Mineral Resources of Chittor (Jogniamata)

Abstract

Rocks belonging to Bhander Group of Vindhyan Supergroup exposed in Jogniamata area show an interesting sequence of rocks. They are geologically as well as economically important rocks.

The litho units present in the area belonging to lower Bhander group are (i) Lower limestone, (ii) Lower greenish gray shale, (iii) intercalated dolomite limestone, (iv) gray dolomite, (v) brownish calcareous shale with thin beds of barites, (vi) red shale with green parting (vii) upper grayish green shale and (viii) upper shale and sandstone. The lower most litho unit limestone (i) exposed in the area is of cement grade containing 42 to 46% CaO.

Barites occur as thin beds in calcareous shale (v) Barites are fine-grained, compact having white, pinkish and buff colours. Barites vein lets are observed parallel to bedding plane, and contain fluid inclusion, which are monophase, indicating lower temperature recrystallization of the mineral.

Dolomite (vi) containing 18-21.5% MgO, contains calcite + fluorite as vug filling. Calcite contains monophase and rarely biphase fluid inclusions. Fluorite contain fluid inclusions with small vapour bubble + isotropic daughter mineral. Lower greenish gray shale (ii) also contains calcite as vug filling. Monophase + biphase fluid inclusions are present in calcite.

Salinity of fluid in inclusions and temperature of homogenization has been determined for barites, calcite and fluorite.

Grayish green shale and red shale with thin parrot green partings contain 5 to 7.5% K_2O.

Introduction

The State Department of Mines and Geology, Rajasthan discovered barites mineralisation in Bhander group of rocks belonging to upper Vindhyan Supergroup near Jogniamata (75^0 7' 12: 25^0 3' 50") in Chittorgarh district of Rajasthan in 1980. The investigated area form part of toposheet 45 0/4 of Survey of India.

The lower Bhander limestone has been found suitable for cement manufacture. Lower grayish gray shale are potash bearing and has vug filling of calcite. The gray dolomite containing 19.5 to 21.5% MgO has been found suitable for use in metallurgical industries. This dolomite also contains vug filling mainly of calcite and calcite ≟fluorite at places. Barites mineralisation has been found as thin beds in Calcareous shale. The red shale with green parting also found to have potash content of 5 to 7.5%.

Although it is not a deposit of barites, calcite or fluorite, the geological characteristics are nonetheless interesting. The barites, calcite and fluorite have been found to contain fluid inclusions that are monophase or biphase with high degree of fill. It is a rare locality where barites mineralisation has been found in the Vindhyan rocks.

Geology of the Area

Jogniamata area comprises the rocks belonging to upper Vindhyans, constituting lower Bhander group of rocks. The rocks belonging to this group consist of a thick succession of limestone, shale, intercalated dolomite limestone, dolomite and shale of different nature and grades and overlying sandstone (fig. 1).

The sedimentary rocks around Jogniamata are exposed 14 km NE of Begun village of Chittorgarh district from Sadi-Chandakhedi in the plain to a height of 120 meters around Jogniamata. According to field observations and characteristics of the rocks present in the area the geological succession is given in Table 1.

Table 1

Upper Vindhyans (Lower Bhander Group)	Upper Shale and sandstone (5-10m) Upper grayish green shale (30-45m) Red shale with green parting (5-7m) partings (5-7m) Brown calcareous shale with barites (10-15m) Grey dolomite (5 to 10 m) Intercalated dolomite limestone and Lower greenish gray shale (30-35m) Lower limestone

Lower Limestone

It is thin-bedded limestone exposed in the plains around Tukrai and Chandakhedi. Most of the limestone is covered by thin soil mantle and cultivated fields. It is bluish to gray and chocolate in colour. It contain thin beds of magnesium, siliceous limestone and thin shale partings. The general strike is NE with gentle dips (6^0 to 10^0).

