Geological Settings, Mineralization and Genesis of Iron Ore Deposit at Pur-Banera Belt of District Bhilwara, Rajasthan (India)

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Abstract:

The Pur-Banera belt is one of the largest iron ore deposits, which is part of the Bhilwara Supergroup. The Pur-Banera belt is located in the central part of the Bhilwara district trending in NE-SW direction, where the geological settings, mineralization, and genesis of iron ore (mainly hematite and magnetite) study has been carried out. The major litho-units of the area are conglomerate, garnetiferous mica-schist, calc-schist, amphibolite, calc-gneiss, calc-silicate marble, and banded iron formation including Banded Hematite Quartzite (BHQ), Banded Magnetite Quartzite (BMQ), and carbonate rocks with associated sulfide mineralization. Iron deposits of the area comprise of iron minerals like hematite and magnetite. Quartz constitutes the silica forming bands alternate with iron minerals.

Geologically in the study area, the hematite-magnetite quartzite and carbonate rock inter-bedded with biotite garnet schist, calc-schist, and calc-gneiss occur as a persistent horizon. The hematite and magnetite quartzite consists of two individual bands separated by partings of biotite-sericite schist and are folded. The two prominent bands representing a line of asymmetrical fold forming a chain of hillocks are exposed from Tiranga in the south to Dhulkhera in north and Suras in the south to Dhulkhera in the north and also from Jipiya in the south to Devpura in the north. The hematite-magnetite quartzite is cherty at places and fractures are filled by secondary silica.

The BHQ and BMQ occurring in banded form and showing sedimentary structure like bedding and flame structure. Banded iron ore occurs with quartzite and another meta-sedimentary sequence that indicating metamorphism took place after a sedimentary deposit. Therefore, it can be concluded that the iron ore in the present area of investigation belongs to metamorphosed sedimentary type deposits. The paper discusses the geological setting of the area, mineralisation, and genesis of iron ore that exist there.

Keywords: *Geological Settings, Pur-Banera Belt, Mineralization, Genesis, and Iron ore.*

I. INTRODUCTION

Bhilwara is a small town in the Mewar region of Rajasthan, India. It is located almost in the center of the Rajasthan state covering an area of 10,455 sq. km. It is bounded by latitudes $25^0$01' to $25^0$58' and longitudes $74^0$01' to $75^0$28' and it is surrounded by other districts, on the north by Ajmer district, on the east by Bundi district, on the south by Chittaurgarh district, and on the west by Rajsamand district.

There are 12 tehsils in the district: Bhilwara, Banera, Mandal, Mandalgarh, Beejoliya, Kotri, Shahpura, Jahazpura, Raipur, Asind, Hurda, and Sahara. The sex ratio of Bhilwara district 973 is significantly higher than the State sex ratio 928.

The total length of Pur-Banera belt is around 30 km, out of which the study area is restricted to 14.2 km. It is bounded by four corners (Point A: $25^0$27’53” North latitude $74^0$37’32” East longitude Point B: $25^0$27’49” North latitude $74^0$41’48” East longitude Point C: $25^0$22’10” North latitude $74^0$36’26” East longitude and Point D: $25^0$22’10” North latitude $74^0$31’46” East longitude) and it is in diagonal i.e. NE-SW and covering total geographical area of 79.5 Sq. Km (Fig. 1) and come under toposheet number 45K/11.

The Banded Iron Formation (BIF) and associated litho-units of the study area part of Pur-Banera Group of the Bhilwara Supergroup of Archean to lower Proterozoic in age. The major rock types discernible in the area are banded iron formation including banded hematite quartzite (BHQ) and banded magnetite quartzite (BMQ). Other litho members of the area are conglomerate, garnetiferous mica-schist, calc-schist, amphibolite, calc-gneiss, calc-silicate marble, and carbonate rocks with associated sulfide mineralization.

