# 3. Prospecting and Exploration

## 3.1 GENERAL

Evaluating the commercial potential of a specific barytes prospect is a complex process that requires careful study of the relation of pertinent geological, technological and economic factors. Geological factors are: (i) the type of deposit and its structure, size, grade and mineralogy, and (ii) knowledge of zoning, texture, grain size and chemical composition of the ore minerals and the associated gangue.

Geologic information puts limit on technical factors such as the choice of mining and beneficiation methods to be used. Economic factors of major importance include, location of the deposit with respect to markets, current and future, transportation, cost of land acquisition, cost of labour and equipment to mine, beneficiation process, problems of financing and taxes. Barytes prospects generally are evaluated geologically by detailed geological mapping and surveying as well as digging test pits and trenches for further examination and sampling of rock body. Drilling is commonly used for evaluation of vein and bedded deposits and also has been used successfully in residual deposits. Beneficiation test must be made to ensure that the anticipated mineral separation and recovery are attainable and that barytes products can be made profitable to meet the specifications of the purchaser. In some cases, barytes is only one of the saleable products recoverable from a deposit.(2)

One of the main problems encountered in the location of bedded barytes deposits has been the lack of outcrops on account of softness of the mineral, e.g. the Mangampeta deposits have practically no outcrops and came to light from well sections and pits. In an area characterized by sedimentary formations like limestones, dolomites and shales such outcrops of barytes beds could be overlooked on superficial examination.(1)

## 3.2 DIFFERENT METHODS OF PROSPECTING AND EXPLORATION

### i) Geochemical Methods

Prospecting for barytes is based on its physical and chemical properties such as high bulk density, cleavage and low solubility. Small rounded fragments of barytes can be found in heavy mineral concentrate, as well as by metallometry in soil samples. High anomalous values of Barium in rocks, soils, stream sediments, natural waters and vegetations are often helpful. The high specific gravity allows it to accumulate in panned soil, weathered residuum and stream sediments, sampling of which is a satisfactory method of locating a barytes deposit. Alluvium samples are taken at every 0.5 to 1 km of the stream. They are screened to below 2 mm size. In the heavy mineral concentrate small fractions are removed using a 0.5 mm mesh sieve and the over sizes are subjected to magnetic separation. The non- magnetic portion is leached chemically and the left over barytes is heated in a saturated $Na_2CO_3$ solution, and then in coloured yellow solution of $K_2Cr_2O_7$, and evaluated semi-quantitatively (Benesvora-Talandora, 1969). The anomalies are assessed by geo- electrical methods for barytes veins of greater thickness, gravimetric techniques and later, trenches, pits and boreholes are employed.[1]

In Cuddapah, Kurnool Formations constitute an uplifted intercratonic basin which has been affected by acid plutonic and volcanic activity. Much of the mineralisation besides that of barytes which is distributed in a manner that is identifi-

able as a clear mineral district is probably related to igneous activity. Since, similar lenticular bodies of barytes may have developed elsewhere in this sedimentary sequence, systematic search is justified. Evidences of acid volcanism particularly of much antiquity of pre-cambrian are difficult to identify except by detailed petrographic scanning, as was done in the case of Mangampeta beds. Some of the so called quartzites, and shales may actually represent acid tuffs and vitric tuffs.(3)

In Cuddapah basin stratified barytes occurring in perfect conformity between layers of carbonaceous tuff which is occurring close to the eastern margin of the basin where the strata have been subjected to strike faulting, thrusting and metamorphism.

Geochemical techniques are available for exploration. A relatively simple and inexpensive turbidimetric test for barium was applied in a region of bedded barytes deposits in Western Arkansas (Brobst and Ward, 1965). It was concluded from the study that barium anomalies could be found and that targets for further study could be outlined. Geochemicalstudies can be carried out with the use of emission spectrographic and X-Ray Fluorescence(XRF) techniques but initial cost of the equipment is high. The use of probable radioisotope fluoroscence analyzer in geochemical prospecting for barytes and celestite in the west of England has been described by Ball et al (1979).(2)

