CHAPTER III

GEOLOGICAL SETTING

The Great (Higher) Himalayan range in Kumaun and the base of the Tethyan Himalayan Sequences, referred to as the 'Central Crystallines' (Heim and Gansser, 1939), and Vaikrita System (Greisbach, 1881), essentially comprise highly metamorphosed Precambrian rocks (Valdiya, 1964 a,b) alongwith Tertiary leucogranitic intrusions. The southern limit of the Higher Himalaya (Central Crystallines) is marked by the Main Central Thrust (MCT) first designated in Kumaun Himalaya (Heim and Gansser, 1939; Gansser, 1964; Misra and Bhattacharya, 1972; Ahmad, 1975; Thakur and Chaudhary, 1983; Chamyal and Merh, 1984; Chamyal et al., 1984).

The MCT hence, forms the tectonic junction between the Central Crystallines and underlying metasedimentaries of the Lesser Himalaya. Valdiya has however (1973, 1979, 1980, 1981, 1993) put the MCT at a higher stratigraphic level. He has designated it as the 'Vaikrita Thrust' or the MC(V)T and named the MCT of other workers as the 'Munsiari Thrust'. The northern boundary of the Central Crystallines is delimited by the Trans Himadri Thrust (Valdiya, 1979, 1980, 1987, 1988 b), also known as the Malari Fault (Kumar et al., 1972; Valdiya, 1973; Shah and Sinha, 1974), a detachment fault along which the crystallines have moved faster than the cover sediments of the Tethyan domain.

CENTRAL CRYSTALLINES

The Central Crystalline thrust sheet predominantly consists of granitoid rocks alongwith associated schists, amphibolitic lenses and bands of micaceous quartzites. The granitoids mainly comprise streaky gneisses, augen gneisses, porphyroblastic gneisses, granitic gneisses, migmatites and granites. The Central Crystalline rocks are very intimately intermixed and hence it is very difficult to precisely demarcate various lithological horizons. Moreover, due to high ruggedness of terrain and inaccessibility, precise demarcations is even otherwise impossible. Hence, the author visited almost all accessible exposures in the valleys of Pindar, Sarju, Ramganga, Goriganga and Darmaganga and

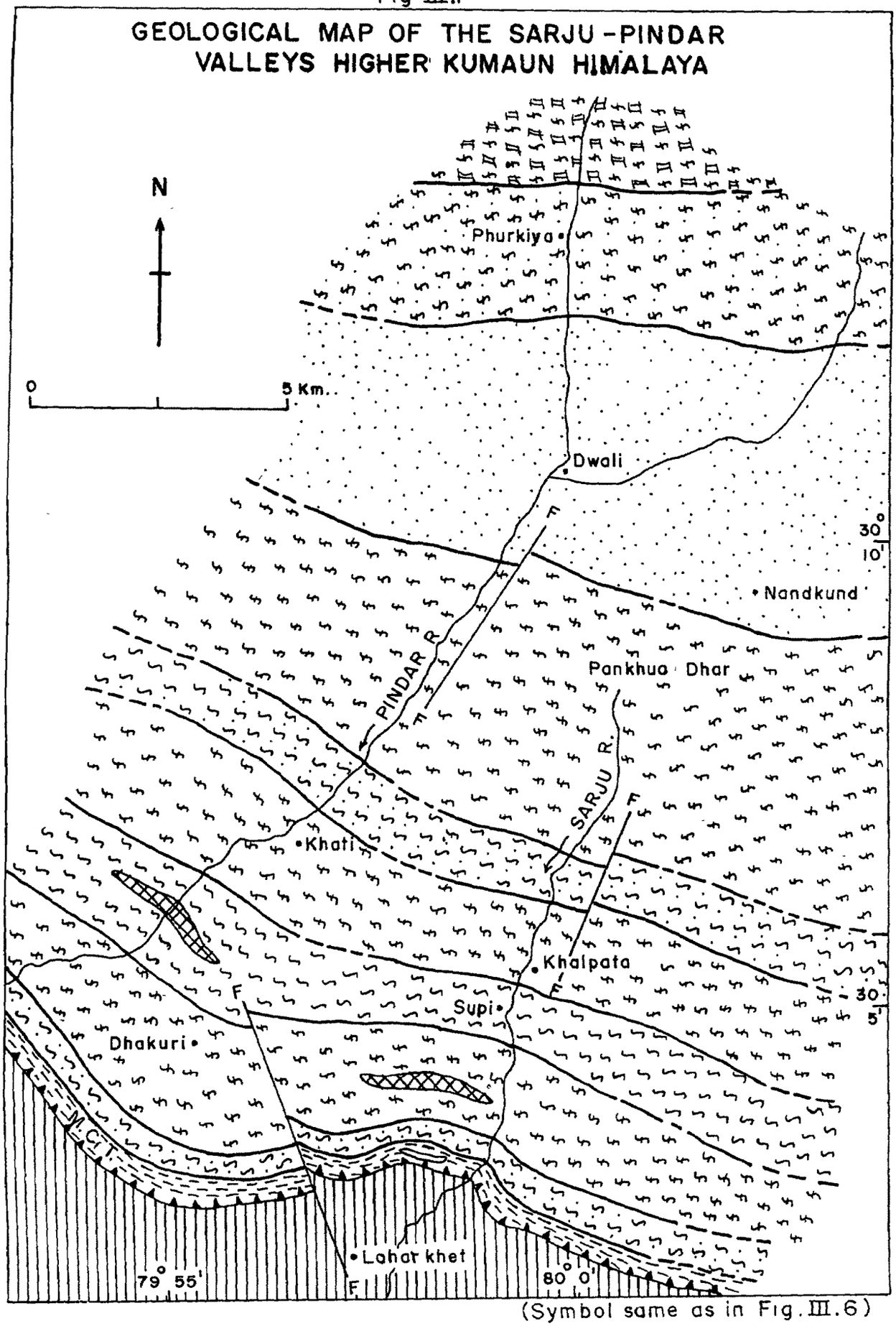
worked out a broad lithotectonic succession (Table I.1) of these rocks from south to north (Fig. I.3).

In this chapter, the author has described the field characteristics of the Central Crystallines that overlie the MCT (= Munsiari Thrust of Valdiya). These rocks are medium to coarse grained and show metamorphism from green-schist facies in the thrust zone to upper-amphibolite facies in the northern parts. The author has described the mode of occurrence of the Central Crystallines in the valleys of Pindar-Sarju, Ramganga, Goriganga and Darmaganga separately and then synthesize the information to obtain a precise and comprehensive field picture of the granitoid rocks.

