Geological reconnaissance around Silgarhi-Doti, West Central Nepal

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Abstract

The Khaptar Gneiss Klippe, which occupies the northern part of the present region, constructs a successive western fringe of the Karnali Klippe. The area between this Klippe and the Dandeldhura Crystallines, which distribute in southern area of the region, is occupied by green mica schist (Doti Schist). The Dandeldhura Crystalline Massif are considered as eastern continuation of the Almora Nappe in Kumaun. The Doti Schist is doubtfully considered to be a member of the MCT zone in the region. The boundary between the Khaptar Gneiss and the underlying Doti Schist seems to be concordant.

Introduction

In Kumaun, west of the region, there is a famous crystalline massif called as the Almora Nappe, and it is still disputed whether real nappe or intrusive sheet. As the probable equivalent of the Almora Nappe, the Dandeldhura Crystalline Group occupies southern part of the region. The Dandeldhura Crystallines had been reported as "Dandeldhura Massif" by Hagen (1959) and Nakajima (1979), as "Serie de la Nappe du Nepal" by Remy (1975), and as "Dandeldhura Crystalline Complex" by Bashyal (1981).

Turning our attention to the north, large gneiss sheet correlated with the Himalayan Gneisses, of which the local name was given as Khaptar Gneisses by Nakajima (1979), is observed and is regarded as a succession of the Karnali Klippe, formerly called Chakhure-Mabu Gneiss Zone by Ando and Ohta (1973). If the Dandeldhura Crystallines would form an steeply inclined intrusive sheet, following question, whether the Khaptar Gneiss continues to the Dandeldhura Crystalline Group or not, could occur in the next. Anyhow, this is one of the most important problem of all over the Himalayan tectonics because of its connection to the origin of nappe.

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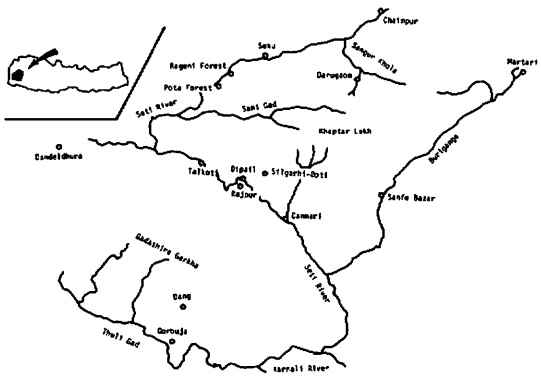


Fig. 1 Index map and local names

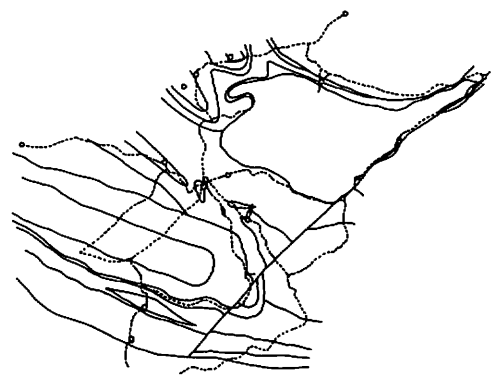


Fig. 2 Surveyed route

The author wish to thank Prof. K. Kizaki of Ryukyu University and Dr. T. Sharma of Department of Mines and Geology of Nepal, for their critical reading of the manuscript.

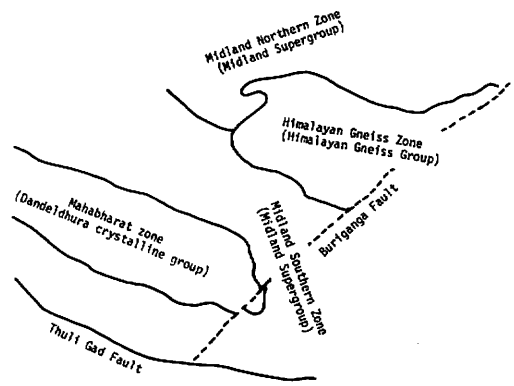


Fig. 3 Zoned map

Outline of Geology

The interesting feature of the geology in the region extends such panoramically, that a gneiss sheet of the Higher Himalayas (Khaptar Gneiss) seems to form western fringe of the Karnali Klippe to cover the meta-sediments (Midland Supergroup) widely distributed in the northern part of the region, while southern part is occupied by a leucocratic granite and a large potashfeldspar porphyroblast bearing gneiss (Dandeldhura Crystalline Group). Intermediate parts are buried by the slightly metamorphosed Lesser Himalayan sediments (Midland Supergroup) which are gently folded in the region and have yielded no fossils. Southernmost formation of the Midland Supergroup contacts with the Siwalik Group along the Thuri Gad Fault which is the local name of the Main Boundary Fault (MBF).

