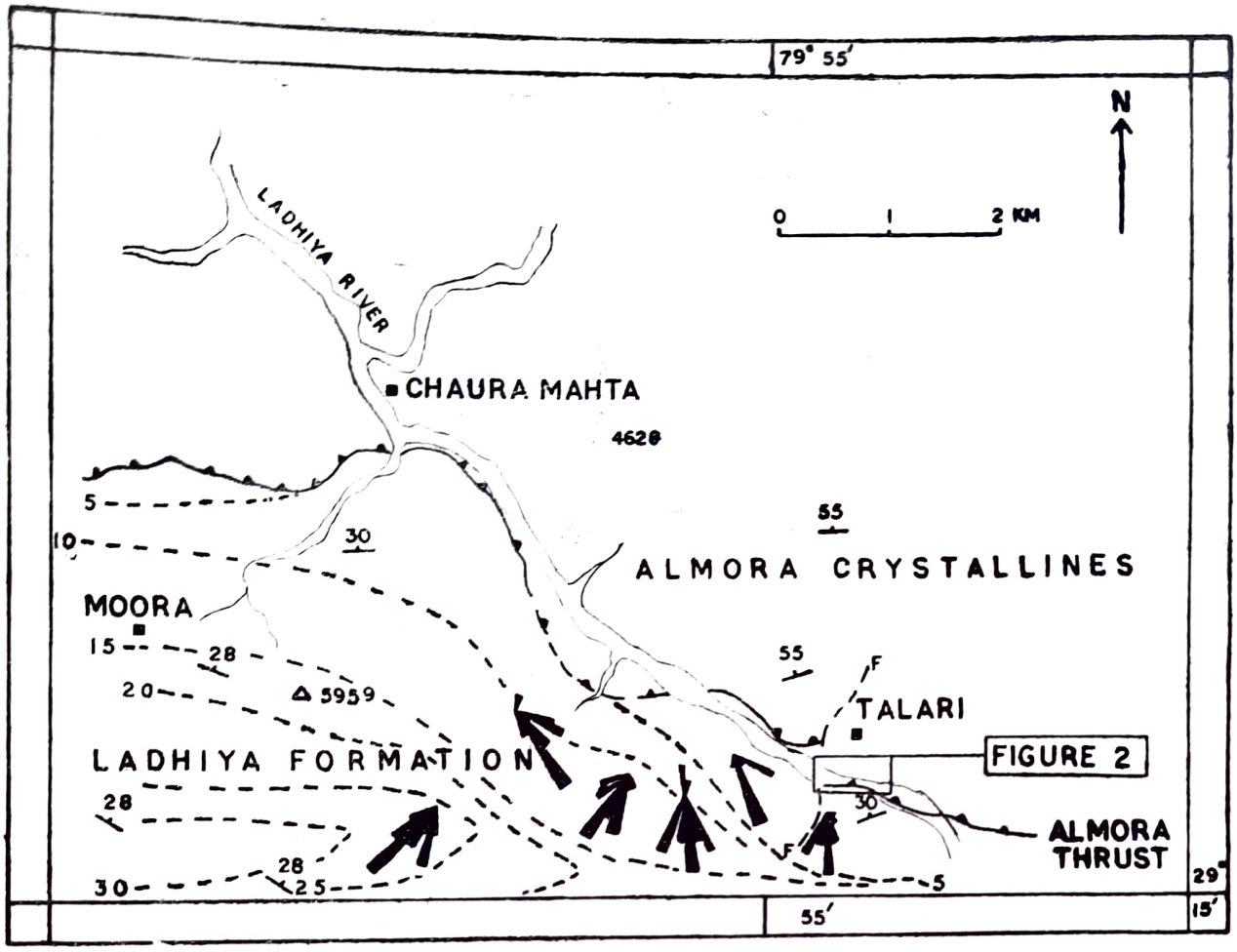
During the course of investigations of the Nainital basin* analysis south of the Almora Crystallines, the author has selected Talari section (79°55′ : 29°16′) of the Ladhiya Formation for petrography and cross bedding analysis. Sedimentaries of the Nainital basin and Almora Crystallines are separated by a thrust which can easily be differentiated on the basis of contrasted lithology and tectonic evidences observed along the thrust zone (Table 1). VALDIYA (1963) has studied these rocks east of the present area and has suggested a huge recumbent fold involving crystallines and sedimentaries of the Calc Zone of Pithoragarh and Krol nappe. According to him the sedimentaries in the south represent the overturned limb.

