CHAPTER IV

STRATIGRAPHIC CORRELATION AND AGE

PROBLEMS OF CORRELATION

Nagthat Formation

The sedimentary sequence placed stratigraphically below the foliated traps, and designated by the author as Nagthat formation (following the recent works of Tewari and Mehdi, 1964, and Mehdi et al., 1972) is rather a controversial group of rocks. These have been variously correlated by different previous workers. Heim and Gansser (1939) considered this sequence as comprising two distinct tectonic units. They have visualised the Ramgarh thrust to be the north dipping

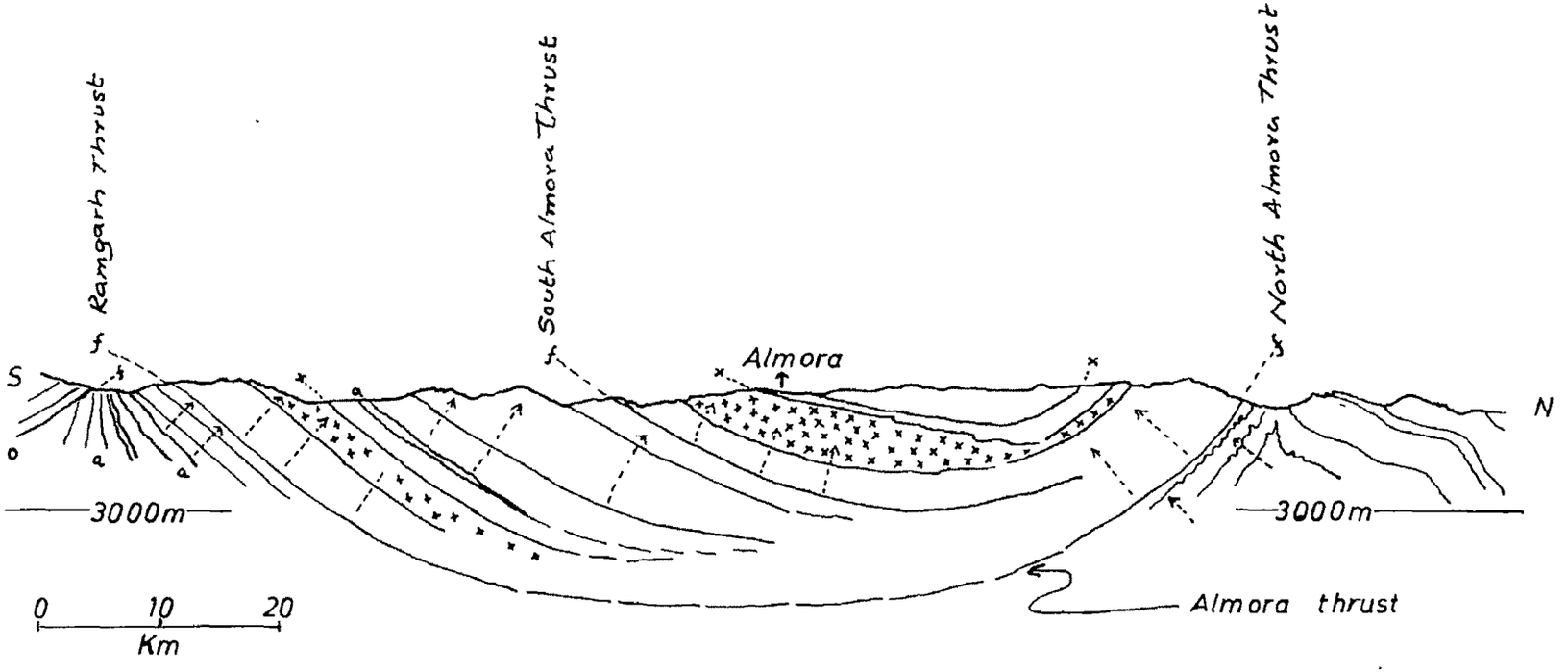
southern limb of the synformally folded Almora thrust and have considered the overlying "gneissic quartz porphyries" (= sheared granites and granophyres of the author) to represent Chandpur crystallines equivalent to the rocks of Almora nappe (Fig. 4.1). According to these workers, the quartzite-slaty phyllite unit that overlies the limestones, forms a recumbent syncline, and is equivalent to the Nagthats.