Geochemical studies have revealed that the concentration of tracer elements is of the same order in granular and lapilli barytes indicating a common source. Presence of excess sulphur in elemental form in granular and lapilli types has been identified, which could be magmatic. The quartz-barytes lapilli tuff contains excess barium over $SO_3$ suggesting that the volcanic (magmatic) phase of $BaSO_4$ contained excess barium in ionic state. Major element analysis indicates an inverse linear relationship between $BaSO_4$ and each of $R_2C$ , percent, $Fe_2O_3$ percent, $SiO_2$ percent and LOI percent revealing the homogeneous nature of the tuff material associated with barytes.(3)

ii) Geophysical Methods :

Geophysical methods of prospecting for barytes has been tried on some barytes deposits in Germany particularly in mine and deposits under active exploration. It is reported that geophysical logging especially resistivity logging gave good results among electrical methods and gamma and gamma-gamma methods among radioactivity methods.(1)

Highly sophisticated technical methods for prospecting barytes deposits have not yet been developed, chiefly because new deposits have been fairly known. The success of future prospecting will be increased if prospecting is guided by a knowledge of the geological association and the role of barium in various geologic environments, especially in the sedimentary environment (Brobst, 1980). Deposits should be sought in residual overlying carbonate rich rocks, especially those of Cambrian and Ordovician age. Other areas of well weathered rocks that have been hosts for veins or pods of barytes also should be examined for residual deposits.(2)

Taking advantage of the marked density contrast, gravity surveys were carried out in some German depoists. The Bouguer gravity map of an area brought out clearly the western foot wall origin of the deposits, where many clear exposures in quarries helped to confirm the values. Away from this margin eastwards and north eastwards in the direction of dip which is variable and rolling, it was not possible to demarcate the boundary of the deposit because of gradual fall of gravity values due to increased thickness of overburden and possible structural peculiarities. However, a broad anomaly zone could be demarcated in the area where structurally also the barytes beds are expected to continue.(1)

The gravity anomaly zones are traceable by resistivity and seismic refraction survey in order to determine the probable thickness of overburden and the thickness of the ore body. These

results are also confirmable by shallow seismic refraction surveys.[1]

Geophysical techniques to explore barytes deposits have not been used widely. Gravity surveys for residual barytes deposits have been undertaken in Missouri (Uhley and Scharon, 1954) where they indicated that large concentrations of barytes could be demarcated and the tonnage computed with an expected error of 35 percent or less. The gravity study must be followed with test pitting to determine the cause of gravity anomalies which reflected not only the preference of ore but also of pinnacles of bed rock, flint bars, and unknown concentrations of mass and or probable errors. In Germany, the use of geophysical techniques to search for hidden deposits of barytes and fluorspar was described as less than ideal (Klans and Schrode, 1967)[2]. Geophysical surveys conducted during 1971-73 in Mangampeta area, have brought out three significant gravity anomalies, of which two fall on the northern lens and one on the southern lens. The result of test drilling of the anomalies over the northern lens deposit proved very encouraging. The exploration involved plane table mapping of 5.48 sq.km. drilling of 8885 m and analysis of 2100 samples. In all 70 boreholes were drilled for the exploration; 61 boreholes in the northern lens deposit, 5 in southern lens and 4 boreholes for testing gravity anomalies in the surrounding area. A total of 55 boreholes intersected barytes.[3]

## 3.3 CASE HISTORIES

### 3.3.1 Andhra Pradesh

(1) **Mangampeta Deposit :** The Mangampeta barytes deposit is located in the Kodur Mandal of Cuddapah district, A.P. It is confined to the Pullampet (Cumbum) Formation of the Nallamali Group of the Cuddapah Super Group.

Mangampeta comprises a thick sequence of tuff with intercalation of dolomite and crystal tuff belonging to the Pullampet Formation. The barytes occurs in the form of two lenses within the upper carbonaceous horizon of the Pullampet tuff sequence. The regional strike of the formation is NNW-SSE with gentle dip, in general to ENE. The rocks are folded along a NNW-SSE axis which is cross folded along ENE-WSW axis.[9]

Geological Survey of India(GSI) reported occurrence of sedimentary barytes deposit in Mangampeta area in 1970. Exploration by drilling through "project barytes scheme" launched during 1974-78, proved a reserve of 74.2 million tonnes of all grades of barytes. It is a single largest deposit of its nature in the world and is considered volcano-genetic sedimentary in nature. GSI drilled at 100 to 200 m interval to delineate the deposit. The quantum of work done by GSI is given below.

