Geochemistry and Economic Aspect of Bhander Limestone occurring around Gudha, Pagra Villages , Tahsil Simariya, District Panna, Madhya Pradesh

[1]Amit Dwivedi, [2]Dr. D.P. Dubey, [3]Dr. Sanjay Tignath, [4]Dr. D.K.Deolia

[1]Research Scholar, Government Model Science College, Jabalpur, M.P.
[2]Retired Professor from Government Model Science College, Rewa, M.P.
[3,4]Professors, Department of Geology, Government Model Science College, Jabalpur, M.P.

Abstract*: This research paper basically focuses on a new unexplored Limestone deposits, located in Gudha, Pagra villages in Simariya Tahsil District Panna, Madhya Pradesh. The area falls in forest land and revenue land admeasuring about 2980.56 hectares. The Geochemistry and economic aspect of this Limestone for cement and other manufacturing industries are discussed in this paper. The rocks in the area belong to Bhander Limestone deposit of Bhander group of Upper Vindhayan Super group. The study area shows excellent exposures of Limestone of variable thickness of about 10 to 20 meters, covering approximately 760.830 hect. This Limestone is Stromatolitic, Pink, light to dark grey, coarse to fine grained, compact, bedded and is massive. During the field study a total 19 nos. of random samples were drawn across the strike of limestone deposit. These samples were analysed to decode the major oxide contents such as CaO, MgO, Al_2O_3, Fe_2O_3, SiO_2, LOI from Advance Research Laboratory, Government Science College, Jabalpur. Percentage of CaO varies from 23.89% to 52.24%, MgO from 0.71% to 17.37% and SiO_2 from 2.84% to 33.61%. Based on chemical analysis and physical appearance the Limestone of the area is classified as Dolomitic Limestone, Cherty / siliceous Limestone, Low grade shaley Limestone and Light grey to Drak grey High grade Limestone. The tentative estimated reserves in the area is 285.311 million tonnes. Broadly Limestone deposit of this area appears to be suitable for cement industries for making cement or may be used as fluxing agent in steel industry.

1. **Introduction:** Vindhyan Super group is the thickest Pre-cambrian sedimentary succession of India and the duration of its deposition is one of the longest in geological history. It is composed mostly of shallow marine deposits. It is believed to have recorded a substantial portion of Proterozoic time and therefore, likely to contain valuable information on the evolution of atmosphere, climate and life on the planet. It also contains some of the most disputed fossils of earliest animal life. This supergroup finds excellent development of arenaceous, argillaceous and calcareous facies. Bhander group is the youngest group of the Vindhayn super group. It is sub-divided into five formations in the ascending order, the Ganurgarh shale, Bhander Limestone, Lower Bhander Sandstone, Sirbu shale and upper Bhander sandstone. The Bhander Limestone shows excellent exposures with variable thickness of about 10 to 20 meters in the area around Gudha and Pagra village, tehsil Simariya District Panna M.P. and is bounded by latitude 2687400 to 2692200 and longitude 383200 to 389600 (UTM values). The area falls in Survey of India Toposheet no. 54P/15. Limestone of the area may be broadly classified into two categories on the basis of their petrological and Geochemical characters. One is well bedded light grey, intraspaite, oosparite, micritic, non-stromatolitic while the other is massive, dark grey, purple or pinkish, fine to medium grained stromatolitic. Sedimentological aspects of Bhander Limestones of Rewa and Satna have been carried out by various workers (Auden;1933, Sarkar;1974, Kumar;1976, Bhattacharya;1996, Tiwari and Dubey;2004). The economic aspects of the Limestone have been carried out by Devi and Duaraha;2015, and Shekhawat;2010. Several leading cement companies in India have shown their interest in Limestone belt in Panna district of Madhya Pradesh state.

Fig.1. Rounded oolite in Limestone. Oo-pelsparite Ooids with layers and nucleus. The matrix is sparitic. Peloids are less than ooids. (PPL)

