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Geological Investigation In Malikhera-Mokanpura Area Of Dariba-Rajpura-Bethunmi Polymetallic Sulphide Belt Rajasthan

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ABSTRACT

The proposed area of study is northern extention of well known Rajpura-Dariba polymetallic sulphide deposit. The Malikhera-Mokanpura area (Latitude 74°07 to 74°11' and Longitude 24°57' to 25°00') is part of Survey of India Toposheet No. 45 K/4 and 45 L/1. The area is part of newly created Rajsamand district. Earlier, it was part of Udaipur The location of the study area has been shown in the location map (Fig. 1).

REGIONAL GEOLOGY OF THE AREA

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 stratigraphi succession of Precambrian rocks of Aravalli craton are given in Table 1 ,2. and regional geology in Fig 2

Stratigraphically stating, these rocks are parts of the Bhilwara Supergroup (Raja Rao et. al. 1971 and Raja Rao 1976). The existance of a definable Bhilwara Supergroup is controversial. The structure and mineralogy of the rocks are similar to those of small metasedimentary enclaves in the B.G.C., that were regarded by Heron (1953) as pre-Aravalli. Roy et. al. (1981) demonstrated that separation of Bhilwara Supergroup from B.G.C. is not tenable on structural grounds. Geological Survey of India (1977) defined the Bhilwara Supergroup, as the B.G.C. exposed in Karera area and the Hindoli group, which was earlier mapped by Gupta (1934) as Aravalli. The original name used by Raja Rao as Bhilwara, was retained, but the concept was greatly changed.

Table 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 Supergroup: Bhandar Group, Rewa Group

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			Kaimur Group Semri Group
	----------Unconformity----------		
1.8-1.5	Delhi Supergroup	Ajabgarh Group Alwar Group	Gwalior Group
	----------Unconformity----------		
2.5-2.0	Aravalli Supergroup	Jharol Group Udaipur Group	Bijawar Group
	----------Unconformity----------		
2.5-2.6			Bundelkhand Bundelkhand Complex granites and gneisses Mehroni Group
>3.00	Banded Gneisses Complex/ Bhilwara Group		

TABLE 2 Regional Stratigraphy (After, Balmiki Prasad et. al., 1997)

Lithostratigraphic units	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 Complex	

LOCAL GEOLOGY OF THE MALIKHERA-MOKANPURA AREA

For the present concern the Malikhera-Mokhanpura area have been considered as part of Bhilwara Supergroup following Geological Survey of India (1977). As per GSI, the area comes under RajpuraDariba Group of Bhilwara Supergroup and consisting of metasediments younger to Banded Gneissic Complex (including Mewar Gneisses) and are equivalent to Jahajpur, Pur-Banera and Sawar groups. The Geological map of the area prepared by the author has been presented as Fig.3.Local Lithostratigraphic succession of the area have been presented in Tab 3.

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Table 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

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 Garnetiferous 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 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.

Ferruginous 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

DEFORMATIONS

The deformational study, shows that there are three deformations named as Dl, D2 and D3. The structural elements which are related kinematically such as folds and planer and linear tectonic anisotropy have been accommodated with in the same deformational episode. It is concluded that the first deformation (Dl) has been recorded by earliest fold (Fl) occur as mesoscopic structures, tight by appressed, overturned and gently to moderately plunging and locally acquire a reclined geometry with axial plane trending N-S. The temporal relationship of D2 has been established on the basis of refolding of Fl by F2. F2 folds are present on micro, meso and macro-scales F2 folds are moderate to steeply inclined open folds with low amplitude to wave length ratio S2 schistosity is well developed as axial plane cleavage of F2 folds. S2 is the regional foliation. In the hinge zone it shows angular relationship with bedding, whereas on the limbs, it tends to be parallel to sub-parallel with bedding. The third deformation (D3) have developed F3, constituting a set of upright folds with almost east-west axial traces. These folds has caused a plunge instability of F2 folds leading to large scale axial culminations and depressions of F2 fold axis. Faults developed north to Rajpura etc. are resultant to rupture along F3 fold axis. Author's study refute the older view that these rocks are western limb of northeasternly plunging macrosyncline a closure of which recorded at Bhinder.

The Dariba-Rajpura part of the area show very narrow basin elongated for a strike length of 3 kms. In this part the mineralized loads are concentrated along two faults. These two faults are parallel to each other and the regional strike of the area, thus almost N-S. Among two faults, eastern fault has accummulated metals to form a load called east load. In the western fault there are two loads named north load and south load. It is very clear that the mineralisation is fault controlled.

Coming to the further north of Rajpura village, the present study area, these faults have been totally vanished from the surface leaving no traces Samaddar, (1987) have clearly mentioned that there are no evidences available for his team of Geological Survey India which could at all have been detected for these mineralized faults.

