CHAPTER X

SUMMARY AND CONCLUSIONS

The area of this geological investigation lies between Laitkor and Mawkyndur covering about 140 square kilometers of the eastern part of the East Khasi Hills and western part of Jaintia Hills district of Meghalaya and is an integral part of the Shillong plateau. The study area, which is covered under the Survey of India Toposheet No. 78 0/14and 83c/2 is geologically mapped on a scale of 1:50000.

The main rock types of the area are the metasediments of the Shillong Group, the metabasic igneous rocks and the porphyritic granite (Mylliem granite). Besides, a small part of the study area is covered by a few dolerite dikes and stratified tuffs of a volcanic rock(Chapter II).

Physiographically the area is a plateau composed of structuro-denudational hills with at least five major plantation surfaces. The area is characterized by steep and moderately gentle slopes. Fluvial morphometric studies reveal that the area is well drained by structurally controlled first order to fifth order streams which followed established stream laws (Chapter III).

From the study of the structural elements, the rocks of the area bears imprints of at at least five phases of deformation (D). In the first phase of deformation (D_1),the dominant foliation (S_1) of the Shillong Group had developed and both S_0 and S_1 were folded into tight isoclinal folds F_1 where the fold limbs are highly appressed and, at places, torn into isolated masses, lenticles and knots due

to a NW-SE sub-horizontal simple shear, with the associated development of bedding cleavage S_1 axial planar to the F_1 folds. The F_1 folds generally plunge towards the NE. The second phase D_2 was responsible for the development of small scale symmetrical open folds (F_2) due to re-folding of S_1 and S_1 and where F_2 is generally co-axial with the F_1 folds. The third phase of deformation (D_3) of compressional nature had affected both F_1 and F_2 folds and resulted in the development of large open asymmetrical folds in the Shillong Group of rocks with a crude axial plane rock cleavage. As the three sets of folds F_1, F_2 and F_3 are nearly co-axial it is probable that there was no break between the three phases of deformation D_1, D_2 and D_3. The fourth phase of deformation (D_4) is related to intrusion of a mushrooming granitic body, which re-oriented the country rocks parallel to its margin with the dip of the country rocks directed inwards towards the granitic mass. The last phase of deformation D_5 was resonsible for the development of numerous NE-SW trending crush- or shear-zones located far away from the granite, resulting in brittle fracturing of the porphyritic granite while longitudinal-, cross- and diagonal-joints are well developed structures in the the porphyritic granite, Khasi greenstones and amphiboles and amphibolites. Bent and contorted laminations besides joints and shear planes are the structures observed in the volcanic tuffaceous rocks (Chapter IV).

The metasediments of the Shillong Group are the most dominant rock type and their stratified nature and the presence of structures like current bedding, ripple marks, graded bedding indicated their sedimentary derivation. These arenaceous and argillaceous rocks were involved with tectonic movement and underwent recrystallization. The arenaceous units were originally composed of quartz set in a clayey

matrix. With onset of metamorphism of regional nature, the clayey matrix were recrystallized to sericite - muscovite along with general coarsening of the quartz grains. With higher degree of metamorphism nearer to the granites and amphibolites, development of a granoblastic mosaic of quartz grains, often meeting in triple points, took place with the sericitic cement recrystallizing to muscovite. Very near to the granite contact, muscovite had given way to the formation of fibrolites(sillimanite).

The argillaceous units of the Shillong Group were much more expressive in reflecting the metemorphic effects. A distinct increase in the degree of metamorphism is noticed from the west to the east of the area. In the western part, development of fine sericite - muscovite with quartz, chlorite and iron-oxide were initiated due to regional metamorphism of pelitic sediments. Towards the east, a coarsening in grain size was noticed and amount of sericite and chlorite decreased and muscovite increased. Besides, small grains of perthite, biotite, garnet and pyrite also made their appearence.

The conglomerate of the Shillong Group also show the effects of regional metamorphism by the presence of recrystallized quartzitic pebbles and well-developed quartz along with muscovite prisms (Chapter V).

The metabasic rocks were represented by the Khasi greenstones and the amphibolites which were early intrusives into the Shillong Group as doleritic and gabbroic rocks, which also suffered regional metamorphism along with the Shillong Group.

In the Khasi greenstones, primary mineral assemblage of calcic plagioclase and clinopyroxene(augite) with magnetite have been altered, through uralitization and saussurization, to a low grade mineral assemblage of actinolite - chlorite - albite - epidote, representing, greenschist facies of metamorphism. These Khasi greenstones(metadolerites) retained some of their original igneous characters such as relict ophitic texture and complex twins in plagioclases. The Khasi greenstones were subsequently affected by thermal metamorphism at the proximity of the porphyritic granite manifested by the development of a decussate texture (Chapter VI).

Along with the Khasi greenstones, the amphibolites at the east were involved with regional metamorphism. An original mineral assemblge of dominately calcic plagioclase and augite underwent retogressive effects and had formed the mineral assemblage hornblende-plagioclase-epidote-iron oxide-quartz belonging to the amphibolite facies. Such an assemblge of hornblede and plagioclase is also indicative of attainment of lower part of medium grade metamorphism. Being far from the granite body, these amphibolites did not show any thermal effects unlike the Khasi greenstone (Chapter VII).

