CHAPTER - 2
GEOLOGY

2.1 Regional Geology:

Through the general geology of the area has been mapped by the GSI in the usually way, various their senslar have contributed to diverse geological aspects of the region. Notable amongs these are Alexander (1979), Babu (1967), Blanford (1869), Barrooah (1962), Choubey (1967), Dixit (1970), Dubey (1952), Durge (1970), Gandhe (1970), Krishan (1982), Medlicott (1859, 1860), Mishra (1970), Pascoe (1975), Rajrajan (1978), Subramanyan (1972, 81), Wadia (1981), West (1964-81) etc. They recorded the principal rock formations namely Bundelkhand granite (quartz veins, basic dyke), Bijawar (white quartzite, red shales & lime stone), Vindhyan (The Vindhyan supergroup has been divided into two lithostratigraphic group viz. the lower Vindhyan and upper Vindhyan groups (medlicott, 1859) separated by a well marked erosional unconformity), Deccan traps and Intertrappean beds, and Alluvium and laterite. The general geological succession of the study area is given below, after Rajrajan (1978).

The Archaean, Bundelkhand (Photo. 2.1, 2.2) granite are the oldest rocks in the Dhasan basin and covered a very large part, 63.6% of the basin. These are succeeded by the Bijawars that rest with non-conformity on the Archaean. Overlying the Bijawars (Photo.2.5) unconformably are the Vindhyan. There are two divisions in the Vindhyan, the lower Vindhyan and the upper Vindhyan. The Semri series constituting the lower Vindhyan comprises only sandstones and shales in this basin. The upper Vindhyan (Kaimur and Rewah series) consist largely of sandstones forming extensive plateaus and scarps

The Vindhyan sandstones and shales show ripple marks (Photo.2.6), current bedding and other characters pointing to shallow water and sub-aerial deposition. After the deposition of the Vindhyan in Pre-cambrian or early Palaeozoic times there was a long hiatus in the stratigraphical history
Photo 2.1 Major Joint in Bundelkhand Granite Exposed Near Ramtoriya Village

Photo 2.2 Highly Weathered Bundelkhand Granite, One Kilometer South-West of Shahgarh
Photo. 2.3 Black Shale Exposed About 400m North-East of Barethi Village

Photo. 2.4 Greenish Brown Shale, Exposed About 4 Kilometer South-East of Shahgarh
Photo. 2.5 Parallel Joint Developed in Bijawar Rock Near Kharoo Village

Photo. 2.6 Ripple Mark in Sandstone Near Madanpur Village Lalitpur
Fig. 2.2

Dhasan River Basin, India
Geology
(Based on Satellite Imagery
& Selected Field Check)
Stratigraphic Succession

<table>
<thead>
<tr>
<th>Recent</th>
<th>Alluvium &amp; Laterite</th>
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<tr>
<td>Lower Eocene and Upper</td>
<td>Deccan Trap and</td>
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<td>cretaceous</td>
<td>Intertrappean Beds</td>
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Unconformity

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<thead>
<tr>
<th>Pre-Cambrian to Cambrian</th>
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<tr>
<td>Upper Vindhyan</td>
<td>Upper Rewah Sandstone</td>
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<td></td>
<td>Lower Rewah Sandstone</td>
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<td></td>
<td>Kaimur Sandstone</td>
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<td>Kaimur Conglomerate</td>
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Unconformity

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<td>Dulchipore Conglomerate</td>
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Unconformity

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<th>Pre-Cambrian</th>
<th>White Quatszite Red shales</th>
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<tr>
<td>Bijawar Series</td>
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Non-conformity

<table>
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<tr>
<th>Archaean</th>
<th>Quartz veins &amp; basic dyke</th>
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<tr>
<td></td>
<td>Bundelkhand Granite</td>
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After Rajrajan (1978)

of the basin. The Deccan Trap comprises 10 or more flows of basaltic lava, with an average thickness of about to 50 feet. They were poured out in enormous quantities through fissures during Cretaceous and Eocene times. The characteristics feature of Deccan Trap topography (Photo. 2.7, 2.8) is its terraced nature, horizontal platforms representing the junctions of flows, terminating in the scarp slopes, which make an angle of about 25° with the horizontal. This topography owes its origin to the fact that many of the flows have an upper vesicular layer, or an upper weathered surface, which is softer than the other portions of the flow, providing a plane that is easily eroded. Around Sagar, in the Deccan Trap hills to the north and south of the town, a prominent platform occurs at about 1900 feet, separating the 8th and 9th flows.
Photo 2.7 Cracks in Basalt in Sesai Village

