CHAPTER II

STRUCTURE AND TECTONICS OF MANIPUR AND ADJOINING AREAS

2.1 INTRODUCTION:

In order to understand the regional tectonic setup of Manipur and adjoining areas, attempts are made to compile the geological data from various workers. The geographic extent of the subduction process encompasses large geographical area. Therefore, the scope of the present studies extended beyond Manipur. The Indo-Burman Ranges form a folded mountain system with slight sigmoidal shape. IBR abuts against Shillong Plateau in NW near N25° latitude whereas in NE in Mishmi hills at E97° longitude. It spreads to 300 km width around Tripura at meridian 24°N and further south it tapers to 15-20 km. near Café Nageris. Dasgupta (1977) linked the tectonics of IBR with Indonesian arc through Andaman and Nicobar Archipelago. Mathur and Evan (1964) and Das Gupta (1977) recognized three major structural zones in Assam-Arakan belt. From east to west, an eastern zone of argillites with varying degree of metamorphism and ultrabasic intrusives, central zone of Disang and
Barai sediments and lastly a belt of Schuppean in north west in imbricate thrust. The tectonics of IBR, Bay of Bengal and Arakan coast is deemed to be the result of collision since Miocene times (Bender, 1983).

It is believed that the collision process started between oceanic extensions of Indian Plate with its neighboring plate around Mid-Cretaceous. The sediments of shelf area and collision zone have been thousand kilometers apart. The gap was decreased during late Eocene between the shelf and peripheral tectonic basins. The configuration of colliding Indian plate and Myanmar continental mass started at the northern end and progressively extended southward. South of Kohima, the continental blocks remained still significantly apart for the Disang to plunge down into shrinking gulf and from the tectonic frame for Kohima Synclinorium which open upto into wide expanse, now represented by Cachhar-Mizoram-Tripura fold belt and Surma valley cum residual Bengal basin. Towards the east and south, all the late Eocene to Pleistocene sedimentations were thus confined to a already existed shelf zone (Shillong-Mikir Plateau edge and submerged basement spur), deep marginal basins of sedimentation (occupied by Naga-Schuppean zone) and Kohima synclinorium and the receding Indo-Myanmar gulf (occupied by Surma valley-Chittagong hills and residual Sylhet and Bengal basin).

Indo Burman Ranges have longitudinal tectonic provinces, which are characterized by distinct lithotectonic assemblages and structural style. The dominant thrusts which demarcate various zones from a NNW trend in south at latitude 19°N and finally sways to NNE north of 24° latitude. They display a varying component of movement and are characterized by a change from wrench to thrust type along the fault trace (Fig 2.1). The prominent dislocations/thrusts are Kadi-Disang, Hail-Hakalula, belt of Schuppean consist of Naga-Disang thrust and Eastern Boundary thrust.
Fig. 2.1. Lithotectonic map of the study area (after D.R. Nandy, 1999)
2.2 *Paleogene Stratigraphical Account:*

At around Mid-Cretaceous, when collision between the oceanic extension of Indian plate with those of its neighbors first started, the sediments of the shelf areas and the collusion zones would have been several thousand kilometers apart. But, as the continental part of India closed in, this gap slowly decreased, so that by around Late Eocene the shelf and the peripheral tectonics basins had come to be reasonably close to each other.

The configuration of the colliding Indian and Myanmar continental masses were such that the collision started at the northern end progressively extended southwards. South of Kohima, the continental blocks remained still sufficiently apart for the central Disangs to plunge down into the shrinking gulf and form the tectonic frame for Kohima Synclinorium, which opens up into the wide expense now represented by Cachhar-Mizoram-Tripura folds and Surma Valley cum the residual Bengal basin. Towards the east and the south, all the late Eocene to Pleistocene sedimentation were thus confined to:

a. The already described shelf zone (i.e. both around the Shillong-Mikir Plateaux edge, as well as, the submerged basement spur)

b. Deep marginal basins of sedimentation, now occupied the Naga-Schuppean Zone, and
c. The Kohima Synclinorium and the receding Indo-Myanmar-Gulf, now occupied by Surma-valley-Chittagong hills belt and the residual basin and Sylhet and Bengal.

In the compressional regime provided by the collusion zone, any basin tends to develop

- a shelf zone adjoining the land mass of the subducting plate
- a Slope leading off from the shelf to the basin deep
- the basin deep where concurrent sinking of the basin floor permits most of the sedimentation to take place
- a mobile rim, which is more immediately affected by the collusion zone mountain building for its tectonic patterns and sediments
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The subduction and consumption of large expense of one plate by another would seldom be achieved in multiple phases. The basin deep sediments of one phase would be folded, faulted and raised as an accretion to the growing collision zone mountain mass. Simultaneously, a new foredeep or trough would form in the front and a new cycle would begin.

