CHAPTER - IV

GEOLOGY OF THE AREA

Geology plays an important role in the ground water investigation of an area. Lithologic unit their distribution, mineralogical composition and feature along with the geological structure are the main factors in the generation of horizons suitable for storage and movement of ground water termed as ground water reservoir. The ground water potential depends upon these reservoirs present in the area. The maximum development of ground water for beneficial use also depends on the ground water reservoir. Therefore, it is necessary to consider the nature of the geological formation present in the upper Urmil river basin. With this objective in view, the author has studied the various rock types by taking a number of traverses. Thus, he has taken up detailed study of the rocks by preparing the geological map of the upper Urmil river basin.

4.1 REGIONAL GEOLOGY

The Regional Geology of the area comprises Bundelkhand Granitic Complex, Bijawar,Gwalior Group and Vindhyan Super group of rocks. Pascoe (1950) and Chatterjee et al. (1971) described the following regional stratigraphic sequence of the area around upper Urmil river basin.
-Deccan traps- cretaceous-Eocene
Vindhyan super group (1500-500 m.y.)
Bijawar & Gwalior Groups. (2400-2300 m.y.)

----------Unconformity-------------
Bundelkhand Granitic Complex. (2600 m.y.)

Mahroni Formation. (Archaean)

The study area is a part of Bundelkhand Granitic massif Table No.4.1 gives the comparative position of the stratigraphic sequences, as suggested by some of the principal workers on the Bundelkhand massif. The author used the above sequences as regional geology of the study area.

Sarkar (1968), obtained 2500 m.y. to 2400 m.y. K-Ar ages for the close of the Bundelkhand orogeny, regional metamorphism and granitisation. Crawford (1970), carried out Rb-Sr total rock age determinations of granite samples from near Chatturbhuj temple, Khajuraho gave an age of 2525 m.y. Sarkar et al. (1984) have identified three distinct granitic suites in the north-central part of the Bundelkhand massif. The first suite comprises banded migmatites. The second suite is made up of medium-grained, massive to briefly foliated granodiorites and granites. These rocks have given isochron ages (Rb-Sr) of about 2400 m.y. The youngest suite comprising coarse-grained massive pink granite and aplites has been radiometrically dated (Rb-Sr) 2200 m.y. old. The average ages of Bundelkhand granitic rocks described by different workers from different parts of the massif puts at 2560±106 m.y. The regional geology of the area is shown in fig.4.1.
# Table 4.1

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<tbody>
<tr>
<td>Peridotites,</td>
<td>basic dykes</td>
<td>Dolerite &amp; other</td>
<td></td>
<td>Madaura formation:</td>
</tr>
<tr>
<td>Pyroxinites</td>
<td>Quartz reefs</td>
<td>basic dykes</td>
<td></td>
<td>(pre to post Bijawar age)</td>
</tr>
<tr>
<td>Intrusive</td>
<td>Granites (of ten mega)</td>
<td>Quartz reef</td>
<td></td>
<td>a. Dolerite dykes, Granite member, graphic granite.</td>
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<tr>
<td>dolerite dykes</td>
<td>scopic types)</td>
<td>pink granites,</td>
<td></td>
<td>b. Gabbro member, coarse to medium grained gabbro, pillow lava, ultra basic member; milky dense sheared vein quartz.</td>
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<td>Relict meta</td>
<td>migmatites</td>
<td>-Unconformity-</td>
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<td>sediments=</td>
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<td>Dharwars (?)</td>
<td>rocks.</td>
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<td></td>
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</tbody>
</table>

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Granite complex with quartz reef and with inclusion of Mahroni schists.

Bundelkhand granite formation: dull pink, dense fine grained to porphyritic granites; coarsely crystalline pink unfoliated granites & migmatites. -Unconformity-

Berwar formation: Iron formation, Carbonate rock, greygreen slates, fushsite quartzite & conglomerate -Unconformity-

Rajaula formation: Sedimentation-volcanism (Amphibolites, biotite feldspar gneiss).

contd...
Misra & Sharma (1975)  

1 Bundelkhand basic intrusives:
dolerites, keratophyres, lamprophyre, other basaltic rocks, carbonatites.

2 Bundelkhand granites; gneisses, grey & pink granites, granodiorites, syenite, porphyritic granites, quartz-veins & feldspathic veins.

