CHAPTER 5

X-RAY RADIOGRAPHY AND PETROLOGY

5.1. INTRODUCTION :

The sandstones of the Mahadek Formation, except only in very few localities are generally devoid of any sedimentary structure. The rocks are characterised by hard to soft nature, coarse to fine grain and buff to grey colour.

As, the rocks invariably fail to display any structure, X-Ray Radiography is aimed to decipher the distribution of minerals, fabrics, stratification and other structural features.

Data obtained from the volumetric determination of the mineral content are used for the classification of the sandstone and to study their variations stratigraphically. Besides mineralogical data, genetic groups of quartz are utilised to decipher the provenance. Petrological investigation is also aimed towards the establishment of lithification and diagenesis.

The maturity of the rocks is also assessed from the mineralogical maturity, as determined from the petrographical investigation (p. 47).
5.2. X-RAY RADIOGRAPHY:

The positive prints made from the X-Ray Radiograph of the structureless sediments of the formation show internal structures (Pl. 10, Fig. A, B, C; Pl. 11, Fig. A, B).

The upper part of the arkosic sandstone member is medium grained, grey coloured sandstone (p. 20). The X-Ray Radiograph of the homogeneous rocks from this part of the member from Sokha reveals the micro-laminae, characterised by alternations of bands of radio-opaque and radio-nonopaque materials. At places radio-opaque materials are quite large and well visible inside the radio-opaque band (Pl. 10, Fig. A). But the X-Ray Radiograph of the bottom part of the member however, fails to reveal any internal structure, except the coarse grained nature of the sandstone (Pl. 10, Fig. B). The rocks from the buff coloured Echinoid bearing sandstone member shows the concentration of organism more or less parallel to the bedding plane (Pl. 10, Fig. C). The steel grey coloured Nautilus bearing sandstone member, exposes the internal structure, marked by the burrowing organisms (Pl. 11, Fig. A). The uppermost member of the formation, i.e. medium to fine grained sandstone, shows the laminations in rhythmic pattern marked by the concentrations of accessory minerals (Pl. 11, Fig. B).
5.3. MINERALOGICAL COMPOSITION:

Among the detrital grains, quartz ranges from 42.36% to 95.94%. Quartz are represented by common, vein, polycrystalline (Pl. 12, Fig. A), composite, undulose and pressure metaquartzite. Common quartz predominates over the other types of quartz, and varies from 69.95% to 99.22%. Many of the common quartz grains are highly fractured and some of them contain inclusions of zircon (Pl. 13, Fig. A), apatite etc. Unit undulose quartz (Pl. 12, Fig. B) ranges from 0.65% to 20.56%, and vein quartz (Pl. 12, Fig. C) from 0.00% to 10.91%. Pressure metaquartzite rock fragments are almost absent and when present do not exceed 2.92%. Likewise second cycle quartz is absent or ranges up to 0.27%.

In the sandstones of the Mahadek Formation detrital feldspar varies from 1.63% to 34.17%. This broad group of feldspar includes microcline (Pl. 13, Fig. B) plagioclase (Pl. 12, Fig. C) orthoclase and lesser amount of perthite (Pl. 12, Fig. A). Alteration of feldspar is common. Fresh feldspar without any alteration and obliteration of the original twining plane are also observed in the sandstones of the Mahadek Formation.

In the sandstones, mica varies from 0.00% to 6.58%. Mica is seldom an important detrital constituent. Micas are represented by biotite, muscovite and chlorite.
Zircon, tourmaline, rutile, leucoxene, magnetite, apatite, garnet (Pl. 13, Fig. C) and glauconite are the miscellaneous grains in the sandstones of the Mahadek Formation and as a group ranges from 0.67% to 11.52%. Pallets of iron and glauconite (Pl. 14, Fig. B) are predominant in the coarse grained fossiliferous as well as non-fossiliferous lower horizon. The percentage of the miscellaneous minerals are higher in sandstone that contains garnet and pallets.

Metamorphic rock fragments in the sandstones of the Mahadek Formation varies from 0.00% to 3.86%. Most of the lithic clasts are polycrystalline quartz. Often the metamorphic rock fragments show obliteration of their original outline and character.

Rock fragments of igneous origin showing affinity with dolerite, trapean rocks are also occasionally met in the sandstones.

