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Glass-grade calcite resources of Borra area, Vizianagaram District, Andhra Pradesh, India

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ABSTRACT

Carbonate rocks are often of economic importance depending on their CaO content. A calcareous rock containing CaO >52%is predominantly calcareous andis considered as high-grade ore for various industrial purposes. A deposit in Andhra Pradesh, Borra area is endowed with such high-grade resources of crystalline carbonatite, in view of their utility in glass industry, is presented in this paper. Analytical results of 10 samples from this area, show that these carbonatite/calcite resources contain an average of 53% CaO and are very well suitable as raw material not only in in glass industry but also in others. A systematic investigation to estimate the resources and proper environment- friendly mining is indeed necessary.

Keywords: High-grade carbonate, Borra, Vizianagaram, Andhra Pradesh.

INTRODUCTION

The Borra calcite deposits were discovered when British geologist, William King unveiled huge caves in karstic terrainin 1807, extending for few kilometres underground, located about 90km north of Visakhapatnam in the Anantagiri hill ranges of Eastern Ghats (800-1300 meters MSL) in Andhra Pradesh. The carbonate rocks of Borra contain enriched $CaCO_3$(calcite) and the deposits predominantly contain crystalline calcite.

Along with other natural raw materials like quartz, silica sand and dolomite, $CaCO_3$ (limestone/calcite) is proportionately used as an important ingredient in glass making. Limestone is used as a raw material in various industries depending on its grade. High-grade limestone (>52 CaO %) is commonly used as raw material in various industries like glass, ceramics, iron & steel, chemical, fertilizer, foundry and sugar industries. In general the term limestone is applied to any calcareous sedimentary rock consisting essentially of carbonates. The two most important constituents of limestones are calcite and dolomite. Limestone often contains magnesium carbonate, either as dolomite CaMg $(CO_3)_2$ or magnesite($MgCO_3$) mixed with calcite. Yet another source of calcite is carbonatite of igneous or meta-igneous origin.

Most of the industry needs of high-grade carbonate raw materials in India are fulfilled by importing from foreign countries. However India is also endowed with good quality high-grade resources of the mineral. In this paper an account of calcareous deposits of Borra area of Visakhapatnam-Vizianagaram districts of Andhra Pradesh is made to report their suitability to glass industry. No first-hand information is available on the available resources of this deposit and of late there was a concern raised by local communities against mining as it may imbalance the local ecology and environment.

Glass-grade limestone/calcite specifications

Glass Industry requires high calcium limestone (94.5% CaCO3) and 97.5% of combined $CaCO_3$ and $MgCO_3$. CaO should be 53% and CaO + MgO needs to be 54.50%. Silica (SiO2) is permissible up to 2.5%. Iron and other colouring matters are regarded as objectionable and Fe_2O_3 should be up to 0.20% (max). For colourless glass,

limestone should contain 98.5% $CaCO_3$ (min), iron content as Fe_2O_3 should not be more than 0.04%; and for bottle glass, Fe_2O_3 up to 0.05% is used [2].

LOCATION

The study refers to Borra area, where the deposit exists amidst picturesque location of *Araku Valley* of Visakhapatnam and adjoining Vizianagaram districts (Figure 1).