Power et al. (1969) have shown this succession as forming a small synform of Almora nappe rocks (Fig. 4.2) and it was implied by them that the quartzites above the limestone and those below the Ramgarh thrust were one and the same, and of Nagthat age.

Merh (1968) however, ruled out the existence of any folded nappe within this succession. On the other hand, he suggested that the Ramgarh thrust is of later date than the Almora thrust, and that the sequence between it and the overlying S. Almora thrust is normal and uninverted. He gave the following stratigraphy:

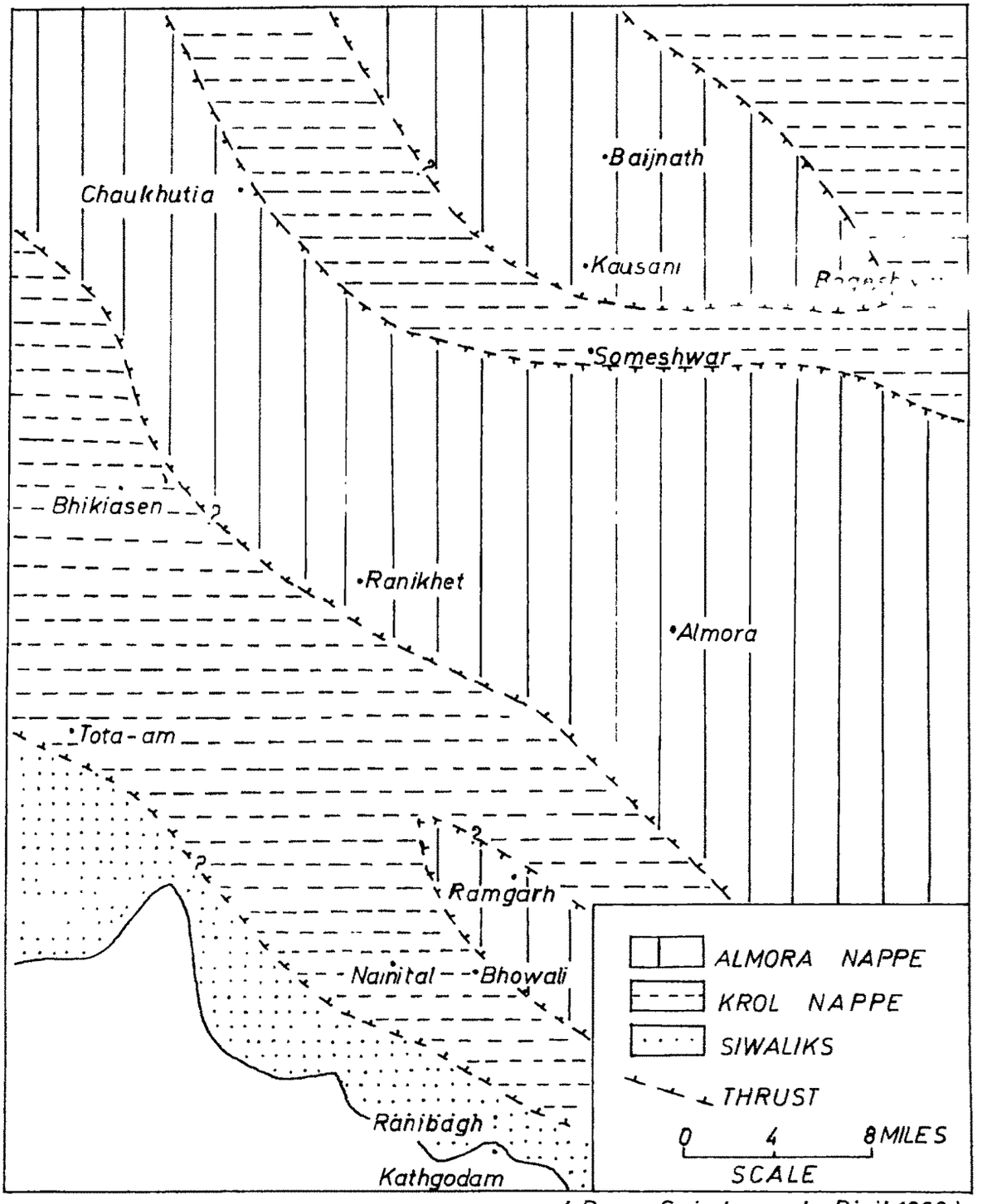
Fig. 4. 1.

