CHAPTER IV

KARCHULI GROUP (ALMORA NAPPE)

GENERAL

Unlike the previous workers, the present author does not consider the dislocation extending along the Khastari river and separating the Almora Crystallines from the argillocalcareous (Krol Nappe) rocks, to be the south-west dipping Almora Thrust (as visualised by Gansser). On the other hand, he considers this tectonic plane to be a later reverse fault, that has downthrown the south-west dipping Almora Thrust beneath the Krol Nappe.

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The rocks lying to the west and south of this location (Khastari Fault), constitute the Karchuli Group, and comprise a portion of the Almora Crystallines, consisting of a group of garnetiferous mica schists, sheared gneisses, quartzites and phyllonites. Relatively a small portion of the area in the southwestern corner is occupied by these W dipping rocks. Obviously, these comprise a part of the northern limb of the Almora Nappe synform. Further south and southwest, outside the study area, these crystallines contain numerous bands and lenses of unsheared gneisses. These gneisses, have been found to be products of granitisation (Merh and Vashi, 1965, Desai, 1968). The quartzites show a development of mesoscopic reclined fold. These folds are of considerable structural significance because a number of workers (Merh and Vashi, 1965, Merh, 1968, Desai, 1968) have found them to be the relics of the earliest fold episode during which the main foliation of the schists showing axial plane relationship with the reclined folds, had developed. It has been found that the axes of the reclined folds trend southwestward, almost at right angles to the trend of the foliation.

Broadly speaking, the mica schists occupy the southwestern corner of the area within these schists, occur some bands of quartzites. A rather conspicuous layer of flaggy quartzite is seen to form an inverted V shaped outcrop and it is not clear whether it forms a big early reclined fold or not. It occurs within the schists. To the east, schists merge into sheared gneisses. All along the Khastari river, these W and SW dipping gneissic rocks abut abruptly against the NE dipping Krol Nappe rocks.

PETROGRAPHY

Mica schists

Though, these micaceous rocks are the most abundant variety of the crystalline nappe as a whole, here in the area they occupy only a small portion. In hand specimen, these show a greyish white colour, well marked foliation and a sheeny lustre. These schists comprise two types - one garnetiferous and the other garnet-free.

Under the microscope, they are seen to consist of quartz, muscovite, biotite, chlorite with or without garnet. The quartz and muscovite are the most dominant minerals, and are almost in equal proportions. The modal compositions of the representative samples, are given in the accompanying table (Table 4.1).

Table 4.1 : Modal Composition of Mica Schist

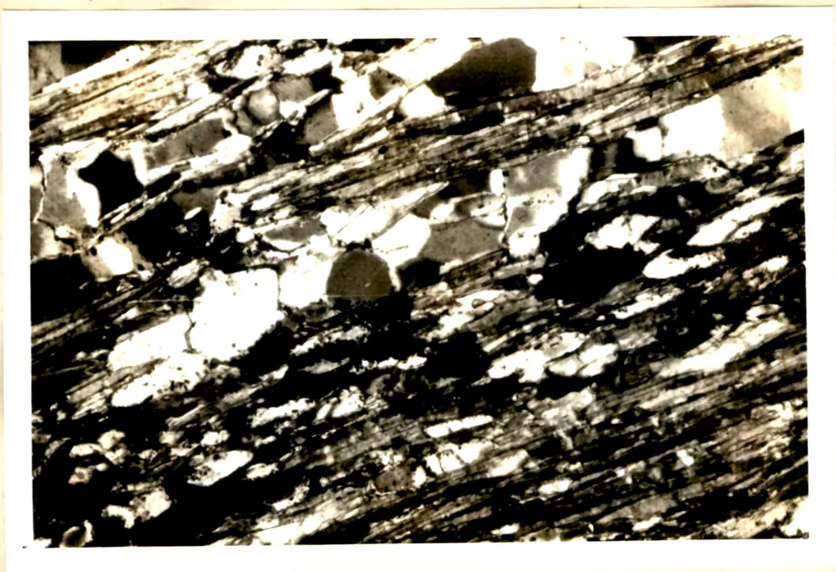
Mineral constitution	Garnet Bearing Mica Schist					Garnet Free Mica Schist	
	A	B	C	D	E	F	G
Quartz	50.84	61.97	52.09	46.61	53.14	71.40	66.29
Muscovite	39.82	30.72	35.61	37.29	40.74	27.10	32.71
Garnet	2.15	0.99	3.30	10.01	1.67	-	-
Biotite	4.45	0.13	4.84	1.33	1.90	-	-
Opaque	1.74	1.19	2.60	3.01	1.35	1.38	0.57
Accessories	0.96	4.97	1.53	0.87	1.17	0.10	0.41
Total Percentage	99.96	99.97	99.97	99.12	99.97	99.98	99.98