PINDAR-SARJU VALLEYS

The Central Crystalline rocks in the Pindar-Sarju valleys trend NW-SE to E-W with moderate to gentle dips due N to NE. The Main Central Thrust is encountered north of Loharkhet (Figs.I.3, III.1,2). The thrust zone is characterised by a thin horizon of fine grained chlorite and sericite schists. With increasing chlorite content the rock becomes more and more greenish and are known as chlorite schists. With increase in sericite content they pass onto the phyllonites becoming greyish to brownish in colour and exhibit strong cleavage. These rocks seem to have been formed due to intensive shearing and retrogressive metamorphism as they

Fig III.1



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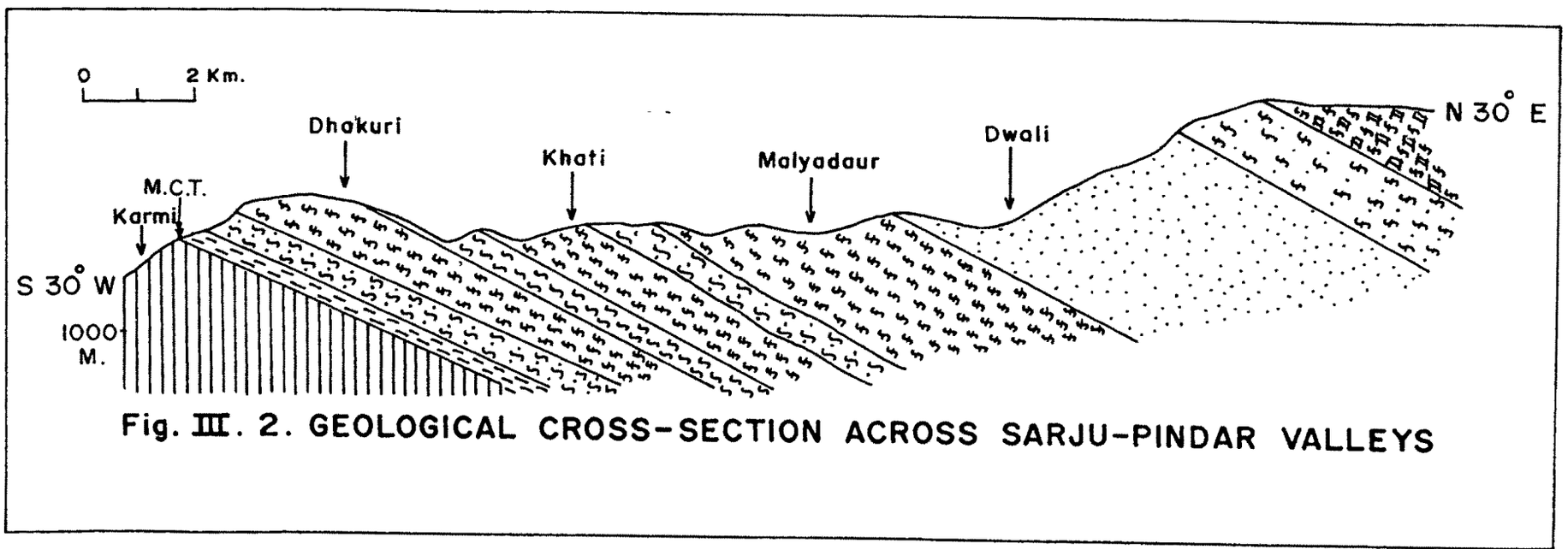


Fig. III. 2. GEOLOGICAL CROSS-SECTION ACROSS SARJU-PINDAR VALLEYS

(Symbol same as in Fig. III 6)

occur in the vicinity of the Main Central Thrust (Merh, 1984; Chamyal et al., 1984; Chamyal and Vashi, 1989; Chamyal and Manudip, 1994).

Tectonically, overlying the phyllonitic zone is encountered a thin horizon of garnet mica schists. These are fine to medium grained rocks showing very well developed cleavage. They are parallel to the phyllonitic horizon and comprise mainly biotite, muscovite, quartz, feldspar and garnet. Within this horizon are seen numerous quartzo-feldspathic veins. These schists are crushed and sheared at places, probably owing to their nearness to the thrust zone. At places they also show development of crinkles. The schists gradually become more feldspathic towards north and passively pass over to a thick horizon of augen gneisses as seen near Dhakuri.

The augen gneisses are fine to medium grained and mainly comprise feldspar, quartz, biotite and muscovite. These augen gneisses point to an increasing granitisation, wherein the feldspar grains have grown into well defined 'auge' (Plate III.1). Within these schists and gneisses are seen sporadic lenses of concordant amphibolites. These exhibit sharp contacts with the country rocks, but they conform to the general trend. These are dark grey to dark green fine to medium grained rocks and are divisible into massive, foliated and sheared varieties. They consist of hornblende, biotite, quartz and feldspar and are encountered as linear bodies

at Rikhari and Talla Dhakuri in the Sarju and south of Surag and Khati in the Pindar Valleys.

Overlying the augen gneisses, once again a schistose horizon is encountered extending from south of Khati in the Pindar valley to Supi in the Sarju valley. These schists also conform to the general trend of NW-SE to E-W with dips of about $25^0 - 30^0$ due NE to N respectively. These schists are highly micaceous, well foliated but garnets are significantly absent. The minerals visible in hand specimen are quartz, biotite, muscovite and feldspar. Around Khati once again augen gneisses are seen exhibiting trend identical to those of the schistose horizons. The contacts are rather gradational. South of Khati near Umla Nala, once again a thin horizon of garnet mica schists is observed, which is overlain by a thick augen gneissic band. Further north around Dwali a very thick conspicuous horizon of micaceous quartzites is encountered. They are fine to medium grained and contain considerable amount of mica alongwith quartz and rarely garnet.

North of Dwali on way to both Kaphni or Phurkiya one would find garnetiferous augen gneisses and migmatites. These are fine to medium grained rocks comprising feldspar, quartz, biotite, muscovite and garnet. The migmatites comprise the palaeosome and the neosome component (Plate III.2). Further north these horizons gradually merge into the garnetiferous kyanite gneisses and show no change in the trend.

