4 . Indian Deposits and Reserves

4.1 INDIAN DEPOSITS

4.1.1 Barytes Resources of India

Indian Bureau of Mines has estimated the barytes recoverable reserves of India at 70.15 million tonnes as on 1.4.90 out of which only 12.00 million tonnes are proved reserves. National Mineral Inventory (NMI) is updated once in five years and updation as on 1.4.95 is in progress.

India is an important supplier of barytes to the world as well as to domestic market. Barytes is extensively mined in Cuddapah and Khammam and to some extent in Nellore and Prakasam districts of Andhra Pradesh. It is also mined in Alwar and Udaipur districts of Rajasthan, Sirmur district of Himachal Pradesh, and Gadchiroli district of Maharashtra. Three grades of barytes are mined in India, viz. snow white, white and off colour. Snow white and white grades usually contain over 97 percent $BaSO_4$, depending upon the impurities present in the mineral. The snow white variety is much favoured in paint industry and is also used as a filler in paper, textile and leather industries. The off colour varieties find increasing demand in petroleum prospecting operations where they are used for weighting drilling muds in rotary drilling. Bulk of the quantity, nearly 90 percent, produced in India is off coloured. Barytes produced from Rajasthan is mostly off colour (containing 92 to 95 percent $BaSO_4$), while snow white and white grades (usually containing over 97 percent $BaSO_4$) are produced in A.P. and Himachal Pradesh only.

(1) ANDHRA PRADESH

Geologically, the barytes occurrences in Andhra Pradesh are confined to the Vempalle limestone and traps belonging to Papaghni Group of lower Cuddapah Super Group except the occurrences in Kurnool district which are associated with the limestone belonging to Jammalamadugu formation. Though the bands of limestone and traps could be observed within Tadpatri shales but these are devoid of any barytes mineralisation.

The generalised stratigraphic succession of the rocks of Cuddapah basin proposed by B.K. Nagaraja Rao and G. Ramalingaswamy is as follows:

	Nandyal formation (50 -100 m)	
	Kollkunta formation (15 - 50 m)	
	Paniam quartzite (10 - 35 m)	
Kurnool	Owk shale (10 - 30 m)	
Group	Narzee formation (100 - 300 M)	
	Bangampalle quartzite (10 - 50 m)	
	- Unconformity -	
	Srisailam quartzite (250 m)	
	- Unconformity -	
Nallamalai	Cumbum- Pullampet	Kolamnalashale
Group	(1500)	(200 m)
	Bairen- (Nagari)	Irlakonda quartzite
	konda (600-700 m)	(80 m)
Cuddapah	- Angular Unconformity -	
Supergroup		
	Chitravati group Gandikota quartzite (250 m)	
	Tadpatri formation (800-3000 m)	
	Pulivendla quartzite (1 - 75 m)	
	- Disconformity -	
	Papaghni group	
	Vempalle formation (1100 - 1800)	
	Gulcheru quartzite (28 - 250 m)	
	- Nonconformity -	
	Granites, gneisses, Schists	

Cuddapah basin occupies an area of 35,000 sq km. Barytes occur mostly in the form of fissure veins, replacement veins and also as a bedded deposit. It is found in large quantities close to the plane of dislocation and is usually found at the contact of Vempalle limestone with associated traps. However, the best quality barytes has been

noticed between the trap sills often in association with the large amounts of calc tuffs.

The district-wise distribution of barytes deposits is as follows :

(i) ANANTAPUR

Barytes occurrences in this district are reported from Tadpatri, Anantapur, Gooty and Kadiri taluks. The important occurences are confined to the Vempalle dolomite/limestone in Tadpatri taluk. Barytes has been reported near the villages Venkatampalle, Mutssukota, Nerijampalle, Mudugupalle, Dosaledu, Tabjula, Lakshumpalle, Obalapuram, Sanjivapuram, Turakapalle, Kondampalle, Chintalcheruvu, and Krishtipadu.[25]

The occurrences of barytes in Anantapur district in Andhra Pradesh form a connecting link between the deposits of Cuddapah and Kurnool districts. They mostly lie along the same Vempalle limestone (with their associated traps) of Papaghani Group of Cuddapah Super Group.

The barytes in this area is associated with the Vempalle limestone which strikes NNW-SSE to N-S and dipping 10 to 20° eastwards. Barytes occurs in the form of veins which in general follow definite line of fracture, i.e. joints and faults fissures. Some veins occur in the zones of brecciation and deposition of barytes in planes of stratification and joints are a few cm to 3 m in thickness but generally do not continue along strike for more than 30 m as compared to the veins which follow a fault fissure which are upto 15 m in thickness and continue for more than 120 m. These barytes veins continue in depth but pinching and swelling both along the strike and depth are common. Veins consist of white barytes which are stained with red and brown shade. Chalcopyrite and fluorite occur as traces in association with barytes along the brecciation zones. Quartz occurs in abundance along with barytes which forms the quartz barytes rock and is pale pink in colour. In the Venkatampalle and Mutsukota areas nickel, cobalt and vanadium are found associated with barytes veins which show in general a sharp contact with the country rock.

Two mines had reported production of barytes in the past. The known reserves are, however, not considered significant. The barytes obtained from this area is mainly of grey colour and is suitable for drilling mud.

(ii) CHITTOOR

Small veins of barytes varying in thickness from 1 to 5 cm are noticed in a coarse grained gneiss in the Gundlamadugu stream east of Bairagi-Khandriga in Chittoor district. The barytes is yellowish in colour and is in association with quartz and hematite. This occurrence is not of any economic importance.[1,25]

(iii) CUDDAPAH

The occurrences of barytes in Cuddapah district are known since 1910 when two prospecting licences were granted. The occurrence of barytes at Kotapalle in this district was first recorded in 1930. The barytes in Cuddapah district have been found in the taluks of Cuddapah, Kamalapuram, Pulivendla, and Rajampet. However, most of the important vein deposits are confined to Pulivendla taluk with a single exception of the bedded barytes deposit in Mangampeta area in Rajampet Taluk.