Texturally, in most cases they reveal a foliated aggregate of micas and quartz. The most striking feature of the quartz grains is that they show very sharp outlines and are quite angular in shapes. Individual grains of quartz generally do not show any elongation (Plate 4.1). Another textural variety, frequently encountered is the one in which micas form narrow, almost continuous layers separating those of quartz (Plate 4.2). Occasionally, thin sections reveal conspicuous and tight microfolds, indicating that the main schistosity originated by the microfolding of an earlier foliation (Plate 4.3).

As stated above, the dominant mica is muscovite, Biotite is quite subordinate and occurs as stray tiny flakes intergrown with muscovite.

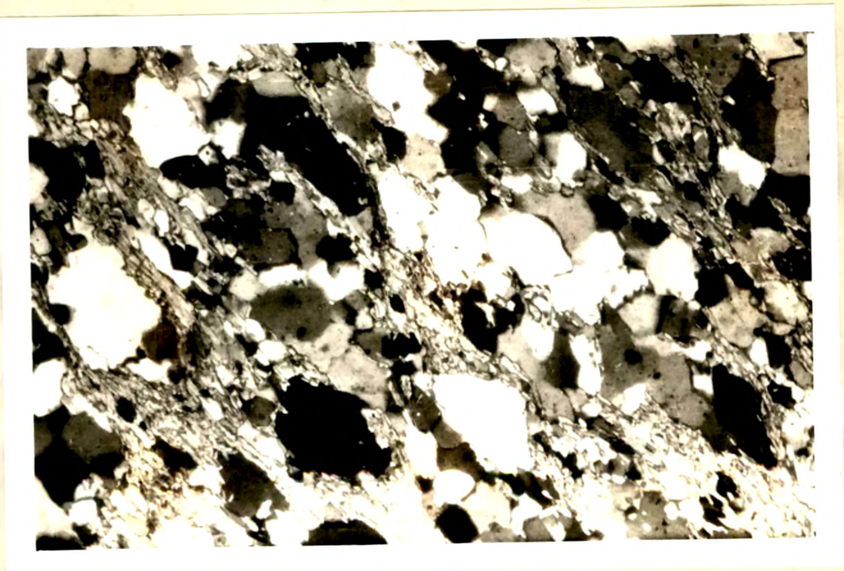
Garnet occurs as somewhat rounded equidimensional porphyroblastic grains, containing inclusions of quartz and magnetite. Its distinct rotational growth is shown by the helicoid pattern of the quartz inclusions (Plate 4.4). At places, the garnet shows alteration to green chlorite and occasionally the alteration product is hematite.

