CHAPTER II

GENERAL GEOLOGY AND STRATIGRAPHY
2.1 **INTRODUCTION**

The area under study is earmarked topographically by the hills having luxuriant vegetation and the low lying plains mostly of granites and dolomites. The highest topographic ridges standing most prominently are those of Jugnu Pahar, Macheri hill (Fig. 2.1 A), Jhalautar Pahar, Dalipur Ridge, Tigoda Ridge, Bamnaura Ridge, etc.

The ridges of Tigoda, Dalipur and Bamnaura are solely comprised of quartz reefs trending ENE-WSW. Granite having considerably large areal extent serves as a basement to the overlying Bijawar and Vindhyan Supergroup rocks. The rocks of the Bijawar Group lie unconformably over the basement granite, with its thick predominantly ferruginous member known as the Ganges Formation. The southern margin of the area is truncated by the Vindhyan escarpment, sloping towards north and dipping sub-horizontally to the south. The Bijawars are succeeded by the Vindhyan Group rocks with a distinct unconformity and consist chiefly of arenites and
quartzites in the area. Immediately overlying the basement granite, with a pebbly conglomerate horizon at places, a carbonate member occurs of 40-50 mts. average thickness, as revealed by the G.S.I. and M.E.C.L. drill hole data. This dolomite member shows secondary silicification at some places both along primary laminations and joint planes. The areas covered by this lithounit are Luhani, Indora, Sujanpura, Padsila, etc.

Metasediments/metamorphites like phyllonite, pyrophyllite associated with reefs also occur in the area within the Great Bundelkhand granitic massif. The granite also shows fairly good development of gneissosity at some places as ENE of Dalipur village. Next to quartz reefs, in abundance, are the basic intrusions in the form of dykes. These intrusions are of two types—those which are pre-Bijawar showing the development of fabric or schistosity and the other which are post Bijawar which are simply hydrothermally altered and appear as olive green coloured rocks in the field. The dykes possess different orientations, the pre-Bijawar ones trending WNW-ESE or N 80° E while those of post-Bijawar age trend WNW-ESE. Some of the dykes are boudinaged and the individual boudins, sometimes as far much as 10 metres apart are found arranged in en-echelon pattern.
2.2 DRAINAGE

A major part of the drainage pattern of the area under study is Bila river catchment - Bila being a perennial tributary of Dhasan river (which does not fall under the study area). The Bila river originates from the Vindhyan mountains in Sagar district and drains ultimately into the Dhasan river about 15 kms. far from the northern limit of the area. The river is passable during dry summer months near west of Indora village, at the confluence with the Bihar river and also at the confluence of the rectilinear NNW-SSE trending stream north of Kishangarh Fort.

Next to Bila, a small rivulet, Sukku, which shows much meandering and mostly dry even after the rains, is seen to flow towards the north-west direction and draining ultimately into Bila river near Kaikali village.

Besides these two rivers, streams and nallas of smaller extent are also seen to occur in the area. The drainage density is very high on Bijawar rocks than on the underlying granite because on account of weathering, granitic rocks result into sandy soil causing less of run-off than run-in, that does not support vegetation as the shallow levels do not contain any water.

The type of drainage pattern is radial around Jhalautar Pahar, dendritic around east of Indora and south
of Manakpura and trellis type around east of Jugnu Pahar. However, the overall drainage pattern of the area is dendritic type, suggestive of homogeneity of rocks. But the trellis type suggests that part of the drainage is controlled by tectonically weak zones.

Springs, namely Arjun Kund and others also occur in the area especially in the dolomite.

Artificial tanks namely Dalipur tank, Jamnaura tank and Akrotha tanks also occur in the area.

2.3 Previous Work

The earlier work was done by Medlicott (1859) followed in recent years by Rajarajan (1978) and Basu (1986).

Out of the total area mapped, about 2/3rd is occupied by the Bijawar Super Group rocks and the rest 1/3rd by the Bundelkhand granites. Correlation of the sequence with the type area near Bijawar town in M.P. suggests that there are some differences, especially the sporadic development of vast breccia deposit in the type area. The ferruginous facies dominates in all the areas extending from Barwaha in Khargon district of M.P. to just west of Sidhi in the eastern part of Madhya Pradesh.

Medlicott (1859) first introduced the name 'Bijawar Series' for the sediments and interbedded volcanics overlying the Bundelkhand granites but underlain
by the 'Vindhyan System' of rocks. According to him
'The Bijawar Formation is too confused to allow of the
safe or ready determination of subdivision although
there is a large variety of rocks'. He divided the
'Bijawar Series' into a lower series and an upper series,
the lower predominantly calcareous and the upper mostly
ferruginous.