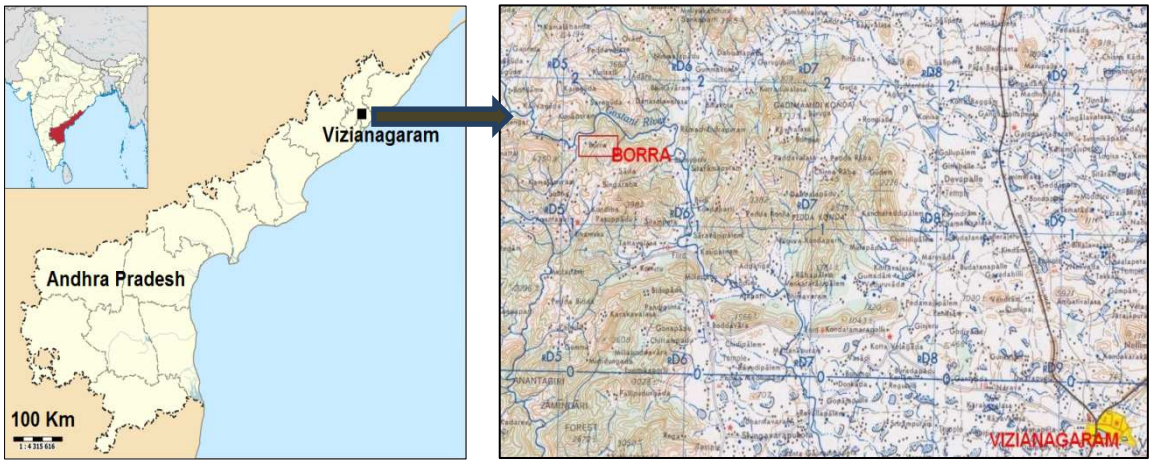

Figure. 1. Location map of Borra area, Visakhapatnam-Vizianagaram Districts
(Source: www.wikipedia.org, 1:250K Toposheet of University of Texas Library)

GEOLOGY & MINERALIZATION

The regional geology in the Eastern Ghats belt (EGB), where the calcite deposit is located, is represented by the Khondalite suite of rocks (Quartzo Felspathic Garnet Sillimanite +/- graphite gneiss) of Archaean age. The area forms a part of the middle migmatite belt of the EGB (Fig 2). The general trend these rocks is NNE-SSW with an easterly steep dip. The upper most Quaternary deposits consist of red bed sediments, laterites, pediment fans, colluvium, alluvium and coastalsands. The calcite deposit occurs in the reserved forest area consisting of 14 villages inhabited by tribal communities.

The archaeo-geological monument, Borra caves is at a distance of 3km from the mine site, basically hosts a variety of speleothems of different sizes and shapes known as stalactites and stalagmites. The calcite deposit is an extension of the same and is located towards North of Borra caves. The geological action of Gosthani River, originating from the Borra caves, flowing through the Karstic carbonate formation, is the cause for the development of the odd shapes of spelean structures. The marbles, pyroxenites and calcite-apatite rock of the Borra complex variously interpreted as of igneous or sedimentary origin has many similarities to the pyroxenite-carbonatite-magnetite deposit of Samchampi of Assam [4]. The calcite deposits of Borra are referred to as crystalline carbonatites. The pyroxenite outcrops are dark and massive and include discontinuous calc-silicate bands, some of brown mica and others with calcite. The calcite occurs in the form of bands and veins with typical rhombohedral cleavage, coarsely crystalline and in different colors (white, pink, blue & blue-green) depending on the metal ion present as an impurity, resembling marbles.

These deformed, crystalline and banded marbles cover a triangular area of 2.1 km^2, surrounded by Diopside–scapolite–feldspar calc-granulites exhibiting ptygmatic folding (Fig.3B).

Old workings for calcite and mica exist in the area and mining activities were banned due to Tribal Act in the past two decades. Drilling was carried out by public and private organizations in the past. GSI and State Department of Mines & geology conducted exploration for limestone and carbonates in Andhra Pradesh; also Mineral Exploration Corporation Ltd (MECL) is engaged in exploration of limestone [5].However the limestones resources estimated in Andhra Pradesh comprise 20% of total limestone resources in the country. In India, grade wise, cement grade has leading share of about 69% followed by SMS & BF grades (12%) and chemical grade (3%). Remaining 16% are miscellaneous, not-known and unclassified grades[5]. Information of evaluated resources of specifically high-grade limestone/calcite resources is not available in the literature.

About 46.61 Hectares, of mining leases of APMDC at Nimmalapadu village and 21.75 Hectares of mining leases granted to private parties exist at Jeerigedda, Konapuram, Thuburthi of Anantagiri sector, Vizianagaram district [1], which remain inoperative.