The characteristics of BHQ and BMQ include sedimentary structures such as bedding, banded form, and flamed structure. Banded iron ore occurs with quartzite and other meta-sedimentary sequences that indicating metamorphism took place after a sedimentary deposit. Hence, the author can easily decipher that iron ore present in the reconnoitred region belongs to deposits of metamorphosed sedimentary type.

Despite thorough study and examination by various scholars for years in different countries, there has been no conclusive opinion on this characteristic of the banded iron examination. The said deposit of BIF dates back to 3.0 to 2.0 billion years without there being established unitary origin of all BIFs. Scholars have not been able to trace a single origin for all BIF deposits. Hence through the research, we can conclude that the majority of deposits are of meta-sedimentary origin.

II. GEOLOGY

Geologically Bhilwara Supergroup occupies the major part of the district. The Vindhyan Supergroup represented by sandstone, shale, and limestone is exposed in the southeastern part of the district along the great boundary fault. The Gogunda Group is exposed in the extreme north-western part of the district and the Kumbhalgarh Group occupies a small area in the south-western part of the district, both belonging to Delhi Supergroup. The Aravalli Supergroup exposed in the western part of the district is represented by Davoda Group.

The Bhilwara Supergroup of iron formation is part of the Pur-Banera belt of the district, explored by GSI in the year 1969-70. The outcrops of the iron ore body are available in Tiranga hill, Tiranga-Samodi, Dhulkhera North & South hill, Suras hill and Samodi-Dhedwas area.

Predominantly chemogenic rocks with bands of clastics, occurring from south of Banera to Samodi in the west. It comprises conglomerate, garnetiferous mica-schist, calc-schist, amphibolite schist, calc-gneiss, dolomitic marble, calc-silicate marble, banded hematite quartzite, banded magnetite quartzite, and carbonate rocks with associated sulfide mineralization (Table 1 and Fig. 1). The grade of metamorphism is up to amphibolite facies.

Pur-Banera Group rocks un-conformably overlie the rocks of the Mangalwar Complex (Suwana Formation and Potla Formation). The Pur-Banera Group has been subdivided into five formations, Pur, Pansal, Rewara, Tiranga, and Samodi; all the formations will fall within the boundaries of the study area. Pansal Formation is part of Aravalli System (Gupta, 1934) but according to the author's research, Pansal Formation is a part of the Bhilwara Supergroup, and the author considered that the conglomerate and quartzite rock of Pur & Pansal Formation. Moreover both of these are of the same period and their description is given below.

Suwana Formation:

Suwana Formation is the basement formation, of the iron formation, which belongs to Pur-Banera belt. It is unconformably overlain by the rocks of Potla Formation of Mangalwar Complex (Table 1). Suwana Formation comprising quartzo-feldspathic rock, chlorite schist, garnet ferrous biotite schist, quartzite, amphibolites, dolomite marble, and chert. The Suwana formation extended west of Amrite to Dadala for over a distance of 50 km.

TABLE 1–LITHOSTRATIGRAPHY OF STUDY AREA

Super Group	Group	Formation	Lithology
	Recent	Recent	Alluvium/Soil
	Intrusives		Amphibolite Dyke
Bhilwara Supergroup	Pur-Banera	Samodi Formation	Amphibolite Dyke intrusives, Mica Schist, Marble interband and Quartzite.
		Tiranga Formation	Sulphide bearing Hematite /Magnetite Quartzite.
		Rewara Formation	Calc-Schist, Calc-Gneiss, Calc-Silicate marble, Mica Schist, Amphibolitic Schist.
		Pansal Formation	Conglomerate, Quartzite, Marble.
		Pur Formation	Conglomerate, Quartzite.
	Mangalwar Complex	Potla Formation	Migmatite, Amphibolite, Garnetiferous Mica Schist.
		Suwana Formation	Amphibolite (Granitised); Mica Schist with Amphibolites, Calc-Silicate rock; Quartzite

Pur Formation:

The Pur Formation is the beginning of Proterozoic age it unconformably overlies the Potla Formation of the Mangalwar Complex and the formation is overlain by the Pansal Formation of the Bhilwara Supergroup of Lower Proterozoic age. The iron ore (hematite and magnetite) bends are exposed between the Pur & Samodi Formation. The Pur Formation of the Bhilwara Supergroup is situated within the basement of the Pur-Banera Group of Bhilwara Supergroup and the formation occurs, intermittently, wholly the Pur-Banera Synform. The Pur Formation dispersal from five-kilometer north-east direction of village Jasma in southern direction to vlillage Mandal within the northern direction along western limb while village Rasmi in the eastern direction to Banera, along the eastern limb.

