CHAPTER – 2
GEOLOGICAL SETTING OF STUDY AREA

2.1 REGIONAL GEOLOGY

The study area around Meghnagar block belongs to Jhabua region of Madhya Pradesh, which is covered by Aravallis formations of Archaean age and lava flows of Deccan Traps (Upper Cretaceous to Lower Eocene span). The generalized account of the geological features of Jhabua district has been described herein. The Jhabua region is occupied by different rocks ranging in age from the Archaean to Recent. The present study is confined to Meghnagar area of Jhabua District.

Geologically, the study region is occupied by rocks such as the granite, gneiss, schist, phyllite, quartzite, limestone, sandstone, coralline limestone, nodular limestone, Nimar sandstone and basalt. The region is rich in mineral resources such as manganese, phosphorite, quartzite, dolomite and rock matter. The region is characterized by the structural features such as the fold, fault, joint and foliation. Landforms include hill, valley and plateau. The hydrogeological studies in the study region indicate the presence of groundwater under both unconfined and confined conditions. The general geological sequence of Jhabua region has been recorded, (Figure 2.1, Table 2.1).

Figure 2.1 Geological map of India showing location of the study area
Table 2.1 Geological succession of the Jhabua District (Modified after Pandey, 2000 and Tiwari et al., 2003).

<table>
<thead>
<tr>
<th>System</th>
<th>Lithostratigraphic unit</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recent</td>
<td>-</td>
<td>Alluvial soil and Laterites</td>
</tr>
<tr>
<td>Cretaceous to Eocene</td>
<td>Deccan traps</td>
<td>Basalt lava flows with intertrapean clay and calcareous beds</td>
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<tr>
<td></td>
<td></td>
<td>----------------------------------------------------------------------------</td>
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<tr>
<td>Upper cretaceous</td>
<td>Lametas and Bagh beds</td>
<td>Limestone, Sandstone, Coralline limestone, Nodular limestone, Nimar sandstone</td>
</tr>
<tr>
<td></td>
<td>Intrusives</td>
<td>Pigmatites, Quartz veins and basic dykes</td>
</tr>
<tr>
<td>Ancient</td>
<td>Aravalli super group</td>
<td>Granite gneiss, Dolomitic - Limestone, Quartzite and Phyllites</td>
</tr>
<tr>
<td></td>
<td>Banded gneissic complex</td>
<td>Gneisses schist, Dolomite marble, Ultra basic rock, conglomerate, mica schist etc.</td>
</tr>
</tbody>
</table>

The characteristic features of the geological formations such as banded gneissic complex, Aravalli supergroup, Bagh beds, Deccan traps of Jhabua region are described herein.

1. BANDED GNEISSIC COMPLEX

Heron (1936, 1953) considered the vast tracts of banded gneisses as forming basement for the overlying Aravalli rocks. Lithological similarity, presence of conglomerates and identification of angular and overlapping relationships were the key factors in Heron’s formulation of stratigraphic framework for Precambrian geology of Jhabua District. It is the oldest geological formation of Jhabua area and constitutes the basement for the rocks of the later periods. The different rocks types are conglomerate, micaceous rock, dolomitic marble, ultrabasic rocks and chlorite schist. Gneissic Complex towards south-west villages Kajlidongri, Rassori and Pangulla of Jhabua District.
Geological Features:

- **Mica schist**
  It is common in metamorphosed clay-rich sediments called Mica schist. Mica schist occurs in some granites and granitic pegmatite, where it can form meter-sized plates. This is highly weathered and appears grayish and greenish in colour (Wilson, 2010). This feature is observed in the south-western part of village Pangula, Ranapur block.

- **Ultrabasic rock**
  The exposures are established in the form of discontinuous linear patches in proximity with the lime-silicates rocks and other metamorphic rocks. The ultrabasic rocks are hard and massive in appearance. This feature is observed in the villages of Pangula and Kajlidongri in the Jhabua region.

