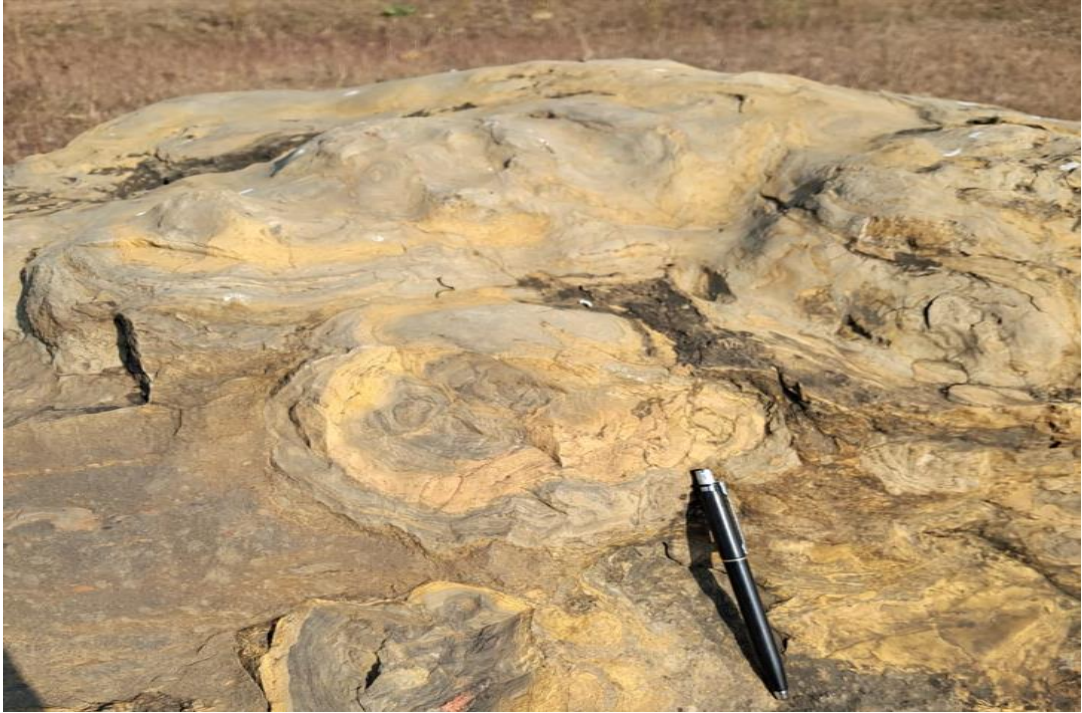


**REPORT ON
RECONNAISSANCE SURVEY (G4-STAGE) FOR LIMESTONE
IN AND AROUND AMANGANJ GUNNOR PAWAI AREA PANNA DISTRICT,
MADHYA PRADESH
(UNDER NMEDT PROGRAMME)**

प्रतिवेदन
चूना पत्थर हेतु प्रारंभिक अन्वेषण सर्वेक्षण (जी4-स्तर)
अमानगंज –गुनौर–पवाई क्षेत्र एवं आसपास, जिला पन्ना, मध्य प्रदेश

टोपोशीट संख्या 63 डी/03 & 63 डी07 / Toposheet No. 63D/03 & 63D/07



एंजियोटेक कंसल्टेंट
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IN AND AROUND AMANGANJ - GUNNOR - PAWAI BLOCK, AREA (93.13 Sq. Km),
DISTRICT PANNA, MADHYA PRADESH

SALIENT FEATURES

1	Name of Block	Amanganj Gunnor Pawai Limestone Block, District Panna, Madhya Pradesh		
2	Mineral	Limestone		
3	Total Area	93.13 Sq. Km.		
4	Area covered under the present scheme	93.13 Sq. Km.		
5	Period of Exploration	01-07-2025 to 30-06-2026		
6	Meterage drilled	100m		
7	No. of Boreholes drilled	2 Nos		
8	Thickness of Different Grades of Limestone	Not Encountered		
9	Cut-off grade	As per the end-use grade classification recommended by the Indian Bureau of Mines (IBM).		
		Grade	CaO (min)	MgO (Max)
		Cement	>44	3.5
		Blendable	38-34	5
		Blendable / Benificiable	>34	6
10	Resources	No limestone resources were encountered in the present Investigation		
11	Grade	Limestone of any grade was not classified		
12	UNFC Category	Reconnaissance (334)		
13	Report Submission	30-06-2026		

चूना पत्थर हेतु प्रारंभिक अन्वेषण सर्वेक्षण (जी4-स्तर) अमानगंज –गुनौर–पवई क्षेत्र एवं आसपास, जिला पन्ना, मध्य प्रदेश

कार्यकारी सारांश

अध्याय-1

1.1.0 (Executive Summary)

वर्तमान प्रतिवेदन में मध्य प्रदेश के पन्ना जिले के अमानगंज–गुनौर–पवई ब्लॉक में चूना पत्थर (Limestone) के लिए किए गए प्रारंभिक अन्वेषण सर्वेक्षण (G4 चरण) के परिणाम प्रस्तुत किए गए हैं। अध्ययन क्षेत्र लगभग 93.13 वर्ग किमी में फैला हुआ है, जो टोपोशीट सं. 63D/3 एवं 63D/7 के अंतर्गत विंध्यन बेसिन में स्थित है। यह क्षेत्र विंध्यन सुपरग्रुप के भांडेर समूह का भाग है तथा इसका अन्वेषण चूना पत्थर खनिजीकरण की उपस्थिति, ग्रेड, मोटाई, पार्श्व निरंतरता एवं आर्थिक संभाव्यता के आकलन हेतु किया गया।

अन्वेषण कार्यक्रम के अंतर्गत 1:12500 स्केल पर विस्तृत भूवैज्ञानिक मानचित्रण, शैलविज्ञानिक संपर्कों एवं संरचनात्मक विशेषताओं का सीमांकन तथा 27 प्रतिनिधिक शैल नमूनों का भू-रासायनिक विश्लेषण हेतु संकलन किया गया। अधःसतही जांच के लिए दो बोरहोल (BH-02 एवं BH-05) द्वारा कुल 100 मीटर की कोर ड्रिलिंग की गई, जिसके पश्चात कोर का विस्तृत लॉगिंग कार्य किया गया, जिसमें शैलविज्ञानिक, संरचनात्मक एवं भू-तकनीकी मानकों का अध्ययन शामिल है। प्रयोगशाला विश्लेषण EDXRF तकनीक द्वारा प्रमुख एवं गौण ऑक्साइड तथा दहन पर हानि (LOI) के निर्धारण हेतु किया गया, साथ ही चयनित नमूनों की पतली स्लाइडों पर पेट्रोग्राफी अध्ययन भी किया गया।

पेट्रोग्राफिक अध्ययन से ज्ञात होता है कि चूना पत्थर मुख्यतः कैल्साइट से निर्मित है, जिसमें माइक्रिटिक से स्पैरिटिक बनावट, स्थानीय पुनःस्फटीकरण, स्टाइलोलाइटिक संरचनाएँ एवं सूक्ष्म दरारें विकसित हैं। गौण अवयवों में कार्बज, मृत्तिका खनिज एवं लौह युक्त अशुद्धियाँ सम्मिलित हैं, जो आर्जिलेशियस एवं सिलिशियस अशुद्धियों की उपस्थिति को दर्शाती हैं। ये विशेषताएँ निम्न-ऊर्जा वाले उथले समुद्री पर्यावरण में निक्षेपण तथा पश्चात् डायजेनेटिक परिवर्तन को इंगित करती हैं, जिससे संरचना एवं संघटन में विषमता उत्पन्न हुई है।

शैल अनुक्रम में चूना पत्थर, शेल एवं शेली सैंडस्टोन के छोटे-छोटे पैच पाए गए हैं, जिनमें चूना पत्थर स्तरों का आंशिक सहसंबंध विंध्यन सुपरग्रुप की सिरबू शेल संरचना से किया जा सकता है। तथापि,

क्षेत्रीय अवलोकन, ड्रिलिंग डेटा एवं पेट्रोग्राफिक साक्ष्य दर्शाते हैं कि चूना पत्थर की परतें पतली, लेंसाकार एवं पार्श्व रूप से असतत हैं तथा शेल की अंतर्वर्तित परतों के साथ उपस्थित हैं, जिससे इनकी निरंतरता एवं आर्थिक महत्त्व सीमित हो जाता है।

कोर रिकवरी औसत 82% पाई गई, जो संभवतः भंगुर एवं अपक्षयित शैलों के कारण कम है।

अन्वेषण के परिणामों से यह स्पष्ट होता है कि बोरहोल BH-02 एवं BH-05 में कोई महत्वपूर्ण या सतत चूना पत्थर खनिजीकरण नहीं मिला। भूवैज्ञानिक, भू-रासायनिक एवं पेट्रोग्राफिक आंकड़ों के समेकित विश्लेषण से ज्ञात होता है कि कार्बोनेट की मात्रा असंगत है तथा इसकी मोटाई एवं गुणवत्ता आर्थिक दृष्टि से उपयुक्त नहीं है। अतः खनिज संसाधन का आकलन संभव नहीं है।

इस प्रकार, उक्त ब्लॉक को UNFC के G-4 चरण (प्रारंभिक अन्वेषण सर्वेक्षण) के अंतर्गत वर्गीकृत किया गया है। यद्यपि विंध्यन बेसिन का क्षेत्रीय भूवैज्ञानिक परिवेश चूना पत्थर के निक्षेपण के लिए अनुकूल है, तथापि अध्ययन क्षेत्र में आर्थिक रूप से व्यवहार्य चूना पत्थर खनिजीकरण की संभावनाएँ नहीं पाई गईं।

1.1.1 अंततः, वर्तमान अध्ययन यह निष्कर्ष देता है कि अन्वेषित क्षेत्र में कोई भी आर्थिक रूप से व्यवहार्य चूना पत्थर भंडार उपलब्ध नहीं है, जिसका मुख्य कारण अपर्याप्त मोटाई, कमजोर पार्श्व निरंतरता तथा संरचना एवं ग्रेड में उच्च स्तर की विषमता है।

**REPORT ON RECONNAISSANCE SURVEY (G4-STAGE) FOR LIMESTONE
IN AND AROUND AMANGANJ – GUNNOR - PAWAI BLOCK, AREA (93.13 Sq. Km),
PANNA DISTRICT, MADHYA PRADESH**

CHAPTER- I

1.1.0 EXECUTIVE SUMMARY

The present report outlines the results of a reconnaissance survey (G4 Stage) for limestone carried out in the Amanganj-Gunnor-Pawai Block, District Panna, Madhya Pradesh, covering an area of approximately 93.13 sq.km. in parts of Toposheet No. 63D/3 and 63D/7 within the Vindhyan Basin. The study area forms part of the Bhandar Group of the Vindhyan Supergroup and was investigated to assess the occurrence, grade, thickness, lateral continuity, and economic potential of Limestone Mineralization.

The exploration program comprised systematic large-scale geological mapping on a 1:12500 Scale, delineation of lithological contacts and structural features, and collection of 27 representative bedrock samples for Geochemical analysis. Subsurface investigation includes limited core drilling in two boreholes (BH-02 and BH-05) to a cumulative depth of 100 m, followed by detailed core logging of lithological, structural, and geotechnical parameters. Laboratory analysis was conducted using EDXRF techniques for major and minor oxides and loss on ignition (LOI), supplemented by Petrography studies on selected thin sections of bedrock samples.

Petrographic analysis indicates that the Limestone is predominantly composed of calcite, exhibiting micritic to sparitic textures with localized recrystallization, stylolitic features, and development of microfracture. Minor constituents include quartz, clay minerals, and ferruginous impurities, suggesting argillaceous and siliceous contamination. These characteristics indicate deposition in a low-energy shallow marine environment followed by diagenetic modification, resulting in compositional and textural heterogeneity. The lithological succession comprises minor patches of Limestone, Shale, and Shaly Sandstone with Limestone horizons tentatively co-relatable with the Sirbu Shale Formation of the Vindhyan Supergroup. However, field observations, drilling data, and petrographic evidence

reveal that Limestone bands are thin, lenticular, and laterally discontinuous with present Shale intercalations, thereby limiting persistence and economic significance.

A core recovery range of 78–86% (averaging 82%) is considered to indicate good to moderate recovery conditions primarily due to the presence of massive, competent rock with minimal natural fracturing and the use of effective drilling practices. Integrated interpretation of geological, geochemical, and petrographic data suggests that the carbonate content is inconsistent and insufficient in thickness and quality to delineate an economically viable ore zone. Consequently, mineral resource estimation is not feasible.

The block is therefore classified under UNFC G-4 Stage (Reconnaissance survey). Although the regional geological setting of the Vindhyan Basin is favourable for Limestone depositing, the investigated area does not demonstrate promising potential for economically viable Limestone mineralization.

1.1.1 The present investigation conclusively indicates the absence of any economically viable deposit within the explored block, attributable to insufficient thickness, poor lateral continuity, and pronounced heterogeneity in composition and grade.

CHAPTER – 2

2.0.0 DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

2.1.0 INVESTIGATING AGENCY

S. No	Investigating Agency	Address	Credentials	Contact Details	Project Coordinator
1	ENGEOTECH CONSULTANT	Office: 1338, Kachnar City Road, Vijay Nagar, Jabalpur- 482002 M.P.	Notified Private Exploration Agency (by Min. of Mines, Govt. of India) Accredited by NABET (A- Category Exploration Agency) ISO 9001:2015 Certified	WhatsApp: +91-9425387402, +91-8989771405 Email: engeotech@rediffmail.com	Indraneel Dawande (M.TECH. APPLIED GEOLOGY)

2.2.0 PERSONNEL INVOLVED WITH PRELIMINARY EXPLORATION (G4) FOR LIMESTONE IN AND AROUND AMANGANJ GUNNOR PAWAI AREA PANNA DISTRICT, MADHYA PRADESH

S. No	Title	Name of Person
1	Project Coordinator (Overall planning, Coordination & Supervision)	Mr. Indraneel Dawande (Geology)
2	Overall Guidance	Mr. Anil Kumar Dawande, Director GSI (R)
3	Overall Guidance	Mr. Padmakar Nahar, Geologist IBM (R)
4	Physical Execution of Work	
4.1	Geology	Mr. Anand Kumar Raikwar (Geologist)
4.2	Geology	Mr. Ashutosh Chourasiya (Geologist)
4.3	Geology	Mr. Ganesh Bisen (Geologist)
5	Drilling	Mr. Anshul Sharma (Mech. Engineer)
6	Sample Preparation	Ashutosh Chourasiya (Geologist)
7	Chemical Laboratory	FCI Aravali Gypsum and Minerals India Limited. (FAGMIL Jodhpur)
8	Petrological Studies	Mr. Anil Kumar Dawande

CHAPTER – 3

3.0.0 TITLE OF THE REPORT & OWNERSHIP

Reconnaissance Survey (G4-stage) for Limestone in and around Amanganj Gunnor Pawai area, Panna District, Madhya Pradesh.

The Directorate of Geology and Mines (DGM), Government of Madhya Pradesh, has ownership of the block.

3.1.0 DETAILS ABOUT PERIOD OF PROSPECTING

The investigation was undertaken to assess the potential of different grades of Limestone within the Bhandar Formation of the Vindhyan Basin, during a G-4 stage of exploration. The exploration program commenced with large-scale mapping on a scale of 1:12,500 over an area of 93.13 square kilometres, which is a part of Toposheet no 63D/3 & 63D/7. This is aimed to identify lithological contacts and delineate areas suitable for detailed mapping and borehole planning. During the large-scale regional traverses, resulting in the collection of 27 bedrock samples and five petrological samples. Initially, 5 boreholes were proposed. Later on, drilling of two boreholes, BH-2 & BH-5, no ore zones were encountered in these boreholes; therefore, the drilling program was stopped for the remaining boreholes. The total cumulative drilling amounted to 100 meters, with a borehole depth of 50 meters each for BH-2 & BH-5.

3.2.0 DETAILS OF EXPLORATION AGENCY, QUALIFICATION, AND EXPERIENCE OF ASSOCIATED TECHNICAL PERSONS ENGAGED IN EXPLORATION

Exploration Agency	ENGEOTECH CONSULTANT
Qualification	M. Tech (Applied Geology)
Experience	20 Years
Address of the Prospector	Office: 1338, Kachnar City Road, Vijay Nagar, Jabalpur-482002 M.P.
Email	Email: engeotech@rediffmail.com
Phone No.	WhatsApp: +91-9425387402, +91-8989771405

CHAPTER – 4

4.0.0 DETAILS OF THE AREA

4.1.0 LOCATION OF THE BLOCK

4.1.1 The Government of Madhya Pradesh administratively governs the area under investigation. The District Collector of Panna holds ownership rights and is responsible for overseeing the block's jurisdiction. The study area, which covers block area 93.13 Sq. Km. is situated 14 km southeast of Amanganj tehsil of Panna district and is a part of Toposheet Nos. 63D/03 & 63/D/7.

4.1.2 In the Amanganj–Gunnor–Pawai area block, the following are villages present in the study area; the main village is Gabhora population of 2499, which is 13.5 km east of the sub-district Headquarter Amanganj (Tehsil office). As per the Census 2011 of respective villages, the population of villages in the study area is given in Table No. 4.1. The area under investigation lies within the Survey of India Toposheet no 63D/03 & 63D/7. The coordinates of the area covered by large-scale mapping on a 1:12,500 scale are bounded by DGPS coordinates of the following corner points of the Amanganj Gunnor Pawai Area block, as shown in Table No. 4.2.