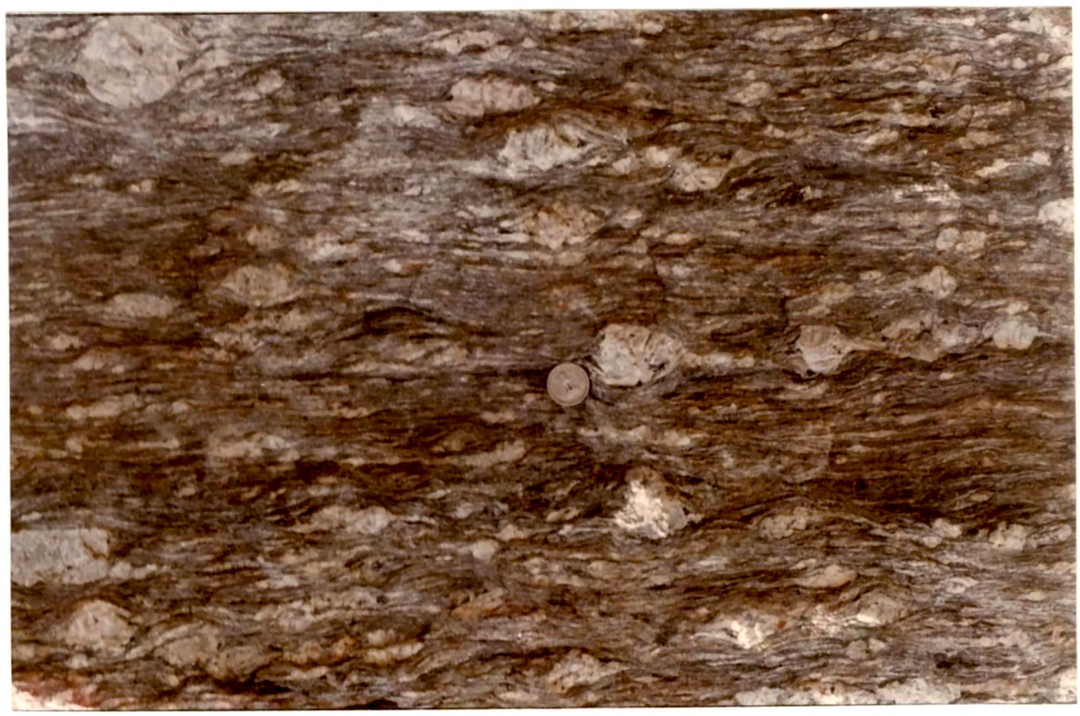


Plate III.1 Augen gneiss at Jhuni in Sarju Valley

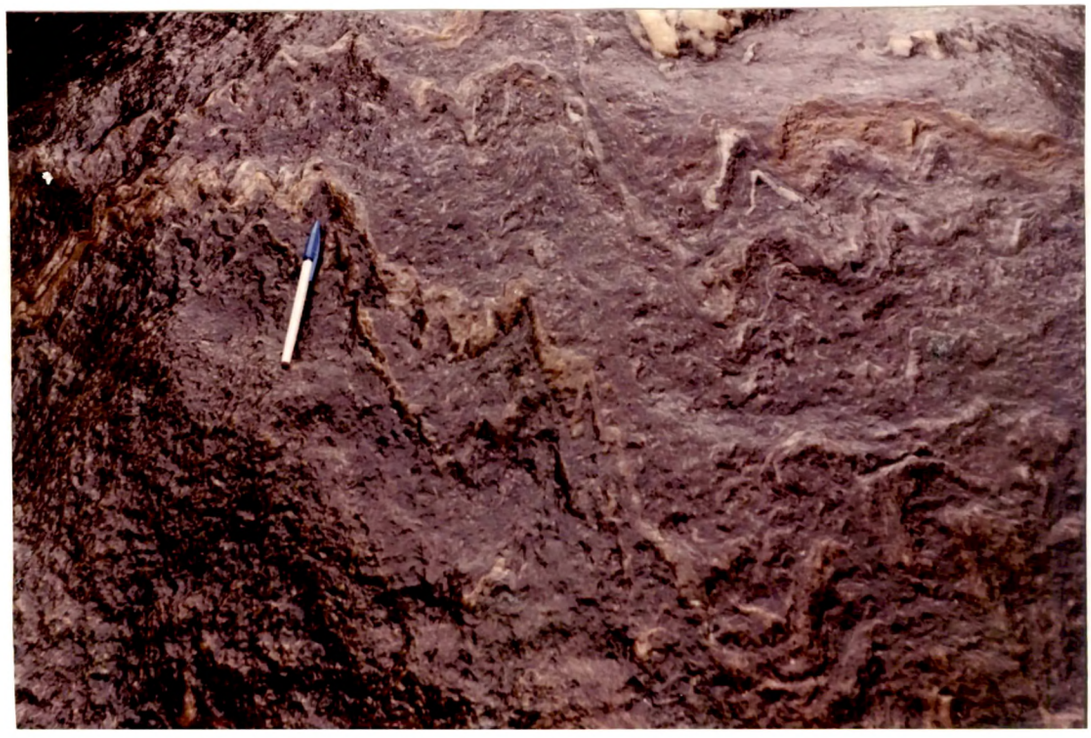


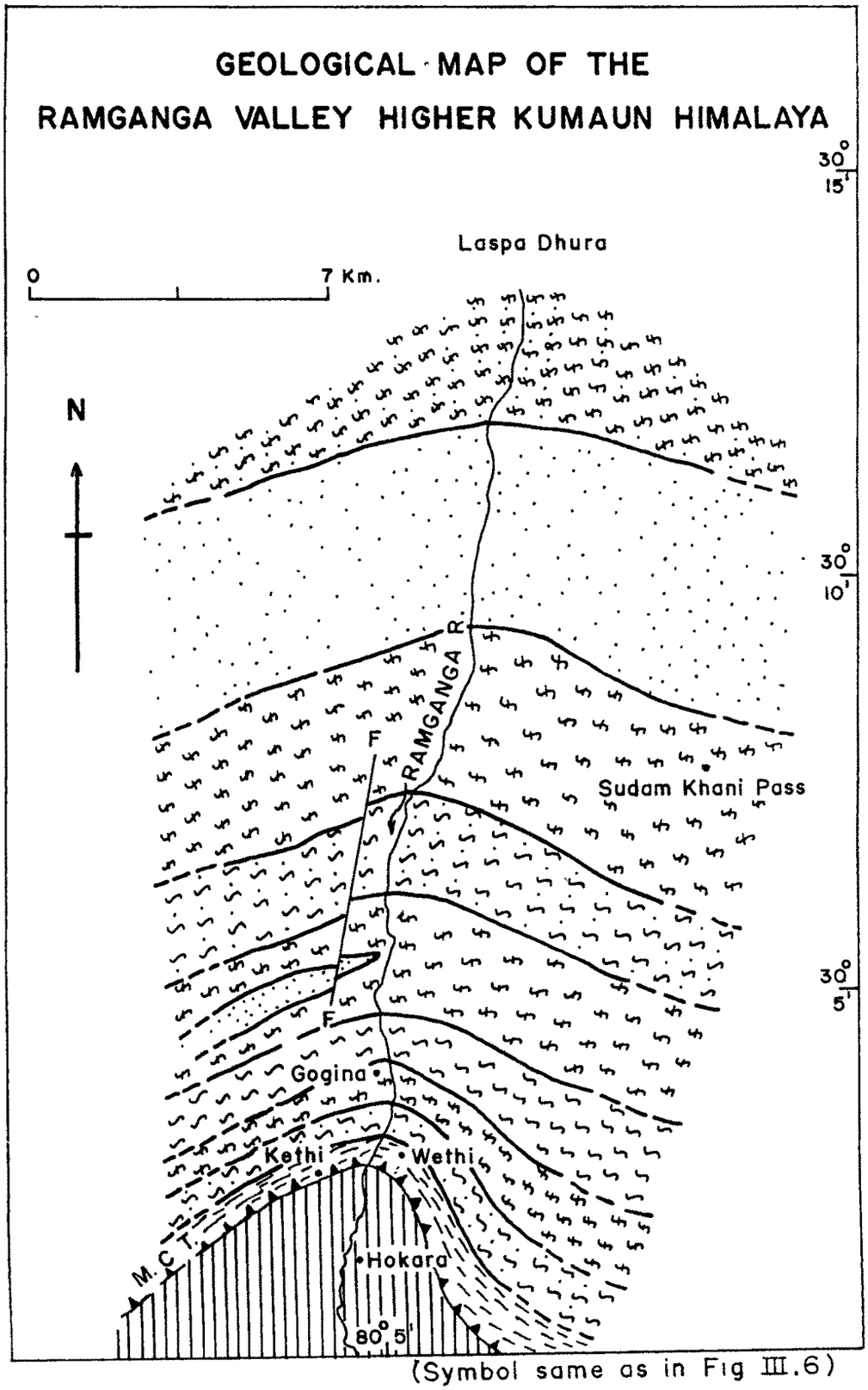
Plate III.2 Migmatitic rock near Kaphni glacier in Pindar Valley