3 Palar formation (low grade metamorphics):
Quartzite, spotted phyllites, sericite schists, 
talc schists, phyllites, black shales, limestones,
ferruginous quartzites with traces of chalcopyrite,
galena, pyrophyllite & diaspore deposits.

________ Unconformity _________

4 Kuraicha formation (high grade metamorphics):
Migmatites, gneisses, para-ortho & augen gneisses, amphibolites, chlorite, biotite schists & quartzites.

FIG. 4.1: REGIONAL GEOLOGICAL MAP OF UPPER URMILO RIVER BASIN

INDEX
State Boundary, Road — River
Railway line

<table>
<thead>
<tr>
<th>ALLOUVIUM</th>
<th>DECCAN (MALWA) TRAPS</th>
<th>VINDHYAN SUPER GROUP</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIJAWAR GROUP</td>
<td>GWALIOR GROUP</td>
<td>BUNDELIKHAND GRANITE MASSIF</td>
</tr>
</tbody>
</table>

4.2 GEOLGY OF THE STUDY AREA

A detailed geological map (fig.4.2) has been prepared on the basis of field traverse to describe the geology of the study area. It shows that the rock formations of the area belong to Bundelkhand gneiss, Granitic gneiss, porphyritic granite and massive granites. These granitic rocks traversed by quartz reefs and basic dykes. The author has recognised eight type of granitic rocks on the basis of texture and colour variation of the rocks as described by Jhingran (1958), Saxena (1961) and Basu (1986). The following is the stratigraphic succession present in the area according to Basu (1986) and workout by the author mainly based on field relationship corroborated by petrographical considerations.

- basic dykes (fine-grained dolerites)
- quartz reefs
- **Bundelkhand**
  - Fine-grained pinkish grey granite
- **Igneous**
  - Medium-grained pink granite
- **Complex**
  - Coarse-grained grey granite
  - coarse-grained greyish pink granite
  - Grey porphyritic coarse-grained granite
  - pink porphyritic coarse-grained granite
  - Bundelkhand granitic gneiss
  - Bundelkhand gneiss

4.2:1 BUNDELKHAND GNEISS

It is not a common rock type in the study area. Minor exposures are noticed only in two places, specially in the west of Bagauta village and west of Dhamchi village near nala section.
FIG. 42: GEOLOGICAL MAP OF UPPER URMIL RIVER BASIN

INDEX

- BASIC DYKE
- QUARTZ REEF
- FINE-GRAINED PINKISH GREY GRANITE
- MEDIUM-GRAINED PINK GRANITE
- COARSE-GRAINED GREY GRANITE
- COARSE-GRAINED GREYISH PINK GRANITE
- GREY PORPHYRITIC COARSE-GRAINED GRANITE
- PINK PORPHYRITIC COARSE-GRAINED GRANITE
- BUNDELKHAND GRANITIC GNEISS
- B.G. BUNDELKHAND GNEISS

SCALE
0 1 2 3 Kms
In these two places the common mode of occurrence is along the fringes of hillocks formed by the fine-grained pinkish grey granite. Under the microscope, these rocks show quartz, feldspar (orthoclase) and biotite with little hornblend. These rocks exhibit typical gneissose structure.

4.2:2 BUNDELKHAND GRANITIC GNEISS

Granitic gneiss is noticed only in front of Maharaja College. The rock shows gneissic foliation along N 10° E-S 10° W direction and here the rock is dark greyish pink due to high percentage of mafic minerals.

4.2:3 BUNDELKHAND GRANITES

Approximately ninety percent part of the study area is covered by the Bundelkhand granites. The Bundelkhand granites, owing to exfoliation, (photograph No.7) have formed dome like masses (photograph No.8), which constitute tors and mounds (photograph No.9) giving rise to rugged and undulating topography (photograph No.10). The Bundelkhand granites is also exposed in the form of small hillocks giving rise to undulated and elevated ground. It varies greatly in texture, mineralogical composition and colour from one exposure to another. On the basis of texture and colour the author has recognised six type of granites which is described below.
PHOTO. No. 7
Exfoliation developed in Bundelkhand granite near north-east of Chhatarpur town.