TABLE 1—Succession north to south

| Group | Formations (Misra & Sharma, 1967) | Tectonic unit |
|---|---|---|
| Almora Group (Cyrstallines) | Gorakhnath Formation | Almora nappe II (Sharma & Sinha, 1972) |
| .. .. .. ... .. .. .. .. .. .. .. .. .. | ..Ladhiya Thrust.. .. .. .. .. .. .. .. .. .. .. .. .. .. | |
| Krol Group (Naini Tal Basin) | Ladhiya Formation | |

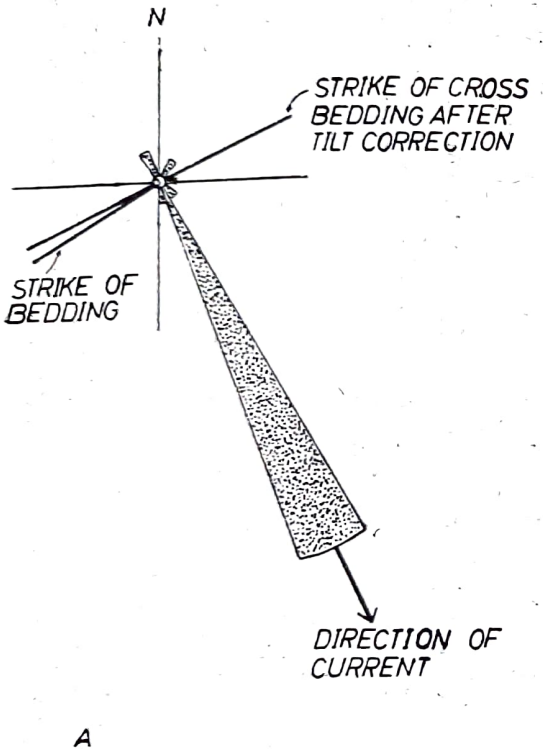
A thick sequence of quartzites, metamorphosed basic rocks, phyllites and slates exposed in the valley of Ladhiya river constitute the Ladhiya Formation (Text-Fig. 1): a part of the Nainital basin (=Krol Basin). So far no palaeocurrent studies were conducted from this sedimentary belt by any worker. A 175 meter vertical section of quartzite in Talari area records graded and cross bedded units with variations in texural maturity. Associated basic rocks occur as interbedded volcanic and tuffaceous rocks with slaty and phyllitic partings; also as dykes of doleritic composition with schistose structure.

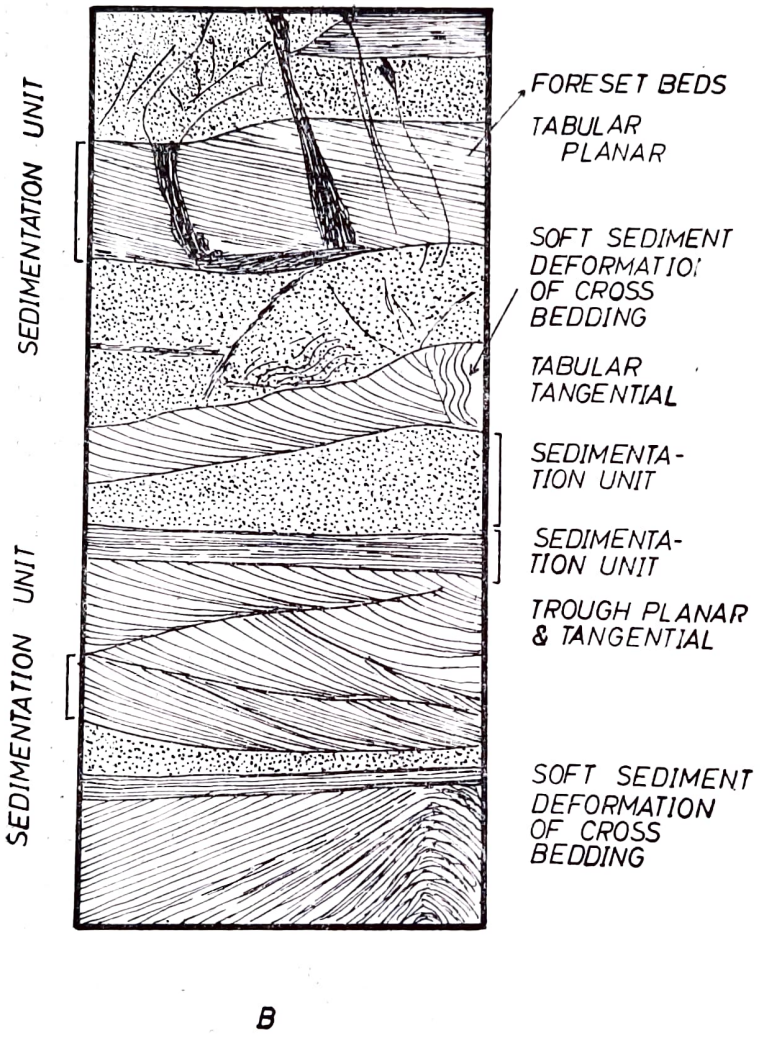
*The term Nainital Basin has been used in this paper to include sedimentary sequence sandwitched between Almora Crystallines and Siwaliks.