As a result, the geotectonic regimes, which influence and control the sedimentation pattern keep on shifting from one cycle to other. The Indo-Myanmar basin was no exception. In the vicinity of Assam, the first of these cycles contributed to the formation of the Eastern Disangs, the second to the Central Disangs, the third to Barails, the fourth to the Surma-Tipam-Giru Jans, fifth to Dupitilas and Namsangs, the sixth to upper Dupi Tila-Dihing-Dhekiajulis and the seventh to the older and present day alluvium. Each has its, own geotectonics realms with their specific sedimentation pattern.

2.3 TECTONIC SIGNIFICANCE OF KOHIMA SYNCLINORIUM:

Kohima synclorium lies to the southwest of Naga hills belt of Central Disang uplift. It occupies an area where the colliding plates were bringing the Indian continental mass at an angle towards Myanmar.

Initially it constituted a funnel shaped wide expense of the intervening sea, narrowing towards the NE. As the collusion progressed, the successive movements narrowed it down further to its present configuration.

At some stage during this process, a submerged basement shelf developed west of Tripura, splitting up the basin into two wide segments. The eastern component lay close to the collusion zone and part took of collusion zone tectonics by forming a series of long geosynclinal trough in front of the earlier uplifted themselves.

The first of these seems to be reflected by the Barails of the eastern limb of the Kohima Synclorium. This is bounded by Tapu thrust to the east and the Kadi fault
to the west. Kadi fault forms the western limit of Barail outcrops in this region. To the west lies a wide belt of north-south folds, which exposed primarily the Surma in their core and some younger rocks along the synclinal valleys to the north and the west.

Tectonically, this wide belt of N-S folds seems to be divisible into two southerly tapering zones. Both are tightly folded and faulted to the south, but open up fan-like to the north. The western zone (and particularly its synclinal valleys) does so much more than the eastern zone.

2.4 Regional Framework of IMR:

Regional tectonics framework of the area is based on the visual interpretation of satellite data have led to recognition of a number of major dislocations, which largely control the tectonic framework, and deposition of various lithotectonic assemblages (Fig. 2.1). Seven such thrust/faults of gigascopic and megascopic dimension referred as Disang, Hail-Hakalula, Kadi, Lainye-Zunki, Moya and Luvvari are recognized. Lainye-Zunki-Moya thrust alignment with its share of ophiolitic suite and mélange represents an intercrustal suture of gigascopic magnitude. Disang-Hail-Hakalula and Disang-Kadi fault alignment of the other hand, with their distinct control on distribution of Hyschoidal and molassic assemblages are suggestive of superorder intracrustal distension. This dislocation running parallel to the regional strike of the orogen permit its zonation into various geotectonic provinces. They are recognized as

i. Outer Molasse zone (west of Disang-Kadi fault alignment)
iii. Ophiolite and Mélange (between Moya and Lurari thrust)
2.4.1 Outer Molasse Zone:

Outer Molasse zone structure from Tripura-Cachhar fold belt in southwest to Naga foothills immediately east and northeast of Shillong-Mikir massif. The western flank of Naga foothills is traversed by several thrusts, each of which loose displacement upsection. These thrusts eventually die out of progressive transfer of the net slip to a fold at moving edge of the sliver or by distribution among several splays to form a stack of imbricate thrust slices, referred as Belt of Schuppen. A number of such upwards or fold having disharmonic relationship with underlying structures are known from the outermost and inner thrust of Naga and Cholimsen respectively. This zone of intense imbrication, bound on the either side of Naga and Disang thrusts terminates around Haflong as a result of sinistral movement along a lateral ramp of Naga thrust which bring about the convergence of bounding thrusts. Further southwest, their unified trace can be followed for some distance along Haflong thrust before it branches along sub-latitudinal Dauki fault and NE-SW trending Hail-Hakaluala lineament/wrench. A notable feature in the manner in which the ENR structural trend swing to NE and NNE direction further south along a number of wrench faults with a right lateral direction of movement. A series of submeridional long linear and enechelon antiformal structure dominate the southwestern part of Outer Molasse Zone, west of Disang-Kadi fault alignment. Evidently the structural style here is at total variance from the imbricate system of northeastern part e.g., Belt of Schuppean. Such enechelon belt of folds and faults has been interpreted as resulting from movements — a rotational couple — on deep wrench faults that do not break directly the sedimentary veneer (Spencer, 1977).