PHOTO. No. 8
Bundelkhand granite exposed in the form of dome near Morwa village.
PHOTO. No. 9
Bundelkhand granite exposed in the form of flat top hill and tor near south-west of Hama village.

PHOTO. No. 10
Bundelkhand granite exposed in the form of isolated rugged hills near south-west of Hama village.
(i) Pink porphyritic coarse-grained granites

It is exposed only about one and half kilometer west of katarwar and about half kilometer west of palautha on the bank of Singhari river and in and around Katra village. These rock is commonly pinkish red on fresh surfaces, and becomes deeper red on weathering. It weathers easily and forms hillocks with gentle slopes. The feldspar pheno-crysts are tabular (Photograph No.11) with larger ones in the size ranges of 4 cm. x 1.5 cm., 3.5 cm. x 1.25 cm. etc.,The ground mass shows smaller feldspar (0.3 cm. x 0.1 cm.) mainly white in colour, colourless quartz and clots of biotite. Disseminated grains of pyrite are also seen in katra area.

The Examination under the microscope shows that the phenocrysts are of microcline, perthite and also of plagioclase which shows replacement by K-feldspars. The plagioclase shows oscillatory zoning. The ground mass is formed of quartz, albite, Saussuritised plagioclase and chloritised biotite. Apatite, Zircon, pyrite and Iron oxide are accessories. All biotite is greenish rather than brownish, and then chloritic which may indicate autometamorphic change. Common pleochroism is brown to deep green. Feldspar and quartz show marginal granulation, where sericitisation has also taken place. Quartz is usually medium-grained and undulose.
PHOTO. No. 11(A)

Pink porphyritic granite showing tabular phenocryst of feldspar.

PHOTO. No. 11(B)

Pink porphyritic granite showing tabular phenocryst of feldspar near south-west of Hama village.
(ii) **Grey porphyritic coarse-grained granite**

It is exposed about one kilometer south of pathapur and about three hundred metres south-west of Gorgaon. The feldspar phenocrysts are long prismatic with larger is of 3cm.x1cm. (Photograph No.12). Number of phenocrysts are less to compared than pink porphyritic coarse-grained granite. Pathapur grey porphyritic granite shows phenocryst of microcline with the size of 3.5cm. x 2.0cm. (Photograph No.13) and ground mass shows smaller feldspar, colourless quartz and small amount of biotite. Gorgaon grey porphyritic granite shows ground mass of quartz, hornblend. Examination under the microscope shows that the microcline is dominant as phenocrysts. Plagioclase also constitute some of phenocrysts. Zircon and sphene with iron oxide are other accessories.

(iii) **Coarse-grained greyish pink granite**

It is exposed in the form of hillocks and tors. The main expourses of these rocks are exposed about three kilometers south-west and four and half kilometers west of Hama, where the biggest exposer range about 1800mts. in length and about 950 mts.of width. These rocks are also exposed one kilometers south-west of Garhi-malahra. Small exposure of coarse-grained greyish pink granites also exposed about 700 metres south-east of Pathapur. These are red greyish pink coloured rocks, with feldspar, quartz and minor biotite.

Under the microscope, the rock shows microclïne (mostly perthitic), albite, quartz and minor biotite.
PHOTO. No. 12

Coarse-grained greyish pink granite showing 3cm X 1cm. size prismatic phenocryst of feldspar.

PHOTO. No. 13

Grey porphyritic granite showing 3.5cm. X 2.0cm. size phenocryst of feldspar.
The texture is equigranular, hypidiomorphic type. Disseminated sulphide mineralization is also recognised in Pathapur area, (Photograph No.14) as described by Rahman and Zainuddin (1993) from Bundelkhand massif near Mahoba, Hamirpur district, Uttar-Pradesh. Raghunandan et al. (1981) described that quartz reefs are mineralized. For example specks of copper occur in quartz reefs traversing pink granites near Shahpur, Lalitpur district and Sparse disseminations of chalcopyrite, pyrite and galena associated with pyrophyllite and diaspore occur in Tande-Bawal quartz reefs near Garhmau, Jhansi district Uttar-Pradesh. These occurrences make the Bundelkhand massif are a potential exploration target for porphyry Cu±Mo±Au deposits. (Sikka and Nehru, 1997). These rocks also shows typical spheroidal weathering, which is formed due to temperature variation. (Photograph No.15&16). Mullar joints are also found in these granite.In a nala section about 4 kilometres south-east of Pathapur circular depression or pot-holes are observed on coarse-grained greyish pink granite outcrops (Photograph No.17&18).These depression might have been formed due to the removal of basic clots in the granite by eddies and currents because further up direction in the same nala the granite outcrops show segregation of dark mafic constituents, mostly biotite. At the same locality the same type granite is traversed by two felspathic veins measuring in width of 8 cm.
PHOTO. No. 14 (A)

Photograph showing sulphide mineralization in coarse-grained greyish pink granite near Pathapur village.

