CHAPTER-2

REGIONAL GEOLOGICAL SETTING

The earliest knowledge about the geology of Himalaya came from the pioneer workers like Oldham (1833a,b); Medlicott (1864, 1876); Stoliczka (1866); Griesbach (1893); Hayden (1904) and others. Among the next generation of workers Pilgrim and West (1928), Auden (1934, 1937); Wadia (1925) and Heim and Gansser (1939) made some of the classical contributions on the geology of Himalaya. In the last two decades several workers from Geological Survey of India, Wadia Institute of Himalayan Geology, Oil and Natural Gas Commission, Universities and foreign geologists from several countries have contributed on the geology of Himalaya. (Gupta, 1972; Srikantia and Bhargava, 1974; Valdiya, 1980; Thakur, 1980, 1981 and others).

2.1. TECTONIC ZONES

The Himalayan organic belt runs for a strike length of 2400 km. and the width of the belt varies from 230 to 320 km. with an average of 270 km. (Fig. 2.1). It has been divided longitudinally into five tectonic zones (Gansser, 1964, 1976; Jhingran et al., 1976).
FIG. 2.1 Structural Zone of the Himalaya (modified after Gansser 1964)

From south to north these zones are as follows:

The Sub Himalaya zone.
The Lesser Himalaya zone.
The Higher Himalaya zone.
The Tethys Himalaya zone.
The Indus Suture and the Karakoram zone.

The principal geological features of each tectonic zone has been described separately, and an attempt have been made here to explain the regional geological setting and structural framework of the area under investigation.

2.1.1. The Sub Himalaya Zone

The Sub Himalaya constitutes the outermost foothills of low elevation. It consists of Tertiary formations which are separated to the north from the Lesser Himalaya zone along the Main Boundary Thrust (MBT). The Himalayan Frontal Thrust (Nakata, 1972 and Gansser, 1980) separates the Siwalik belt from the alluvium of Indogangetic plains. The Outer Himalaya consists of Subathu group (Palaeocene to Lower Eocene), Dharamsala or Murree group Lower Miocene to Oligocene) and Siwalik group (Middle Miocene to Lower Pleistocene).

The Subathu group is marine, the Dharamsala group represent lacustrine to fluviatile and the Siwalik group is a continental molasse deposit. Early Pleistocene folding has affected strata as young as the Upper Siwalik, indicating
post-Pliocene folding phase. The eroded Siwaliks have been affected by over thrusting and steep reverse faulting in the Late Pleistocene times. In Nepal the Siwalik starts are thrust over Quaternary conglomerates and in the Sikkim and Bhutan foot-hills the alluvial fans have been folded, indicating neotectonic activity along Himalayan Frontal Thrust (Gansser, 1974).

2.1.2 The Lesser Himalaya Zone

The Lesser Himalaya zone consists of predominantly sedimentaries together with volcanics and low grade metamorphites. The rock sequence of this zone lies between MBT to the south and MCT to the north. The Lesser Himalayan sequence is largely unfossiliferous except a very few fossiliferous horizons. Lack of organic remains and complex thrust tectonics have given rise to a very controversial stratigraphy of the Lesser Himalaya.

It is not feasible to go into the age controversy and different interpretations of the order of superposition of different tectonic units of the Lesser Himalaya in the chapter. Stratigraphy of the Lesser Himalaya as worked out by Valdiya (1980) is summerised here.

The lithostratigraphic groups of the Kumaun region are divided into five divisions, which are extending from the frontier of Nepal in the west to the border of Himachal in the east. Out of these groups, the Damtha and Tejam
groups constitute the autochthon and also occur in the
tectonic windows of the Lesser Himalaya. The remaining three
groups, namely the Jaunsar, the Mussoorie and the Sirmur are
involved in the thrusting of the Krol nappes. Within the
Damtha group the turbidites of the Chakrata Formation grade
upward and laterally into the flyschoid assemblage of the
Rautgara Formation. Age of the basic intrusives of Rautgara
indicates that the Damtha rocks are older than about 1200
my. and may belong to the Lower Riphean in age. The Chakrata
Formation is southeasterly extension of the Simla slates of
Himachal Pradesh; and the Rautgara Formation is correlative
with Sundernagar Formation of Himachal Pradesh, Kuncha of
west and central Nepal, the Sinchula-Jaintia of Sikkim,
Phuntshobing of Bhutan and Bichom of western Arunchal. The
carbonates shale succession of the Tejara group constitutes
an unbroken succession of Deoban (Gangolihat) and Mandhali
(Sor) Formations.