All the three main units stretch along nearly the same trend: NWW to SEE. The trend is cut across by the Buriganga Fault being assumed to be a left-lateral normal fault running from NE to SW along the Buriganga River.

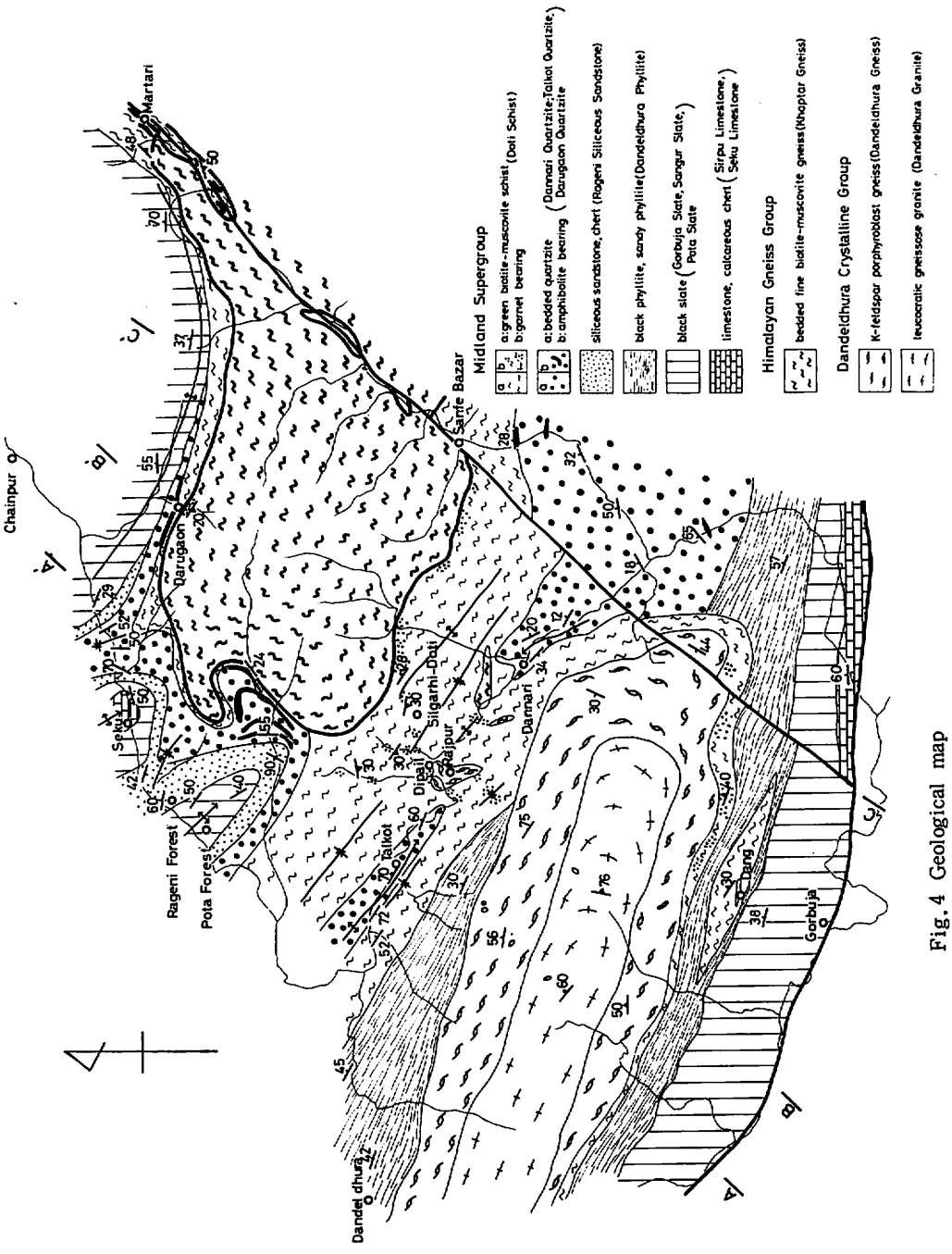


Fig. 4 Geological map

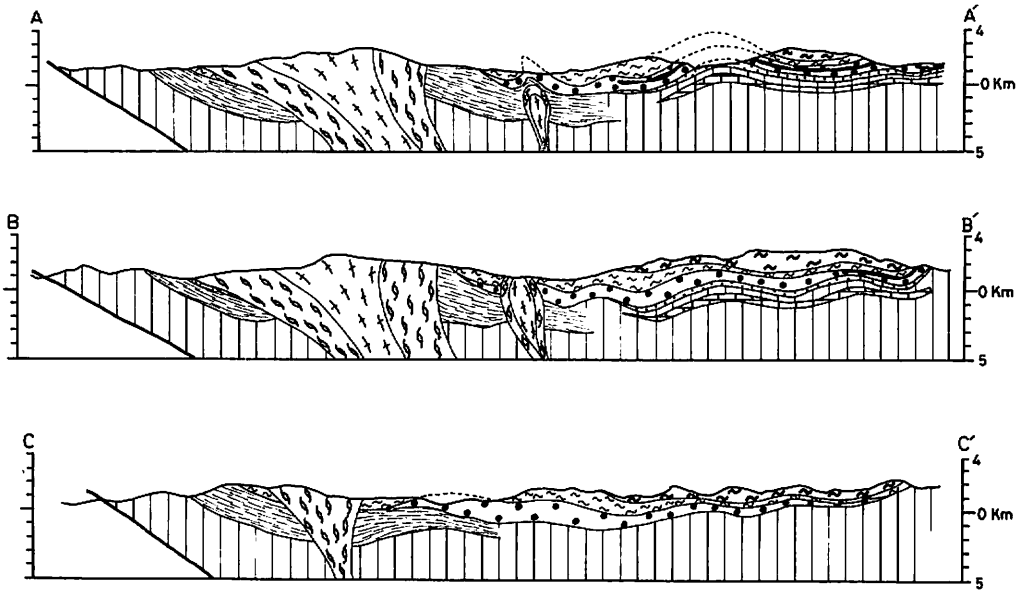


Fig. 5 Geological cross sections

Geological Division

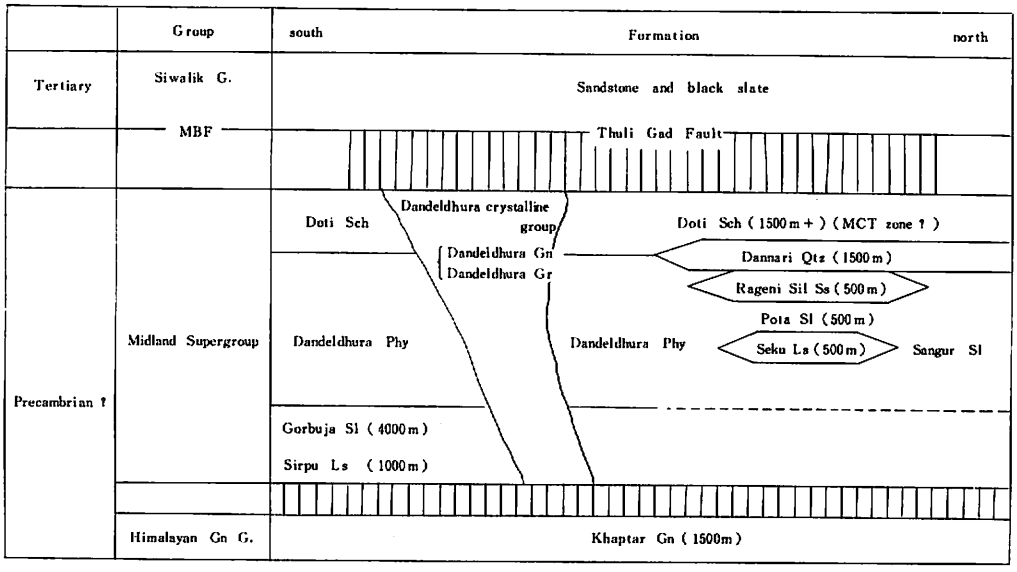
Surveyed area is stratigraphically divided into three geological groups except for the Siwalik Group (Table 1). The Midland Supergroup is distributed widely in the region, while the Himalayan Gneiss Group extends particularly in the north and the Dandeldhura Crystalline Group in the south.

The Himalayan Gneiss Group composed only of the Khaptar Gneiss, is considered to be the basement underlying the Midland Supergroup, however, it is tectonically emplaced over the latter as a Klippe in the region. The Midland Supergroup indicates two different lithofacies which are separately observed north and south. Its southern facies is composed from lower to upper, of the Sirpu Limestone, Gorbuja Slate, Dandeldhura Phyllite and Doti Schist.

Its northern facies comprises the Sangur Slate, Seku Limestone, Pota Slate, Rageni Siliceous Sandstone, Dannari Quartzite and Doti Schist in ascending order. The Dandeldhura Phyllite of the southern facies is the equivalent of the succession from the Sangur Slate to the Dannari Quartzite of the northern facies.