The crystalline thrust masses in the Kumaon Lower Himalayas Almora.



(A. Gansser 1964)

Generalised tectonic map of Nainital-Almora-Kausani area.



(Powar, Gairola and Dixit 1969)

	Mica schists and migmatitic gneiss with quartzites	
ALMORA NAPPE	Chlorite schists	Chandpurs
	Sericitic schist (Phyllonites)	
---------- Almora Thrust ----------		Garhwal Thrust
	Quartzites with slates	Nagthats
	Dolomitic limestones with slates	Deobans
KROL NAPPE	Chlorite and talc chlorite schists (metamorphosed basic rocks) with quartzites	Chandpurs
	'Porphyries' (mylonilised granite)	
	Talc chlorite schists (metamorphosed basic rocks)	
---------- Ramgarh Thrust ----------		
	Quartzites and associated basic rocks (Bhowali traps)	Nagthats

Later on J.P. Patel (1971) working exclusively on the Ramgarh-Nathuakhan area, also suggested a similar stratigraphy.

It is obvious that both Merh and J.P. Patel, never suspected the pebbly quartzite of the Garampani-Bhowali area to be of Blaini age, and thus they suggested the above correlation to fit in with the then prevalent ideas of Heim and Gansser.

The present author has however benefitted from the investigations of Merh's students in the adjoining areas and he is in a position to considerably modify the existing ideas on the stratigraphy of these rocks. According to him, the sequence under question, could be taken as equivalent to Jaunsars of Simla, but he would not hazard to correlate the various members of this formation with the different sub-divisions of the Jaunsar originally suggested by Auden (1934). As considerable confusion prevails in respect of the term "Jaunsars", the author has preferred not to use this term, but follow a recent nomenclature by Mehdi et al. (1972) who have called these as Nagthat formation, by enlarging the scope of this term to include underlying rocks, other than quartzites and phyllites.

Foliated Traps

From the stratigraphic point of view these traps have been placed beneath the Blainis and above the Nagthat. As stated already, it is not clear whether there exists an unconformity beneath these traps, but its presence is quite likely, because the author is inclined to include these trappean rocks as the fore-runners of the Blaini-Krol deposition in a basin whose

basement was perhaps of Nagthat rocks. On the other hand, the fact that all over the Krol belt, the upper Nagthats have been found to be associated, with extensive lava flows and tuff beds, might point to a considerable narrowing down of the time interval between the close of Nagthat sedimentation and volcanic effusive activity. Thus, the author does not rule out the possibility that there was no significant break in the deposition after Nagthat. Of course, this is just a conjecture to be substaintiated and verified by further work.

Blaini-Infra Krol sequence

The sedimentary sequence that comes over the foliated traps, starting with the Bouldery beds and ending upward (in Naini Tal area) with the oolitic limestone, typically resembles the Blaini-Infra-Krol-Krol sequence of the Simla, the type area of Krol Belt. The similarity between the rocks of Naini Tal and those of the Krol Hills of Simla were observed long back by Middlemiss (1890) who suggested that the Naini Tal limestone belonged to the Krol series of Simla. Auden (1934) has in his classic work on the Krol belt, clearly mentioned that the Naini Tal rocks form the south-eastern

limit of Krol belt.