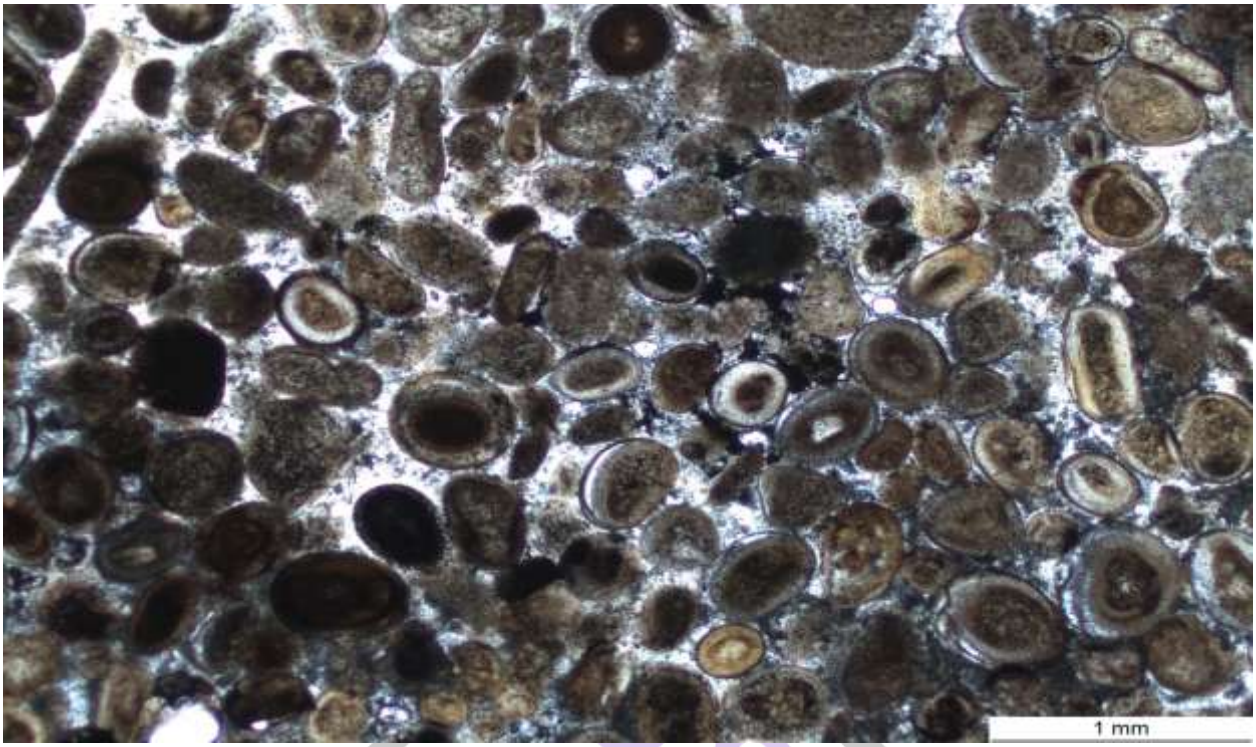


Fig.2. General view of various types of pellets in Limestone. Peloids micritic as well as neomorphosed. (PPL)