Barytes deposits lie in a 32 km long and 1.6 km wide belt rock extending from Chinnakudala to Velidendla. A number of old workings are noticed around Chinakudala in this long valley NW of Lopatanutula.[1,25]

The important deposits of barytes are located at Bakkannagaripalle, Chimalapenta, Elamvaripalle, Rachegaripalle, Polatala Kotluru, Kottaplle, Lingala, Mangampeta, Midipenta, Mittamidapalle, Nandipalle, Rachegaripalle, Rajupalem, Tallapalle, Tangedupalle, Vemula, Velpura, Vempalle and Velidendla, in Cuddapah district.[1,26]

The barytes mineralisation in this area is confined to shears within : (i) trap, (ii) dolomitic limestone and (iii) quartzites. These shears are mostly long as compared to their widths and the mineralisation is in the form of lens. They mostly trend in E-W direction with steep southerly dips. The barytes mineralisation has sharp contact at

many places with the host rock while at other places gradational contacts can also be observed.

The mineralisation along weak planes (joint/bedding) within quartzites and at the contacts of quartzites and conglomerates has been observed in Kummaragotta and in Shrivenkateshwara barytes mines. The barytes associated with the traps is generally snow-white to white in colour.

The only occurrence of bedded barytes in the Cuddapah basin is located at Mangampeta, in the Rajampet taluk which is the single biggest deposit of its kind in the world. This deposit is unique not only for its huge thickness and reserve but also for being the nucleus of detailed studies carried out recently in the Cuddapah basin resulting in the identification of a sequence of volcanogenic rocks. Here, the barytes occurs within the Pullampet tuff and comprises a thick pile of stratiform and grey granular barytes overlain by lapilli barytes.(1)

The general trend of the rocks in Mangampeta deposit is NNE-SSE with gentle to moderate dips towards ENE. The rocks are folded into a number of gently, plunging anticlines and synclines with their fold axes trending NNE-SSE. Variations in strike and reversal of dip due to folding and swerving is common. Barytes occurs in the Mangampeta area in the form of two lensoid bodies, separated by a distance of about 700 m.

In North lens the strike of barytes and other associated formations, is NW-SE with dips of 20° to 30° towards NE. The workings located in north western part indicates NNW-SSE strike which gradually swerves to almost N-S in the southern part of the deposit. Variations both in the strike and dip of the barytes bed occur at short intervals which signify warping both along strike and dip directions. Barytes and associated beds are folded along NNW-SSE axis and plunge gently at 5° to 10° either towards NNW or SSE. At places cross-foldings along ENE-WSW axis are observed. A number of gentle anticlinal warpings, seen in the workings, are attributed to cross-foldings. A shear zone in barytes, trending in NNE-SSW direction, observed in the central part of APMDC working is also deciphered in some of the drill cores.

In Southern lens the strike of the bed swerves gradually from N 60°W-S 60°E in the north-western part to N 10°W-S 10°E.

The local geological sequence of the Mangampeta deposit both in the Northern lens and Southern lens along with the thicknesses of various formations occuring in the area is given below:

Generalised lithological succession of the beds in the Northern lens :

Litho units	Thickness range (m)
Soil	0.50 - 02.50
Quartz veins	-
*Tuff (partly weathered)	1.70 - 181.05
Carbonaceous tuff with quartz lapilli	0.05 - 05.85
Tuff with quartz and barytes lapilli	0.24 - 02.90
Tuff with barytes lapilli. Alternate bands of lapilli barytes and tuff	
Lapilli barytes	0.30 - 22.10
Granular barytes	01.28 - 35.19
Carbonaceous tuff	02.20 - 76.05
Dolomite with thin black tuff bands	52.5 (max.)thickness
Alternate grey and black tuff with thin dolomite	15.25. thickness
Dolomite	more than 68.60 m.

** The term "Tuff" used in the above succession refers to a combination of altered glass and crystal fragments or "mixed tuff".*

Generalised geological succession of beds in the Southern lens :

Litho units	Thickness range(m)
Soil	0.50 - 2.00
Tuff (partly weathered)	2.00 - 51.62
Quartz pyrite lapilli tuff	1.58 (max).
Barytes lapilli tuff	4.55 (max).
Granular barytes	1.15 - 12.38
Barytes lapilli tuff	0.20 (max).
Tuff (carbonaceous)	11.30

Source : Neelakantam S : (1987) : Mangampeta Barytes Deposits Cuddapah District, Andhra Pradesh.

The Northern lens has a strike length of 1,200 m, a maximum width of 900 m and an average thickness of 21 m. This lens occurs in the form of doubly plunging syncline. The thickness of the overburden (tuff) varies from 170 to 180 m, the maximum depth at which the floor of deposit occurs being 200 m below the ground surface. The probable reserve for this lens is of the order of 65 million tonnes. The Southern lens has a strike length of 300 m and a maximum width of 70 m. The thickness of the ore body varies from 4 to 10 m. An inferred reserve of about 0.269 million tonnes of barytes is expected from this lens up to a depth of 50 m in the freehold area.(1)

The bedded barytes sequence comprises layers of granular or saccharoidal type of barytes intercalated with thin tuff laminae. This is overlain by a zone of concentrated lapilli barytes which grades upwards into sparse lapilli of barytes set in grey, argillaceous tuff matrix. A thin band of quartz lapilli tuff occurs at the top of ore zone. The lapilli are spherical or ellipsoidal in shape and vary in size from fraction of a centimetre to about a centimetre in diameter. These lapilli have a rosette structure and represent the devitrified product of a hollo-hyaline barium and silica-rich glass, and which along with the finer pyroclastics, were ejected during the volcanic explosions. The granular barytes is considered to be the product of the exhaustive phase of volcanism and the close association between the two types of barytes suggests that they are the products of the same volcanic activity. In addition to the stratified barytes, some occurrences of vein barytes are also noticed in and around the Mangampet area. These veins are found to cut across all the litho- stratigraphic units of the area including the bedded barytes.(1)

Types of Barytes : Genetically, four types of barytes have been recognised to occur in this area. They are : (a) Granular type, (b) Lapilli (Rossette) barytes, (c) Replacement type, and (d) Vein type.(1) The granular and lapilli barytes constitutes bulk of the ore in Mangampeta area while the replacement and vein types are of little economic significance.

