The Cretaceous sediments of the Mahadek Formation were deposited in the shelf condition on the southern part of the Shillong Plateau. The sediments are represented by the Mahadek Formation in the present area. The formation was affected by the Dawki-Tear fault.

Lithostratigraphically the sandstones of the formation are represented by arkose, quartzose arkose, feldspathic quartzite and orthoquartzite. Amongst the detrital group of quartz, plutonic group overwhelmingly supersedes the metamorphic and reworked sedimentary group of quartz. Microcline is dominantly present in the lower part of the formation.

The presence of glauconite in the sandstones of the Mahadek Formation pertains that the sediments were definitely deposited under inter-tidal to innermeritic marine conditions (Pettijohn 1957, p.468 and Cloud 1955, p.486). Hadding (1932 p.159) believed........"glauconite is always marine, always sub littoral, always a shallow marine formation, as a rule formed in agitated water..........under decreased deposition ..............never formed in highly oxygenous water". So, presence of glauconite in the sandstones of the Mahadek Formation indicates that the environment of deposition was shallow
marine. Sandstones also house iron pallets which are formed by gentle action of current or wave on fine grained precipitates (James 1954, p. 268).

Most Geologists agree with Harker (1895, p. 193) that "arkose is ............ derived from ........... granite, or gneiss .................". The high content of excellent sorting and rounding exhibited by the orthoquartzitic sandstone is indicative of a high degree of textural and mineralogical maturity. These rocks are obviously the end product of protracted and profound weathering, sorting and abrasion. In order that there be sufficient time to achieve these results, it is imperative either that the source area and site of deposition be tectonically stable and that the sand go through several cycles of sedimentation. Such association of divergent mineralogy is probably an indication of a complex source area. The basal conglomerate is well exposed at and around Pynter wherefrom all the overlying sediments are denuded away. The huge thickness of sediments were developed due to marine incursion during the Cretaceous time. From the study of different aspects, it is found that the transgression was from south to north.

The X-Ray Radiography points to the fact that the sandstones are influenced by diagenetic affect, possess micro-structures, and marine dwelling micro-organisms played their role.
The sandstones rarely show well developed palaeocurrent. The inclination of fore-set beds is a function of angle of repose of the sand at the time of deposition. McKee (1940, pp.811-824) has found maximum dip angles 27°-28° in two water laid sandstones and 33° in the sandstone considered to be eolian. According to Dunber and Rodgers (1957, p.189) the angle hardly exceeds 20° for water laid sandstones. Most of the workers have found the average angle below 22° for water laid deposits (Potter, 1955, p.12; Farkas, 1960, p.451).

Most of the inclination values (average angle 14°) in the present study are well within the limits of water laid sediments. The parallel master stratifications in the grouped sets, regular bedding planes without cross-laminations substantiate the view. (Evans, 1944, p.95; Casshyap, 1968, p.938).

Many workers have observed higher fore-set inclinations specially in tectonically deformed rocks and the suggested interpretation is that the fore-set beds have been rotated by deformation (Yeakel, 1962, p.1518, Nilsen 1965, p.811). Though the present area is a deformed one, the lower inclinations of fore-set beds indicate that rotation of the beds have not taken place to an appreciable amount. The presence of normal bedding planes between "co-sets"
probably represent intervals of relatively quiet deposition under weak current (Hamblin 1961, p.7).

The variation of azimuth in some localities is due to the fluctuation in the direction of palaeo-current. The local topography (bottom irregularities) was also responsible to some extent in controlling the attitude of cross-bedding.

The conglomeratic horizon of the formation crops up near Pynter, where it rests directly on the metamorphites. There are published literatures indicating dominant up-current imbrications (Schlee, 1957; Sanju and Srivastava 1959) and dominant down-current inclination (Nicholson, 1965) of the conglomerate pebbles. Higher percentage of pebbles of the conglomerate bed are inclining towards the down-current direction. The mean inclination of the pebbles is generally less than 20° (Table 7) which indicates them to be marine beach pebbles (Pettijohn 1957, p.250). The inclination of the pebbles are towards S.W. Dominantly the pebbles are composed of quartzite. On the north-west of the outcrops of the Mahadek Formation, quartzite occurs as a mappable unit in the area. The composition and inclination of the pebbles suggest their derivation from the above cited quartzite.