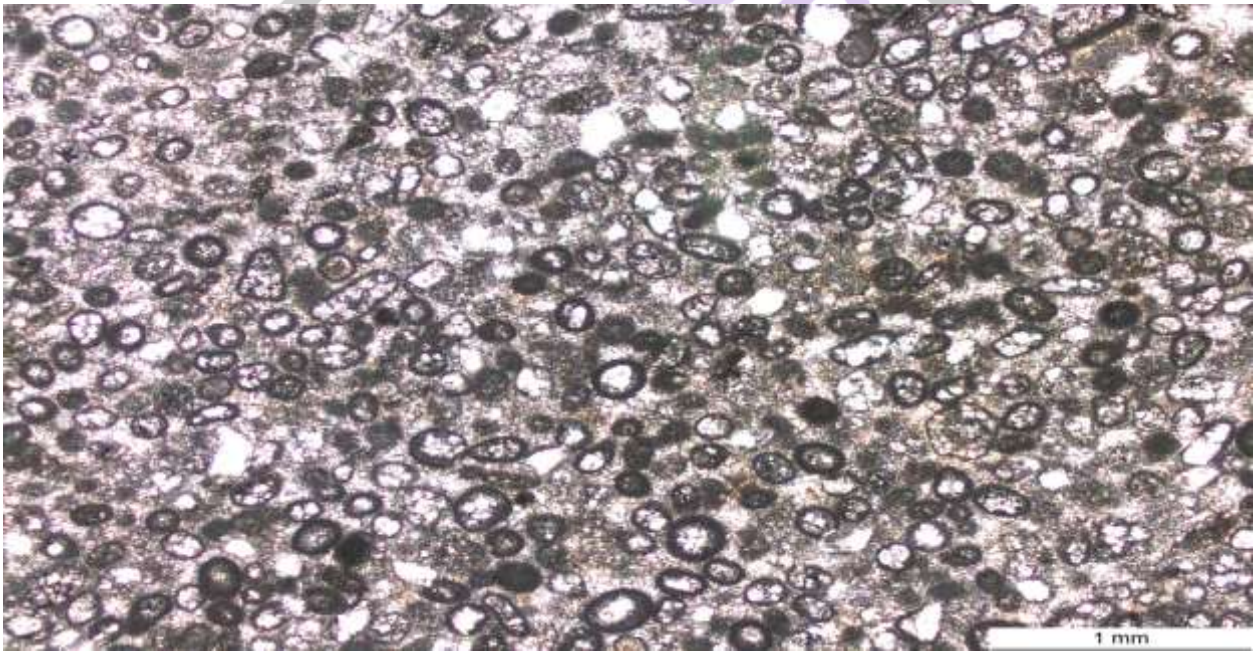
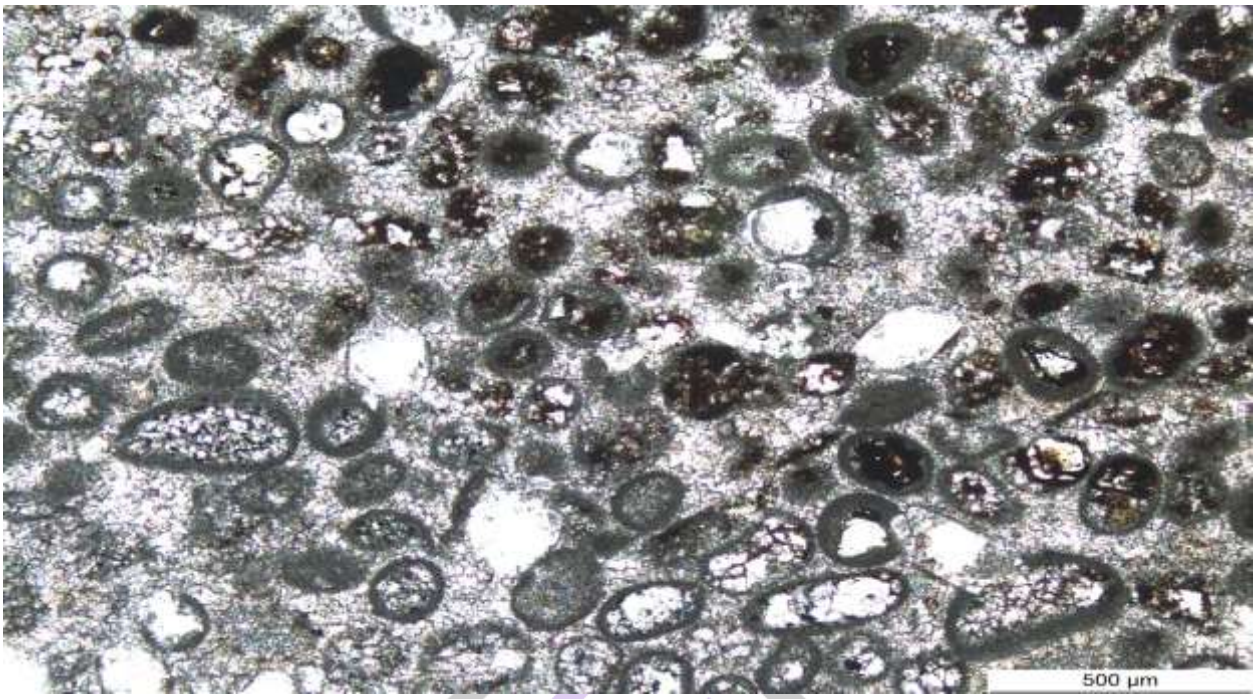


Fig.3. Rounded pellets encircled by tiny calcitic material in Limestone. Peloids micritic as well as neomorphosed. (PPL)



1.1 Location of study area: Limestone deposit in the area falling in the forest and revenue land in Gudha and Pagra villages, together with many others in Simariya Tehsil. It is geographically bounded by latitude 2687400 - 2692200 and Longitude 383200 – 389600. The area selected for present study falls in parts of Survey of India Toposheet no. 54P/15. It is located about 75 Kms. N-W of Panna , the district headquarters. Nearest state highway is SH 49 from Panna - Amanganj to Damoh passes through Simariya, the tahsil headquarters adjoining the study area. Nearest railway station is Damoh of West Central railway and is about 70 Km whereas the nearest airport is Khajuraho, the historical place and is located at a distance of about 115 Km from the study area. The location and approach to the study area are shown in Fig.4.

