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Geology and Sedimentation History of Bijawar Area Chhatarpur-Sagar Districts, Madhya Pradesh, India

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ABSTRACT

This research paper includes, detail field study was carried out and geological data has been collected from the study area. Initially reconnaissance survey was taken for further study of the area. To understand Geology of the area on the basis of lithological interpretation and criteria for rock material were found or exposed. Regional scale sampling has been carried out for Geological survey of various litho units in the study area and understands the Geology, Sedimentary history of Bijawar type area has been carried out with the help of Survey of India Toposheet and geological map of study area. The Bijawar basin is sandwiched between Bundelkhand granite and Vindhyan sediments. Based on field data, the rocks of Bijawar Group comprises namely Moli sub-group and Gangau sub-group (Kumar et.al.1986, 1990). Bijawar sedimentation appeared in small erosional depressions of primordial Bundelkhand Complex Craton. In such small depressions, the lower formations of the group were probably deposited by littoral currents in stable shelf type of environment. The nature of arenaceous unit of Raidaspura member indicates a change of high to low energy environments. The quartz-arenites was probably formed in the shallow depositional condition with repeated sub-aerial exposures as evidenced by the presence of mud cracks. The palaeo current direction as noted in the sandstone units were towards NE. Deposition of dolomite might indicate change in climatic condition during that time. Intermittent volcanic activity resulted in the form of lava flow of Kawar Formation, agglomerate of Raidaspura member and the Dargawan Intrusive Formation. During this time, Bijawar basin gradually shifted to the west and at the close of the deposition of Bajna Formation. The dolomites of Bajna dolomite Formation was found to be associated with sandy arenaceous layers interbedded with precipitated cherty dolomite signifies a rather change of depositional environment. The clastic units (calcareous coarse grained sandstone) exhibiting cross stratifications and ripple mark again signifies a shallow water deposition in contrast to the chert-dolomite beds. Increase of chert beds in dolomite towards the lower part i.e. towards the contact with the Malehra Chert Breccia Formation indicates that the change in chemical conditions suitable for precipitation of silica to carbonate was gradual. It seemed to be somewhat fluctuating during the Malehra Chert Breccia Formation and Bajna Dolomite Formation.

KEYWORDS: *Geology, sedimentary history, Bijawar type area.*

INTRODUCTION

The Bijawar Basin (Paleoproterozoic) is an important segment of the Indian peninsular shield that preserves geological evolution of the Early Archaean crust (Sharma, 2000). Bijawar sediments are unconformably deposited over the Bundelkhand basement in the form of Proterozoic meta-sedimentary basins (Sonrai, Hirapur and Gwalior). The name Bijawar basin was proposed by Medlicot (1859) after Bijawar town. It trends ENE-WSW with a gentle to moderate (12˚ to 40˚) northerly and southerly dips for about 100 km. The width various form 4 to 20 km from Ken River in the East to Sonrai in the West. The basin is sandwiched between Bundelkhand Granite and Vindhyan sediments.

Hirapur Phosphorite deposit is associated with Bijawar Group of rocks (Kaul et. al., 1989) in Sagar-Chhatarpur districts of Madhya Pradesh and adjoining Lalitpur district of Uttar Pradesh. These meta-sediments consist mainly of quartzites, carbonates, sandstones, shales, limestones, and massive iron formations. The major clay minerals associated with sedimentary rocks are of detrital origin. They strongly reflect the character of their source material and slightly modified in their depositional environments. The sediments of the Bijawar group are deposited unconformably over the Bundelkhand Granite over the older supra-crustal enclaves (BIF) at Girar District Lalitpur. The sediments are locally folded and faulted and have an estimated thickness of <1000m. (Pant and Banerjee, 1990, Kumar et. al. 1990, Haldar and Ghosh, 2000 and GSI, 2004). Atomic Mineral Division and MECL had prospected the Bijawar area and reported the Phosphorite deposit in Hirapur-Mardeora section. Earlier workers investigated various aspects of phosphate bearing sections and other associated rocks of Bijawar Basin such as Geology and Mineralization (Prakash et. al., 1975); Geology (Mathur and Mani, 1978); Geology of the Deposit, Litho-tectonic and Phosphorite Mineralisation has been presented by Banajee (1982); Petrography and Geochemistry (Saigal and Banerjee, 1987), Precambrian Phosphorite in the Bijawar rocks (Banerjee et. al., 1982); Structural Geological study (Roday et. al., 1989); Stromatolite, Biostratigraphy, Sedimentary History and Age (Gupta and Verma, 1989); Pattern of Sedimentation (Pant and Banerjee, 1990).