(a) Granular (Chemical Sedimentary) type

This variety is grey to dark grey, massive to well bedded, fine grained and forms the lowermost horizon of the barytes body. It forms the bulk of the ore in Mangampet and is rich in $BaSO_4$, analysing generally between 90 and 98 per cent. It carries thin hair like tuff bands whose thickness increases towards the footwall side. Its specific gravity varies, usually between 4.2 and 4.5. The thickness of the granular barytes varies from 0.30 m to 40 m, the maximum thickness being in the central portion of the lens. Chemical precipitation of volcanic exhalatives under submarine or subaqueous conditions is considered responsible for the deposition of granular barytes.(1)

(b) Lapilli (Rossette) barytes

It is of spherical, oval, elliptical, discoidal or bow-tie shape made up of radiating platy aggregates of barytes set in a matrix of devitrified glass tuff. The incidence of barytes lapilli in tuff

increases with increasing depth, whereas the lapilli size decreases with increasing depth, thus resulting in a massive type of rock containing barytes with little or negligible tuff material or matrix. It has a maximum thickness of 12 m in the central part and ranks second in economic significance.[1]

(c) Replacement type

Barytes replacing quartz and pyrite along grain boundaries or margins constitute this type which is of little economic significance.[1]

(d) Vein type

The vein type of barytes consists of crystalline aggregates of generally white barytes and some quartz, often coated with limonite. The veins (traversing the dolomite and bedded barytes and devitrified glass tuff) vary in width from 10 mm to 50 mm. The discordant nature of these barytes veins indicates them to be of hydrothermal origin. The barytes is of little economic importance.[1]

Description of some of the leased deposits in Cuddapah district is given below :

Mangampeta Barytes Deposit 'A'

This deposit is located at Mangampet village in Rajampet taluk in Cuddapah district. This deposit occurs conformably within the carbonaceous shales/tuffs Pullampet shales of lower Cuddapah age. Generally the rock units met within the region are tuff, barytes with intercalated thin bands of tuff and dolomite. As regards the granular barytes, field evidences suggested a sedimentary origin. Chemical precipitation of volcanic exhaustives under submarine or subacqueous conditions is considered responsible for the deposition of barytes. Barytes occurs as bedded deposit which has undergone folding and cross folding. Barytes occurs generally below the tuff cover. The ore is invariably associated with thin bands of tuff. Low grade barytes having a specific gravity of 3.8 to 4.2 occurs at the top followed at depth by granular variety comprising of high grade barytes with a specific gravity of 4.22 and above (Plate I).

Vemula Barytes Deposit 'B'

The deposit is situated in Vemula village of Cuddapah district and covers an area of over 13 ha. which includes the important veins like Shrotrium, Vighneshwara and Kumaragatta. Because of alternate local variations in the gradients at different topographic horizons, the slope gives the appearance of step like configuration, with three major steps on a roughly WNW-ESE trend. In this area quartzite and the basaltic trap rocks and one doleritic dyke belonging to the Chitravati group are present. The barytes mineralisation occurs in the fractured zone in the lowermost part of the area. In all, three veins are present.

All the three veins show a general trend in N70°W-S70°E to N80°W-S80°E direction and dips steeply at about 65°SW.

Thallapalle Barytes Deposit 'C'

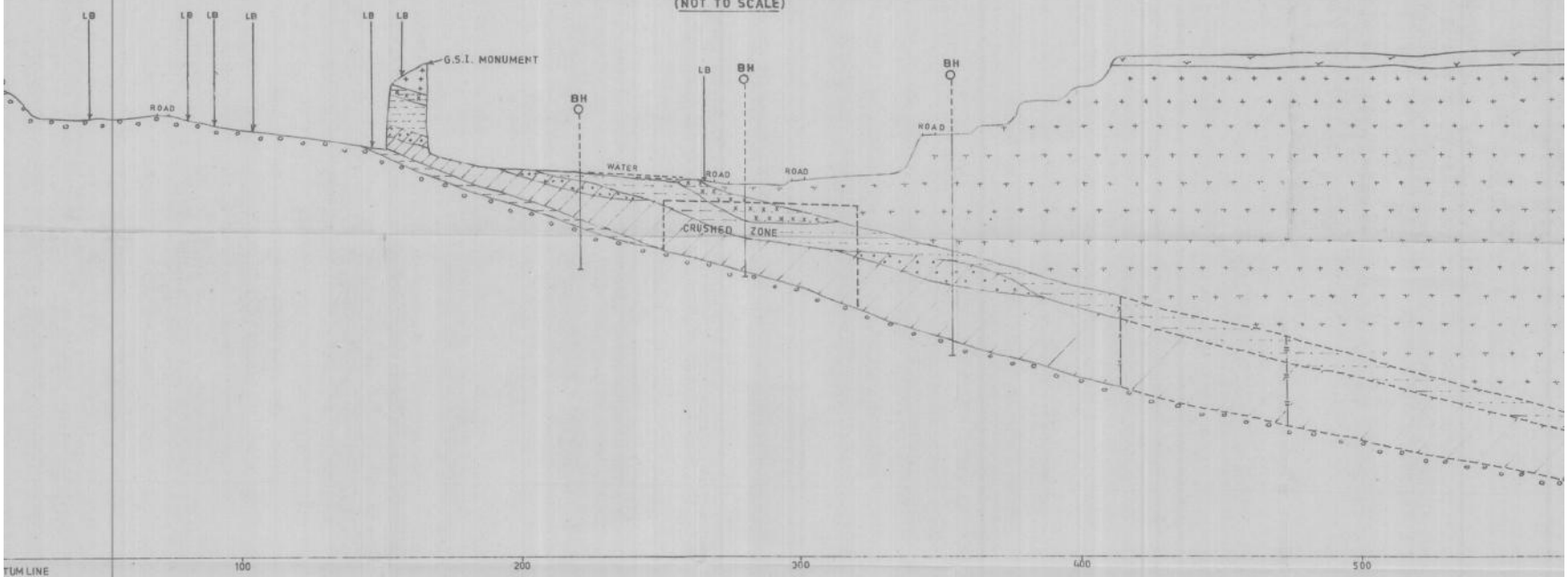
The deposit is situated in Thallapalle village and covers an area of about 3 ha. Here the Pulivendla quartzite and associated basaltic trap and dolerite dyke are encountered. The strike of the formation is N 80° E - S 80° W and it dips at 32° towards north. Only two thin barytes veins are present whose width ranges from 8 to 10 cm. The veins show signs of pinching at a depth of 4 m. The colour of the vein is off-to-white, highly siliceous and of little commercial value[10].