The named of this formation after the Pur-village in the district and it covers the quartzite and conglomerate rock. In the nature Pur Formation of lowest quartzite rock massive to schistose. It comprises tremolite & actinolite. It shows gradational joining with the overlying calcareous mata-sedimentary rocks. The conglomerate bands are seen in the south-east direction of the study area and the very ferruginous quartzite belt is exposed in the SW direction to the eastern direction of the study area, near village Pur. The Pur pebbles are comprised of the veins of quartz & the beds of quartzite rock are ellipsoidal and many sizes; the pebbles are very overstretched and deformed (Shrivastava, 1970). Pebbles are set in a fine-grained matrix which consists of fine size sand particles and the pebbles are cemented by silica content & iron oxides (hematite and magnetite).

The rock quartzite is composed essentially of the grains of the quartz with the submissive amount of mica mineral, iron oxides and feldspars are a result of the impurities of the new sandstone rock during the metamorphism. The rock quartzite indicates the sharp contact with the overlying rock i.e. mica-schist of the Rewara Formation of Pur-Banera Group.

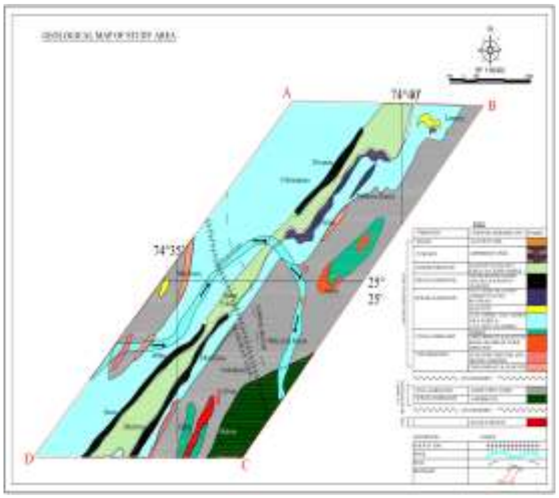

Fig. 1 Geological Map of Study Area

Fig. 2 Deposition of BHQ along with Quartz vein within Quartzite showing Tiranga Formation of Pur-Banera Group

Fig. 3 Outcrops of Iron ore deposit showing Tiranga Formation of Pur-Banera Group

Fig. 4 Garnetiferous mica schist showing Rewara Formation of Pur-Banera Group

Pansal Formation:

The Pansal Formation of rock was previously considered as a part of the Aravalli System (Gupta, 1934). The rock quartzite comprises a fairly large amount of tremolite & actinolite and grades into the calc-silicate-bearing marble, at the places.

According to the author's research, the conglomerate and quartzite rocks of the Pansal Formation of Pur-Banera Group are equivalent to the conglomerate and quartzite rocks of Pur Formation of Pur-Banera Group. Both the formations are part of the Bhilwara Supergroup. The Pansal Formation is underlying by the rocks of the Pur Formation of Pur-Banera Group and The rocks of this formation comprises quartzite, conglomerate, and marble, it occurs near the villages Pansal & Arjiya and extending for about 6 km and over a width of 1 km.

Rewara Formation:

The Pansal Formation of Pur-Banera Group is followed by the Rewara Formation of the same group. The Rewara Formation is extending from 3.5 km eastern direction of village Wari in the southern direction to village Banera in the northern direction for over a distance of 80 km in a width of about 1 km to 10 km. The formation is consisting of calc-schist, calc-silicate marble, quartzite, calc- gneiss, mica schist & amphibolite schist (Table 1).