Table No. 4.1 Population of villages in the study area

S.No	Village Name	Latitude	Longitude	Population
1	Sahitwara	24°22'9.95"N	80° 7'16.24"E	1012
2	Juri	24°22'13.79"N	80° 9'59.67"E	942
3	Palka Kalan	24°23'17.65"N	80°11'23.22"	1930
4	Saujani	24°23'11.27"N	80°11'16.09"E	576
5	Imalia	24°23'28.77"N	80°11'29.60"E	819
6	Bakulaha	24°23'5.76"N	80°11'29.49"E	1054
7	Palka Khurd	24°24'3.32"N	80°10'32.76"E	313
8	Khalpura	24°24'34.68"N	80°11'21.26"E	278
9	Tikaria	24°24'44.26"N	80°12'8.46"E	361
10	Patna	24°24'52.17"N	80°12'52.89"E	68
11	Shankargarh	24°23'41.83"N	80°13'17.35"E	1459
12	Bhatuatola	24°23'0.60"N	80°12'43.40"E	286
13	Simaria	24°22'10.86"N	80°13'33.72"E	255
14	Puraina	24°23'9.69"N	80°14'30.40"E	812

S.No	Village Name	Latitude	Longitude	Population
15	Salgrah	24°24'24.23"N	80°14'44.08"E	296
16	Chhota Patna	24°25'23.22"N	80°14'7.33"E	259
17	Dighaura	24°24'30.04"N	80°16'2.54"E	408
18	Mahuakhera	24°23'48.90"N	80°17'30.17"	576
19	Sanaura	24°23'45.13"N	80°16'8.63"E	256
20	Sarwara	24°23'22.73"N	80°17'27.48"E	408
21	Majhiari	24°22'16.84"N	80°15'35.26"E	942
22	Gabhora	24°25'22.13"N	80°15'17.38"	2499

Table No. 4.2: GPS Coordinates of the Amanganj- Gunnor- Pawai Block

Points	Northing	Easting	Longitude	Latitude
BP-A	409906.75800	2694065.74200	80.111778	24.357229
BP-B	421208.50100	2695245.04300	80.223128	24.368491
BP-C	425746.76300	2694982.83800	80.267885	24.366346
BP-D	426079.25300	2695045.37200	80.271160	24.366927
BP-E	428617.14900	2696222.26500	80.296122	24.377673
BP-F	424812.98900	2702934.39400	80.258259	24.438112
BP-G	424103.92000	2702493.39200	80.251288	24.434095
BP-H	415467.34700	2699448.65300	80.166276	24.406153
BP-I	413138.94800	2697944.43400	80.143405	24.39244
BP-J	408998.54900	2695993.45100	80.102702	24.374585

4.2.0 DETAILS OF THE AREA WITH LAND USE

4.2.1 The exploration area is primarily covered by soil, predominantly used for the cultivation of rice, pulses, and paddy. The terrain is generally flat with low topography. The highest elevation, at 350 meters above mean sea level (AMSL), is located in the north-eastern part of the area, while the lowest elevation is around 310 meters AMSL in the southwestern section. The cadastral details reveal that most of the exploration area is privately owned land, with no forest cover. The study area falls under the freehold category.

4.3.0 MINERAL(S) UNDER INVESTIGATION

4.3.1 Mineral (s) under investigation or granted under G4 category for exploration of Limestone.

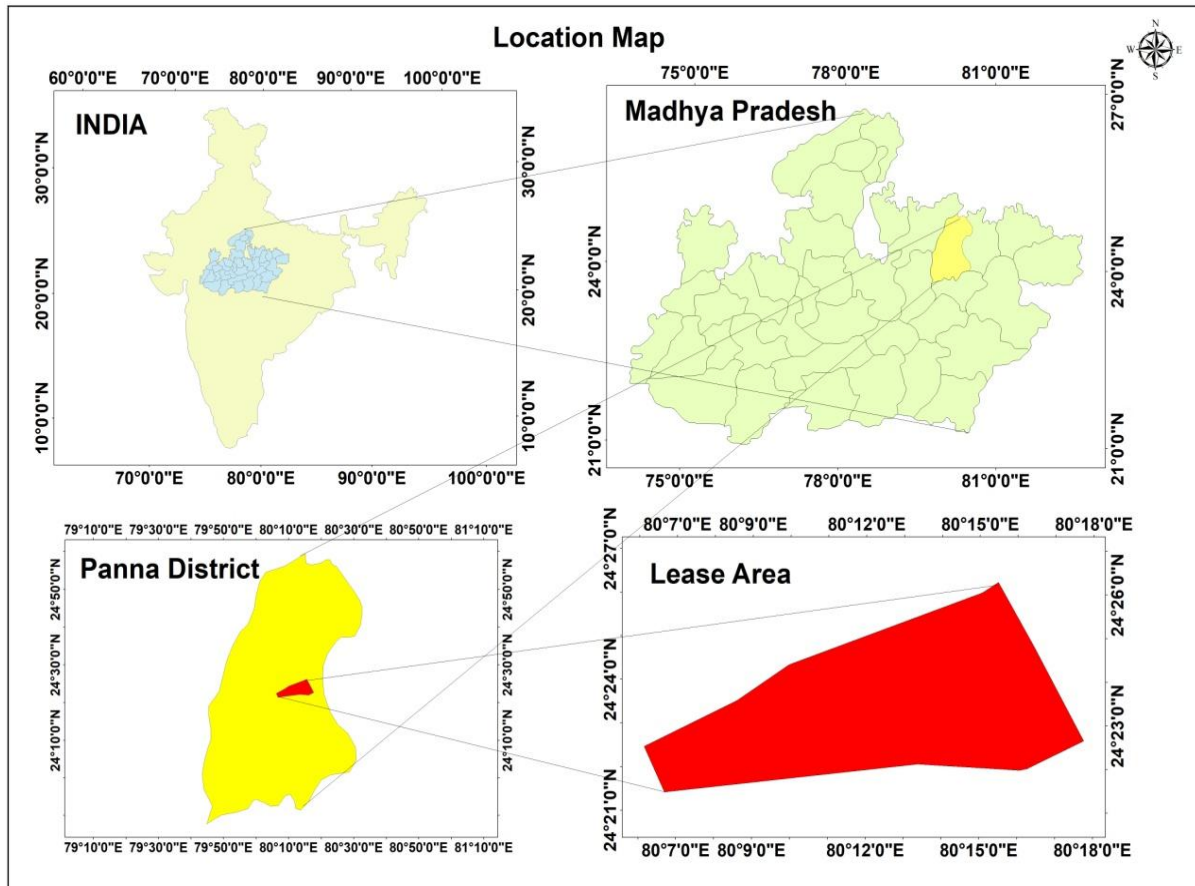


Figure. No.4.1 Showing Location of the Amanganj-Gunnor-Pawai Block

CHAPTER – 5

5.0.0 PHYSIOGRAPHY AND ENVIRONMENT

5.1.0 RELIEF OF THE AREA WITH MINIMUM AND MAXIMUM ELEVATION, DRAINAGE PATTERN, NATURAL WATER COURSES, RESERVOIRS, ETC.

5.1.1 The terrain is generally flat with low topography. The highest elevation, at 350 meters above mean sea level (AMSL), is located in the north eastern part of the area, while the lowest elevation is around 310 meters AMSL in the southwestern section. The cadastral details reveal that most of the exploration area is privately owned land, with no forest cover.

5.2.0 ROADS, RAILWAY TRACK, ELECTRIC TRANSMISSION LINE, TELEPHONE LINE ETC.

5.2.1 The Amanganj–Gunnor–Pawai sector is moderately developed, with facilities adequate to support geological exploration and small-scale industrial activity. Roads-The tehsil headquarters at Amanganj, Gunnor, and Pawai are connected by district roads to Panna, Katni, and Satna. Interior villages are linked by fair-weather tracks, which become difficult to traverse during the monsoon. Railways: The nearest railheads are Katni (approx. 65 km), Satna (approx. 85 km), and the Damoh (approx. 95 km), providing access to the Central Railway network. Airways: Khajuraho Airport (about 90–100 km from Panna) serves as the nearest air link, with flights to Delhi and other metropolitan centers. Utilities- Electricity supply is available in the tehsil headquarters and larger villages, though rural interiors face intermittent shortages. Drinking water is largely sourced from wells, hand pumps, and seasonal streams. Industrial Units: Small-scale lime kilns and stone-crushing units operate locally, while cement plants in nearby districts utilize Limestone from this belt. Social Infrastructure: Primary schools, health centers, and local markets are present in the tehsil towns. However, advanced medical and educational facilities are concentrated in Katni, Satna, and Panna.

5.3.0 HOST POPULATION (LOCAL TRIBES), HUMAN SETTLEMENTS WITHIN AND NEARBY THE AREA

In the Amanganj–Gunnor–Pawai area block, the following are villages present in the study area; the main village is Gabhora population of 2499, which is 13.5 km east of the sub-district

Headquarter Amanganj (Tehsil office). As per the Census 2011 of respective villages, the population of villages in the study area is given in Table No 5.1.

Table No. 5.1 Population of villages in the study area

S.No	Village Name	Latitude	Longitude	Population
1	Sahitwara	24°22'9.95"N	80° 7'16.24"E	1012
2	Juri	24°22'13.79"N	80° 9'59.67"E	942
3	Palka Kalan	24°23'17.65"N	80°11'23.22"	1930
4	Saujani	24°23'11.27"N	80°11'16.09"E	576
5	Imalia	24°23'28.77"N	80°11'29.60"E	819
6	Bakulaha	24°23'5.76"N	80°11'29.49"E	1054
7	Palka Khurd	24°24'3.32"N	80°10'32.76"E	313
8	Khalpura	24°24'34.68"N	80°11'21.26"E	278
9	Tikaria	24°24'44.26"N	80°12'8.46"E	361
10	Patna	24°24'52.17"N	80°12'52.89"E	68
11	Shankargarh	24°23'41.83"N	80°13'17.35"E	1459
12	Bhatuatola	24°23'0.60"N	80°12'43.40"E	286
13	Simaria	24°22'10.86"N	80°13'33.72"E	255
14	Puraina	24°23'9.69"N	80°14'30.40"E	812
15	Salgrah	24°24'24.23"N	80°14'44.08"E	296
16	Chhota Patna	24°25'23.22"N	80°14'7.33"E	259
17	Dighaura	24°24'30.04"N	80°16'2.54"E	408
18	Mahuakhera	24°23'48.90"N	80°17'30.17"	576
19	Sanaura	24°23'45.13"N	80°16'8.63"E	256
20	Sarwara	24°23'22.73"N	80°17'27.48"E	408
21	Majhiari	24°22'16.84"N	80°15'35.26"E	942
22	Gabhora	24°25'22.13"N	80°15'17.38"	2499

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.4.1 The exploration area in Panna District, Madhya Pradesh, lies within the Bundelkhand region, where the population is predominantly rural and distributed in numerous villages and small towns. Human settlements are generally concentrated along major roads, cultivated plains, and near seasonal and perennial water sources, while forested and rocky uplands remain sparsely inhabited. The district comprises approximately 947 inhabited villages, with nearly 88% of the population residing in rural areas. The district has a population of approximately 1.02 million (Census 2011), with Scheduled Tribes constituting about 16.8% and Scheduled Castes about 20.5% of the total population. The literacy rate is around 65–66%, and agriculture

remains the principal occupation, supplemented by livestock rearing, forest produce collection, wage labour, and mining-related activities.

5.5.0 HISTORICAL SITES AND ARCHAEOLOGICAL MONUMENTS, PLACES OF WORSHIP, PUBLIC UTILITIES ETC. WITHIN OR NEARBY

5.5.1 The Amanganj–Gunnor–Pawai sector lies within a region of considerable historical and cultural significance: Khajuraho Temples (UNESCO World Heritage Site): Located about 90 km from Panna, these temples of the Chandela dynasty (10th–12th century A.D.) are renowned for their architectural and sculptural excellence. Ajaygarh Fort: Situated in the northern part of Panna District, this fort occupies a prominent hilltop and represents medieval Bundelkhand architecture. Kalinjar Fort: Although located in Banda District (U.P.), it lies close to the Panna boundary and has strong historical associations with the Chandela rulers. Numerous local shrines, stepwells, and village temples are scattered across the tehsil areas, reflecting the cultural heritage of Bundelkhand.

5.6.0 FOREST, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARY

5.6.1 Panna National Park / Tiger Reserve: Situated in the northern part of the district, extending along the Ken River. Declared a Tiger Reserve in 1994, it is a critical habitat for tigers, leopards, sloth bears, chital, sambar, and numerous avian species. The Park also contains important geological features, including Vindhyan sandstone cliffs and waterfalls such as Pandav Falls and Raneh Falls. Ken Gharial Sanctuary: - Located downstream of the Ken River, this sanctuary is dedicated to the conservation of gharials (fish-eating crocodiles). It forms part of the broader ecological setting of the district. The environmental setting of the Amanganj–Gunnor–Pawai area is defined by its plateau physiography, forest cover, and river systems. Gently undulating Vindhyan plateau with escarpments and valleys. Vegetation: Predominantly tropical dry deciduous forest, with teak, sal, tendu, and bamboo as common species. Soils: Red and black soils, supporting rain-fed agriculture. Drainage: Controlled by the Ken River and its tributaries, exhibiting dendritic to sub-dendritic patterns. Quarrying and Limestone mining may lead to deforestation, soil erosion, and disturbance of drainage. Proximity to Panna National Park necessitates careful environmental management to avoid adverse impacts on biodiversity. Seasonal monsoon floods influence siltation and agricultural productivity.

5.7.0 FLORA AND FAUNA

5.7.1 The Amanganj–Gunnor–Pawai area of Panna district, located in Madhya Pradesh, supports vegetation typical of the dry deciduous forests of central India. The region falls within the forest belt associated with Panna National Park, and much of its natural vegetation consists of tropical dry deciduous forest. The dominant tree species is teak (*Tectona grandis*), locally known as Sagwan, along with other important species such as salai (*Boswellia serrata*), tendu (*Diospyros melanoxylon*), mahua (*Madhuca longifolia*), Bija (*Pterocarpus marsupium*), and khair (*Acacia catechu*). The forest canopy is generally open to moderately dense, with a well-developed undergrowth of shrubs, grasses, and climbers. During the dry season, many trees shed their leaves to conserve moisture, giving the landscape a brownish appearance, while the monsoon season brings lush greenery and rapid vegetative growth. The fauna of the area is rich and diverse due to its proximity to protected forest zones. The region provides habitat for major mammals such as tiger, leopard, sloth bear, wolf, hyena, and jackal. Herbivores include chital (spotted deer), sambar, nilgai, chinkara, and wild boar. The Ken River and its tributaries also support aquatic life, including fish, turtles, and marsh crocodiles (mugger). The area is home to a variety of bird species such as peafowl, partridges, eagles, vultures, and migratory waterfowl during the winter season. Reptiles like monitor lizards and various species of snakes are also common. Overall, the flora and fauna of the Amanganj–Gunnor–Pawai area reflect the ecological characteristics of the dry deciduous forest ecosystem of central India and play a significant role in maintaining regional biodiversity.

5.7.2 The entire block area is under agricultural cultivation and is extensively utilized for farming activities.

5.8.0 WATER BODIES SUCH AS RIVER, NALA, STREAM, RESERVOIR, ETC.

5.8.1 In terms of drainage, the area falls within the basin of the Ken River, the principal river system of the district, and a major tributary of the Yamuna River. The drainage pattern is predominantly dendritic to sub-dendritic, reflecting the homogeneous and horizontally bedded sedimentary rocks. Numerous seasonal streams (locally called nalas) originate from the plateau uplands and flow mainly during the southwest monsoon, carving shallow valleys and contributing runoff to the Ken River and its tributaries. Some streams exhibit structural control, following joints and fractures in sandstone formations. During the dry season, most minor channels remain dry, with only a few perennial stretches sustained by groundwater discharge.

5.9.0 CLIMATE CONDITIONS

5.9.1 The Amanganj–Gunnor–Pawai area of Panna District experiences a sub-tropical monsoon type of climate, with three well-defined seasons: Summer (March–June): The summers are hot and dry, with maximum temperatures frequently exceeding 40 °C. May is generally the hottest month. Hot winds prevail during this period, resulting in rapid evaporation and desiccation of soils and streams. Monsoon (July–September): The area receives rainfall from the south-west monsoon, with an average annual precipitation of about 1,100–1,300 mm. July and August are the rainiest months. Heavy showers recharge streams and rivers, but also make interior roads and tracks difficult to traverse. - Winter (October–February): Winters are cool and dry, with minimum temperatures falling to 7–10 °C in December and January. The climate during this season is generally pleasant, with clear skies and low humidity.

5.10.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENT FACTOR

5.10.1 The block area is generally flat with moderately sloping down terrain. Generally, the area is covered by soil cover, agriculture lands with some limestone exposures along seasonal water way. The main source of the income is agriculture. The block area is surrounded by cement manufacturing industries like JK Cement Limited, Panna Unit, Sotipura, Panna District, 20–35 km, Integrated cement plant (commissioned in 2022); clinker capacity 2.64 MTPA and cement capacity 2.0 MTPA. Other cement industries are situated in adjoining district of Panna Madhya Pradesh.