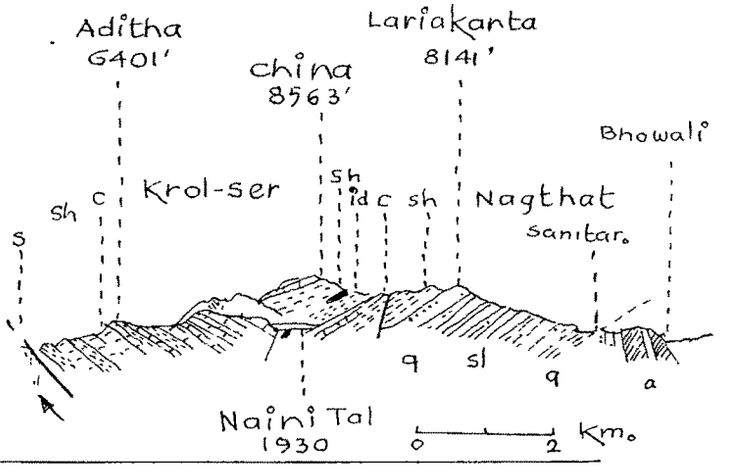
Heim and Gansser (1939) too correlated the limestones of Naini Tal (of Deopatha and Ayarpatha ridges) with the Krols of Simla, and stated that the slaty formation of the northern slopes of the China peak were Infra-Krols.

The author too finds this correlation quite valid so far as the Krol and upper part of the Infra-Krol formations are concerned, but as regards the bouldery and pebbly quartzites of Bhowali Garampani are concerned, they are not Nagthat as shown by Heim and Gansser. These workers have included the entire succession from Lariakanta eastward upto Bhowali, within Nagthat (Fig. 4.3). They write that they searched for Blainis in vain and got them nowhere (op.cit. p.27). The author is surprised how these two eminent geologists could not observe this so obvious Blaini assemblage. The bouldery and pebbly quartzites with intercalated slates and a lensoid limestone horizon in association with red slates near the top, clearly show a sequence which tallys well with a number of typical occurrences of Blaini formation. As in the type area, here too, the Blaini slates grade imperceptibly into the Infra-Krol quartzite-slate sequence.

fig. 4·3

SECTION SHOWING SUCCESSION FROM LARIAKANTA TO BHOWALI

(HEIM AND GANSSER)



a. amphibolite, diabase and chloritic schists
sh. shale
c. carbonates, mainly limestone, incl. marble
s. sandstone
id. igneous, dioritic
q. quartzite
sl. slate

The accompanying Table (4.1) shows the correlation of the Krol group rocks of study area with that of the Simla-Naini Tal areas.

STRATIGRAPHIC AGE

The unfossiliferous rock formations of the Lesser Himalaya, have always posed a problem in respect of their correct stratigraphic age. In the absence of systematic mapping from one end to the other, it is rather difficult to correlate rocks sequences in videly separated areas. The lithological similarity alone could be misleading and the structural complexity and textural and mineralogical changes due to metamorphism, have further complicated the issue.

So far as the Blaini-Infra Krol sequence is concerned, the author is in a somewhat happy position. At least there are some references and correlation that could be helpfully utilised in arriving at the possible age of these rocks. But in the case of the underlying Nagthat formation, the problem of age is rather difficult.

