CHAPTER I

INTRODUCTION

1.1 Preamble

Mountain belts created by continent-continent collision are perhaps the most dominant geologic features of the surface of the Earth (Dewey & Burke, 1973). Lots of researches are still going on to give emphasis to understand the genesis of this orogenic system since the development of plate tectonics in nineteen sixties, owing to the fact that continent–continent collision is the dominant and the most efficient process in forming the super continent, which profoundly affect the geologic and biologic evolution of the Earth. The youngest, loftiest and the most mysterious continent-continent collision belt on earth is Himalayan-Tibetan orogen, occupying the east-west trending high altitude Himalaya and Korakaram ranges in the south and the vast Tibetan plateau to the north. This orogenic system was largely created by the Indo-Asian collision over the past 70-50 Ma and is a part of the Greater Himalaya Alpine system that extends from the Mediterranean sea in the west to the Sumatra arc of Indonesia in the east over a distance of more than 7000 Km. This extra ordinary long and complexly amalgamated belt was developed by the closure of the Tethys oceans between two great landmasses- the Paleozoic Laurasia to the north and Gondwana to the south (Hsu.et.al.1995, Seugar and Matal, 1996).

The 2500 km long, arcuate belt of the most vibrant South East Asia is traditionally named as Himalaya (Nagadhiraj of Kalidasa) stretching between two structural syntaxes- Nanga Parbat (8125m) on the west and Namse Barwa (7782m) on the east (Fig. 1.1). The Himalaya can be subdivided into western, central and eastern
sectors and the present study area broadly belongs to eastern Himalaya. The Himalayan-Tibetan orogen and its neighbourhood regions in East Asia are the ideal places for the study of continent-continent collision for several reasons. First, the orogen is active so that much geologic relationship can be demonstrated directly using the methods of neotectonic studies. Second, the plate boundary history is well known so the cause of intracontinental deformation can be quantitatively defined as a time-dependent, boundary value problem. Third, collision process has produced a variety of geologic features such as large scale thrust, strike-slip and normal fault system, leucogranitic magmatism, widespread volcanism, regional metamorphism and formation of intracontinental and continental margin oceanic basins.

![Fig. 1.1 Generalised tectonic divisions of the Himalaya after Gansser, 1981.](image-url)
1.2 Regional Geological Setting

The Himalayan-Tibetan collision zone is exposed in Arunachal Pradesh, of NE India. The Arunachal Himalaya could be divided into four distinct physiographic segments, viz; Himalayan ranges, Mishimi hills, Naga-Patko ranges and Brahmaputra plain (Kumar, 1997) (Fig. 1.2). The Himalayan ranges, which form the easternmost part of Great Himalaya, continue up to Siang Valley and are further subdivided based on the relief into sub Himalaya, Lesser Himalaya, Higher Himalaya and Trans-Himalaya from south to north respectively. Each of these segments has a different geology and tectonic history and made up of rocks ranging in age from Pleistocene to Proterozoic.

Since the days of Blanford and Meddlicott (1879) and Heim and Gansser (1939) the Himalaya is classically divided into four tectonic units (6 tectonic units after Ramakrishnan and Vaidyanadhan, 2008) showing lateral continuity namely:

a. The Sub Himalaya which thrust along the Main Frontal Thrust (MFT) over the Quaternary alluvium;

b. The Lesser Himalaya thrust over the Sub Himalaya along the Main Boundary Thrust (MBT);

c. The Central Himalayan Sequence which is the backbone of Himalayan orogeny at higher structural level and thrusted over Lesser Himalayan Sequence along Main Central Thrust (MCT) and

d. The Tethyan or Tibetan Himalaya separated from the Higher Himalaya by low angle normal fault called South Tibetan Detachment System (STDS) or Trans Himadri Thrust.
e. The Tethyan Himalaya is bounded by the 50-60m wide Trans Himalayan Indo-Tsangpo Suture Zone in the North.

f. The Trans Himalayan batholith forming a large linear plutonic complex of I-type pluton.