LOCATION OF THE STUDY AREA

The study area is confined to latitudes 24˚20'27'' and 24˚35'27''N and longitudes 79˚9'0'' and 79˚52'30'' E (Survey of India, Toposheet No. 54P, Figure 1). It covers an area of 1200 Sq. Km. from Gangau in the ENE to Hirapur in the WSW. The area is approachable from Chhatarpur, and Sagar (M.P.) by State Highway No. 15. It is also well connected by road from Damoh Jabalpur and Tikamgarh. The Bijawar area can be approached by air from Delhi via Khajuraho and by Train from Jhansi, Khajuraho, Bina, and Sagar.

GEOLOGY OF BIJAWAR BASIN

The Bijawar Basin in Central India forms isolated small basins, overlying unconformably the Archaean basement and underline by Vindhyan sediments (Banerjee, 1982 and Sharma, 1982). During the evolution and emplacement of Bundelkhand massif, the region was subjected to rapid upliftment, intense weathering and swift erosion of granitic rocks (Sharma, 1998 and 2000). The Proterozoic Sonrai – Hirapur - Gwalior metasedimentary basins were developed as marginal basins at the periphery of Bundelkhand massif (Figure 1) with conspicuous unconformity and highly weathered and eroded surfaces.

The contact between granitic basement and Bijawar metasediment is faulted (E-W and N-S) in the North-Eastern part of the Bijawar Basin (Figure 2). The E-W trending faults possibly represent reactivation of rift related to the earlier faults in the granitic basement which initiated the development of the Bijawar basins around the Bundelkhand massif (Sharma, 2000). The sedimentation with conglomerate, grit, arenite and cross-bedded, buff coloured sandstone. Bijawar Group consists of quartzite, sandstone, shale, limestone, dolomite, banded hematite quartzite, and basic dykes. It is exposed in a narrow zone in the south of the granitoid complex. The Bijawar basin is folded forming a large WSW plunging synclinorium, the southern limb of which is concealed below the Vindhyan rocks. The northern limb is traversed by several strike and oblique faults.