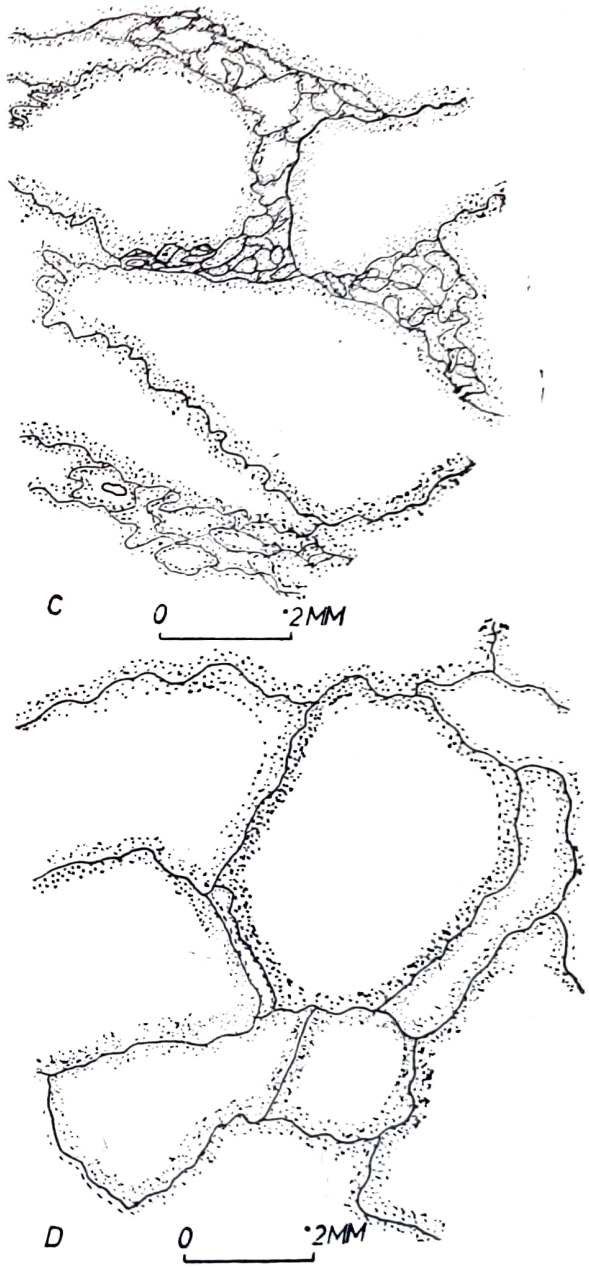



Text-Fig. 1. Geological map of the Talari area. Rose diagrams for the cross bedding directions in each sector. Dashed lines are percentage contours for nonclastic sediments.