The rock calc-gneiss shows thick bands of strata and it related to the quartzite rock. The calc-gneiss rock is well banded and shown the compositional banding with the parallel quartz vein in the study area.

Mica schist composed of garnet, muscovite, plagioclase, biotite, and quartz (Fig. 4). Garnet is irregular in the form of mica schist. The mica-schist associated with quartzite and gneisses rock.

Amphibolites are found in discontinuous thin bands and contact with quartzite and calc-gneiss rock and intruded by the quartz vein. In some places BHQ, BMQ, and amphibolite are getting together and amphibolite is found merged with banded hematite quartzite in dyke form.

Calc-Silicate is a broad term to state siliceous and calcareous rocks. The major constituents of these litho-units are quartzites and dolomites. Fine to medium-grained, compact, highly jointed, greenish-white to brownish (ferruginous) in appearance are the quartzite's that constitute siliceous part of the unit. The nature of quartzite can be considered uncertain as it does not show the development of any prominent sedimentary structures except a few bedding. The calcareous part of this rock is made up of siliceous dolomites. There are a good number of lenses of siliceous dolomites in the quartzites and visa-versa.

Tiranga Formation:

The BHQ and BMQ, occurring in the middle portion of the group, Pur-Banera has been assigned to the Tiranga Formation of the same group. This formation is spasmodic, understood along with the binary limbs of the synform in a five hundred meter extensive region band between south-east direction of village Gurla to south-east direction of village Banera, for over 37 kilometers. This formation conformably overlies the rocks of Rewara Formation of Pur-Banera Group.

The main rock of this area BHQ and BMQ intercalated with thin layers of biotite sericite schist & folded into an irregular appressed synform. The rocks are intruded by quartz veins & the pegmatite rocks.

The BHQ and BMQ are exposed prominently as 3 bands along the crest of the Tiranga hill ridge. The interior band creation the core of the synform and it is exposed on the northern peak of the study area and it extends in the north direction through village Samodi, Chimanpura, the eastern direction of villages Dhulkhara, Dedwas, Rangpura, Bhanlikhera, Jaliya and the western direction of village Lampiya. The western direction of the band possesses through villages like Dariba, Gurla, Salampura, Suras, the western direction of the Dhulkhera area, the eastern direction of Devapura, Jaliya & Banera reserve forest. The average thickness of iron ore bands varies from 30 m to 40 m except where it gets repeated by folding. The BHQ and BMQ are folded in the study area. The hematite quartzite and magnetite quartzite are shown in brown, reddish-black in color.

The mineralized magnetitic is composed of 3 ubiquitous minerals, i.e. garnet hematite-magnetite, & quartz with variable sizes of biotite and amphibole. The BHQ, BMQ is very much jointed and fractured and has alternate bands of hematite or magnetite & quartz-rich layers, the single-layer ranging from one centimeter to ten centimeters in thickness. Interlayered with these is 1 centimeter to 3 centimeters of biotite (fine-grained) & sericite with a variable proportion of magnetite. The hematite or magnetite-rich layers of the BHQ or BMQ are mainly composed of anhedral or octahedral hematite-magnetite, rounded or subrounded quartz, garnet, and subordinate amount of calcite. The hematite or magnetite poor latters generally show gradation to biotite schist.

In the study area hematite-magnetite quartzite and carbonate rock inter-bedded with biotite garnet schist, calc-schist, and calc-gneiss occur as a persistent horizon (Fig. 3). The magnetite quartzite consists of two individual bands separated by partings of biotite-sericite schist and are folded. The two prominent bands representing a line of asymmetrical fold forming a chain of hillocks are exposed from Tiranga in the south to Dhulkhera in the north and Suras in the south to Dhulkhera in the north and also from Jipiya in the south to Devpura in the north. The hematite and magnetite quartzite is cherty at places and fractures are filled by secondary silica (Fig. 2).