CHAPTER – 6

6.0.0 INFRASTRUCTURE AND ENVIRONMENT

6.1.0 LOCAL INFRASTRUCTURE DETAILS

6.1.1 The Amanganj–Gunnor–Pawai sector is moderately developed, with facilities adequate to support geological exploration and small-scale industrial activity. Roads: The tehsil headquarters at Amanganj, Gunnor, and Pawai are connected by district roads to Panna, Katni, and Satna. Interior villages are linked by fair-weather tracks, which become difficult to traverse during the monsoon. Railways: The nearest railheads are Katni (approx. 65 km), Satna (approx. 85 km), and the Damoh (approx. 95 km), providing access to the Central Railway network. Airways: Khajuraho Airport (about 90–100 km from Panna) serves as the nearest air link, with flights to Delhi and other metropolitan centers. Utilities: Electricity supply is available in the tehsil headquarters and larger villages, though rural interiors face intermittent shortages. Drinking water is largely sourced from wells, hand pumps, and seasonal streams. Industrial Units: Small-scale lime kilns and stone-crushing units operate locally, while cement plants in nearby districts utilize Limestone from this belt. Social Infrastructure: Primary schools, health centers, and local markets are present in the tehsil towns. However, advanced medical and educational facilities are concentrated in Katni, Satna, and Panna.

6.2.0 HISTORICAL SITES

6.2.1 The Amanganj–Gunnor–Pawai sector lies within a region of considerable historical and cultural significance: Khajuraho Temples (UNESCO World Heritage Site): Located about 90 km from Panna, these temples of the Chandela dynasty (10th–12th century A.D.) are renowned for their architectural and sculptural excellence. Ajaygarh Fort: Situated in the northern part of Panna District, this fort occupies a prominent hilltop and represents medieval Bundelkhand architecture. Kalinjar Fort: Although located in Banda District (U.P.), it lies close to the Panna boundary and has strong historical associations with the Chandela rulers. Numerous local shrines, stepwells, and village temples are scattered across the tehsil areas, reflecting the cultural heritage of Bundelkhand.

6.3.0 FORESTS, SANCTUARIES, NATIONAL PARK AND ENVIRONMENT SETTING OF THE AREA

6.3.1 Panna National Park / Tiger Reserve: Situated in the northern part of the district, extending along the Ken River. Declared a Tiger Reserve in 1994, it is a critical habitat for tigers, leopards, sloth bears, chital, sambar, and numerous avian species. The Park also contains important geological features, including Vindhyan sandstone cliffs and waterfalls such as Pandav Falls and Raneh Falls. **Ken Gharial Sanctuary:** - Located downstream of the Ken River, this sanctuary is dedicated to the conservation of gharials (fish-eating crocodiles). It forms part of the broader ecological setting of the district. The environmental setting of the Amanganj–Gunnor–Pawai area is defined by its plateau physiography, forest cover, and river systems. Gently undulating Vindhyan plateau with escarpments and valleys. **Vegetation:** Predominantly tropical dry deciduous forest, with teak, sal, tendu, and bamboo as common species. **Soils:** Red and black soils, supporting rain-fed agriculture. **Drainage:** Controlled by the Ken River and its tributaries, exhibiting dendritic to sub-dendritic patterns. Quarrying and Limestone mining may lead to deforestation, soil erosion, and disturbance of drainage. Proximity to Panna National Park necessitates careful environmental management to avoid adverse impacts on biodiversity. Seasonal monsoon floods influence siltation and agricultural productivity.

CHAPTER – 7

7.0.0 GEOLOGY OF THE AREA

7.1.0 REGIONAL GEOLOGY

7.1.1 Rock formations ranging in age from Neo–Proterozoic to Quaternary are exposed in the Panna and Damoh districts. A major part of the district is occupied by Vindhyan Super Group of the rocks. The sequence consists of Porcellanitic with black Carbonaceous shale, Dolomitic Limestone and Chert Breccia of Semri Group, Conglomerate and Quartzite/Sandstone of Kaimur Group and Shale and Sandstone of Rewa Group, Sandstone and Limestone of Lameta Group overlie the Vindhyan and Basaltic flow and Bhandar Sandstone in the southern part of the area. Alluvium is found along the Sonar River and its tributaries. The Vindhyan Super Group of rocks shows intense deformation in the southern and south-eastern parts. A shallow Dome structure trending ENE- WSW occurs within the Vindhyan at Jabera and as overall broad and shallow synclinal structure trending NE –SW in the southern part, are the main structural features in the area. Limestone and dolomite occur in appreciable amounts in Panna & Damoh district. Low silica Dolomitic Limestone occurs as lenses within shale around Chauraiya village. Limestone of Bhandar Group is extensively quarried for lime burning and cement manufacture. Glass sand from Lameta sandstone is also locally quarried.

The Limestone deposits of this region belong to the Bhandar Group (Upper Vindhyan, group of Vindhyan Super Group) within the Vindhyan Supergroup, a major stratigraphic unit of the Indian geological framework. The Bhandar Group is particularly noted for its extensive Limestone reserves, which hold considerable economic importance. The Vindhyan basin, together with other Proterozoic basins such as the Cuddapah and Chhattisgarh, represents a significant intercontinental Proterozoic basin that developed in the central part of the Indian Shield (Ghosh, 1980; Kale & Phansalkar, 1991). Structurally, the Vindhyan strata form a broad syncline trending ENE–WSW. The axis of this syncline shows a gentle westward curvature, while its southern limb dips more steeply than the northern limb, producing a southward inclination of the axial plane. The Vindhyan Supergroup encompasses the full sequence of Vindhyan rocks, with an estimated maximum thickness of nearly 3 kilometers. Its lithology is dominated by sandstone, shale, and Limestone, reflecting a complex

depositional history (Chakraborty, 2006; Verma, 1995). Table No 7.1 shows the stratigraphic sequence of the Vindhyan Super group as per GSI.

7.1.2 The Detailed Stratigraphy after GSI is as per Table No. 7.1, given below:

Table No. 7.1 Showing Stratigraphic Succession of the Vindhyan Supergroup

Stratigraphic Succession of the Vindhyan Supergroup			
Standard lithostratigraphic Succession according to the Geological Survey of India (GSI)			
Supergroup	Group	Formation	Major Lithology / Key Diagnostic Rock Types
VINDHYAN SUPERGROUP	BHANDER GROUP (Youngest)	Upper Bhander Sandstone	Dark red, fine-grained, cross-bedded sandstone with white specks.
		Sirbu Shale	Olive-green, fissile shales interbedded with stromatolitic limestone bands and siltstones
		Lower Bhander Sandstone	Red, fine-grained sandstone, often quartzitic.
		Bhander (Nagod) Limestone	Distinctive pink, grey, and cream-colored microcrystalline limestone; heavily stromatolitic.
		Ganurgarh Shale	Deep red to chocolate-colored calcareous shales with siltstone ribbons and gypsiferous layers.
	REWA GROUP	Upper Rewa Sandstone	Massive, white to light pink, coarse-grained quartzitic sandstone (forms prominent escarpments).
		Jhiri Shale	Greenish-grey to thin-bedded clayey shales, occasionally containing volcanic ash/tuff horizons.

Stratigraphic Succession of the Vindhyan Supergroup			
Standard lithostratigraphic Succession according to the Geological Survey of India (GSI)			
Supergroup	Group	Formation	Major Lithology / Key Diagnostic Rock Types
		Lower Rewa Sandstone	Fine-grained, flaggy sandstone, compact and well-bedded.
		Panna Shale	Dark green to ferruginous splintery shales; contains diamond-bearing conglomerate zones at its base.
	KAIMUR GROUP	Dhandraul Sandstone	Ultra-mature, white, massive quartz sandstone.
		Scarp Sandstone	Fine-to-medium-grained red sandstone with distinct current ripples.
		Bijaigarh Shale	Pyritiferous, carbonaceous carbon-rich dark shales (indicative of reducing basinal conditions).
		Ghurguja Sandstone	Glaucinitic sandstone and siltstone variations.
		Markundi Quartzite / Sandstone	Thickly bedded, pinkish, hard quartzitic sandstone.
		Kaimur (Susnai) Conglomerate	Basal conglomerate marking a prominent regional unconformity with the underlying Semri Group.
	SEMRI GROUP (Lower Vindhyan)	Rohtasgarh Limestone	Alternating bands of high-grade grey limestone and shaly limestone; widely mined for cement manufacture.
		Rampur Shale	Silty carbonaceous shales with porcellanite bands.

Stratigraphic Succession of the Vindhyan Supergroup			
Standard lithostratigraphic Succession according to the Geological Survey of India (GSI)			
Supergroup	Group	Formation	Major Lithology / Key Diagnostic Rock Types
		Glaucanite Sandstone	Greenish, mature sandstone rich in authigenic glauconite grains.
		Fawn Limestone	Buff to brownish, dense dolomitic limestone showing prominent conical stromatolites.
		Olive Shale	Greenish-brown, highly splintery fine shale.
		Porcellanite Formation	Cherty, hard, silicified tuffs and porcellanites derived from contemporaneous acid volcanism.
		Kajrahat Limestone	Thickly bedded grey crystalline limestone and basal dolomite.
		Deoland Formation	Basal conglomerate and quartz grit resting unconformably on the basement complex.
UNCONFORMITY / BASEMENT: Bundelkhand Gneissic Complex / Mahakoshal Group			Archean to Paleoproterozoic granites, gneisses, and metasedimentary greenstone belts.

7.2.0 REGIONAL STRUCTURE

7.2.1 The Amanganj–Gunnor–Pawai area of Panna District forms part of the northern Vindhyan Basin and is underlain predominantly by the sedimentary rocks of the Bhandar Group of the Upper Vindhyan Supergroup. Structurally, the region is characterized by a stable intracratonic setting, where the sedimentary succession is only gently deformed and retains its original stratification over large areas. The regional structure is represented by a broad ENE–WSW to E–W trending synclinal basin with very low-angle bedding dips, generally ranging

between 1° and 5° towards the north or northeast. The strata are nearly horizontal over extensive areas, and local variations in dip are mainly attributable to gentle warping rather than intense tectonic deformation. Folding is insignificant, and no major regional anticlines or synclines are observed within the proposed exploration block. The sedimentary succession is affected by widely spaced vertical to sub-vertical joints and minor fractures, which have developed due to regional tectonic stresses. These joints generally occur in NE–SW, NW–SE, and E–W directions and locally control weathering, drainage development, and groundwater movement. No major faults have been mapped within the Amanganj–Gunnor–Pawai exploration area. The nearest regional tectonic influence is associated with the Son–Narmada Lineament, situated well to the south of the Vindhyan Basin. Although this major crustal feature influenced the evolution of the basin, its structural effects are not directly manifested within the proposed limestone exploration block. The regional structural framework indicates a tectonically stable platform characterized by nearly horizontal sedimentary strata, gentle regional dips, absence of major faulting, and well-developed joint systems.

7.2.2 PRIMARY SEDIMENTARY STRUCTURES

(i) Bedding plane:

It is defined by colour banding and compositional layering in limestone. The limestone beds in the study area generally have a strike direction of ENE–WSW and dip at angles of 2° to 5° towards the south.

(ii) Stromatolites

The morphology of the stromatolites found in the Limestone of the Sirbu Formation of Bhandar Group of the Vindhyan Supergroup serves as a precise paleoenvironmental barometer, where the physical structure of species like *Stratifera* sp. and *Tungussia* sp. reflects the specific hydrodynamic energy and water depth of the ancient Amanganj–Gunnor–Pawai marine basin. In this setting, flat, laminated forms such as *Stratifera* typically indicate low-energy, protected intertidal or supratidal flats where microbial mats could spread laterally without significant disruption from waves. As the environment transitioned into more agitated, subtidal conditions, the microbial communities adapted by building upward into the domal and columnar shapes of *Collenia* and *Colonnella*, structures designed to maximize light exposure while resisting moderate current flow. The presence of complex, branching taxa like *Baicalia baicalia*, *Inzeria*, and *Tungussia* further suggests a higher-energy or deeper subtidal

regime; these sophisticated architectures allowed the microbial colonies to remain stable and continue trapping sediment despite stronger wave surges or shifting currents. Consequently, the diverse assemblage identified by Gupta (1982) suggests a dynamic depositional setting characterized by fluctuating sea levels and varying degrees of exposure to the open ocean, where the interplay of light availability, sediment supply, and current velocity dictated the biological blueprint of the reef-building microbes. Shown in Figure No.7.2.

7.2.3 SECONDARY/ DIAGENETIC STRUCTURE

(i) Joints:

Joints are developed in the Limestone and Shale of the Sirbu Formation of the Bhandar Group. In the area, 2 sets of Vertical to Sub-vertical joints are common, mainly along NW-SE and ENE-WSW directions.

7.3.0 REGIONAL MINERALISATION

7.3.1 The Amanganj–Gunnor–Pawai area of Panna District, Madhya Pradesh, forms part of the mineral-rich Vindhyan Basin, where sedimentary rocks of the Semri, Kaimur, Rewa, and Bhandar Groups host several economically important mineral deposits. The region is particularly known for its extensive deposits of cement-grade limestone, which constitute the principal mineral resource and support the establishment of several cement industries in the adjoining districts of Panna, Katni, and Satna. The proposed exploration block lies within the Bhandar Limestone Formation, which comprises thick, laterally persistent, fine- to medium-grained limestone interbedded with dolomitic limestone, shale, and calcareous sandstone. The limestone is generally grey to bluish-grey in colour, compact, and suitable for cement manufacture owing to its favourable chemical composition, characterized by high CaO and low MgO, SiO₂, and other deleterious constituents. The continuity of these limestone horizons over large areas makes the region highly prospective for systematic exploration and resource evaluation. Apart from limestone, the Panna district is internationally renowned for its diamond mineralisation, hosted within the Majhgawan Kimberlite Pipe and associated kimberlitic and lamproitic intrusions emplaced within the Vindhyan Supergroup. Although diamond occurrences are confined to specific intrusive bodies and are unrelated to the limestone-bearing formations, they highlight the overall mineral potential of the district. Other minerals reported from the district include building stone (sandstone), flaggy limestone,

murrum, and ordinary clay, which are locally quarried for construction purposes. Minor occurrences of silica sand, dolomite, and laterite have also been reported from different parts of the district, though these are of comparatively limited economic importance. The adjoining Katni and Satna districts constitute one of India's most important cement-grade limestone belts, where extensive mining is carried out by major cement manufacturers. The geological continuity of the Bhandar Group limestone from Satna and Katni into the Panna region indicates favourable conditions for the occurrence of additional cement-grade limestone resources within the proposed exploration block. The regional geological setting, characterized by thick, laterally continuous limestone horizons, simple structural disposition, and proximity to major cement manufacturing centres, indicates a high potential for cement-grade limestone mineralisation. The reconnaissance geological mapping and preliminary observations further suggest that the proposed block is prospective for delineation of substantial limestone resources through systematic exploration.

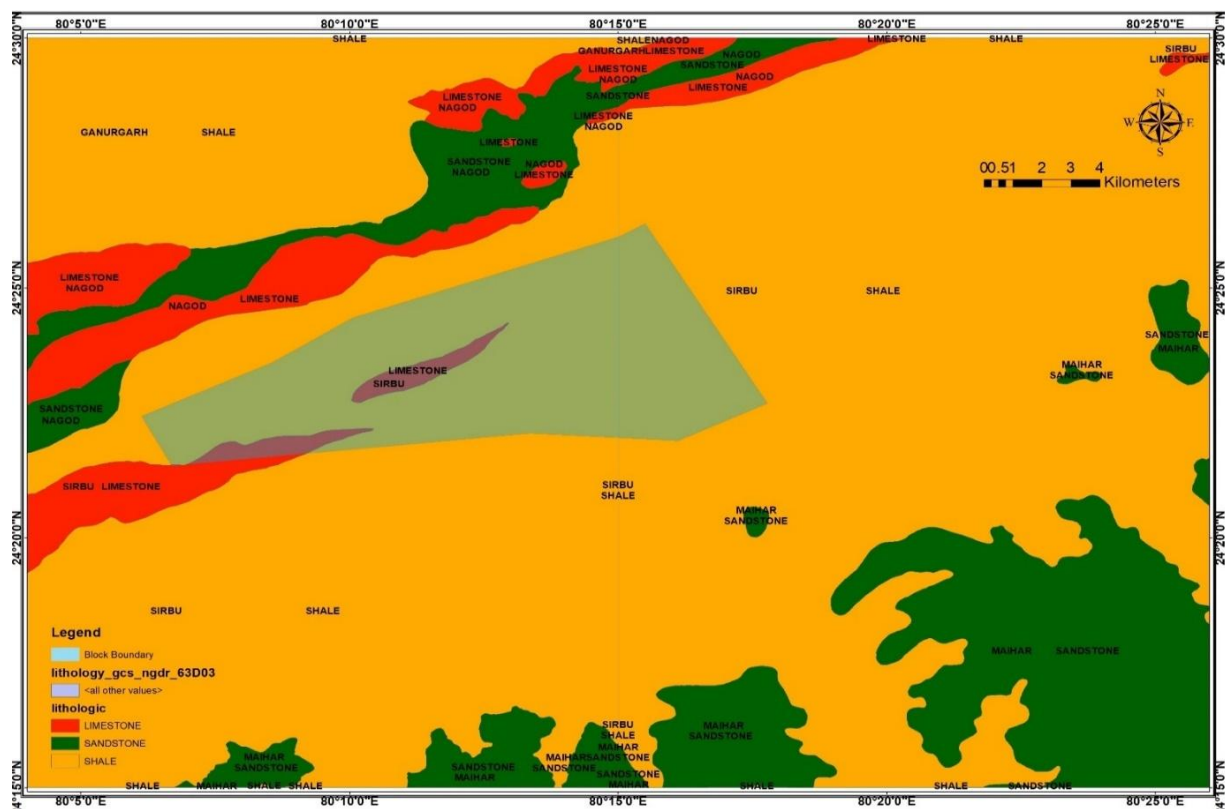


Figure No.7.1 Map showing the regional Geological setup around the exploration block. (Source: National Geoscience Data Repository (NGDR))

7.4.0 GEOLOGY OF THE BLOCK

7.4.1 The large-scale mapping was carried out in the Amanganj-Gunnor-Pawai block in part of toposheet No. 63D/03 & 63 D/07, covering an area of 93.13 square kilometres on a scale of 1:12,500 to demarcate Limestone of Sirbu Formation exposures in the study area. The majority of the area is covered by soil at the top and yellowish clay at the bottom, primarily used for cultivation purposes. During the mapping, prominent litho-units, namely the Sirbu Shale with lenses of Limestone, belonging to the Bhandar Group of the Vindhyan Super Group. The geological succession in the present block is shown in Table No. 7.2.