PLATE 4.1



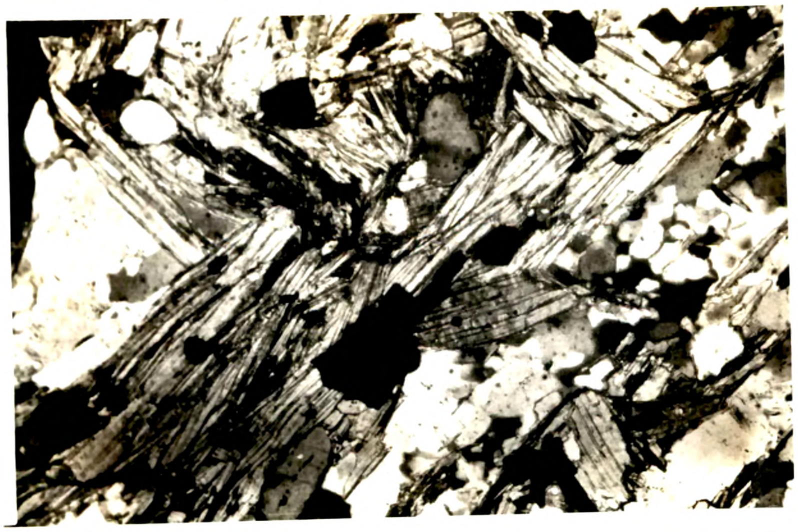
Texture of Mica schist
(Photomicrograph: Cross nicols, X75)

PLATE 4.2



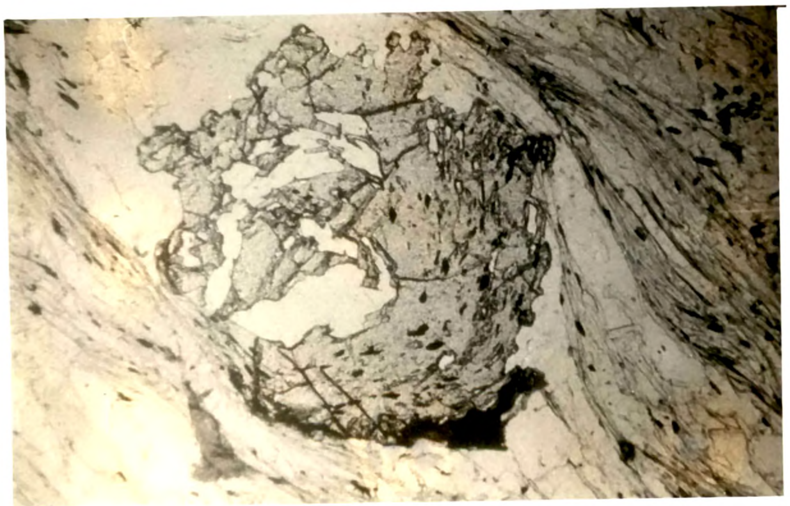
Texture of Mica schist
(Photomicrograph: Cross nicols, X75)

PLATE 4.3



Mica schist showing the microfolding of an earlier foliation.
(Photomicrograph: Cross nicols, X75)

PLATE 4.4



Rotated garnet in Mica schist
(Photomicrograph: Polarised light, X30)

Chlorite is the next abundant mineral. It is restricted to the garnetiferous variety and is seen to be the alteration product of garnet.

The most conspicuous accessory mineral is tourmaline which is almost invariably present as small pleochroic grains. Other accessory minerals are the usual apatite, magnetite etc.

Quartzites

Quartzites form a V shaped band nearly 1600 m thick extending NW-SE and 'intertonguing' with the mica schists. These are fairly micaceous and flaggy, and tend to break into flat smooth slabs. Dirty grey to yellowish brown in colour, the quartzites merge into mica schist through a narrow zone of transitional rock which could best be described as quartzose mica schist. For the convenience of description the author has included these transitional rocks also into quartzites only.