The author has called the sequence as Nagthat formation, and considered it broadly equivalent to the Jaunsars (or Nagthats) of Simla area. This correlation

TABLE 4.1

Correlation of Garampani area with the Naini Tal area and other parts of the

Simla-Chakrata area Auden (1934, p.429)	Simla area Pilgrim and West (1928, p.3)	Nigli Dhar area Bhargava (1969,72,p.52)	Naini Tal area D. Pal (Personal communication)
Nahans (only at Kalka)	-	Siwaliks	Lower Siwaliks (= Nahans)
Kasauli	-	-	-
Dagshai	Dagshai	Dagshai	-
Subathus	Subathus	Subathus	-
		Unconformity	
Upper Tal	-	Tal	Non deposition
Lower Tal	-		
? absent (Trias L.St.)			
Krol E | Upper Krol		Krol E	-
Krol D | Limestones	| Massive blue	Krol D	Krol D | Upper Krol
Krol C |	| limestone	Krol C	Krol C | limestones
	Krol |		
Krol B Red shales	Series | Red shale	Krol B	Krol B Red shales | Lower
	|		| Krol
Krol A Lower Krol limestones	| Limestone and shale	Krol A	Krol A | lime- | stones
-	Krol sandstones	-	-

is most tentative and open to many doubts. It is difficult to conclusively mention that this correlation is final and correct. Assuming that this formation is equivalent to the Nagthat in general, then the next problem that arises is that what is the actual age of this sequence. There is no unanimity on this point amongst previous workers, and the Jaunsars have been taken to occupy stratigraphic age anywhere between Proterozoic to Lower Paleozoic. Pilgrim and West (1928) considered the Jaunsar series of Simla to be of Purana age (Algonkian to Torridonian). But Auden (1934) puts the Jaunsars in Lower Paleozoic (Silurian-Devonian). This age is accepted by almost all subsequent workers. (Niyogi and Bhattacharya, 1971; Bhargava, 1972).

The author, therefore, is of the opinion that the Nagthat formation of the study area could be considered to be of an age anywhere from Ordovician to Devonian.

The overlying foliated traps, could be taken to represent the widespread volcanism that took place during the Upper Carboniferous times. The Panjal traps of Kashmir are perhaps equivalent rocks of the same age.

Recently, Sharma and Gupta (1972) have reported an occurrence of spillite-keratophyre association from the Panjal rocks of Thanamandi area in Kashmir. It is not unlikely that the Upper Carboniferous period witnessed extensive submarine volcanism at many places in the Lesser Himalayas, and comprised a major geosynclinal event heralding the deposition of the overlying Krol group rocks.

The overlying Blaini-Infra-Krol-Krol-Tal sequence (comprising Krol group) are better investigated, but still much uncertainty exists in respect of their age. Ever since Oldham (1888) assigned it an Upper Paleozoic age, the problem has been much debated. In the absence of adequate direct fossil evidences, it has been found rather difficult to assign proper age to this important stratal sequence. The fixation of the age of this rock group has been attempted by a number of workers during the past 80 years, and mainly the following two criteria have been taken into consideration in this respect:

(i) The contention that the Blaini boulder beds are glacial and equivalent to the Talchirs of South India, and

(ii) The discovery of fossil remains in Infra-Krols, Krols and Tals.

Oldham (1888) was the first worker to correlate the Blainis with Talchirs. On the other hand,Holland (1908) correlated these rocks of lesser Himalaya with rocks of the Peninsula including Vindhyans, and considered them of Pre-Cambrian or Cambrian age. He suggested that the Blaini Boulder bed marked an unconformity between Pre-Cambrian and Cambrian. Practically at the same time, Hayden (1907-8) correlated Blainis with Spiti Beds, and contended that the Spiti shales were non-glacial and much younger than the Talchir Boulder Bed considered to be of Upper Carboniferous age.

Vredenburg and Dasgupta (1918) noted the occurrence of Upper Palaeozoic brachiopod chonetes from the Krols of Solon area near Simla. Dasgupta (1929) therefore suggested an Upper Paleozoic age to the entire Krol group. Subsequent work by Hayden (1919) and Auden (1932) regarding this fossil find, revealed that the rocks under question were in fact Lower Tertiary marine formations, and the latter opined that the reference to chonetes was erroneous, and a case of misidentification of a Subathu oyster.