Table No. 7.2 The geological succession of Amanganj-Gunnor-Pawai block 1:12,500 Scale (93.13 sq.km area)

Lithology	Formation	Group	Super Group	Age	Thickness	Drilling Depth (m)
Soil				Recent	0.5 -1m	50
Sand Stone	Sirbu Formation	Bhandar Group	Vindhyan Supergroup	Neo-Proterozoic	1-2 m	50
Shale with Limestone (small lenses of Limestone)					0.2-0.5 m (Limestone)	50
Shale					1-50m (Drilled)	50

7.5.0 DESCRIPTION OF ROCK TYPES IN THE BLOCK

7.5.1 The area under investigation, encompassing the Amanganj-Gunnor-Pawai block of Panna District, forms a part of the Upper Vindhyan sequence. The rock formations exposed herein belong to the Bhandar Group, the youngest lithostratigraphic unit of the Vindhyan Supergroup in this region.

7.5.2 Top Soil

Most of the study area is blanketed by soil, which restricts direct observation of the underlying geology.

7.5.3 Sandstone

Sandstone of the Neoproterozoic Sirbu Formation (Sirbu Shale Formation of Bhander Group, Vindhyan Super Group) is a texturally mature, fine- to medium-grained rock ranging in color from light grey and buff to reddish-brown due to ferruginous material. Mineralogically classified as quartz arenite to sub-arkosic sandstone, it is dominated by quartz (often exceeding 80%) with subordinate feldspar, minor clay matrix (kaolinite and illite), and accessory heavy minerals like zircon, tourmaline, and rutile. The rock features a grain-supported framework of sub-rounded to rounded, moderately to well-sorted grains bound primarily by strong siliceous cement, alongside localized ferruginous and calcareous cements, with common diagenetic features including silica overgrowths, iron oxide staining, and minor recrystallization. Well-developed sedimentary structures—such as planar and trough cross-bedding, ripple marks, parallel to wavy laminations, and occasional mud cracks—indicate a dynamic depositional history under variable wave and current energy within a shallow marine to nearshore environment featuring localized tidal flats. In Amanganj-Gunnor-Pawai Block the sand stone exposures were observed in the field near Sitwara village in the dug-wells & excavated pits and nallha cuttings. Sandstone is reddish in color, Strike: ENE–WSW to nearly E–W and Dip direction towards South to South-Southeast (S to SSE) shallow dipping towards south.

7.5.4 Limestone

In the stratigraphic sequence of the Sirbu shale Formation, the Limestone occurs as minor lenses, with is positioned between the Shale (intercalation of limestone as lensoidal form with limited aerial extent and thickness) of the Sirbu Formation. This formation is a carbonate rock, primarily composed of Limestone. It is often described as being part of a calcareous (calcium carbonate-rich) unit. The Limestone is noted for the profuse development of stromatolites, which are layered bio-chemical structures formed by the activity of cyanobacteria and other microbes. These stromatolites are a key identifying feature of this formation, distinguishing it from other Limestones in the Vindhyan sequence. The presence of abundant stromatolites suggests deposition in a shallow marine, photic zone where sunlight was able to penetrate to the seafloor, supporting the growth of benthic microbial mats. This setting contrasts sharply with the deeper marine conditions under which the overlying Sirbu Shale was formed.

In the Amanganj Gunnor Pawai block, exposure of limestone was observed west of the village Palkakalan approx. 1.5 km, south-western direction of Palkakalan village 300m, Near village Bakulaha & Sujhani limestone exposure was observed, Near Imaliya village limestone

exposure was observed in Northern direction approx. 400m and south eastern direction 500m, near Ghabhora village in north western direction at a distance of 300m limestone exposure was observed, limestone exposure was observed 500m north easter side of Nagod-Gunnor Road. Limestone exposures also observed in dugwells, ponds and nallah cuttings in the area. Limestone exposures are in the shape of lenses; no lateral expansion along the strike was observed. The average thickness of these lenses is approx. 0.2-0.5m. In this explored block Limestone was present in patches intercalated with shale and has limited lateral extent and thickness (0.2-0.5m approx.); therefore, it has no significance in economic.

7.5.5 Sirbu Shale

The Sirbu Shale is the uppermost shale-dominated formation within the Bhandar Group in this region, directly overlying the Bhandar Limestone. The Sirbu Shale is primarily composed of fine-grained clastic sedimentary rock. It is typically described as shale, often intercalated with siltstone and fine sandstone layers. The shales are generally argillaceous (clay-rich) and exhibit fissility, splitting into thin, flat layers. The formation has a reported thickness of approximately 250 meters in the broader Vindhyan Basin. The Sirbu Shale is famous for its biostratigraphic significance. The fine-grained nature of the Sirbu Shale suggests a low-energy depositional environment, likely a deeper marine or lagoonal setting where fine silt and clay particles could settle out of the water column.

In Amanganj -Gunnor-Pawai Block, the whole area is covered by soil cover, beneath its patches of Limestone shales were exposed. The Sirbu shale Formation within the Amanganj–Gunour–Pawai sector represents a thick, predominantly argillaceous, unmetamorphosed sedimentary sequence. Geometrically, the strata occur as flat-lying to exceptionally gently dipping tabular sheets exhibiting a highly uniform regional strike trending ENE–WSW to nearly E–W and dip direction towards south to south-southeast (S to SSE) dipping to 2–5-degree S to SSE. In the Amanganj-Gunnor-Pawai Block, the thickness of the shale is 50m as per drilling data of 2 bore holes, namely BH-2 & BH-5.

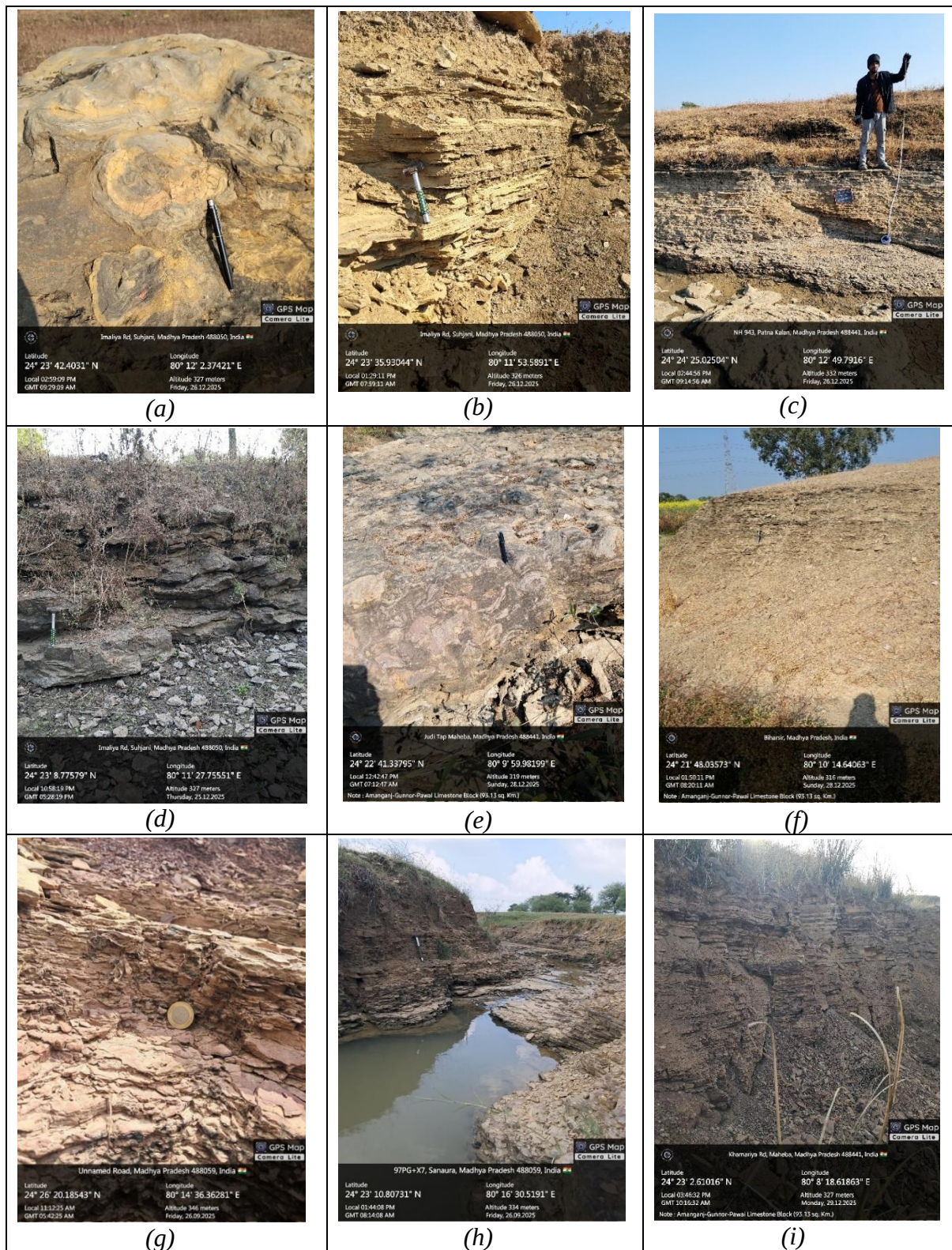


Figure- 7.2: Field photographs of litho-unit (a) Stromatolitic Limestone outcrop in Suhjani village, (b) Bedded and Stromatolitic Limestone outcrop in Suhjani village, (c) Bedded Limestone outcrop in Suhjani village, (d) Calcareous Shale & Stromatolitic Limestone exposures in Pantna Kalan village, (e) Stromatolitic Limestone outcrop in Judi Tap Maheba village, (f) Bedded Shale exposures in Biharsir

7.6.0 STRUCTURAL FEATURES OBSERVED IN THE BLOCK

7.6.1 STRUCTURE OF THE BLOCK

The main structure in the study area is the bedding planes, which show the natural layers of the rocks. Fractures are also present as secondary structures. Most of the area is covered by thick soil, which conceals much of the underlying rock formations., but where the rock is exposed, the bedding and fractures can be observed.

7.6.2 Primary structures

(i) Bedding plane:

It is defined by colour banding and compositional layering in limestone. The limestone beds in the study area generally have a strike direction of ENE-WSW and dip at angles of 2° to 5° towards the south shown in Figure 7.2.

(ii) Stromatolites

The morphology of the stromatolites found in the Limestone of the Sirbu Formation of Bhander Group of the Vindhyan Supergroup serves as a precise paleoenvironmental barometer, where the physical structure of species like *Stratifera* sp. and *Tungussia* sp. reflects the specific hydrodynamic energy and water depth of the ancient Amanganj-Gunnor-Pawai marine basin. In this setting, flat, laminated forms such as *Stratifera* typically indicate low-energy, protected intertidal or supratidal flats where microbial mats could spread laterally without significant disruption from waves. As the environment transitioned into more agitated, subtidal conditions, the microbial communities adapted by building upward into the domal and columnar shapes of *Collenia* and *Colonnella*, structures designed to maximize light exposure while resisting moderate current flow. The presence of complex, branching taxa like *Baicalia baicalia*, *Inzeria*, and *Tungussia* further suggests a higher-energy or deeper subtidal regime; these sophisticated architectures allowed the microbial colonies to remain stable and continue trapping sediment despite stronger wave surges or shifting currents. Consequently, the diverse assemblage identified by Gupta (1982) suggests a dynamic depositional setting characterized by fluctuating sea levels and varying degrees of exposure to the open ocean, where the interplay of light availability, sediment supply, and current velocity dictated the biological blueprint of the reef-building microbes. Shown in Fig.7.2.

7.6.3 Secondary structure:

(i) Joints:

Joints are developed in the Limestone and Shale of the Sirbu Formation of the Bhandar Group. In the study area, 2 sets of Vertical to Sub-vertical joints are common, mainly along NW-SE and ENE-WSW directions.

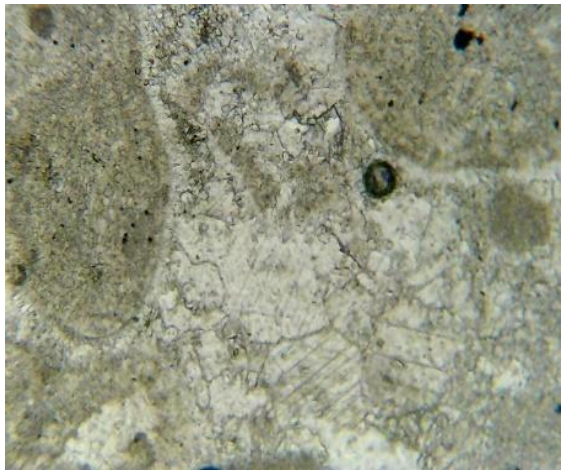
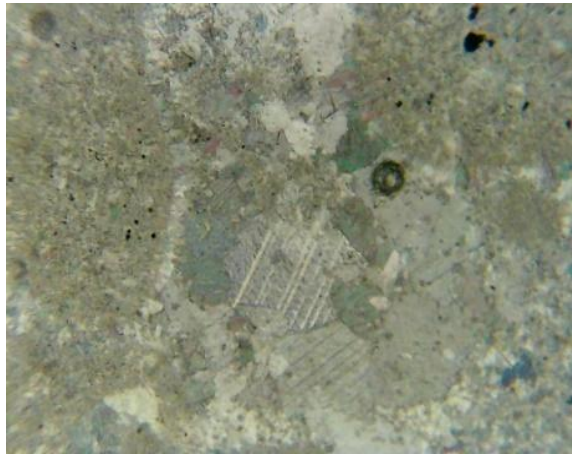
7.7.0 PETROGRAPHIC STUDIES

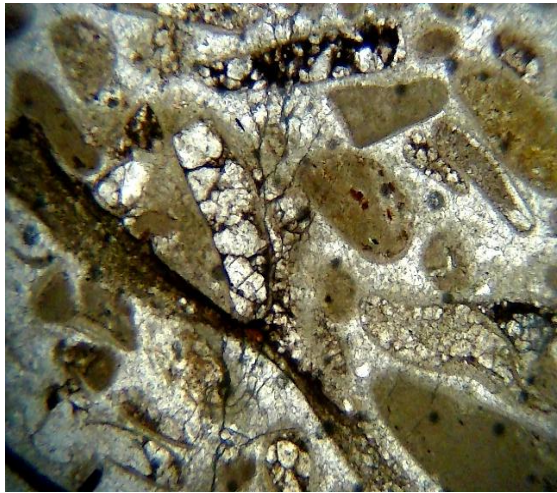
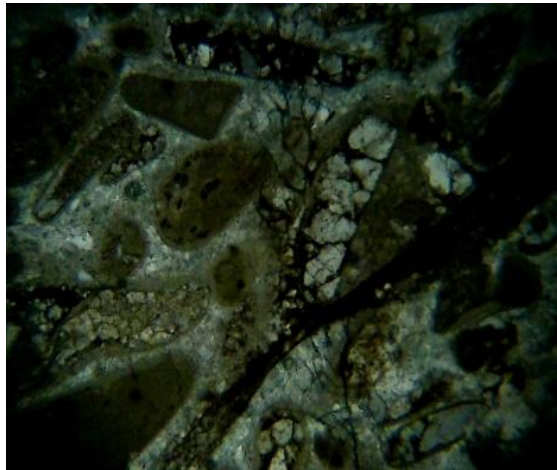
7.7.1 The petrological study of the Limestone of Sirbu Formation from the Amanganj-Gunnor- Pawai block, Panna District, Madhya Pradesh, was carried out at the In-house lab in Jabalpur. This study aimed to identify the minerals present, understand their relationships, and explore how they formed and evolved. Thin sections of bedrock samples (Limestone was not encountered in drilled holes) were prepared to observe the mineral content under different light conditions, including plane-polarized light (PPL), crossed polarized light (XPL). The study focused on 5 samples, each representing different types of Limestone, such as yellow and grey varieties. The examination was conducted using a Metzer-M microscope, equipped with a high-resolution Metzer-M camera, which allowed for precise observation and documentation of the mineral textures and structures at up to 40 X POL magnification. The details of petrological samples (PS) are given in Table 7.3.