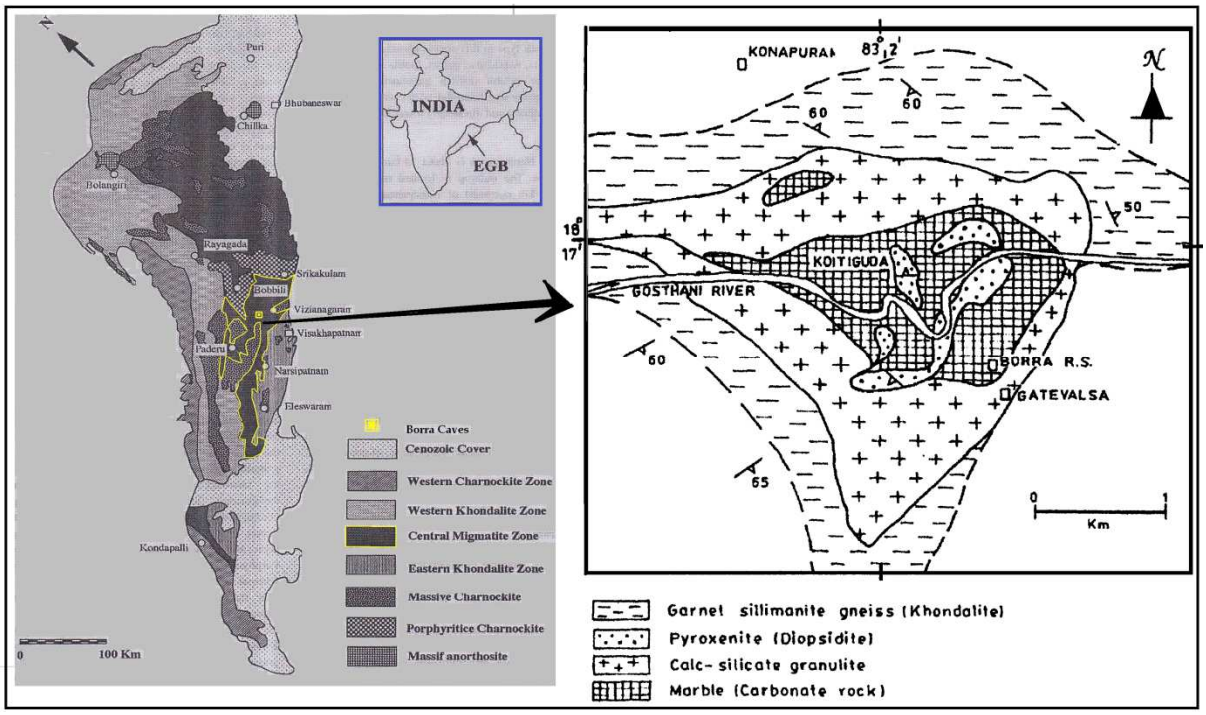

Figure 2. Regional geology of Eastern GhatMobole Belt and Borra Caves area[(3), (8) (9) and (13)]
Blank space represents quartzo- feldspathic gneisses. R.S.: Railway Station)

MATERIALS AND METHODS

About 10 samples were collected from fresh in-situ exposures of carbonate and crystalline calcitized bands. The samples were analysed using XRF, to determine chemical components. Analysis was limited to calcite/crystalline carbonate samples only.

RESULTS AND DISCUSSION

Field Relationship

The field relationships of the Borra complex show that these rocks are either a sequence of strongly metamorphosed and folded carbonate and silicate sediments or an intrusion of pyroxenite and carbonatite that has been strongly metamorphosed, folded and recrystallized. Hence they are not strictly calcite deposits. Field relationships at Borra were given by Ramam and Viswanatham [9] and by Rao [10]. The former considered the rocks to be carbonatitic and the latter contradicted this based on mineral assemblages and opined a sedimentary origin. Ratnakar and Leelanandam [11] considered the carbonate rock at Borra to be a carbonatite and one of several in a belt along the east coast of India. Field photographs display the disposition of Borra carbonate rocks (Figure A-D).

Quality & Quantity

The geochemical analysis of the samples revealed that the Borra carbonate rocks are of high quality due to enrichment in calcite with respet to industrial usage (Table 1 and Figure 4).