RAMGANGA VALLEY

In the Ramganga valley the Main Central Thrust is encountered north of Hokara and little south of the Kethi (Figs. III.3,4) wherein it is evidenced by the severe retrogression of the overlying garnet mica schists into chlorite schists and phyllonites in the thrust zone. The general trend is E-W to NW-SE with dips ranging from 20-25^0 due N and NE respectively. Overlying these schists occur the augen gneisses around Gogina (Plate III.3). These are fine to medium grained rocks showing well developed 'auge'. These mainly consist of feldspar, quartz, biotite and muscovite and show numerous intercalations of schists. The augen-gneisses further north of Gogina gradually pass into a thin schistose horizon. These are particularly devoid of garnets and are more feldspathic in their mineral content. These conform to the general trend passively merging into augen gneisses around Namik.

On the opposite banks of Ramganga on way to village Namik, around the Nethi Rauli stream a thin lense of quartzite is encountered; with increasing feldspathisation, it gradually changes over to augen gneisses (Plate III.4). North of Namik once again well developed garnet mica schists are encountered, made up of mainly quartz, feldspar, biotite, muscovite and garnets. They do not show any change in the trend and are overlain by a very thick horizon of augen gneisses. The gneissosity of which is marked by

Fig. III.3



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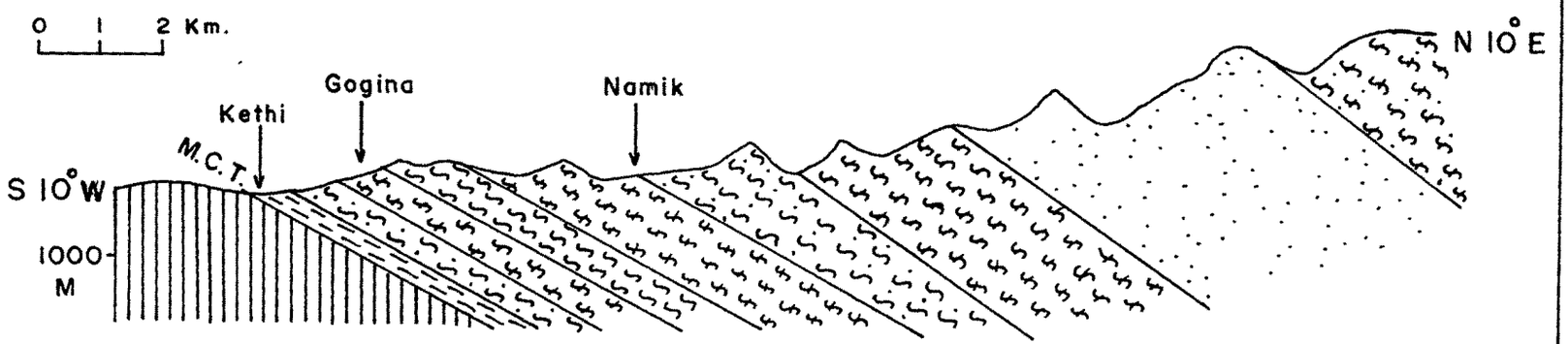


Fig. III. 4. GEOLOGICAL CROSS-SECTION ACROSS RAMGANGA VALLEY

(Symbol same as in Fig. III.6)

Plate III.3 Augen gneiss near Gogina in Ramganga Valley

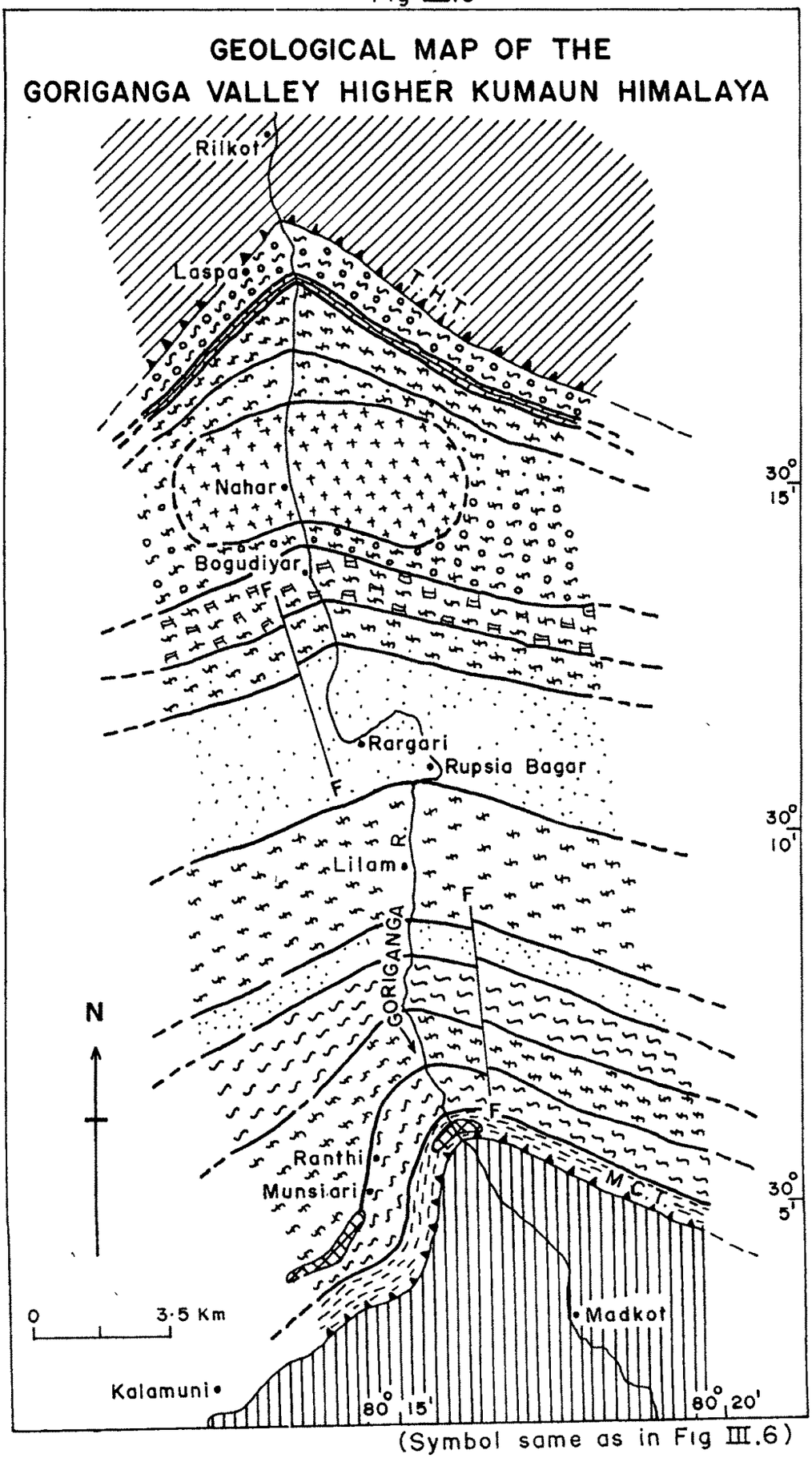
Plate III.4 Quartzite passively changing over to augen gneiss at Wethi Rauli in Ramganga Valley

