International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 08, August 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

GEOLOGY OF MALIKHERA-MOKANPURA AREA OF DARIBA-RAJPURA-BETHUNMI POLYMETALLIC SULPHIDE BELT RAJASTHAN

Dr. Samir Nawal

GSSS Jhanwar, Jodhpur, Ex Research Scholar, Department of Geology,
Jai Narain Vyas University Jodhpur Rajasthan (India)

ABSTRACT

Statigraphic position of Malikhera-Mokanpura area of Dariba-Rajpura-Bethunmi polymetallic sulphide belt has been worked out by different workers andvaried status has been given by them. These different views have been discussed in the present paper, Considering lithology, and geochronological data in the present paper an attempt has been made to compare these different views on the stratigraphy. . Stratigraphic status of host lithology has been identified for use as tool for prognostication of base metals in the Rajpura-Dariba Group of rocks.

Keyword : Aravalli Crotan,Bhilwara Super Group, Malikhera-Mokanpura Area, Polymetallic Sulphide Belt Rajasthan , Rajpura-Dariba Group

I.INTRODUCTION

Precambrian stratigraphy of northwestern India can be assigned to the Bhilwara (>2500 Ma), Aravalli (2500 Ma to 2000 Ma) and Delhi (2000 Ma to 700 Ma) Geological Cycles on the basis of environment of deposition and tectonomagmatic events. The metasediments, concordant and discordant intrusives ad their extrusive phases, corresponding to these geological cycles have been designated as the Bhilwara, the Aravalli and the Delhi Supergroups. These have been further subdivided into several groups and still further into formation. The rocks of the Bhilwara Supergroup occur in an arcuate belt, extending from Deyi in the northeast through Kishangarh to Pipalkhunt in the southeast, underlying the Mewar plains of Rajasthan, and consist of metasedimentary sequences with associated migmatitic complex and igneous rocks. The rocks of the Arava!Ii Supergroup are exposed in south-eastern part of the Aravalli Range and northeastern part of Gujarat extending from Kankroli in the north to Champaner in the .south and mainly consist of argillaceous and arenaceous metasedimentary sequences with associated basic volcanics and ultra basic igneous rocks. The main Aravalli Range extending from Ajmer in the north to Himmatnagar and Khed Brahma in the south. The Marwar Plains between Pali in the north and Reodhar in the southwest are occupied by the rocks of Delhi Supergroup which consist of calcareous, argillaceous and arenaceous metasedimentary sequences with associated basic volcanics and igneous rocks. The rocks of the Aravalli Region have been complexly folded and faulted, metamorphosed and migmatised during the orogenic episodes related to different geological cycles

.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

INTRODUCTION TO BHILWARA SUPERGROUP

Aravalli Craton show two Aravalli mountain range and Bundelkhand Son valley areas, where exposures are available and define its boundary by boundary fault in the north, Cambay garben in the southwest and Narmada-Son lineament in the south and Southeast.

The supera crustal rocks of Aravalli Craton are different than other Indian Cratons in two ways. Firstly, the Aravalli superacrustal rocks are mostly Proterozoic and consist of phyllites and graywacks with abundent Orthoquartzites, Carbonates and minor maficlultramafic schists. Secondly, there is absence of BIF shows non-availability of iron to be oxidized and deposited. Also, presence of phosphorites indicate abundant availability of oxygen.

Stratigraphy of the Craton suffer controversial terminology (Basu et. al. 1976, Geological Survey of India, 1977; Naha, 1983; Naha and Roy, 1983; Sen, 1983; Naha et. al., 1984; Roy and Paliwal, 1981; Roy et. al., 1984; Roy, 1985; Roy1 1988a; Roy, 1988b; Roy et. al., 1988; Naqvi and Rogers, 1987). The stratigraphic succession of the precambrian rocks of Aravalli craton are given in Table 1.1 and regional geology in Fig. 1.1.

Bhilwara Supergroup comprises metapelite and quartzite, protoquartzite, conglomerate, metagraywacke, marble, calc-silicate rack, cale-schist, calc-gneiss, mica schist, kyanite-silimanite schist, para-gneiss, para-amphibolite, synsedimentational metavolcanics, feldspathised mica schist and gneisses, migmatites, granite, granite gneiss, granodiorite, charnockite, norite, enderbite, dolerite and ultramafics. These rocks have attained progressively higher grade of regional metamorphism, from greenschist facies in the east to granulite facies towards west, and have undergone syntectonicrnigrnatisation. Sulphide-bearing chemogenic sequences of RajpuraDariba, Pur-Banera, Jahazpur and Sawar have also been tentatively included in the Bhilwara Supergroup, by GSI. The Berach Granite is intrusive into the metasedimentary sequences. The Ban Sadri, the Hora, the Mandalgarh and the Ranthambhor Quartzites have been considered, as post-orogenic molasse type sequences, younger to the Berach Granite.

The Bhilwara Supengroup extend in a crescent shape outcrop over a distance of over 400 km from Pipalkhunt in the south to Deyi in the northeast and beyond over a width of a few km in the south to 130 km across Bhilwara. The rocks strike NW-SE in the south, N-S in the west of Chittaurgarh and NE-SW in the Hindoli area.

The Bhilwara Supergroup is overlain by the Aravalli Supergroup in the southern part and by the Delhi Supoergroup in the north with an erosional unconformity. The Bhilwara and the Delhi Supergroup of rocks have a faulted contact between Todgarh and Shrinagar The eastern part is covered unconformably by platformal sediments of the Vindhyans. A major part of this contact is faulted by a post-Vindhyan fault referred to as the Great Boundary Fault of Rajasthan.

In the earlier stratigraphic studies (Heron, 1953; Gupta, 1934), gneisses gneissic granites, amphibolites, associated high-grade rnetasediments and basic and acid intrusive rocks, forming the basement of the Aravalli and the Delhi rocks, were referred to as the Banded Gneissic Complex, while a large body of granite, northeast of Chittaurgarh in the Berach river valley, was designated as the Bundelkhand Gneiss/Granite. The Banded Gneissic Complex and the Bundelkhand Gneiss, regarded as the oldest rocks of Rajasthan and Gujrat were, assigned a stratigraphic position as pre-Aravalli Formation (Pascoe, 1950). The contact between these rocks and the Banded Gneissic Complex and also the Bundelkhand Gneiss was considered to be that of erosional

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

unconformity. Heron (op. cit.) considered the rocks of Darauli, PurBanera, Sawar and Jahazpur areas belonging to the Raialo Series and those of Rajmahal area to the Delhi System on the basis of lithological similarities.

Raja Rao (1967) on the basis of the work done by various geoscientists during sixties, included the metasediments along with migmatite and various gneisses of the Banded Gneissic Complex, metapelitic rocks of the Gwalior Series and calcareous rocks of the Raialo Series, into a major lithostratigraphic unit designated as the Bhilwara Supergroup. He considered that the gneissic rocks of the Banded Gneissic Complex are the result of extensive migmatisation and their contact with the rocks of Pur-Banera, Sawar and Jahazpur areas is conformable.