- **Conglomerate**
  Conglomerate is a clastic sedimentary rock with large, rounded fragments in a fine grained matrix and is characterized by the presence of large particles. This rock reflects nature of the rock types that have been eroded (Wilson, 2010). Conglomerate consists of rounded fragments of different sizes generally of 1 to 3 mm in size cemented commonly in clay or mixed matrix. Conglomerate occurs near Naganwat, Pipalkonta, Devigarh, Visalpur and Gura-chhota villages.

![Figure 2.2 A view of Conglomerate exposed near Naganwat village, Meghnagar, Jhabua District, Madhya Pradesh.](image-url)
• **Dolomitic marble**
It is most promising in the Jhabua District, which occurs in from of parallel bands running in directions south-west and north-east. The dolomitic marble is hard and compact rock crystalline in nature, colour varies from snow white to grey. Tentative grade corresponds to the blast furnace grade specification, but the reserve is small for any large scale mining. It is mainly used as flux in iron and steel industry. Its other uses are refractory brick manufacture; mosaic tiles and rangoli manufacture. The important localities of these bands are villages of Kajlidongri, Rassori, Rambhapur and Pipalkonta (Pandey, 2000).

2. **ARAVALLI RANGE**

The Aravalli Mountain Range (AMR) occurs in western parts of Madhya Pradesh and physiographic regions represented by the Aravalli hills the west part of the District. The 800 Km long AMR extends from near Delhi in north to Jhabua in central India. Archaean rocks of Jhabua district occur in Aravalli hill region in the form of a part of the very large anticline and synclinorium. An effort has been made to identify major lineaments; different tectonic blocks and their litho stratigraphy have been worked out by Geological Survey of India (2010).

The recognition of Aravalli series in Jhabua belt is of much significance. The different lithological units are phyllite, quartzite, dolomite with few marble lenses and limestone. These rocks occupy a big area in the western part of the Jhabua District. Their southern-western extension is around villages of Phoolmal, Pipliya, Negriya, Anterveliya, Bhagora, Kajlidogri, Rassori, Naganwat, Kachaldara, Kelkua, Mandali, Madrani, Pipalkonta, Garwara, Agral, Phuttalab and Kheri.

• **Granite gneisses**
Granite gneisses usually occur where the mica schist and phyllite are not observed. The well developed exposure of these rocks has been observed near the district Hospital and Jail of Jhabua City. In general, gneisses appear as having alternating bands of quartz and feldspar. Petrographic studies have indicated the uniformity in mineral assemblage of the pink and grey granites (Mahapatra, 2006). These are regularly exposed in the plains and low-lying area, in contrast to the pink and grey granites, which are generally found as the hillocks or mounds.
The granites rocks have been observed gray granite, pink granite, granitic gneiss and quartz feldspathic gneiss. Granites gneisses are exposed at Rambhapur village in Meghnagar area.

- **Quartzite**

Quartzite is the metamorphic equivalent of quartz, sandstone. Quartzite is of white and pink colour, medium specific gravity. The principal constituent is quartzite, which is a non-foliated metamorphic rock, resulted due to thermal or regional metamorphic of arenaceous rocks such as sands and sandstone. The quartzite exposure is noted near villages of dedicated Phoolmal, Antervaliya, Pipliya, Anas kothi, Meghnagar town, Rambhapur, Madrani, Kajlidongri and Rassori Jhabua district (Mahapatra, 2006).

### 3. BAGH BEDS

The marine Cretaceous rocks, developed in the Narmada Valley covering an extensive area from Indore (Madhya Pradesh) to Rajpipla (Gujarat) known as the Bagh Beds. The major portion of southern-eastern part of Jhabua District is covered by the nimar Sandstone, nodular limestone and coralline limestone exhibiting considerable variation in their characters (Kumar, 1985, 1991). The rock types of Bagh beds are displayed (Table 2.2).