Mapping : On 1" = 1 mile, 1" = 1/4 mile, 1:4000 and 1:2000 scales.

Area covered : Over 5.48 sq. km

| Drilling | Northern Lens | Southern Lens |
|---|---|---|
| No. of bore holes | 61 | 5 |
| Metreage drilled | 7800 | 283 |
| Sample | 2030 | 73 |

Dimension of deposit proved

| | | |
|---|---|---|
| Length | 1200 m | 300 m |
| Width | 900 m | 70 m |
| Thickness | 4.4 to 39.88 m | 7.37 to 12.199 m |

Reserves

| | Million tonnes | Sp. gr. | Million tonnes | Sp. gr. |
|---|---|---|---|---|
| (i) In other area (free hold area) | | | | |
| + 92% $BaSO_4$ | 34.16 | 4.21 | - | - |
| low grade | 35.07 | 3.60 | 0.3 | 3.79 |
| (ii) In private lease holds | | | | |
| All grades | 4.16 | 4.19 | 0.27 | 3.67 |

Reserves are based on cross sections at 100 to 200 m. intervals.[9]

In October 1976, at the instance of M/s. Andhra Pradesh Mineral Development Corporation(APMDC), Indian Bureau of Mines(IBM)

prepared mining scheme based on the examination of exploratory data of the GSI. IBM suggested further drilling at closer interval. In all, 19 boreholes, as suggested within the selected blocks, were drilled. The reserves as established by IBM are 6.013 million tonnes of crude barytes. Subsequently, IBM prepared a mining feasibility for the project[8].

**Feasibility Study by IBM**

Size of the priority block of APMDC ..... 240 m x 260 m

**Drilling :** A total of 19 boreholes at 30 m interval along strike and 60 m along dip.

Meterage - 1356

Sampling - 654 for specific gravity (sp.gr.) test

- 346 for $BaSO_4$ content

Reserves Proved : 6.01 million tonnes

The method of exploration adopted for the barytes investigation at Mangampeta included detailed geological mapping, drilling, logging and sampling of drill cores, determination of specific gravity of the samples from the ore zone and the associated rocks.

**Mapping**

Detailed geological mapping of an area of about 5.48 sq.km on a scale of 1:2000 was carried out covering the Northern and Southern lens deposits. The area forming north western strike continuity of the Northern lens deposit upto Makkavaripalli was also mapped on 1:2000 scale along the geophysical traverse lines. In addition, the quarries/mines of the Northern and Southern lense deposits were mapped on 1:1000 and 1:500 scales, respectively to clearly bring out the structural and lithological details.[3]

Regional mapping of the Pullampet Formation, utilizing aerial photographs, has been carried out with a view to locating acid volcanic rocks with which the barytes is genetically associated.[10]

**Drilling**

Drilling operations in the Mangampeta area can be broadly grouped into four categories and an aggregate drilling of 8884.59m was carried in 68 vertical and 2 angle boreholes. Details are as follows :

| | |
|---|---|
| (a) Exploratory drilling of the Northern lens deposit which includes the initial test drilling of the gravity anomalies (61 boreholes) ..... | 7799.54 m. |
| (b) Exploratory drilling of the Southern lens (2 boreholes) ..... | 283.50 m. |
| (c) Test drilling of gravity anomalies inMangampeta area (2 boreholes) ..... | 436.30 m. |
| (d) Test drilling of gravity anomalies in Challampeta and Mukkavaripalli area North-Western strike continuity of Northern lens deposit (2 boreholes) ..... | 365.25 m. |
| | 8,884.59 m. |

The borehole points are in general located along the cross- section lines and are drilled at staggered intervals. Normally, the strike interval between the boreholes has not exceeded 220 m. Along dip, the interval between boreholes is 100 m and 150 m. The first line of intersections located adjacent to quarries and/or outcrops are shallow and depth being 60 m and 80m. The depth of remaining boreholes lies between 140 m and 200m. The maximum and minimum depths drilled in the area are 203.55 m and 42.50 m respectively.[3]

**Sampling**

Sampling at Mangampeta is as follows :

**(a) Core Sampling**

The cores were obtained from the boreholes. The length of a core sample rarely exceeded a metre. A total No. of 1812 samples were collected from 51 boreholes. Of these 1775 samples are from northern lens and remaining 37 samples from Southern lens deposit.