The quartzites are massive white, fawn, grey and olive green in colour showing a considerable range of variation in granularity and the cementing material. Constituent grains of quartz are elongated and show rounded margins becoming angular towards the thrust. They show prominent undulose extinction and strain shadows. The margins of the larger grains are crenulated, granulated (Text-fig. 2C) of stretched type. Quartzites with unimodal grain size show interlocking relationship but their intergranular boundaries are crenulated and sutured (Text-fig. 2D). They represent well sorted sandstone which have undergone low grade metamorphism. The boundaries of bigger grains of quartz can be differentiated by the thread like dusty ferruginous material of light green and black colour. Thread-like inclusions are also seen within the quartz grains. The cementing material is silica and sericite flakes arranged at right angles to the elongation directions of quartz grains (Pl. 1, Fig. 7). Zircons with round terminations and authigenic growths are also present. Thin bands of grey phyllites, slates and lithified tuffs as purple phyllites at definite intervals are commonly seen associated with these quartzites. The association of pure quartz sandstone, clayey shales, grey and green shales—a characteristic feature of stable and unstable shelves—is represented by the sedimentaries of the Ladhiya Formation. However, the orthoquartzites forming a sedimentation unit do not contain the shaly sequence but they are followed by another sedimentation unit of argillites. Correlation coefficient between the cement and grains is —0.32 with a progressive value upto —0.58 towards south and southwest indicate an inverse relationship. Relative proportions of grains, matrix, and cement plotted on a triangular diagram (Text-fig. 3) suggest an increase of cement proportion towards south.