**Table 2.2 Bagh beds succession of the Jhabua region.**

<table>
<thead>
<tr>
<th>Deccan Traps</th>
<th>Bagh Beds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coralline Limestone</td>
</tr>
<tr>
<td></td>
<td>Nodular Lime stone</td>
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<tr>
<td></td>
<td>Deola marl</td>
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<tr>
<td></td>
<td>Nimar Sand stone</td>
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</tbody>
</table>

Geologically, the study region is important characteristic such as Nimar sandstone, nodular limestone and coralline limestone. The important feature of the rock types are described in the following lines:
• **Nimar sandstone**
Nimar sandstone developed in Bagh area (Jhabua and Dhar districts) is covered by Nodular limestone and it is mainly horizontal. Nimar sandstone was deposited in fresh water. It is good and durable building stones. The Nimar sandstone exposed at villages of Para and Devjhir (Kumar, 1991).

• **Nodular limestone**
The Nodular limestone is of light cream colour, compact and argillaceous. It is usually horizontal, fine grained and variable of colours. In the Jhabua region, lower horizontal part of dark coloured, granular grey coloured beds are exposed on Bagh, Kukshi road in Dhar District. This bed covers 2.10 km area and nodular limestone exposure dedicated in Devjhiri village of Jhabua region (Krishnan, 1982).

• **Deola Marl**
Deola Marl is only 3 m. thick but richly fossiliferous. The Deola marls are exposed in Bagh, Para (Jhabua) and Kukshi (Dhar District). Deola marl is the chief fossiliferous bed but closely related fossils occur (Bagh District Dhar). The most important fossils include -Echinoids-Cidaris, Hemiaster, Gastropods - Turritella.

• **Coralline limestone**
Coralline Limestone is developed in North-South direction 800 m. range in Bagh area. Its colour is sometime red and white. This limestone in upper part of bed is having high silica percentage. Thickness of Coralline bed is approximately 0.5 m. It is fine to medium grained, yellow, brown, purple yellow, red and white colour. Bagh beds are generally exposed in the 43 sq km. is eastern part and boarder of the Jhabua and Dhar District. The thickness of Bagh Beds in North-South is 14.20 km. Oldest unit of these beds in area is Nimar sandstone (Krishnan, 1982).

4. **DECCAN TRAPS**
The Deccan traps extend over an area of 200,000 sq. miles, including Bombay, Kathiawar, Kutch, Madhya Pradesh and Central India. The lava flows of Deccan Trap igneous activity cover an area of about 800 Sq km of Jhabua district and they are the considered as a single rock unit. The topographical features of rest of the lava plains and lava plateaus are typical of the rest of the Deccan Traps of Malwa region. The eruption of volcanic materials was mostly through the fissures and the Deccan Trap
exposures of Meghnagar area, are observed at Petlawad, Jhabua town, Ranapur and others. The Deccan Traps are mainly composed of basalts with little variation at places. Around the Jhabua, lava flow exposed in Hathipawa and Malkhandawi and Khalkhanwai (Meghnagar) and the rock types of plateau like hill near Thandla have been examined. Hathipawa hill located near Jhabua, has the maximum elevation reveals the succession of basaltic lava flow along the road cuttings (Krishnan, 1968, 1982). The traps show well developed columnar jointing caused by tensile stresses and result of contraction due to cooling. The columns are fairly long and polygonal.

2.2 GEOLOGY OF STUDY AREA

The geology of an area is essential for the optimum development of the water resources. The rock types including phyllite, quartzite, meta-conglomerate, limestone, sandstone and flows of the basalt. This litho-group shows continuity with the Aravalli super group of Rajasthan. The geological map and succession of study area have been displayed (Figure 2.3, Table 2.3).

Figure 2.3 Geological map of the study area (Modified after Khan et al., 2005).
Table 2.3 Geological succession of the Meghnagar study area (Khan et al., 2005).