The Dandeldhura Crystalline Group composed of the Dandeldhura Granite and Dandeldhura Gneiss, is considered as intrusives into the Midland Supergroup.

Table 1 Generalized stratigraphic columnar section



The region is separated into four zones; the Midland Southern Zone, Mahabharat Zone, Midland Northern Zone and Himalayan Gneiss Zone from south to north (Table 2). The Midland Southern Zone comprises the Sirpu Limestone,

Table 2. Zonation around Silgarhi Doti

	Zone	Group	Formation
North	Himalayan Gn zone	Himalayan Gn G.	Khaptar Gn
	Midland Northern Zone	Midland Supergroup	Doti Sch (MCT zone?)
			Darugaon Qtz Rageni Sil Ss Pota bk Sl Seku Ls Sangur bk Sl
			Doti Sch (MCT zone?)
			Dannari Qtz, Talkot Qtz
			Dandeldhura Phy
	Mahabharat zone	Dandeldhura Crystalline G.	Dandeldhura Gn Dandeldhura Gr Dandeldhura Gn
	Midland Southern Zone	Midland Supergroup	Doti Sch
			Dandeldhura Phy
			Gorbuja bk Sl Sirpu Ls
	MBF		Thuli Gad Fault
South	Siwalik zone	Siwalik G.	Ss & bk Sl

Gorbuja Slate, Dandeldhura Phyllite and Doti Schist. The Mahabharat Zone comprises the Dandeldhura Gneiss and Dandeldhura Granite. The Midland Northern Zone consists of the succession from the Sangur Slate to Doti Schist. The Himalayan Gneiss Zone is constituted only of the Khaptar Gneiss.

Several formations are structurally repeated: the Doti Schist repeats three times, Dandeldhura Phyllite two times, and the Dannari Quartzite is the equivalent of the Talkot Quartzite and Darugaon Quartzite.

Lithology

Khaptar Gneiss (Himalayan Gneiss Group)

The gneiss distributes as three separate bodies throughout the region, one is found as a large sheet of klippe in north, and other two small bodies lie in the central and southern areas. The northern gneiss sheet is composed of banded fine grained (garnet)-(tourmaline)-biotite-muscovite gneiss.

As the boundary between the gneiss and the underlying green mica schist (Doti Schist) appears obscure, it is difficult to discriminate clearly their contacts. Small gneiss bodies distributed between Dipail and Dannari are fine grained biotite-muscovite gneiss. The other small isolated gneiss body, is observed in the south, enclosed within the Doti Schist.

Midland Supergroup

Sirpu Limestone

The limestone lies north of and along the Thuli Gad Fault (local name of MBF) and is composed of white-light green limestone, grey calcareous sandstone and grey calcareous chert intercalated with minor red slate film. The formation is considered to increase its thickness and width towards east. The formation disappears in the west probably cut off by the Buriganga Fault.

Gorbuja Slate

This formation is situated to the north of the Thuli Gad Fault, and comprises white quartzite and black-red-green slate intercalated with pink-green quartz arenite. The formation decreases its thickness towards east and may disappear.

Dandeldhura Phyllite

The formation lies south of the region and is a homoclinal structure dipping NNE, intruded by the Dandeldhura Crystalline Group in its central zone parallel to the general strike of the area. This is composed of green-black pelitic and sandy phyllite alternating with green quartz sandstone, and green schist. Owing to the similarity of the stratigraphical sequence, the Dandeldhura Phyllite is considered as the southern equivalent of the succession from the Sangur Slate to Dannari Quartzite.

Doti Schist

Distribution of the Doti Schist is generally limited in the central part of the region, and the formation encloses apparently the Khaptar Gneiss in the northern part and the Dandeldhura Crystallines in the southern part. Lens of this formation is observed within the zone of the Dandeldhura Phyllite in the south, and it encloses a smaller gneiss body. The other small masses of the Doti Schist expose along the Buriganga Fault to accompany with several amphibolite sheets.

Sangur Slate

The Sangur Slate is observed along the Sangur Khola in the northernmost part of the area where an anticline runs in the E-W direction. The formation comprises black graphitic slate, light green siliceous slate, light green fine meta-sandstone, green slate intercalated with minor amount are found about 3 km south from the confluence of the Sangur Khola and the Seti River. The formation, interbedded with the Seku Limestone, is considered to cover the northern area in Chainpur, and its upper horizon is considered as the equivalent of the Pota Slate.

Seku Limestone

The formation occurs more south along the Seti River, which strikes NE-SW with steep dip to SE and NW forming an anticline plunging to SE. They consists of white-grey limestone and alternation of limestone and black slate.