**(b) Groove Sampling**

Groove samples from the mine faces of Northern and Southern lenses were collected with a view to understanding the lateral and depth wise

variations in grades of barytes. A total of 197 samples from 19 grooves (16 grooves from the mines of Northern lens and 3 grooves from the mines of Southern lens) were collected. Size of each groove is 10 cm in width and 2.5 cm in depth. The length of the individual sample dependent upon the lithology and change in the litho character.[3]

(c) Composite Sample

A total number of 64 composite samples from 54 boreholes were prepared and analysed chemically to check the reliability of sampling and chemical analysis[3]. Each drill cores from the boreholes were systematically sampled and analysed for $BaSO_4$. In addition one sample out of ten was analysed for $R_2O_3$, $Fe_2O_3$, $SiO_2$, loss on ignition(LOI), water solubility etc. From the analytical data, weighted average composition and computations of grade-wise zones were analysed.[10]

Specific Gravity Determination

Specific gravity of the individual core samples of the ore zone from all the boreholes was determined in the field with the help of Walker's steel yard balance. In zones with frequent variations in lithology a number of pieces of the core representing different lithological variation with their sizes proportional to the thickness of the litho layer were chosen, their sp.gr. computed for the sample.[3]

Reserves

A total reserves of 74.12 million tonnes of barytes comprising both marketable and lower grade have been estimated for entire Mangampeta deposits including Southern lens and also the ore within the private lease holds.[3]

Grade

Based exclusively on $BaSO_4$ content the different grades of barytes computed are :

Grade I - Over 94 percent $BaSO_4$

Grade II - Over 92 percent $BaSO_4$ (inclusive of Grade I)

Grade III - Over 80 percent $BaSO_4$ (inclusive of Grade I & II)

Uncategorised grade - below 92 percent $BaSO_4$ (exclusive of Grade II and inclusive of Grade III).

The grades I and II are suitable for oil well drilling. Grade III is partly suitable for blending with Grade I and II and partly amenable to beneficiation.[10]

(2) Vinjamur Area, Nellore District

The occurrence of barytes was first reported by GSI in 1908. The barytes occurance near Vinjamur is being exploited by M/s S.A. Sattar & Co., and M/s. Drilling Mud Corporation. In view of its genesis as well as indications of barytes over a length of 14 km, a detailed survey was undertaken by way of geological and geophysical surveys followed by drilling. The detailed geophysical surveys undertaken during 1976-78 were followed by test drilling.

A total area of 4.40 sq.km. has been mapped by plane table survey on scale 1:2000,in Kodandarama and Venkatadripalem area. Another 5 sq.km. mapping was done on 1:15,840 scale in the massive barytes band which extends for a strike length of 600 m as a linear band with width varying from 2 to 5 m. This band widens near Kodandarama mine due to folding where the maximum exposed width is 16 m. The total strike of the main barytes band is 3.5 km. The second barytes band is exposed near Venkatadripalem village. The total strike length of this band is 600 m.[11]

The strike of the formation is NNW-SSE which swings to north south in the south eastern part of the area. The dips range from 30° to 50° with local steep dip up to 65° towards south west and west. The change in strike to E-W with southerly dips (35° to 55°) near Venkatadripalem appears to be due to the effect of a cross fold axis trending NNE-SSW.

In Kodandarama mine barytes is associated with magnetite and silica. Manganese is also associated at places with occasional pyrite along

with magnetite. It is also noticed the barytes as thin layer occurs within the carbonatite and haematite magnetite tuff in the area southwest of Kodandarama mine. The presence of flow layering in barytes, association of volcanic rocks with titaniferous magnetite and presence of manganese proves that the barytes is of volcanic origin.(7)

Geophysical surveys were carried out (gravity and magnetic) in an area of 8.10 sq.km. around Kodandarama hill Venkatadripalem area by GSI to trace the extensions of the known barytes bands and to locate additional bands. Based on these geophysical studies, 19 anomaly points were recommended by them for test drilling.