The general Himalayan trend through Darjeeling-Sikkim-West Arunachal Pradesh areas is ENE-WSW to NE – SW, which swerves to N-S along Bame Fault, west of Siang Valley. The Himalayan trend along Dibang-Lohit valley is NW-SE. The swerving of these trends is attributed to the Himalayan orographic bend or syntaxial bend by many earlier workers (Wadia, 1957; Gansser, 1966, 1980, 1991; Nandy, 1976). But the actual syntaxial bend is reported at Namche Barwa of Tibet by Burg et.al. (1997). Thus, the NW – SE trending block in Dibang-Lohit valley is termed as Mishmi block (Nandy, 2001). NW-SE trending Mishmi granite-granodiorite complex along with associated metamorphics and ultramafites are believed to continue towards south in Burma/Myanmar (Nandy, 1976; Acharyya, 1980; Goosens, 1978). Sinha Roy (1976) correlated the Mishmi Complex to the Cenozoic Kyi Chu granite of South Tibet and part of the granite in Ladak and Karakoram in northwestern Himalaya. Further, he opined the Tidding suture of Lohit-Dibang valley is in continuation with the Indus-Tsangpo suture of northwest of Arunachal Himalaya.

There is no general consensus of agreement in correlation of the major lithotectonic belts from western Arunachal Pradesh forming the eastern part of Great Himalaya to the Mishmi block towards further east. One school of thoughts believes that the western zones do not continue into Mishmi block (Thakur and Jain, 1974, Srikantia 1988) and another school of thoughts argues a simple continuation of the western units in response to the syntaxial bend (S.Singh, 1993). The Mishmi block is
believed to be separated from the eastern part of Great Himalaya by the Mishmi thrust/Miju thrust (Evans, 1964; Nandy, 2001). The Mishmi block from south to north is made up of gneiss, metasedimentaries, mafic-ultramafic association (Tidding suture) and granite-granodiorite assemblages of Lohit plutonic Complex (Thakur, 1986).

The N-S trending Naga-Patkoi ranges are the continuation of well-known Indo-Myanmar Mobile Belt (IMMB) in the southeastern part of Arunachal Pradesh. They are made up of Paleogene-Neogene sediments over the concealed Precambrian basement of Shillong plateau. In northeast India, the Mishmi block and Indo-Myanmar (Burmese) are occur in close juxtaposition along the EW Noa Dihing Valley, Arunachal Pradesh and upper Hukung Valley, Myanmar. WNW-ESE Mishmi thrust dipping to NNE marks the contact of these two tectonic domains (Nandy, 2001). Therefore, the Arunachal Himalaya takes a sharp turn and continues further SE merging into Indo-Myanmar Mobile Belt (IMMB) is not advisable.

Quaternary sediments characterised by the post Himalayan orogeny is observed in the Brahmaputra plain. The valley is bounded by Himalayan ranges in the north, Shillong plateau, IMMB to the SE and Mishmi hills in the northeast. The plain trends in NE-SW to E-W direction and merges with the Indo-Gangetic plain further west.
1.3 Tectonic block from south to north

The Mishmi Block can be divided into 3 sectors namely (a) Siang Valley Sector in the west, (b) Dibang Valley Sector at the central part and (c) Lohit Valley Sector to the east. In the Arunachal Himalaya, Mio- Pliocene foredeep molasses (Siwalik) of the Sub-Himalayan zone, followed to the north by continental and marine Gondwana sequence which are thrusted over the Siwaliks along a moderate to steep northward dipping thrust (Main Boundary Thrust- MBT). Gondwana outcrops continue as a thin belt upto Siang river section in Arunachal Pradesh and are tectonically overlain by the orthoquartzite-dolomite sequence of Buxa of the Lesser Himalayan zone. The Lesser Himalaya lithotectonic units in turn are tectonically overlain by the Central Crystallines along another extensive north dipping thrust (Main Central Thrust- MCT). In the eastern part of Arunachal Pradesh other than Himalayan sequence of the Mishmi tectonic block, some parts of Indo- Myanmar Mobile Belt are also present in Changlang-Tirap area. The Himalayan sequence of the lower reaches is continued upto Siang valley, but it pinches out in Dibang valley. Mishmi block seems to be thrusted over the Himalayan sequence along Mishmi thrust and well exposed in the north of Siang valley, Dibang valley and Lohit valley.

Fig. 1.3 District map of Arunachal Pradesh, India. Two inset maps of India and Dibang Valley Districts are shown.
1.4 Study area

The area under investigation is a part of Mishmi Hill and geographically falls in the Lower and Upper Dibang Valley Districts of Arunachal Pradesh (Fig. 1.3). These two districts are named after Dibang River, one of the three main tributaries, viz Dihang (Siang), Dibang and Lohit Rivers of the mighty river Brahmaputra. The area is included in the survey of India toposheet numbers 82 P/16, 82 P/15, 82 P/14. The study area is shown in the degree sheet and is bounded by Latitudes 28°48'00" N to 29°04'00"N and Longitudes 95°45'00" E to 96°00'E (Fig. 1.4). It covers an area of 100 sq. km and located in between Roing to the south and Anini in the northern corner of Arunachal Pradesh and forms a part of the Dibang valley district.