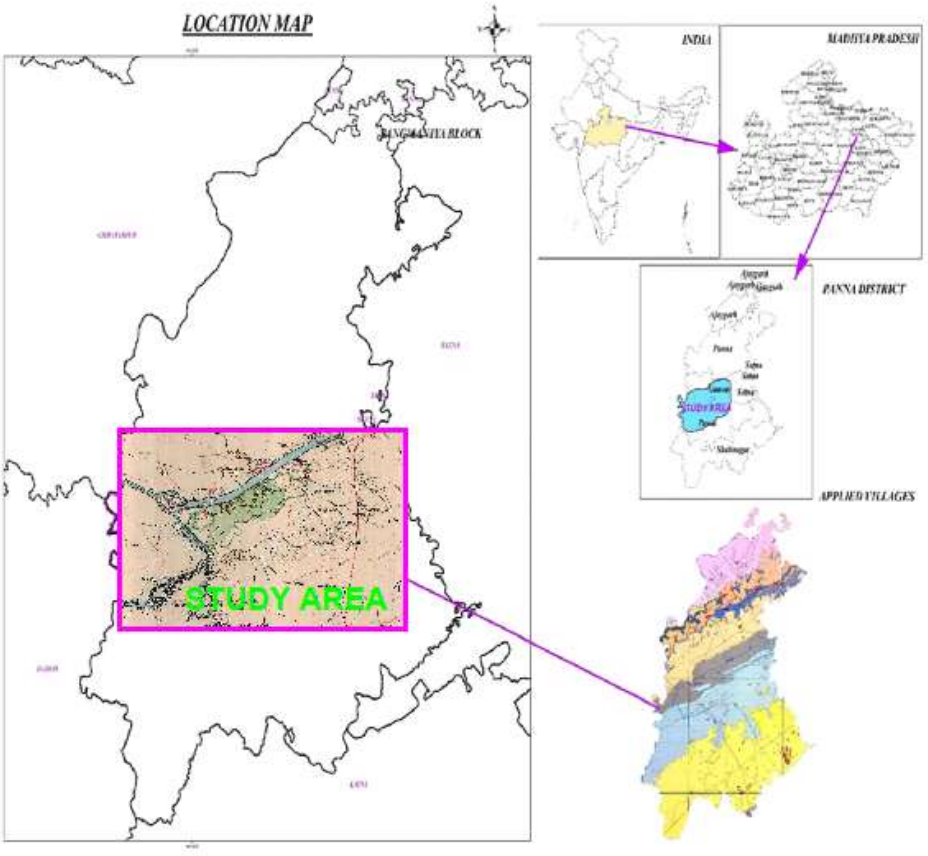


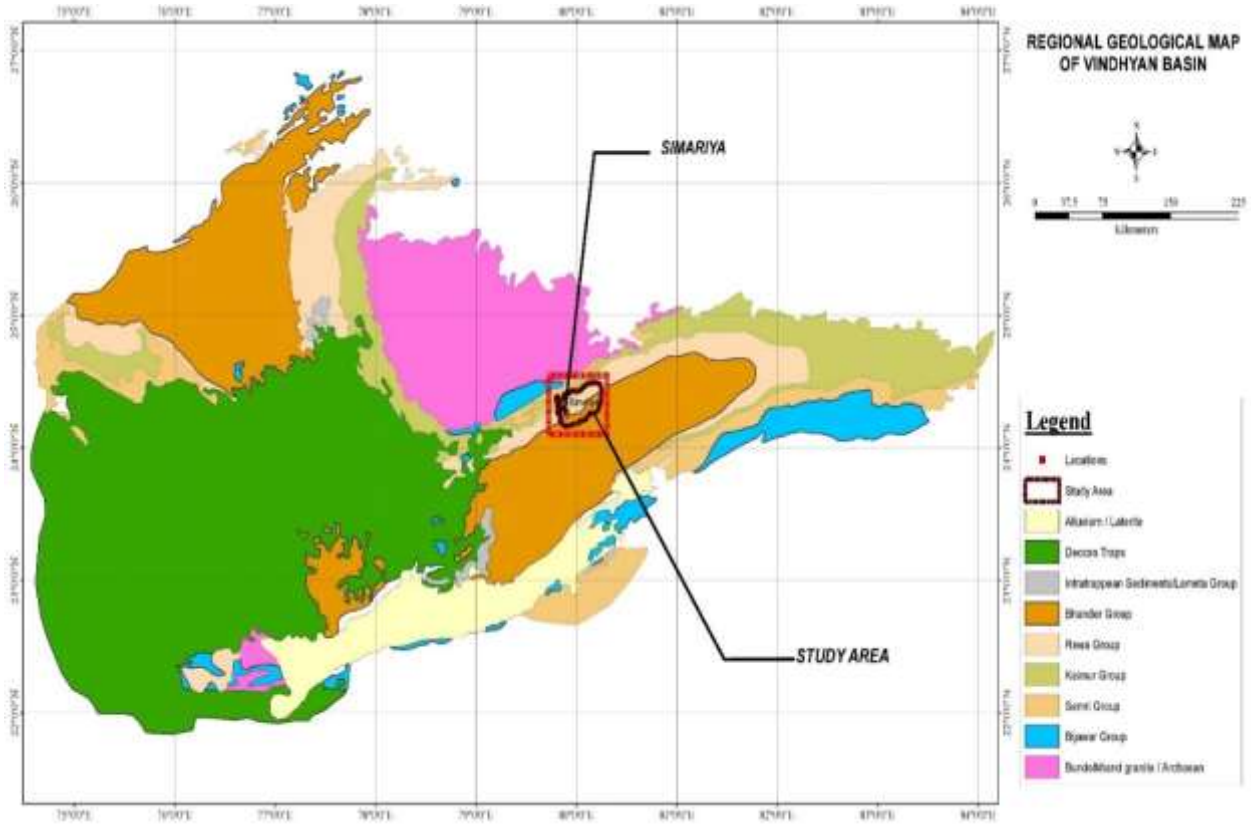
Fig. 4 – Location and approach of the study area