Microscopic sections show the limestone to be composed of fine-grained groundmass of calcite with quartz and varying amounts of iron oxide in some sections. Vein lets of calcite are rarely seen.

Lower Greenish Grey Shale and Intercalated Dolomite Limestone

It is conformably overlying the lower limestone. The shale are compact, thinly bedded, well jointed and splintery. It is generally green or pale green but brownish or purplish at places. Vug filling of calcite is observed in the shale. Intercalated beds of dolomite limestone is brownish to pale yellow in colour, hard and compact and well jointed, having thickness, 0.5 m to 2 m and is not a separate mapable unit.

Grey Dolomite

It is hard compact and massive dolomite containing 19 to 21.5% MgO. In the hills it forms vertical escarpment with maximum thickness of 10m. In the northern part it is exposed in plains where its thickness is only 0.5m to 1m (east of Samaria) but attains maximum width further north. The dolomite is almost horizontally bedded or with gentle dips towards northeast. The dolomite bed runs

throughout the lower part of the hill for a distance of about 15 km forming escarpments at many places. It shows uniform thickness and forms a characteristic market bed. Vug filling of calcite + fluorite are observed in the dolomite. Fluorite is mainly found in the east of Samaria. Near Chanda Khedi the vugs in dolomite are filled with botryoidal calcite only. Acicular calcite is also present in vugs.

Brownish Calcareous Shale

These calcareous shale are overlying the dolomite and are thinly bedded having brownish, purplish, pale brown colour. Sedimentary structures like bedding, current bedding are found well preserved in these shale. They are almost horizontally bedded and contain zones of barites + calcite mineralization. The barites zones are located east of Chanda Khedi in the hillock called Ambavgarh where relicts of old fort are seen. Similar occurrences of barites are also found northeast of Uthane. In calcareous shale irregular patches of charts are invariably observed and scattered chart pieces are found in the area.

Red Shale with Green Partings

Following the calcareous shale, thinly bedded red shale with green shale partings are exposed in the hill along road cutting section. These shale are soft, thinly jointed, splintery and show various colours like red, brownish, green, olive green, parrot green, pale brown, etc. They are almost horizontal having 2^0 to 5^0 dips towards north and northeast. The green shale partings are well exposed in the hill section having 0.20m to 1m thick alternating beds in the red shale. The green shale contains 5 to 7.5% K_2O.

Upper Grayish Green Shale

This shale is similar in nature to lower greenish gray shale but these are devoid of intercalatory dolomite limestone. They are more erinaceous and contain intercalated thin beds of ferruginous sand stone. This shale are exposed in thick pile of about 30 to 45m thick sediments.

Upper Shale and Sandstone

These are the upper most rock unit exposed in the Jogniamata area. The shale are found intercalated with the thin sandstone beds and in the upper most part sandstone is exposed, which is brown, reddish or purplish in colour and is splitable in nature. At many places in Menal and Rewarda areas this sandstone is quarried for slab stones.

The sandstone comprises quartz, which are sorted, fine to medium grained, rounded to sub angular and closely packed with cementing material in a few cases. Few rounded grains of tourmaline and vein quartz are also seen. The cementing material is siliceous and ferruginous. The inter-collated shale are pale brownish, green in colour and are thinly bedded and well jointed.

Barites, Calcite and Fluorite Mineralisation

In Jogniamata area barites mineralisation occurs in calcareous shale of lower Bhander Group as barites rich beds. There are such 5 individuals beds varying in thickness from 0.10m to 0.25m separated by barren calcareous shale. The shale are horizontally bedded or strikes $N30^0$ E-$S30^0$ W dipping 4^0 towards north. The barites occurs as fine-grained granular, plenty or as fibrous aggregate. Barites occurs along bedding planes along laminations and as dissemination in calcareous shale (Fig. 2 A, B, C). The barites is buff to off white and brownish in colour. The specific gravity varies between 3.8 to 4.1 fibrous calcite is also noted. Calcite and fluorite occurs as vug filling in gray dolomite. The vugs ranges in size from 5 cm to as large as 30 cm along axis. Calcite is also present as vug filling in lower greenish gray shale. Fluorite occurs in vary minor quantity in the central portion of vugs indicating its formation later to calcite. Calcite shows different layering separated by two to three layers of brown iron oxide in the vugs (fig. 2D). Calcite is coarse crystalline in nature, semitransparent to transparent and white in colour. Fluorite is coarse granular and purple to violet in colour.