Pota Slate

The Pota Slate formation encloses the Seku Limestone and exposed forming the anticline plunging to SE, whereas the formation is repeated to occur more south along the Seti River as a core of the other anticline plunging to SE. The formation comprises black-brown-grey slate dominantly, minor black chert, biotite bearing meta-sandstone, weekly bedded white limestone and bedded white quartzite. The formation occurring more south, is considered as the upper part of the Sangur Slate.

Rageni Siliceous Sandstone

The formation i repeated by folding and appears four times along the Seti River, and is mainly composed of light green - grey - black siliceous sandstone with minor siliceous slate.

Dannari Quartzite

Type locality of the formation is around the confluence of the Seti River and Buriganga, while other equivalent quartzite formations lie in the northwest and in the central part of the region, e. g. Darugaon Quartzite and Talkot Quartzite respectively. The formation comprises white bedded quartzite intercalated fre-

quently with several sheets of bedded homogeneous amphibolite near Darugaon, and constructs a part of fringe of double anticline plunging to southeast, whose cores are composed of rather pure quartzite, while the wing is siliceous (biotite /muscovite) schist. Most widely distributed, is the Dannari Quartzite, which consists of white bedded quartzite intercalated with thin white-light green siliceous schist, whose lower-half is composed mainly of white siliceous coarse sandstone; sand grains as big as 1 cm.

Dandeldhura Crystalline Group

Dandeldhura Granite

The granite body stretching E-W, occupying the central part of the Dandeldhura Gneiss, is composed of tourmaline-muscovite-biotite leucocratic granite; tourmaline crystals are occasionally big. In places, small gneiss bodies of Khaptar Gneiss type are inclosed within the granite body. Small bodies of the Dandeldhura Granite seem to intrude into the Doti Schist along the Seti River at Rajpur and near Dannari.

Dandeldhura Gneiss

The gneiss has a distinct property against the Khaptar Gneiss, and occurs as a mantle enclosing the Dandeldhura Granite body. Foliation of the Dandeldhura Gneiss and Dandeldhura Granite indicates steep dip, and the structure is very different to the adjacent Doti Schist and Dandeldhura Phyllite. It is therefore, the Dandeldhura Group is considered to be an intrusive sheet. The gneiss body consists of rectangular porphyroblast of potash-feldspar bearing leucocratic gneiss which includes biotite, tourmaline and muscovite in general. Feature of the gneiss in outcrops seems similar to that of the augen gneiss observed in the eastern Mahabharat Range (Arita et al., 1973).

Some Remarks

Some sedimentary structures as cross laminae, ripple marks and rod structures are observed in the area and their locality is shown in Fig. 6. One of the ripple mark in siliceous schist belonging to the Doti Schist indicates a current orientation trending N68E with 36° plunge In general, the Midland Supergroup seems to be gently undulated.

A boulder of stromatolitic limestone, probably derived from the Sangur Slate is observed near Thalara.

Lineations of minor fold axis, crenulation cleavage and mineral lineation are shown in Figs. 7, 8 and 9. The superposed lineations are shown in right-hand side of Fig.7, which indicates clearly that NE-SW lineation is folded by NW-SE lineation, as have been observed in Central and Eastern Nepal (Ohta, 1973).

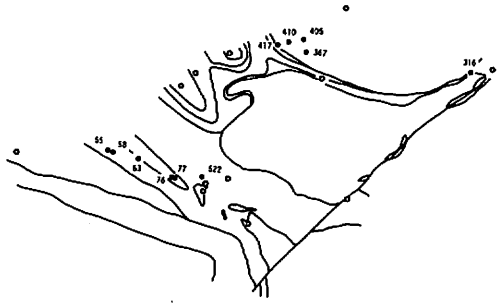


Fig. 6 Location of sedimentary and tectonic structures.

55: cross lamina indicates normal polarity in calcareous sandy schist.
58: ripple mark (normal) presents current trend 36N68E in siliceous schist.
63: normal cross lamina in siliceous schist.
76: rod structure in biotite quartzite.
77: reverse cross lamina in biotite quartzite.
316: ripple mark in rolling limestone.
367: rod structure in limestone.
405: characteristic cleavage oblique to bedding plane in grey-black slate.
410: stromatolite in rolling limestone.
417: pencil cleavage in green slate.
522: normal cross lamina in siliceous sandstone.