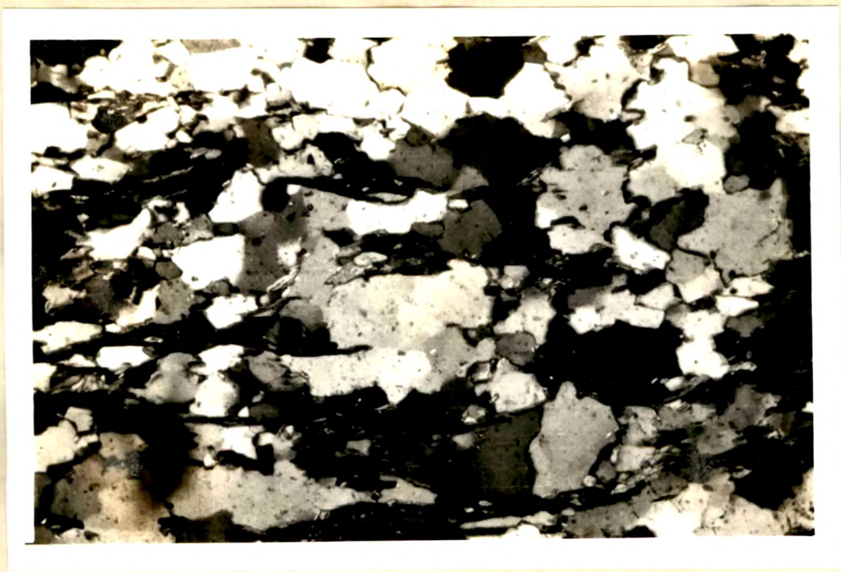
The more micaceous variety under the microscope is seen to consist of foliated matrix of fine flakes of muscovite within which are embedded quartz grains. On the whole, the quartz shows little flattening or elongation, and most grains are subhedral and equidimensional (Plate 4.5). Except a few tiny flakes of biotite, grains of tourmaline, apatite and magnetite, no other mineral is recorded.

The quartz-rich less micaceous variety which constitutes the main bulk, is seen under the microscope to consist of an equigranular mosaic of slightly elongated quartz grains with rather sharp contacts, within which are interspersed tiny specks of biotite. Muscovite which is subordinate to biotite, occurs as discrete thin long flakes scattered uniformly throughout the mass (Plate 4.6). Biotite is generally green and chloritic. Magnetite as tiny grains is the only accessory mineral.

Sheared gneisses

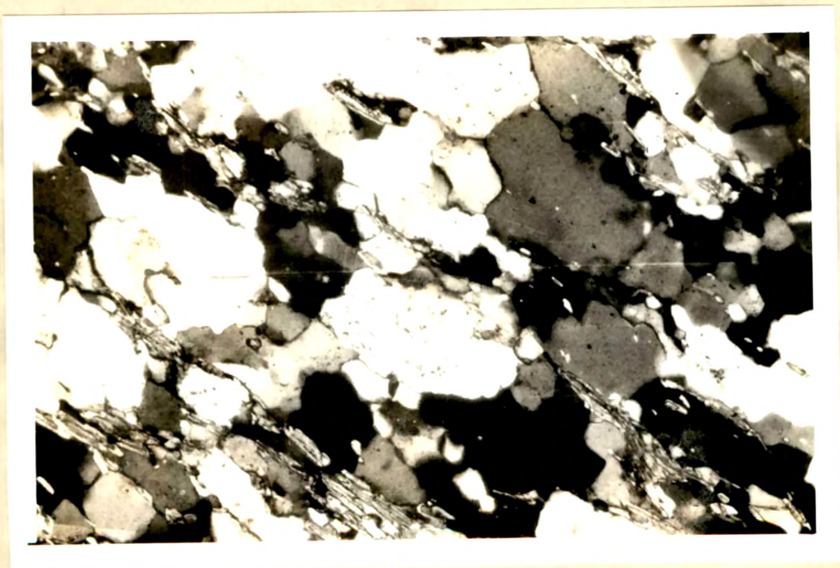
Sheared gneisses form about a kilometer wide continuous zone all along the Khastari river. In hand specimen, these are seen as light grey streaky rock with small elongated patches and 'porphyroclasts' of quartz and felspar. Thin sections reveal a finegrained foliated mass of chlorite, sericite and quartz in which streaks and lenses of granulated quartz and partly altered felspars are seen

PLATE 4.5



Texture of Micaceous quartzite.
(Photomicrograph: Cross nicols, X75)

PLATE 4.6



Texture of quartzite
(Photomicrograh: Cross nicols, X75)

embedded (Plates 4.7 and 4.8).