In the outer Lesser Himalaya, the Jaunsar and the
Mussoorie groups, with restricted capping of the Sirmur
group make up the Krol nappe which is thrust over the
Siwaliks. The Jaunsar group comprises of two formations,
flyschoid assemblage of the Chandpur Formation and ortho-
quartzite and basic volcanics of the Nagthat Formation. The
Nagthat Formation stretches to the north as a vast and thick
sheet of the Berinag Formation to cover the Damtha-Tejam
autochthon. The conformably succeeding Mussoorie group,
developed in an elongated basin and restricted to the outermost outer Lesser Himalaya, consists of the Blaini, the Krol and the Tal Formations. Since no brake has been noticed between the truncated base cut Mandhali and overlying Chandpur Formation, it is inferred that the latter is younger than the Vendian and may belong to the Cambro-Ordovician sequence. The Jaunsar group is thus of Lower Palaeozoic in age. Probably the Mussoorie group covers the Upper Palaeozoic time span.

2.1.3. The Higher Himalaya Zone

The crystalline rocks of the Higher Himalaya have been named variously in different areas such as Vaikrita Group in Himachal Pradesh (Hayden, 1904), Central Crystallines in the Kumaun (Heim and Gansser, 1939), Tibetan Slab (Bordet et al., 1972) and Himalayan Gneiss zone in Nepal (Ohta and Akiba, 1973), Darjeeling Gneisses in Darjeeling and Sikkim (Ray, 1976), Takhtsang Group in Bhutan (Gansser, 1964) and Siang Group in Arunachal Pradesh (Jain et al., 1974). The Higher Himalayan zone is made up of mesozonal and katanzonal crystallines rocks constituting as what is known as the Central Crystallines zone (Heim and Gansser, 1939). This zone is the backbone of the Great Himalayan range and the base of the Tethys Himalaya sequence. The Central Crystallines essentially consists of para and ortho metamorphites together with acidic and basic igneous intrusions.
The gneisses of the Central Crystallines have been dated as 1800-2000 my., the biotite granites have yielded ages ranging for 500-600 my. and the leucogranites have given 15-20 my. ages. These radiometric ages indicate that the Central Crystallines are originally of Precambrian age. The Tertiary ages of micas and leucogranites and metamorphism effecting Mesozoic rocks indicate that the Central Crystallines have been remobilized by Himalayan orogeny during Tertiary time.

The southern or lower margin of the Central Crystallines is defined by Main Central Thrust and the northern or the Upper margin is broadly gradational to the overlying Tethys Himalaya sequence (Gansser, 1974). However in Kumaun Himalaya Thakur (1976) observed a sudden break in metamorphic grade and an abrupt change in lithology between the gneisses of the Central Crystallines and the overlying Martoli Formation of the Tethys Himalaya sequence, thus inferring a tectonic contact between the Central Crystallines and the Tethys Himalaya sequence.

2.1.4. **The Tethys Himalaya Zone**

The Tethys Himalayan zone overlying the Higher Himalaya zone consists of fossiliferous sediments of Late Precambrian to Upper Cretaceous age. The northern margin of the Tethys Himalaya is sharply defined by a thrust against the rocks of the Indus suture zone and the southern margin
is broadly gradational where Palaeozoic starts with independent tectonics pass southwards into competent Precambrian starts with tectonics of the Higher Himalaya zone (Gansser, 1974).

The Tethys Himalaya rocks are occurring in the four separate areas, namely Kashmir-Chamba, Lahaul-Spiti, Kumaun and Nepal. These areas were originally joined into a single major basin as indicated by litho and biostratigraphic affinities. Though complete record of succession from Late Precambrian to Jurassic or Cretaceous is preserved in these areas, several stratigraphic gaps indicating epierogenic episodes have been reported. Tethys Himalayan starts of Kashmir-Chamba, Lahaul-Spiti, Kumaun and Nepal form broad open synclinoria of gigantic dimensions. Their axial traces run in NW-SE direction.