Prasad (1973, 1976, 1982) considered that the regional metamorphism and syntectonic migmatisation of metasediments gave rise to migmatites and various gneissic rocks of the Banded Gneissic Complex. The Berach Granite intruded the aforesaid metasediments during the late tectonic magmatic phase of the geosynclinal cycle. The Ban Sadni, the Hora and the Mandalgarh Quartzites were considered as molasses facies deposition. He grouped metasedimentary rocks into the Chittaur Group in Chittaurgarh area and migmatites, gneissic rocks and the Berach Granite into the Mangaiwar Group and both these groups were included in the pre-Aravalli Bhilwara Supergroup.

Jayaram and Mathur (1974) considered the suiphide-bearing mineralized belts of Jahazpur, Sawar, Pur-Banera and Rajpur-Dariba as a typical chemogenic/euxinic association of carbonaceous phyllites, banded silicified ferruginous cherts, dolomitic marble, calc-schist, calcgneiss and calc-silicate rocks. The mineralised bands are stratiform and synsedimentary in nature. The salient feature in the geological setting of the predominantly lead-zinc rich deposits of southern Rajasthan and northern Gujarat is, that these do exhibit a marked affinity to the lithology of reduzates, characteristic of nonclastic and hybrid assemblages.

In short, the entire belt of pre-Aravalli rocks in southern Rajasthan has been designated as the Bhilwara Supergroup including metasediments as well as magmatic events older than the Aravalli Geological Cycle and assigned to the Bhilwara Geological Cycle. This also includes argillaceous rocks of the Gwalior Series, calcareous rocks at Darauli, Pur-Banera, Jahazpur, Sawar and Rajmahal Quartzite. The Bhilwara Supergroup belongs to Archaean (2500 Ma - 3000 Ma) as no trace of life has been reported so far. Besides, the Berach Granite, which intrudes the Bhilwara rocks, has been dated to be 2585 Ma by Crawford (1970).

Migmatised rocks have been grouped into the Mangaiwar and the Sandmata Complexes, the former attained amphibolite grade of metamorphism whereas the latter granulite grade. The low-grade metamorphites marginal to the Vindhyans in the east, have been subjected to regional metamorphism which show progressive increase in the metamorphic grade from east to west. Charnockite, enderbite, pyroxene granulite and hybrid metabasic rocks in Bhim and Bhinai areas of the Sandmata Complex may represent oldest rocks derived from reworked cratonic material due to heat-flow from mantle sources during vertical tectonics in the mobile zone. The deposition of chemógenic sequences appears to have taken place in the interspersed successor basins of Rajpura-Dariba, Pur-Banera, Jahazpur and Sawar There are various acid and basic intrusives which were emplaced during synto-late Orogenic phase. The tectono-environmental setting, lithologtical homogeneity, strike persistency, local relationship of superposition, ciepositional consanguinity, and deformational styles, rocks of the Bhilwara Supergroup, have been classified into several groups as shown in Table 2.2.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Table 1.1 General Stratigraphy of Aravalli Craton (Modified after Naqvi and Rogers, 1987)

Age (in Ga)	Avaralli-DeIhi Belt	Bundelkhand-Son Valley
<.1.00	Marwar Supergroup	Nagaur Group
		Bilara Group
		Jodhpur Group
	Malani igneous rocks	
	----------Unconformity----------	
1.4-0.9		Vindhyan Bhandar Group
		Supergroup Rewa Group
		Kaimur Group
		Semri Group
	----------Unconformity----------	
1.8-1.5	Delhi Supergroup	Ajabgarh Group
		Gwalior Group
		Alwar Group
	----------Unconformity----------	
2.5-2.0	Aravalli Supergroup	Jharol Group
		Bijawar Group
		Udaipur Group
	----------Unconformity----------	
2.5-2.6	Bundelkhand Complex granites and gneisses	Mehroni Group
>3.00	Banded Gneisses Complex/	
		Bhilwara Group

TABLE 1.2 Regional Stratigraphy (After, Balmiki Prasad et. al., 1997)

Lithostratigraphicunits	Igneous events
	Undifferentiated granites,
	dlerite dykes and sills
Ranthambhor Group	Berach Granite and gneiss
	and Jahazpur Granite
Rajpura-Dariba,	
Pur-Banera, Jahazpur	
and Sawer Groups	
	Dolerite dykes and sills
	Untala and Gingla Granites
Hindoli Group, Mangaiwar	
Complex and Sandmata	

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346
Complex

HINDOLI GROUP

The Hindoli Group is named after Hindoli, located 20 km northwest of Bundi. It comprises a low-grade (greenschist), predominantly argillaceous flysch-like sequence deposited during main geosynclinal phase of the Bhilwara Geological Cycle. The rocks of the Hindoli Group extending from Gyaspur in the south to Deyi in the north and further northeastward, over a strike length of a about 400. km, trending NNWSSE in the southern part, becoming N-S near Chittaurgarh, and further northwards veers to ENE-WSW in Hindoli-Deyi area. The Hindoli sequence is bounded by the Vindhyans on the east having either unconformable relationship as seen south of Chittaurgarh or faulted as seen northeast of Chittaurgarh, the fault has been referred to as the Great Boundary Fault of Rajasthan. On the south it is covered by the Deccan Traps. In the west, the contact of the Hindoli Group with the Mangaiwar Complex is not very clear The grade of metamorphism increases gradually towards west and the rocks get migmatised in MangalwarDeoli area. At the contact the greenschist facies rocks of the Hindoli Group grade into intermediate pressure amphibolite facies rocks of the Mangalwar Complex.

The Hindoli Group comprises shales, slates, phyllites, mica schist, with interstratified sequence of metagraywackes, metavolcanics, quartzite, dolomite and limestone. In terms of sedimentary components the Hindoli Group comprises pelite 60% to 65%, semipelite and siltstone 20%, graywacke 5% to 10%, and 5% of arenite and carbonate sediments. The thickness of argillaceous metasediments is of the order of several thousand metres, whereas arenaceous and carbonate members are intercalatory in nature except the Bhadesar Quartzite which has attained considerable thickness.

The rocks assigned to the Hindoli Group were included in the Aravalli System by Heron (1936) and Gupta (1934) and in the Gwalior Series of the Aravalli System by Coulson (1928) on the basis of argillaceous composition and very low-grade metamorphism. Raja Rao (1967) included them in the Jahazpur and the Pur Formation of the Bhilwara Group. Prasad (1973, 1982) grouped these rocks, in Chittaurgarh, area into the Putholi, the Bhadesar and the NangauliSompura Formations. Sahai (1967) included metagraywackes and phyllites into the Sujanpura Formation.

The Hindoli Group has been subdivided into three lithostratigraphic units, viz., the Rhadesar Formation, the Sujanpura Formation and the Nangauli Formation, on the basis of lithology and general order of superposition.

MANGALWAR GROUP

The Mangalwar Complex comprises, an assemblage of migmatite, feldspathised mica schist, garnetiferous mica schist, sillimanite-kyanite schist, hornblende schist, quartz-feldspar gneiss, granite gneiss, granitised amphibolite, para-amphibolite, caic-silicate rocks, dolomite, dolomitic marble and quartzite. The heterogeneous assemblage, containing pelitic rocks deposited during the orogenic phase of the Bhilwara Geological Cycle, regionally metamorphosed to amphibolite facies and syntectonically migmatised to varIous degrees, have been included under the Mangalwar Complex. These rocks occur in the west and northwest of the Hindoli Group.
Mangalwar Complex occurs in three main stretches, the first one extending as a 12 km to 48 km wide belt, from Pipalkhunt to Mangaiwar, through Shampura, Phulia to Mahuwa and beyond, for over a distance of 350 km; the

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

second one occurs from west of Amrita to Dadala for over a distance of 50 km (Sarara-ki-Pal area) and the third one extends from Kunda to Pratappur for over 30 km in width of 6 km to 12 km (Mando-ki-Pal area). Rocks of the Mangalwar Complex are overlain by the type sequence of the Aravalli Supergroup, in Sarara-ki-Pal and Mando-ki-Pal areas and west of Pipalkhunt to northwest of Gangapur with an erosional unconformity. From west of Gangapur to further northeastward, these rocks are in contract which is not very clear, with rocks of the Sandmata Complex.