The large limestone inliers of Jammu, have often been referred to of Permo-Carboniferous age (Medlicott, 1876; Wadia, 1928, 1937). Fermor (1931) established

that the Infra-Trias Sirban limestones of Hazara were identical to those of the Krol series. A close resemblance between the Krol limestone, Permo-Carboniferous limestone of Jammu and that of Hazara, has been observed.

Pilgrim and West (1928) considered that the Krol group could be of Upper Palaeozoic to Mesozoic in age. They did not think that the sequence was Pre-Cambrian as suggested earlier by Holland. Auden (1932) was not very certain but thought the Krols to be Permian to Mesozoic, on the basis of the Blaini Boulder Beds being of Uralian (Upper Carboniferous) age. In his subsequent paper on the Krol belt, Auden (1934) suggested Blainis and Infra-Krols to be of Upper Carboniferous, while the Krols and Tals were equated with Permo-Carboniferous, and Jurassic and Cretaceous respectively.

Boileau (1954) on the other hand, included Krol formation with the Shali and Dharmakot limestones and correlated them with the upper part of Vindhyans. Thus, he doubtfully suggested an Ordovician to Devonian age to the Krol series.

In the course of last 20 years, numerous workers have succeeded in obtaining microfossil evidences from

Tal, Krol and Infra-Krol formations, and their findings have thrown some light on this complex problem of age. Sitholey et al. (1954) and Lakhanpal et al. (1968) have reported the occurrence of plant microfossils from the Infra-Krol carbonaceous slates of Naini Tal area, and according to these workers, the assemblage indicates affinity to the microfossil fauna from the Permo-Carboniferous Gondwana rocks. Ghosh and Srivastava (1962) on the basis of the occurrence of certain fossil spores in the Infra-Krols, Krols and Tals near Mussoorie in Garhwal, have assigned a Triassic age to Krol formation.

Bhargava and Srikantia (1967) have also suggested that Krols must be of Mesozoic age. They have arrived at this conclusion on the basis of a precise and detailed mapping.

More recently Shah et al. (1968) have published another paper on the palynological assemblage from the Infra-Krol carbonaceous slate of the Naini Tal area. These have reiterated the earlier views of Sitholey et al. (1954) and Lakhanpal et al. (1968), and suggested that the dominance of non-striate bisaccate pollen in these rocks, points to the lowermost part of the Triassic.

In the same year, Tewari and Ratesh (1968) reported bryozoan and formainiferal fossils from the Upper Tals of Garhwal. On the basis of these fossils, they suggested a Lower Cretaceous age to the Tal formation, and accordingly considered the Krols underlying "with the intervening small unconformity" to be as young as Jurassic.

Bhattacharya and Niyogi (1971) have more or less accepted the Upper Palaeozoic to Jurassic age for the Blaini-Krol sequence originally suggested by Auden (1934). They have written (op cit., p.200), "The Krols because of their normal sedimentary occurrence over the supposedly Upper Carboniferous Blainis, were thought to represent the Permian and Triassic by earlier workers. Though the glacial origin of the Blaini boulder beds and their consequent correlation with the Talchirs can be challenged, a probable Upper Palaeozoic to Jurassic age for the Blaini-Krol sequence is still suggested by recent finds of animal fossils and spores in the south-east extension of this belt."

In the most recent work on the Krol belt, Bhargava (1972) has also mentioned that the Krol group is Permo-Carboniferous to Lower Cretaceous. He has considered

the Blaini formation to be of glacio-marine origin, having been deposited at the time of the Talchir glaciation. He has assigned Blainis an Upper Carboniferous age.

On the basis of the above discussions, the rocks of the study area have been arranged as per following stratigraphic ages:

Formations		Age
Infra-Krol	- ?	Permian or Triassic
Blainis	-	Permo-Carboniferous
Foliated Traps	-	Upper-Carboniferous
Nagthat	- ?	Ordovician to Devonian