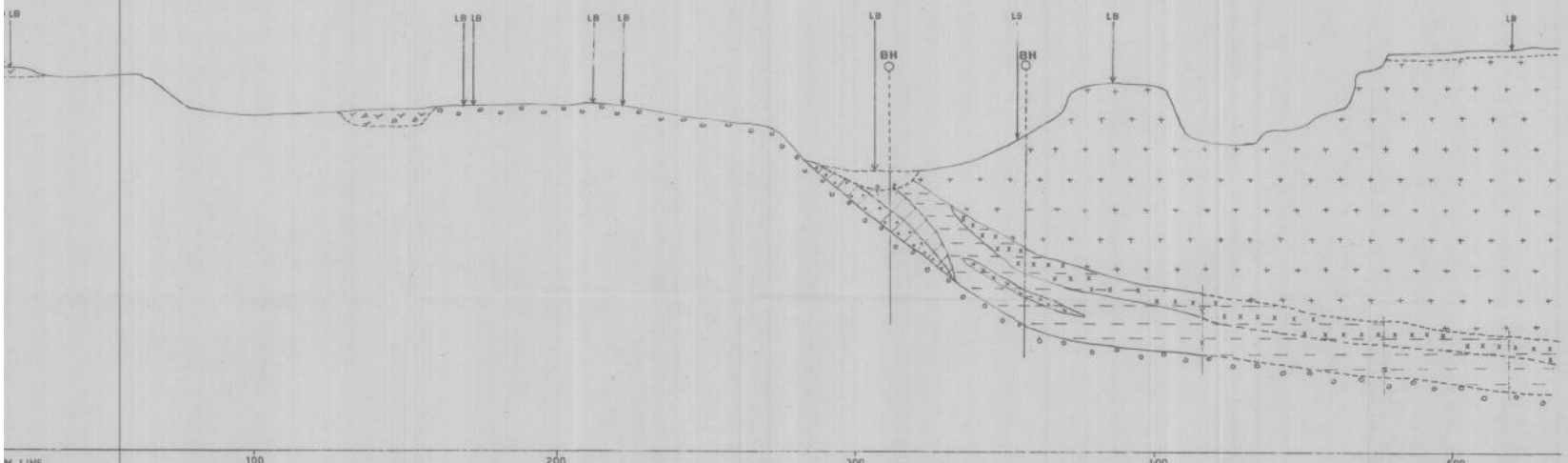
Chellamoola Deposit 'D'

This deposit is located 2 km south of village Kothapalli at a distance of 24 km from Pulivendla. The geological formation of the area belongs to the Chitravati group of the lower Cuddapah system. The entire area is covered with trap rocks which are of three types viz. (a) brecciated trap with disseminated barytes, (b) sheared and weathered traps with barytes veins and (c) hard massive traps, generally devoid of barytes mineralisation. The area is covered by fairly thick formation of basic trap rocks with crude foliations developed at certain places. The barytes mineralisation is generally restricted to more or less E-W trending shear zones within weathered trap rocks. The

A TYPICAL SECTION OF MANGAMPET DEPOSIT

(NOT TO SCALE)





TUM LINE 100 200 300 400 500

M LINE 100 200 300 400 500

TRACED

DRG. No. 18

D.

I N D E X

- SOIL COVER/FLOAT WORKING
- TUFFACEOUS SHALE TUFF
- D GRADE BARYTES (3·60 TO 4·00 Sp. Gr.)
- C GRADE BARYTES (4·00 TO 4·22 Sp. Gr.)
- B GRADE BARYTES (4·22 TO 4·32 Sp. Gr.)
- A GRADE BARYTES (4·32 Sp. Gr. and above)
- BLACK TUFF CRYSTAL TUFF/ DOLOMITE
- BH — BORE HOLE DRILLED BY G.S.I.
- LB — LEASE BOUNDARY
- DUMP
- LIMIT OF PROVED RESERVES
- LIMIT OF PROBABLE RESERVES
- LIMIT OF POSSIBLE RESERVES

main shear zone has an average width of 8 m, whereas the two subsidiary shear zones have average width of 1 m and 6 m. Within the shear zone barytes occur as thin films, stringers and veinlets. The films and stringers are generally less than 2 mm in width and have limited strike length rarely exceeding 2 to 3 m. The veins generally range in width from 0.05 m to 0.20 m though some show widths varying from 0.40 m to 0.60 m. The thinner veins or veinlets commonly persist for a strike length of 4 to 5 m. Whereas, the thicker veins are observed to have lateral extension over 20 m. The veinlets and veins are parallel to the shear zones with their strike WNW-ESE and steep dips over 60° to subvertical, at times. Even though dissemination of barytes has been noted in brecciated epidotised trap, no discrete and economically workable barytes veins have been noted. It is only in the sheared and deeply weathered trap rocks, economically workable veins of barytes mineralisation has been observed.