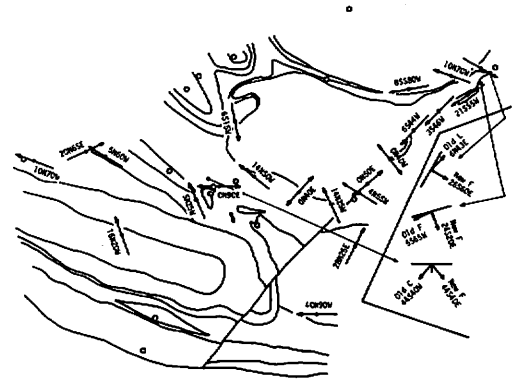


Fig. 7 Distribution of minor fold axes. Three sets of lineation illustrated in right of the figure indicate that NE-SW lineation is older than that of NW-SE.

Old L: old lineation, New F: new minor fold axis,
Old F: old minor fold axis, Old C: old crenulation creavage.

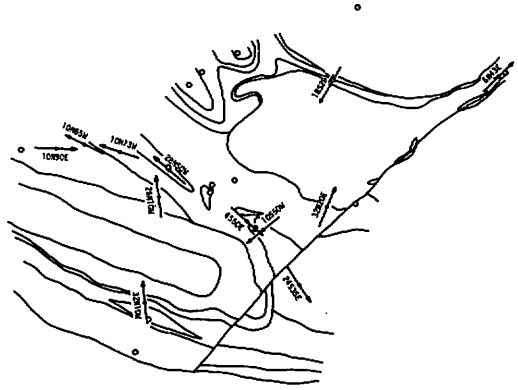


Fig. 8 Distribution of crenulation creavages.

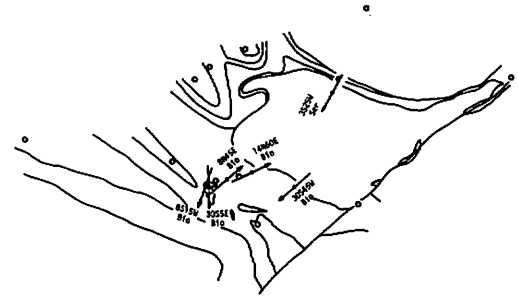
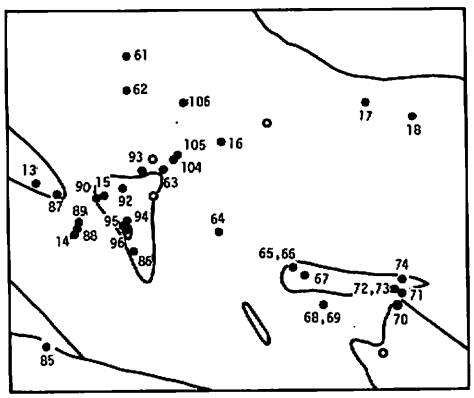
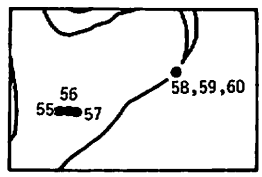


Fig. 9 Distribution of mineral lineations.
Bio: lineation of biotite, Ser: lineation of sericite.



10 - A



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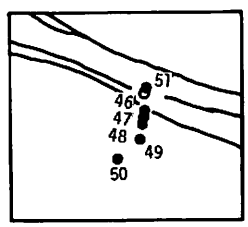

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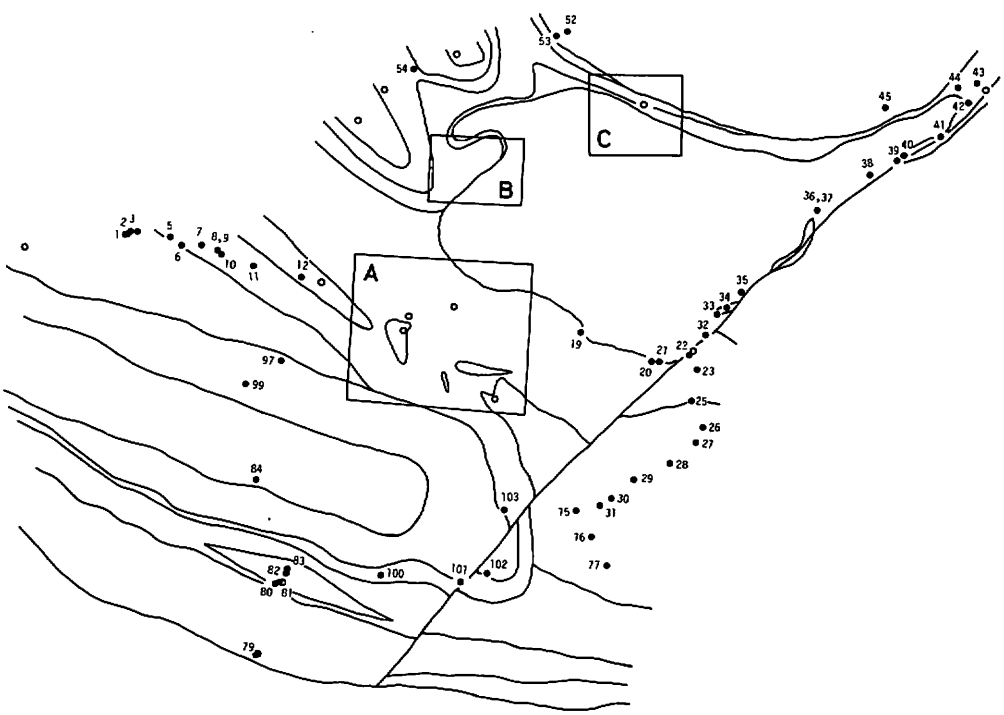