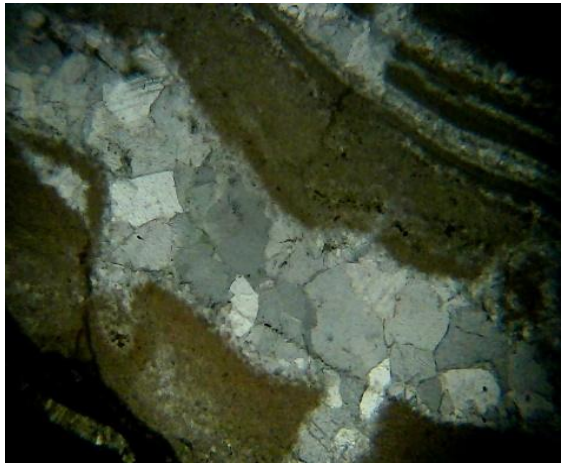
Table No. 7.3 List of petrological samples of the Amanganj-Gunnor-Pawai Block, Panna District, Madhya Pradesh.

S. No	Sample No.	Location	Latitude	Longitude	Lithology
1	S-20	Palka Kalan	24° 23' 35.4120" N	80° 11' 53.5563" E	Limestone
2	S-21	Palka Kalan	24° 23' 40.3245" N	80° 12' 00.3060" E	Limestone
3	S-33	Patna Kalan	24° 24' 41.6090" N	80° 13' 21.1576" E	Limestone
4	S-35	Chauda	24° 22' 39.4381" N	80° 09' 20.2459" E	Limestone
5	S-38	Barha Khurd	24° 22' 39.9577" N	80° 08' 51.1001" E	Limestone

7.7.2 The following sections provide a detailed petrographic description of each thin section photomicrograph based on the observations made under various lighting conditions. A detailed petrographic report is provided in Annexure VI.

S. No	Photomicrograph	Petrographic Description
1		(PPL), Sample No. S-20 The limestone sample from the Sirbu Formation (Vindhyan Supergroup), studied under PPL, is a calcite-dominated rock showing microcrystalline to sparry texture. It exhibits a bioclastic/allochemical framework with poor to moderate sorting and mainly grain-supported to partially matrix-supported fabric. Micrite forms the primary cloudy matrix, while sparry calcite acts as cement filling pores and fractures. Allochems include bioclasts, intraclasts, and possible peloids, along with minor opaque minerals. Recrystallisation of micrite to microspar and calcite vein fillings are evident. The rock has very low primary porosity, with secondary porosity partly filled by calcite. Overall, it indicates deposition in a shallow marine environment under low to moderate energy conditions.
2		(XPL), Sample No. S-20 The limestone sample (S-20) under XPL is a calcite-dominated carbonate rock showing high-order interference colors and well-developed polysynthetic twinning. Calcite occurs in both micritic and sparitic forms, with minor dolomite and scattered opaque minerals present. The texture is mainly micritic with patches of sparry calcite, indicating recrystallisation to a mosaic fabric. Diagenetic features such as cementation and recrystallisation are prominent, with pores largely filled by sparry calcite. The rock was deposited in a shallow marine environment and later modified by diagenetic processes.
3		(PPL), Sample no. S-21 The limestone from the Sirbu Formation (Vindhyan Supergroup), observed under PPL, is a fine-grained, micrite-dominated carbonate rock with a light grey to buff appearance. It consists mainly of calcite, with minor sparry calcite in patches and veins, along with scattered opaque minerals and traces of clay. The texture is predominantly micritic with localized recrystallisation to microspar and a generally massive fabric. Thin calcite-filled fractures and patchy mottling due to diagenesis are present, while fossils are absent. The rock shows very low porosity due to cementation and represents deposition in a low-energy marine environment followed by recrystallisation and fracture filling.

4		(XPL), Sample no. S-21 The limestone sample under XPL is predominantly composed of calcite (85–95%) with minor quartz and opaque minerals. It shows a micritic to microsparitic texture with patches of sparry calcite formed due to recrystallisation. The rock is fine-grained, massive, and largely homogeneous, with occasional granoblastic mosaic texture. Calcite displays high-order interference colors with faint twinning in coarser areas, while quartz shows low-order grey colors. Diagenetic features such as recrystallisation, calcite-filled fractures, and minor compaction effects are evident. Fossils are absent, and porosity is very low due to cementation. The rock represents a fine-grained carbonate sediment deposited in a low-energy setting and later modified by diagenetic processes.
5		(PPL), Sample No. S-33 The limestone sample from the Amanganj area is a fine-grained, micrite-rich limestone containing abundant peloids, moderate bioclasts, and minor intraclasts. It shows a grey to brown color with a wackestone to packstone texture, poor to moderate sorting, and sub-rounded grains. Micrite forms the main matrix, while sparry calcite fills pores and fractures. Diagenetic features include strong micritization, partial recrystallisation to microspar, compaction, and calcite cementation. The rock represents a low-energy shallow marine deposit later modified by diagenesis.
6		Sample S-33 (XPL) The limestone sample, examined under crossed nicols (XPL), is a calcite-dominated limestone with minor quartz and opaque minerals. It shows a micrite to sparite texture with well-developed recrystallisation forming coarse sparry calcite patches. Calcite displays high-order interference colors with clear polysynthetic twinning and patchy extinction. The fabric varies from grain-supported to matrix-supported. Prominent calcite-filled fractures, microfractures, and vuggy porosity are present, with pores partly filled by sparry calcite. Strong diagenetic features include recrystallisation, cementation, compaction, and brittle deformation. Fossils are absent, and the rock is best described as a vuggy, vein-bearing limestone formed under significant diagenetic alteration.

7		(PPL), Sample No. S-35 Sample S-35 (PPL) is a recrystallized limestone dominated by sparry calcite with minor micritic patches. It shows a fracture-controlled fabric, where cracks and voids are filled with secondary calcite forming a coarse crystalline mosaic. Original allochems are poorly preserved due to intense recrystallisation, though faint relics of wackestone to packstone texture remain. Minor opaque impurities are present. Diagenetic features such as strong recrystallisation, calcite cementation, and vein filling are prominent. The rock represents a low to moderate energy carbonate deposit that has undergone significant diagenetic alteration.
8		(XPL), Sample No. S-35 Sample S-35 (XPL) is a calcite-dominated, recrystallized limestone showing a well-developed mosaic of interlocking sparry calcite crystals with high-order interference colors. Prominent fracture- and vein-filling by sparry calcite is observed, along with minor opaque impurities. A granoblastic mosaic texture indicates intense recrystallisation, with only minor relics of micritic matrix preserved. Strong diagenetic features include recrystallisation, calcite veining, and fracture filling, suggesting post-depositional modification possibly linked to fluid movement and tectonic activity.
9		(PPL), Sample No. S-38 The limestone from the Amanganj area is a fine- to medium-grained, micrite-dominated carbonate rock with a wackestone to packstone texture. It contains scattered peloids and poorly preserved bioclasts, showing poor to moderate sorting and mainly matrix-supported fabric. Minor sparry calcite cement and disseminated opaque minerals are present. Diagenetic features include micritization, partial recrystallisation to microspar, compaction, and slight iron staining. The rock represents deposition in a shallow marine, low-energy environment followed by diagenetic modification.

10		(XPL), Sample No. S-38 The limestone is a fine- to medium-grained, calcite-dominated carbonate rock with a wackestone to packstone fabric and granular to mosaic texture. It shows moderate recrystallisation, forming sparry calcite with minor dolomite, opaques, and siliceous impurities. Original textures are partly obliterated, and diagenetic features include recrystallisation, cementation, micritization, and compaction. Primary porosity is absent, while secondary porosity occurs as calcite-filled veins and fractures. The rock was deposited in a shallow marine, low to moderate energy environment and later modified by diagenesis.
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Figure No. 7.3 Petrographic Descriptions of Thin Sections.

7.8.0 MINERALISATION IN THE BLOCK

7.8.1 Drilling of two boreholes, designated BH-2 and BH-5, did not encounter any Limestone zones in this block. As a result, no mineralized intervals were identified within these boreholes, and consequently, no resource estimation was carried out for these locations. The absence of Limestone in BH-2 and BH-5 suggests that the ore-bearing horizon may be laterally discontinuous within the study area, or that these boreholes were positioned outside the extents of the mineralized zones. This outcome highlights the importance of detailed geological interpretation and the need for adequate drilling density to accurately delineate the spatial distribution and continuity of the Limestone deposits. During the course of geological investigations, limestone was observed only sporadically in the form of small lensoidal bodies occurring in patches. The exposed limestone bands exhibited very limited lateral continuity and thickness, generally ranging from 0.20 m to 0.50 m, as observed in surface cuttings and well sections. Considering the restricted occurrence, insignificant thickness, and poor lateral persistence of the limestone horizons, no pitting or trenching was undertaken, as such investigations were not envisaged under the approved exploration programme / NQT. Based on field observations, the limestone occurrences are not considered economically viable for resource evaluation.

CHAPTER – 8

8.0.0 PREVIOUS WORK

8.1.0 DETAILS OF PREVIOUS EXPLORATION CARRIED OUT BY OTHER AGENCIES/PARTIES

8.1.1 K. Srinivasa Rao, (1970-1971)- Measurement of stratigraphic thickness of Vindhyan in parts of Rewa, Satna, Sidhi, and Panna districts, Madhya Pradesh. The measured sections are Jigna-Bhogun, Chandrehi-Govindgarh, Pipartola Majgawan and Bagchorchoki-Choprachoki, which are depicted in Toposheet Nos. 63H/03; 63H/07, 54P/14 and 63D/02 and 63D/02 respectively. According to him, the Vindhyan represent a more or less continuous process of sedimentation with local disconformities. The presence of glauconite, authigenic feldspars, and calcareous oolites and the enormous thickness of the Limestone are suggestive of marine deposition, while the wide prevalence of ripple marks, cross-bedding, mud cracks, clay galls, and intraformational conglomerate adduces evidence in favor of a shallow intertidal environment. The presence of stromatolites, recorded in the Rohtas, Nagod, and Limestones of Sirbu Formation, also adds evidence in favor of an intertidal environment. From the lithologic assemblage and the sedimentary structures present, it appears that the Vindhyan may be grouped with the Orthoquartzite-Carbonate facies, characteristic of the marginal stable shelf sedimentation.

8.1.2 T. Kameswara Rao (1979-1980) - carried out Systematic geological mapping on a 1:50,000 scale in Toposheet Nos. 63D/03, Toposheet Nos. 63D/07 & Toposheet Nos. 63D/11 in parts of Panna and Satna districts of Madhya Pradesh, covering an area of about 540 sq. km and elucidated the lithology, structure, stratigraphy, and economic importance of Nagod Limestone of Bhandar Group of Vindhyan Supergroup. According to him, Nagod Limestone is cement and B.F. Grades the bottom part of Nagod Limestone (8 to 9m thick), while the top part (6 to 7m) is separated by a shale/siltstone unit that continues westerly. The top part, being more argillaceous, may not be of much use for lime and cement manufacturing. A generalized sequence of bottom part of Nagod Limestone is dark coarse Limestone (+0.5m), dark grey and greenish grey Stromatolitic Limestone (0.5m), dark and ash grey Limestone with lenticles of black chert (0.75m), yellow and pink Argillaceous Limestone (0.3m), dark grey coarse Limestone (1.5m), dark and ash grey fine Limestone (0.5m), greenish grey broken stromatolitic Limestone (3.0m) and purple stromatolitic Limestone (1.0 m) in the ascending order. The dark

grey Limestone analyses for about 46-48% of Ca CO₃, 1-2% of MgO, and 7-8% of acid-insoluble (Rao, 1979).

8.1.3 S.Chakraborty and P.K.Nanda (1979-1980)- carried out Systematic geological mapping on a 1:50,000 scale in Toposheet Nos. 54P/15, Toposheet Nos. 54P/16 & Toposheet Nos. 54P/13 in Simaria-Salaiya, parts of Jabalpur, Damoh, and Panna districts of Madhya Pradesh, covering an area of about 1200 sq. km and map the rock units of the Vindhyan Supergroup together with tracing their facies variation and lateral correlation to arrive at the stratigraphy, structure, tectonics, and evolution of the Vindhyan basin. According to them, Nagod Limestone Formation is present between the Simrawal Shale Formation and the overlying Sirbu Shale Formation. The Nagod Limestone Formation consists of three members - a Lower Limestone Member, a central Sagama Shale Member, and an Upper Limestone Member. The Lower and Upper Limestone Members are the most significant as they contain thick beds of Limestone. The Limestones belonging to these members are grey to buff in color and show features like lamination, presence of intraclasts and stromatolite structures. Microscopic analysis reveals that they predominantly comprise of sparite with various allochems like intraclasts, oolites, and quartz grains. Stromatolites in the form of columnar and laminated structures are commonly found within the Limestone beds. The formation also contains argillaceous Limestones and shale interbeds. The Nagod Limestone Formation is an economically important unit as it is a source of building materials and Cement-grade Limestone.

8.1.4 The regional stratigraphic succession of the Vindhyan Supergroup, as outlined by Soni et al. (1987), Kale & Phansalkar (1991), and Chakraborty (2006), highlights the diversity of lithological units and formations within this ancient basin. This framework underscores both the geological complexity and the historical significance of the Vindhyan system in Indian stratigraphy.

Table No. 8.1 The Regional geological succession of Vindhyan Supergroup (After Soni et al (1987)), Kale & Phansalkar (1991) and Chakraborty (2006)

Group	Formation	Alternative/Equivalent	Lithology
Bhander Group	Shikoda Formation		Sandstone, Limestone and Shale
	Sirbu Formation		Shale, Siltstone and Sandstone
	Bundi Hill Formation	Lw. Bhander	Sandstone

Group	Formation	Alternative/Equivalent	Lithology
	Lakheri Formation	Bhander Lst., Nagod Lst.	Limestone with shale Parting
	Ganurgarh Shale Formation	Simrawal Sh.	Shale
----- Disconformity /Gradational Contact-----			
-			
Rewa Group	Govindgarh Formation	Upper Rewa Sandstone	Sandstone
	Drummondgang Formation		Sandstone
	Jhiri Formation	Varegadt Sh.	Shale with basal conglomerate (diamondiferous)
	Asan Formation	Lower Rewa Sandstone	Sandstone, Limestone, chert.
	Panna Formation		Shale, Calcareous with Limestone interbeds
-----Normal Contact/Facies Change-----			
Kaimur Group	Dhandraul Formation	Upper Kaimur Sandstone	Sandstone
	Mangesar Formation		Sandstone with Siltstone and Shale interbeds
	Bijaygarh Formation		Shale with glauconitic Siltstone
	Ghaghar Formation	Markundi Sandstone	Sandstone
	Susnai Formation	Ghurma Shale	Breccia, Conglomerate, gritty Sandstone
	Sasaram Formation	Lower Kiamur Sandstone	Sandstone
-----Unconformity/Normal Contact-----			
Semri Group	Bhagwar Formation	Suket Shale	Shale and porcellanite
	Rohtasgarh Formation	Nimbahera Limestone	Limestone with shale partings
	Rampur Formation	Chorhat Sandstone	Glauconitic sandstone and shale
	Salkhan Formation	Bargawn Limestone	Siliceous and Cherty Limestone
	Koldaha Formation	Khenjua Shale	Olive Green Shale
	Deonar Formation	Chopan Porcellanite	Porcellanite
	Kahrahat Formation	Kuteshwar Limstone	Limestone
	Arangi Formation		Shale

Group	Formation	Alternative/Equivalent	Lithology
	Deoland Formation	Khardeol Sandstone	Sandstone with basal conglomerate
-----Angular Unconformity/ Non conformity-----			
Granite and Supracrustals			

CHAPTER – 9

9.0.0 GEO PHYSICAL EXPLORATION

Geophysical/Geochemical survey was not carried out by MECL and it was also not proposed to the NMET for the approval.

CHAPTER – 10

10.0.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 OBJECTIVES OF INVESTIGATION

The exploration of Limestone deposits in the Amanganj–Gunnor–Pawai sector of Panna District has been undertaken with the following objectives:

The objective of the present proposal is-

1. To carry out a Topographical survey and Geological mapping on a 1:12,500 Scale for the demarcation of Limestone band for mineralization, with the structural features to identify the surface manifestations and lateral disposition of the mineralized zones.
2. Demarcation of various types of Limestone bands in the area, along with detailed lithology to identify the occurrence of Limestone within it.
3. To collect Geochemical samples (bedrock, old pits, cuttings, etc.) and analyze them for Limestone to pave the way for the further course of the exploration program.
4. To know the depth-wise and lateral continuity of the mineralization.
5. Attempt to delineate a block or more than one block to upgrade investigations in the G3 Stage.

10.2.0 EXPLORATION ACTIVITIES TAKEN UP

The project was started initially with the approval of NQT, vide Office Memorandum F.No.23/626/2025-NMET/1485 issued on 01-07-2025. with an estimated cost of Rs 86.26 lakhs from the National Mineral Exploration and Development Trust (NMEDT). Later on, NQT and cost of project was revised by NMEDT with vide Office Memorandum no. F. No. 23/626/2025-NMET/112 with a revised estimated cost of RS.44.95. ENGEOTECH Consultant, Jabalpur, has undertaken exploration activities in the designated areas. The details regarding the nature, scope, and quantum of works completed are presented in Table No. 10.1 & 10.2 below for Amanganj Gunnor Pawai Block of Panna District, Madhya Pradesh.

Table No. 10.1 Nature and Quantum of work as per Office Memorandum 23/626/2025-NMET/1485 issued on 01-07-2025.

S. No	Component / NQT	Quantity	Target	Achievement
1	Geological Mapping (1:12,500) & other Geological Work	93.13 Sq. Km	93.13 Sq. Km	93.13 Sq. Km
2	Survey Work			
i	DGPS Survey for Boundary Pillar & BH demarcation	15	15	15
3	Drilling	250m	250m	100m
4	Lab Work			
i	XRF (+10% check)	187	187	
ii	Specific Gravity Determination	10		5
iii	Petrological Studies	10	10	5

2.4 Nature & Quantum of work (Revised)

Table No. 10.2 Nature and Quantum of work as per Office Memorandum F. No. 23/626/2025-NMET/112.