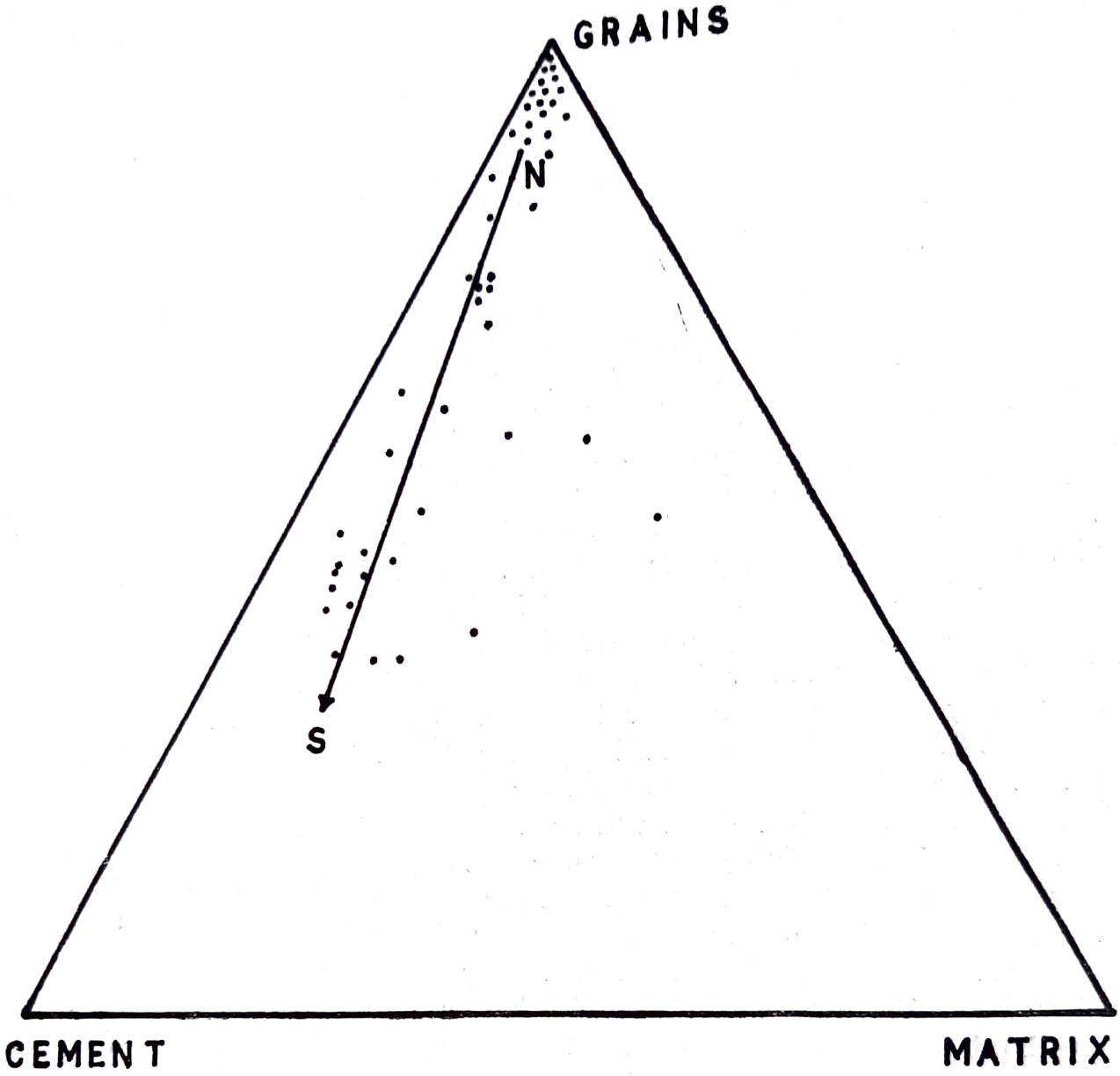




Text-Fig.2. A. Rose diagram for total cross bedding directions, B. Cross bedded units in the Talar section, C. Quartzite showing silica as cementing material, D. Well sorted quartzite showing granulated margins of quartz grains.

On the basis of lithology and sedimentary structures studied in this area, it can be stated that sedimentation took place in a fluctuating basin which permitted the deposition of shallow water to deep water sediments. Clayey shales present in the north change into silty shales towards south. The sedimentation began with the stable shelf conditions followed by subsidence, intermittant lava flows and the deposition of the quartz wacke in the form of lenticles. The orthoquartzites are result of considerable transport and winnowing as is evident from their textural and mineralogical maturity (Text-fig. 2D). Tuffs form a small part of sedimentation. Non-uniformity of the grain size with low sphericity and rounding index in some of the units may be due to the proximity of the provenance and products of different energy levels. Clastic sediments fringing the Almora Crystallines are replaced by the nonclastics towards south and westward where the krol sequence has developed. Thicknesses of the clastic and nonclastic sediments have been determined from the geological cross sections along the three traverses. Average thickness has been calculated for the every 1000 feet aerial horizontal distance from the Almora Crystallines. Percentage of nonclastic sediments shows a increasing trend towards south and southwest (Text-fig. 1). This indicates a linear type basin with its depth increasing towards Nainital where the Krols have attained a vast sequence. Major transverse fault along the Gola river (Misra & Sharma, 1967) may have developed in the early stage of the Nainital basin and uplifted the eastern block thus limiting the deep Nainital basin west of the fracture.

Cross laminations well preserved in these quartzites in Talari section are marked by ferruginous staining and can be easily recognised in the field. The orientation of cross bedding was systematically measured and recorded from rocks near Talari where they were well exposed (Text-fig. 1). Cross bedded units range from a few centimetres to three metres with an average of 0.5 metres. Cross bedding structures represent single sedimentation unit (Otto, 1938), which are separated by a massive sedimentation unit (Pl. 1). Cross lamination less than one centimetre (Pl. 1, Fig. 3) are commonly seen in these cross bedded sedimentation units. Torrential current bedding recorded from these quartzites give anamolous results of current directions (Pl. 1, Fig. 5). Conforming with the definitions of Potter and Pettijohn (1963), tabular and trough types can be identified in this zone on the nature of basal contacts of laminae (Text-fig. 2B). Actually both the types grade into each other. The transition from tabular to trough type is so smooth that a sharp differentiation cannot be made between the two sedimentation units. This indicates a steady change in the basinal conditions during the sedimentation history. Detailed classification based on their contacts with the approaching base of the set as: tabular tangential (Pl. 1, Fig. 1), tabular planar (Pl. 1, Fig. 2) and trough planar and tangential (Pl. 1, Figs. 3 & 6) can be made. All types of cross beddings are present in the Talari section of quartzites exposed for about a mile in the Ladhiya river cutting at Talari without facies variation, i.e., a continuous horizon of quartzites (Text-fig. 2B). 1378 cross lamination data have been systematically collected from Seven Sectors (Text-Fig. 1) and analysed here. Close association of trough and tabular type cross bedding indicates fluctuation in basinal conditions which may be related with the continuous uplift of the shelf areas (Text-fig. 2B).