Photo 2.8 Joints in Basalt Near Paharikalan Village Lalitpur
Around Sagar the scenery consists of hills of horizontal Vindhyan and Deccan Trap, the former commonly standing up above the level of the latter. Study of the elevation of the different flows and inter-trappen beds in the vicinity of Sagar shows that there has been no faulting.

The topography of the Vindhyan in the Sagar area is one that is characteristic of horizontal sedimentary rocks. Where the highest bed is massive sandstone, the hills are fairly flat topped. The scarp slopes are steeper than those of the Deccan Trap, and in places may be almost vertical above the scree slope. Being fairly pure quartzitic sandstone, the weathering is almost entirely mechanical, and the roots of trees penetrating the vertical joints and splitting the rocks apart generally help erosion. Unlike the Deccan Trap, terracing in not a feature of the Vindhyan.

South basin of the Dhasan river the flat valleys between the Vindhyan hills are commonly partly filled with Deccan trap, and the complete profile of the original Pre-Deccan Trap valleys cannot be seen. However, at Naryawali (Photo. 2.9a &b), some 18 kms NW of Sagar, there occur two hills of Vindhyan, between which the village is situated. Here, for some distance around the hills, the Deccan trap has been completely removed, and the original Vindhyan topography can be seen to consist of the steep scarp slopes surrounding the two hills, with a platform between and around the hills. This platform is not quite horizontal, sloping gently away flow the sharps, and may, unlike the horizontal Deccan trap platforms, be appropriately termed a pediment.

A further difference between the topography of the two formations in the Sagar area is to be seen in the shapes of the contours on the scarp slopes. In the case of the Vindhyan scarps the contours are fairly smooth, with few indentations. The scarps are steep, in places approaching verticality and there is little opportunity for streamlets to develop. But on the Deccan Trap scarps the contours are indented by many little streams which unite lower down to provide a dendritic pattern of drainage.

As a result of this difference it is generally possible to tell from a topographical map which hills are Vindhyan and which Deccan trap. The distinction is clearly seen in the hills to the south-west and north-west of Sagar (Topo-sheet No. 551/9). The former, e.g. around Rajauwa, are of Deccan Trap; the latter, e.g. on either side of the Karawan river, are of Vindhyan.
Photo. 2.9 (a) A View of Hill of Sandstone in Naryawali Village

Photo. 2.9(b) A View of Hill of Sandstone in Naryawali Village
2.2 Bundelkhand Granite:

The greater part of Bundelkhand is occupied by the Bundelkhand granite and gneiss, grano-diorite and pegmatite. The entire massif covers an area of 26,000 square kms, approximately equally shared by U.P. and M.P. states. It is really a massive granite with rare and obscure banding or foliation, so that the term, ‘gneiss’ is rather a misnomer as applied to the typical rock. The Bundelkhand granite is the most prominent formation and it is found forming dome-like masses, tors and mounds (Photo.10). It is mostly a pinkish; medium grained granite, though at places it shows some gneissic foliation. The foliation is developed in the Bundelkhand gneiss, it has a general NNE direction.

The Bundelkhand gneissic country is traversed by pegmatite veins and well marked quartz reefs of varying dimensions. These quartz reefs (Photo.2.12) form a characteristic feature of the land scape in lower Bundelkhand and trend in a NE or NNE direction. In some places they form dams across the courses of streams. They consist of bluish white quartz associated some times with a little serpentinous material. It is interesting that the quartz reefs stop short of the schists in the southwestern region.

