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Mineralisation in the Malikhera-Mokanpura Area of Dariba-Rajpura-Bethunmi Polymetallic Sulphide Belt Rajasthan

Dr. Samir Nawal
Gsss Jhanwar, Jodhpur, Ex Research Schoolar, Department Of Geology, Jai Narain Vyas University Jodhpur Rajasthan

Abstract: To assess the possibility of the potential of mineralization in the Malikhera-Mokanpura part of the mineralized belt, the present paper on Mineralisation has been added. The assessment has been discussed in the light of genetic model already available for belt and certain studies performed by GSI earlier including geochemical and geophysical studies. Gossans and old woking is study as a guide for mineralization. Biogeochemical and geobotanical implication to mineralization also studied and geochemical and geophical prospecting study also done. Significance of present detailed study of deformations and polymetamorphism has also been discussed.
Keywords : Dariba-Rajpura polymetallic sulphide belt, Genetic model, Gossans, Geochemical prospecting, Geophical prospecting, Deformation, Polymetamorphism

I. INTRODUCTION

The Dariba-Rajpura is one of the most important polymetallic sulphide deposit of the world The Malikhera-Mokanpura area is adjacent area to the Rajpura mineralized block of Dariba-Rajpura-Bethunmi polymetallic sulphide mineralized belt. The belt is almost 17 kms. long with Dariba as its southern end and Bethunmi as its northern end. 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 district In fact it is a junction of three political districts, Rajsamad, Chittorgarh and Udaipur within the radius of 15 kms.

II. IMPLICATION OF GENETIC MODEL

As the study area is part of a mineralized heft, namely DaribaRajpura-Bethunmi polymetallic sulphide belt, the possibility of mineralisation can be expressed in the light of Genetic model of the deposit, available. Shrivastava (1992), on the basis of evidences has proposed that the Dariba-Rajpura deposit belong to the sedimentary exhalative category, as far as their genetic modelling is concerned Such models been reviewed earlier by Morganti (1981); Garson and Mitchell 31); Gustafson and Williams (1981); Large (1981, 1983); Turnit J84) and Hutchison (1983) The physico chemical control on formation 1F deposits have been discussed by Finlow-Rates (1980), Russell et. al (1981), Russell (1983), Lydon (1983), Lydon et al (1986), Goodfellow and Jonasson (1986a, 1986b) and Macintyre (1992) In general, the consensus among these workers is that the deposits formed by precipitation of sulphide minerals from metalliferous brines that were exhaled along active submarine faults. Metals and fluids were most likely derived from the sedimentary pile either by normal dewatering during basinal subsidence or by hydro-thermal leaching during periods of elevated heat flow and convective circulation of seawater through the sedimentary pile.

In the Rajpura-Dariba deposit, there is direct association of acid volcanic layers in the host rocks. The doubtful microfossils of bacterial dimension including framboids (Shrivastava, 1981) provide some evidence of life, if not their active involvement in the oregenesis. Profuse occurrence of Graphitic-mica schist (organic/carbonaceous matter) in the Dariba-Raipura deposits is probably the most impoilant evidence of life. The most likely source of organic matter seems algae.

It is further proposed by Shrivastava (op. cit.) that the water column in the basin can be divided into three parts, the deepest reducing conditions with rich H2O, the intermediate or CO2 zone, and the shallow oxygen zone. The bacterial decomposition occur at the deepest zone The intermediate or transition zone is conducive to partial oxidation of organic matter so as to produce abundant CO2 while maintaining strongly reducing milieu. In the shallow zone, there is virtually complete oxidation of all organic matter. Before deposition of parent to the graphitic-mica-schist (Carbonaceous shales) at Dariba-Rajpura there were evaporitic conditions as evidenced by presence of scapolite. Silica is also deposited being rich in the sea water, in the form of chert or somewhat replacing carbonates. The high carbon content indicate slow sedimentation in anoxic sedimentary exhalative deposition in subsiding basin may also be controlled by movement of rifted blocks.