Balisettykona Barytes Deposit 'E'

This deposit is situated in Kothappalli village. The leased area is represented by basaltic traps and dykes of Chitravati group of lower Cuddapah Super Group. The principal rock types exposed are basaltic traps of three distinct types viz. (i) massive traps exposed on a small patch along the south boundary, (ii) a small patch of brecciated and serpentinised trap along northern margin of massive trap and (iii) sheared and weathered traps distributed over the remaining area. Small outcrops of dolerite dyke occur in western part. There is a major shear zone and this serves as main locale for barytes mineralisation. The shear zone is confined to the sheared, fractured and weathered trap rock and extends for about 400 m along the middle portion of the area. The general trend of the shear zone is east-west and is about 7 m in width. The barytes mineralisation in this shear zone occurs in the form of lensoid or as tabular body and is exhibited by the presence of small veins, veinlets and stringers, arranged in 'en echelon' pattern. These veins or veinlets have widths of 20 to 40 cm with strike persistence of more than 20 m.

(iv) Khammam

In Khammam district occurrences of barytes are confined to a narrow belt of Pakhal which runs approximately NNW-SSE, 6.5 km east of Khammam town. The important occurrences in this district are : Cheravupuram, Gopalpur, Venkatayapalem, Rudramkota, Kodamur and Pocharam.[26]

Barytes occur as lens, stringer and vein associated with the cherty dolomite belonging to the lower Cuddapah rock. The thickness of the vein is reported to vary from few centimetres upto 6 m. The maximum length for which a single vein is exposed is about 3000 m. The mineral found in the group of deposit is generally massive and often stained with iron oxide to assume a brown or pink colour. There are only 3 mining leases for barytes in this district covering an area of 180.3 ha.

(v) Krishna

Barytes has been reported to occur at a distance of 1.4 km SSE of Vemulanarava village in Krishna district. Discontinuous veins of barytes varying in thickness from 15 cm to1.2 m are exposed over a strike length of 100 m. The mineral is associated with the vein quartz within biotite chlorite schist of Archaean age.

(vi) Kurnool

Occurrences of barytes in Kurnool district have been known for a long time. The first large deposit at Balapalapalle came to light in the year 1909. The pioneering work carried out by Ghose and subsequently by Ray and B.P. Sesha Reddy had resulted in the development of barytes industry in this region. Barytes deposits in this district are located mostly in Dhone taluk while some are also known from Kurnool, Nandyal, Sirwel and Nandikotkuru taluks.

The important deposits of barytes in the district are located at Betamcherla, Brahmankotkuru,

Boyanapalli, Rangapuram, Hussainapuram, Peddapaya and Yaparlapadu.[26]

The barytes occurrences in this area are associated with the limestone and quartz veins within quartzites belonging to Kurnool system. The thickness of barytes which occurs as veins along the fracture, and joint planes have been noticed to vary from few cm to 4 m. The veins generally strike in NW-SE to E-W direction. These veins dip NE to North at steep angles varying from 55° to 75°. Pinching and swelling have also been noticed both along strike and dip. Float ore is also worked in few areas. The size of the float ore boulders varies from a few cm to 30 cm. The recovery of the barytes from the float working is hardly 10 to 20 percent.

(vii) Mehaboobnagar

Occurrences of barytes have been located near Bolaram village in Kollapur taluk of Mehaboobnagar district. Barytes veins are traced from the locality about 1.5 km east - northeast of the village to near the confluence of the Kanglavagu with the Krishna river, at a distance of about 2 km. The barytes occurs in the form of veins trending N 70°W to S 70°E with southerly dip. They range in thickness from mere stringers to 3.5 m. The mineralisation is either along or close to the faulted contact of the Vempalle chert beds with Pulvendla quartzite.

(viii) Nellore

Minor occurrences of barytes are reported from Bundokindapalle in Udyagiri taluk in Nellore district. Near Vinjamuru, bedded barytes is found associated with metavolcanic carbonatites considered to belong to the Dharwar. The occurrence belonging to the early pre-cambrian and is unique in view of the association and genetic relationship with carbonatite and volcanic rocks.

(ix) Prakasam

In Prakasam district barytes occurrences have been reported at Ganjivaripalem and Gajjalakonda. Barytes veins occur in the Cumbum Shale of Nallamalai Group. The barytes veins, which vary in thickness from 1 to 3 m, occur as pinch and swell type veins and are localised along an WSW trending shear zone which dips to the south at 40° to 80°. The barytes is off coloured. In general, the barytes veins occurring in shale are of better quality.Minor occurrences are also reported from Daddonalapenta, Janapalacheruvu and Suddapenta.

(2) BIHAR[2,3,4]

In this state, barytes deposits occur in Singhbhum, Ranchi and Palamau districts of which the deposits of Singhbhum are regarded as important.[25]

(i) Singhbhum

In Singhbhum district, barytes occur around Kolpotka, Pradhanpali and Dhanapal which occur as disconnected extension of the Kolpotka belt. The individual description of these deposits is as follows :

KOLPOTKA

Barytes occurs as discontinuous lenticular patches, SW of Kolpotka, forming three zones, the southern, central and northern zones, all of which run in NE-SW direction within an area of about 4500 sq.m. The direction of veins conform with the strike direction of the country rock - sericite-schist, which has a dip of nearly 70° towards SE and has been intruded by quartz veins. The length of the barytes veins varies from a few cm to a maximum of about 8 m and in width from paper thickness to 1.5 m.