2. GEOLOGICAL SETTING OF THE AREA

The area under study is almost flat with gentle undulations. The area signifies general slope from South east to North West. The reduced level in the area ranges from about 300 meters to a maximum of 326meters. The maximum elevation is observed in the southern part of area whereas minimum elevation is in the northern part, towards the rivers.

The main drainage feature in the area is River Sonar and Bearma. Sonar River flows from west to North- East direction and crosses the area on the west-north margin. Rivers Sonar and Bearma join the main drainage feature. The drainage pattern is dendritic. Geologically the area forms part of the Bhander Group of the Upper Vindhyan Super Group. (Fig.4 showing the regional geological map of the Vindhyan Basin).

Fig.4. Regional Geological map of the Vindhyan Basin



The Vindhyan formations are broadly classified into lower calcareous and upper arenaceous facies. The upper arenaceous rocks, however, have a calcareous unit, the Bhander Limestone varying in thickness from about 2 mtrs to 20 mtrs.

The limestone deposit of the study area is classified as the Bhander Group. The general trend of the Bhander limestone in the area is ENE – WSW. The rocks are characterized by low dip of about 3^0 to 5^0 due south. The major part of the area on the surface is covered by the soil. Several limestone out crops were marked during mapping in the field and data like amount and direction of dip, strike direction and several minor and major structures were recorded and marked on the Geological map.