Samodi Formation:

Samodi is the uppermost formation of the Pur-Banera Group. In this formation, the clastic rocks with intercalatory marble & it occurred between south-east directions of village Gurla in south-east direction to village Banera, for about 40 kilometers over a width of 0.1 kilometers to 1 kilometer, have been assigned as the Samodi Formation of Pur-Banera Group. It occurs in the highest part of the area and forms the core of the synform. This formation mainly comprises quartzite with bands of mica schist, marble, and calc-schist rock. The Samodi Formation takes its name after the village Samodi in the Bhilwara district of Rajasthan where a type section of the formation is exposed by the Geological Survey of India and mining operation.

In the study area, outcrops of the samodi quartzite are seen nearby village Samodi, east direction of the village Suras, and in the Banera reserve forest. The north-east direction of the village Samodi, the rock comprises intercalatory bands of garnetiferous mica schist rock. In the direction of village Dhulkhera, the rock gradually grades into quartz-mica schist, micaceous quartzite, & finally to mica schist. The rocks which are found in this formation are massive and compact with greenish-grey in color.

III. MODE OF OCCURRENCE OF IRON ORE

The iron ore mineralization around Pur-Banera area is found in banded form hematite is the main iron ore mineral. This type of iron ore is steel black in color. It is found in the banded form. It is associated with quartz, garnet, and inter layered with biotite-sericite schist. The thickness of iron ores varies from 30 m to 40 m. Iron ore chiefly associated quartzite and biotite schist are intruded by pegmatite and quartz veins. It is extending roughly in the NE-SW direction. The general attitude of banded hematite quartzite is 23^0/80 NE.

The iron ores are found in the study area and are largely black, reddish in color and massive, granular, and bedded in form. The texture of iron ore is coarse to fine-grained. The banded magnetite quartzite has developed numerous micro-folds in the limbs of pur synform.

(A). Control of mineralisation:

The iron mineralization is confined to the stratigraphic horizon having the ferruginous bed. The mineralization has a bedded / laminated character with alternate bands of iron and silica.

(B). Mineralisation structure in the study area:

1. Banding: It is a banding structure. It is characterized by banding in which iron ore inter-layered with silica-rich layered. Hematite iron ore occurs as massive bands. Hematite is associated with magnetite (brownish-black).
2. Flame Structure: It is a sedimentary structure. It is characterized by the intrusion in which iron ore intrudes in the overlying strata.

(C). Optical properties under reflected light:

1. Hematite (Fe_2O_3): It is gray-white in color. Bireflectance / Pleochroismare very weak and it is anisotropic. Polishing hardness is more than magnetite.
2. Magnetite (Fe_3O_4): It is gray to brownish-gray in color. Bireflectance / Pleochroism and internal reflections are not present. It is isotropic and slight anomalous anisotropism. Polishing hardness is less than hematite.

(D). Mineral association

Hematite is the main iron ore mineral in the investigated area. Under the ore microscope, hematite (martite) Fe_2O_3 is minor associated with magnetite (Fe_3O_4). Hematite occurs as bands and disseminated with magnetite.

IV. CHARACTERISTICS OF BANDED HEMATITE-MAGNETITE QUARTZITE IN STUDY AREA

The banded hematite quartzite and banded magnetite quartzite occurring in banded form and showing sedimentary structure like bedding and flame structure. Banded iron ore occurs with quartzite and other meta-sedimentary sequences that indicating metamorphism took place after a sedimentary deposit. Therefore it can be concluded that the iron ore in the present area of investigation belongs to metamorphosed sedimentary type deposits.

Looking to the mode of occurrence, mineralization textures, structures, and field association, it can be said that the iron mineralization at Pur-Banera belt is of banded iron formation type and can be grouped as metamorphosed sedimentary type deposit.

This is an aspect of banded iron formation on which no final opinion has been possible despite years of study in so many countries. The bulk of the BIF was deposited between 3.0 to 2.0 billion years ago. No single mode of origin for all the BIF can be thought of. It is conceded that the larger and more widespread deposits are of sedimentary origin.