Wilson (1873-1877 field season, in Mathur, 1954)
had classified the Bijawar rocks as follows -

**TABLE 2.1**

Upper Bijawar
Volcanics
Bijawar Limestone
Lower Bijawar

Mathur (1954) modified Wilson's work and proposed
a revised stratigraphy as given in the Table 2.2 below -

**TABLE 2.2**

Upper
Bijawar 'Quartzite
Chocolate shales including tillite
Ferruginous conglomerate

--- --- Slight Unconformity --- --- --- --- --- --- --- ---

Lower
Bijawar 'Quartzite, chert, Jasper, limestone and
sandstone
Trap flows
Basal chert breccia and conglomerate.
An unmistakable unconformity between the Bijawar Group rocks and granitic floor is found near Hirapur where a conglomerate band is seen to separate the two. The suggestion by Pascoe (1950) of Bijawar rocks having been deposited on an undulating granitic floor is supported by the presence of subaqueous slump structures, described in Chapter III.

In the area investigated, the most conspicuous member overlying the basement granite is the dolomite which is quite competent and has high magnesia content. This dolomite occurs at different levels suggesting either faulting subsequent to deposition, synsedimentational faulting or irregularity of the basin floor on which Bijawar Group rocks were laid down.

The lithologic set up of the Vindhyan quartz arenites to the south of the area with typical saccharoidal texture suggests that these are the lower Vindhyan belonging to the Semri Group, an observation which was also made by Mathur (1954).

The tillites described by Mathur (1954) are perhaps present in the area investigated as striations and structures indicating glacial conditions, were found in the rocks of the ferruginous sequence in the Jugnu Pahar Section.
Bijawar Group rocks are lower Proterozoic in age (older than 1400 ma. Crawford and Compston, 1970) and the presence of stromatolites in the rocks probably corroborates this age. Isotopic dating (Sarkar et al., 1984) places the age of Bundelkhand granites around 2300 ma. and therefore the Bijawar Group sequence may have age limits between 2300 and 1400 ma., the latter being the age of the lowermost rocks of the Vindhyan Supergroup.

The Bijawar Group rocks extend from Barwaha to Handia in an inlier surrounded by Deccan basalts on all sides and have an Archaean floor near Barwaha and a Vindhyan cover near Chandgarh (Joy Choudhary and Sastry, 1956, Doday, 1983). In the entire inlier, the dolomite occurs at the base, overlain by ferruginous racies of rocks and chaotic breccia mass as recorded in the study area.

The Bijawar rocks were earlier called 'Transitional rocks' by Oldham et al. (1901) and have often been correlated with the Aravallis, the Dharwars, the Cuddapahs and also with those of the Gwalior Group (Saxena, 1986) of rocks. The correlation with Dharwar Supergroup rocks was generally attempted by earlier workers (Mallet, 1871, Bose, 1884, Fermor, 1909, 1936, Krishnan, 1936, 1953, Auden, 1933), a view that is finding much support now, based on the existence of some typical greenstone belt rocks such as quench textured basalts (Agarkar and Kumar, 1990).
Although the Bijawar rocks have been presumed to belong to Satpura Orogeny (Holmes, 1955; Krishnan, 1955) or even a separate Majgir Orogeny (Das, 1966), the author believes that since the deformation is very mild, this belt does not constitute a typical strongly shortened region in the earth's crust but the fold structures are presumably fault or shear induced. In other words, direct compression did not play a major role in the development of deformation structures noticed in these rocks.

2.4 STRATIGRAPHIC SET UP

The post Bijawar (Supra-Bijawar) rocks do not occur in the mapped area but Semri Group quartz arenites of Vindhyan Super group occur about 4 kms. south of Hirapur. They are shallow water marine deposits (partly eolian Auden, 1981) and showing structures such as current bedding, ripple marks, mud cracks etc.

2.41 THE BUNDELKHAND GRANITES

The basement granites are strikingly uniform in certain places as far as texture and megascopic characters are concerned but there are many varieties of granites which are separated from each other by faulted clear cut sharp contacts. Though as many as 10 varieties of granites are reported by Basu (1986), only four types are recorded in the area under investigation.
Fig. 2.2

(A) K-felspar phenocrysts in granite with a preferred orientation south of Dalipur reef about 14 km. east of Dalipur village. The granite is intruded by basic material along fine tensile fractures.

(B) Quartz-epidote rock emplaced along Manakpura shear zone near Manakpur village. The host rock is granite.
The earliest variety is of Raphakivi type (Fig. 2.2 A) with K-felspar phenocrysts having a strong preferred orientation. It is interesting to note that the preferred orientation lies parallel to adjacent faults and also axial traces of synclinal 'Keels' in adjoining areas.

The second type is the aplogranite variety and the contact between the two is presumably faulted at some places and undulating at others. Enclaves of Raphakivi type older granite are found in the aplogranite east of Dalipur tank. This was perhaps followed by intrusion of basic dykes, mostly doleritic and well cleaved.

Late K-felspar veins are seen cutting across (Fig. 4.9 C) the basic dykes and therefore it may be stated that the intrusion of basic dykes occurred which was after the emplacement of K-felspar veins. As a result, at the last, the Bundelkhand granite complex has been formed by episodic intrusions of a variety of granites through space and time. The later intrusions seem to be those of pegmatite dykes having NNW trend being comparable with tensile fissures that would develop along ENE to EW trending dextral ductile shear zones-cum-wrench faults in granites.