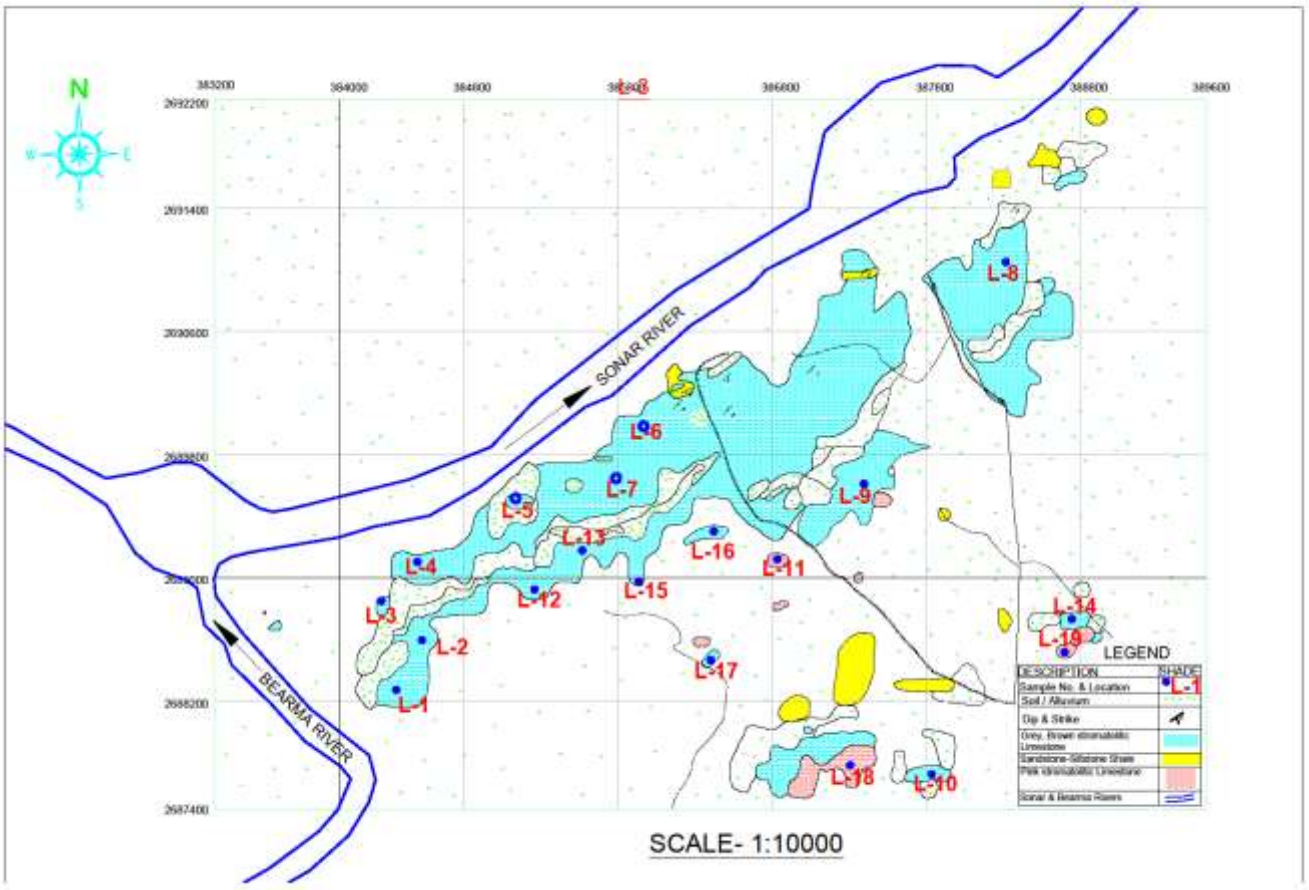


Fig.-5. Geological map of the Gudha – Pagra area in Simariya Tehsil, District Panna, Madhya Pradesh

Based on the detailed mapping in a part of the area, the prevalent sequence of rock types observed in the area is as follows -.

Bhander Group - Sirbu Shale
Lower Bhander Sandstone
Bhander Limestone
Ganurgarh Shale

On the basis of detailed mapping it is inferred that the two sets of Limestone horizons occur in the study area named as Lower Limestone and upper limestone belonging to Bhander group of Limestone. These two Limestone bands are distinctly separated by a shale silt stone band of substantial thickness. The lower Limestone band at places is exposed on the present surface, jutted out due to the dip. The same horizon, when traced towards the dip direction it traverses down and is overlain by upper Limestone and the shale silt stone bands. It may be debated as a sort of peneplanation. Where the lower Limestone is exposed on the surface and the weathered and eroded surface has reached the deeper horizons, thus exposing the lower Limestone band, partly reducing its original thickness and also taking the toll as complete elimination of the upper Limestone band as well as the underlying shale siltstone band. At places where the mantle of waste has not reached to that depth, only the upper limestone band is eroded exposing the shale – siltstone band as outcrop.

Limestone of the study area is mostly fine to coarse grained, grey to dark grey and purple / pinkish in colour, stromatolitic, micritic, sandy and shally in nature. It is generally intercalated with thin shale bands. Depending on CaO content and physical appearance Limestone has been classified into four types, namely Grey to Dark grey high grade limestone, Dolomitic Limestone, Cherty/Siliceous Limestone and Shelly Limestone, later three categories are characterized by low CaO%).

3.0 GEOCHEMICAL STUDY : Total 19 nos. of samples were analysed during study of the entire area for detailed research work. Major oxides of Limestone (6 radicals) were analysed to examine their applicability for various purposes depending on their chemical variability. Table no. 1 showing the result of chemical analysis of Limestone samples.

Table no. 1 showing the Chemical Analysis Report of the Limestone samples for Six Radicals

Sample No.	CaO%	MgO%	SiO_2 %	Al_2O_3 %	Fe_2O_3 %	LOI	Lithology
L-1	49.56	0.94	6.03	1.33	0.64	40.59	Light to dark grey Limestone
L-2	52.24	0.80	2.84	0.57	0.26	42.70	Light to dark grey Limestone
L-3	51.93	0.92	3.06	1.19	0.44	41.99	Light to dark grey Limestone
L-4	49.41	0.86	6.18	0.79	0.30	40.45	Light to dark grey Limestone
L-5	51.60	0.98	3.56	0.92	0.41	42.29	Light to dark grey Limestone
L-6	52.00	0.80	3.15	0.70	0.40	41.91	Light to dark grey Limestone
L-7	50.51	0.71	5.73	0.70	0.75	40.60	Light to dark grey Limestone
L-8	49.46	1.38	5.50	0.64	1.12	41.09	Light to dark grey Limestone
L-9	48.74	0.84	7.73	1.37	0.73	39.39	Light to dark grey Limestone
L-10	30.03	1.34	32.08	5.67	3.63	25.45	Cherty / Siliceous Limestone
L-11	44.40	1.79	11.70	2.14	1.30	37.49	Light to dark grey Limestone
L-12	47.70	1.50	7.93	1.43	0.79	39.79	Light to dark grey Limestone
L-13	49.83	1.58	5.03	1.15	0.54	41.60	Light to dark grey Limestone
L-14	23.89	2.54	33.61	8.85	6.66	21.53	Low grade Shally Limestone
L-15	48.26	1.27	6.82	1.67	1.05	39.98	Light to dark grey Limestone
L-16	47.54	1.25	7.62	1.77	1.09	39.38	Light to dark grey Limestone
L-17	46.24	1.47	9.00	1.64	0.99	39.42	Light to dark grey Limestone
L-18	30.23	17.37	25.29	1.74	1.41	38.89	Dolomitic Limestone
L-19	37.54	15.92	2.00	1.10	1.07	42.00	Dolomitic Limestone