Author's study, on deformation is significant in the sense that these fults have been traced. Availability of the ferruginous breccia itself is the most prominent evidence. The breccia is also rich in gossans and hówing high geochemical values, including that of Hg. Further north, the fault have been traced as huge yellow soil (of gossan) recovered from at least two dugwells, one at Malikhera another further north to Malikhera.

POLYMETAMORPHISM

The pelitic metasediments in the study area are characterized by the following mineral assemblages:

(i) Biotite-muscovite-sericite-chlorite-quartz.

(ii) Biotite-muscovite-sericite-almandine-quartz.

(iii) Biotite-muscovite-graphite-almandine-quartz.

(iv) Biotite-muscovite-graphite-almandine-Kyanite-quartz.

(v) Biotite-muscovite-graphite-almandine-Kyanite-Staurolite-quartz.

Impure carbonate metasediments are represented mineral assemblages

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(i) Calcite-dolomite-quartz.

(ii) Calcite-tremolite-quartz.

(iii) Dolomite-calcite-tremolite-quartz.

The rocks of the Malikhera-Mokanpura area have undergone prograsive regional metamorphism of the Barrovian type showing an upward increase in grade of metamorphism from chlorite to kyanite and staurolite jkare five various metamorphic zones marked in the metamorphic.The metamorphic mineral assemblages of each zone has been studied graphicalIy The lowest grade of metamorphism attained by these rocks pura-Dariba area is of quartz-albite-biotite sub facies of the green st facies The highest is staurolite-almandine sub facies of amphibolite os in the Barrovian type of metamorphism Three main metamorphic episodes, named Ml, M2 and M3, have been recognised.

First phase of metamorphism (Ml) took place in rocks which were subjected to increase in temperature and confining pressure due to load and overburden of rocks During this phase the main schistosity was formed Alignment of chlorite, muscovite, biotite, quartz along the SI schistosity plane and absence of growth of garnet, staurolite and kyanite related to SI (Dl deformation) suggest that the schistosity was formed under greenschist facies. This schistosity forming metamorphism is syn-kinematic to Dl and is designated as Ml metamorphism.

The metamorphism reached its peaks during second phase of metamorphism M2, with the crystallization pelitic index minerals like garnet, staurolite and kyanite. Garnet and biotite showing alteration to chlorite is widely distributed, suggesting a retrograde phase of metamorphism (M3). This retrograde phase of metamorphism was resulted due to fall in temperature and pressure as a result of uplift. Retrogression is post D2 and hence this phase of metamorphism is designated as M3. It shows growing down grade with decreasing temperature involving hydration and carbonation reactions.

MINERALISATION

Shrivastava's genetic model (1992) has explained the ore genesis to enough degree of satisfaction. As the model says, the mineralization occur in a sedimentary basin where metals and possibly sulphur have been exhaled periodically before get deposited to the form one layer, after another.

The synsedimentation has although made the metals available to the belt but could not concontrated the same to make a deposit of economic potential. In fact, later processes are responsible for the same. At a later date, the metals must have been remobilized and get concentrated in the form of loads making ore shoots, veins, stringers, cross cutting the host syn-sedimentary rocks (now, metamorphites) and to each other.

While making a total scanning of all the geological events and their order the area has suffered, it is authors conclusion that possibly the effective mobilization could have occur at the time of M2 phase of metamorphism. The second phase of metamorphism (M2) was most intense and effective because there has been maximum spread of heat and pressure both. Preservation of graphite shows a role of gaseous phase. There is a possibility that maximum temperature and pressure must have reached some 650°C with 4 to 6 KB pressure. It is concluded on the basis of Kyanite, Staurolite and Pyrrhotite geothermometry and geobarometry.

Deb. et. al. (1989) has expressed that Pb isotopic data shows the date of mineralization around 1800 Ma. If author will treat the data as reliable one, this must be time of M2 metamorphism intense remobilization of metals and hydrothermal activity.

