# CHAPTER I

# I N T R O D U C T I O N

## GENERAL

Several decades back Middlemiss (1890 p.44) remarked that "the geology of Naini Tal in its, purer scientific aspects is neither very attractive, nor very instructive." The author to-day is however, constrained to differ from the above view. The complexities of stratigraphy and tectonics are so many and obviously Middlemiss failed to understand them. In this thesis, the author has attempted to substantiate this fact. The rather complex geology of the Naini Tal region, in addition to being both attractive and

instructive, is also of great importance in the regional correlation of the rocks of the Krol Belt.

A number of workers in the past have tried to unravel the structural and stratigraphic complexities of the Naini Tal region but none has fully succeeded in giving a coherent account which could clarify the rather confused geological picture of this area.

The rocks of Naini Tal and its neighbourhood show large-scale folding and faulting, and these structural features have been duly recognised by all in the past. But no investigation has come out with a detailed and systematic geological account of this area. Having realised the great importance of Naini Tal area in understanding the regional tectonic history of this part of the Himalaya, the author took up the present study. His work comprised a detailed mapping of the structural elements and lithology, and his effort has been fully rewarded. This thesis, thus incorporates a full report of his investigations, and its contents reveal all aspects of the geological evolution and importance of the Naini Tal area.

The Himalaya, as a whole has been posing a challenge to the geologists for the last 100 years or more. The

The problems, connected with its origin, age, lithology, metamorphics, structure and mineral resources, have not been fully solved and inspite of the great amount of work being done at present, still only a hazy picture is available.

The Great Himalayan system is classified into the following three longitudinal zones:

1. The Great Himalaya, forming the innermost line of high ranges, rising above the snow-line. The average height of this zone rises upto 6000 metres. The major peaks included in it are Nanda Devi, Nanga Parbat, Dhaulagiri, Kanchenjunga, Gosainthan and Mt. Everest etc.

2. Lesser Himalaya or the middle ranges are closely related to the former but are of considerably lower elevation. Heights generally do not rise beyond 4500 metres. The average width of this zone is about 80 km within which occurs an intricate system of interconnected ranges.

3. Outer Himalaya or the Siwalik ranges, showing a considerable variation in width from 8 to 48 km comprise the last chain of hills before the plains

begin. These ranges form a system of low foothills with an average height of 900 to 1200 metres.

On the basis of geological structure and age, the Himalaya can be divided into three broad stratigraphical belts or zones which do not necessarily correspond with the geogfaphic zones as a rule.

1. The Northern Tibetan Zone is composed of a continuous series of highly fossiliferous marine sedimentary rocks, ranging in age from the earliest Palaeozoic to Eocene age. Except near the north-western extremity in Hazara and Kashmir, rocks belonging to this zone are not known to occur south of the line of snowy peaks.

2. Central or Himalayan Zone consists of the Great Himalayas and the Lesser Himalayas together, and is composed mainly of crystalline and metamorphic rocks - granites, gneisses and schists and also unfossiliferous sedimentary deposits of Purana (Algonkian-Torridonian) age.

3. The Outer or Sub-Himalayan Zone corresponds to the outer or the Siwalik ranges, and is composed predominently of upper Tertiary

fresh water sedimentary deposits. The Outer or Sub-Himalayan ranges are structurally quite simple. They consist chiefly of a series of broad anticlines and synclines. The characteristic tectonic features of the Sub-Himalaya, are the reversed overthrust faults. The Main Boundary Fault which separates this zone from the Central zone is a prominent thrust which extends all along the length of the Himalayas from Panjab to Assam.