The sandstones of the Mahadek Formation are very well cemented. The percentage of cement varies from 1.96% to 30.00%. Calcite, iron-oxide, silica and chlorite are the main cementing materials. In most sandstones particularly in the buff coloured Echinoid bearing sandstone and steel grey coloured Nautilus bearing sandstone members, the calcite cement (Pl. 15) is predominant and percentage ranges upto 30.00%. The calcite occurs as dust and found well distributed. Diagenetic etching of quartz and feldspar by calcite
is common (Pl. 14, Fig. A). In most cases the detrital grains are widely separated and are floated in the calcite ground mass. The cement calcite must have derived by chemical alteration from the shells of organisms which are almost abundantly found in the same sandstones of the Mahadek Formation.

Volumetrically iron-oxide ranks second as the cementing materials. It occurs either as filler of the inter-granular spaces or as a staining material over the grains.

Authigenic cement quartz (Pl. 14, Fig. C), also occurs in an appreciable amount. Such overgrowth has got optical continuity with the original detrital quartz grains.

Matrix, the important petrographical unit includes those grains which are smaller than 0.3 microns in the longest direction. The sandstones of the Mahadek Formation contain smaller amount of such materials which vary from 0.00% to 2.66% by volume (Table 8, Fig. 8 and 10).

A study of the distribution of the mineralogical constituents in the stratigraphical sections shows that quartz become gradually dominant with the impoverishment of the feldspar from the basal part of the uppermost part of the Mahadek Formation. In the Dawki-Sokha section quartz, gradually increases from 50.92% to 75.00%; in the Sokha-Nongtalang section from 42.36% to 68.02%; in
the Dawki-Pamshutia section from 70.48% to 76.77% and then from 61.89% to 66.69%; in the Dawki-Muktapur section from 48.35% to 73.52%. The distribution of feldspar decreases from lower to upper part of the formation. In the Dawki-Sokha section it decreases from 21.52% to 2.80%; in the Sokha-Nongtalang section from 17.65% to 2.95%; in Dawki-Pamshutia section it decreases from 6.37% to 2.92% and then from 4.83% to 2.15%; in Dawki-Muktapur section it decreases from 25.10% to 3.13%. Similarly the distribution of mica in the Dawki-Sokha section decreases from 0.72% to 0.19% but increases up to 1.00% in the uppermost part. In the Sokha-Nongtalang section mica increases from 0.47% to 1.25% from bottom to top. In the Dawki-Pamshutia section it increases from 0.79% to 1.05% and then increases from 0.40% to 1.04%. In the Dawki-Muktapur it increases from 0.00% to 1.31% from bottom to top. Distribution of matrix in the Dawki-Sokha section decreases from 1.52% to 0.30% from bottom to top. In the Sokha-Nongtalang section it decreases from 2.39% to 0.35% and then from 1.22% to 0.90% from bottom to top. In the Dawki-Pamshutia section the distribution of mica increases from 0.00% to 2.51% from lower to upper. The Dawki-Muktapur section shows the variation from 0.00% to 0.31% and then to 0.12 from bottom to top. In the Dawki-Sokha section cement decreases from 11.79% to 6.13% and then from 27.32% to 16.00%; in the Sokha-Nongtalang section it
increases from 26.79% to 29.52% and then decreases from 29.79% to 25.33%; in the Dawki-Pamshutia section it increases from 10.79% to 29.96% and then decreases to 26.43% from bottom to top. In the Dawki-Muktapur section it decreases from 14.98% to 6.13% and then increases from 19.48% to 21.17% from lower to upper.

5.4. MINERALOGICAL MATURITY:

The mineralogical maturity of the sandstones measured from the ratio of quartz/feldspar shows a wide range from 1.93 to 33.53 in the Mahadek Formation (Table 9).

In the Dawki-Sokha section, the basal arkosic sandstone member shows the maturity as 2.37 which increases to 5.66 and 6.47 in the buff coloured Echinoid bearing and steel grey coloured Nautilus bearing sandstone members. In the medium to fine grained sandstone, the topmost member, the maturity increases to 26.81. In the Sokha-Nongtalang section the maturity increases from 3.39 to 6.32 and 7.11 to 23.01 from bottom to top. In the Dawki-Pamshutia section however, the maturity increases from 11.07 to 26.49, and then from 11.66 to 31.08 in the stratigraphical order. In the Dawki-Muktapur section, it increases from 1.93 to 5.66 to 33.53 and then a slight fall to 23.52 from bottom to top.
5.5. MINERALOGICAL CLASSIFICATION:

On the basis of mineralogy, the sandstones of the Mahadek Formation are classified into arkose, quartzose arkose, feldspathic quartzite and orthoquartzite. Dominant amongst these types is feldspathic quartzite and is followed by orthoquartzite, arkose and quartzose arkose in the order of preponderance (Fig. 8, table 8).