Fluid Inclusion Study

Polished plates of barites, calcite and fluorite from different beds and locations were prepared. These plates were studied under petrographic microscope and areas containing fluid inclusions suitable for heating and freezing test were marked. The shape, size, phases, degree of fill, necking and type of fluid inclusions (primary, pseudosecondary and secondary) were studied for these plates.

Fluid Inclusions in Barytes

Barites contain monophase fluid inclusions (primary and secondary, Fig. 2E). Primary fluid inclusions have a regular outline, usually their long axis parallel to banding in barites. The size of these inclusions varies from 5 x 3.25 mille micron m^2 to 10 x 8.25 mille micron m^2. Monophase (secondary) inclusions are of irregular shape and some times net like structure is produced due to interconnections. Tubular and trails of inclusions are seen along cleavage planes.

Fluid Inclusions in Calcite

Calcite contains primary regular shape biphase fluid inclusions (Liquid + vapour bubble). Pseudosecondary and secondary biphase inclusions are also present. Monophase secondary inclusions are also not uncommon. The primary inclusions have high degree of fill showing small spherical vapour bubble. They are negative faceted cavities. Heating studies of the primary biphase inclusions show temperature of homogenization, varying from 77^0 to 150^0 C. Few inclusions with larger vapour bubble did not homogenize till 170^0 C, such inclusions possibly represent leaked fluid inclusions. Most of the fluid inclusions homogenize between 135^0 C to $14W0^0$ C (Fig. 3).

Table 2: Chemical Analysis of the Rocks from Jogniamata Area

Limestone	Greenish	Intercalated	Grey dolomite		Calcareous (20 analyses) shale (20 analyses) (5 analyses) (5 analyses)	Red shale Grey shale with limestone green partine	Barites dolomitic zone (30 analyses) (6 analyses) (20 analyses)
SiO_2+ Acid	12.90	59.61	10.12	19.91	5.66	5.66	18.60 insoluble
R_2O_3	2.80	-	0.90	0.91	3.81	-	3.43
CaO	42.5	1.58	30.60	30.80	29.48	2.53	12.52
MgO	0.87	1.95	13.35	19.59	0.47	0.89	0.36
LOI	35.02	5.08	44.50	44.18	26.40	5.28	8.47
Na_2O	-	0.69	-	-	-	0.58	-
K_2O	-	6.55	-	-	-	6.5	-
AI_2O_3	-	17.06	-	-	-	16.87	-
Fe_2O_3	-	4.92	-	-	-	5.36	-
$BaSO_4$	-	-	-	-	-	-	58.3

Freezing study was carried out of primary fluid inclusions. They freeze to brownish ice and the vapour bubble is retained have Te+-47^0 C and temperature of final melting of ice Tm (ice)=-30.1^0 C.

Fluid Inclusions in Fluorite

Fluorite contains two phase (liquid + vapour bubble) primary inclusions. Various shapes (regular to irregular) and size of inclusions are noted. Cubic, tetrahedral, combinations of sub regular shape and perfect negative faceted fluid inclusions are commonly present. Some times small cubic daughter mineral is also present (Fig. 2F). Inclusions varies in size 10 x 85 to 15 x 10.5 microns having 95% degree of fill. Nicking down has been noted in some of the fluid inclusions. Two phase pseudosecondary and secondary fluid inclusions occur frequently along cleavage planes. Heating study show that temperature of homogenization varies between 138^0 C to 145^0 C.