The general current direction is from N.E. towards S.W. as indicated by pebble analysis, fossil orientation and also confirmed by the cross-bedding analysis of the Mahadek
Formation. Geological observations indicate that long axes of the pebbles are oriented in the direction of current flow (White 1952, pp. 189-199). The present analysis reveals that most of the pebbles are oriented in the current direction. The conglomerate bed separates the underlying granite and quartzite and overlying sandstones of the Mahadek Formation and represents the strand or shore-line.

The conglomerate pebbles are fairly of large size and they are well rounded. The rounded nature of the pebbles is in favour of littoral environment for the deposit (Sames 1966, p. 126).

From the very well sorted nature and lithologically homogeneous types of conglomerate, it is probable that this conglomerate was formed in a transgressive sea (Krumbein and Sloss, 1963, pp. 162-164). The basal occurrence of the bed suggests shallow marine environment—beach or littoral. Further, the moderate to low value of kurtosis and skewness represents a small amount of reworking which also confirmed by the respective values of sandstones.

The sandstones of the Mahadek Formation contain bi-valves lying predominantly concave-up. The concave shell assemblages are attributed to the deposition from turbidity currents (Compton 1962, p. 226; Crowell and Others 1966, p. 30; Hoskins, 1967, p. 470). Further, distinction was made between turbidity current deposits and tractive current deposits with
the help of the position of the shell. The tractive current deposits contains convex-up shell (Potter and Pettijohn 1963, p.38; Middleton 1967, p.229). Emery (1968, p.1264) has shown that concave-up shells arrangement is possible to occur on the continental shelf where water is quite and carnivores and scavengers or bioturbation are active. Toots (1965a, p.223) attributes concave-up shell arrangement to the absence of a significant horizontal force during the deposition and transportation. However, experiment with the shells indicate that concave-up shells are formed on the sea floor by the migrating small sand ripples (Clifton and Boggs, 1970, p.888).

The abundance of concave-up bi-valve shells in the Mahadek Formation suggest predominance of turbidity current and little wave action during the sedimentation. The sandstones are characterised by bi-modality and poly-modality (p.53). This characteristic of the sediments were further reflected by the relationship of $\phi$ Mz and $\phi$ Kg. (Fig. 164. Folk and Ward 1957, p.20, Fig.13).

Extreme high and low values of kurtosis imply that part of the sediment achieved its sorting elsewhere in a high-energy environment, and that it was transported essentially with its size characteristics unmodified into another environment where it was mixed with another type of material. The new environment is one of the less effective
sorting energy so that the two distributions retain their individual characteristics i.e. the mixed sediment is strongly bimodal (Folk and Ward 1957, p.25). Relationship between $\phi_{Sk1}$ and $\phi_{Kg}$ is indicative of the fact that the modes are widely separated and poor effect of sorting (Folk and Ward 1957, 1958, p.21). Tectonic history of the area of provenance and depositional site judged from the relationship between the mean grain size and $\phi$ standard deviation is in agreement with the type of sandstones of the Mahadek Formation.

Inman (1952, p.128) after a detail and careful study has pointed out that V-shaped pattern of scatter diagram is possible to obtain from the statistical analysis of sandstones from different tectonic set-up. Most of the scatter points of sandstones of the Mahadek Formation fall on the right side of the V-shaped arm. This is a special characteristic of high rate of subsidence of the area of deposition with low tectonic uplift of the source area (Cadigan 1962, p.142).

Folk and Ward (1957, p.17) have pointed out that if a wide range of grain size (Gravel and clay) is present, scatter bands often form some segment of a broadened M-shaped trend. Often only a V-shaped or inverted V-shaped trend develops if the size range is smaller and if the range is very small, only one limb of the V may occur.
The pattern shows that (Fig. 17, E) in the sand fraction of the sediments, best sorting occurs at a mean size 2.10 Ø - 2.6 Ø with $d_1$ about 0.40 Ø - 0.80 Ø. The suggestion of an upward hook at the right of the diagram is caused by mixture of the dominant sand mode with small amount of a third mode in the silt sizes. This further decreases the mean size and starts to worsen the sorting again.

In the bimodal sediments the skewness is a very close function of grain size where the sand fraction shows the symmetrical size curves but with the addition of coarse fraction the skewness becomes negative (Folk and Ward 1957, p. 19).

The sandstones of the Mahadek Formation are mostly leptokurtic and platykurtic in a very sub-ordinate amount. The distribution of the central part is better sorted than the finer and coarser fraction of the distribution. They are slightly or moderately skewed and are normal to moderately peaked. The formation is represented by coarse to medium grained sandstones.