The broad specification of cement grade ROM limestone is given in the following Table-2 along with the limiting values which may need beneficiation, blending etc.
As per NCCBM, Table-4, p.25, 2003 (National council for Cement and Building Material).

Table no. 2- BROAD SPECIFICATIONS FOR CEMENT GRADE ROM LIMESTONE

Oxide components (%)	**Acceptable range for manufacture of Ordinary Portland Cement (33, 43 & 53 grades) (percent)**	**Limiting values, taking into consideration other types of cement, scope of beneficiation and blending (percent)**
CaO	**44-52**	**Minimum - 40**
MgO	**Maximum 3.5**	**Maximum- 5.0**
SiO2	**To satisfy the LSF, Silica Modulus and Alumina Modulus**	
Al2O3		
Fe2O3		

The Indian Bureau of Mines (IBM) in a Circular bearing No.T45031/CGBM/2007(PF) (IBM, 2007) have made it imperative to include limestone occurring in Madhya Pradesh having up to 34 percent CaO (Min) and MgO up to 4 percent (Max) as the "Threshold Value" for use in manufacture of cement.

3. DETERMINATION OF CALCIUM CARBONATE, MANGANESIUM AND SILICA CONTENT IN THE LIMESTONE OF THE STUDY AREA

In terms of percentage, in study area Cao ranges from 23.89 to 52.24%, MgO from 0.71 to 17.37%, SiO_2 from 2.84 to 33.61%, Al_2O_3% from 0.57 to 8.85 %, Fe_2O_3 from 0.26 to 6.66% and LOI 21.53% to 42.70%. On the basis of analytical result most of the samples collected from the study area show suitable quality and qualify as cement grade. The low grade material will also be consumed in cement manufacturing unit after blending it with the high grade material. The material which cannot be consumed due to its inappropriate chemical composition for cement making, it will be used for construction purposes.
Although the number of samples drawn from the area of study do not suffice to arrive at a conclusive interpretation of the overall grade of Limestone in the area, yet they provide an excellent basis of understanding the Bhander Limestone in the area. Results of these studies have been used to delineate different microfacies of Limestone exposed in the study area. On the basis of chemical study and physical appearance, the following types of Limestones are identified in the study area –

i) High magnesia Dolomitic Limestone
ii) Cherty / siliceous Limestone
iii) Low grade shaly Limestone
iv) Light to Dark grey high grade Limestone

High Magnesia Dolomitic Limestone:
Light and Dark grey alternate bands are found with high Magnesium content. Thickness of this limestone varies from 0.5mtr. to 5 mtrs. Normally in the field it is showing fine grained and slightly fractured bands of thickness varying from less than half a centimeter to about 1 centimeter.

Cherty / Siliceous limestone:
It is argillaceous bedded units of varying thickness found mainly near Kuluwa village. Its upper part is laminated with silica / chert bands and the thickness of these laminae varies from 0.15 mm to about 60 cm. It is often associated with mud cracks, burrow structures, flat pebble conglomerate, chert nodules and chert bands.

Low grade shaley Limestone:
The shale gradually losses its arenaceous nature and passes into thin calcareous shale. This shale is of various colours, the predominant being pinkish/ purple colour, greenish and yellowish. It is fine grained with low lime and high silica content.

Light to dark Grey high grade Limestone:
It is an important and economically potential litho unit in the study area. This Limestone is generally fine to coarse grained, flaggy to massive, thinly laminated to thickly bedded and sometimes showing high irregular lenticular bedding. Considerable part of the Limestone is micrite, composed of calcareous particles of varying diameter and is formed by recrystallization of lime mud. This lithounit has a gradational contact with shale and shaly limestone. Thickness of this unit varies from about 5 Meters to 20 Meters.