PHOTO. No. 14 (B)

Photograph showing sulphide mineralization in coarse-grained greyish pink granite near Pathapur village.
PHOTO. No. 15

Coarse-grained greyish pink granite showing typical spheroidal weathering near Pathapur village.

PHOTO. No. 16

Coarse-grained greyish pink granite showing typical spheroidal weathering near Hama village.
PHOTO. No. 17

Circular depressions or pot holes observed on greyish pink granite in a nala section about four km. south-east of Pathapur village.

PHOTO. No. 18

Circular depressions or pot holes observed on greyish pink granite in a nala section about three and half km. south-east of Pathapur village.
These veins show cross-cut relationship, therefore, older felspathic vein is straight and undisplaced, where younger vein is displaced. (Photograph No.19).

(IV) **Coarse-grained grey granite**

It is exposed only about two kilometres east of Barairapurwa. It consists of white feldspar, lesser quartz and minor biotite and hornblend. Under the microscope, this rock shows, plagioclase, with an altered core followed outward by a relatively free zone and an outer most albite zone free from alteration.

(v) **Medium-grained pink granite**

It is exposed in the central portion of the study area between Urmil and Singhari river, several minor exposures are also exposed in various parts of the study area, it has a sharp to marginally diffuse contact with surrounding coarse-grained greyish pink granite. It is a massive rock with equigranular hypidiomorphic texture. Under the microscope, the rock exhibits dominant microcline, mostly sericitised, oligoclase, perthite, rare biotite and grains of zircon.

(vi) **Fine-grained pinkish grey granite**

It is a most dominant rock type in the study area. It has covered about seventy percent of the study area. It is exposed in southern and northern part of the study area. It is a greyish white to greyish pink rock with moderate proportion of dispersed ferromagnesian constituents. It is characteristically non porphyritic massive granite.
PHOTO. No. 19
Medium-grained pink granite showing cross-cut relationship in feldspathic veins near Pathapur village.

PHOTO. No. 20
A view of quartz reef exposed near Khnop village.
Under the microscope, the rock shows aplitic to pegmatitic intergrowth of microcline, albite, quartz, minor hornblend and biotite.

4.2.4 INTRUSIVE ROCKS

(i) Quartz reef

The most spectacular land marks in the study area are the NE-SW trending ridges of quartz. Pascoe (1950) described these as quartz veins which form abrupt wall like ridges rising about 175 metres above the surrounding country.

According to Jhingran (1958), the reefs give out small offshoots. He noted that the cataclastic and the granulated nature of the cherty reef rock would suggest that the reefs represent long narrow zones along which intense mylonitisation had taken place. Mishra (1960), considers the reefs as product of recrystallisation of quartzites. Saxena (1961), says that the rocks of the older series constitute the quartz reefs and the secondary quartz only forms the mantle of the outcrops. Prakash et al. (1975), consider these as dense sheared veins of quartz.

Geological mapping done by the author reveal that in the study area of about 453 square kilometres, there are ten major and fifteen minor quartz reefs (Photograph No.20), with average widths of 90 metres to 400 metres and lengths of 1 kilometre to 2.5 kilometre. The longest body passes through Khnop-Niwari is range 2.5 km. in length and 400 mts. in width. Smaller bodies are 10 mts. to 20 mts. wide and 300 mts. to 400 mts. long.
The bodies trend between N 33° E-S 33° W and N 40° E-S 40° W with an average trend of N 36° E - S 36° W. The majority of the quartz reefs occur in the area North-East and South-East of Chhatarpur town.