The grain size curves of the sandstones of the formation are characterised by three or four populations namely - surface population, $A'$ - Saltation population, $A$ - Population and suspension population. The environmental analysis with the help of discriminant functions show that the different members of the formation i.e. bottommost
arkosic sandstone, Echinoid bearing sandstone, steel grey
coloured Naulitus bearing sandstone, and medium to fine
grained grey coloured sandstones are represented by shallow
agitated marine environment, shallow marine, turbidity and
river environments respectively (pp.57-58).

Inter relationships of $\phi Mz$, $\phi \phi$, $\phi S_k$ and one
percentile show that the environments of deposition are
river and beach as most of the plots are concentrated both
in river and beach environment (p.66). The environment as
indicated by the mutual relationship of different textural
parameters are also supported by the plots of data in the
C.M. pattern (p.62). Further, the F-M, L-M and A-M diagrams
are diagnostic of the tractive current environment.

From the textural classification of the sandstones
it is found that the formation is composed mostly of silty
sand group and the rest is represented by sand. The sandstones
of the Mahadek Formation house zircon, tourmaline, garnet,
epidote, ilmanite and magnetite, rutile, chloritoid, apatite
etc. as heavy minerals.

The stratigraphic variation of the heavy minerals
in the sandstones of the Mahadek Formation is very signifi-
cant. Garnet and rutile occur comparatively in higher propor-
tion in the lower members of the formation. The maximum con-
centration of garnet in the lower member of the formation of
the Dawki-Sokha section indicates that it was probably
derived from an area represented by garnet bearing rock.

Quddus* (1960, p. 68) reported occurrence of garnet-schist rock from a few kilometers outside of northeastern part of the present area.

Zircon and epidote are found to be fluctuating in distribution, while the chloritoid maintains more or less uniform trend. Presence of zoned zircon (p. 69) confirms the provenance to be acid igneous origin. The inclusion of bubbles and air cavities etc. in the tourmaline minerals also elucidates its derivation from granite rocks (Krynine 1946, p. 68).

The size variation from sub-angular to rounded as well as sub-rounded supports the idea of derivation of sediments from different areas and/or variation in dispersal.

The behaviour of the Catena in all the cases further show that the scattering is appreciably away from the origin of the co-ordinates implying less attrition during transportation (p. 77). Further, the wing shaped catena implies the water laid sediments (Smithson, 1939, p. 352). The roundness and sphericity is indicative of maturity and distance of transport. The size of the zircon and its elongation ratio which is greater than 2.00 is indicative of derivation from the granite or calc alkaline rocks (Foldervang 1955 and 1956).
The idea of provenance and environment can be have from the study of different clay minerals. The clay minerals of the Mahadek Formation are represented by kaolinite, illite, montmorillonite and chlorite. The predominance of kaolinite throughout the area indicates that the environment of deposition was either continental or near shore (Mankin and others 1970, pp.802-804). Kaolinite generally reacts with sea water and it is lost during diagenesis under marine conditions altering to illite and chlorite (p.82). The montmorillonite is undoubtedly carried into the sea by river following primary stage of weathering on the land. Further, the preponderence of kaolinite which is produced due to alteration of the feldspar indicates that the provenance to be granite rocks which are abundently present in the near by area of study.

From the above findings, it is concluded that the Mahadek Formation was developed during the Cretaceous Period in the shelf condition. During this period there was marine incursion from the south to the Shillong plateau. The sediments were laid down dominantly in river and beach environments. Along the shore line conglomerates were formed, whereas away from the shore line the sediments are represented by finer clastic materials. The sandstones of the formation are represented by arkose, quartzose arkose, feldspathic quartzite and orthoquartzite. They are mostly composed of silty sand and sand.
The clastic materials were deposited in the shallow littoral condition and were carried from the land mass by the tractive and turbidity currents. The clastic sediments are characterised by surface population, A-saltation population, A-saltation population and suspension population.

The sandstones house zircon, tourmaline, rutile, epidote, apatite, chloritoid, ilmenite, magnetite, garnet and amongst the quartz groups, plutonic group dominates over the others. The clastic rocks were carried down to the depositional site from the area dominantly represented by igneous or microcline bearing granitoid rocks. However, little admixture has taken place from garnetiferous metamorphic rocks. The source area with all probability was the Shilloog plateau. The directional properties obtained from the pebbles and paleo-currents also support the above contention. During the time of deposition of sediments, there was high rate of subsidence in the area of deposition and low tectonic uplift in the source area. The sandstones were cemented by iron oxide, calcite and silica and experienced diagenesis.