The area exhibits different lithotypes from the river bed to the high mountain range. Exposures are well observed along the road sections or new road cuttings. Good exposures of rocks are also well observed along some river bed section, like Ithun bridge section (N28°22'27": E95°55'54"), Ithun river- Dibang river confluence zone (N28°29'27": E95°49'37") and river section near Anini. There are mainly two geographical heights Mayudia pass (2627m) and Anini (1677m). Mayudia pass is mainly confined to mafic-ultramafic rocks, whereas the Anini area in mainly situated on Lohit Granitoid Complex (LGC). Exposures in the mafic-ultramafic area and granitoid area are very good relative to the metasediments of the Dibang Group. Due to extensive shearing and thrusting some areas are vulnerable to sliding zone and the road communication (single road tract) is disrupted in totality during rainy seasons till BRO (Border Road Organisation) clears the tract.
Fig. 1.4 Degreesheet of Dibang Valley districts
From January middle to mid-February heavy snowfall is observed around Mayudia Pass and disrupt the communication system (Fig. 1.5) from defence and strategic point of view because of International border the road needs extra care and the Government of India has taken initiative to convert the present road into two lane system and work is in progress.

Fig. 1.5 A panoramic view of the snow covered Mayudiya Pass during winter.

Fig. 1.6 A satellite imagery of Western Arunachal Himalaya, Mishmi Himalaya and adjoining Indo-Myanmar Mobile Belt
1.5 Aims & methods of Research

The broad aims of the research reported herein are:

1) To prepare a lithological traverse map of the study area
2) To workout the structural framework and their interferences (minor & major structures) of the area.
3) To determine the petrogenetic evolution of the Mishmi Block with respect to Dibang valley area from petrographic and petrochemical studies.
4) To construct a tectonic model of the Mishmi Block in Himalayan tectonics.
5) Correlation of the area in respect to global tectonics in other parts of Himalaya.

The present work is a part of a collaborative project between Geological Survey of India (GSI) and Gauhati University sponsored by DST. The work is basically field based with detail structural and microstructural works with extensive petrological and petrochemical input. Traverse mapping as well as sector mapping has been done as per requirements. Field mapping is assisted by satellite imagery study using Google earth and Global mapper software to delineate the major lineament or discontinuity zone. Geological maps were drafted using software at the Department of Geological Sciences, Gauhati University. Structural analysis has been done using structural software like GeOrient, Rhode’s six-strain analysis. Whole rock geochemistry of the few rock samples by XRF technique has been done from Chemical Laboratory, GSI, Nagpur. EPMA study is mainly done in EPMA Laboratory, GSI, Kolkata for petrochemical study. Further the analytical data has been processed by MINPET software in GSI, Kolkata.
1.6 Terminology & Convention

Rock names are given based on physical properties, field criteria, petrographic observation and geochemistry and are used throughout the thesis. Although in some circumstances purely chemical definitions may be more appropriate. Field definitions are generally adequate and provide continuity through all phases of study. Most rock units have been metamorphosed, but are generally referred to by their precursor name. For instance, metamorphosed ultramafic are referred to as ultramafic, whereas precursor cannot be conclusively identified, typical metamorphic terms are used. Standard chemical conventions are used, and comparative analyses for normalisation are referred to. International standardised structural notations and symbols are used.

1.7 Thesis Organisation

Chapter 1 is Introduction. In chapter 2 geological overview of the studied area is described and in addition earlier works done on this area, has been discussed. Field relations of different lithounits are also discussed in detail. In Chapter 3, Structural work has been described including mesoscopic, macroscopic structures, sectorwise structural analysis, identification of structural elements and their interferences phase wise to establish the structural history of this area. In Chapter 4 detail petrography, petrochemistry and geochemistry of different lithotype under different geological formations, groups are described and interpreted in order to determine the geological conditions during their formation. Correlation between deformation and metamorphism is worked out to establish the Tectonometamorphic evolution of the Mishmi block in Chapter 5. In Chapter 6 Tectonostratigraphy of the area is described. The conclusion and discussion along with a more realistic model in this part of
Himalaya is dealt in Chapter 7. References are given in the last part of the thesis. References are cited as far as practicable.