The volcanic nature of the period during which the Archaean iron formation was accumulated has also been recognised. The oldest iron formation like those of Isua probably was deposited in a submarine exhalative environment (Appel, 1980).

A controlling factor was probably was the composition of ocean water during the Archaean. The pH and oxidation potential were significantly different from that of later years. The oceans of that period were major reservoirs of both iron and silica their source was mainly volcanogenic and partly terrestrial. Even cosmic origin is envisaged.

Gross(1965) concludes that hydrothermal effusive processes are the principal sources of metal constituents in the stratified iron formation and those modern metalliferous sediments and crusts formed in the sea bed are progenitors of older sedimentary formations preserved in the geological record (Simonsen, 1985).

The character of the Late Archaean-Early Proterozoic atmosphere is also one of the important aspects to be taken note only considering the origin of iron formation the atmosphere at that time was different from the present-day atmosphere and is believed to have been rich in carbon dioxide and nitrogen and deficient in oxygen the ferrous form of iron could occur in solution in warm sea water. Vast quantities of iron could do get stored in the ocean and lakes of that period. Photo dissociation of water vapour no doubt produced oxygen but that was very much limited.

It was only when life first appeared on the scene; photosynthetic release of the bulk of the oxygen became possible. The released oxygen combined with the dissolved iron in the oceans and precipitated it giving rise to iron-rich bands. When once the dissolved iron was used up there was no further precipitation of iron (Cloud, 1973).

V. SOURCE OF IRON MINERALIZATION AND GENESIS

The materials that enter into sedimentary mineral deposits have been derived chiefly from the weathering of rocks. Occasionally, materials have come from the weathering and oxidation of former mineral deposits such as iron, manganese, and copper.

Krauskopf has shown that in the earth's crust the average content of iron is 5.6 percent. The iron comes from the weathering of iron-bearing minerals of igneous rocks such as hornblende, pyroxene, or mica, from the iron-bearing minerals of sedimentary and metamorphic rocks, and the red coloring matter of sedimentary rocks.

There are signs of flourishing ancient mining activity in the form of abundances old workings in Pur-Banera area. The ancients have mined out many metals. These are stains of hematite and magnetite at several places. GSI has also reported the presence of base metals in the region. Since these are not enough samples of these reported minerals, the present study is based on samples of iron ores only and the areas targeted for this study include those around Pur-Banera Area.

These are numerous occurrences of amphibolite bodies in the area. This amphibolite is a metamorphosed product of basic-ultrabasic intrusion. These basic-ultrabasic rocks along with other metal have supplied by the weathering of pre-existing rocks also.

Solution and Transportation

The solution of the constituents of economic sedimentary deposits in large part goes on during weathering. The chief solvents are carbonated water, humic and other organic acids, and sulfate solutions.

Carbonated waters are very effective solvents of iron. Where iron is present in the ferrous state, its solution offers no difficulty, since in that form it is unstable and soluble. But ferric iron is almost insoluble in most surface waters and to undergo solution must first be changed the ferrous state. Organic matter aids this. The Precambrian iron ores that were formed before organic matter vegetation became very abundant were probably transported as ferrous bicarbonate or in the colloidal state. Vast quantities of calcium carbonate, as well as other salts, are readily removed in solution and transported to bodies of standing water of higher pH. where precipitation may occur to form sedimentary deposits.

Humic and organic acids derived from decomposing vegetation considered effective solvents by Harrar. The hydroxyl acids dissolve large quantities of iron, but the weak organic acids dissolve remarkable quantities and are the most effective of all-natural solvents. Moore and Maynard’s experiments on the solution and precipitation of iron indicate that carbonated water is the most effective solvent of iron and silica from norite and diabase and that peat solution is next. They concluded that iron is not carried as bicarbonate in surface waters high in inorganic matter, but that the main part entering sedimentary iron formations was probably transported as ferric oxide hydrosol stabilized by organic colloids.