The Genetic model (Shrivastava, 1992) keep on saying that at the sediment water interface in such an anaerobic basin, several centres of nucleation of crystallization of the precursor minerals of pyrite were initially formed and later produced their microcrysts. The microcrysts were attracted by each other, probably magnetically, and appear to have aggregatised to form microspherules. The pyrite framboids were formed through a process in which precursor spherules have undergone sulphur oxidation resulting into pyrite microcrysts. The spherical form of the framboid can be interpreted as the response to the requirement of achieving minimum surface area. Good number of textural variations observed helped to clearly demarcate atleast three major onological stages of diagenesis. Leaving a side this first stage, in the second stage, framboids showing segregation textures producing opthalmic pattern, poly framboidal texture, motion and disruption features. In the third stage, all the framboidal pyrites gradually got converted into massive types by coalescence followed by recrystallization then producing tripple point junctions and later pentagonal tendency before their complete digestion into massive variety. Shrivastava's model (op.cit) can be summarized in the form of following steps:-

A. Heated metal rich dense brines are exhaled periodically from fault controlled vent bounding graben where slow sedimentation is in progress into deep anoxic parts.

B. The pulses of exhalation of metals show a defined sequence - Fe, Zn, Pb and Cu. The combinations of the two nearer metals in the transition is more likely, although there may be more than two metals.

C. Organic matter might have contributed 's' as part of organic sulphur become available as H_2S during bacterial attack before consolidation of sediments, while the residue is gradually released during thermocatalytic breakdown of the burned organic matter. Alternatively, brines carrying metal chloride complex causing the release of hydrogen suiphide by thermal degradation of sulphur ntaining organic compounds Sulphur in part might have derived ogenically from sulphate

D. As, the exhalation occur in the form of neutrally buoyant plumes that spread laterally across the sea floor below a density interface, it satisfy the formation of thin laminae of sulphides over relatively a wide areas The deposition of metals from hot brine is more effective around the margins of the basin where they met and mingled with cooler waters The sulphides are precipitated from these plumes in response to the physico-chemical conditions of the depositional basin.

III. GOSSANS AS GUIDE FOR MINERALISATION

The spectacular and conspicuous gossans in the area forms the mineralogic guides. A diagnostic in situ gossan has formed due to intensive chemical weathering of the ore body. Particularly between Dariba and Rajpura. The gossan shows dark-brown bright-reddish yellow vermillion, brickred-red purple, yellow, pale grass green, bluish green, asure blue, black, grey and white colours indicating the presence of several minerals like limonite, goethite, jarosite, jasper, melachite, axurite, tarquois, hematite, manganese-oxides, clay minerals etc.

Cubic, cellular and honey-comb boxworks, diamond mesh, pear shaped globular and rounded voids (Plate 1 Fig.. 1) and dense limonite are found in the gossan indicating the presence of sphalerite, galena, pyrite, and pyrrhotite. Relicts of galena, pyrite and chalcopyrite are also present in the gossan. A very fine granular indigo-blue mineral particularly replaces galena and chalcopyrite. The supergene minerals display colloform texture and various stages of pseudo morphism alter sulphides coarse crystalline barytes and hydrated iron, copper and alluminium sulphate indicates arrested leaching of sulpher and form a characteristic feature of the gossan, but no such features observed in the area. Primary sulphide are seen in gossan at breccia near Malikhera.

IV. OLD WORKING AS GUIDE FOR PROSPECTING

Heaps of slag, mine wastes and old workings in ancient mining centers specially near village Rajpura, provide reliable clues to the presence of ore in the area. Old workings like open pits, shafts, inclines, etc. are spread all along the strike of the gossan between Dariba and Rajpura, but absent further north. Extensive cutting along the dip slope of the Quartzite ridge further indicate some amount of workings of the oxidised ore. Heaps of slag and extensive mine waste give indications of a thriving mining and metallurgical industry.

Figure1.1: Different type of gossans

V. BIOGEOCHEMICAL AND GEOBOTANICAL IMPLICATION TO MINERALISATION

Plants growing on mineralised ground tend to pick up the metals through solution, and store them If these plants or crops are analysed 5emically then the normal and anamolous metal contents can be dEtermined. Although the metal content in a plant is controlled by (i) chemistry of soil, (ii) pH of soil, (iii) sun light, (iv) soil moisture àontent and (v) season. Some plants are restricted to or flourish well on a particular type of mineral deposits, as geobotanical guides. For example the species Viola calamina characteristically grow on zinc rich soils, although remained unobserved in the study area.

In the area a small plant Aspera grown very profusely along the mineralised gossan and limonite zone and also on old mine dups. This plant attains its optimum growth during the rainy season and dies out after the rains. The same plant when growing in the adjoining areas does not have such a luxuriant growth, and there is a marked difference between the size and flowering of the plants.

VI. GEOCHEMICAL PROSPECTING

Geological Survey of India, (Geochemistry wing) has conducted geochemical prospecting in the almost in the entire belt (Poddar and Chatterjee, 1965).