In all, three gravity high closures with relief varying from 0.8 to 1.2 milligal have been recorded on the Kodandarama hill to the west of it. In the Venkatadripalem area five points have been identified.(11)

**Test-Drilling**

The drilling has been under taken only with the aim of testing some of the important geophysical anomaly points and to ascertain the depth persistence of barytes bands of Kodandarama mine and Venkatadripalem area. Accordingly, a total of 1041.35 m of drilling was carried out in seven boreholes during the period from Dec. 1978 to Nov. 1979. The initial three boreholes are vertical and the remaining four are angle holes.(11)

Drilling carried out was not in a systematic way so as to estimate the reserves, but aimed at testing certain important geophysical anomaly points and to establish the persistence of the known barytes bands. The important barytes zones have been delineated. The barytes is in general granular, crystalline variety layered with magnesite and is considered to be volcanic type. A possible reserve of 1.75 million tonnes from the main Kodandarama zone and 0.40 million tonnes from the Venkatadripalem zone had been arrived at upto a vertical depth of 30 m. The BaO content varies from 22 to 50 percent.(11)

**(3) Pulivendla area, Cuddapah District**

The important workable main barytes occurrences are located in the Pulivendla taluk of Cuddapah district apart from Magampeta area.

The barytes belt occurring near Vemula has received considerable attention of GSI. The area was investigated in greater details during 1970-71. Geological maps were prepared on a scale of 1:31,860 covering the full area and on 1:4000 scale covering important mines viz. Shrotrium I and Vighneswara.

The veins have a general E-W to WNW-ESE trend with dips of 70° and above southwards which is opposite to the direction of the country rocks. Majority of the veins are along fracture planes, the walls showing signs of brecciation. The veins vary in width from stringers upto 4 m. Mostly these deposits occur in association with minor amounts of quartz and calcite in fissures, shear zones faults, fractures and joint planes in traps, dolomite/limestone and quartzite. The barytes mined here is of good quality and analyses around 95 to 99 percent $BaSO_4$ with $SiO_2$ varying from 0.78 to 3.5 percent. The specific gravity ranges from 4.34 to 4.50. Barytes is generally coarsely crystalline and is snow white to light grey in colour.

**3.3.2 Himachal Pradesh**

**(1) Sirmur district**

Sirmur barytes deposits are located around Kanti, Tatyana, Korga, Sakando, Bhandera-Ki-Dhar, Ghurwa-Ki-Dhar, and Kheel. GSI has carried out the exploration work in Sirmur district of Himachal Pradesh.

Barytes occur as small lensoid bodies at Kanti within the limestone. Five minor occurrences were located. Near Tatyana a new occurrence of barytes, 9 m x 2.80 m is reported in Khell within Krol E. Another vein of barytes 8 m x 1 m, is reported from Juwan-ki-nala[7]. At Batewari the barytes occurs as a lensoid body of 9.60 m to 2.40 m dimensions, the mineralisation is localized along the faulted Krol-Tal contact. The barytes generally has a thick cover of reddish soil and is

underlain by dark grey massive and fine grained limestone containing minor barytes veins.[12]

GSI mapped 108 sq.km. area on scale 1:63,360 around Kanti, Tatyana, Korga, and Sakando; 10 sq.km on a scale of 1:15,840 around Bhandara-Ki-Dhar and Ghurwa-ki-Dhar ; 0.265 sq.km. on scale 1:2000 at Bhandara-Ki-Dhar and Kheel. 41 cu.m. of excavation was also done to locate and assess the continuity of the barytes occurrences. A total of 140 rock samples and 28 soil samples were collected.[7]

GSI also covered an area of 105 sq.km. on scale 1:50,000 by reconnoitory mapping near Batewari and Bhangunta and an area of 26 sq.km. on scale 1:15,840 . 0.2 sq.km. of plane table mapping on scale 1:2,000 was covered. 70 cu.m. of pitting and trenching was carried out. Geochemical sampling on grid pattern covering an area of one sq.km. was also carried out and 392 samples were collected.[12]

### 3.3.3 Maharashtra

#### (1) Gadchiroli district

Barytes deposits are located around Kopela-Bodela and Jingaur Area and on east of Ahmed Ali in the Sironcha tehsil of Gadchiroli district over 5.5 Km long NNW-SSE trending belt of Pakhal limestones.