Mangalwar Complex was included by Heron (1936) and Gupta (1934) in the Banded Gneissic Complex. During the recent work, no sign of unconformity has been observed anywhere along the contact-of rocks of erstwhile Banded Gneissic Complex and the adjoining metasediments included earlier in the Aravalli System. Prasad (1973, 1976, 1982) considered the migmatite and associated gneissic rocks to be the product of syntectonic migmatisation accompanying regional metamorphism. The migmatitic front cuts across the regional trend, the rocks progressively get feldspathised and migmatised and no evidence of unconformity is seen. He assigned these rocks a lithostratigraphic rank and named it as the Mangalwar Group after the village Mangalwar, located about 57—I(m southwest of Chittaurgarh. Typical exposures of the MayaIrs were seen 55W of Mangalwar in Kanor area.

Considering its heterogeneous nature, the Mangalwar Group has now been redesignated to as the Mangalwar Complex. This also includes the pre-Aravalli inliers of Sarada-ki-Pal and Mando-ki-Pal areas. Due to progressive westward increase in grade of metamorphism, deformation and migmatisation, it is not possible to determine the order of superposition in these sequences, as such they have been kept coeval.

On the basis of lithological association, grade of metamorphism, spatial continuity, and nature of occurrence and disposition the racks of the Mangaiwar Complex have been subdivided into four formations: (i) Lasaria (ii) Suwana (iii) Potla and upper most, (iv) Rajmahal. The Kekri formation, Sarada formation and Mando-ki-Pal formation have been considered equivalent to Lasaria formation.

SANDMATA GROUP

The Sandmata Complex represents the highly deformed supracrustals admixed possibly with reworked cratonic material, due to heat flow related to mantle sources. Further, their temporal relation with rocks of the Mangalwar Complex is not very clear and present spatial disposition may be due to vertical tectonics.

The rocks, deposited during orogenic phase of the Bhilwara Cycle, regionally metamorphosed to high-pressure amphibolite and granulite facies and migmatised to various degrees, have been included into the Sandmata Complex. These rocks occur to the west of the Kekri and the Potla Fetions of the Mangalwar Complex having metamorphic and migmatitic contact. The Complex is unconformably overlain by the rocks of the gogunda Group of the Delhi Supergroup in the west. The major part of their contact appears to be faulted and sheared. The Sandmata rocks are overlain unconformably by rocks of the Dovda Group in the south.

The Sandmata Complex comprises migmatite, composite gneisses, calc-gneiss, biotite schist, garnet-sillimanite schist, sillimanite-staurolite garnetiferous biotite schist, hornblende schist, biotite-chiorite schist, mica schist, dolomitic marble, conglomerate, quartzite, para-amphibolite, epidiorite and pyroxene granulite. It is interesting to note that the area occupied by rocks of the Sandmata Complex exhibits a domal feature on the Landsat imagery bounded by the Kaliguman Lineament in the west and the Deiwara Lineament in the east. Rocks of the

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Sandmata Complex occur as a 200 km long and about 50 km wide belt, extending from Amet in the south to Kishangarh in the north.

These rocks were included into the pre-Aravalli Banded GneiSsic Complex by Heron (1953). Raja Rao (1967) included these rocks into migmatites and gneisses of the Bhilwara Group. These rocks have now been designated as the Sandmata Complex, after the Sandmata temple on jji/'2681, south of the Khari river These rocks have been seyfted from the Mangaiwar Complex on the basis of higher grade of metamorphism (granulite facies) and preponderance of varied suits of igneous rocks (viz., Ultramafic, Raipur-Jalayan Mafic and giyangarhAsind Acidic Suites).

On the basis of spatial disposition, lithological association, and grade of metamorphism, following formations along with syntecton acid igneous intrusives have been recognised in the Sandmata Complex:

Giyangarh-Asind Acidic Suite;	
Raipur-Jalayan Mafic Suite; Ultramafics	
	Baranch Formation
Sandmata Complex	Badnor Formation
	Shambhugarh Formation

However, the exact position of Giyangarh-Asind Igneous Suite in the stratigraphic sequence is not clear, and as such they have been considered separately with the intrusives.

RAJPURA-DARIBA GROUP

The group derives its name from Rajpura and Dariba villages in Rajsamand district, where rich zinc-lead mines are located. These rocks were included into the Aravalli System and the Raialos (calcsilicate aj3ure dolomitic marbles) by Heron (1936) and Gupta (1974 Jayaram and Mathur (1974) recognised and separated these as typical chemogenic sequence overlying the pre-Aravalli gneiss and schist. The rocks of Rajpura-Dariba area have been tentatively included in the Bhilwara Supergroup.

Suiphide-bearing predominantly chemogenic rocks, admixed with minor clastics, lying unconformably over the rocks of the Mangalwar Complex and occurring from Bhinder in the south to northwest of Dhor, over a strike length of 100 km as a 2.5 km wide belt, have been assigned to the Rajpura-Dariba Group. They have a synclinal disposition and were deposited under reducing and euxinic conditions in linear inland basin/trough, successor to the first deformation of the Bhilwara Geological Cycle. Rocks have attained amphibolite facies grade and consist of calc-silicate-bearing dolomitic marble, calc-biotite schist, actinolite schist, garnetiferous mica schist, graphitic mica schist, staurolite-kyanite-bearing graphitic mica schist, quartzite, ferruginous chert/ breccia and banded chert. The Zn-Pb-Fe suiphide bands, associated with the caic-silicate-bearing dolomitic marble, chert and graphitic mica schist, are stratiform and synsedimentary in nature. Surface expression of mineralisation is manifested in the spectacular development of gossan at Rajpura-Dariba.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

The rocks of this group unconformably overlie the Potla Formation of the Mangaiwar Complex in the north whereas in the south near Dhanera and Akola, an unconformable relationship is seen with the underlyingLääfläFormation of the Mangalwar Complex.

The Rajpura-Dariba mineralised belt have a typical chemogenic euxinic association of graphitic mica schist, banded silicified cherts and calc-silicate-bearing dolomitic marbles. The dolomitic marbles carry prominent bands of banded ferruginous and manganiferous cherts towards the top. The salient feature in the geological setting of these predominantly lead-zinc rich rocks, is that these exhibit a marked affinity to the lithology of reduzates and doubtful bioliths (?) characteristic of nonclastic and hybrid assemblages (Jayaram and Mathur, op. cit). The influx, of land-derived detrital material, was minimum probably owing to the crystal stability and moderately low-relief. The preponderance of dolomites and carbonaceous sediments in the lower sequence marks an overall reducing environment under the prevalence of humid atmosphere while presence of ferruginous chert indicates a change over, in late stages, to oxidising environments and prevalence of anaerobic atmosphere.