There are also numerous basic igneous dykes traversing the gneiss, their general trend being NNW or NW. These are also fairly prominent though not as much as the quartz reefs. In contrast with the quartz reefs, which show the effect some crushing, the basic dykes are free from disturbance or metamorphism. From the geological map of the Dhasan basin, it may be noticed that a very large part covered by Bundelkhand granite. In the Dhasan basin there are 69 dykes present in Bundelkhand granite. The central northern portion of Madhya Pradesh including the Jhansi and Hamirpur district of Uttar Pradesh is occupied by a slightly foliated granite.

2.3 Bijawar Series:

This series, first recognized in the Bijawar state in Bundelkhand (Central India), occurs in a series of outcrops extending from Bundelkhand to the south of the Narmada and has a thickness of less than 800 feet in the type area (H.B. Medlicott, 1860). Medlicott (1859) first introduced the name ‘Bijawar series’ for the sediments and interbedded volcanics lying between the Bundelkhand granite, and the ‘Vindhyan system’ of rocks. Quartzites and sandstones, sometimes conglomeratic form the basal beds resting on gneisses. A siliceous limestone is found with the quartzites.
Photo. 2.10 Bundelkhand Granite Exposed in the Form of Tors and Mound Near Shahgarh

Photo. 2.11 Parallel Joint in Bundelkhand Granite 200m North-East of Tikamgarh
2.12 Quartz Reef in Bundelkhand Granite Exposed in Shahgarh
Photo. 2.13 Fracture & Joint in Dyke Exposed in Dhasan River Near Girar Village

Photo. 2.14 Dyke Exposed in Dhasan River Near Girar Village
Three are rather irregularly distributed and are of less than 200 feet thickness. These are overlain by Ferruginous sandstone containing pockets of hematite. The rocks are either horizontal or have a low south easterly dip, though in a few places in the south they have been sub-jected to crushing.

The Bijawars consisting of quartzites, limestones and red shales. The quartzites are thick bedded, massive and white. They generally show gentle southerly dips and overlie the Bundelkhand granite with a non conformity. Near the granite they are thin-bedded. The limestones are impure and bluish-grey in colour. They show rolling dips and are silicified to various degrees. Towards the top they are highly silicified and pass into a compact breccia. Associated with the limestones are red shales and hornstone. Some of the shales contain ferruginous nodules rich in haematite which were formerly worked for the extraction of iron by local smelters (Photo.2.15).

2.4 Vindhyan Supergroup:

As described by Wadia, “The Vindhyan system is a vast stratified formations of sandstone, shales and limestones encompassing a thickness of over 4270 metres, developed principally in the central Indian highlands which form the dividing ridge between Hindustan proper and Deccan, and known as the Vindhyan mountains.” The Vindhyan system ranks third in surface extent within the rock area of the Peninsula. It occupies a single basin a larger surface than the combined areas of any other formations except the granite gneisses and the Deccan trap. It occupies a large basin of the country, a stretch of over 103600 square kms from Sasaram and Rohtas in western Bihar to Chitorgarh in Rajasthan, with the exception of a central tract in the Bundelkhand. A large area of the Vindhyan rocks is buried beneath the Deccan Traps.

2.4.1 Lower Vindhyan:

The lower Vindhyan is separated from the upper by an unconformity that is very apparent in the north but which tends to disappear in the southern areas of Mewar Chitor and the Son valley. This signifies that earth-movements supervened after the deposition of the lower Vindhyan
Photo. 2.15 Ferrogenous Sandstone Exposed About 200m North-East of Barattiha

Photo. 2.16 Rock Phosphate Exposed in Hirapur Mine
sediments, which elevated them into land in the Aravalli area of the north and put a stop to further sedimentation in these areas. When, after re-submergence, deposition was renewed, an interval of time had elapsed, during which the former set of conditions disappeared and the mountains and highlands that yielded the detritus changed completely. Such earth movements, causing cessation of deposition in a particular area, with a change in the physical conditions, are at the root of stratigraphic divisions.

The lower Vindhyan series are represented here by the semri series, which consists of the Dulchipor conglomerate, sandstones and porcellanite beds. The Dulchipor conglomerate rests unconformably over the Bijawar quartzites. The conglomerate is composed of fragments of white veinquartz and quartzite embedded in a siliceous matrix. The semri sandstone are coarse grained, gritty, and thinly laminated. They show current bedding prominently. The sandstone is white to pinkish in colour and at places contains intercalation of shale. The porcellanite beds consist of silcified shales which are generally black or khakhi-green (Photo.2.17) in colour. The beds are either horizontal or gently dipping.