Table 1. Chemical analysis of crystalline carbonatite of Borra area

Sample No.	CaO	P_2O_5	Fe_2O_3	FeO	Al_2O_3	SiO_2	Na_2O	SrO	MgO	SO_3	F	Cl
BC1	54.34	40.62	0.054	0.05	0.065	0.13	0.02	0.03	1.532	0.007	2.39	1.29
BC2	54.86	41.87	0.098	0.09	0.059	0.07	0.03	0.07	1.223	0.098	2.41	1.21
BC3	53.602	40.35	0.065	0.06	0.066	0.998	0.02	0.04	1.518	0.008	2.33	1.19
BC4	53.492	40.58	0.051	0.05	0.058	1.817	0.02	0.03	1.186	0.054	2.56	1.22
BC5	51.57	41.98	0.087	0.08	0.101	1.273	0.02	0.05	3.078	0.033	2.44	1.23
BC6	50.317	41.33	0.097	0.09	0.082	1.328	0.03	0.03	4.051	0.127	2.22	1.21
BC7	54.282	40.66	0.112	0.10	0.084	1.12	0.03	0.03	0.805	0.03	2.67	1.28
BC8	54.708	41	0.076	0.07	0.099	1.034	0.03	0.04	0.471	0.061	2.87	1.32
BC9	53.24	40.32	0.132	0.12	0.088	1.13	0.03	0.07	0.512	0.05	2.66	1.34
BC10	54.45	41.78	0.098	0.09	0.088	1.15	0.02	0.08	0.489	0.133	2.78	1.2