Barytes occurs as veins breccia fractures, joint fillings and to a limited extent as disseminated grains along the bedding planes of Pakhal limestones with intercalated shales and quartzite.[13] Boulders of barytes in brecciated red shale have also been noticed on the slope of some nala banks. At some places, occurrences of lumps of white green and brown barytes associated with calcite with 18 m long and 3 m wide are seen. Exploratory pitting and analysis of sample has indicated barytes associated with limestone . Few samples have analysed 82.73 to 97.22 percent $BaSO_4$ with specific gravity varying from 3.36 to 4.48.

GSI carried out mapping over an area of 30 sq. km. on scale 1:63,360 in the area south of Jignanur and east of Ahmed Ali in the Sironcha tehsil.[7]

Basement investigations undertaken in the Dubarpeth area, located barytes mineralisation along a shear fracture for a length of 100 m win a felspathic metabasic rock[7,18].

### 3.3.4 Rajasthan

#### (1) Udaipur District

Two mining leases viz. Jali-Ka-Guda and Kharwa Chanda are located in Udaipur district. Mining Geological Study of the leaseholds undertaken by the IBM during 1986-87 has brought out the following details:

The leaseholds areas expose complex suite of basement rocks of pre-Aravalli group consists of banded gneissic complex, Quartzites, chlorite, biotite schist and amphibolites. The area is affected by pronounced acid igneous activity.

The barytes occurs as irregular veins,veinlets, stingers and lenses in the host rock. They are either in the form of lumps or as network of veinlets. The width of the barytes veins is highly variable. It varies from a few cms. to about 0.5 m. Exposed strike length varies from a few metres to about 40 m. in Kharwa Chanda lease area. Jali-Ka-Guda area also has similar width and strike length varying from a few metres to about 25 m. Rocks of the area have been subjected to repeated structural disturbances as a result of which the rock formations of this region have been folded. The shear zones, brecciated zones, fault zones, etc., seem to control the localisation of barytes. In Kharva Chanda area, barytes mineralisation seems to be along a fault zone. Except for a few stray trenches and pits, practically no exploratory work has been carried out.

#### (2) Bundi District

A mining geological study of Umar barytes area in Bundi district by the IBM has brought out the following:

The area is having an undulating topography with small hillocks. Outcrops of dolomitic limestone with quartz veins are seen. The different rocks exposed are correlated with Aravalli System. The general strike of the formations in the region is ENE-WSW with NNW dips. In the

barytes zone the strike is NESW with dip 25° to 30° due SE. In the shear zone the barytes is associated with malchite, specks of galena, and chalcopyrite. The barytes occurs at two places namely; (a) Krishnaganj and (b) Pagara.

**(3) Alwar Distrrict**

The barytes deposits of this district fall in two prominent belts, commonly known as Rajgarh belt and Alwar belt. The important localities in Rajgarh belt are: Khora-Makora, Bhagatka-Bas, Girara, Tetra, Jamrauli, Khera, Ferozpur, Ramsinghapura, Goarah, Gujar Nangal and Mundia and in Alwar belt barytes deposites are locatedin Jhandoli, Dholera, Bhankeda, Bhurasidh, Dholidhoop, Umrain, Rawan Dera and Zakir-Ka-Kheda, Sham-Ki-Baori and Bas areas etc. The description of some important deposits/mines covering the aspects of exploration are given below:

**(A) Rajgarh Belt**

**(i) Khora-Makhora**

The Khora Makhora area in Alwar district litho units belongs to the upper part of Alwar Group. The rock units exposed in the leasehold area from foot wall to hanging wall are gritty/Arkosic quartzite, quartzite interbedded with shaly phyllites and massive quartzites. The post Delhi intrusions are represented only by quartz veins and the intrusive granite is absent in the lease areas around Khora-Makhora though the same have been reported from Rajgarh belt area. Generally, the barytes mineralisation in the area is restricted to the arenaceous formations of Delhi Group. The host rock for barytes mineralization is quartzites with intercalations of phyllites. The barytes mineralisation occurs as fissure filling in case of Khora Makhora deposit within the Alwar Quartzite. The barytes occurs as veins, veinlets and stringers of limited length. The individual veins are seldom more than few metres in length, though cumulative strike length sometimes may exceed even 50 m. The thickness of veins varies from 5 cm. to 2.2 m.