Suiphides occur as thin bands and layers exhibiting bedded geometry and show relict primary structures viz., early diagenetic frambiodal pyrite, slump structures, diagenetic load casts, crumpled lamination etc. which amply demonstrate the syngenetic sedimentary, nature of base metal mineralisation. Later polyphase deformation, metamorphism, recrystallisation and remobilisation have obhterated the original sedimentary geometry giving rise to discordant strata bound suiphide bodies along fractures, shear fold closures and flexures (Poddar, 1970; Raja Rao and Mathur, 1975). Bhinder, Malikhera, Dariba, Sindesar and Satdhudia Formations have been recognised in the Rajpura-Dariba Group on the basis of homogeneity of characters and spatial disposition.

PUR-BANERA GROUP

The Pur-Banera Group of rocks occur in a synformal disposition and overlies, unconformably, the rocks of the Potla Formation of the Mangalwar Complex. Predominantly chemogenic rocks with bands of clastics, occurring from south of Banera to Samodi in the west, bfor over a distance of 80 km in a 3 km to 12 km wide belt, have been assigned to the Pur-Sanera Group. It comprises conglomerate, garnetiferous mica schist, calc-schist, amphibolite schist, calc-gneiss, dolomitic marble, calc-silicate marble, magnetite quartzite, banded magnetitechert and carbonate rock with associated sulphide mineralisation.

Gupta (1934) considered the Pur-Banera metasediments to be of the Aravalli age and their granitised equivalents occurring west and northwest of the belt as a part of the Banded Gneissic Complex while the marbles were included in the Raialo Series. Mahajan (1964), Basu (1966) and Dhara (1970) considered the cover sequence of the Pur-Banera Group belonging to the Aravalli System. As the PurBanera sequence was not having direct links with the Aravallis and the Raialos and was associated with the underlying gneissic rocks, this sequence has been included in the Bhilwara Supergroup.

The rock typesexposed in the Pur-Banera belt consist of a sequence of pelitic, psam iand calcareous metasediments represented by garnetiferous mica schist, quartzite, marble, calc-schist, calc-gneiss, magnetite

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

calc-silicate-bearing carbonate rocks and banded magnetite quartzite. Basic sills and dykes followed by granite and pegmatite intrude the metasediments. The Pur-Banera Group has been subdivided into the Samodi, the Tiranga, the Rewara, the Pansal, and the Pur Formations.

JAHAZPUR GROUP

The characteristic chemogenic stratigraphy and structural discordance with the underlying Hindolis and presence of a conglomerate band towards the base of the sequence, the Jahazpur rocks have been assigned a distinct stratigraphic status as the Jahazpur Group. The Jahazpur rocks appear to have been deposited in linear inland basins/ troughs under starved conditions. Locally strong euxinic conditions resulted in the synsedimentational deposition of lead-zinc-copper sulphides, while oxidising environment facilitated the formation of banded ferruginous cherts and banded haematite-limonite rocks.

Volcanic, clastic and chemogenic rock sequences, occurring from about 2 /1m southeast of Nandrai in Bhilwara district to Naenwa in Tonk /district running for over 110 km, as a 0.5 km to 8 km wide linear belt, have been included in the Jahazpur Group. It occurs in three stretches; the . one extending from Nandrai to Jhikri, the second from Kakralia to Jahazpur and the third from Utrana to Naenwa. These are grouped under the Chuleshwarji, the Jhikri and the Umar Formations. The Jahazpur Group takes its name after the small tehsil-town Jahazpur in Bhilwara district. It comprises conglomerate, quartzite, gritty quartzite, mica schist, ferrugenous chert and breccia, dolomitic marble, carbonaceous phyllite, and metavolcanics. The rocks have attained low-grade of metamorphism (greenschist fades) and overlie, unconformably, the Sujanpura Formation of the Hindoli Group. JaipurKota highway and Chuleshwarji-Kachola road expose the type sections.

Hacket (1881) and Heron (1935) included these pelitic sediments in the Aravallis. The carbonate sequence was correlated by Hacket (1881) with the Delhis while Heron (1935) included these rocks in the Raialos. Gupta (1965) and Sahai (1966) considered the metasediments of the Jahazpur Formation to occur in a continuous sedimentary sequence with the rocks of the Gwalior Series.

The Jahazpur Group have been divided into (i) Chuleshwarji Formation (ii) Jhikri Formation (iii) Umar Formation.

The dolomitic marble occurs as discontinuous patches along the of syncline. it is massive, very fine-grained and siliceous, at place. Thin lenses of chert, found along bedding, are 1 cm to 2 cm wide and 5 cm to 50 cm long. These are usually grey in colour and stand out as ribs on weathered surfaces. A few bands of phyllite and lenses of talc and ferruginous quartzite are also seen within the dolomitic marble. Some of the talc lenses are fairly large (about 40 m long and 5 m thick). In thin section, the dolomitic marble is finely crystalline. Angular grains of quartzite, some fine-grained siliceous matter and a few flakes of plagioclase feldspar and muscovite are seen in the dolomite.

Outcrops of dolomitic marble are seen as fairly persistent, 200 m to 800 m, wide bands in the vicinity of Umar, Pagara, Sujanpura, Sitapura and Gardari. These bands, at places, taper out along the strike. In general, the dolomitic marble shows steep dips and therefore, forms narrow, steep flanked ridges, but near Umar, Pagara and

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Bhoraila, it dips at low-angles and forms extensive outcrops. Near Umar, Pagara and Dhorala, the dolomitic marble is interbedded with banded calcitic marble (Sahai, 1968). Thin impersistent bands of marble are also seen in the area between Umar and Dewa-ka-Khera. The marble is well-bedded and banded in shades of purple, reddish-brown, green and white. It is intercalated with thin, grey or dark-green, argillaceous laminace rich in caic-silicate minerals.

In the vicinity of Chainpura, Badhola, Nayana, Rajlaota and Na nwa, the slaty phyllities are also associated with a number of ba ic flows (Sahai, 1970). The flows are 5 m to 20 m thick and are traceable from tens of metres to several kilometers along strike. North of Naenwa, as many as nine flows can be recognised. In hand specimen, the flow comprises fine-to medium-grained, dark-grey to dark greenish-grey rock which shows circular and irregular vesicles, up to 0.5 cm in diameter, filled with calcite and chlorite.

A specimen of basic flow from 1.2 km west of Jajawar consists of chlorite, quartz, plagioclase and biotite. Chlorite is light-green and is seen as flakes and patches. Grains of quartz with irregular corroded margins are observed and a few grains show strain effect. Plagioclase (labradorite-bytownite) showslamellar twins. Patches of carbonate and light-green to dark-green biotite are also noticed. The groundmass is highly altered.

SAWAR GROUP

A sequence of chemogenic and clastic rocks occurring as a 13 km long and 3 km to 5 km wide, isolated outcrop between Bajita in the north and Sawar in the south, has been designated as the Sawar Group. The rocks of the group are folded to form a NE-SE trending synformal structure. (Devapriyan, 1971 and Ray, 1971). It consists of quartzite, dolomitic marble (suiphide-bearing), calcsilidate-bearing marble, mica schist, biotite schist, phyllite, and carbonaceous phyllite. These rocks uriconformably overlie the Kekri Formation of the) Mangalwar Complex. The type sections are exposed aroundalong which all the units are exposed in a wider expanse. The Sawar Group takes its name after the Sawar village in Ajmer district.