In the feldspathic quartzite type, the percentage of feldspar varies from 5.48% to 22.73%. Quartz ranges from 73.75% to 93.02%. Mica varies from 0.17% to 6.58%.

In the orthoquartzite type on the other hand the percentage of feldspar ranges from 1.63% to 4.54%. Quartz ranges from 94.18% to 95.94%. Mica varies from 0.00% to 2.68%.

In the arkosic sandstones the percentage of feldspar ranges from 29.18% to 34.17%. Quartz ranges from 65.82% to 70.29%. Percentage of mica varies from 0.00% to 0.77%.

In the Dawki-Sokha stratigraphical section (pp. 22-24) the basal part is represented by arkose followed up by feldspathic quartzite and the upper part is represented by orthoquartzite. Same pattern of distribution is maintained by the petrographically determined rock types in the Sokha-Nongtalang stratigraphical section. But in the Dawki-Pamshutia, the stratigraphical order is feldspa-
thic quartzite, ortho quartzite, feldspathic quartzite and ortho quartzite. Likewise there is little variation in the Dawki-Muktapur section where the succession is arkose, feldspathic quartzite, ortho quartzite and ortho quartzite (Pl. 14, Fig. A).

5.6. GENETIC GROUP OF QUARTZ:

Grouped on the basis of genesis the following quartz types are observed (Table 10, Fig. 9).

- Plutonic: 74.16% to 99.28%
- Metamorphic: 0.71% to 25.82%
- Reworked sedimentary: 0.00% to 0.27%

A study of the distribution of quartz in the stratigraphical sections (Fig. 9) shows the following variations:

In the Dawki-Sokha section the plutonic quartz decreases from 98.79% to 85.75% and then increases from 91.09% to 97.85% from bottom to top. Sokha to Nongtalang section shows that the percentage of plutonic quartz increases from bottom to top with a range from 96.90% to 98.35%. In the Dawki-Pamshutia section plutonic quartz increases from 96.12% to 98.16% and then it is almost uniform in distribution from bottom to top. In the Dawki-Muktapur section the plutonic quartz decreases from bottom to top with a range from 94.26% to 85.75% and then increases from 91.84% to 93.98% towards the top.
Likewise the metamorphic and sedimentary quartz show the following stratigraphical variation.

In the Dawki-Sokha section the metamorphic quartz gradually increases from 1.21% to 14.22% and then decreases from 8.91% to 2.15% from bottom to top. The Sokha-Nongtalane section shows that it gradually increases from 3.10% to 14.75% and then decreases from 10.21% to 1.65% upwards. In the Dawki-Pamshutia section the distribution of metamorphic quartz is more or less uniform from bottom to top. The Dawki-Muktapur section shows that it gradually increases from 5.74% to 14.75% and then decreases from 7.88% to 6.02% upwards.

Sedimentary quartz is not met with in any section except in the section Dawki-Muktapur with a very small percentage.

5.7. SUMMARY:

The sandstones of the Mahadek Formation are represented by arkose, quartzose arkose, feldspathic quartzite, and orthoquartzite amongst which the feldspathic quartzite preponderates over the others. The sandstone also houses pallets of iron and glauconites. The detrital grains are cemented by calcite, iron-oxide, silica and chlorite. Authigenic cement of quartz is also present in the sandstone. The basal part of the formation is dominantly
represented by arkosic and in a very subordinate amount by feldspathic quartzite. Stratigraphically the sandstone is followed by dominantly feldspathic quartzite and to a very subordinate amount by orthoquartzitic sandstone, but the upper part of the formation is entirely represented by orthoquartzitic sandstones. Amongst the detrital group of quartz, plutonic group overwhelmingly supersedes the metamorphic and reworked sedimentary groups of quartz. The sandstone has become more mature from bottom to top as evident from the mineralogical maturity.

The X-Ray Radiography of sandstone reveals the existance of internal structure like micro-lamellae concentration of organisms, and occurrence of burrowing organism.