4. TENTATIVE RESERVES IN THE AREA –

Limestone deposit in the Gudha – Pagra area are bedded, horizontal to sub-horizontal undisturbed and more or less uniform in quality. Thickness of Limestone deposit in the area was determined by the measuring of thickness in river cuttings, dug wells and nalla sections. Reserves of Limestone assessed on the basis of area of influence of Limestone outcrops occurring in the deciphered area by using Autocad. Total area of Limestone outcrop occurring in the area is 760.830 hect. Since the measurement was done in the hect. hence it is converted into meter by multiplying the hectare values by 10000 meters. Thickness of the limestone is considered as 15m. For calculation of Reserves following formula was adopted –

Reserves = Area of Limestone outcrop in meters x Thickness of Limestone x Specific Gravity

Reserves = 760.83hect. x 10000m = 7608300meter x 15m x 2.5 = 285311250 tonnes or 285.311 Million tonnes.

5. CONCLUSION:

Limestone of the study area is composed of allochemical constituents mainly intraclasts, oolites, pseudo oolites, peloids along with probably some fossiliferous material also. (Fig. No.1). Neomorphism is clearly seen in oolites. The original micrite material is changing into microspars, and sparitic calcite. Dolomitisation is also seen in the upper part of Limestone. Pellets, composed of Micrite, have also been affected by neomorphism (Fig. 2). The micrite peloids are surrounded by a sparry calcite, often called as calcsparite or Sparite also, the course grained crystalline calcite, radiating fringe or dogtooth fringe (Fig.3). Chert nodules are also common in the Limestone of Study area. Most of the chert is of replacement origin.
Nineteen samples were analysed and six major oxide were determined to examine their suitability for making of cement in Cement industries. The CaO ranges 23.89 to 52.24%, MgO ranges from 0.71 to 17.37%, Al2O3 from 0.57 to 8.85% and Fe2O3 from 0.26 to 6.66%. The light grey to dark grey limestone of the area is economically useful for cement making. The estimated reserves is calculated conservatively and is about 285.311 Million Tonnes
The techno economic study in the area forming an independent arena of detailed study is strongly recommended.

REFERENCES:
[1] Akhtar, K., 1976. Facies analysis and depositional environments of the Bhander Limestone (Precambrian), Southeastern Rajasthan and adjoining Madhya Pradesh, India. Sediment. Geology, 16: 299-318.

[2] Auden, J.B., 1933. Vindhyan sedimentation in the Son Valley. Mirzapur district. Mem. Geol. Surv. India, 62(2): 141-250.

[3] Bhardwaj, B.D., 1977. Stratigraphy and depositional environments of the Rewa group (Upper Vindhyan) around Bhainsrorgarh, Rajasthan, Jour. Ind. Assoc. Sedimentologists, 1: 52-61.

[4] Bhattacharyya, A. (1996). Recent advances in Vindhyan Geology;Geol. Soc. India Memoir 36, 331p.

[5] Chakraborty, C and Bhattacharya, A., 1996. The Vindhyan Basin: an overview in the light of current perspectives. Mem. Geol. Soc. India, 36: 301-312.

[6] Folk, R. L., 1966. A review of grain size parameters, Sedimentology, 60:73-93.

[7] Ghosh, D.B., 1981, The Vindhyan basin in Bundelkhand. Son Valley region, Misc. Pub. Geol. Surv. India, 50: 75-88.

[8] Jafar, S.A., Akhtar, K and Srivastava, V.K., 1966. Vindhyan Paleocurrent and their bearing on the northern limit of the Vindhyan sedimentation. Bull. Geol. Soc. India, 3:82-84.

[9] Krishnan, M.S., 1968. Geology of the India and Burma. Higginbothams Ltd. Madras, 5"" Edition; 1-536.

[10] Krumbein, W.C and Pettijohn, F.J., 1938. Manual of Sedimentary Petrography. Appleton Century, Inc. New York, 549p.

[11] Prasad, B., 1984. Geology, sedimentation and paleogeography of the Vindhyan Supergroup, southeastern Rajasthan, Memo. Geol. Surv. Ind. Misc. Publication, 50: 31-40.

[12] Singh Y. and Dubey D.P. (1990) The stratigraphy and depositional environment of the Vindhyan sediments in Rewa area, Madhya Pradesh. Geol. Surv. India, Spl. Publ. vol. 28,pp.354-368

[13] Tiwari R.N. and Dubey D.P. (2004) Ooids and coated grains in Bhander Limestone (Vindhyan Super group) of Rewa area, Madhya Pradesh. Gond. Geol. Magz., vol 19(1),pp.31-36.