Quartz occurs as (i) irregular porphyroclasts, (ii) lense shaped aggregates of interlocking grains, and (iii) fine granules in close association with micaceous minerals. The porphyroclasts mostly show strain effects.

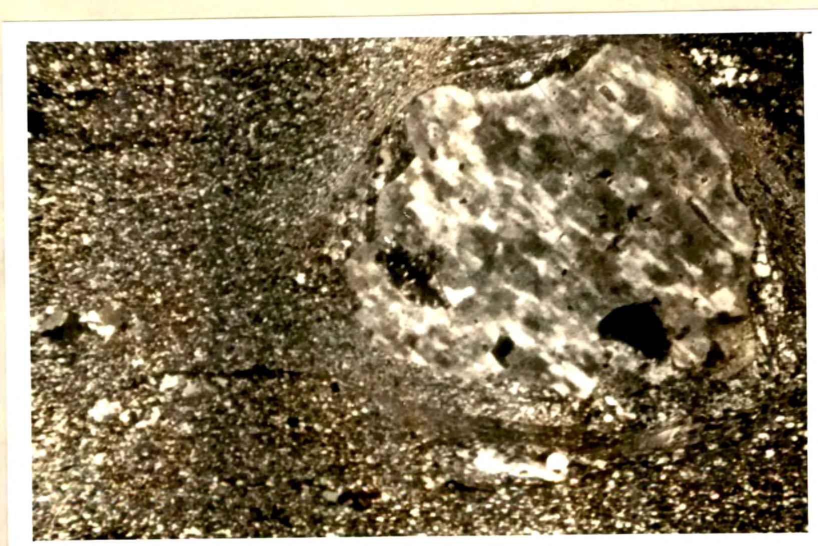
Felspars, both potash and plagioclase are recognised, but at most places they are invariably in a state of partial alteration (Plate 4.8). Most of the bigger grains are seen somewhat elongated with envelopes of fine sericite around them (Plate 4.7). On the whole, the potash felspars are almost wholly altered, and most relicts are those of oligoclase,

Chlorite, sericite and saussurite are the dominant secondary minerals, derived by the alteration of felspars and biotite of the gneiss. These vary in relative proportions depending on the original felspar and biotite content of the gneisses. Chlorite, a derivative from biotite, forms tiny flakes and streaks, occurs in linear clusters, shows green colour and low birefringence, sericite is after potash felspar, and forms foliated mass of tiny scales. At places, late recrystallisation has given rise

PLATE 4.7

Sheared gneiss with a partly altered plagio-
clase porphyroblast embedded in a finely
granulated matrix (Photomicrograph: Cross
nicols, X30)

PLATE 4.8



Sheared gneiss showing a partly altered
plagioclase (Photomicrograph: Cross nicols,
X30)

to the development of tiny flakes of biotite and muscovite at the expense of chlorite and sericite respectively. Such recrystallisation is more common in puckered varieties. Saussurite represents alteration product of plagioclase, and comprises a finegrained confused aggregate in which tiny granules of zoisite and quarts are recognised. Iron ores, mostly magnetite and hematite, occur as tiny opaque grains often forming streaks.

METAMORPHISM

The rocks of this Group exhibit metamorphic characters that indicate a progressive phase followed by retrogression. The mineral assemblages of the garnet-mica schists clearly point to a amphibolite facies metamorphism. The spiral inclusions in the garnet point to intense differential stresses to which the rocks were subjected during this metamorphism. Many thin sections have revealed that the main schistosity itself was derived by the tight microfolding of an earlier metamorphic cleavage. So it is suggested that the existing metamorphism might have been superimposed over an earlier metamorphism. Of course, at present it is difficult to say anything about this early metamorphism.