Some of the antiformal structures mapped are tight and show moderate to high photo dips along its axial trace, while synforms being much wider are characterized by low to moderate attitude. Such linear antiforms with flanks of sharply upturned beds are considered to result from upward and outward diverging strands on a wrench
fault with reverse separation (Harding & Lowell, 1979). It is pertinent to mention that
in some antiform e.g., Kalphundai, Ramphan etc. may very high dips (>80°).

Faults trending NNE-SSW and slightly oblique to the general fold trend are
inferred to exercise a definite control on the enchelon arrangement of folds. The Kadi
fault which runs through the entire area in NNE-SSW to NE-SW direction, until it
ends up as a splay southwest of Kohima and nearly coincides with alignment of
Disang Thrust, has all the characteristics of a wrench with a dominant dextral slip.
The important and notable features for its corroboration as a major strike slip fault
are:

i. Partially apparent discontinuous character and splaying tendency at
various places along fault trace.

ii. Location of fault between two broad linear and subparallel synformal
structure viz Tamenglong and Irang synform.

iii. Sharply upturned beds on either side of the through going fault
giving the structure on antiformal morphology.

iv. Apparent dextral movement direction of fault block.

v. Normal and reverse topography displayed by each block across the
fault respectively.

Transverse faults trending ENE-WSW to E-W and with a right lateral
movement direction appear to offset the axial trace of antiforms and synforms. The
Irang fault is indicative of large scale wrenching especially the former across whose
trace the dominant submeridional structure trend of folds and faults seems to
terminate.

2.4.2 Naga Chin Hill Flysch Zone:

The Naga-Chin hill Flysch Zone lying to the east of Disang-Kadi fault
alignments, characterized of Disang and Barail group of sediments, characterized by
fairly persistent linear NNE-SSW to NE-SW trending folds, faults and thrusts. This
zone referred variously by earlier workers as inner zone of Disang and Barail, Naga-
Patkoi orogenic belt and Kohima-Patkai Synclinoria and Manipur-anticlinorium
(Evans & Mathur 1964, Das Gupta 1977) is marked by a series of antiformal and synformal reversals and a zone of pronounced imbrications to the east constituted of Kodom, Lainye and Zunki thrust. Based on flat-bottomed synforms (Irang, Khoupum, Kangchup etc.), the southwestern extension of Kohima synclinorium is inferred in east of Kadi fault. It is also marked by the topographic reversal with synformal crest occupying hilltops and antiformal/fault the valley, in sharp contrast with normal topographic order encountered in outer Molasse Zone west of Kadi fault. The faulted antiforms/ faults, which intervene the synforms, are invariably formed of sharply upturned flanks. Some of these antiformal and synformal structures are also seen to terminate against NNW-SSE to NW-SE trending transverse faults with left lateral movement direction.

2.4.3 Ophiolite and Mélange:

East of the synformal trends a major faulted antiformal structure, runs all along the Naga-Chin Hill Flysch Zone close to western edge of Manipur valley. The structural trend of Mao thrust is evidenced by the truncation of lithological bands at acute angle along its long and linear structural trend. It is a low angle thrust, which extends from Churachandpur (south Manipur) to Tapu (Nagaland).

In the imbricate zone of Barail, Disang and Meluri slivers around Lambui, Ukhrul and Chingai occur the sub-rounded to lenticular and elliptical exotics of varying dimensions from over 15 km² to few square km. This exotic includes limestone, chert, silicified recrystallised rocks, sandstone and grit of varying fossil assemblages. The Melluri, Disang and Barail sediments of Naga-Chin Hill Flysch zone, are thrust over to the east by dismembered and tectonised serpentinites, volcanics cumulates, cherts and limestones. In the eastern Manipur hills narrow slices of serpentinites and associated members of ophiolitic suite occur within Disang and Barail like sediments, along Palel-Moreh sector. The contact between ophiolite and sedimentaries is always sharp and tectonise and no evidence whatsoever, of any
backing effect is observed. Fracturing and pulverization along with growth of secondary veinsions along induced weaker planes marks the site of such tectonic contacts. Further east of ophiolitic suite and associated sedimentaries are limited by Laruri thrust, which brings the mesograde metamorphics of Naga Metamorphic Complex to override them.

2.5 **Indo Myanmar Mobile Belt**: 

The Patkoi-Naga-Manipur-Chin-Arakan Yoma regions form a westerly convex arcuate belt, which in NW-SE trending at its southern extreme and ENE-WSW trending at the northern end. This arcuate belt representing Outer Arc Ridge in an arc trench setup comprises Eocene-Oligocene flysch and subflysch scarped off from the leading edge of Indian plate along with narrow-strip of older Paleozoic-Mesozoic sediments, patches of metamorphics and dismembered ophiolites, which are intimately associated. These occur along the Eastern Boundary Thrust (EBT) zone.