Grid mapping at intervals 25 m. was carried out and has served as a base for correlation of various barytes veins in the two blocks. In the past, the barytes veins have been worked out by the surface trenches, but for the last ten years, the underground development is continuing.

The trenches (old workings) were about 10 to 15 m. apart where two main barytes veins of 50 to 75 cm thickness have been worked out in the past. The northern trench extends over 75 m. strike length while southern one extends over 175 m length. These two trenches extend down the dip nearly upto adit No.1.

When the surface workings were abandoned, the adit No.1 and No. 2 levels were opened up. The adit No.2 being termed as level I underground operations started by developing drivages along the barytes veins. There are in all 7 levels. Five winzes developed in the mine area have been utilized for the haulage of the ore/waste.

**Grade**

Chemical analysis of the barytes shows following result :$BaSO_4$ : 95.86 percent; BaO : 62.92 percent; $SiO_2$ : 2.34 percent; $Fe_2O_3$:0.12 percent, SrO:0.06 percent; $Al_2O_3$ : 0.48 percent; CaO : 0.39 percent, MgO : 0.32 percent ; LOI : 0.4 percent; Sp.gr.4.50.

**(ii) Bhagat-Ka-Bas**

Bhagat-Ka-Bas area consists of two isolated hillocks surrounded by flat ground near Babeli and Bhagat-Ka-Bas villages. The rock units exposed in the area are quartz-sericite-schist/phyllite interbedded with quartzite. The post Delhi intrusives are represented only by the quartz veins whereas the intrusive granite was not found exposed in the area. The thickness of individual quartz vein varies from 10 to 50 cm. The host rock for barytes mineralization is quartz-sericite-schist and the barytes veins follow the bedding and foliation plane. The barytes veins vary in thickness from 0.3 to 1.0 m. It is observed that though the dips of country rock at the surface are about 50°, but in the depth, in underground workings the dip varies from 20° to 45°. Thus, the host rock appears to have a marked westward swing followed by a

gentle swing toward west in further depth. The mining activity in Bhagat-Ka-Bas area has proved the persistence of barytes to a considerable depth (beyond 70 m vertical depth).

## (B) ALWAR BELT

### (i) Jhandoli

Barytes deposit is located 26 km NE of Alwar. The area comprises Alwar quartzites and sericite schist striking N 20° E-S 20° W dipping 34° due east. Barytes as veins and veinlets mostly occur along joints. One important vein of about a metre thick is exposed over a distance of 250 m in N 30° to 40° W to S 20°to 40°E direction. This probably follows a shear zone. The area has been worked by putting two shafts at a distance of 12 m.. Two levels have been developed upto the depth of 22 m and 34 m. The mine has been abandoned due to its uneconomical proposition. Float/talus ore on western foot of the hill has also been worked at 5 places. Talus ore of barytes contains boulders ranging from 15 cm to 45 cm in size and are found over a length of 1050 m upto average depth of 1.5 m. Recovery of barytes is 15 percent. It is buff to white in colour, analysis results shown $BaSO_4$ contents 92 to 96 percent.

### (ii) Other Deposits/Occurrences

Bhankhera, Rupbas, Bhurasidh, Ravandera, Dholi Dhoop and Umraih areas are within 6 to 12 km from Alwar. The Bas Ringaspura and Shami-Ki-Baori are at a distance varying from 17 km to 25 km from Alwar. The Jharoli mine is at a distance of 25 km due north of Alwar. The Sainpuri mine is located due NE of Parisal railway station at a distance of about 6 km.