the 'auge'. These are dominantly coarse grained and comprise feldspar, quartz, biotite and muscovite. Further north on way to the Ramganga glacier a thick horizon of micaceous quartzites is observed; breaking along the micaceous planes the mica shows a definite orientation. They are medium grained and mainly comprise quartz, feldspar and garnets at few places. Overlying these are encountered the garnetiferous augen gneisses. These are medium to coarse grained with the auge defining the gneissosity. They show a similar trend of E-W to NW-SE with dips ranging from 25^0 - 35^0 due N to NE, showing similarity in the structural elements with the adjacent horizons in the Ramganga valley.

GORIGANGA VALLEY

The presence of chlorite schists and phyllonites south of Munsiari marks the MCT zone in the Goriganga valley (Figs. III.5,6). The zone is traceable westward from south of Kalamuni up to Girgaon. The phyllonitic rocks are highly cleaved crushed and sheared. These are the retrograded products of the overlying schistose rocks. Near Kalamuni amphibolitic lenses are observed within the augen gneisses. These are seen forming fold cores at places (Plate III.5). The amphibolitic lenses are either foliated or massive and are of dark green coloured medium grained consisting of mainly hornblende, biotite, quartz and feldspar. The amphibolitic lenses are also intercalated with numerous quartzo-feldspathic veins. These exhibit sharp contacts with the

Fig III.5



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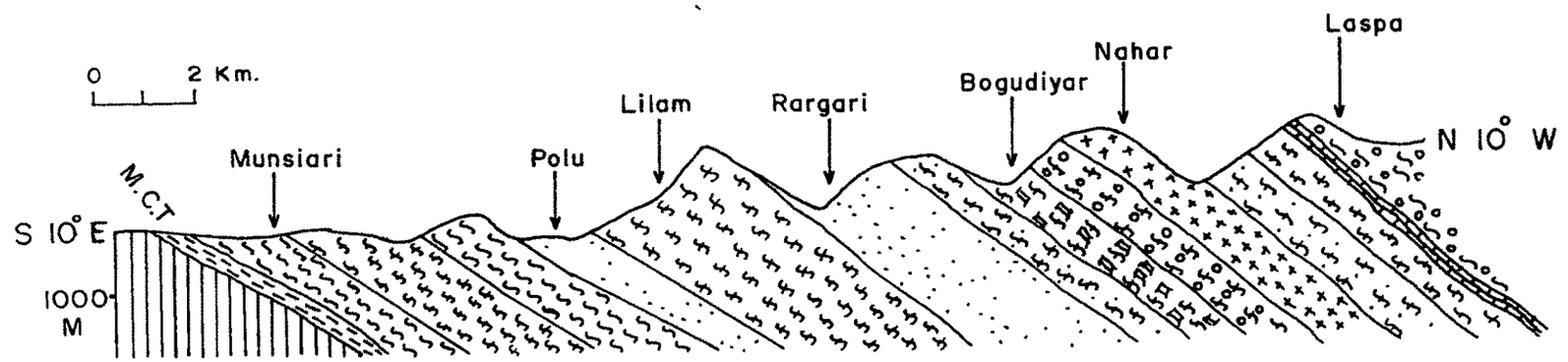


Fig. III. 6. GEOLOGICAL CROSS-SECTION ACROSS GORIGANGA VALLEY

LEGEND

- PORPHYROBLASTIC MICA SCHISTS
- CALC SILICATE ROCKS
- TOURMALINE AND GARNET BEARING LEUCO-GRANITES WITH PEGMATITIC AND APLITIC VEINS
- PORPHYROBLASTIC AND GRANITIC GNEISSES
- GARNETIFEROUS KYANITE GNEISSES
- GARNETIFEROUS AUGEN GNEISSES AND MIGMATITES
- STREAKY, AUGEN AND BANDED GNEISSES
- MICACEOUS QUARTZITES
- GARNET MICA SCHISTS
- MICA SCHISTS
- PHYLLONITES, CHLORITE AND SERICITE SCHISTS
- METASEDIMENTARIES OF INNER LESSER HIMALAYA

M.C.T MAIN CENTRAL THRUST

surrounding rocks. A similar lense is observed north of Madkot also. The schists as observed near Ranthi are also deformed to some extent as they occur in the vicinity of the thrust zone and run parallel to the underlying phyllonitic horizon. The general trend is NW-SE with gentle to moderate dips ranging from 15^0 to 20^0 due NE. At places these schists are crinkled. The schists mainly comprise biotite, muscovite, quartz and feldspar. The schistose rocks are highly intercalated by quartzo-feldspathic veins.

Towards north of Ranthi the schists become more feldspathic and gradually pass over to a horizon of augen gneisses (Plate III.6) near Munsiari without exhibiting any change in the general trend. At places these gneisses show intercalations of schists on a very minor scale. The augen gneisses are fine to medium grained and also show crinkling at some places (Plate III.7). These are mainly composed of feldspar, quartz, biotite and muscovite. North of Munsiari once again a schistose horizon is encountered without any perceptible change in the general trend. These schists are well foliated and show a NW-SE trend with 25^0 - 35^0 dip due NE. South of Lilam a thin horizon of micaceous quartzites is encountered. Numerous quartzo-feldspathic veins are seen intercalating this quartzitic horizon. These quartzites mainly comprise quartz, with some biotite, muscovite and feldspar. At places these quartzites also exhibit crude foliation due to orientation of the mica flakes.