Sulphate solutions are effective solvents of iron but are rarely abundant enough to affect large-scale solutions and transportation. The oxidation of pyrite yields sulfuric acid and ferric sulphate.

Deposition

The materials that form economic sedimentary beds are deposited mechanically, chemically, or biochemically. The manner of deposition depends upon the nature of the solvent, the place of deposition, and the pH and redox (Eh) conditions as, for example, whether in the sea or a swampy basin.

Garrels and others have aided the understanding of solution and deposition at low temperatures through the study of mineral equilibria under varying pH and Eh conditions. This subject is treated in more detail in the section on “Oxidation and Supergene Processes.”

Product of Deposition Iron is commonly precipitated as (1) ferrous carbonate (siderite); (2) hydrous ferric oxide, goethite (limonite); (3) ferric oxide (hematite); and (4) minor basic ferric salts. It seems probable that most of the marine hematites were deposited directly as ferric oxide. Glauconite, chamosite, and greenalite are less common forms. In the presence of air, ferric oxides form; at lower pH and Eh, siderite, the ferrous carbonate, forms. The carbonate may be deposited in the absence of air and the presence of excess carbon dioxide.

The Cycle of Iron

Because of the solubility of ferric iron, it is probably ferrous iron that is dissolved during rock weathering and moves largely in streams to favorable sites of deposition. The iron may be lost during transportation (1) if the solutions traverse limestone, where reactions cause deposition of ferrous carbonate of ferric oxides; (2) if the solutions come to rest in enclosed basin undergoing evaporation; (3) by contact with organic matter; or (4) by a decrease in carbon dioxide content of the solutions. That which is precipitated in bogs gives rise only to small, impure, low-grade deposits rarely exceeding 45 percent iron.

Marine Shallow-Water Deposition

The iron solutions that reach the shallow seas give rise to the largest iron ore deposits in the world. The optimum conditions are where sluggish streams enter from deeply eroded, low-lying, coastal areas, with gradients too low to permit the abundant suspended matter to be transported. Consequently, little sediment accumulated with the iron ore. Shallow waters are indicated, where, gently churned the bottom, and macerated the fossils present. Ripple and current markings also show that the depth of water was not great, and mud cracks indicate occasional elevation and exposure to the sun. The marine life was not dwarfed, which gives evidence of no unusual conditions of the environment.

Garrels and co-workers have shown that the deposition of iron in seawater in equilibrium with calcium carbonate is largely controlled by the pH and the Eh conditions. They showed that when slightly acid river water containing iron in solution entered such seawater, the iron would be precipitated as pyrite at low Eh and either acid or alkaline pH. However, with increasing Eh and pH, the iron would be deposited as siderite and then as hematite, over a broad range of Eh. Aerated seawater has a pH of about 7.8. Thus iron in solution would be precipitated as a ferric oxide in aerated seawater. Colloidal iron would be deposited almost instantaneously upon contact with oppositely charged electrolytes of seawater. Extensive beds may thus be formed. Some iron was deposited as oolites; some coated or replaced shell fragments on the sea bottom, and some were deposited as an iron mud. It has also been suggested that low Eh groundwater disgorging Fe^{2+} into shallow marine seas (Fig. 5).

When pH and Eh of the depositional basin reached the limits of deposition of iron ions, it started precipitation. The formation of magnetite from Iron metal proceeds non-stoichiometrically. The reduction of hematite to magnetite occurs more rapidly than the oxidation of iron. The various reactions that take place can be explained:

$2Fe + 3H_2O = Fe_2O_3 + 3H_2$ (Oxidation of iron metal with water).

$3 Fe_2O_3 + H_2 = 2 Fe_3O_4 + H_2O$ (Reduction of hematite with hydrogen).

According to Holser & Shneer (1961), ferrous species dominate the solution in equilibrium with magnetite under hydrothermal condition. The Mechanism for the hematite reduction is:

$3 Fe_2O_3 + 3 H_2 + 3 H_2O = 6 Fe (OH)_2$ (Reduction & dissolution of hematite).