Pascoe (1950), described the Sawar rocks as doubtful Raialo Series while Jam (1965) included the rocks of Sawar into the Delhis. The rocks are predominantly chemogenic in nature and probably have been deposited under starved condition and reducing environment in an inland basin. On the basis of environment of deposition, spatial disposition and lithological and metallogenic characteristics, the rocks of the Sawar Group have been found correlatable with the RajpuraDariba, the Pur-Banera and the Jahazpur Groups.

RANTHAMBHOR GROUP

Low-grade metamorphites, consisting predominantly of quartzite with slaty shales and phyllite, occurring south of Sari Sadri, north of Hora and Mandalgarh, have been included in the Ranthambhor Group. The Ranthambhor Group of rocks comprise quartzite, slate, phyllite and concordant sill-like intrusions of dolerite. The nature of sedimentation, lithological composition and structural setting indicate that the group represents a molasse-like

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

facies of the Bhilwara Geosynclinal Cycle. The type sections can be seen to the south of Ban Sadri, Jakham river section in Jakham dam area, north of Hora, north of Mandalgarh and east-non east of Hora along Bhilwara-Mandalgarh road.

The rocks of the Ranthambhor Group extend over a distance of 200 km fr'm SE of Sari Sadri to north of Mandalgarh and further beyond ENE of Sawai Madhopur Rocks included in the Ranthambhor Group were considered the youngest horizon of the Aravalli System by Heron (1936). Hacket (1881) included these rocks into the Alwar Series of the Delhi System. Prasad (1966, 1974) mapped Sari Sadri, Hora and Mandalgarh Quartzite and Sahai (1967) mapped Mandalgarh Quartzite and they included these into pre-Aravallis.

The Ban Sadri, the Hora and the Mandalgarh Formations have been grouped in the Ranthambhor Group as per their spatial disposition in separated basins of deposition.

Malikhera-Mokhanpura area as a part of Rajpura-Dariba Group

Table 1.3. Local Stratigraphic Succession at Malikhera-Mokhanpura area

Lithounit		Charactrs and Distribution
Gossan/Soil/Blown Sand	:	Recent to subrecent. Blown sand typical of semiarid climate and soil are present. Varying box work structures and colours are present as leached sulphide outcrops.
Ferruginous Breccia	:	Ferruginous matrix inclosing angular fragments of milky white Quartz. Weathered to produce orange yellow, red, brown maroon colours in rock and soil.
Metachert and quartzite	:	Metachert and Quartzite bands constituting core of symmetrical distribution of meta sediments; alternating with chlorite schist. Bold topography representing metachert and Quartzites constituting the central ridge.
Graphitic-Garnetiferous-Mica Schist	:	Dark gray coloured soft rock, also containing Kyanite in outer parts of symmetrical distribution treating metachert and Quartzites as core and still outer part towards village Shivpura Staurolite is also present.
Dolomitic marbles	:	Creamish white coloured recrystallized dolomitic marbles showing concordent Amphibolite bands at few places. Exposed symmetrically at both sides of GraphiticGarneteferous mica schist. Better Exposed at Malikhera, Bera Ka Khera and Mokhanpura.
Banded Gneissic Complex	:	Garnet biolite gneiss (with phyllites bands) exposed at eastern part of the area, around villages Sunariyakhera, Chauthpura and Amarpura.

BANDED GNEISSIC COMPLEX

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

Eastern **part** of the study area, as shown in the Geological map, have been covered by Banded Gneissic Complex rocks. The contact between Banded Gneissic Complex and rest of the metasediments is available at village Sunariyakhera. Banded Gneissic Complex is consisting of calcareous garnetiferrous biolite schist interbedded with Granite Gneiss which is not only migmatised but also penetrated by Quartz veins and Pligmas. It is interesting to record more accumulation of garnets and muscovite at the contact between the BGC and Dolomitic marble of the study area. The accumulation of garnets, although is available all along the eastern contact but is better visible around village sunariyakhera. The size of garnets is moderate, neither uncommonly small nor big.The BGC contact with the metasediments of the study is also available with Garnet-Kyanite-Graphitic micaschist. It is again interesting to record that staurolite have been developed in Garnet-Kyanite-Graphite mica schist only where BGC is very close.

DOLOMITIC MARBLES

Creamish white dolomitic marble is present symmetrically at both sides of the Garneteferous-Graphitic mica schist (±. Kyanite and ± Staurolite). Excellent exposures of dolomitic marble are available at Malikhera, Bera Ka Khera and Mokhanpura villages. The contact between Garnet-Graphite mica schist and dolomitic marble is very sharp and distinct. The contact between Banded Gneissic Complex and dolomitic marble, as mentioned, showing accumulation of garnets at BGC side.

Dolomitic marble is hard and compact rock. Attempt have also made to use it as dimentional building stone. Dolomitic marble have been penetrated by melenocratic concordant intrusives. These amphibolite sills have been better observed at village Malikhera, where breccia is making a contact with dolomitic marble and at Mokhanpura village. A regular pattern with detached continuity of sills have been noted in between villages Mokhanpura and Sunariyakhera. The thickness of Amphibolite sills is varying from half a meter to one meter and totally following dip and strike directions of the host dolomitic marble. Dolomitic marble has shown presence of stromatolites, specially near villpge Malikhera at one end and Mokanpura at another.

GRAPHITIC GERNETIFEROUS MICA SCHIST

Ash gray colored graphitic-garnetiferous mica schist is the major constituent among rock types of the study area. Like dolomitic marble, graphitic-garnetiferous-mica schist is also present at both sides, East and West, symmetrically treating elongated quartzite ridge as central topographic feature. Exposures of graphitic-garnetiferous mica schist are available at the slope of both sides of the ridge and along nallah cuttings at very low reaches.

Graphitic-garnetiferous-mica schist is soft rock susceptable to weathering, thus has produced enough ash gray soil in the region. Invariable graphite and garnet can be identified in this rock even in the field and hand specimen. Rock soils with hand because of presence of graphite. Size of garnet varies from very small to moderate, around one tenth of a milimeter Garnets are of pink colour Among micas, biotite and muscovite are the representative minerals.

Presence of mineral kyanite and staurolite in graphitic-garnetiferous mica schist is not omni but restricted to certain areas. Kyanite is absent, in general, in the central parts below the quartzite ridge and staurolite has shown

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

its presence only towards Shivpura part of the rock. Possibly, temperature and pressure are the factors controlling these distributions. In the field and handspecimen, mineral kyanite showing radial development of its blades. Staurolite is distinct not only because of its columnar appearence but also because of its cross twinning.

METACHERT AND QUARTZITE

Hard and bold metachert and quartzite are of off white colour with some gray diffusing bands in between. Quartzite constituting the only bold topography of the area. The central ridge is showing some such quartzite bands alternating with schist. Most of these schists are biotite-chlorite schist which may gradually transit to graphitic mica schist without any sharp boundary. Possibly the gray band in the quartzites are representing original bedding. Good exposures of quartzite and metachert bands are available at the central ridge and also at few isolated detached hillocks near Rajpura village. Both quartzites and interbedded schists have been effected by local faults, thus have been shifted.