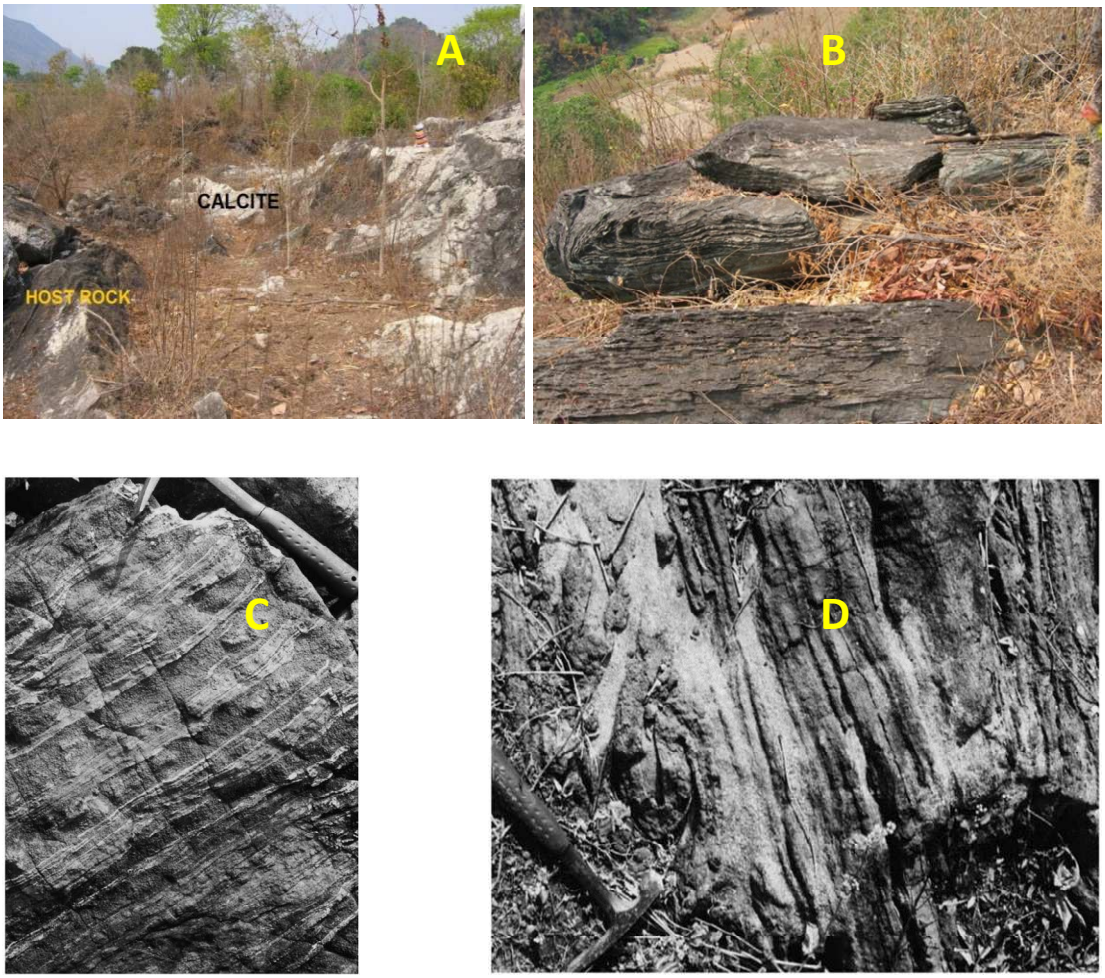

Figure 3. A. Contact between migmatitic host rock and crystalline carbonate (calcite) B. Ptygmatic folding in migmatitic host rock C.*Drawn out bands of dark diopside- rich pyroxenite interbanded with pale anorthite-scapolite-Al diopside D. Pyroxenite interbanded and folded with white scapolite-bearing marble [7]*

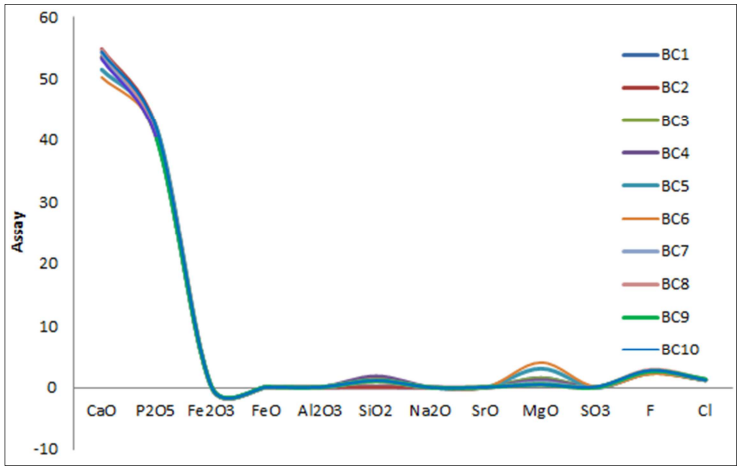

Figure 4. Trends of major oxides in samples

Technical information on reserve estimation is available with public organizations and results of investigations conducted by the private organizations are undisclosed or unavailable due to local community issues. However, approximately80-90 Tons of boulder dumps are available for crushing and industrial use. A systematic investigation may give rise to a clear understanding about the ore reserves present in this area.

Petrogenesis

There is a controversy regarding origin of calcareous carbonate rocks of Borra. Limestones commonly have >0.5% [12]but it rises to 10% or even more in the vicinity of sedimentary phosphate deposits [6]. However marbles occasionally contain prismatic crystals of fluorapatite at Borra, which would not have been original detrital apatite but more likely would have been formed from phorsphorous bearing organic matter originally preserved as the mineral dahllite. At Borra, the association of marble with pyroxenite in metamorphic terranes is no indication of the presence of metacarbonatite. Marble of sedimentary origin can be mineralogically identical to carbonatite, the assemblage phlogopite-magnetite-apatite-calcite being common to both and pyroxenites can be of either origin. The presence of anorthite, scapolite or spinel is generally a clear indicator of a limestone origin. As per the investigations made by Le Bas et al., calcareous rocks were termed as marbles and are evidently metasedimentary. Low Sr and REE contents and the presence of europium anomaly and aluminous minerals indicate a source rock with high Al, which is rare with carbonatites but common in argillaceous limestones indicating that Borra rocks are evidently metasedimentary[7].

CONCLUSION

By virtue of its high-quality (average 53% CaO), the Borra calc-carbonate deposit is very much useful to use as a raw material in the glass making industry. A systematic environmental friendly mining methodology is unavoidable, if these deposits are revamped to mining eitherto public or private sector agencies. The increased usage of glass in green buildings and constructions, demands increased production of clear glass, which demands enhanced supply of glass-grade natural raw materials out of which high-grade limestone/calcite is one among them. Hence deposits like Borra, need to be thoroughly evaluated for mining feasibility in an eco-friendly manner which will also generate employment to the local communities.

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