Intrusive into the amphibolites were a few basic dikes and veins. These were doleritic where ophitic or sub-ophitic texture as well displayed. Uralization was marginal with a development of chilled margins of the dikes. Preservation of the doleritic character of the rock with almost no metamorphic effects is indicative of much younger age to the rock (Jurassic?)(Chapter VII).

Occurences of a highly altered stratified volcanic tuff as cappings over two hillocks were noticed for the first time.These rocks were characterized by the presence of altered feldspar set in a fluidal mass showing flow banding.Glass in the rock identified it as a volcanic rock and this coupled with a flow structure implied it to be a rhyolitic rock.Incipient divitrification with the formation of minor amount of fine microlites in the rock was indicative of its post Precambrian or later origin.(Chapter IX).

The porphyritic granite of the area was considered to be the part of the Mylliem pluton and intrusive into the metasediments of the Shillong Group showing cross-cutting relation with the foliation of the latter. The granite contained xenoliths of older country rocks. Its distinctive character was its porphyritic nature where the phenocrysts were composed of potash feldspar and which displayed a preferred orientation. The phenocrysts constituted about 33 percent of the total rocks by volume. A typical hypidiomorphic granular texture was exhibited by the groundmass. The presence of two kinds of feldspar, potash feldspar and plagioclase, in the rock implied a sub-solvus granite had crystallized in a sub-plutonic environment. The results of zircon study revealed the presence of euhedral grains of zircon and suggest of magmatic/ melt origin and density inversion caused material to bouyantly mushroom into overlying rocks. The granite plotted in sub-field 3a of Streckeisen (1976) which identified it as a syeno-granite, due to the dominance of K-feldspar (Chapter VIII).

Geochemical studies of the various rock types of the area threw light on their origin.The metapelites of the Shillong Group showed affinity to sedimentary parentage, a siliceous shale poor in soda with addition of potash taking place later from nearby intrusive through diffusion.

The Khasi greenstones and amphibolites were derived from original basic igneous rocks. They both show tholeiitic trends, very similar to the Karroo Dolerites and Palasides Sill, in island-arc settings. The Kutulin's Function indicated their intrusive nature. While the Khasi greenstones were inferred to be middle stage differentiates, the amphibolites were deduced to be ortho-amphibolites. Evidences indicated that the Mylliem granite to have formed by solidifiaction of a granitic magma (anatectic). With high K_2O and $K_2O/Na_2O>1$, they were microcline bearing granites. From various geochemical diagrams the rocks was interpreted as normal granites. The granite was peraluminous and deduced as S-type with materials derived from deeper crustal parts associated with orogenic activity. A high proportion of ferric oxide impurities imparted a pinkisk color to the granite at places. The volcanic rocks (tuff) were silica saturated, alkali defficient and paraluminous in character. These rocks plotted within volcanogenic fields and formed in rift tpye of tectonic setting (Chapter V, VI, VII, VIII, IX).

The geological history of the area could thus be inferred to be as follows:

At first, during Proterozoic times, deposition of gravels, sands and muds took place over a weathered base of crystalline rocks in a marine environment under shallow water(shelf) conditions. After lithification and diagenesis, these sediments were indurated into a sandstone, mudstone, and conglomerate sequence.

This sequence of rocks were than subjected to tectonic activity and dynamothermal/regional metamorphism. While regional metamorphism gave rise to quartzites,metapelites and metaconglomererates, tectonic

activity, in the earlier phases, affected only the metapelites by generating small-scale folds; but, in the later stage affected all the metasediments by forming large open folds. Either pre-metamorfic or syntectonic to the later stage of deformation of the metasediments, intrusion of basic rocks as pre-tectonic sills or syntectonic dikes took place within the metasediments. Then, these intrusives too suffered regional metamorphic giving rise to amphibolites and Khasi greenstones, the recrystallization being in consonance with the metamorphism of the enveloping rocks. The close this major orogenic events was marked by large intrusion of a porphyritic granite. The granitic intrusion re-oriented the sorrounding rocks parallel to its margin besides imposing thermal metamorphsm in a relatively thin aureole. Continued earth movements brought about uplift of the whole area accompanied by weathering and erosion. Much later (Mesozoic ?) a set of doleritic dikes and veins intruded into the amphibolites and extrusion of a tuffaceous rock occurred over the metasediments. Continued denudation brought about peneplanation of the land surface and dissected by structurally controlled drainage pattern gave rise to the present configuration.

→

The stratigraphic succession established for the present study area is as follows :

Volcanics : (Tuffaceous rocks)

Dolerites

Porphyritic granite (Mylliem granite)

Metabasics : amphibolite and Khasi greenstone

Shillong Group —
- phyllite
- mica schist
- garnetiferous mica schist
- quartzite
- conglomerate

******