Freezing study was carried out on primary biphase inclusions. The inclusions freeze to brownish ice. Vapour bubble is retained on freezing. While heating brown colour of ice clears by 32^0 C. First melting of ice (Te) took place around-40^0 C. Temperature of final melting of ice (Tm) is-25^0 C.

Economic Consideration

The occurrence of barites, calcite, fluorite, dolomite and potash rich shale is interesting both from the point of view of its academic and economic importance. Since the deposit of barites appears to be small for the present, but it has opened the possibility of finding occurrences of bedded barites deposits in the Vindhyan formations. The calcite and fluorite occurring in vugs is in minor quantity and is of academic interest only, the potash rich shale containing 5 to 7.5% K_2 O is due to presence of elite and minor glauconite. More detail study will be required if these shale can be of any use in fertilizer industries.

The lower limestone occurring in the area is marginally of cement grade, containing average CaO= 4205%, MgO= 0.8%, R_2O_3- 2.5%, silica + insoluble= 12%. The tentative reserve of limestone in the area comes to about 80 million tones up to a presumed depth of 10m detail study by putting drill holes will be required to find out the depth persistence and grade of the limestone to assess the suitable reserves. The limestone is also suitable for use in metallurgy and glass industries.

The reserves of gray dolomite has been assessed as 45 million tones (considering Sp. Gravity as 2, 7 although sp. gr. varies between 2.7 to 3.1), containing average 19.5% MgO, 30% CaO, 1.0 R_2O_3, 1.10% SiO_2+ insoluble and LOI 45%. This dolomite is of S.M.S. grade and ferromanganese grade and is suitable for metallurgical industries for fluxing purpose.

The sandstone is extensively exposed in the area is being used as slab stone and more quarries may open in near future.

Discussion and Conclusion

The first occurrence of barites has been recorded recently from Vindhyan sediments in Rajasthan at Jawarakalan near Rawatbhata (24^0 56': 75^0 35') district Chittorgarh. It occurs as veins, stringers, vug fillings and laminations in the shale of the lower part of the Rewa Group known as Panna shale.

In Joginamata area barites rich beds are located in calcareous shale of lower Bhander Group of Upper Vindhyan. The barites mineralisation in the area occurs in five different barites: individual barites bed range in thickness from 10 cm to 25 cm being separated by layers of shale. Much of the barites show distinct laminations parallel to bedding. It is also found disseminated in shale particularly in varytes zones. Recrystallised thin veins of barites occur along bedding planes and laminations, associated with calcite.

Field evidences, textures and structures and fluid inclusion study indicate that barite is related to Vindhyan sedimentation. The Lower Bhander Group of the rocks was deposited in shallow water marine tidal flats in tectonically stable platform (Basumalik, 1962). The seawater is known to contain barium, strontium and fluorine (White et. al., 1963, Puchelt, 1972). The baryted must have been precipitated under suitable conditions during sedimentation and lithification, which later on, recry stallised along bedding planes and laminations in the calcareous shale. The frequent presence of monophase fluid inclusions in barites and associated calcite also indicated low temperature of formation of barites.

Later on the calcite and fluorite were deposited in vugs by the circulating solutions in shale and dolomite. The homogenization temperature of fluid inclusions in calcite and fluorite show that the temperature of solutions ranges between 75^0 to 145^0 C.

Fluid inclusions data indicate that calcite and fluorite were deposited as vug filling from the solutions ranging in temperature from 145^0 C to 75^0 C (Fig. 3). Freezing data show presence of $CaCI_2$ in the solutions (Roedder, 1963). Temperature of final melting of ice is also fairly low, viz, 30.1^0 C to 25^0 C again indicate presence of $CaCI_2$ and $CaCI_2$/NaCI is between 2 to 1 (Crawford, 1981).

The deposit of barites appears to be small for the present but there is every possibility to find out an economic deposit in the lower Bhander formations in Rajasthan and adjoining areas.