A few more small barytes areas located due North and South of Alwar namely Bhankera, Rupbas, Bhurasidh, Ravandera, Dholi Dhoop and Umraih, etc. where the rock types exposed in the region are quartzite, sericite quartz schist, phyllite hornblende quartz schist, quartz chlorite biotite schist. The general strike of the formations is due NNE-SSW with dip of 45° to 60° due ESE. The quartzite and sericite quartz schist are jointed and fractured. The barytes occurs alongwith the fractured and jointed planes of quartzite and sericite quartz-schist. The rock formations belong to Alwar series of Delhi system in the Indian stratigraphy.

In all, in these leasehold areas total 16 quarries, 55 small pits and trenches and around 10 underground development of levels or adits were found serving exploration purpose. Few holes were also drilled.

## References

1. KARUNAKARAN C,(1973) GSI, BARYTES, Indo-Soviet symposium on Recent trends in exploration of minerals, oil and ground water, October 15-20, 1973. Sponsored by Academy of Sciences of USSR and Indian National Science Academy, pp. 1 to 16.

2. DNHALD A.BOOST(1985) Industrial Minerals and Rocks, 5th Edition, pp.493 to 495.

3. NEELAKANTAM S, SUTHANANDAM P, ROY S and MURTHY Y. G. K : (1980)Final Report on the investigation for barytes in Mangampeta, Cuddapah district, A.P., pp.1 to 8, 99 to 110.

4. BLIGH RP (1973), Barytes in Petroleum Exploration (1) North European shelf : Industrial Minerals, Aug. 1973, pp 9-23.

5. BLIGH RP (1973) Barytes in petroleum exploration Australia, Far East and Other areas, Industrial Minerals, September, 1973.

6. PETER HARBEN IN HOUSTON(1980) : U S Market Barytes pressured by drilling Surge - Industrial Mineral, March, 1980, pp. 74 to 77.

7. KRISHNASWAMY VS (1984) Records of the GSI volume 113, Part I, Annual General Report of the R.S. 1978-79, pp. 102, 239, 324.

8. IBM (1976) Mining Feasibility Study: Barytes in Andhra Pradesh, Indian Bureau of Mines, technical Consultancy Division, Publication Cell.

9. Proceedings of the Workshop on Mining Geology and Mineral Conservation (28th and 29th November 1990) IBM, Nagpur, pp 36-57, Mangampeta Barytes Deposits, A Mining Geological Appraisal, R.M. Umathey RMG, IBM.

10. KURIEN TK, SETTI DN, NEELAKANTAM S, SUTHANANDAM P, and ROY S (1976) Barytes

deposits of Mangampeta, Cuddapah district, A.P; Indian Minerals, Volume 30, No.3, pp 13-15,.

11. PRASAD RAO AD (1984) : Report on the investigation of barytes in Vinjamur Area, Nellore district, A.P.

12. KRISHNASWAMY VS (1986) Records of the GSI Volume 114, Part-I, Annual General Report for 1979-80, p 82.

13. DESH BR, SEN AK, SANKARAN SP, RAO KJ and RAO KV (1979): Report on the Geophysical Survey for Barytes in Kopela-Bodela Jingnaur Area, Sironcha tehsil, Chandrapur district, Maharashtra.

14. BANERJEE AC, AND SHARMA PC (1986) Unpublished report of IBM on the Mining Geological Study of Jali-Ka Guda & Kharwa Chander Barytes lease holds of M/s Ashok Minerals & Chemical Industries, Udaipur district, Rajasthan, Oct. 1986.

15. SINGHAL ML, (1987) Unpublished report of IBM on the Regional Study of the Barytes in the Umar Block, district Bundi, Rajasthan.

16. CHAUHAN SBS, AND PRABHAT KUMAR (1980) Unpublished report of IBM on the Mining Geological Study of Khora-Makhora Barytes Mine of M/s Ram Narain and Bros., Alwar district, Rajasthan, Ajmer, February, 1980.

17. SINGHAL ML, Unpublished report of IBM on the Regional Study of Barytes areas in Block No.1, Alwar district, Rajasthan.

18. SUBRAMANIAM D, AND MUJUMDAR S (1977) Mineral Investigation in connection with the multi disciplinary investigation for rural development of Sironcha area, Chandrapur distt., Maharashtra. Unpublished progress report of Geological Survey of India for the F.S. 1976-77.