2.4.2 Upper Vindhyan:

The upper Vindhyan series are exposed in the great Vindhyan basin. They consist largely of sandstones and shales with subordinate limestones, the sandstones forming extensive plateaux around and to the south of the Bundelkhand granite mass. The upper Vindhyan series consist of the Kaimur series, and the Rewah series.

2.4.2.1 Kaimur Series:

In Bundelkhand the Kaimurs show a basal conglomerate containing pebbles of jasper the main formation being a fine-grained quartzite of grayish or brownish colour with conspicuous current bedding.
Photo. 2.17 Sandstone Intercalated With Shales in Extreme South of Shahgarh

Photo. 2.18 Conglomerate Exposed About Three Kilometers South-West of Shahgarh
Photo. 2.19 Elephant Skin Weathering, a Characteristic Feature of Dolomite Near Bajna Village

Photo. 2.20 Stromatolite Structure in Dolomite, Near Bajna Village
The Kaimur series is found in the northern part of the Sagar district and consists of conglomerate at the base and sandstone at the top. The Kaimur conglomerate marks the unconformable junction between the lower and upper Vindhyans. It consists of pebbles of banded jasper, grey and white cherts. The Kaimur sandstone is generally pinkish in colour, compact, massive, fine grained, and quartzite. The beds are horizontal or gently dipping.

2.4.2.2 Rewah Series:

The middle series of upper Vindhyan system is represented by the Rewah series. The Rewah series consists of Upper Rewah sandstone and lower Rewah shales. The Rewah series is exposed around the north and eastern part of the Sagar district.

The upper Rewah sandstone is the prevalent formation of this series. It is a fine-grained, hard, compact, quartzite, vitreous sandstone, and in colour reddish-brown, white, red, pinkish and gray, compact and quite resistant to weathering, and frequently breaks along the joints into large cubical blocks. It is generally massive strata though flaggy and thinly laminated varieties are present at places. The thickness of the sandstone varies from place to place. The beds are horizontal or show gentle and rolling dips. Current bedding and ripple marks are often found in these sandstones.

The lower Rewah shales are splintery and in colour they are red, pinkish-yellow, brown or white.

2.5 Deccan Trap:

This great volcanic formation is known in Indian geology under the name of the Deccan Trap. The term ‘trap’ is a vague general term, which denotes many igneous rocks of widely different nature, but here it is used not in this sense but in its Swedish meaning of ‘stairs’ or ‘steps’ in allusion to the usual step like aspect of the weathered flat-topped hills of basalt which are so common a feature in the scenery of the Deccan Trap. Stratigraphically above the Cretaceous formation of the Peninsula is a series of the volcanic rocks which forms one of the most prominent and widely spread of all the rock systems found in this region. This basaltic material is known as the Deccan Trap. It dominates in the south part of the Dhasan river basin.
The geological map of the Dhasan basin (Fig. 2.2), it becomes clear that the Deccan traps are dominating in the south part of the basin, and it has a very irregular boundary with the underlying Vindhyan formation. It consists of ten or more horizontal flows of light-gray, and dark-gray basalt. The traps wither with spheroidal exfoliations (Photo.2.21) which frequently give rise to large rounded boulders of the out-crops. Glassy vesicular, scoriaceous and amygdaloidal (Photo.2.22) varieties are also met.

In this note attention is directed to the estimated duration of volcanicity in the area of Sagar in Madhya Pradesh. In the latter area Alexander (1980) has estimated that the first six of the 9 flows found there were erupted over a period of 8 million years. Therefore, in each area well over one million years on an average are estimated to have elapsed between the eruptions of successive flows. But a million years is a very long time, and one would except that during such a long period a great deal of erosion would take place, leading to the development of a new topography on the top of a flow after eruption. But the field evidence is quite contrary to this.