Fig. 10 Locality of samples used to describe mineral assemblage on Table 3.

Mineral assemblages are described on Table 3 and their locality is shown in Fig. 10, though distinct mineral zonation can not be constructed in the area because of the lack of index minerals.

Table 3 Mineral assemblage

Khaptar Gneiss

No.	Field name	G	B	M	S	A	E	T	Others
21	mica gn		o	o				o	q, k
32	tourmaline gn		o	o				o	q, k', p'
33	bio gn		o	o					q', k', p
35	bio gn		o	o				o	q, k', p'; schistose
36	bio gn		o	o				o	q, k', p'
37	bio gn		o	o					q; schistose
38	sil gn		o	o					q, k', p'
41	bio gn		o	o					q, k'; schistose
42	bio gn		o	o					q; schistose
46	mica sch		o	o				o	q, k, p
48	fine gn	o	o					o	q, p, ?
49	sil gn		o		o				q"
50	fine gn	o	o	o					q, p, ?
59	gn		o	o			o		q, p', k'
60	gn		o	o			o		q, p', k', ?
65	pel gn		o	o					q, k'
66	sil gn		o	o					q, k', p'
67	fine gn		o	o					q, k', p'; schistose
68	fine gn		o	o					q, k, p; spotted
72	fine gn			o				o	q, k', p
73	fine gn		r	o				o	q, k', p, chlorite
81	fine gn		o	o					q, k', p'; large K-feldspar

Gorbuja Slate

No.	Field name	G	B	M	S	A	E	T	Others
79	sil ss				o				q", chlorite

Sangur Slate

No.	Field name	G	B	M	S	A	E	T	Others
45	green sch				o			o	q, k, p, chlorite
52	cal-sil ss								q, calcite
53	sil ss							o	q", graphite; schistose

Rageni Siliceous Sandstone

No.	Field name	G	B	M	S	A	E	T	Others
54	meta ss							o	q, graphite; schistose

Dannari Quartzite

No.	Field name	G	B	M	S	A	E	T	Others
12	mica sch		o						q, chlorite; schistose, large q-grain
13	sil sch		o		o			o	q; schistose
26	sil sch				o				q, chlorite; schistose
28	sil sch				o			o	q; schistose
29	sil ss				o			o	q" ; schistose
30	sil ss				o			o	q" ; schistose
31	phy sch								q, chlorite, calcite; q-pool part
56	sil sch				o				q
70	green sch						o		q, chlorite, calcite; schistose, fine grain
75	meta ss				o			o	q', graphite
76	meta ss				o			o	q'
77	amphibolite ?								chlorite, p, calcite; fine grain, tuff origin ?
87	sil sch		o		o				q

Doti Schist

No.	Field name	G	B	M	S	A	E	T	Others
5	sil sch				o				q; q domi
6	sil sch				o			o	q; q domi
7	sil sch							o	q, chlorite, hematite; q domi
8	cal phy								q, chlorite, sphene
9	cal sch								q, calcite, hematite
10	sil sch		r		o				q
11	cal sch		r		o				q; schistose
14	mica sch		o	o					q, chlorite, k
16	mica sch	o	o	o				o	q, chlorite; schistose
17	sil sch		o		o			o	q; schistose
18	sil sch		o		o			o	q, chlorite; schistose
19	mica sch		o		o				q, k, chlorite; coarse grain, q-pool part
20	sil sch		o	o					q, k'; schistose
22	bio sch		o		o			o	q, k', p; schistose
23	mica sch		o	o				o	q, k', p'; schistose
24	sil sch				o			o	q, chlorite; q domi
34	green sch				o			o	q, chlorite; schistose
40	sil sch				o				q; q domi
43	ls				o				q, calcite, chlorite; fine grain, cal domi
44	green phy			o					q; schistose
47	bio sch	o	o	o				o	q, p, ; schistose
51	mica sch				o				q
61	sil ss		o	o				o	q
62	sil sch		o		o			o	q, chlorite; q mosaic
63	sil sch				o	?			q, chlorite; hornblende or chloritoid ?
64	pel sch	o	o	o				o	q, p
69	pel sch			o					q; schistose
71	sil sch			o				o	q" , k' , p
80	pel sch		o	o					q" , k' , p
82	sil sch	o	o		o				q; schistose
83	sil sch		r		o				q" , k; schistose =meta ss
88	cal sch		o						q, chlorite; schistose, fine grain
93	cal sch	o	o	o					q, chlorite
99	sil sch	o				o	?		q

