CHAPTER 2

GEOLOGICAL SETTING

In this chapter, the distribution and disposition of various lithostratigraphic units has been described. An emphasis is given to their physical features and mutual field relationships. A broad outline of the lithology and structure of these units is also given in order to elucidate the geology of the area. However, detailed lithology and structure of the various rock types, and different lithologic units have been described in the subsequent chapters. Rocks of the Naraul area have been classified and described under two broad categories comprising the Banjar Group and the Larji Group.

Banjar Group constitutes an assemblage of low grade metamorphics such as slate, phyllite, chlorite schist and interbedded quartzite and basic rocks. This sequence was named as Banjar Series by Das and Srikantia (1962). Later Sharma (1977) renamed it as Banjar Formation. The rocks of this sequence have been traced for about 90 Km along the strike direction, from north of Parvati in the north, to Tiklech in the Sutlej valley in the south. The Manikaran Quartzite, Green Bed and Bhalan Formations form part of the Banjar Group.

The Larji Group which has been named after the village Larji comprises rocks of orthoquartzite-carbonate suite such as dolomite lime stone, quartzite, slate stone and conglomerates. Auden (in Sharma, 1977) was the first to name
these rocks as Larji Series, and Sharma (1977) latter modified it as the Larji Formation. The Naraul, Hurla and Aut Formations form part of Larji Group. These rocks occur as a tectonic window which is surrounded by the Banjar Formation, except in the west, where Jutoghs are exposed. Both Larji and Banjar Group of rocks, form a part of the larger Rampur window. Therefore they represent a unique window in a window structure. Moreover, Larji window forms the core of a large anticlinal structure which is a part of regional Mandi fold structure. As all the lithologic units designated as members by Sharma (1977) are mappable on 1 : 50,000 scale, the author preferred to designate them as formations and respective formations as groups. The various formations of Banjar and Larji Group are described below:

**BANJAR GROUP**

**MANIKARAN QUARTZITE FORMATION** : It consists of about 2500 m thick, predominantly orthoquartzite sequence (Fig.3) which is well exposed between Malana and Parvati valley in the north and Tiklech near Rampur in the south. Quartzite being highly resistant, forms high ridges and peaks in the area. Towards north of Hurla Nal, it forms transverse ridge that extends from Kharli Gulu (3600m) in the east to Talawa (10,621') in the west. This ridge forms the watershed between the River Parvati and Hurla Nal and is about 15 Km across the strike. The quartzite is fine grained, massive and shows variegated colours like white, green and grey. At places it contain bands of hematite which vary in thickness from a few mm. to
a few cms (Pl.1f). Along these bands, rocks cleave easily. Quartzite is highly jointed and along a few joint surfaces, secondary pyrite mineralization is observed in Garsa valley. Quartzite show sedimentary structure like current bedding, which is normal at Raoli, but it shows inversion 1.5 km west of Raoli. In Thela-Jhuni section, near Raoli bridge and further east and to the west of Raoli, quartzite contains concordant band of basics. These bands are amygdaloidal, amygdules being filled with secondary minerals like quartz and epidote alongwith sulfides of copper and iron. Quartzite also shows apophyses of Bandal Granite, which can be observed 0.5 km west of Raoli and at many places on the Raoli-Jhuni section. At the granite contact, quartzite becomes fluffy and schistose in nature.

Manikaran quartzite occurs as a large anticlinal structure of regional dimension, whose core has been occupied by Bandal Granite (Sharma, 1977). The area under study forms the western limb of this folded structure. Manikaran Quartzite comes in direct contact with Khamrada Formation of Jutogh Group, from which it is separated by a tectonic contact known as Jutogh Thrust.

GREEN BED FORMATION: It forms a persistent horizon and has been traced from Parvati valley in the north to the Sutlej valley in the south. It has been named Green Bed Formation because of a predominant green colour and basic nature. Green bed Formation of Banjar Group conformably overlies the Manikaran quartzite on the flanks of the anticlinal structure. Sharma (1977) has suggested a thrust contact
between the two; but the author's observations in Thela-Jhuni section suggest a sharp conformable relation. Typical development of the rocks in Garsa valley is observed in Kotkandi Dhar-Hawai-Sis area.