Ferruciinous Breccia

Near village Malikhera, there is one exposure of highly ferruginous rock containing fragments of milky white quartz, possibly derived from a quartz vein. The exposure as mapped shows a trend that is in accordance with the host dolomitic marble. The exposure of ferruginous breccia is also showing some pattern of preservation of first generation folding. Ferruginous breccial, at one contact (western), showing amphibolite band which is metamorphic derivetive of a basic intrusion. Possibly, ferruginous breccia is of volcanic origin.

Gossans

Leached sulphide outcrops in the form of gossans are available as cap over metachert and quartzite ridge at Rajpura village. Gossan capings are almost continuous over all the three hillocks. Gossans show both box work structures and various shades of iron oxides including yellow, orange, brown, red maroon and there combinations Colourations have also been recorded over main metachert-quartzite ridge in very small quantity and over ferruginous breccia.

Blown Sand and Soil

Lower reaches of the area are crop fields. Away from central ridge Mokhanpura Sunariyakhera, Chothpura, Amarpura and Shivpura are better covered by soil. Being semi-arid, the region is also showwing enough blown sand specially during summer

II CONCLUSION

The Dariba-Rajpura is one of the most important polymetallic sulphide deposit of the world. It remained an important lapse as far as geological studies are concern, not to establish, a reliable age of the deposit. The author's work was confined to an small part of the area thus it remained beyond the scope of the present work. It is author's suggestion that better attempts should be made to understand the stratigraphic age of the belt. Obiously, it must be useful not only to understand the mineralization but also its possible extension within the belt and the belts of equivalent age like Sawar, Jahazpur etc.

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 08, August 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

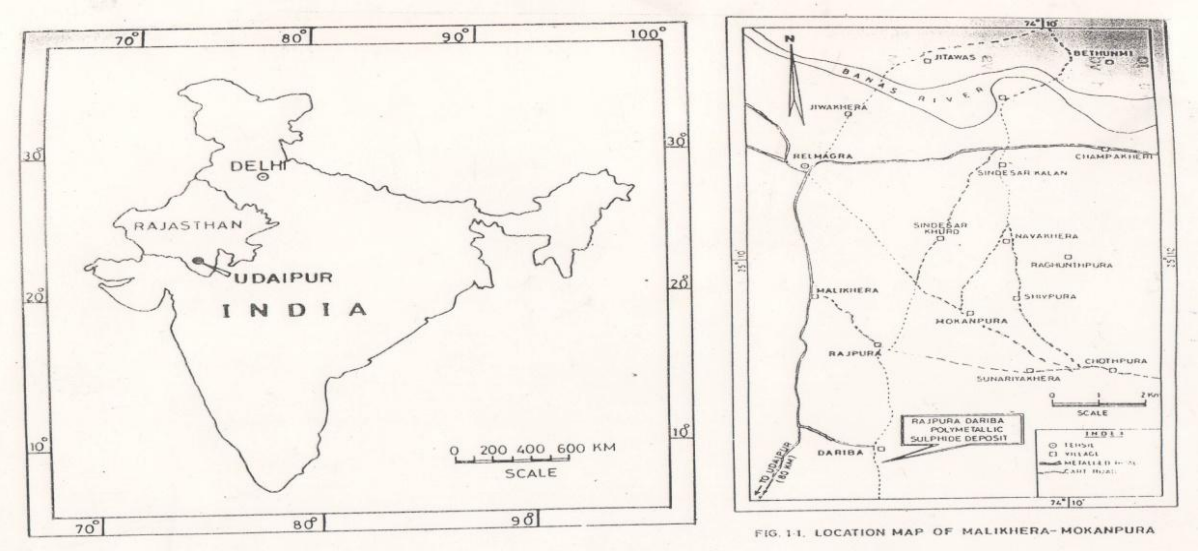


FIG. 1.1. LOCATION MAP OF MALIKHERA- MOKANPURA

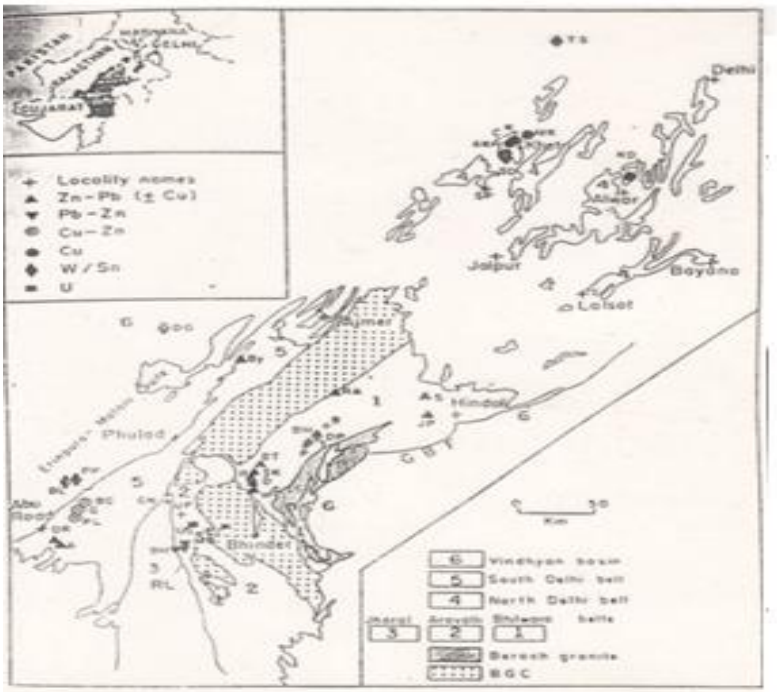
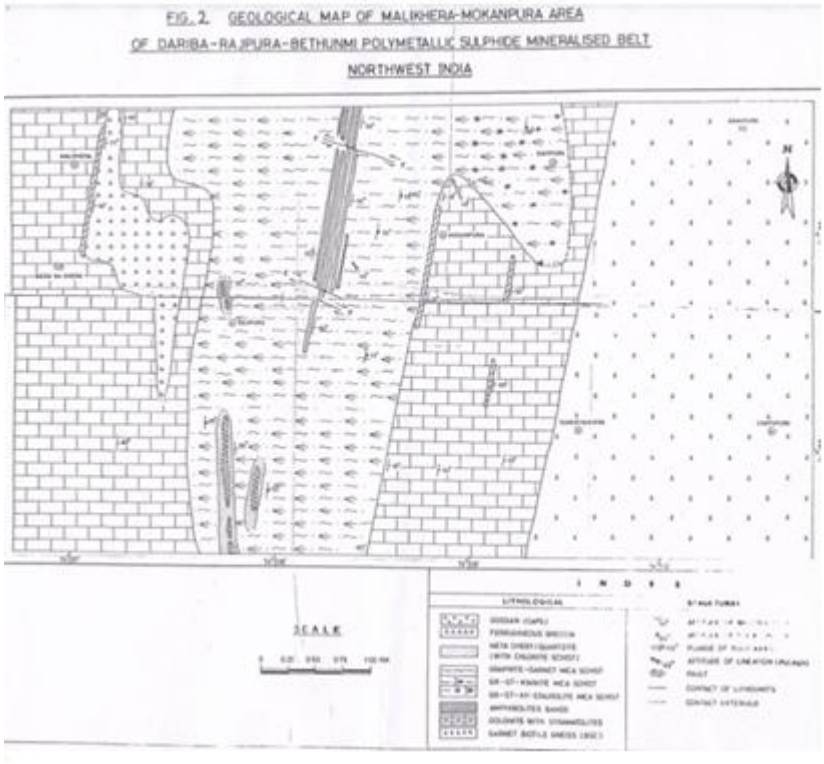
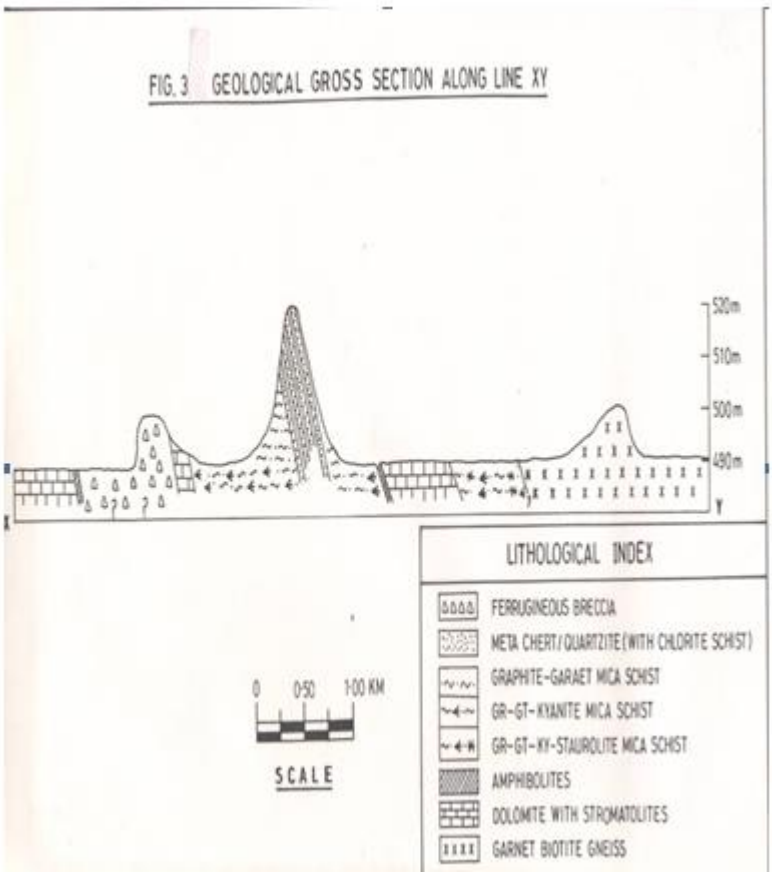