S. No	Component / NQT	Quantity	Target	Achievement
1	Geological Mapping (1:12,500) & other Geological Work	93.13 Sq. Km	93.13 Sq. Km	93.13 Sq. Km
2	Survey Work			
i	DGPS Survey for Boundary Pillar & BH demarcation	15	15	15
3	Drilling	100 m	100 m	100m
4	Lab Work			
i	XRF (Core + Bed Rock)	40	40	40
ii	Specific Gravity Determination	5	5	5
iii	Petrological Studies	5	5	5

10.2.1 Topographical Survey

The block boundaries of Amanganj Gunnor Pawai Block are surveyed with the help of DGPS (LEICA GS14 make). For Amanganj Gunnor Pawai Block for 93.13 sq.km. GPS survey was

carried out using a pair of DGPS instrument. One DGPS Instrument was used as Base Station and the other DGPS instrument was working as Rover. Base station fixes at a stationary position while the Rover move by the survey team by walking along the Block Boundary and collect a survey point on each and every turn or bend from each point of the Block Boundary. The distance between the Base Station and rover was always less than 3 km. The survey was conducted in Real Time Kinematic (RTK) mode. Surface Contouring done at 2m contour intervals along with survey of surface features for Amanganj Gunnor Pawai Block (Scale 1:12,500). During current exploration boreholes are fixed on the ground. RL's and co-ordinates of survey and exploration points are determined by DGPS survey. The RL and co-ordinates of corner points and boreholes have been determined and furnished as Annexure-VII.

10.2.2 Geological Mapping

Geological mapping of the Amanganj Gunnor Pawai Block was carried out on a 1:12,500 scale covering an area of 93.13 sq.km. The block area is covered with soil/alluvium, and the same is marked in the Topographical and Geological Map enclosed as Plate-V on 1: 12,500 Scale.

10.2.3 Exploratory Drilling

In the present investigation, a cumulative 100 meters of drilling was executed utilizing in-house drilling rigs. The drilling operations began on 13/02/2026 and were completed on 26/02/2026. A total of 2 vertical boreholes, designated as BH-2 & BH-5. Each borehole depth was 50 meters below ground level, resulting in the recovery of 13 core samples.

10.3.0. DETAILS OF SURFACE SAMPLING, DRILLING, ETC.

10.3.1 A total of twenty-seven bedrock samples (BRS) were randomly collected from various Limestone exposures. From each location, several chips weighing over 1 kg were gathered to ensure representativeness. The collected chips were ground to a 120-mesh size fraction, thoroughly homogenized, and reduced to about 500 g using the coning and quartering method. Of this, approximately 250 g was sent to the Chemical Laboratory for analysis (FCI Aravalli Gypsum and Minerals India Limited (FAGMIL), Jodhpur, while the remaining portion was retained as a duplicate sample.

**Table No. 10.3 Details of 27 BRS samples of the Amanganj- Gunnor- Pawai Area
Block, Panna District, Madhya Pradesh**

S. No	Sample No	Latitude	Longitude	Lithology
1	AMANGANJ/S.NO. -1	24.37654	80.109616	Limestone
2	AMANGANJ/S.NO. -2	24.37661	80.149971	Limestone
3	AMANGANJ/S.NO. -13	24.42514	80.262635	Limestone
4	AMANGANJ/S.NO. -14	24.40103	80.218131	Limestone
5	AMANGANJ/S.NO. -15	24.3989	80.218706	Limestone
6	AMANGANJ/S.NO. -17	24.39841	80.218226	Limestone
7	AMANGANJ/S.NO. -18	24.39576	80.21698	Limestone
8	AMANGANJ/S.NO. -19	24.37704	80.166631	Limestone
9	AMANGANJ/S.NO. -20	24.39317	80.19821	Limestone
10	AMANGANJ/S.NO. -21	24.39454	80.200085	Limestone
11	AMANGANJ/S.NO. -22	24.39338	80.196098	Limestone
12	AMANGANJ/S.NO. -23	24.38694	80.190706	Limestone
13	AMANGANJ/S.NO. -25	24.39421	80.19065	Limestone
14	AMANGANJ/S.NO. -26	24.38421	80.190792	Limestone
15	AMANGANJ/S.NO. -27	24.38005	80.185031	Limestone
16	AMANGANJ/S.NO. -28	24.38807	80.198213	Limestone
17	AMANGANJ/S.NO. -29	24.37018	80.151542	Limestone
18	AMANGANJ/S.NO. -30	24.36967	80.151496	Limestone
19	AMANGANJ/S.NO. -32	24.40142	80.21734	Limestone
20	AMANGANJ/S.NO. -33	24.41156	80.222544	Limestone
21	AMANGANJ/S.NO. -35	24.37762	80.155624	Limestone
22	AMANGANJ/S.NO. -36	24.37718	80.152748	Limestone
23	AMANGANJ/S.NO. -37	24.37977	80.149171	Limestone
24	AMANGANJ/S.NO. -38	24.37777	80.147528	Limestone
25	AMANGANJ/S.NO. -40	24.40336	80.226056	Limestone
26	AMANGANJ/S.NO. -41	24.40458	80.220565	Limestone
27	AMANGANJ/S.NO. -42	24.41861	80.241665	Limestone
28	AMANGANJ/S.NO. -43	24.41805	80.239992	Limestone
29	AMANGANJ/S.NO. -44	24.41787	80.206643	Limestone

Chemical analysis of 27 BRS samples of Limestone shows variation in CaO (51.95% to 23.68%), Fe₂O₃ (0.705% to 0.530%), SiO₂ (49.108% to 4.182%), MgO (4.703% to 0.371%) and P₂O₅ (0.179% to 0.076%). A laboratory report is attached as Annexure-IV.

10.3.2 The Pearson Correlation Coefficient (r) is a fundamental statistical metric in geological reporting used to quantify the strength and direction of linear relationships between two continuous variables, such as the concentration of associated elements or the link between rock porosity and depth. Calculated as the covariance of two variables divided by the product

of their standard deviations, r ranges from -1.0 (perfect inverse relationship) to +1.0 (perfect direct relationship), providing a standardized value that is essential for identifying pathfinder elements, estimating ore reserves, and validating lithological models. It is a powerful tool for streamlining large datasets and identifying key geochemical drivers. The correlation matrix heatmap of the 27 bedrock samples is shown in Figure No.10.1.

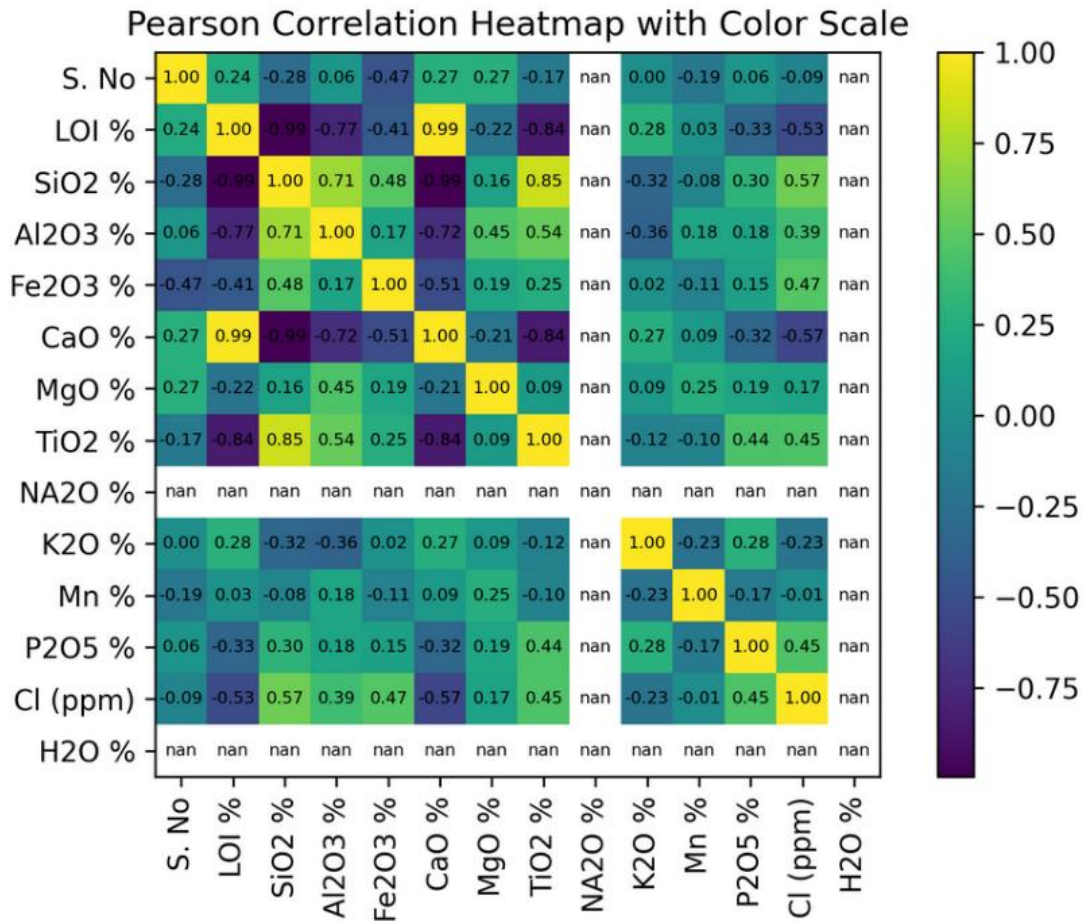


Figure No. 10.1 Correlation matrix heatmap of the 27 Bed rock samples.

10.3.3 Interpretation

Geochemical analysis of Bed Rock Samples (BRS) samples was collected from the study area was carried out to determine the major oxide composition and assess the quality and variability of limestone within the deposit. The analytical results indicate that the limestone is predominantly composed of CaO with significant Loss on Ignition (LOI), reflecting the carbonate nature of the formation, while minor constituents such as SiO₂, Al₂O₃, Fe₂O₃, MgO, and other trace oxides represent varying degrees of siliciclastic input and secondary influences. The observed variation in chemical composition suggests heterogeneity within the

deposit, controlled by depositional conditions as well as post-depositional processes. To further understand the inter-relationship between these constituents, a Pearson correlation analysis was carried out, wherein correlation coefficients ranging from -1 to +1 indicate inverse to direct relationships among variables. Strong correlations ($r \geq 0.7$) reflect significant geochemical association, whereas weak correlations indicate independent variation or mixed sources; certain parameters such as Na₂O and H₂O show negligible or undefined correlations due to limited or uniform data distribution.

Pearson's correlation matrix reveals several significant relationships that provide insight into the geochemical behavior of the rock. CaO and SiO₂ exhibit a very strong negative correlation ($r \approx -0.99$), indicating a dilution effect of silica within the carbonate matrix, where higher CaO values correspond to high-purity limestone and increased SiO₂ reflects siliciclastic contamination. In contrast, CaO and LOI show an extremely strong positive correlation ($r \approx +0.99$), confirming that CaO is predominantly present in the form of calcite (CaCO₃) and indicating high carbonate purity with minimal non-carbonate influence. SiO₂ and Al₂O₃ display a strong positive correlation ($r \approx +0.71$), suggesting a common detrital origin primarily from clay minerals, while SiO₂ and TiO₂ also show a strong positive correlation ($r \approx +0.85$), indicating association with heavy minerals and further supporting the detrital contribution to the silica fraction. Fe₂O₃ and CaO demonstrate a moderate negative correlation ($r \approx -0.51$), implying that iron is associated with non-carbonate phases such as clay minerals or iron oxides. MgO shows a weak negative correlation with CaO ($r \approx -0.21$), indicating limited dolomitization and confirming the dominantly calcitic nature of the limestone. K₂O exhibits moderate positive correlation with Al₂O₃ ($r \approx +0.36$), suggesting the presence of K-bearing clay minerals such as illite. P₂O₅, MnO and Fe₂O₃ show weak to moderate correlations with other oxides, indicating localized enrichment likely controlled by secondary or diagenetic processes rather than primary depositional factors. Based on the overall correlation behavior, the elements can be broadly grouped into three categories: a carbonate association group comprising CaO and LOI, which show strong positive correlation and represent the carbonate fraction of the rock; a siliciclastic association group comprising SiO₂, Al₂O₃, TiO₂ and K₂O, which exhibit positive inter-correlation and indicate detrital or clay input; and an accessory or diagenetic group including Fe₂O₃, MnO and P₂O₅, which display variable correlations suggesting secondary enrichment or post-depositional control. The correlation trends clearly indicate that the limestone deposit is predominantly calcitic in nature, with intermittent input of siliciclastic material. The strong inverse relationship between CaO and SiO₂ reflects mixing

between carbonate and detrital components during deposition, and the overall geochemical signature suggests a shallow marine carbonate platform environment periodically influenced by terrigenous influx. The weak correlation of MgO with CaO indicates minimal dolomitization, while variability in iron and manganese points to minor post-depositional alterations under oxidizing conditions.

From an economic and industrial perspective, the strong positive relationship between CaO and LOI signifies zones of high carbonate purity, making them suitable for cement-grade limestone, whereas increased SiO₂ and Al₂O₃ content indicates impurity-rich zones that may reduce the grade and require selective mining or beneficiation. Thus, the Pearson correlation analysis not only establishes the geochemical framework of the deposit but also aids in delineating high-grade and low-grade zones, thereby supporting resource evaluation and mine planning. Overall, the deposit is characterized by high carbonate purity with minor siliciclastic contamination, reflecting a carbonate-dominated depositional system with episodic clastic input, and is considered suitable for industrial applications, particularly in the cement sector.

Scatter plots of Bedrock samples (BRS)

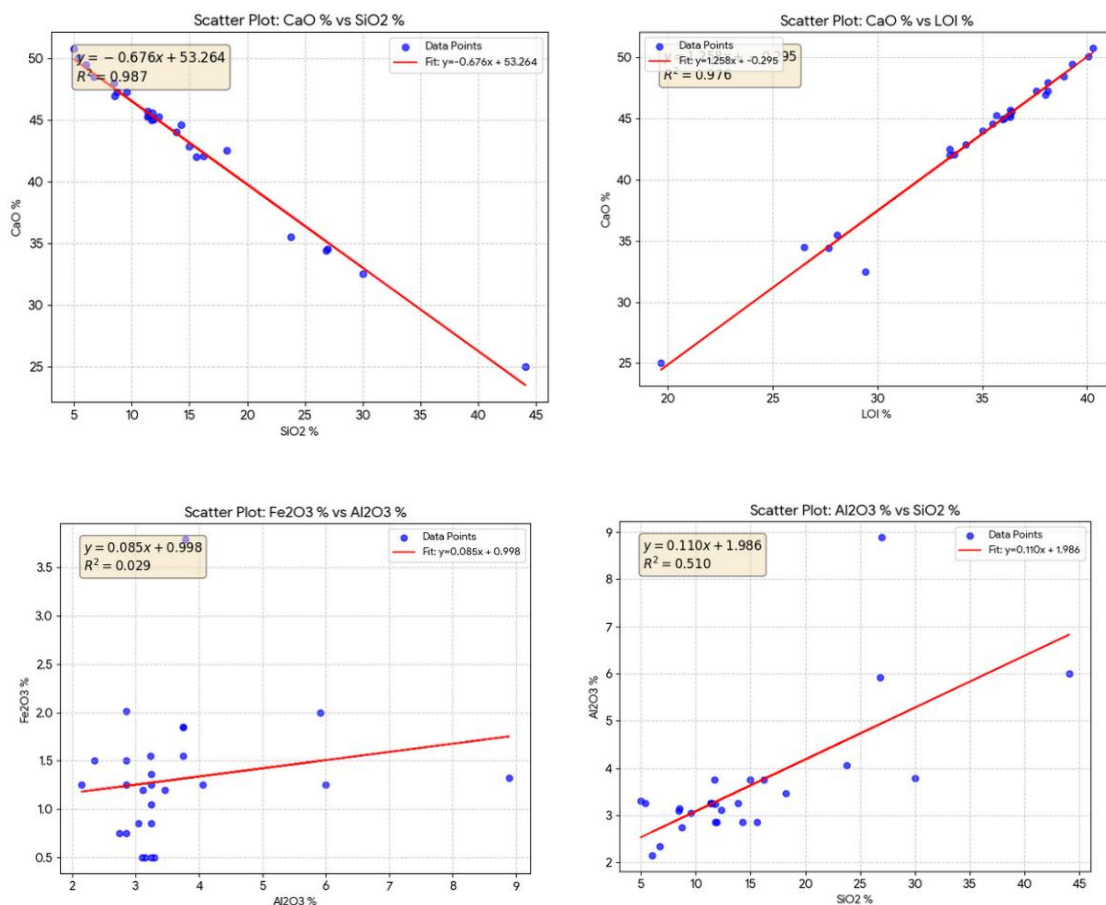


Figure No. 10.2 Scatter plots of Bedrock samples (BRS)

The geochemical relationships captured in these scatter plots offer a compelling visual narrative of the limestone's formation and quality within the Amanganj area. The striking alignment of data points along the regression lines reveals a high degree of mineralogical consistency across the Sirbu and Nagod Formations. For instance, the nearly perfect positive correlation between CaO and LOI acts as a chemical fingerprint for the carbonate fraction, where every increase in lime is mirrored by the volatile carbon dioxide bound within the rock.