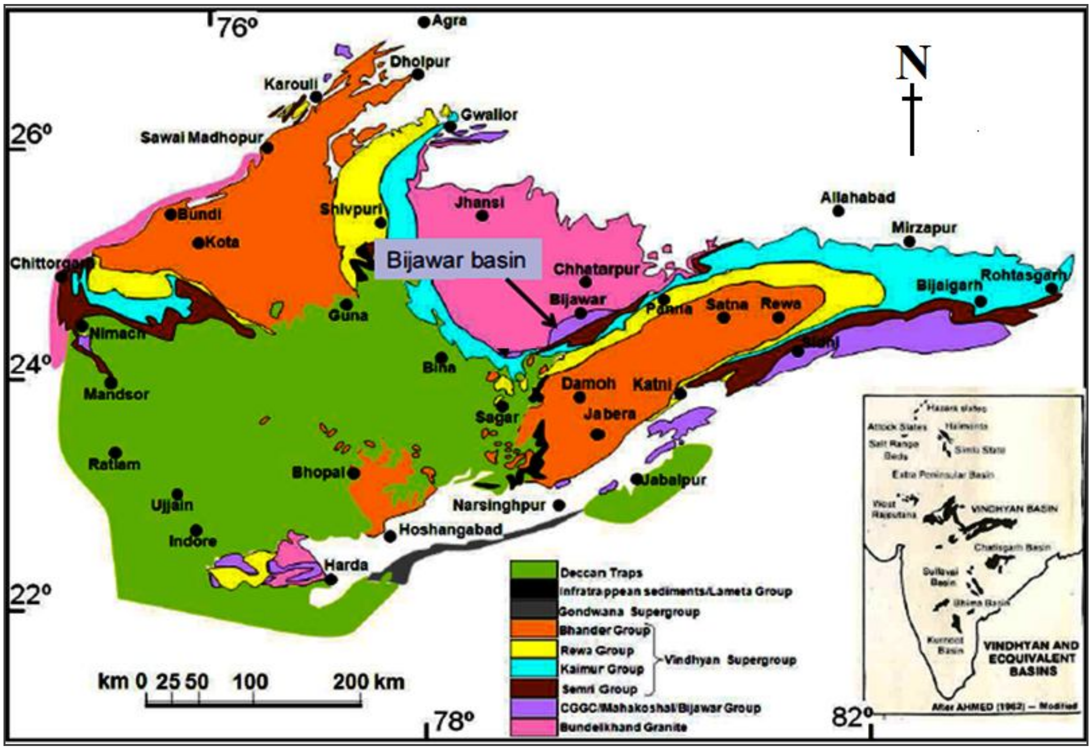

Figure 1: Location and Regional Geological map of Bijawar Basin (Modified after Soni et. al., 1987).

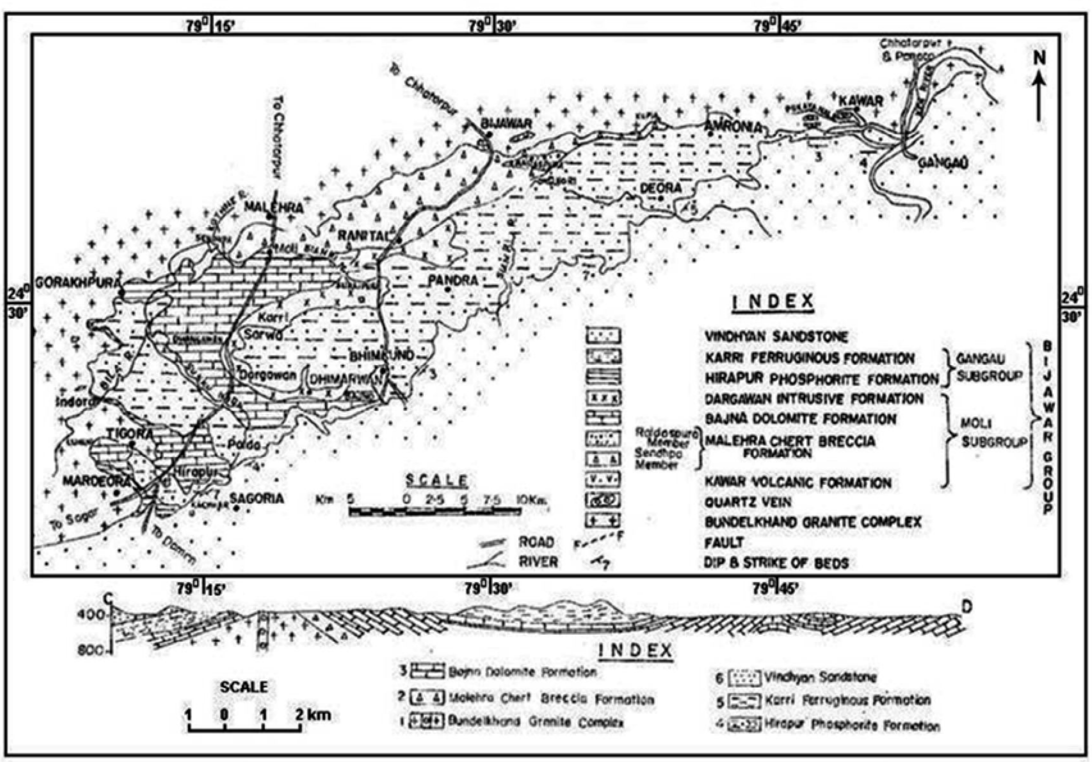

Figure 2: Geological map of the Bijawar Basin (After Kumar et.al., 1990).