The retrogressive phase is related to the thrust which is nowhere exposed on the surface. It is observed that progressively the shearing effect increases downwards towards the concealed thrust. Though in the study area, typical phyllonites are not met with, yet adequate evidences of granulation and mineralogical breakdown are encountered. Streaky aggregates of crushed quartz, granulation and partial alteration of garnets to chlorite and hematite, and breaking of muscovite to sericitic aggregates - all these are typical evidences of metamorphic downgrading brought about by the thrust.

As envisaged by Merh (1968), Merh and Vashi (1965) the reclined isoclinal folding that has given rise to the main schistosity, finally culminated into the thrust, and if this conclusion is valid, then the progressive and retrogressive metamorphic events shown by the Karchuli rock comprise distinct metamorphic changes related to a single and continued deformational process which gave rise to reclined folding and ended up in a thrust.

As such, the rocks of Karchuli group show well marked metamorphic downgrading from SW to NE, and this phenomenon is related to the thrusting. Vashi (1966) who worked on the southern limb of the synformally folded thrust (Upradi thrust) has recorded a much better well defined sequence of increasing metamorphic downgrading. Merh (1968), Merh and Vashi (1974) on the basis of their detailed investigations in the crystalline thrust sheet to the south of the area near Ranikhet and Almora have worked out the following relationship between the metamorphic and structural events:

Deformation	Metamorphism
1. Load	Development of a bedding cleavage, metamorphic minerals not known.
2. Isoclinal folding	Development of the main schistosity, formation of garnet mica schists with occasional staurolite and kyanite.
3. Thrusting	Development of phyllonitic cleavage, intense shearing giving rise to retrograde assemblages, mostly sericite-chlorite schists.
4. Synformal folding	Crinkling of the foliation and development of strainslip cleavage, formation of a new garnet and of porphyroblasts of muscovite and biotite along the axial planes of crinkles.
5. NNE-SSW flexures	No metamorphic changes

EVOLUTION OF GNEISSIC ROCKS

In the extensively sheared state, the gneissic rocks do not reveal much, and their original nature is not properly understood. But data from the adjoining areas to the south and south-east, amply tell about the unsheared gneisses. To south-east of Chaukhutia, at Dwarahat, ideal exposures of coarse porphyroblastic gneiss are encountered, and here all gradations from mica-schist to coarse gneiss with increasing granitisation are seen. In Dwarahat area as well as to its further south-east, the gneisses continue to occur in force, abutting in the north against the dislocation that separates the Almora Crystalline from the metasedimentaries of the Krol Nappe all along, the effect of shearing is quite pronounced, though unsheared or partly sheared gneisses occur in fair abundance. But in the present area, unfortunately, intense shearing has almost totally obliterated the original texture and mineralogy of the gneisses.

The gneisses of Almora Nappe have been considered to be of migmatitic origin (Pande et al., 1963, Merh and Vashi, 1965). Merh and Vashi (op. cit.) classified the migmatitic gneisses of Ranikhet into four types showing an increasing migmatisation, and according to these workers the schists were gradually transformed into gneisses by the addition of alkalis. The transformation started with the addition of Na_2O which was soon followed by K_2O.

Recently, R.V. Karanth (Personal communication) has suggested a somewhat different mode of origin of gneisses. Working on the gneissic rocks of Almora and Kapaleshwar, he has concluded that all gneisses are not metasomatic. On the other hand, he has envisaged occurrence of intrusive layers of granitic material along whose margins, some granitisation has taken place. He has further to suggest that the granite emplacement and granitisation took place at a date much earlier than the isoclinal folding. This view is contrary to those of Merh and Vashi (1965) and Desai (1968) who are of opinion that the migmatisation preceded, synchronised with and outlasted the main deformational event viz. isoclinal folding.

Unfortunately, in the study area, the gneisses are in such an advanced stage of shearing that, it is not at all possible to throw any more light on the true nature of these controversial rocks.