Conversely, the sharp negative correlation between CaO and SiO₂ illustrates a geological "tug-of-war" between purity and impurity; as silicate minerals like quartz or clay infiltrate the deposit, the calcium carbonate is physically displaced, lowering the industrial grade of the stone. The moderate links between Al₂O₃, Fe₂O₃, and SiO₂ further suggest that these impurities aren't random but are likely tied to the presence of specific detrital clay minerals. By quantifying these trends through regression equations, we move beyond simple observation into predictive modeling, allowing for high-precision resource estimation and more effective quality control during potential extraction.

**Table No. 10.4 Statistical Analysis of Bedrock samples of exploration
Amanganj-Gunnor-Pawai Block**

	Mean	Standard Error	Median	Mode	Standard Deviation	Sample Variance	Range	Min.	Max.	Sum	Count
LOI %	34.68	0.91	36.04	36.33	4.71	22.22	20.59	19.68	40.27	936.26	27.00
SiO ₂ %	14.70	1.70	11.80	11.37	8.83	77.93	39.08	5.00	44.08	396.95	27.00
Al ₂ O ₃ %	3.60	0.26	3.25	3.25	1.36	1.84	6.74	2.15	8.89	97.23	27.00
Fe ₂ O ₃ %	1.30	0.13	1.25	1.25	0.67	0.45	3.29	0.50	3.79	35.18	27.00
CaO %	43.33	1.16	45.11	47.25	6.00	36.05	25.75	25.00	50.75	1169.96	27.00
MgO %	1.13	0.06	1.00	1.00	0.31	0.10	1.64	0.56	2.20	30.41	27.00
TiO ₂ %	0.31	0.03	0.28	-	0.16	0.03	0.73	0.11	0.84	8.42	27.00
Na ₂ O %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.00
K ₂ O %	0.55	0.04	0.62	0.48	0.22	0.05	0.87	0.08	0.95	14.80	27.00
So ₃ %	0.46	0.08	0.29	0.27	0.42	0.18	2.15	0.19	2.34	12.45	27.00
Mn %	0.39	0.04	0.37	#N/A	0.18	0.03	0.78	0.00	0.78	10.48	27.00
P ₂ O ₅ %	0.13	0.03	0.11	0.00	0.16	0.02	0.84	0.00	0.84	3.56	27.00
Cl (ppm)	249.19	18.67	224.00	165.00	97.02	9413.08	340.00	132.00	472.00	6728.00	27.00
H ₂ O %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	27.00

10.3.12 A total of 5 no. of samples were studied for petrological study and 5 no. of samples for bulk density determination, which are enclosed as Annexure-V and VI, respectively.

CHAPTER – 11

11.0.0 LOCATION DATA POINTS

11.1.0 ACCURACY AND QUALITY OF SURVEY USED TO LOCATE BLOCK BOUNDARY AND DRILL HOLES

11.1.1 The Amanganj–Gunnor–Pawai sector forms part of the southern and south-western tract of Panna District, Madhya Pradesh. Geographically, the area lies between Lat- 24° 21' 26.0255" N to 24° 26' 17.2038" N Long - 80° 06' 09.7290" E to 80° 17' 46.0408" E, covering portions of the administrative Tehsils of Amanganj, Gunnor, and Pawai. The region is bounded by Satna District to the north, Katni District to the south, and the Damoh District to the west. Area is covered by Toposheet no 63D/03 & 63D/07. Roads in the area are approachable by metalled and fair-weather roads from Panna town (district headquarters). The National Highway 39 (Jhansi–Nagpur) passes close to the district, while State Highways and district roads connect Amanganj, Gunnor, and Pawai with adjoining towns such as Katni, Satna, and Damoh. The nearest Railway station is located at Katni (approx. 60–70 km), Satna (approx. 80–90 km), and Damoh (approx. 100 km), all lying on major trunk routes of the Western Central Railway. From these junctions, the area is accessible by road transport. Airways: The nearest airport is at Khajuraho (about 90–100 km), which provides scheduled flights to Delhi and other metropolitan centers. Local Access: Within the area, village roads and forest tracks provide communication between settlements and field localities. During monsoon months, certain interior tracts become difficult to access due to flooding of streams and deterioration of unmetalled roads.

11.1.2 The Topographical survey, Borehole connection and Block Boundary demarcation in this block has been carried out by the LEICA VIVA GS14 Instrument. Details of Base Station and its details are given below.

Table No. 11.1 Co-ordinate of the Primary control point

POINT NAME	LONGITUDE			LATITUDE			UTM	
	D	M	S	D	M	S	Easting (X)	Northing (Y)
BASE1	80	06	44.86	24	22	09.88	409984.63 E	2695414.17 N
BASE2	80	13	23.61	24	22	26.78	421221.85 E	2695866.63 N
BASE3	80	16	37.75	24	22	42.02	426693.68 E	2696305.83 N
BASE4	80	15	19.58	24	25	03.38	424514.86 E	2700665.31 N
BASE5	80	08	45.45	24	24	25.94	413407.89 E	2699577.75 N

11.1.3 TECHNICAL SPECIFICATIONS OF DGPS

Make: LEICA VIVA GS14

Model: CS10

Year: 2018

Measurement Accuracy:

Static Mode

Horizontal: 3 mm + 0.1 ppm or better

Vertical: 3.5 mm + 0.4 ppm or better

11.1.4 Baseline Processing Results:

Total 10 no. of block boundary corner points and 2 no. of Boreholes points have been fixed by ENGEOTECH, Jabalpur as part of present G4 stage exploration. Co-ordinates & Reduced level (RL) of the borehole are given in Table No.11.1 and Table No.11.2.

Table No. 11.1 DGPS Surveyed Boundary Co-Ordinates of Block.

BP No.	UTM Co-Ordinates		Geographical Co-Ordinates	
	X	Y	Latitude	Longitude
A	409906.758	2694065.742	24° 21' 26.0255" N	80° 06' 42.4022" E
B	421208.501	2695245.043	24° 22' 06.5686" N	80° 13' 23.2597" E
C	425746.763	2694982.838	24° 21' 58.8455" N	80° 16' 04.3858" E
D	426079.253	2695045.372	24° 22' 00.9355" N	80° 16' 16.1751" E
E	428617.149	2696222.265	24° 22' 39.6245" N	80° 17' 46.0408" E
F	424812.989	2702934.394	24° 26' 17.2038" N	80° 15' 29.7342" E
G	424103.92	2702493.392	24° 26' 02.7420" N	80° 15' 04.6379" E
H	415467.347	2699448.653	24° 24' 22.1504" N	80° 09' 58.5946" E
I	413138.948	2697944.434	24° 23' 32.7854" N	80° 08' 36.2598" E
J	408998.549	2695993.451	24° 22' 28.5068" N	80° 06' 09.7290" E

Table No.11.2: Details of Drilled boreholes in Amanganj-Gunnor-Pawai Block, Panna district, Madhya Pradesh.

BH-No	Latitude	Longitude	Surface RL(m)	Bottom RL (m)	Depth of BH	Date of Commence ment	Date of Closing
BH-2	24°23'10.83"N	80°11'21.026"E	319.5	269.5	50	2026-02-19	2026-02-26
BH-5	24°25'12.708"N	80°14'0.004"E	338.5	288.5	50	2026-02-13	2026-02-26

11.2.0 QUALITY AND ADEQUACY OF TOPOGRAPHIC CONTROL

11.2.1 The survey work has been carried out with the help of DGPS (LEICA VIVA GS14) for higher-level measurement accuracy. A detailed DGPS survey report is attached as Annexure-VII. Survey work carried out by the experienced, qualified surveyor as per the prevailing standard procedures.

CHAPTER – 12

12.0.0 SAMPLING TECHNIQUES

12.1.0 NATURE AND QUALITY OF SAMPLING AND MEASURES TAKEN TO ENSURE SAMPLE REPRESENTATIVITY

12.1.1 The sampling and analyses have been carried out for the entire length encountered in boreholes drilled on a visual identification basis. The primary samples have been marked in the zones based on type and concentration of mineralization/lithology, and in general, the sample length has been kept as 1.00 m to 2.00 m, which varies in some instances because of variation in lithology and type. The core has been split into two halves in such a way that the concentrations of ore minerals are uniform in both halves. One-half of the core sample has been crushed to (-) 200 mesh size. By progressive coning and quartering and repeatedly mixing the sample has been reduced to 600 g. A representative sample of 200 g has been collected and analyzed for CaO, MgO, Al₂O₃, SiO₂, Fe₂O₃, Na₂O, SO₃, TiO₂, P₂O₅, K₂O, Cl and LOI at Chemical Laboratory of FCI Aravali, Gypsum and Minerals Ltd, Jodhpur (NABL Accredited).

12.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

12.2.1 The details of the sampling procedure for primary samples are described in Para 12.1.1. Quality of the sample preparation is maintained by proper cleaning, maintenance of the equipment, and proper crushing, sieving, and coning and quartering of samples. For sample preparation, proper technique and expertise have been used.

12.3.0 QUALITY CONTROL PROCEDURES ADOPTED

12.3.1 The primary core samples have been collected from the entire length intersected in the boreholes drilled, and the samples have been prepared at the centralized mechanized sampling unit. The standard sampling procedure in supervision of a qualified sampling technician has been adopted to control the quality of samples. Similarly, internal check and external check samples have also been prepared under the supervision of a qualified sampling technician following the standard sampling procedure.

12.4.0 MEASURES TAKEN TO ENSURE THE SAMPLING IS REPRESENTATIVE OF THE IN-SITU MATERIAL COLLECTED

12.4.1 All the primary samples have been marked and prepared from cores. During the preparation of primary samples, the cores have been studied meticulously, and samples have been marked properly. These cores are subjected to preparation of primary samples as per the sampling procedure for primary samples are described in Para 12.1.1. The proper marking of primary samples from drilled cores and following the standard procedure for sample preparation shows that the representative samples have been collected from the in-situ materials.

12.5.0 WHETHER SAMPLE SIZES ARE APPROPRIATE TO THE GRAIN SIZE OF THE MATERIAL BEING SAMPLED

12.5.1 The primary samples have been prepared (-) 200 mesh size, and all the other samples have been prepared from the primary samples. As per the previous studies in the area, (-) 200 mesh size is appropriate for the analysis of limestone mineralization in the block area.

CHAPTER – 13

13.0.0 DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

Drilling constitutes a fundamental component of mineral exploration, serving to delineate the subsurface configuration of mineralized bodies and to facilitate the development of three-dimensional models of mineralization. In the present investigation, a cumulative 100 meters of drilling was executed utilizing in-house drilling rigs. The drilling operations began on 13/02/2026 and were completed on 26/02/2026. A total of 2 vertical boreholes, designated as BH-2 & BH-5. Each borehole depth was 50 meters below ground level. The details of drilled boreholes are given in Table No.13.1.

Table No. 13.1 Details of Drilled boreholes in Amanganj-Gunnor-Pawai Block, Panna district, Madhya Pradesh.

S. No	BH-No	Latitude	Longitude	Surface RL(m)	Bottom RL (m)	Depth of BH	Date of Commencement	Date of Closing
1	BH-2	24°23'10.83"N	80°11'21.026"E	319.5	269.5	50	2026-02-19	2026-02-26
2	BH-5	24°25'12.708"N	80°14'0.004"E	338.5	288.5	50	2026-02-13	2026-02-26
Total Depth						100 m	-	-

13.1.2 The Drilling operation in the block was performed by a skid-mounted Voltas - 90 Drill Rig. All the boreholes in the block were drilled in NQ size with double-tube barrel wire line, using the wet core drilling method. Initially, 0.00 m to 6.00m NX casing was set in each borehole by using a NX casing short piece. After setting the NX casing, drilling advanced in NQ size to the total depth of each borehole. Drilling was done by an NQ Diamond bit till closure of the borehole.

13.1.3 The quality of drilling was ensured during the operation. After closure, all the boreholes have been properly plugged and sealed with cement pillars.

13.2.0 DEVIATION SURVEY IN DRILLING

13.2.1 All the exploratory boreholes drilled in the block are vertical and drilled up to 50m depth in each of the boreholes BH-02 and BH-05. Since the depth is shallow and no deviation occurred hence deviation survey was not performed for the boreholes.

13.3.0 WHETHER CORE AND CHIP SAMPLE RECOVERIES HAVE BEEN PROPERLY RECORDED AND RESULTS ASSAYED

13.3.1 The core samples have been recorded properly, and the detailed borehole-wise run-wise lithologs and summarized lithologs for boreholes are given in Annexure I. The run-wise lithologs of drilled core as well as the cuttings from boreholes, have helped in discerning the physical characters like colour, shape, size, and nature of the rock, as well as texture, structural features, and identification of different litho units.

13.4.0 MEASURES TAKEN TO MAXIMIZE SAMPLE RECOVERY AND ENSURE REPRESENTATIVE NATURE OF THE SAMPLES

13.4.1 The drilling has been done by an NQ-size diamond drill bit with single-barrel wire line, wet core drilling method. Initially, 0.00m to 6.00m NX casing was set in each borehole by using NX casing short piece. After setting NX casing, drilling advanced in NQ size till NX casing was set in the drilled ranging from 10m to 25m, depending on the formation of the boreholes. The polymer was used as drilling fluid to flush out the cuttings and stabilize the borehole wall. The drilling fluid also works as a coolant to avoid the burning of drill bits. Proper core recovery of more than 90% was maintained by using a double-tube core barrel; however, in the case of weathered, loose, and fractured zones and in solution cavities, the core recovery was low. Whenever core recovery is less, the grade of the recovered portion is extrapolated over the non-recovered section. However, all the precautions like modulated water pressure, proper liner, optimum head pressure, and the hands of an expert drilling technician had been taken to maintain the quality of drilling.

13.5.0 WHETHER CORE AND CHIP SAMPLE RECOVERIES HAVE BEEN PROPERLY RECORDED AND RESULTS ASSAYED

13.5.1 The core samples have been recorded properly, and the detailed borehole-wise run-wise lithologs and summarized lithologs for boreholes are given in Annexure-I. The run-wise lithologs of drilled core as well as the cuttings from boreholes have helped in discerning the physical characters like color, shape, size and nature of the mineralization as well as texture, structural features and identification of different litho units.

13.6.0 CORE LOGGING

13.6.1 The core recovered by drilling was logged systematically in detail describing lithological units with mineralisation details that can be observed by visual inspection. The details of lithology, grain size, colour, texture, structural features, presence of intercalations and cavities have been recorded. Wherever the recovery is less than 100%, extrapolations of drilled depth were done on proportionate basis considering the physical characteristics of individual units recovered. All the cores were kept and preserved properly in the GI core boxes of specifications given by NMEDT following “Book pattern”. The detailed run wise lithologs and summarized lithologs for boreholes are given in Annexure- I.



Figure No. 13.1 Drilling Operations in the Amanjanj Gunnor Pawai Block Panna District, M.P

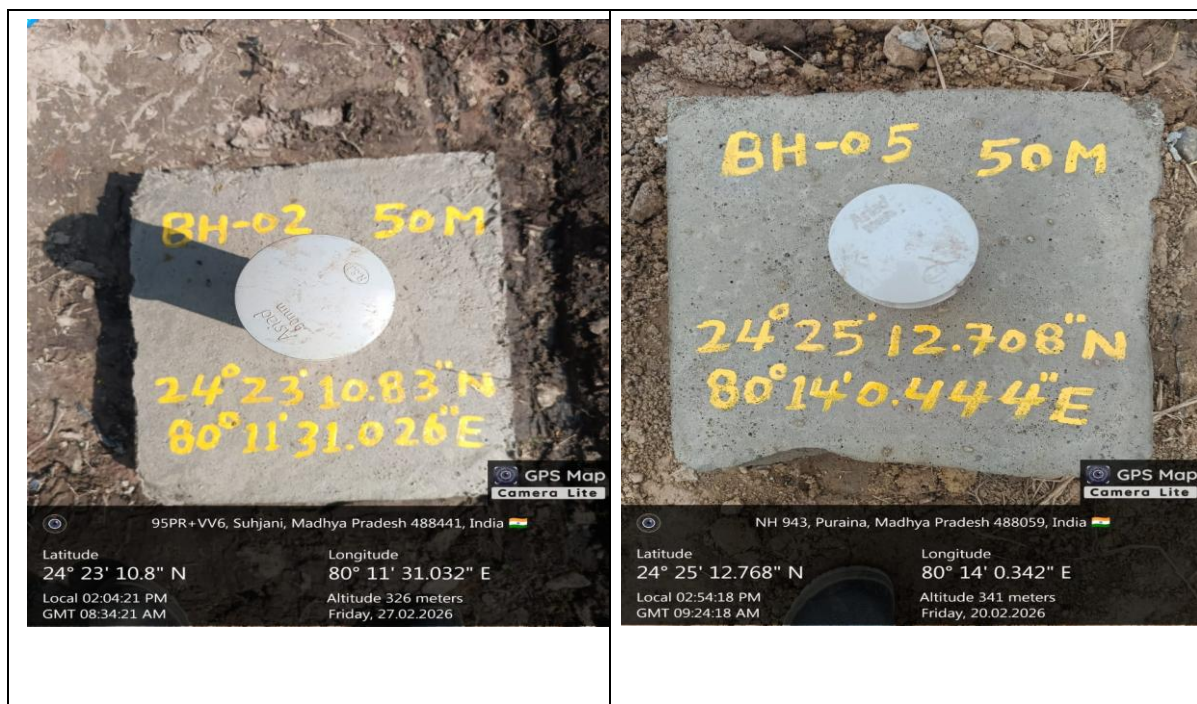


Figure No. 13.2 Photograph showing Bore Closer of Drilled Borehole BH-02 & BH-05

Core Photographs:



Figure 13.3 Sample photographs of the core of Amanganj-Gunnor-Pawai Block of BH-2 & BH-5.