Lithologically, rocks belonging to this horizon consist mainly of a 1000 m thick sequence of greenish phyllites, schists and basics with bands of massive quartzite (Fig. 3). Basics show an amygdaloidal structure, anygdules being filled with secondary minerals like quartz, zeolite, epidote and calcite. About 2 km west of Raoli on Garsa-Jhuni road section, a basic body is observed which shows sulfide mineralization. Sulfides are observed both in the rock body as well as in the anygdules. Sharma (1977) on the basis of field studies and chemical analysis has suggested that the basics belong to spilite-Keratophyre suite and indicate volcanic eruption in a sedimentary basin of marine environment. Ahmad and Bhat (1987) on the basis of trace and REE studies categorized these basics along with those of Larji Group as volcanic flows. These rocks show gradational and conformable contact with the rocks of overlying Bhalan Formation.

BHALAN FORMATION The Green Bed Formation, towards west grades into slate-phyllite-quartzite horizon with subordinate basics. This horizon is well exposed around village Bhalan in Sainj valley and has been named after the Bahlan Member of Sharma (1977). It has been traced from Jochhni-Phagu area in Parvati valley to west of Banjar in the south. Bhalan
Formation is approximately 200 m thick sequence (Fig. 3).
On Hurla-Jhuni and Larji-Sainj road sections and around Garsa, Bhalan Formation consists of thick beds of slates and grey phyllites which are interbedded with quartzite and basic schist. However, around Bhalan, the rocks are mostly sheeny phyllite with interbedded quartzite bands. Slates are light to dark grey, thinly laminated and are traversed by quartz veins which carry pyrite mineralization. Near the contact with the overlying Larji Group, slates show contortion, Kink folds (Pl. 3f) and development of many sets of linear and planar structures as a result of multiple deformation (Pl. 3e).
Phyllites are sheeny, talcose and golden yellow to grey in colour and like slates are highly deformed. Quartzite is fine grained, white to greyish white in colour and show sedimentary structures such as ripple marks and current bedding (Pl. 1c). These structures can be observed on Garsa-Jhuni road section and Bhalan-Sainj section.
Bhalan Formation has been separated tectonically from the underlying Larji Group. The tectonic contact which brings the Banjar Thrust Sheet (Manikaran Quartzite, Green Bed and Bhalan Formation) to rest over the paraautochthonous unit (Larji Group) is known as Banjar Thrust. The contact is defined by a zone of strong simple shear deformation which can be observed near Garsa in Hurla-Jhuni road section and Spangni-Talara segment of Larji-Sainj road section. The shear zones takes an approximate 90 degree turn about 0.5 km north of Garsa, and abruptly cuts the rocks of Larji Group to the south of the thrust zone. The zone of deformation broadens
towards south.

The intense deformation in the shear zone is indicated by
a) Highly contorted and puckered slates near Garsa;
b) Change in style of deformation;
c) Change in metamorphic grade;
d) Presence of mylonites and
e) Presence of complex vein system throughout the zone (Pl.3b).

LARJI GROUP

NARaul FORMATION : It is the name given to the approximately 2000m thick sequence (Fig.3) of rocks exposed on both the sides of the ridge lying between the village Naraul in the north and village Chashani in the south. It has been traced from Gobha in the north to south of Sainj Khad.
Lithologically, it is composed of shale, slate, phyllite, siltstone, quartzite and conglomerate. Conglomerates consists of rounded to subrounded pebbles in argillaceous matrix of dirty white to grey colour (Pl.3d). Ratio of pebbles to matrix is highly variable. Most of the pebbles have been deformed resulting in an elongation and alignment in the dip direction. Good exposer is found south of Naraul and west of Bhalan. Quartzites are highly compact, fine grained to gritty and are generally pure white or rusty in colour. They are also found to carry disseminations of sulfides. At the top of compact quartzite, a thick band of calcareous quartzite has been observed. This band shows a high concentration of sulfide mineralization (Pl.2a). These
sulfides occur in the form of veins and stringers. Quartz-carbonate ratio in the rock is almost 50:50. Rocks show criss-cross development of veins of carbonate and siliceous material. Slates are thinly laminated and dark in colour. At places, they show rusty weathered patches, indicating the presence of sulfide or iron oxide. Siltstones contain fractured cubes of pyrite, quartz and rarely feldspars and are exposed on top of the ridge between Naraul and Chashani. Phyllites, at places are basic in nature, especially on the ridge north-east of village Chashani. All these lithologic units show facies variation laterally as well as vertically and have been folded into broad anticlines and synclines along with other formations of the Larji Group. Rocks of Naraul Formation show conformable contact with those of the overlying Hurla Formation as observed from Bare Tach.