Quartz is the chief mineral constituent in most of the reefs. The reefs show a dominantly greyish white colour. Milky white colour is rarely observed in only Angah quartz reef. Over most stretches the quartz seems to be medium to fine-grained and some of the grains appear mega-crysts. However, the grain boundaries are fused, at places the rock is aphanitic. The reefs exhibit sharp contact with inclosing granites.

Examination under the microscope shows that the rock presents varied textures. Most parts show large rectangular grains of quartz with straight borders and undulose extinction.

Extensive examination in field could not reveal any foliation as noted by Pascoe (1950). Series of milky white secondary veins of quartz traverse the greater parts of the reefs. These are largely longitudinal in trend and alternate veins are coarse and fine-grained.

(ii) Basic dykes

These are chiefly dolerite, their dykes are not very common in the study area probably mark the last phase of intrusion. Majority of the dykes trend NW-SE cutting across the NE-SW trending quartz reefs.
Important bodies have been delineated through field mapping. (Photograph No.21). Intrusive relation of dolerite to quartz reefs could be seen at several places. The maximum length and width recorded is 500 mts. and 35 mts. respectively. Most of the dykes are concentrated in the south-western part of the study area. They are usually dark greyish green in colour and medium to fine-grained. A. one dolerite dyke near police lines, Chhatarpur presents typical spheroidal weathering (Photograph No.22).

Examination under the microscope reveals that the dolerites has pyroxenes, plagioclase and opaque minerals. Most of the dolerites exhibit ophitic to sub ophitic texture.

4.3 STRUCTURAL ASPECTS

The study area is not much subjected to the tectonic activities. Therefore, the presence of major structural features are not present in the area. Gneissic structure and joints are the predominant structural features of the area.

4.3.1 Gneissic Structure

Bundelkhand gneiss and granitic gneisse exhibit this structure. The segregation of the biotite and amphiboles is partially complete. The mafic minerals commonly form thin lenticles and layers. The general NE-SW strike with northwesterly dips around 35°-40° is exhibit by gneiss and granitic gneiss. (photograph No.23)
PHOTO. No. 21

Basic dyke (dolerite) exposed near the Police Line at Chhatarpur town.

PHOTO. No. 22

Photograph showing spheroidal weathering in dolerite near the Police Line at Chhatarpur town.
PHOTO. No. 23
Photograph showing gneissose structure in Bundelkhand gneiss.
4.3.2 Joints

Joints in the Bundelkhand granites are much dominant in southern and central area than northern area. Pink granites are more jointed than the grey granites. In the pink (grey) granite (All types i.e., Porphyritic, coarse, medium and fine-grained.) three sets of joints are commonly developed two steply dipping NE-SW and NW-SE trending ones (Photograph No.24) and the third horizontal. Joint spacing in the case of grey granite is quite wide sometime reaching up to three feet and and even more. (Photograph No.25)

While in the case of pink granites it is 10-15 cm. Most of these joints are open and openings are not filled by any dykes. Epidote, quartz veins fill some of the joints. The joint planes are usually straight. (Photograph No.26), No slickenside and striation are seen on the joint planes.

TABLE - 4.2
JOINTS IN BUNDELKHAND GRANITES, IN UPPER URMIL RIVER BASIN.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Attitude of joints</th>
<th>spacing</th>
<th>open or tight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>N 20°-35° E to 20°-35° W- dip 50° to 88° mostly towards S-E and sometimes sometimes towards N-W.</td>
<td>10cm-1.0 mts</td>
<td>usually open but tight</td>
</tr>
<tr>
<td>2.</td>
<td>N60°-80°W to S 60°-80° E dip 50° to 80° mostly sometimes towards S-W and sometimes towards N-W.</td>
<td>15cm-75cm.</td>
<td>usually open but tight</td>
</tr>
</tbody>
</table>
PHOTO. No. 24

Pink granite showing cross-joints near Pathapur village.

PHOTO. No. 25

Grey granite showing three feet wide open joint near Pathapur village.
PHOTO. No. 26

Vertical joint developed in pink granite near Pathapur village.
PHOTO. No. 26

Vertical joint developed in pink granite near Pathapur village.
PHOTO. No. 27

A view of quartz reef showing cross-joint at Chhatarpur town.
Some quartz reef also exhibit same type of Joints pattern. (Photograph No.27).

4.3.3 Lineament pattern

A lineament map of the study area has been prepared using Liss-II data which is described in Chapter-VI.