Investigations by Shah and Sinha (1974) in Kumaun and Colchen (1975) in Nepal have thrown some new light on the sedimentation history of the Tethys Himalaya. Their studies of sedimentary structures and trace fossils in Garbyang Formation, referable to the Cambrian, indicate it to be a tidal flat deposit formed under very shallow water conditions. The shallow shelf condition continued from Ordovician up to Lower Cretaceous with some pauses in sedimentation and emergence of land in Hercynian time. A progressive facies change from a typical platform condition to geosynclinal condition commenced from Giumal sandstone.
(Upper Cretaceous) which represents monotonous thick flysch deposits in deep water conditions.

2.1.5. **The Indus Suture and the Karakoram Zone**

The rocks of the Indus Suture Zone is separated from the Tethys Himalaya Zone by a south dipping counter thrust. It consists of three major tectonics units, namely the Indus suture belt, the Ladakh plutonic complex (batholith) with volcanics and the Shyok suture. The Indus Suture zone consists of a remanent of tectonised oceanic lithosphere represented by the Shergol melange and the Nidar ophiolite complex. The Indus Formation consists of sedimentaries of Cretaceous to Eocene age and the Kargil Molasse deposit of Mio-Pliocene age also belong to the Indus Suture. The plutonics of Ladakh batholith and Calc-alkaline volcanics of the Dras and Shyok Formations and the acid volcanics of the Khardung Formation represent a plutonic-volcanic arc which range in age from Early Cretaceous to Oligocene. The Shyok suture zone consist of petrotectonic assemblage of volcanics, flysch and molassic sedimentaries and ultrabasic lenses which are interpreted to represent a relic of a back-arc basin.

The Shyok suture is separated to the north along north dipping Shyok Thrust from the Karakoram zone. The Karakoram zone is made up of three tectonic units, namely the Pangong Tso group metamorphics, the Karakoram super
group and the Karakoram plutonic complex. The Pangong Tso group is overlain by Carboniferous to Cretaceous sequence of Karakoram supergroup. They are intruded by granite plutons of Karakoram plutonic complex.

2.2. LOCATION OF THE AREA IN REGIONAL FRAMEWORK

The Bhilangna Valley falls in the Garhwal sector of Kumaun Himalaya and includes the Central Crystallines, the Outer Crystallines and the Garhwal Group. The Central and Outer Crystallines can be grouped under the Higher Himalaya zone and the Garhwal Group forms a part of the Lesser Himalaya zone. The regional geological framework of the Garhwal Himalaya is similar to that of Kumaun in the east and Himachal in the west. The lithotectonic zones of the Sub Himalaya, the Lesser Himalaya, the Higher Himalaya and the Tethys Himalaya are exposed in the Garhwal Himalaya, but the Trans-Himalaya zone passes through the southern Tibet. A brief stratigraphic correlation and structural framework of the Garhwal Himalaya is described here to elucidate the regional framework of the investigated areas vis-a-vis the regional geology of the Garhwal Himalaya (Table 2.1) (Fig.2.2). In the following description author follows the classification of different tectonic units modified after Valdiya (1980).

In the Bhilangna Valley, the area under investigation, the rocks have been classified into three principal
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<tr>
<td><strong>HIGHER HIMALAYA</strong></td>
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<tr>
<td>Central (Inner) crystallines</td>
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<tr>
<td>Vaikrita Group</td>
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<td>___Vaikrita Thrust (MCT-III)</td>
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<td>Almora = Jutogh Group</td>
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<td>___Jutogh Thrust (MCT-II)</td>
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<tr>
<td>Outer Crystallines</td>
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<tr>
<td>Ramgarh = Chail Group</td>
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<td>_______________ Chail Thrust (MCT-I)</td>
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Fig. 2.2 TECTONIC MAP OF A PART OF GARHWAH LESSER HIMALAYA (modified after Valdiya, 1980)
tectonic units, viz. the Garhwal Group, the Outer Crystallines and the Central Crystallines. Referring to the Table-2.1 described here, the Garhwal Group consists of mainly Berinag Quartzite; the Outer Crystallines are correlatable with the Chail-Ramgarh Group and the Central Crystallines includes the Almora, Jutogh and the Vaikrita groups. The Chail Thrust, separating the Garhwal Group from the Outer Crystallines is referred to as MCT-I. The Jutogh Thrust lying between the Outer Crystallines and the lower part of the Central Crystallines is called as the MCT-II, and Valdiya's Vaikrita Thrust is designated as the MCT-III.