The Southern Zone - This zone comprises an area of 1,220 sq.m. in which a total of fifteen veins occur. The maximum length, width and depth of the veins are 8 m, 1.5 m and 7.5 m respectively, whereas the minimum length is 1.8 to 2 m. The soil overburden varies from 0.6 to 3 m in thickness. The $BaSO_4$ content of the ore is high, ranging between 93.86 percent and 98.12 percent.

The Central Zone - It lies within an area of 520 sq.m. There are two pits and trenches in which a total of three veins occur. The veins vary in length from 1.5 to 2.4 m. The width and depth on an average are 60 cm and 90 cm respectively. The

veins thicken downwards. All these veins possess a soil cap of 0.9 m thickness. The ore contains 94.67 percent $BaSO_4$.

The Northern Zone - This zone covers an area of 2,770 sq.m. There are eight pits and trenches. The total number of veins in the zone is nine. The maximum length, width and depth of the veins are 7.5 m, 1.5 m and 3.9 m respectively and the minimum of these dimensions are 1.5 m, 0.3 m to 0.6 m. The overburden of the veins varies from 0.6 m and 2.4 m thickness. The $BaSO_4$ content is between 74.53 and 92.95 percent, but a majority of them contain more than 90 percent $BaSO_4$.

PRADHANPALI

Nearly 800 m west of the Pradhanpali village, there is a small old prospecting trench, in which barytes was located.. The vein is 4.5 m in length, 1.5 m in width and 90cm in thickness. It runs in an EW direction. No barytes was traced on clearing the pit. Apparently, the vein died out in shallow depths.

DHANAPALI

Two old pits and trenches are located nearly 800 m west of Dhanapali and on the eastern flank of the hillocks trending NS. The distance between the two is 100 m running in the NE-SW direction. No vein was exposed on clearing the trench but a vein could be traced after clearing the 90 cm thick soil cover. Some material found stacked adjacent to the trench. The bulk sample analysed 73.66 percent $BaSO_4$. The barytes here is stained black and is of dirty yellow colour.

(ii) Ranchi

In Ranchi district a series of veins of barytes occur in the granite gneiss some 22 km east of Ranchi striking EW from Silwai, Bahea, and Bangaibera.[27]

(iii) Palamau

In Palamau district barytes is reported to occur near Sunghitalli [27].

(3) HIMACHAL PRADESH[5,6]

In Himachal Pradesh, barytes is reported to occur only in Sirmur district, as veins at Kanti and Tatyana. The veins at Kanti occur in Krol limestone and have a fairly large reserve[6]. Lenses of snow white barytes measuring 50 cm occurs across within calcite vein of 50 m long and one metre thickness at the contact of red shale with dark grey limestone and shale.

(4) HARYANA

In Haryana, barytes is reported to occur in Mahasu and Mohendragarh districts.

(i) Mahasu

In Mahasu district, barytes is reported from Saibathan, Haripur and Sair.[6]

(ii) Mahendragarh

In Mahendragarh district, barytes veins occur in association with calcite and quartz in calcschists belonging to the Ajabgarh Group as small pockety deposit near the village Bail-ki-Dhani and a small vein has been recorded from Musnota village [6]. The veins occur over 2.5 km length with a maximum width of 0.5 m upto a depth of 2.5 m. The barytes is crystalline, off coloured and at places with malachite.

(5) JAMMU AND KASHMIR

Barytes deposits occur in Riasi tehsil of Udhampur district near Jangal Gali pass and Kheri Kot where it occurs as narrow veins in Sirbau limestone. In Jangal Gali, small veins extending from two to nine metres in length and 0.30 to 1 m in thickness are reported. Barytes here often contain specks of chalcopyrite and malachite. At Kheri Kot the barytes is associated with galena and is white to red in colour[7].

(6) MADHYA PRADESH[10,11]

In Madhya Pradesh, there are very few occurences of barytes reported from Dewas, Dhar, Jabalpur, Shivpur, Sidhi and Tikamgarh districts.

(i) Sidhi

A number of thin barytes veins was observed in the area in barytes comprising Sukwari and Bagwari villages of this district. The country rocks include granite showing intrusive relation-

ship with talc-chlorite schist, quartz-sericite schist, hornblende schist, amphibolite and meta-dolerite. At places, lenses of banded-hematite-quartzite, phyllite and orthoquartzite of the meta-sedimentary group were noted within the older metamorphics. Veins of barytes in the form of narrow fracture fillings were seen within the granite as well as the schistose formation specially along the sheared contact zones. The other minerals found in close association with barytes include quartz, siderite, hematite, malachite, azurite and rarely chalcopyrite.[10,11]

In Sukwari area, the mineral veins are found in the granite- talc-chlorite schist and meta-dolerite. Almost pure white crystalline variety of barytes occurs in lens like bodies extending from 2 cm to about 36 m in length, 2 cm to 12 cm in width and are within one metre in thickness. In Bagwari area, the veins extend from about one metre to 156 m in length, 15 m in width and 2.5 in thickness. Veins of barytes of better quality extend upto 65 m in length, 25 m in width and one metre in thickness.

(ii) Jabalpur

In this district, barytes occurs in association with dolomite and dolomitic limestone at Sunehra, Manhera, Mohania, Khirsua, and Imalia.[10,11].

(iii) Dewas

In this district, occurrences of barytes are known in Gairi, Rethi and Andar [10,11].