Pant and Bannergee (1990) suggested that the initial rifting of Bundelkhand Craton led to the development of horsts and grabens in which terrigenous sediments were deposited with intrusion of mafic volcanics. Geochemical and tectonic evidences indicate that these rocks were erupted in an island arc environment in the southern margin of Bundelkhand protocontinent which formed the zone of subduction.

The regional trend of Bijawar Basin is ENE–WSW with a gentle to moderate (12° to 40°) northerly and southerly dips. Two phases of folding are clearly discernible F1 deformation has produced the major synclinorium, commonly referred in the geological literature as Bijawar synclinorium. Faults trending NW-SE are seen offsetting the contact about 3 km. South-West of Hirapur. Similarly a NE –SW trending fault near Indora village displaces the contact by about 400m.The regional geological set up is given by Kumar et.al. (1986, 1990) has been divided into two sub groups and six formations (Table 1).

(I) Moli Sub-Group:

This is divided in the following four formations

(a) Kawar Volcanic Formation:
The lowermost formation of the Bijawar group, exposed South of Kawar and North of the Pukhara Nala is known as Kawar Volcanic Formation which rests unconformably over the BCG. The basal part is nearly 20 to 50 m thick polimetric conglomerate associated with 5 to 10m thick arenite bands and overlain by 50m thick massive thoelitic basalt intercalated with 5 to 10 m thick arenite bands. This unit is not present in the west south western portion of the basin.

Table 1: Stratigraphy of Bijawar Group (Kumar et al. 1990)

Vindhyan Supper Group			
……………………………………………..Unconformity…………………………………			
Bijawar Group	Gangau Sub-Group	Karri Ferruginous Formations Hirapur Phosphoritic Formation	
	………………………………..Unconformity …………………………………		
	Moli Sub-Group	Dargawan Intrusive Formation Bajana Dolomite Formation Malehra Chart -Breccia Formation Kawar volcanic Formation	Raidaspura member Sendhpa member
……………………………Unconformity……………………………………........................			
Archaean Group	Basement- Bundelkhand Granitic Complex (BGC)		

(b) Malehra Chert Breccia Formation:
This formation is widely exposed in the eastern part of the basin. It has been subdivided into lower Sendhpa member and upper Raidaspura member. Sendhpa member is composed mainly of variegated chert, chert breccia, conglomerate, white and light coloured sandstone, subordinate dolomite, chert andmetabasic flows. Metabasic flows, 8-9m thickness exhibit vesicular and amygdalcidal structures.

(c) Bajna Dolomite Formation:
This is the best developed formation of the Bijawar group and can be seen extensively around Dhangawan, Sarwa, Bajna, Dalipur, Luhani and Dargawan villages. It frequently overlaps the lower Bijawars and directly overlies the Bundelkhand Granite Gneiss.

There are two large exposures of dolomite in the central and west-central part of the basin around Dhangawan, Sarwa, Bhimkund and Bajna. It is frequently intercalated with thin chert bands occurring in the western part of Luhani (Figure 3), Hirapur and Tigoda areas, exhibits comparatively rare to occasional chert banding. Dolomites are fine grained, occasionally stromatolitic and exhibits various shade of grey like light grey, greyish white, pink to dark-grey. Though the stromatolites, in general, are not very common. Stromatolitic structures can be observed at places such as South of Tigoda, East of Dargawan etc. Both circular and columnar stromatolites have been recorded (Figure 4). At some places dolomite becomes arenaceous and is found intercalated with clastic rocks. Sedimentary features such as cross stratification, graded bedding etc. can be seen South of Dhangwan and 2km. S-W of Dargawan. These features are suggestive of fluctuating condition of the basin from chemogenic facies to clastic one. Similarly, thin argillaceous bands in the western part near Sujanpura and Tigoda indicate fluctuating conditions of the basin during the deposition of the Bajna dolomite Formation.