Around Sagar the most striking feature of the Deccan Trap topography is the flatness of the upper surface of the flows. To take one of many examples 3-4 miles to the north of Sagar, the top of the eighth flow on which the village of Shyampura is situated, forms a flat plateau nearly three miles long from south to north and more than a mile wide. The level of this plateau does not vary more than 50 feet over this distance. There is no sign of its having been eroded prior to the eruption of the next flow, though a little laterite has formed in one place. Again, the junction of the sixth flow, with overlying flow is very well seen in a cliff face by the university gate where the junction is a straight line. Though the top 4-5 feet of the lower flow are badly weathered, there is no sign to any erosion having taken place. Other flows in the area show similar flat tops. It is therefore difficult to believe that on an average more than a million years could have elapsed between successive eruptions without erosion having taken place.

Around Sagar, it appears that the lava poured out on an uneven surface of the Vindhyan rocks. The present topography exhibits the Vindhyan hills at a higher elevation than the Deccan trap in some places. It is suggested by west and Choubey that the boundary between the two, is a disconformity, the lava exposed on the surface eroded much faster than the
Photo. 2.21 Spheroidal Weathering in Basalt Near Mangal Geeri Sagar

Photo. 2.22 Amygdule (1 to 3 cm diameter) in Basalt Jasrathi Hills Near Jasrathi Village
hard compact Vindhyan sandstone. Due to the differential weathering and erosion, the present topography has come into existence. During the field study, the author has seen that the Deccan trap flows only partly fill the Vindhyan valleys near Sagar. On the basis of weathering, flat traces and structural characteristics, different flows around Sagar have been recognized. The weathered material of fifth flow is of small rounded boulders, which are seen along the road from the Sagar University to its playground.

2.5.1 Inter-Trappen Beds:

The inter-trappean bed occur in some parts of the Madhya Pradesh; in Chhindwara they have yielded plant remains, among which are palms with distinct Eocene affinities. In Berar and the Narmada valley, the beds are found 300 to 500 feet above the base of the traps and contain plant and animal fossils in some places. Inter-trappean beds are found between the flows largely near Sagar and consist of pure and siliceous limestone, cherts and days. In places, especially in the chert, they contain fossil shells, the commonest being species of physa (butinus), paludina, turriilella and lymnaea while fossil wood, mostly of palms is also found.

The presence of the inter-trappean beds between the two successive flows indicates that there must have been a fairly long interval of time between successive eruptions. There was enough time for the top of the flows to undergo partial decomposition, before it was covered by the next flows. The deposition of the inter-trappen beds at 533 m around Sagar separates the fifth and the sixth flow.

2.6 Alluvium and Laterite:

Apart from the hard rock geological formations in the Dhasan basin an extensive area in the upper of the basin is covered with alluvium the newer alluvium is light coloured and poor in calcareous matter. It changes by insensible gradations into the recent or deltaic alluvia and should be
assigned an upper Pleistocene to recent age. The sediments are sands, silts and clays with occasional gravel beds and lenses of peaty organic matter. The fossils in the newer alluvium are mostly those of animals still living. The area is geologically uninteresting but, being a rich agricultural tract, is a great interest and importance.

Laterite is extensively distributed in Peninsular India. It is common over the Deccan Trap in the greater part of Madhya Bharat and Madhya Pradesh. According to fax, F. Buchanan (1923) had already given the name 'Laterite' to a remarkable ferruginous residual rock, which he recognised in many part of south India. The deposits of the laterite are found in many parts of the India Peninsula. Generally it occurs as a sub aerial residual weathered product on the high hills or uplands. But it is generally noticed that all the better-known extensive occurrences of the laterite in the Peninsula are capping on the basaltic lava flows of the Deccan Trap and the Vindhyan sandstone and shales that are ferruginous. The thickness of the laterite varies from a few centimetres to more than 30 metres. Near Tinsmal village, about 40.23 kms northeast of Sagar along the Sagar-Chhatarpur road, the Tinsmal hill (651.96 m) is composed of the Deccan trap in which the capping of the laterite is more than 30 metres in thickness. The hilltops at the source of the Dhasan river are also covered with thick laterite. laterite is a porous, pitted, clay-like rock with red, yellow, brown, grey and mottled colours, depending in some measure on the composition. It has a hard protective limonitic crust on the exposed surface, which is generally irregular and rough.
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