<table>
<thead>
<tr>
<th>Age</th>
<th>Formation</th>
<th>Lithology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cretaceous to Eocene</td>
<td>Deccan Traps</td>
<td>Basalt flows</td>
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<td></td>
<td>---------------------</td>
<td>------------------------------------------------</td>
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<tr>
<td></td>
<td>Unconformity</td>
<td></td>
</tr>
<tr>
<td>Upper cretaceous</td>
<td>Lametas and Bagh beds</td>
<td>Limestone, sandstone</td>
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<tr>
<td></td>
<td>Unconformity</td>
<td></td>
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<tr>
<td>Archaeans</td>
<td>Aravalli super group</td>
<td>Granite gneiss, Phosphate bearing dolomitic-limestone, Quartzite and Manganese bearing phyllite</td>
</tr>
</tbody>
</table>

The Meghanagar group occurs towards west of Anas lineament zone. The granite bodies of the Aravalli period are exposed displaying features, petrologically of much interest in the Kajlidongri village of the study area. The present study has been carried out in and around Meghnagar area located in Jhabua District of Madhya Pradesh.

2.2.1 ARAVALLI RANGE

The Aravalli Mountain Range (AMR) southern-western and northern-western parts of Meghnagar block of Jhabua region is represented by the Aravalli hills. The different lithological units are phyllite, quartzite, and dolomite with few marble lenses. Their south-western extension is around Kajlidogri, Rassori, Naganwat, Kachaldara, Kelkua, Mandal, Madrani and Pipalkonta villages and whereas the eastern limit extends up to Garwara, Agral, Phuttalab and Kheri villages.

- **Manganese bearing Phyllite**

Phyllite is the most prominent rock, occupying low-lying region in study area. Manganiferous sediment in association with these quartzites occur interbeded with Phyllite at many places. Those at Kajlidogri are the principal source of manganese ore in the Meghnagar block (Khan et al., 2005).

The rock exposure dedicated the south-western Villages of Kajlidogri, Rassori, Naganwat, Mandal, Rambhapur and Pipalkonta. Phyllite marks a stage of more advanced metamorphism as a result of that its grain size is coarser than slates. Sericite
and chlorite with or without biotite exceeds 50%. Albite may amount to as much as 20% and quartz is other abundant constituent (Figure 2.4).

Figure 2.4 A view of Phyllite exposure near Naganwat village, Meghnagar block, Jhabua District, Madhya Pradesh.

- Quartzite
  In the present area quartzite is regularly intercalated with the phyllite, quartzite usually consists completely of recrystalized quartz. Most commonly these are derived from siliceous sediments- quartz arenite or pure chert (Figure 2.5).

Figure 2.5 Photograph showing a close up of Phyllite with existence of Quartzite near Naganwat village in Meghnagar study area.
The grade of metamorphism can be conditional based on the nature of associated rocks of other lithology. Rock exposure dedicated the south-western Villages of Kajlidogri, Rassori, Naganwat, Mandali, Rambhapur, Pipalkonta, Umradara, Gujarpara, Goslia chhota and Rakharia.

- **Phosphate bearing dolomitic-limestone**
  Phosphate bearing dolomitic-limestone occurs as bands in north-western part of the Meghnagar region a 13 km., long band running north-south from Madrani to Kachaldara in Meghnagar area and adjoining localities in villages of Amliyamal, Khatama, Talavalli, Devziri and Nagankheri (Figure 2.6). It is a compact, fine-grained, massive rock. These bands are associated with lenses and bands of chert and veins of quartz. In Meghnagar study area, recently phosphorite has been discovered in association with these bands. This limestone can be used for lime burning and as filler in fertilizer factory (Khan et al., 2005, Pandey, 2000).