HURLA FORMATION: Named after the village Hurla Thras, this dominantly quartzite horizon has been traced from north of Hurla to Banjar in the south. Beds of this horizon have been folded into tight plunging synclines and anticlines and can be observed from Bare Tach. It is approximately 200 m thick carbonate quartzite sequence (Fig. 3).

Quartzites are fine to coarse grained and pinkish to white in colour. They show shale-slate partings ranging in thickness from a few centimeters to few meters. Bands of light to dark coloured pink limestone are also found interbedded with these quartzites. Near Spangni, these slates and the limestones become conglomeratic, and show the development of large boudinaged structure (Pl. 2c). Slates contain deformed lenses
North and east of Larji Rest House, volcanic flows with syngenetic sulfide mineralization are observed. Quartzites show well preserved sedimentary structures like current bedding (PI.1a) and ripple marks (PI.1b) which can be observed at Amru on Hurla-Garsa road section, 1.5 km east of Larji in Larji-Sainj road section and at many places in the Hurla-Larji section. With the overlying Aut Formation, these rocks show a gradational and conformable contact.

**AUT FORMATION**: It is the name given to approximately 1000m thick sequence of stromatolitic dolomites (Fig. 3). It has been named after the township Aut, where good exposures of these rocks are observed on both banks of the Beas River. The dolomites are fine grained, massive and grey in colour and show the development of stromatolites (PI.1d). They are well bedded and highly jointed. The best exposures are observed near Aut bus stop, along the Hurla-Larji Briddle path, near Hurla bus stop, along the Hurla-Larji road section and on the hill in front of the Larji Rest House. The dolomites are in direct contact with the rocks of the Banjar Formation. This has been observed 1 km north of Hurla. These dolomites contain angular to subrounded fragments of dolomite and pink and yellowish limestone in a fine to gritty carbonate matrix (PI.8b). In this section, the breccia does not show any sign of intense deformation. Therefore, it is proposed that they are the product of diagenesis rather than thrusting. Near Larji rest House basic flows are observed.
interbedded with these rocks. Ahmad and Baht (1987) has described these rocks, as a part of Proterozoic Mandi-Darla volcanics flows intercalated with the low grade meta sediments of the Sundarnagar Group of the lesser Himalaya.

**BANDAL GRANITE**: It is a granitoid body of batholithic dimensions and has been mapped by Sharma (1977) over an area of 500 sq.km extending from Gāsā valley in the north to Sutlej valley in the south. Owing to the typical development of these granitoids east of Bandal, they have been named after it by Sharma (1977). In the northeast part of the study area, these rocks occur as apophyses in the Manikaran quartzite.

Lithologically, the granite is foliated and shows variations in grain size ranging from fine grained to porphyritic varieties. Phenocrysts in porphyritic granite are mostly made up of potash feldspar and quartz. Other minerals that can be distinguished in hand specimen are biotite, muscovite, and at places crystals of tourmaline and fluorite.
Stromatolitic dolomite
Sedimentary breccia
Sandy limestone
Current bedded quartzite
Oolitic limestone
Calcereous quartzite
Slate siltstone
Massive quartzite
Gritty phyllite
Pyrite bearing quartzite
Slate phyllite
Conglomerate
Foliated granite (intrusive)
Pyrite bearing phyllite
Quartzite
Phyllite
Quartzite
Basic phyllite
Quartzite
Sulfide bearing traps
Quartzite
Current bedded hematite bearing quartzite
Sulfide bearing metabasics
Quartzite

Fig. 3 Lithostratigraphic column along the Hurla-Raoli road section