Fig. 2.1 Regional Geological Map of study area
(After Deb and Sarkar, 1990)

International Journal of Advance Research in Science and Engineering
Vol. No.6, Issue No. 08, August 2017
www.ijarse.com
IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346





IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

REFRENCES

[1.] Ameta, S. S. and Sharma, B. B.; 2008: Geology, Metallogeny and Exploration of Concealed Lead-Zinc Deposit in Sindesar Khurd-Lathiyakheri Area, Rajasmand district, Rajasthan, Jour. Geol Soc of India, v.72, pp. 381-399.

[2.] Basu, K.K., 1966. 'Systematic geological mapping in Bhilwara district Rajasthan'. Rep. - (Unpublished Geol,Surv. Ind. (F.S. 1965-66).

[3.] Bask K.K., Arora, Y.K. and Naha, K., 1976. 'Early Precambrian stratigraphy of Central and Southern, Rajasthan'. Pre-Camb. Res. Vol. 3, pp 197-205.

[4.] Coulson, A.L., 1928. 'The geology of Bundi state, Rajputana', Rec. Geol. Surv. Ind. 60 (2) : 161-204.

[5.] Crawford, A.R. and Compston, W., 1970. 'The age of Vindhyan System of Peninsular India'. Quart. J. Geol. Soc., London Vol. 1 (125) pp. 351-72.

[6.] Dhara, M.K., 1970. 'Report on regional exploration of lead-zinc-copper deposits in the Pur-Banera belt, Bhilwara District, Rajasthan'. Rep. (Unpublished) Geol. Surv. Ind. (F.S. 1969-70)

[7.] Devapriyan, G.V., 1971. 'Report on the assessment of lead-zinc deposits in Sawar area. Ajmer district, Rajasthan'. Rep. (Unpublished) Geol. Surv. md. (F.S. 1966-67 and 1970-71).

[8.] Geological Survey of India, 1977. 'Geology and Mineral of the states of India : Part XII, Rajasthan' Geol. Surv. Ind. Misc. PubI. Vol. 30. 75 p.

[9.] Geological Survey of India, 1997. "The precambrain geology of the Aravalli region, Southern Rajasthan and Northeastern Gujrat'. Memoirs of the GSI, Vol. 123 pp. 16-86.

[10.] Gupta, B.C., 1934. 'The Geology of Central Mewar'. Mem. Geol. Surv. Ind. 65 (2)

[11.] Gupta, B.D., 1965, 'Report on systematic geological mapping of Deoli-Jahajpur area of Tonk, Bhilwara and Bundi District, Rajasthan'. Rep. Rep. (Unpublished) Geol. Surv. Ind. (F. S. 1964-65).

[12.] Hacket, CA., 1881. 'Geology of Aravalli Region, Central and Eastern Rajasthan'. Rec. Geol. Surv. Ind. Vol. 14(4).

[13.] Heron, A.M., 1935. 'Synopsis of Pre-Vindhyan Geology of Rajputana'. Trans. Nat. Inst. Ind. Vol. 1(2).

[14.] Heron, AM., 1936. 'Geology of Southeastern Mewar, Rajputana'. Mem. Geol. Surv. lnd. Vol. 68(1)

[15.] Heron, A.M. 1953. 'The geology of central Rajputana'. Mem. Geol. Surv. Ind. Vol. 79.

[16.] Jain, R.S., 1965. 'Progress report on investigation of lead occurrences in Sawar and adjoining areas in Ajmer district, Rajasthan'. Rep. (Unpublished) Geol. Surv. md. (ES. 1964-65).

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[17.] Jayaram, B.N. and Mathur, R.K., 1974. 'Syngenetic sulphide metallogenesis in the precambrian of southern Rajasthan'. tnt. Sem. on Tectonics and Metallogeny of southeast Asia and Far East, Calcutta. Abstract, p. 82.

[18.] Mahajan, V.D., 1964. 'luterim report on investigation of copper lead deposits of Pur-Banera belt, Bhilwara district, Rajasthan'. Rep. (Unpublished) Geol. Surv. md. (F.S. 1963-64).

[19.] Naha, K., 1883. 'Structural stratigraphic relations of pre-Deihi rocks of south-central Rajasthan : A summary'. Res. Geol., Vol. 10 pp. 40-52

[20.] Naha, K. and Roy, A.B., 1983. 'The geology of the precambrian basement in Rajasthan, Western India'. Pre-camb. Res., Vol. Vol. 19 pp. 217-223

[21.] Naha, K., Mukhopadhyaya, D.K., Mohanty, R., Mitra, 5K., and Biswal, 1K., 1984. 'Significance of contrast in the early stages of the structural history of the Delhi and Pre-Delhi groups in the proterozoic of Rajasthan, Western India'. Tectano-physics, Vol. 105, pp. 193- 206.