Plate III.5 Fold core amphibolite at Kalamuni in Goriganga Valley

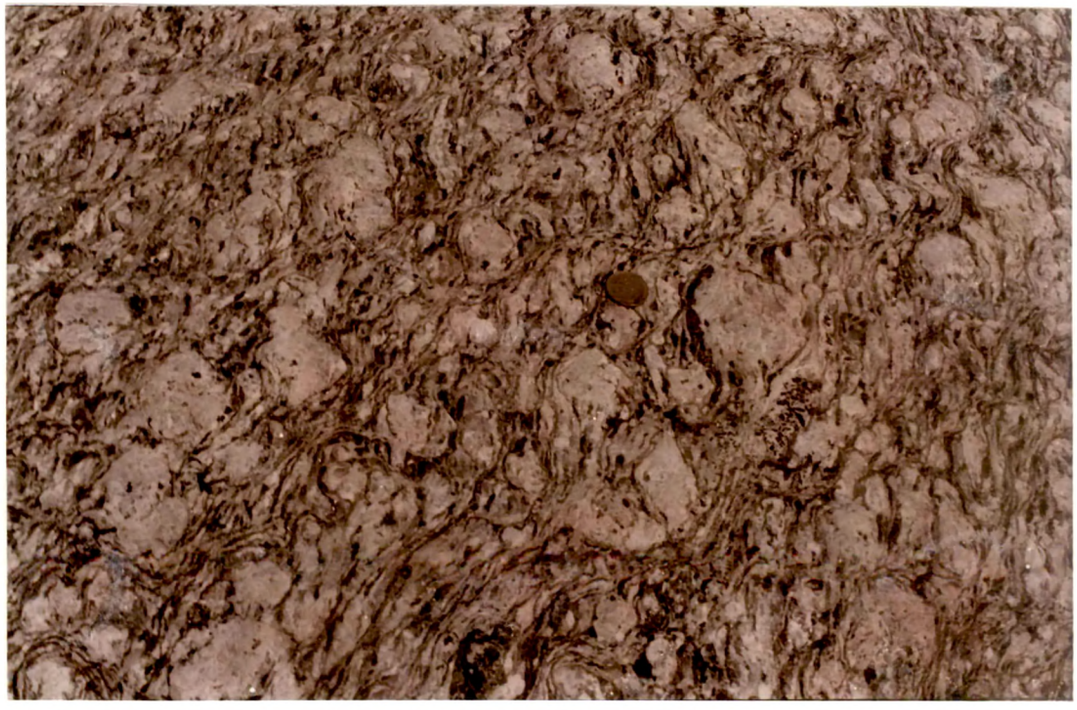


Plate III.6 Augen gneiss near Munsiari in Goriganga Valley

Overlying the micaceous quartzites a thick augen gneissic band is observed near Lilam, with numerous schistose intercalations. The trend remains same i.e. NW-SE but the dips become a little high, around 40^0 - 45^0 due NE. The gneisses are medium grained. North of Lilam near Rupsia Bagar a thick conspicuous horizon of micaceous quartzites is observed, consisting mainly quartz, muscovite and feldspar and containing garnets. The quartzites are highly jointed showing a trend similar to those exhibited by the overlying garnetiferous gneisses, however the dips become moderate, being of the order of 20^0 - 25^0 due NE. The gneisses are medium grained with garnets developing to the size of 1-3 mm, aligned along the foliation planes. At Bogudiyar, the garnetiferous augen gneisses show development of well developed crystals of blue coloured bladed kyanite. The kyanites are 1/2-1 cm in length and are aligned along the foliation planes of the garnetiferous gneisses.

North of Bogudiyar the gneisses become rather coarse grained with garnet and kyanite disappearing. The gneisses become porphyroblastic and contain well developed porphyroblasts (Plate III.8) of oval to rectangular shape, ranging in size from 20 x 25 cm to 15 x 30 cm in cross-section. The porphyroblastic gneisses gradually change over to granitic gneisses. The granitic gneisses northwards near Nahar gradually merge into the massive garnetiferous tourmaline bearing granite, a medium to coarse grained rock mainly comprising, quartz, feldspar, biotite,