(7) MAHARASHTRA

In this state barytes is found to occur with the granites and gneisses intruding the Dharwar metasediments and also with some coal seams of lower Gondwana period.At present, significant occurrences of barytes are found in Gadchiroli district only. Minor occurrences are also reported from the districts of Yavatmal and Ratnagiri.[12]

Districtwise distribution is as follows :

(i) Gadchiroli[13,14]

In this district, barytes is reported from Kopela - Bodela - Jinganur area and Phutana - Nalesar - Janala area. Kopela, Bodela and Jinganur areas lie nearly 25 km to the east of Sironcha tehsil. The quartzite and limestone strike in NW-SE direction. The geological formations encountered in the area are the Archean gneisses to the NE followed by the Pakhals in the centre and then the Gondwana Formation to the SW. Barytes occurs within the Pakhal limestone. They occur as thin veins, breccia, and fracture joint fillings. Boulders of barytes have also been noticed on the slope of some nala bank of the area.

In Phutana, Nalesar and Janala barytes occurs as a constituent of veins and lenses in the main shear zone, which is composed of granitic gneisses. The deposit occurs as fissure veins, breccia, fillings, replacement veins and disseminations. The veins show a general trend NNW-SSE to N-S which is conformable with the trend of the granitic gneiss. The exposed length of vein varies from 20 m to 25 m and width between 1 m to 3 m. Minerals associated with barytes are calcite and quartz.

(ii) Yavatmal

In this district, at Wani a 5 cm thick vein of barytes is associated with the coal seam.[12]

(iii) Ratnagiri

The occurrence of barytes is reported at Dewoolwade in Malvan tehsil in Ratnagiri district[12].

(8) RAJASTHAN

Rajasthan is one of the important barytes producing States in India. Barytes occur in the districts of Alwar, Bharatpur, Bhilwara, Bundi, Chittorgarh, Pali, Sikar and Udaipur, of which Alwar district is the main producer. In this State, barytes occurs as fissure veins and veinlets along bedding planes, joints, fractures and minor fault zone within quartzite and quartz mica schist of both the Alwar and Ajabgarh Group[15].

The lithological unit of this region belongs to Delhi Super Group. The stratigraphic sequence is as follows[17].

(Acid Intrusives : Granites, pegmatite and quartz vein Post Delhi)
(Basic Intrusives: Amphibolite and metadolerite)

		Ajabgarh Group	
Delhi Super Group	Alwar group	Pratapgarh - formation	Massive quartzite with minor schist and marble
		Kankawarhi - formation	Schists (sericite, biotite, garnet and andalusite bearing) with quartzite and conglomerate
		Rajgarh - formation	Quartzite, marble, gritty quartzite, conglomerates, and pebbly quartzite.
		Local unconformity	
		Rialo group	
		Unconformity	
Pre-Delhi		(Granite and gneisses	
		(Quartzite with interlayered schist and phyllite	
		(Impure marble and assoicated quartzite	

The district wise description is as follows :

(i) Alwar

Barytes occurs mostly as fissure fillings and are reported from Sainpuri, Babeli Bhagat-Ka-Bas , Jamrauli, Dholera, Tetra, Ladia, Khora-Makhora, Girara, Burasidh, Bhankheda, Umrain, Khera, Ramsinghpur and many other adjoining localities. Some important deposits of this district have already been covered beltwise in para 3.3.4; those not covered is described below.

Sainpuri Deposit

The deposit is located about 1 km SE of this village. The veins st ike N 25°E-S25°W in quartz biotite-chlorite schist of Alwar Group. The main vein is 50 m long and 6 m wide. The associated minerals are quartz, chalcocite and cuprite. Mineralisation is considered to have taken place due to hydrothermal solutions which have deposited these minerals[15,16].

Babeli Deposit

The barytes veins are of pure massive type ranging from 1 cm to 3 cm in width and from 0.5 m to 10 m in length and occur in schists of Alwar Group of rocks. Barytes is buff coloured with occasional specks of pyrite and chalcopyrite. These veins are of 220 m length and follow the bedding (N10° E - S10° W) of sericite quartz schist of the Ajabgarh Group. The g neral trend of the rocks is N-S. The veins dip at 35 - 45° west[18].

Jamrauli Deposit

The deposit is located about 0.5 km SE of Jamroli village. Baryte occurs as fissures, veins and veinlets along bedding planes, fractures joints and fault zones. Potential deposits are observed as fissure fillings along the faulted and fractured zones. The mineralisation is essentially in upper quartzite along the northwestern slope of the hill. The granites and phyllites are devoid of barytes mineralisation. The thickness of vein varies from 1 m to 3 m. Dip of the vein is towards SW ranging from 75° to 85°[19].

Dholera Deposit

The deposit is located just SE of Dholera village. The general strike is N 40° - 45° E and dip is towards NW varying from 55° to 65°. Barytes occurs as veins and veinlets along bedding planes, fractures, joints and fault zones. The mineralisation is essentially in granite.(20)

Tetra Deposit

This deposit is located just south of village Tetra on Reni - Rajgarh Road. The mineralisation occurs in the form of veins and veinlets. Granite is the source of mineralisation. The prominent mineralisation is along dip and oblique joints. The thickness of the vein varies from 0.4 to 0.6 m with an average of 0.5 m and strike from 15 to 30 m. There are thinner veins in the area with thickness varying from 0.2 to 0.3 m. The general strike of the barytes mineralisation ranges from NW-SE to NNE-SSW with dip ranging from 50° to 70°. The barytes occurring in this area is mostly of off coloured variety, snow white and also white.(21).