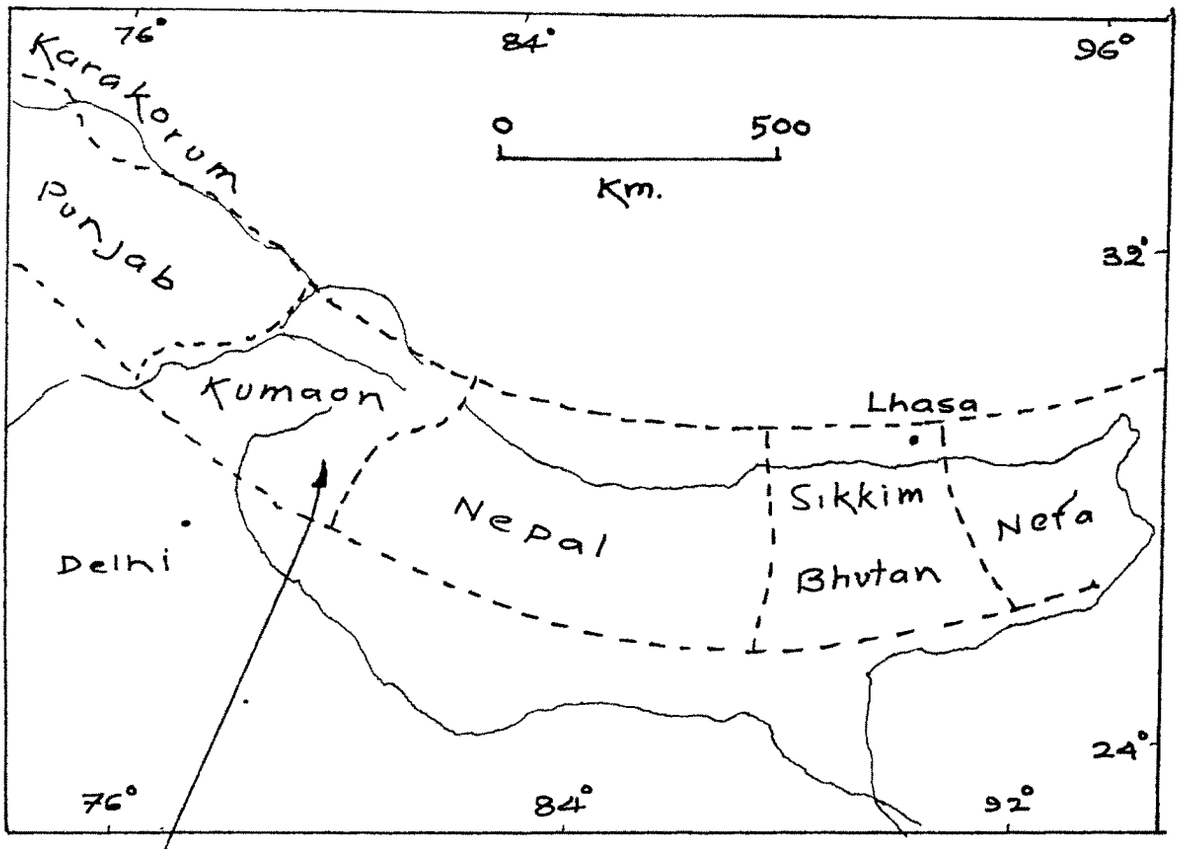
The Sub-Himalayan zone is strictly autochthonous in its position and forms a belt of more compressed isoclinal folds. This is followed by the next zone - a system of recumbent overfolds severed by thrust plane; along which large sheets of mountains have shifted bodily southwards, giving rise to nappe zone of Himalayas.