Preliminary sampling of bed rock gossan and soil was done by G.S.I. along selected lines The samples were collected from depth of 2.0 to 10.0 cm and about 2,200 samples were analysed for Pb, Zn, Cu and Ni. The results indicated high value for Pb (up to.. 4000 ppm) and Zn (3000-4000 ppm) in the Dariba area. High Cu values were obtained locally. The geochemical values were poor near Rajpura village. Nickel was constently low all over the area.

Geochemical orientation sampling of the soil cap in two traverses over the Malikhera-Mokanpura area revealed consistent high values of lead (200 to over 3000 ppm) and zinc (200 to over 4000 ppm), and low values of copper (less than 50 ppm) over a width of 500 m. Limonitic stringers in the graphitic schist were also inferred to be alteration products of lead and zinc sulphides. Interestingly, ferruginous breccia shows high value of Mercury.

VII. GEOPHYSICAL PROSPECTING

Geophysical methods donot directly help in locating specific deposits but give us an indication about the presence of ore bodies. The portions within which there are no significant variations (anomalies) of the relevent physical property of the ground, are eliminated, while those portions which show an appreciable variation in that property from the surrounding rocks, are takes up for further work.

It can not be decided from the geophysical data alone whether the anomalies are caused by the presence of ore deposits or by other physical differences. However, by incarporating these data with 9blogicaI and other information as well as past experience, one can often select some of the indications which are particularly likely to.be caused by the presence of ore. The costly exploratory operations like: drilling, etc. are only used to obtain the ultimate proof of ore.

Electrical, magnetic and electro-magnetic surveys for sulphides wre carried out by G.S.I. along the entire belt. In the Dariba Rajpura block a prominent spontaneous potential anomaly axis trending N-S direction and extending over a length of nearly 3-5 Km. was delineated and a number of negative centres were obtained with values ranging from nearly 100 my. to about -500 my. The axis almost corresponds to the fault accentuated the SP anomalies. Depth calculations indicated that the depth of the top of the causative body ranges from 20 to 50 metres.

Over the prominent SR negative centres the electromagnetic surveys have encountered pronounced anamolies in the phase as well as out-of-phase component with the value ranging from 20% to 5%, the ratio in phase to out of phase component is more than 1 indicating a very good conductor at depth.

Test resistivity soundings taken over some of the SP anomolies centres have not indicated any significant results. The geophysical survey carried out over the end portions of the mineralized fault jane in Dariba - Rajpura area has given definite indications of the extension of the mineralized zone below the soil cover Towards north the fault zone probably gets gradually burned, deeper and deeper The electromagnetic, magnetic and resistivity surveys in the southern part of the area indicated a possible cross fault about 4.2 Km sâuth of Rajpura. It is probable that the mineralized zone is cut off by this cross fault, which may be aligned in an approximately E-W direction.

The electromagnetic anomalies are generally very strong and at places attain a maximum a negative value of 35% in in-phase and out of-phase component, it could be inferred that the causative body is highly conductive. The electromagnetic measurement taken over the anamoly zones with different transmitter receiver separation indicated that the conductive body extends in depth. At some places the electromagnetic anomalies are associated with broad and minor SP lows of the order of 30 Mv to 40 Mv and are also corroborated by resistivity laws. The electromagnetic anomoly axis which pass over the area of Bethumni old workings, are the most significant zones from the point of view of mineralization due to the fact that the anamolies which have high magnitude are consistant in nature and are also corroborated by SP and resistivity anomalies.

VIII. BEARING OF STUDY ON DEFORMATIONS

The Dariba-Rajpura part of the belt show very narrow basin iongated for a strike length of 3 kms. In this part the mineralized Toads 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 accumulated 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 mineralization is fault controlled.

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

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

This is authors presumption presumption that the mineralized faults have been greatly shifted west ward following fanning of F3 folds.

IX. BEARING OF STUDY ON POLYMETAMORPHISM

As model says, the mineralization occur in a sedimentary basin where metals and possibly sulphur have been exhaled periodically before get deposited to form one layer, after another.

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

While making a total scanning of all the geological events the area has suffered, it is author's proposal 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 pyrrholite geo-thermometry and geobarometry.

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

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X. 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 indicating that ferruginous breccia zone is inviting detailed search to discover the extension of the Dariba-Rajpura mineralization to Malikhera area. Author will also like to suggest that in future, there should be more ore petrological study of mineralization. It will help to understand silicatesulphide relationship of the deposit. The ore petrology of the belt will be able to explain better remobilization event(s) of the metals. 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.

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