Bhankheda Deposit :

The deposit is located at a distance of 6 km from Alwar town on Alwar-Jaipur Road. Barytes mineralisation is in sericite- quartz-schist which forms a part of Alwar Group of Delhi Super Group. Barytes vein varies in length and width and appears to be steeply dipping towards south. They are normally trending N75°W S75°E and dipping towards 75° due south. Veins are extending upto strike length of 85 m, thickness varies from 0.3 to 0.9 m.(23)

Ladia Deposit

The deposit is located 18 km away from Reni. General strike of the various litho units is N30°E - S30°W dipping 75° west. Thickness of barytes is 0.3 m . The vein occupied the fracture zone trending N35°W and dipping 85°SW(24).

(II) BHARATPUR

In Bharatpur district, barytes occurs in rock of Delhi Super Group. Deposits are closely associated with post Delhi basic intrusives and occur at Hatori, Ghatri and Karwar villages.(16)

Hatori Deposit

The exposures are noticed at a number of places in the west and north of Hatori village. The barytes vein runs in NE-SW to NNE-SSW direction as lenticular fissure fillings in quartzites. The veins are irregular and extend over a length of nearly 14 m. Baryte is associated with chalcopyrite, pyrite and quartz(16).

Ghatri Deposit

Barytes occurs on the southern flank of a small hill about 1.75 km WNW of Ghatri village. Mineralisation is confined to a NNE-SSW trending vertical to steeply dipping 1 m to 15 m wide zone and a few cm to 30 cm in thickness(16).

(III) CHITTORGARH

In this district, barytes is reported from Jaura kalan area near Rewat Bhata in the upper Vindhyan sediment. It occurs as small veins, stringers, fillings and lamination in the shales of upper Vindhyan age(16).

(IV) UDAIPUR

In this district, barytes occurs as streaks, lenticles and veins in association with quartz carbonate veins within the biotite chlorite schists, phyllites and dolomites of Pre-Aravalli and Aravalli Super Group of rocks at number of places between Delwara Nathdwara in gneisses and schists near Relpataliya constituting two belts.

Delwara-Nathdwara Belt : In this the barytes occurs mainly as fissure and breccia fillings or replacement in limestone. The mineralisation is mostly confined to the chlorite schist and occurs as en echelon veins along foliation planes. The barytes deposits/occurrences of this belt are found in Gurli, Kioli, Junagarh, Laxmi Guda, Barwalia, Pipalwas, Nerach, Khetrapal-Ka Gudah, Kagmadar, Nagaria, Ramela, Chora Ghali and Keroli localities.

The description of some important areas is given below :

Gurli deposit : A thin vein of barytes about 25 m long and 5 cm to 30 cm wide occurs about 900 m N 35°E of Gurli or about 600 m N 50°W of Gajela on the western slope of the hill range west of the National Highway. The country rocks are biotite-chlorite- schist into phyllites and grey quartzite. The rock trend about N 20° W-S 20°E and dip 75° towards west. The vein is intruded along the strike and dips vertically.

The barytes is milky white to greyish white in colour, fine grained, massive and forms more than 60 percent of the vein. Other associated minerals are calcite and dolomite, pink felspar, siderite and quartz.

Kioli Deposit : About 250 m NNE of Kioli, thin veins of barytes crop out in the plain ground within the chlorite schist. The veins are intruded along the foliation with trend N 50° E-S 50°W and dip about 80°to 85° towards north west. These veins can be traced southwestwards along strike intermittently for a distance of about 100 m, within a zone of about 5 m. The individual veins are about 1.20 m, 20 cm and 30 cm in width respectively.

Junagarh deposit : Thin streaks, lenses and pockets of barytes occur within the dolomite marble band near Junagarh. The dolomite band runs from 1 km west of Kioli to SW of Larmi. But the barytes is seen to occur impersistently only from near Junagarh to 600 m east of Dulwatan-Ka-Gurha. Near Junagarh, it occurs as thin lenticles within the marble, but east of Dulwaton-Ka-Gurha, it occurs at the contact of the quartz veins and the dolomite. The barytes bearing zone runs impersistently for a distance of about 50 m along strike and veins in width from 25 cms to one m. The individual lens however does not exceed for more than 5 m along strike. The barytes is milky white to greyish white, hard, compact, heavy and massive. It is fine to medium grained and occassionally coarsed grained. It contains intercalation of dolomite and vein quartz.

Relpataliya Belt : In this belt the barytes occurs in granetised gneisses and schists and flanked by metabasites on both sides. Only two localities namely Relpataliya and Babarmal have been identified in this belt. Of these Relpataliya is an important area, which is described below :

Relpataliya deposit : The deposit is located near village Relpataliya 7 km NW of Jagat in Udaipur district. The barytes occurs as a long band in granitized gneisses and schists, flanked by metabarytes on both hanging and footwall sides. These metabasics are parallel to sub-parallel in disposition with relation to barytes veins. The barytes bearing zones occur following N 30°- 60°E strike over a length of about 2.5 km. The main barytes band starts about 1.4 km. south of Relpataliya village and continues in north east for a strike length of about 0.2 km making a total of 1.6 km length. Besides this main zone, there are two more bands of barytes which also follow the genral trend of barytes mineralisation. These veins have a strike length varying from 150 m to a maximum of 450 m.

The barytes veins occur in prominent low lying ridges and can well be identified with its peculiar physical outlook in contrast to other associated geological formations. The barytes occur chiefly in two modes. One is massive type deposit, and the other type is represented by small veins and veinlets in the host rocks forming a mixed zone of barytes and country rocks. The width of barytes zone in general varies from half a m to about 5 m exceptionally reaching to 8 m. The thickness of veins reduces in the dissected valleys in comparison to the top ridges.

(V) BUNDI

The barytes occurs in the form of veins associated with quartz intruding the dolomitic limestone or at the contact of limestone and phyllites near Umar village in Bundi district. Generally it follows the fissures and fracture planes. In the Pagora area barytes veins are located just south of village in the prominent quartz veins running along a fault @ 30°W. There are two barytes veins, one is about 1.5 m wide and 8 m long. These