![Figure 2.6 Displaying a view of Dolomitic limestone association with phosphorite exposure around Kachaldara village.](image)

- **Granite gneisses**
  The well developed exposures of granite gneisses have been observed near the Kajlidogri and Rassori villages in the Meghnagar region. In general, gneisses are in appearance with alternate band of quartz and feldspar.
2.2.2 BAGH BEDS

The main part of South-Western and North- Eastern part of Meghnagar area is covered by the Sandstone, nodular limestone. The exposures are dedicated Villages of Khatama, Kachaldara, Kelkua, Mandali, Hatyadeli, Jhonsali and Rajpura.

- **Limestone**
  Limestone is mainly made of the mineral calcite (Caco$_3$), limestone can formed by the accumulation of biochemical material. The Nodular limestone is greys-white colour, compact. This bed covered 1 km area and nodular limestone exposure a close up of basaltic rock. In the Meghnagar region, dark coloured beds are exposed near villages Hatyadeli, Jhonsali and Rajpura (Figure 2.7).

![Figure 2.7 Photograph showing a view of Limestone near Jhonsali village in Meghnagar block, Jhabua, Madhya Pradesh.](image)

- **Sandstone**
  Sandstone forms an important ingredient in construction of buildings. It should be clean and of specific sizes for different uses. Much of mica, feldspar and iron-oxide in sand are unwanted (Prasad, 2011). The contribution of sand is generally made from River beds and the resource is vast. The rock exposures are witnessed in villages of Khatama, Kachaldara, Kelkua and Mandali.
2.2.3 DECCAN TRAPS

Overlying the Archaean and Bagh beds are 150 m. thick basalt of Deccan traps. Around the Meghnagar block, lava flow exposed in villages of Hatyadeli, Jhonsali, Semalpara, Machlaimata, Thandla, Chainpura, Malkhandawi, Khalkhandawi and Jarat. The rock type of plateau like hill has been examined near Jhonsali and Malkhandawi villages.

**Basaltic lava Flows of study area:**

Basaltic lava flows are exposed as the vertical and horizontal flows in the study area. Two lava flows have been identified:

- **First flow**
  
  First flow is well exposed in parts of study area at an elevation of 337 m (amsl). Lava flow along the Hatyadeli nala section around Jhonsali, Hatyadeli, Malkhandawi, Khalkhandawi and Rajpura villages. The flow is characterized by dark to grey colour, well developed grains with 5 to 15 m thickness. The basalts show wide variety of shear joints in the study area (Figure 2.8).

![Figure 2.8 A view of first flow exposed near Jhonsali village in study area.](image)

- **Second flow**
  
  Second flow is well exposed at an elevation of 320 m (amsl). Lava flow beside the Pat river section around Umarda and Garwara villages. The flow is characterized by dark
to brownish colour. The flow is fine grained basalt with 4 to 10 m thickness. The structural feature includes the presence of columnar joints (Figure, 2.9).

Figure 2.9 A view of second flow exposed near Umarda village in study area.

Structural features:
1. Folds
Fold is defined as an undulation in the rock. The style and the intensity of folding fluctuate from place to place. A fold being an undulation or a bend, it is divided into two parts called as the “limbs”. The well developed folds in the metamorphic rock of the study region (Figure 2.10). The rock exposure dedicated the south-western villages of Kajlidogri, Naganwat and Pipalkonta (Gokhale, 2013).

Figure 2.10 Photograph showing pattern of fold in Phyllite rock near Naganwat village in Meghnagar block, Jhabua District.
2. Joints
These generally share the properties of the rupture and fracture. The well developed columnar joints in basalts are very common in the study area. The columnar joints exhibit a two, three or four sided prism arrangement. The columns develop perpendicular to the cooling surface, so that in a sill or lava flow stand vertically in a dyke.

![Columnar Joints](image)

**Figure 2.11 Photograph showing pattern of columnar joints in basaltic rock near Umarda village in Meghnagar block, Jhabua District.**

The columnar joints are well developed in Umarda, KhabKhandawi and Malkhandawi villages. Joints play very important role in the process of the percolation of water and increase in ground water level (Figure 2.11).