(continued)

No.	Field name	G	B	M	S	A	E	T	Others
100	sil sch	o	o						q", chlorite; fine grain
101	sil sch	o	o						q, chlorite, k; schistose
103	sil sch	o	o		o			o	q
104	mica sch		o	o					q, chlorite
105	sil sch		o	o					q, chlorite
106	sil sch		o	o				o	q, chlorite; schistose

Dandeldhura Phyllite

No.	Field name	G	B	M	S	A	E	T	Others
1	sandy phy		o		o				q, p, k; schistose
2	sandy phy		o						q, p; schistose
3	black phy		o						q; schistose
4	green sch				o				q; q domi

Dandeldhura Gneiss

No.	Field name	G	B	M	S	A	E	T	Others
85	tourmaline gr		o	o				o	q, k', p'; coase grain
86	blasto gn		o	o				o	q, k', p'; medium grain
90	gr gn	o		o				o	q, k', p; microcline bearing
92	blasto gn	o	o	o					q, k'; large K-feld
94	blasto gn	o	o	o					q, k', p'
102	blasto gn		o	o					q, k'

Dandeldhura Granite

No.	Field name	G	B	M	S	A	E	T	Others
15	mica gn		o	o				o	q, k', p'
74	fine gn			o				o	q, k', p'
84	gn gr		o	o					q, k', p', chlorite; coarse grain
89	gn gr			o					q, k, p, chlorite; schistose
91	bio gr		o	o					q, k, p, chlorite; coarse grain
96	aplitic gr		o	o				o	q, k
97	aplitic gr			o					q, k, p, chlorite

Amphibolite

No.	Field name	G	B	M	S	A	E	T	Others
25	amphibolite		o			o	?		q, p', k, hematite; hornblende domi
27	amphibolite					o	o		k; hornblende domi
39	amphibolite					o	o		q; green hornblende
55	amphibolite		o			o			q, p; fine grain
57	sch amphibolite					o	o		q, calcite, p; schistose
58	mass amphibolite					o	o		k, q, p; green hornblende, epidote abundant
95	amphibolite					o			q, k, p

G: garnet, B: biotite, M: muscovite, S: sericite, A: amphibole, E: epidote, T: tourmaline

o: exist, r: rare, q: quartz, k: K-feldspar, p: plagioclase, q": quartz which indicates wavy extinction, k' & p': K-feldspar and plagioclase which indicate poikiloblastic texture

gn: gneiss, sch: schist, ss: sandstone, phy: phyllite, ls: limestone, gr: granite bio: biotite, sil: siliceous, pel: pelitic, cal-sil: calcarious siliceous, meta ss: meta sandstone, phy sch: phyllitic schist, cal: calcarious, blasto gn: K-feldspar porphyroblast gneiss, mass amphibolite: massive amphibolite, sch amphibolite: schistose amphibolite

Discussion

The Doti Schist appears to distribute around the Khaptar Gneiss sheet and the Dandeldhura Crystallines. This feature insists to consider that the zone of Doti Schist is the equevalent of so called Main Central Thrust (MCT) zone. Even in this case, this should be applied only to the Doti Schist enclosing the sheet of the Khaptar Gneiss. However, there are several doubts, for example, there are no augen gneisses, no sheared zones and few varieties of rock species, which is in contrast to the observation in Central and Eastern Nepal (Ohta, 1973). The southern formation of green mica schist around the Dandeldhura Crystallines may be formed through the process of intrusive movement of the Dandeldhura Crystallines.

Considering the structure of Doti Schist and concordant boundary of the Khaptar Gneiss and the underlying amphibolites of the Dannari Qurartzite, it is safely concluded that the gneiss sheet has not accompanied with appreciable sheared zone, at least, in this region. This is also witnessed by no disturbed stratigraphical structures of the Midland Supergroup in the region.

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