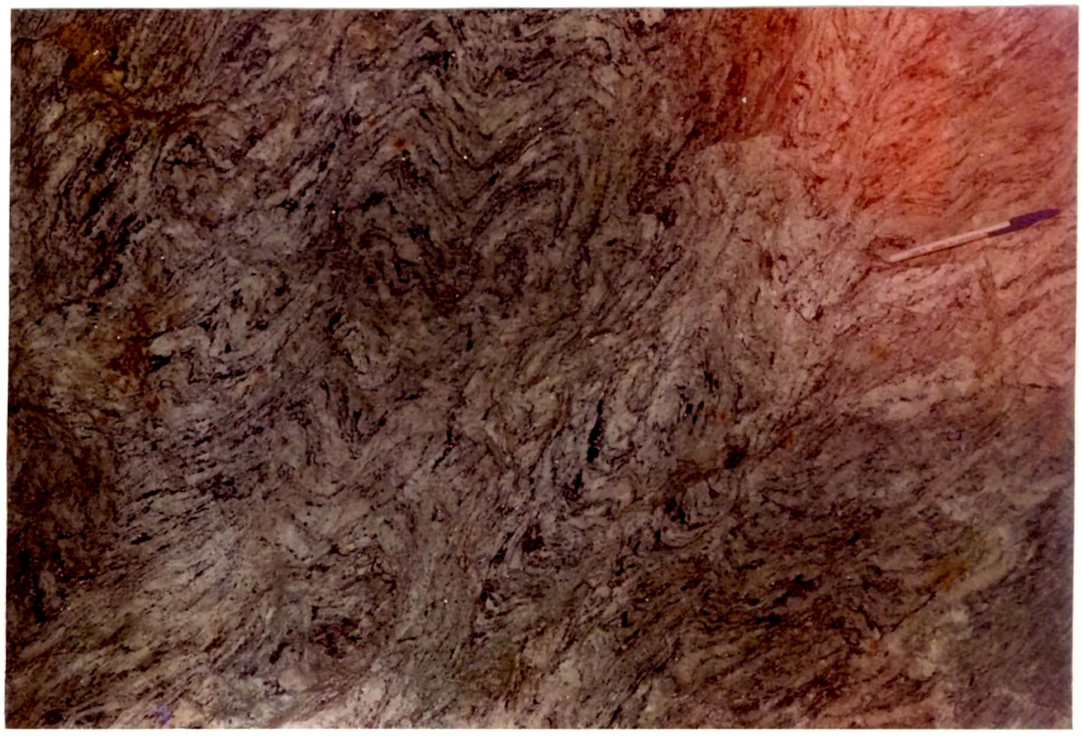


Plate III.7 Augen gneiss showing crinkling near Jimighat in Goriganga Valley

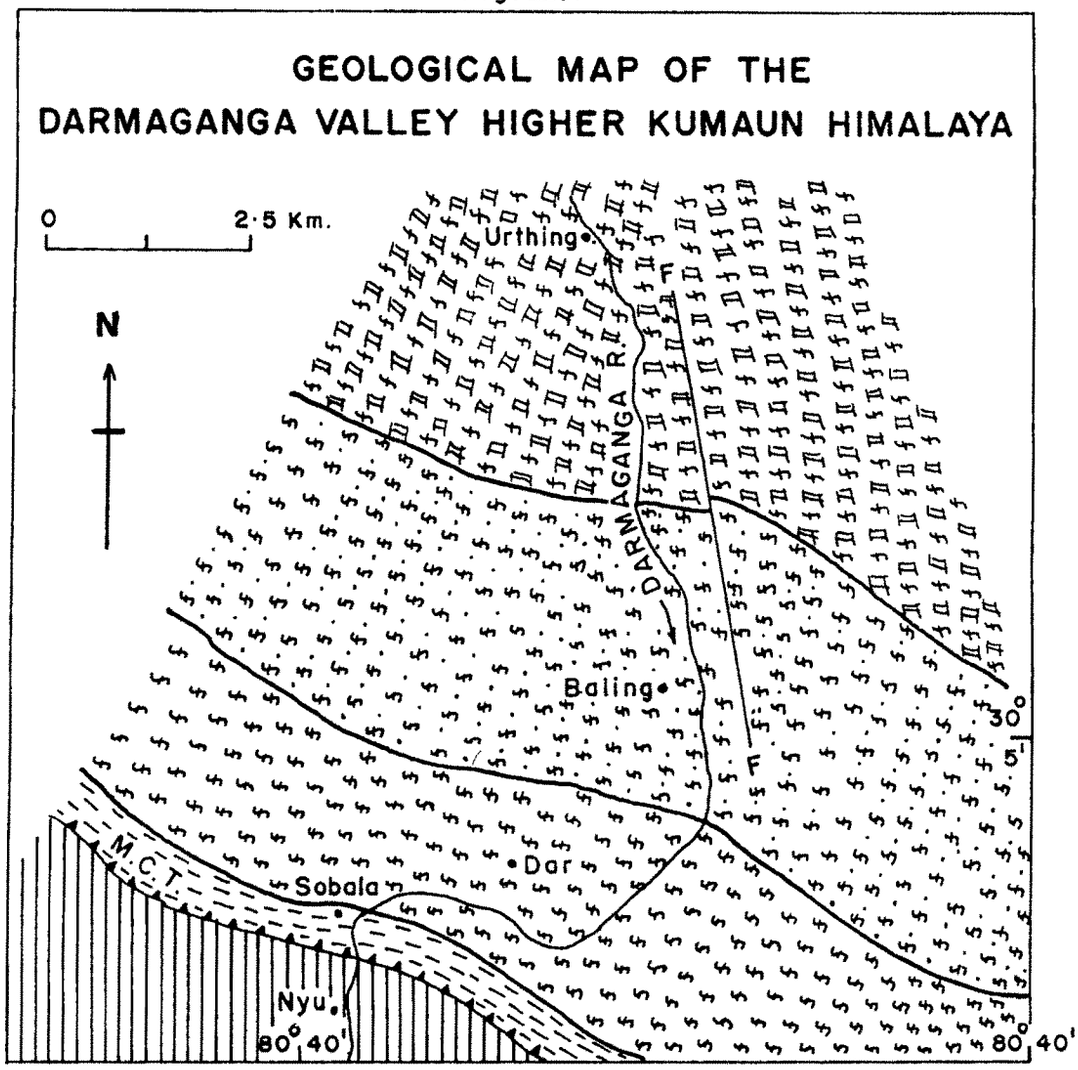
Plate III.8 Specimen photograph of a porphyroblastic gneiss north of Bogudiyar in Goriganga Valley

muscovite, tourmaline and garnet. Towards north of Nahar this granite merges into garnetiferous gneisses without exhibiting any apophyses or thermal aureole, or sharp contacts. However, younger tourmaline bearing pegmatitic and aplitic intrusive veins are observed in the vicinity of the Nahar Devi granite cutting the garnetiferous gneisses at Chikani. These are medium to coarse grained rocks and comprise quartz, feldspar, muscovite and tourmaline. Associated with these garnetiferous gneisses are thin horizons of calc-silicate rocks. Further north highly sheared and crushed schists are encountered near Laspa. This is the zone of the Trans Himadri Thrust beyond which lies the Tethyan domain.

DARMAGANGA VALLEY

The Main Central Thrust is observed north of Nyu in the Darmaganga valley marked by typical retrograde rocks, phyllonites and chlorite schists (Figs. III.7,8). The trend of these rocks is NW-SE with dips ranging from 20^0 - 25^0 due NE. The phyllonitic horizon gradually changes over to the augen gneisses (Plate III.9). The augen gneisses mainly comprise feldspar, quartz, biotite and muscovite. Further north without any change in their trend the augen gneisses merge into the garnetiferous augen gneisses near Baling and further north to kyanite bearing gneisses. Near Urthing garnetiferous augen gneisses are observed. All throughout, the rocks show no change in their trend, however the dips become steeper from 20^0 to 35^0 due NE as one moves northwards. The garnets

Fig. III.7



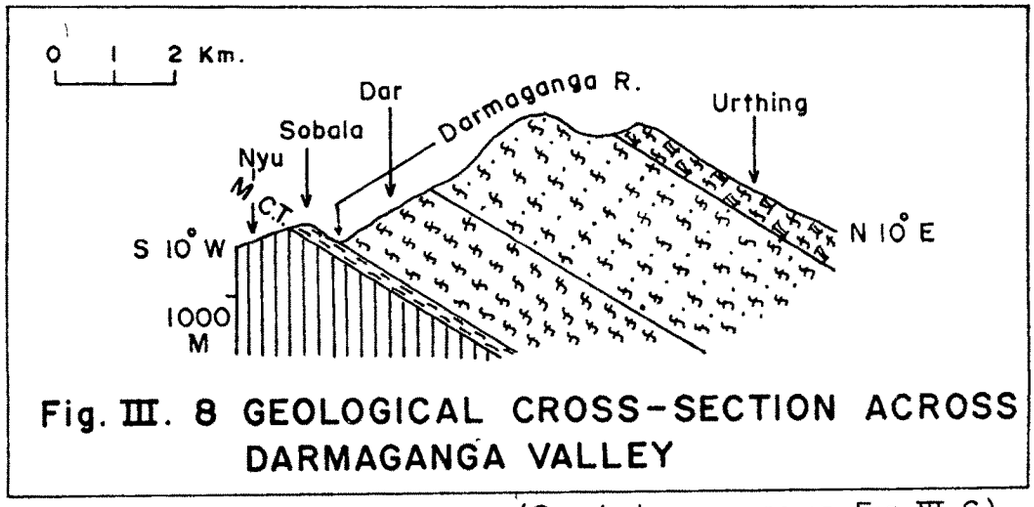


Fig. III. 8 GEOLOGICAL CROSS-SECTION ACROSS DARMAGANGA VALLEY

(Symbol same as in Fig. III.6)

and the kyanites are aligned along the gneissic foliation. The gneisses are medium to coarse grained comprising predominantly feldspar, quartz, biotite and muscovite.