The general dip of these quartzites is 15° to 38°/N 33°, which is quite a high tilt of the strata for the consideration of the direction of current at the time of deposition. The azimuths of inclination thus recorded were all rotated over the stereographic net to calculate the original direction of current bedding. The data after tilt correction were classified into groups of 10°, and rose diagram prepared( Text-fig. 1 & 2A). The mean direction of inclination of cross bedding, i.e., N. 155°, is the direction of current in this particular zone during sedimentation. Palaeocurrent direction indicating flow of sediments towards south




Text-Fig. 3. Textural variation in Arenoceous members of Ladhiya Formation from North (N) to South (S).

through southeast supports a possible positive area north of the Nainital Basin. Almora Cyrstallines must have existed as positive area during the sedimentation. Present outcrop pattern has developed after the folding of the Cystallines. Younger sediments deposited on a basement of the Almora Crystallines may have been involved in the folding of Crystallines. Disposition of the cross bedded units suggests a normal position of the Formation and does not support hypothesis of huge recumbent fold and inversion of sediments especially in this part of the sedimentaries.

ACKNOWLEDGMENT

The author is indebted to Professor R. C. Misra, F.N.A. and Dr. S. Kumar for guidance and going through the manuscript and valuable suggestions. The financial assistance by the University Grants Commission is thankfully acknowledged.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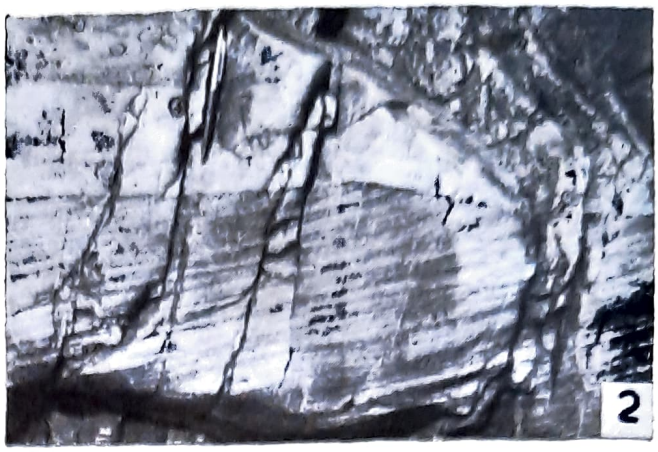
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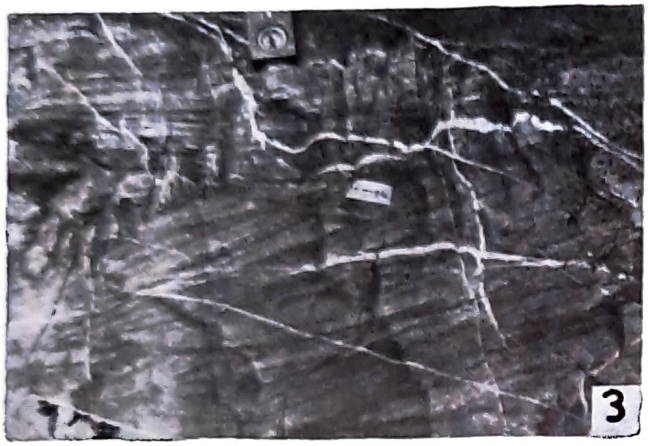
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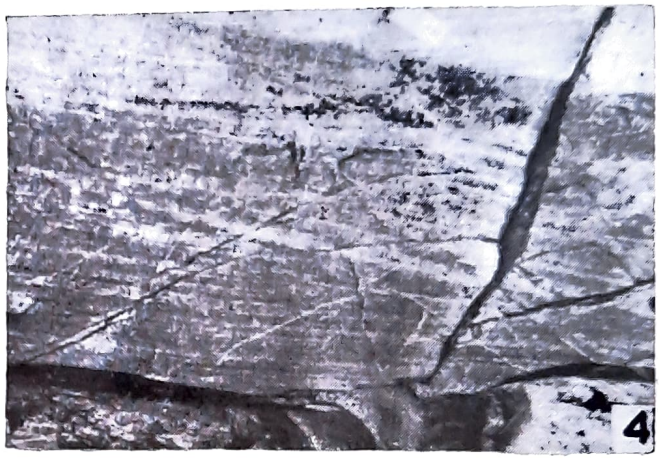
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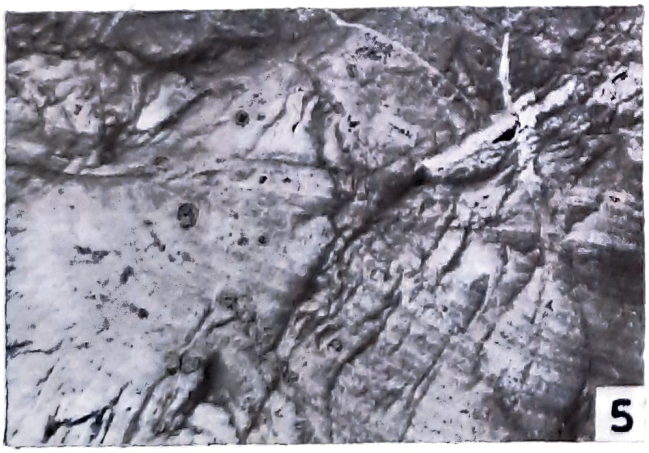
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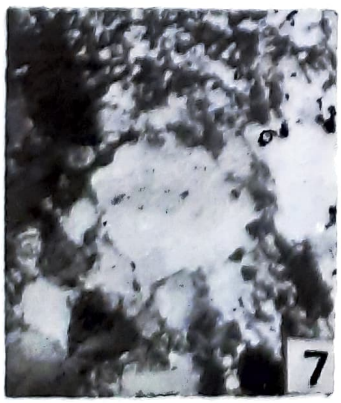
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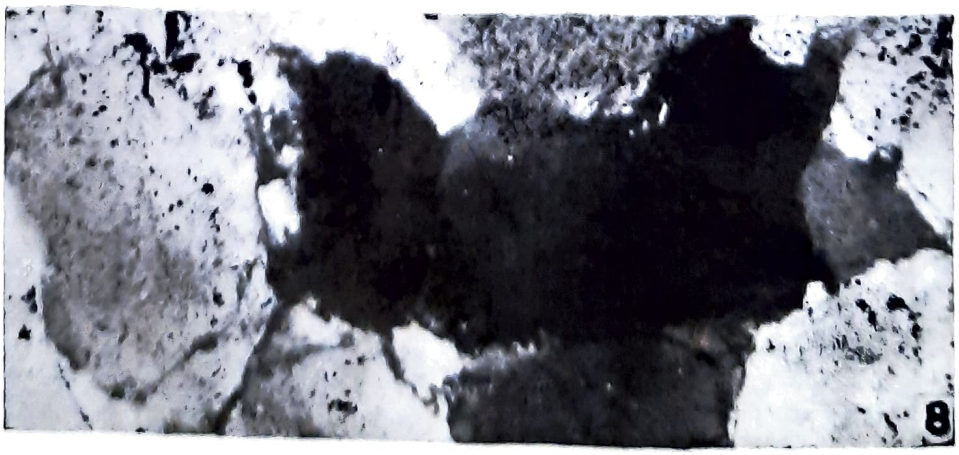
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## REFERENCES