The latest intrusions within the Bundelkhand granites are the quartz reefs or veins, trending either EW (or ENE-WSW) or NNE to NE. The latter are arranged
generally en-echelon and are related to the positive dilational sinistral shear zones. These shear zones are generally of brittle-ductile type. The quartz is milky white in colour and the reefs are associated with diaspore and pyrophyllite mineralization. Quartz-epidote rocks are also found to occur as intrusives (Fig. 2.2 B).

Basu (1986) described quartz-sericite rocks (esmeraldites) as intrusives into the complex but these are found to be phyllonites formed by the break down of pre-existing granite. The quartz-sericite band is suggestive of deformation of granites by shearing aided by hydrothermal fluids and the author does not believe them to be of the same generation but formed later since they always flank the boundaries of the overlying Bijawar Group sediments. It is reasonable to assume that they are intimately related to the deformation in Bijawar Group rocks as is shown near Hirapur by Roday et al. (1989).

Mishra and Sharma (1974) believed that the quartz reefs were metasediments within the granite country assuming them to be of the Bijawar age. This view is not supported by Basu (1986) nor by the author.

2.42 BIJAWAR GROUP ROCKS

The lower most member of the Bijawar Group is the carbonate rock mostly dolomite showing secondary silification (Fig. 2.3) solution openings, and
elephant-skin weathering. The dolomite is high in magnesia content and can be correlated with the Bajna dolomite in the type area near Bijawar. This dolomite does not allow any thick vegetation to be grown over it and thereby helps to work out the major structure of the area. The fresh outcrop of dolomite is bluish grey in colour, highly stromatolitic at places and well jointed, the joints being both of tensile and shear origin. Where calcite content is high, solution openings are common. The presence of springs indicates that there are caverns in dolomite below, but the caverns may be of small size because of low lime content. Dolomite at places contains blocks of basement granite (Fig. 2.4 A).

According to previous workers, there is a distinct unconformity between Bajna dolomite and the overlying Gangaur formation. The dolomite is interbedded with calcareous shales and at places, or overlain by calcareous shales which are sometimes metamorphosed to slates which exhibit conjugate pressure solution cleavage (Fig. 5.19). So we may conclude that while at Hirapur dolomite is interbedded with the argillaceous matter and overlain by calcareous shales/slates, but in the area north of Hirapur, they are interbedded with chert and overlain by massive or bedded cherts which give rise to a bolder topography. These cherts actually are found as a thin band over dolomite ESE of Hirapur, just close to the forest rest House. At places,
the cherts are very rich in hematite content as for example, to the east of Shelda, where they dip to north at a moderate amount. The cherts are also found at the base of entire Gangaur pile from east of Manakpura to east of Indora as a fairly wide band. The cherts have various colours such as yellow, red, jasper red, milky white, olive grey, olive green, deep yellow and scarlet.

Continuous chert bands are found at rather few places throughout the Gangaur pile. At most of the places, cherts are completely dislodged, their layering is hardly indistinguishable and has given rise to a chaotic mass of chert breccia.

The massive or bedded cherts are directly overlain by ferruginous quartzite which shows traces of layering at a few places and merging into a chaotic mass and gives rise to brecciated huge blocks. This in turn, is overlain by ferruginous shales varying in thickness from 5 to 20 metres. These again are interbedded with chert layers and it is because of the laminations in shales that one can really see the various stages of brecciation of chert layers. The brecciation is normally found where traction has probably occurred in the basin because of over-riding over the palaeoslope in the sedimentary basin, one might call them as olistostromes although the scanty mineralization of chalcopyrite and bornite associated with chert breccia points to their having been derived from another basin.
which is now probably eroded away. It appears that this mineralization was syngenic in nature in the original basin from which the breccia have come. The ferruginous quartzites at places are overlain by ferruginous shales which in turn are overlain (Fig. 2.4 B) by again a thick pile of breccia and then again a pile of phosphorite bearing shales which indicate $P_2O_5$ over 30 percent as tested by using ammonium molybdate solution (Fig. 2.5).

The topmost unit is again a chaotic breccia mass which is the youngest unit in the Gangau pile. The thickness varies from place to place because of peneccontemporaneous deformation as well as different erosion levels at different places. These chert fragments are embedded in very hard siliceous/ferruginous matrix. Ferruginous material is so common in breccias that it overwhelms in amount than any other component except chert, hence author concludes that the whole Gangau pile is nothing but a chaotic mass of cherty breccia with thin interbedded shale layers. It occupies a large part of the mapped area (Fig. 2.5 in pouch).

The pisotitic ironstones consisting of chamositic pisolites (chamosite derived from older chloritic shale enclaves) (Fig. 2.1 B) as found in the Hirapur area, is the youngest member of Gangau pile. Within the Gangau pile, we get large amount of goethite, hematite, marcasite
but not at the same place but in isolated patches and never in association which suggests the variation of redox potential in different parts and levels of the basin. Phosphatic shales are typically found at the margins of the basin and these margins are invariably faulted suggesting that the phosphorite is concentrated at shallow continental shelf regions because of tectonically induced tides or convection currents.