CONCLUSION

Author will also like to conclude that the most potential zone of possible mineralization is concentrated in the ferruginous breccia parts. All the deformational patterns, possibility of concealed mineralized fault, availability of huge gossans at surface and subsurface and high geochemical values

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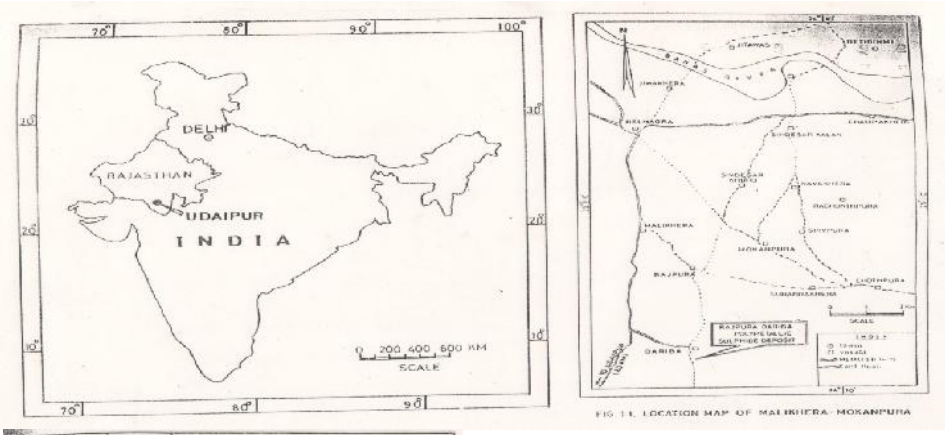
indicating that ferruginous breccia zone is inviting detailed search to discover the extension of the Dariba-Rajpura mineralization to Malikhera area. The Dariba-Rajpura is one of the most important polymetallic sulphide deposit of the world. It remained an important lapse as far as geological studies 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.

There is a scope of correlation of age of mineralization and/or remobilization of metals in different parts of the belt like Dariba, Rajpura, Sindesar and Buthunmi areas. To better understand the behaviour of the mineralization dating of ore minerals should be done.

Lastly, the geochemical studies has revealed high concentration of Hg and As in the ferruginous breccia area of the study area. These two elements are being treated as pathfinder elements for the mineralization of gold. This possibility also need serious attempts of exploration.



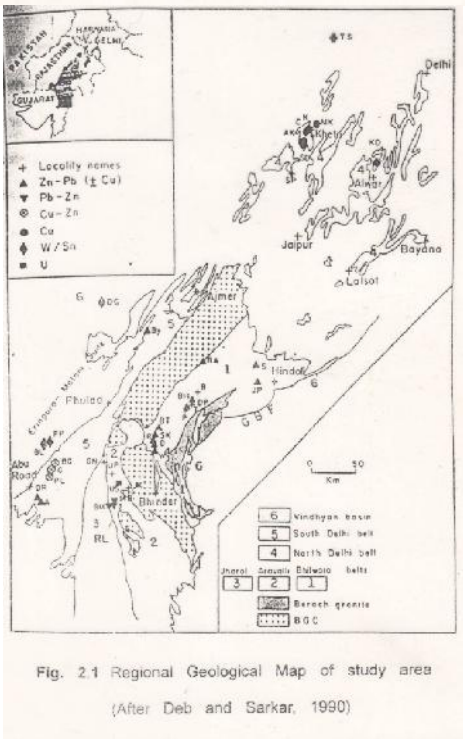


Fig. 2.1 Regional Geological Map of study area (After Deb and Sarkar, 1990)

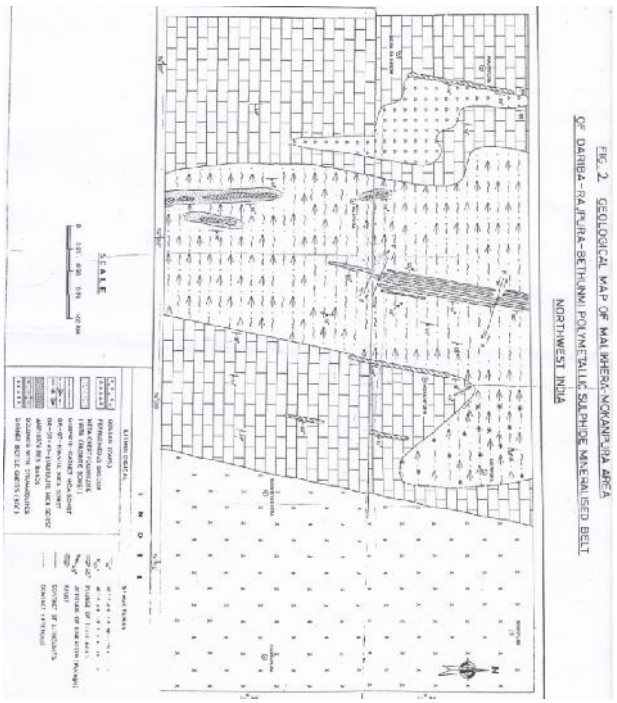


FIG. 2 GEOLOGICAL MAP OF MALIKHERA-MOKANPURA AREA OF DARIBA-RAJPURA-BETHUNI POLYMETALLIC SULPHIDE MINERALISED BELT NORTHWEST INDIA

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