All along the Central Crystallines as observed in the Sarju-Pindar, Ramganga, Goriganga and Darmaganga valleys the Main Central Thrust zone is marked by the presence of the thin horizons of highly sheared, crushed and retrograded phyllonites. The thrust zone is typically characterised by numerous landslides (Plate III.10), tilting of terrace material, waterfalls (Plate III.11) and an abrupt rise in altitude to the north. The base of the Central Crystallines is marked by mica-schists and sporadic concordant amphibolitic lenses, exhibiting sharp contacts with the country rocks.

A traverse passing from south to north of the Central Crystallines reveals the following zonal arrangement :

In the southern parts in the MCT zone the garnet-mica schists and mica schists exhibit retrogression to chlorite, sericite schists and phyllonites. Whereas, northward the schists exhibit feldspathic nature, passing into augen gneisses with gradational contacts. These augen gneisses with gradual increase in feldspar content and simultaneous decrease in the quartz content pass into augen gneiss, and porphyroblastic gneiss, granitic gneiss and finally granite with nearly homogenous appearance. The original

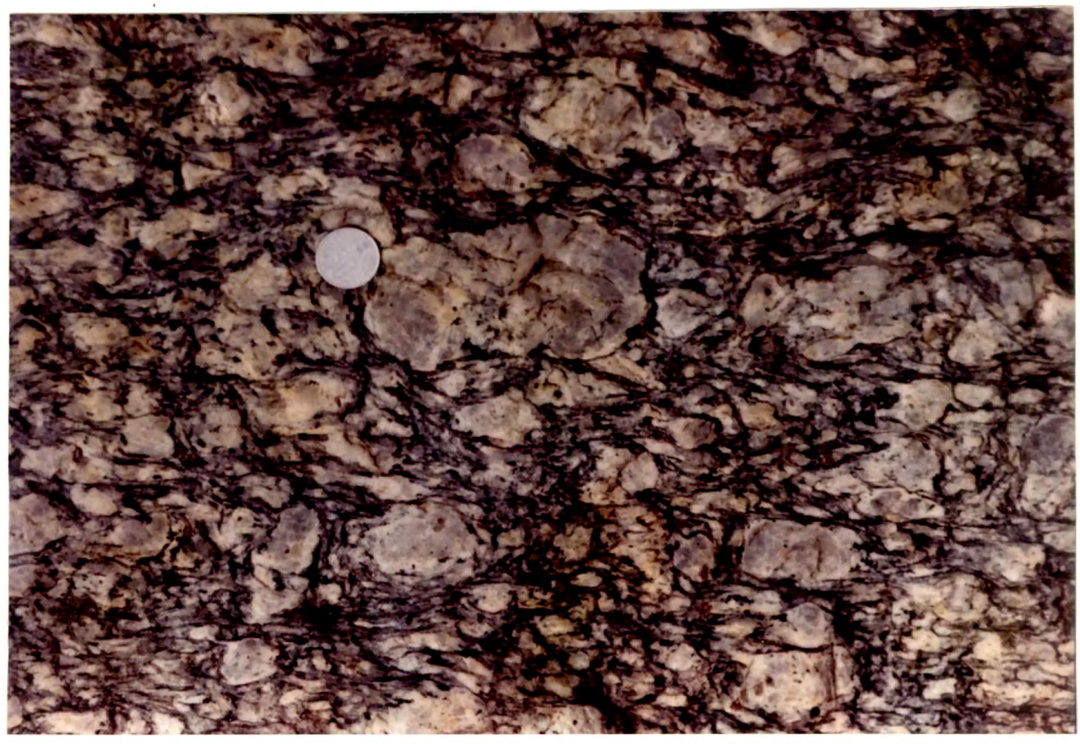


Plate III.9 Augen gneiss near Sobala in Darmaganga Valley

Plate III.10 Landslide in the Main Central Thrust zone, Goriganga Valley

gneisses are found to retain the relic fabric of the parent rocks (Plate III.12). All the gneissic horizons are found at similar stratigraphic levels in Sarju, Pindar, Ramganga, Goriganga and Darmaganga valleys. These granitoids show no structural discordance with associated schistose and micaceous quartzite horizons and regionally exhibiting similar trends. The micaceous quartzites have gradational contacts with associated gneissic horizons and locally show development of crude foliation. Except for the younger leucocratic tourmaline granites and aplitic and pegmatitic veins observed in the Goriganga and Pindar valleys, nowhere else is noticed any kind of intrusive and discordant nature of the granitoid rocks.

It is now well established that a close relationship exists between metamorphism and granitisation in orogenic belts where gradational junctions between granitoids and country rocks, absence of thermal aureoles, interbanded nature of two litho-units, coincidence of foliation and schistosity, variation of grain size within a single or different bands, variation in thickness of bands, occurrences of schistose rafts within the granitoids, preservation and continuity of stratigraphy and structures, variation in chemical composition of bands etc, are recorded. This fact is adequately corroborated in Himalaya by Powar (1972) in the northeastern parts; Misra and Bhattacharya (1976) in the Sarju, Pindar and Ramganga valleys; Valdiya and Goel (1983) and Roy and Valdiya (1988) in the central sector; Chamyal (1984) in the Sarju,

Plate III.11 Waterfall in the Main Central Thrust zone, Goriganga Valley

Plate III.12 Relict of pelitic rocks in the gneiss, Darmaganga Valley

Pindar valleys and Sinha (1989) along various traverses; in Higher Kumaun Himalaya. In the adjacent areas of Garhwal Higher Himalaya also, Agarwal and Kumar (1973) in the Bhagirathi and Yamuna valleys; Singh and Pande (1985) in Himachal Pradesh; Gupta (1985) in Dhauladhar range; Virdi (1986) in the Alaknanda and Dhauliganga valleys and Islam and Thakur (1988) and Islam et al. (1991) in the Bhilangna valley, have given more or less similar field and tectonic setup for the granitoid rocks of Higher Himalaya.