Karstification, represented by sink hole, dolines, stalactite, stalagmanite, caves etc, are developed profusely in Bajna Dolomite formation which can be noted at Bhimkund, Pandajhir, Arjun Kund and Belajhir etc.

(d) **Dargawan Intrusive Formation**

This formation is well developed in the central part around Dargawan and Dhimarwan area. It comprises sills and dykes of doleritic and gabbroic rocks which are found to be intrusive into Bajna Dlomitic Formation. Recrystallisation of dolomite, as a result of basic intrusion, is very well noticeable to the South of Dargawan village. Intrusive formation is medium to coarse grained, dark greenish-grey in colour, very hard and compact containing amphiboles (hornblende, tremolite, actinolite) plagioclase, chlorite, opaques and occasionally quartz group.

(II) Gangau Sub-Group:

This is divided in to two formations

(a) Hirapur Phosphorite Formation:

This basal formation of Gangau sub group is deposited over the Moli sub group with a low angle, angular unconformity and it is prominently developed towards the western end of the Bijawar basin. Hirapur phosphorite formation rests unconformably over the Bajana Dolomite Formation. It has developed mainly in the western part of the basin. Its most extensive development is seen in the southwestern fringes of the basin around Bassia, Mardeora, Hirapur, Kachhar and South of Palda village.

Figure 3: Bajna Dolomite exposure near Luhani village.

Figure 4: Stromatolite in Bajana Dolomite Frmation, near Hirapur-Taura road.

Figure 5: Bijawar Phosphorite with ferruginous shale near Hirapur mining area.

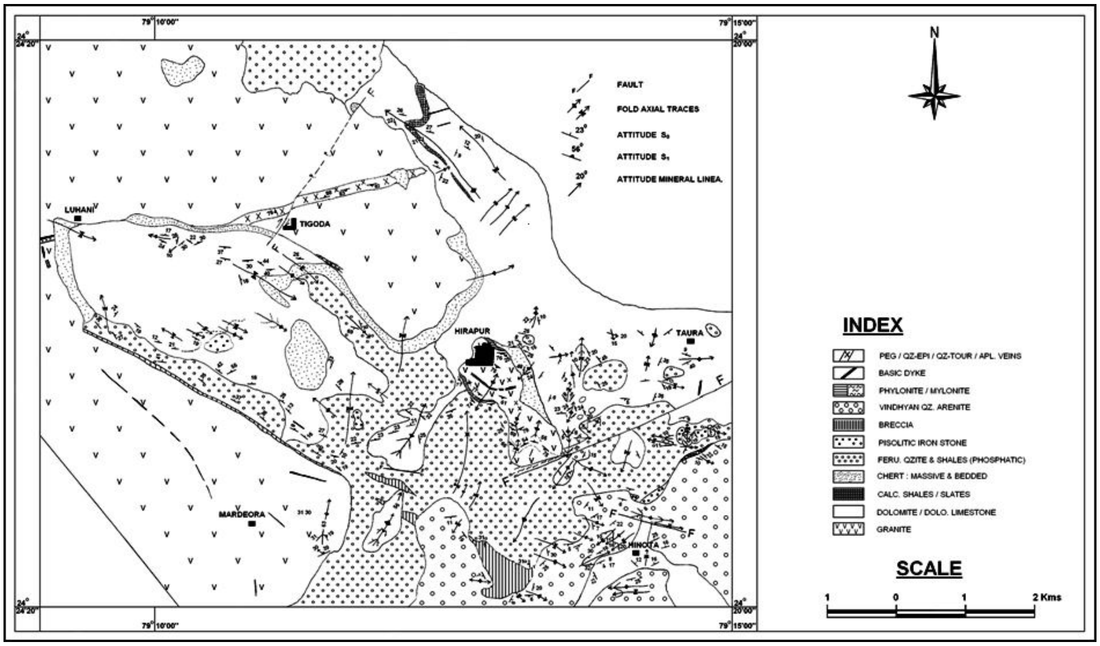

Figure 6: Geological Map of the Hirapur Phosphorite Formation and its adjoining area (After Roday et.al., 1989).