$6 Fe(OH)_2 = 2 Fe_3O_4 + 2 H_2 + 4 H_2O$ (Precipitation of magnetite).

Matthews (1976) has indicated that the reduction of hematite to magnetite at elevated temperature (350^0-570^0) pressure (1-2 kbar) in the presence of water can be represented by the equation:

$3 Fe_2O_3 + H_2 = 2Fe_3O_4 + H_2O$

Magnetite can also be formed at high temperatures in the presence of water by the reduction of hematite with iron metal. The reaction can be expressed by the equation:

$Fe + 4Fe_2O\ 3Fe_3O_4 = 3Fe_3O_4$

The present configuration of iron mineralization around the Pur-Banera area is the result of post-depositional metamorphism and deformation.

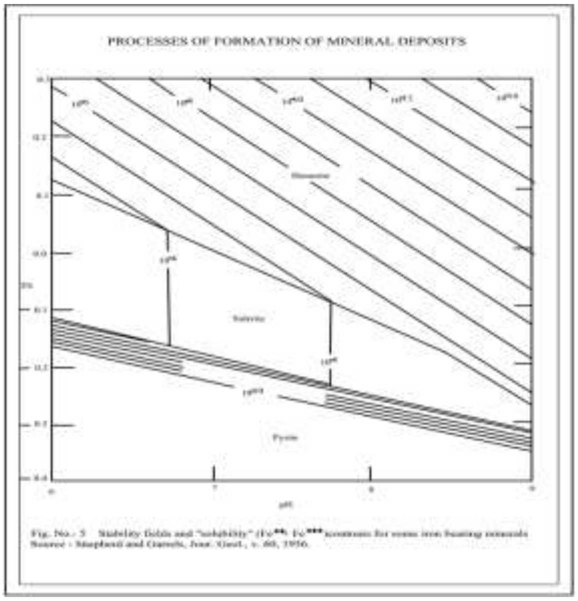

Fig. No.- 5 Stability fields and "solubility" (Fe++, Fe+++)contours for some iron bearing minerals
Source : [illegible] and Garrels, Jour. Geol., v. 60, 1956.

VI. CONCLISION

Geologically two main litho-units that occur in the study area are known as sulfide-bearing banded hematite quartzite and banded magnetite quartzite which covers the maximum Banded Iron Formation (BIF) disposition belongs to Tiranga Formation of Pur-Banera Group (lower Proterozoic). The Tiranga Formation is underline by Rewara Formation which is composed of calc-gneiss, mica schist, amphibolite schist, BIF streaks, quartzite, calc-schist, calc-silicate marble and overlain by Samodi Formation which is composed of quartzite, quartz mica schist, calc-schist, and marble.

In the study area, hematite is associated with magnetite. Hematite occurs as a banded and disseminated form. The mode of occurrence, mineralization textures, structure, and field association, it can be said that the iron mineralization at Pur-Banera is of banded iron formation type and can be grouped as Metamorphogenous deposit.

The iron ore mineralization around Pur-Banera area is found in the banded form. Hematite is the main iron ore mineral and it is steel black in color. However, it is associated with quartz, garnet, and interlayered with biotite-sericite schist. The average thickness of iron ore bands varies from 30 m to 40 m except where it gets repeated by folding.

The belt is mostly meta-sedimentary, metamorphosed dolomite and, a small number of igneous rocks. The deposit was originally a sedimentary exhalative deposit before experiencing a metamorphic event. The high-grade metamorphic event is theorized to have occurred approximately 3.0 to 2.0 billion years ago. The study area has undergone medium grade metamorphism. There are a few oxides and sulphide minerals that form within the ore that have a particular interest, the major one being hematite. Magnetite is commonly occurring with the hematite.

Iron ore is formed under sedimentary lacustrine to fluvio-marine conditions during the deposition of sediments.

The iron is mostly dissolved from bottom sediments and mobilized in "carbon-dioxide zone" as ferrous bicarbonate, then precipitated in an oxidizing environment as ferric hydroxide.

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