To the east of Eastern Boundary Thrust (EBT) occurs the 200 km wide and 1400 km long Paleogene-Neogene central Myanmar sedimentary basin which is bounded to the east by the N-S Shan-Sagaing Fault and Sino Myanmar high land. This basin is medially traversed by westerly convex arc that divides the basin into western forearc and eastern backarc basins.

At the close of Oligocene, two well-known molasses basins (Tipam and Surma Basins) have developed on the foreland side of Indo-Myanmar-Tectonogene. The Tipam molasses sequence (4100 m) have developed near the northern extremity in upper Assam foredeep, in front of raised outer arc ridge, is wedged between the Indo-Myanmar belt and north eastern protrusion of the Indian shield producing imbricate thrust structures. The fold belt generated by the sub-flysch-molasse (4000 m) of the Surma basin is on the other hand, developed in a relatively open basin lying south of
Meghalaya Plateau. Sediments in both the basins were deposited with a pronounced unconformity at the base.

2.6 **Spatio-Temporal Emplacement of Ophiolites:**

Three possible mechanisms for generation and subsequent emplacement of the Indo-Myanmar Ophiolites have been put forward, *viz.*

i. obducted Indian ocean lithosphere  
ii. transducted oceanic crust  
iii. exposed floor of the forearc basin.

Implicity or explicitely, this has been suggested by various workers (Nandy 1980, 1983, 1986; Mitchell 1981, 1985, 1986; Acharya *et al.* 1989). Mitchell suggested an eastward under thrusting of a Jurassic spreading center located west of the Shan-Tenasserim block followed by detachment of the ophiolite slab from the subducting oceanic lithosphere. Acharya proposed that the ophiolites emplacement within the accretionary prism was caused by collision between an ocean island chain and subduction zone which also resulted in temporary blockage in subduction; steady state convergence was reestablished after slabs of oceanic crust were scraped off from the down going Indian Plate which later got under plated at the leading edge of overlying Myanmar plate. These suggested mechanism of Ophiolite generation and emplacement are, however, not consistent with the fact that the Indo-Myanmar-Andaman Ophiolites represent a narrow, newly created intracontinental oceanic crust.

i. Banerjee *et al.*, (1980) proposed that the Indo-Myanmar and Andaman-Nicobar ophiolites are tectonically transported as allochthonous terrain within the older metamorphics. A similar mechanism has been suggested for Zambales Ophiolite bordering the Luzon forearc basin, Philippines (Bachman *et al.*, 1983). Large-scale horizontal translation through strike-slip faulting and docking at the collision front is implicit in this model and is also possible within an environment of highly oblique convergence. There, is however, no evidence of transcurrent movement along the eastern slope of outer arc ridge where Ophiolites occur within the accretionary prism (Das Gupta and Nandy, 1995).
ii. Ophiolites may also occur as exposed ophiolites basement in the outer part of the forearc basin in northern California (Dickinson & Seely, 1979) or the Luzon basin in Philippines (Bachman, et.al., 1983), where fragments of oceanic crust occur between the fossil trench slope break and forearc basin. This setting, arguably in most cases, of marginal ocean basin origin (Hamilton, 1988).

The Indo-Myanmar and Andaman ophiolites broadly represent marginal ocean basin crust has been suggested on the basis of geochemical studies of the volcanics in the ophiolites suites (Sengupta et.al., 1989; Vohra et.al., 1989). The 100 km or so wide leading edge of overriding Myanmar plate has been an oceanic lithosphere flooring the forearc marginal basin. Mid-Jurassic-Early Cretaceous rifting and splitting of eastern Myanmar continental margin (and older arc) and migration of the western part (that included slivers of pre Jurassic rocks) away from Eastern half by diffuse or irregular spreading (Hamilton, 1988) generated a thin oceanic crust which constituted the leading edge of the overriding Myanmar plate that rammed on to the thick accretionary prism of the subducting Indian plate by early mid Eocene. The rifted and transported fragments of the Myanmar continental arc crust (Naga Metamorphics, Kanpetlet schist, Triassic schist etc) and the ophiolites from part of the accreted terrains within the accretionary prism (Das Gupta and Nandy 1995). Thus, the Indo-Myanmar ophiolites are not part of the underplated oceanic crust of the leading edge of the Indian plate below the forearc trough; rather with continued subductions of Indian plate below the central Myanmar basin upturned the outer ridge sediments by the late Oligocene along the Eastern Boundary Thrust.

It is, however, possible that the time of generation, accretion and thrusting of the ophiolites is likely to vary along the strike of the arc. Ophiolites are likely to vary along the strike of the arc. Ophiolites of Indo-Myanmar, Andaman and also of western Sunda arc represent accreted forearc basin crust.