It also occurs in the northwestern fringe of the basin. The lithological succession of Hirapur phosphorite formationis given as follows-

Hirapur Phosphorite formation-

- Iron concretionary shale
- Phosphorite with chert nodules / chert
- Breccia / Shale / Pink Dolomite / Black Shale
- Laminated Phosphorite
- Black Shale / Dolomite / Sandstone
- Brecciated Phosphorite
- Ferruginous Breccia / Shale

The Hirapur Phosphorite formation (Figure 5 and Figure 6) has a maximum thickness of 100m. and its unconformably grades into overlying Kurri Ferruginous Formation. Phosphatic shale and phosphoritic breccias overlying the dolomite are rich in P_2O_5 content which range from 15- 32 % (Kumar et.al.1986).

(b) Kurri Ferruginous Formation:

Kurri Ferruginous Formation overlies all other units of the Bijawar Group and it is the youngest formation of the Bijawar sequences. It comprises ferrugineous shale, sandstone and conglomerate / chert breccia. This formation, ingeneral, is highly ferrugineous and contains shale bands with high iron concentration. Fe_2O_3 content, at places ranges up to 72%. It is exposed intermittently almost the entire basin and forms a rugged topography. Kurri Ferrugineous Formation exhibits a plethora of sedimentary structures indicating a varying array of sedimentation environments operative at the time of its deposition. Calm and quite environment of deposition represented by shale and high energy basinal conditions are indicated by sandstone. Sandstones exhibit mud cracks and ripple marks etc. indicating shallow water conditions of the depositional environment.

DISCUSSION AND CONCLUSION

Based on observed field data, the Bijawar sedimentation seen that erosional depressions of primordial Bundelkhand Complex Craton. In such small depressions, the lower formations of the group were deposited probably by littoral currents in stable shelf type of environment. The nature of arenaceous unit of Raidaspura member indicates a change of high to low energy environments. The quartz-arenite was probably formed in the shallow depositional condition with repeated sub-aerial exposures as evidenced by the presence of mud cracks. The palaeocurrent direction, as noted in the sandstone units, was towards NE. Hence, mainly chemogenic sediments like cherts and dolomitic stromatolites which belong to Moli sub-group. Deposition of dolomite indicates change in climatic condition during their deposition. Intermittent volcanic activity is indicated by the lava flows of Kawar Formation, agglomerate of Raidaspura member and the Dargawan Intrusive Formation. During this time, the basin gradually shifted to the West and at the closure of the deposition of Bajna Formation. The dolomites of Bajna Dolomite Formation found to be associated with sandy arenaceous layers interbedded with precipitated cherty dolomite which signifies a change in the depositional environment. The clastic units (calcareous coarse grained sandstone) were exhibiting cross stratifications and ripple marks this suggests that shallow water deposition. Increase of chert beds in dolomite towards the lower part of Malehra Chert Breccia Formation indicates that the change in chemical conditions suitable for precipitation of silica and carbonate was gradual and close to the transitional environment. It seems to be somewhat fluctuating during the deposition of Malehra Chert Breccia Formation and Bajna Dolomite Formation. Intertidal littoral environment is responsible for the concentration of phosphate in the western margin of the basin. Absence of phosphate in Stromatolitic Bajna Dolomite indicates non-biogenic origin. Hence, phosphate might have been contributed by the granitic complex and intermittent igneous activity. The phosphorite and subsequent ferrugineous sediments were deposited by sub-aerial erosion. Reworking, slump structures, coalescing and brecciation of sediments indicate frequent changes in water level due to minor tremors and shocks during deposition of Gangau Sub-Group. Towards the closure of the basin was subjected to deformation which resulted in first folds and the large synclinorium. The secondary folds developed after the first deformation axis.

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