[22.] Naqvi, SM. and Rogers, J.J.W., 1987. 'Pre-cambrian Geology of India' Oxford Monographs on Geology and Geophysics No. 6, Oxford University Press, 233 p.

[23.] Nawal, S., 2002. "Geological investigation in Malikhera-Mokanpura area of Dariba-Rajpura-Bethunmi polymetallic sulphide belt Rajasthan". Ph.D. Thesis (unpublished), J.N.V. University, Jodhpur (India).

[24.] Nawal, S.,2017."Polymetamorphism in the Malikhera-Mokanpura area of Dariba-Rajpura-Bethunmi polymetallic sulphide belt Rajasthan". IJETSR,ISSN 2394-3386 Volume4, Issue 7, july 2017,pp 795-802.

[25.] Nawal, S., 2017. "Mineralisation in the Malikhera-Mokanpura area of Dariba-Rajpura-Bethunmi polymetallic sulphide belt Rajasthan". IJETMAS, ISSN 2349-4476 Volume 5, Issue 7, July 2017,pp 686-691.

[26.] Nawal, S., 2017. "Deformation in the Malikhera-Mokanpura area of Dariba-Rajpura-Bethunmi polymetallic sulphide belt Rajasthan". IJARSE,ISSN 2319-8354 Volume 6, Issue 8, August 2017,pp 795-802.

[27.] Nawal, S., 2017. "Geological investigation in the Malikhera-Mokanpura area of Dariba-Rajpura-Bethunmi polymetallic sulphide belt Rajasthan". IJETMAS, ISSN 2394-3386 Volume 4, Issue 8, August 2017 .

[28.] Pascoe, E.H., 1950. 'A manual of geology of India and Burma'. Geol. Surv. Ind. Miscellaneous Publication. Vol. 1 pp. 245-250.

[29.] Pasad, B., 1966. 'Systematic geological mapping in parts of Chittaurgarh district, Rajasthan'. Rep. (Unpublished) Geol. Surv. Ind. (F.S. 1965-66)

[30.] Prasad, B., 1973. 'Geology of the pre-Aravalli rocks in parts of Chittaurgarh and Udaipur districts. Sem. Recent advances in the geology of Rajasthan and Gyjrat, Jaipur Abstract p. 4.

[31.] Prasad, B., 1974. 'Systematic Geological mapping in parts of Bhilwara Bundi districts, Rajasthan'. Rep. (Unpublished) Geol. Surv. Ind. (F.S. 1973-74).

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[32.] Prasad, B., 1976. 'Revised stratigraphic Position of Banded Gneissitc Complex and Berach Granite and their relationship, Chittaurgarh area, Rajasthan'.Sem.on Archeans of Central India. 30th Nov.-1st Dec., 1976., Nagapur. Abstract

[33.] Prasad, B., 1982. 'Geology of pre-Aravalli Formations, Chittaurgarh district, Rajasthan'. Rec. Geol. Surv. Ind. 112(7) 26-45.

[34.] Raja Rao, CS., 1967. 'On the age of Precambrian Group of Rajasthan'. J. Mm. Met. and Fuel. 15(9).

[35.] Rao, C.S. and Mathur, R.K., 1975. 'Rajpura-Dariba lead-zinc copper deposit, Udaipur district, Rajasthan'. (Abst) Jour Geol. Soc. Ind., Vol. 16, Suppl. p. 28-29

[36.] Roy, A.B. and Paliwal, B.S., 1981. 'Evolution of lower proterozoic epicontinental sediments : Stramatolite bearing Aravalli rocks of Udaipur, Rajasthan India'. Precam. Res., Vol. 14, pp. 49-74.

[37.] Roy, A.B. and Paliwal, B.S., and Bejarniya, BR., 1984. 'The Aravalli rocks : An evolutionary model and metallogenic trends'. Indian Jour. Earth. Sci. C.E.I.S.M. Seminar, Vol., PP. 73-83

[38.] Roy, A.B. 1988a. 'Precambrian of the Aravalli Mountain Rajasthan India'. Memo. No. 7 (Ed. A.B. Roy), Geol. Soc. India, pp. ii-viii.

[39.] Roy, A.B., 1988b. 'Stratigraphy and Tectonic Framework of Arvalli Mountain Range'. Memo. No. 7, Geol. Soc. India, pp. 3-31 (Ed. A.B. Roy)

[40.] Roy, A.B., Paliwal, B.S., Shekhawat,S.S., Nagori, D.K., Golani, P.R. and Bejarniya, B.R., 1988. 'Stratigraphy of the Aravalli Supergroup in the type area'. Memo No. 7. Geol, Soc. Ind., pp. 121-138

[41.] Sahai, T.N., 1966. 'A report on systematic geological mapping in parts of Bhilwara district, Rajasthan'. Rep. (Unpublished) Geol. Surv. Ind. (F.S. 1966-67)

[42.] Sahai, T.N., 1967. 'A report on systematic geological mapping in parts of Bhilwara district, Rajasthan'. Rep. (Unpublished) Geol. Surv. Ind. (F.S. 1966-67)

[43.] Sinha Roy, S. Malhotra, G. and Mohanty, M.; 1998: Geology of Rajasthan: Geological Society of India, 278 P.

[44.] Shrivastava, K.L. 1992. 'Ore Petrographic geophysical and geochemical investigation of sedimentary and metamorphosed pyrites from two sulphide deposits of India and its bearing to the ore genesis. Ph.D. Thesis (unpublished), J.N.V. University, Jodhpur (India).

[45.] Yadav, P.K, and Avadich, P.C.; 2007: Hematite bearinggarnetiferous quartzite in Rajpura – Dariba Group of Rocks.Emerging trends of Research in Geology (NW India). Eds.Avadich, P. C.and Bhu, H., pp189-190.

IJARSE
ISSN (O) 2319 - 8354
ISSN (P) 2319 - 8346

[46.] Yadav, P.K, and Avadich, P.C.; 2010: Volcano – SedimentarySuccessions Hosting Base metals in Sindesar Khurd.Contributions to Mineral Exploration, edit. P.C.Avadich and Harsh Bhu, Mem.v 76 Journal Geol. Soc of India, pp 114-132.

[47.] Yadav, P.K and Avadich, P.C.; 2010: Ore Guides and History ofBase-Metal Exploration in Rajpura-Dariba Belt, Rajasthan -suggestions for a New Approach for Future ExplorationDiamond Jubilee National Seminar Volume M.L.S.UniversityUdaipur.Published in Diamond Jubilee National Seminar Volume 29-30 Jan 2010, pp 61-67.

[48.] Yadav,P.K and Avadich, P.C.; 2010: Synthesis of Geological and Airborne Geophysical Data for Prognosticating New Area for the Exploration of Lead and Zinc in Sindesar Khurd Area, Rajpura-Dariba Belt Rajsamand District, Rajasthan. Journal Geol. Soc of India, v.75, May, pp.731-738.

[49.] Yadav P. K and Avadich P. C.; 2015: Sindesar Khurd Lead-ZincMineralisation and Techniques of searching new deposits,International Research Journal of Geology and Mining (IRJGM)(2276-6618) Vol. 5(1) pp. 6-11, January, 2015

[50.] Yadav P. K ; 2015: Geology of rajpuradariba group of rocks ,International Research Journal of Geology and Mining (IRJGM) Vol. 2(3)