MISRA, R. C. & SHARMA, R. P. (1967). Geology of Devidhura area, Almora, U. P. *J. geol. Soc. India.* **8**:110-118.

OTTO, G. H., (1938). The sedimentation unit and its use in fields exampling. *J. Geol.* **46**: 562/582.

POTTER, P. E. & PETTIJOHN, F. J. (1963). *Palaeocurrents and basin analysis.* Springer-Varlag, Gerlin-Gattingen Heidelberg.

SHARMA, R. P. & SINHA, A. K. (1972). Stratigraphy and structure of Ranikhet area, Kumaon Himalayas. *Proc. Indian Sci. Cong. Assoc.* 59th Session.

VALDIYA, K. S., (1963). The stratigraphy and structure of the Lohaghat Sub-division, district Almora, Uttar Pradesh. *Q. Jl geol. Min. metall. Soc. India.* **35** (3): 170-171


## EXPLANATION OF PLATE 1

1. Tabular tangential cross bedding (Normal) and soft sediment deformation.
2. Tabular planar cross bedding (Normal).
3. Trough planar and tangential cross bedding (Normal).
4. Trough planar, tabular planar and tangential cross bedding (Normal).
5. Tabular planar cross bedding and soft sediment deformation.
6. Trough tangential and planar cross bedding (Normal)
7. Photomicrograph of quartzite showing sericite and silica as cementing material.
8. Photomicrograph of the Orthoquartzite.