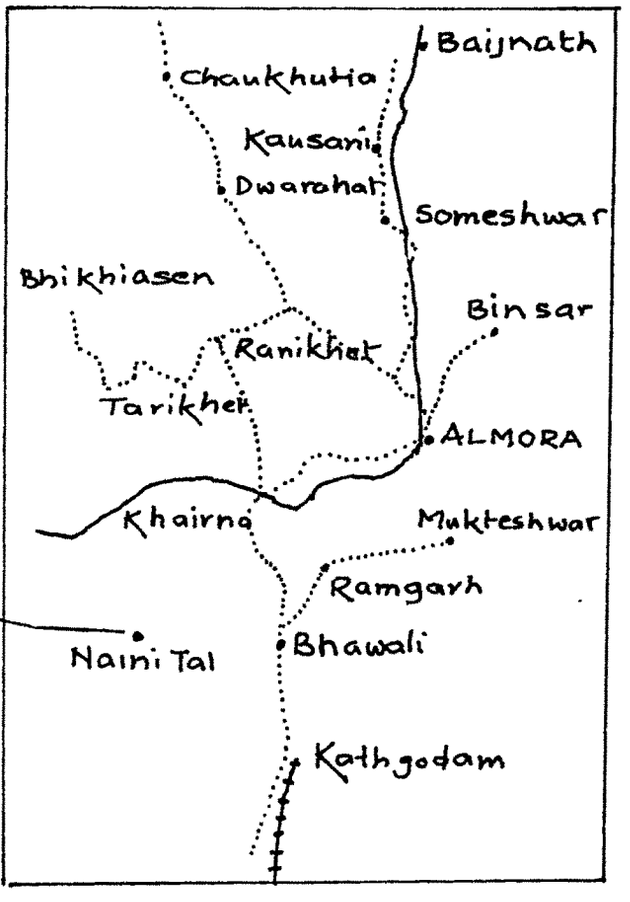
## STUDY AREA

### Location

The study area comprises roughly a rectangular terrain of about 125 sq km area, enclosed by the E. Longitudes 79°22'50" and 79°30' and the N. Latitudes 29°20'30" and 29°26' (Fig.1.1). The famous hill station of Naini Tal is situated almost in the centre of the

Fig.1.1 LOCATION MAP



area (Plate 1.1). In the west, the area extends upto Timalpani village (i.e. slope of Tit-Ka-Danda) while its eastern boundary is marked by Bhowali and Gainthia Sanatorium. Baldiya Khan village lies on the southern boundary while the villages of Harial and Jakh respectively mark the north-western and northern limits.

Physiography

The area shows a highly rugged terrain, and its physiographic features are expressed as hills of varying heights, dissected by a number of valleys of small rivers and nalas together with numerous lakes, all controlled by and related to the lithology and structure of the rocks.

The area typically shows a topography that has been controlled by folding and faulting. The main Naini Tal Lake and the related valley is a combination of syncline and a fault. The area is characterised by numerous steep scarps and narrow straight valleys - both being expressions of large-scale faulting. The craggy and rugged hill tops owe their origin to the limestones of which they are made of. The entire area is further dotted with rock-slides, and many geomorphic features have been found to be due to sliding of large rock masses and accumulation of rock debris.

**PLATE 1.1**

Panoramic view of Naini Tal Hill Station

The elevation of the region varies from 1073 m to 2626 m. The hill of China Peak forms the highest ground. The main summit of China Peak is 2610 m though on this ridge, there is a still higher to the NW of the main China Peak summit, which has a height of 2626 m and is inaccessible. Other prominent peaks are those of Lariakanta (2481 m), Ayarpatha (2352 m), Deopatha (2434 m) and Ghugua (2333 m).

The occurrence of various lakes in this region, is a unique geomorphic feature. In the entire Kumaon, it is only the Naini Tal - Bhim Tal area which contains several lakes, at fairly high altitudes. In the study area, in all, five lakes have been recorded; of these the lake of Nainital (1934 m) is the most prominent one. Others are Sukha Tal (1981 m), Saria Tal (1748 m) Khurpa Tal (1602 m) and Lampokhra (2204 m).

The principal stream that flows through the area is Balia Nala, which originates from the Naini Tal lake and flows SE to meet the Gola river near Ranibagh. The other stream is the Lunwanta Gad which starts from the China pass and flows E to W and meets Baur river. Nihal river, originates from the watershed of Handi Bandi south of Sukha Tal, flows due south, while Jakh river flows from south to north and meets the Kosi river at

Khairna bridge. Deep valleys and gorges have developed at a number of places all along their courses.

The geomorphic evolution of the Naini Tal Landscape has been discussed by the author at length in Chapter VI.

Climate and Rainfall

The town of Naini Tal being is situated around the Naini Tal lake at a height of 1934 metres. On account of this altitude, the weather is quite pleasant and healthy. Average temperatures are 17°C during summer (Mid. April-June) and 3°-4°C during winter (November-February). During summer months, the cool climate of Naini Tal attracts a large number of tourists from all parts of the country. The monsoon by westerly winds, which breaks earlier than the plains, lasts from the middle of June to the end of September, and the area receives about 1500-1700 mm of rainfall annually. Considerable snowfall takes place during the month of January.

Fauna

The forested regions of the area are inhabited by leopards, panthers and black bears. Pigs, jackals and spotted deer are also common. Forests also abound in several species of birds. Ponies, goats, bullocks and

dogs can be named as the common domestic animals. Fish are abundant in flowing rivers, lakes and ponds.

Flora

The vegetation of the area is controlled by cold climate, altitude and rainfall. The flora is typically tropical to temperate, characterised by cedars, oaks and pines. Sal, the Sain etc grow upto the elevation of 1700 metres. Above this altitude higher up, the Chir (Pine) and Banj Oak are common. Among the fruit trees are apple, appricot, orange, lemon, peache, walnut, plum and strawberry. In fact, the area is famous for its strawberries. Besides, figs and kaphal are the common jungle fruits. Potatoes, onions, tomatoes, cabbage, peas, cauliflowers and other hill vegetables are usually grown by the villagers. Summer also witnesses brilliantly coloured alpine species of flowers.

Agriculture

The land available for agriculture is confined to terraced fields made on the slopes of the hills. The higher portions of the hill slopes contains relatively thinner soil cover, while the seirra lands near the bottom of the slopes are extremely fertile. The area around Gainthia being a little warmer than the Naini Tal

proper, is more suitable for growing cereals. Khurpa Tal side, including Runsi area, is the major source of vegetable supply to Naini Tal.

Rabi and Kharif are the two main crops of the year. Kharif includes rice and 'Mandua' while wheat, barley and mustard come under Rabi crop.

Habitation

The population mainly comprises various Hindu communities. A considerable number of Nepalese and Bhotiyas come in search of employment during the tourist season. The local dialect is Kumaoni, though Hindi is spoken and understood by all.

Communication

Naini Tal is situated at a distance of 35 km from Kathgodam, the terminus of NE Railways and can be reached from there, by Government Roadways Buses which ply almost at intervals of 25 minutes. Private taxis are also easily available. Naini Tal is connected to the various hill stations to the N and E by good motorable roads. Ranikhet is at a distance of 52 km in the north, while Bhowali is 11 km to the east. Naini Tal is also connected by all-weather motorable roads to different places in the plains viz. Bareilly, Moradabad and Delhi etc.

SCOPE OF THE PRESENT WORK

The author mapped the area by spending an aggregate period of about 45 weeks in the field during the summer and autumn months of the years 1969, 1970, 1971 and 1972. The area forms a part of the One-Inch Survey of India Topographical Sheet No. 53 O/7 (R.F. = 1:63,360). The mapping was carried out on an enlarged map of scale 10 cm = 1 km.

The rock types of the area, belong to two tectonic units, the autochthonous Siwalik rocks and the Krol nappe rocks, separated by the Krol thrust or the Main Boundary Fault. The Siwaliks of Tertiary age are strictly autochthonous and have not moved from the place of their origin, while Krol nappe rocks have been thrusted over them from the north.

These rocks were mapped in considerable detail and all aspects of geology and geomorphology were studied. Apart from a close study of the various geomorphic features, like scarps, lakes and rock-slides, due attention was also paid to investigate their likely causes of genesis. The geological mapping was done outcropwise, and attempt was made to collect samples and field data from almost all accessible spots. A careful delineation of the various

lithological types was made, and the different formations and bands were traced along and across their strikes.

The author paid special attention to the various linear and planar structures developed in the rocks. He systematically recorded their geometric orientation. In all, he took 400 readings of lineations, 2000 readings of foliations (both bedding and cleavages). The most salient feature of his investigation was a careful observation of the cleavage-bedding relationship in different parts of the study area. It was with the help of this observation that the author could decipher the structural pattern of the area. For working out the structural history, he carried out a statistical analysis of the linear and planar structural elements, by plotting his data on Schmidts' Equal Area Net.

The rocks of the study area are such that their correct lithological identification and nomenclature had to be made mainly on the basis of field observations and megascopic characters. Thin section studies furnished rather limited information. The author has attempted to suggest the lithological associations and depositional

significance of the various formations, but this aspect, he could not study in much detail because it would have gone beyond the scope of the present study.

This thesis which incorporates all his results touches upon almost all aspects of the geology of the Naini Tal area. An attempt has been made for the first time to work out the correct stratigraphy and structure. Having realised that for unravelling the geological complexities of the area a correct understanding of the structural pattern was most essential, the author has laid more emphasis on the structural studies. Accordingly, this thesis has a structural bias and on going through it, the reader will find that it was mainly through structural analysis that the author has succeeded in working out all other aspects of geology including those of stratigraphy and geomorphology.