Lithologs

BH-2

BH-5

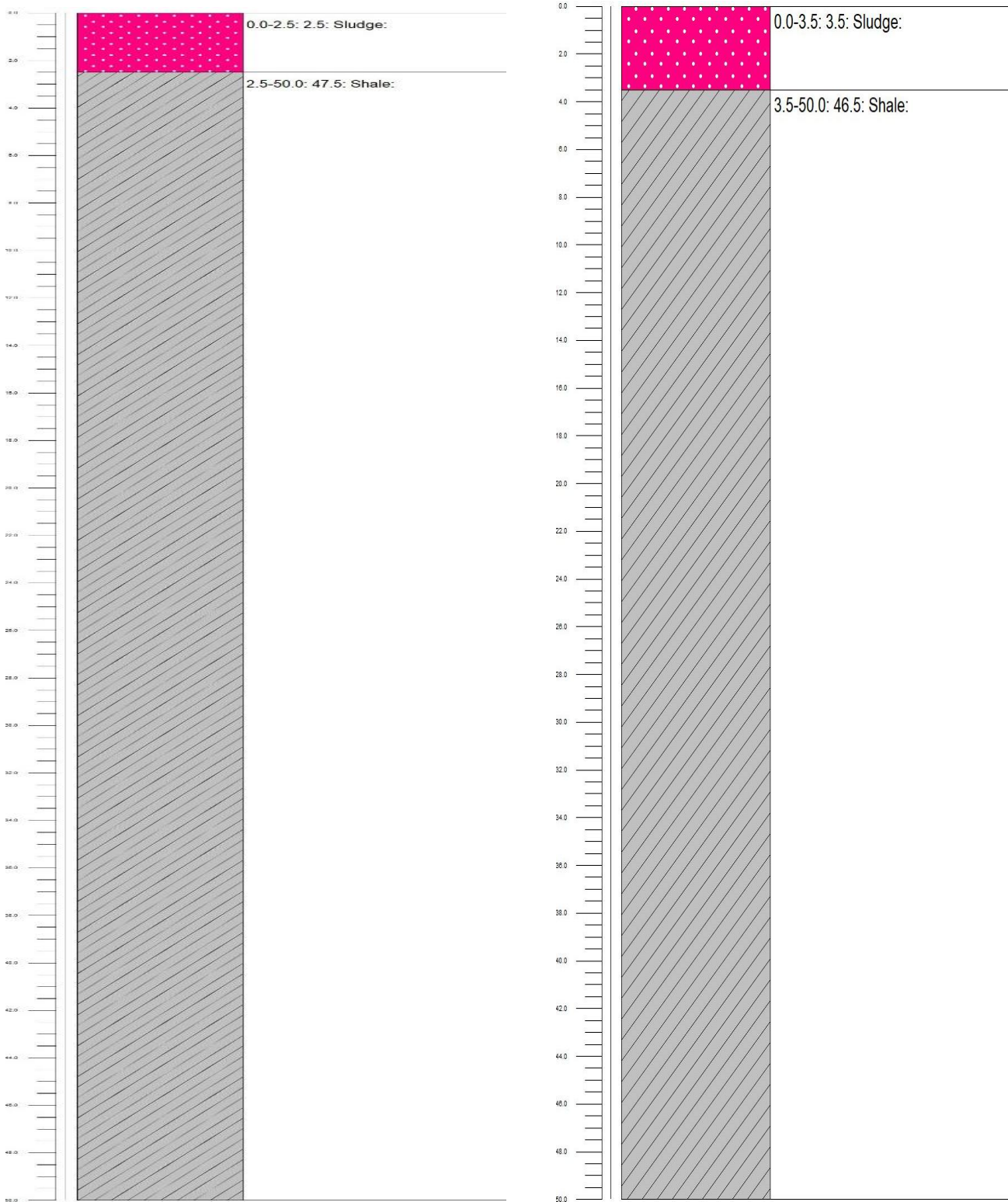


Figure No 13.4. Lithologs of BH-2 & BH-5

CHAPTER – 14

14.0.0 SUB SAMPLING TECHNIQUES AND SAMPLE PREPARATION

14.1.0 WHETHER CUT OR DRAWN AND WHETHER QUARTER, HALF, OR ALL CORE TAKEN

14.1.1 The core sampling and chemical analysis of core samples have been carried out for the entire length intersected in the boreholes drilled. Samples were marked in the appropriate zones on the basis of visual inspection. The core has been split into two halves by a core splitter in such a way that the concentrations of ore minerals are uniform in both halves. The whole quantity of half portion of the sample was crushed to (-) 200 mesh, and about 600g representative sample was drawn by coning and quartering method of gradual size reduction with the help of a crusher and pulverizer. Two sample pouches weighing 200g each were drawn, one of which was analyzed for analysis of 13 radicals CaO, MgO, Al₂O₃, SiO₂, Fe₂O₃, Na₂O, SO₃, TiO₂, P₂O₅, K₂O, Cl, and LOI were analyzed in at Chemical Laboratory of MECL, Nagpur and external check samples were analyzed in FCI Aravali Gypsum and Minerals India Limited. (FAGMIL Jodhpur, NABL-accredited Laboratory). The remaining 200g fraction was kept for future purposes, including composite sample analysis etc.

14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

14.2.1 Quality of the sample preparation is maintained by proper cleaning, maintenance of the equipment, and proper crushing, sieving and coning and quartering of samples. For sample preparation, proper technique and expertise has been used.

14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

14.3.1 The primary core samples have been collected from the entire length intersected in the boreholes drilled and the samples have been prepared at the centralized mechanized sampling unit, ENGEOTECH, Jabalpur. The standard sampling procedure in supervision of a qualified sampling technician has been adopted to control the quality of samples. Similarly, external check samples have also been prepared under the supervision of a qualified sampling technician following the standard sampling procedure and analysed at FCI Aravali Gypsum and Minerals India Limited. (FAGMIL Jodhpur, NABL-accredited Laboratory) Lab.

14.4.0 MEASURES TAKEN TO ENSURE THE SAMPLING IS REPRESENTATIVE OF THE INSITU MATERIAL COLLECTED

14.4.1 All the primary samples have been marked and prepared from cores. During the preparation of primary samples, the cores have been studied meticulously and samples have been marked properly. These cores are subjected for preparation of primary samples as per the sampling procedure for primary samples are described in Para 14.1.0. The proper marking of primary samples from drilled cores and following standard procedure for sample preparation shows the representative samples have been collected from the in-situ materials.

14.5.0 WHETHER SAMPLE SIZES ARE APPROPRIATE TO THE GRAIN SIZE OF THE MATERIAL BEING SAMPLED

14.5.1 The primary samples have been prepared (-) 200 mesh size and all the other samples have been prepared from primary samples. As per the previous studies in the area (-) 200 mesh size is appropriate for the analysis of limestone etc. mineralization in the block area.

CHAPTER – 15

15.0.0 QUALITY OF ASSAY DATA AND LABORATORY TESTS

15.1.0 THE NATURE, QUALITY AND APPROPRIATENESS OF THE ASSAYING AND LABORATORY PROCEDURES

15.1.1 The primary samples from the drilled core have been analysed for 13 radicals i.e., CaO, MgO, Al₂O₃, SiO₂, Fe₂O₃, Na₂O, SO₃, TiO₂, P₂O₅, K₂O, Cl and LOI by in Chemical Laboratory FCI Aravali Gypsum and Minerals India Limited. (FAGMIL Jodhpur, NABL accredited Laboratory) Lab. No Limestone zones were encountered in the drilled boreholes, namely BH-2 & BH-5 therefore, check sample analysis was not carried out in the present study.

15.2.0 STANDARD OPERATING PROCEDURE (SoP) FOR THE ANALYSIS BY FCI ARAVALI GYPSUM AND MINERALS INDIA LIMITED. (FAGMIL JODHPUR, NABL ACCREDITED LABORATORY) LAB.

CHEMICAL ANALYSIS

1. Pellet Method (using ED XRF)

2. ED XRF

Procedure for Preparation of Pellets by Hydraulic Press:

For XRF measurement a sample must be homogenized, pulverized to -100 mesh and pressed into pellet.

- (i) Weigh accurately 5 gms of sample and used 10 gms of boric acid as a binder
- (ii) Press the sample at a pressure of around 20-22 tons on a hydraulic press (Pallet Making Machine) with a diameter of 40 mm
- (iii) Calibrate the EDXRF equipment using known standards for elements present in limestone (Calcium, Magnesium etc)
- (iv) Ensure the instrument is set up correctly according to standard guidelines
- (v) Place the prepared pellet into the sample holder
- (vi) Ensure the sample cup is positioned correctly in the instrument for carrying out the analysis
- (vii) Start the EDXRF analysis using the software and initiate the analysis process automatically

- (viii) Allow the EDXRF instrument to scan the sample. It will emit X-rays onto the sample, causing the atoms to emit fluorescence
- (ix) Record the results in a report, including elemental concentrations and any relevant information about the analysis conditions
- (x) Intermediate check also performed using a bead with in-built software

LOSS ON IGNITION

WCL procedure for determination of LOI:

Weighted quantity of sample (duly dried at 110 °C) is placed in a platinum crucible and heated to 1000 °C for about an hour. The sample is again weighted after it is cooled. Difference in weight expressed in percentage as LOI.

15.3.0 STANDARD OPERATING PROCEDURE (SoP) FOR THE DETERMINATION OF LOSS ON IGNITION (L.O.I.) AT FCI ARAVALI GYPSUM AND MINERALS INDIA LIMITED. (FAGMIL JODHPUR, NABL ACCREDITED LABORATORY) LAB.

Procedure

1. Weigh 1 g of dry sample in a Silica or platinum crucible.
2. Place this crucible in the muffle furnace at a temperature below 300°C. Raise the temperature of the furnace to 1000°C. Keep this at this temperature for about 30 minutes.
3. Cool the crucible in desiccators and weigh the crucible.
4. Find the loss in weight.
5. % Loss on Ignition (LOI) = $\frac{\text{Loss in weight}}{\text{Sample Weight}} \times 100$

15.4.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.4.1 To ensure the accuracy of the analysed samples, **NCSDC-16006** has been used as certified reference material. The Certified Reference Material (CRM) was processed under similar conditions as samples and run after every 20 samples.

15.4.2 Because no mineralization for limestone was encountered in the entire drilled borehole BH-2 & BH-5 therefore no external check samples have been analyzed in the present investigation.

15.5.0 DETAILED CORE SAMPLES ANALYSIS

15.5.1 A total of 13 core samples were systematically collected at 1-meter intervals using standard rotary drilling procedures to ensure consistency and representativeness of the subsurface material. Each recovered core was carefully split into two halves immediately after extraction. One-half was designated for sample preparation and subsequent laboratory analysis, while the other half was securely stored in labelled core boxes for archival purposes and later submission to the state unit GSI, Bhopal, thereby maintaining a permanent record of the drilling program.

The preparation of the analytical half involved several standardized steps designed to minimize contamination and preserve the integrity of the samples. Initially, the cores were crushed to reduce particle size, followed by fine powdering to achieve uniformity. The powdered material was then sieved using a –120 mesh ASTM standard brass sieve, ensuring that only particles of the required grain size were retained for further processing. To guarantee homogeneity, the sieved powders were subjected to coning and quartering, a widely accepted technique for reducing sample bias and achieving representative subsamples. The homogenized powders were subsequently packed in airtight polythene bags, each clearly labelled with sample identification codes, depth intervals, and drilling details to facilitate traceability.

For quality assurance, the prepared material was divided into two portions. One portion was retained as the original reference sample, securely stored to serve as a backup for future verification or reanalysis. The second portion was dispatched to the Chemical Laboratory in FCI Aravali, Gypsum and Minerals Ltd, Jodhpur, for detailed geochemical characterization. Analytical procedures focused on the determination of major oxides, including calcium oxide (CaO), silicon dioxide (SiO₂), magnesium oxide (MgO) aluminum oxide (Al₂O₃), and ferric oxide (Fe₂O₃). These oxides were selected due to their significance in understanding lithological composition, mineralogical variations, and geochemical processes within the sampled strata.

This systematic workflow from drilling and core handling to sample preparation, storage, and chemical analysis was designed to ensure reproducibility, minimize contamination, and provide reliable geochemical data for subsequent interpretation of the geological setting. The chemical analysis of thirteen (13) borehole core samples collected from BH-2 and BH-5 indicates significant variation in major oxide composition, reflecting heterogeneity in

lithology and carbonate content across the explored interval. The analytical results show that SiO₂ ranges from 32.80% to 61.30%, Al₂O₃ from 4.98% to 15.10%, Fe₂O₃ from 2.10% to 9.80%, CaO from 2.52% to 29.50%, MgO from 0.42% to 3.11%, and Loss on Ignition (LOI) from 5.93% to 24.95%. The relatively high silica (SiO₂) content, particularly in several samples exceeding 50%, indicates dominance of siliceous material such as quartz and suggests significant contamination or intercalation with shale and sandstone units. The Al₂O₃ and Fe₂O₃ values are moderate to high, reflecting the presence of clay minerals and ferruginous constituents, which further degrade the purity of limestone. The CaO content, which is the principal indicator of limestone quality, shows considerable variability and generally remains low to moderate (mostly between 10% and 30%), with only a few samples approaching marginally acceptable carbonate levels. This indicates that the carbonate fraction is inconsistent and diluted by non-carbonate impurities. Correspondingly, LOI values, which broadly represent carbonate content (mainly CO₂ loss from calcite), also show wide variation and are relatively low in many samples, supporting the inference of poor to moderate limestone development. The MgO content remains low to moderate (<3.5%), suggesting limited dolomitization; however, this does not compensate for the high silica and alumina content that adversely affects overall grade. From an industrial and economic perspective, cement-grade limestone typically requires CaO > 42% and low silica/alumina, which is not achieved in any of the analyzed samples. Instead, the chemical composition indicates that the studied intervals are dominated by argillaceous and siliceous lithologies with subordinate carbonate content, rather than high-purity limestone. Overall, the geochemical data clearly demonstrate that the limestone encountered in the boreholes is impure, heterogeneous, and of sub-economic grade, with significant lateral and vertical variability. These results corroborate field observations and petrographic studies, confirming that the limestone horizons are thin, discontinuous, and heavily contaminated, thereby precluding their classification as economically viable mineral resources at the current stage of exploration.

A Pearson correlation analysis was conducted on the two boreholes (BH-2 & BH-5) chemical data. Analysis is as follows.

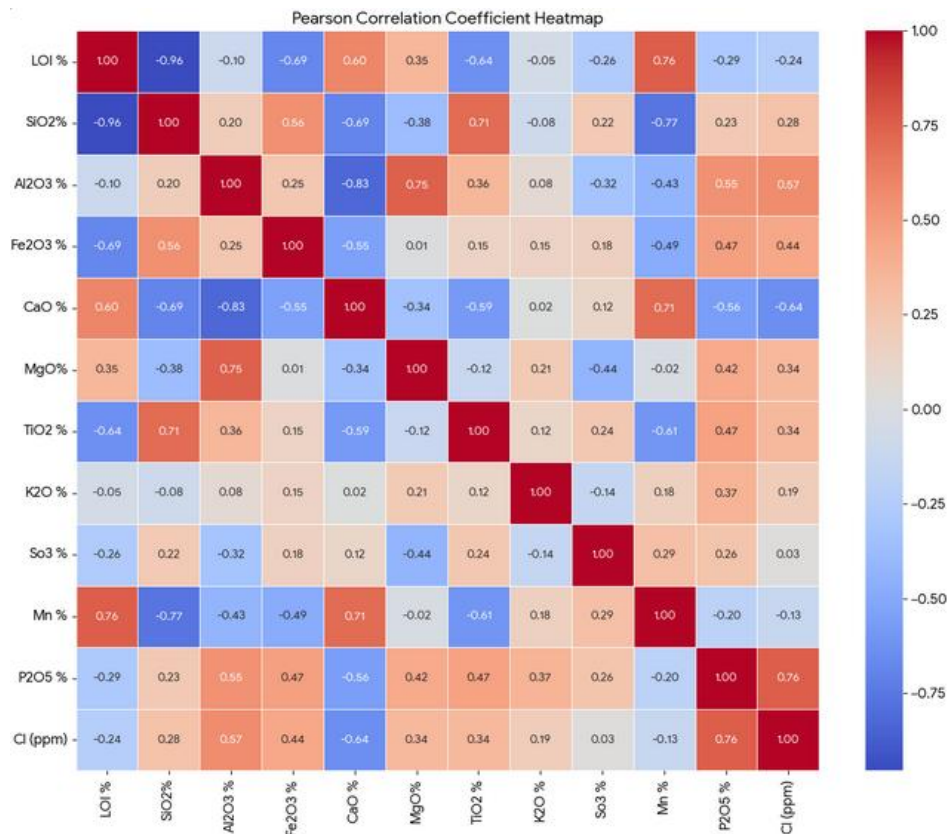


Figure No.15.1. Showing the correlation matrix heatmap of the 13-core samples.

The Pearson correlation heatmap of core samples reveals several significant geochemical relationships that characterize the lithological variations within the Amanganj-Gunnor-Pawai block area. Geologically, these correlations reflect the competition between carbonate sedimentation and siliciclastic input:

- **Carbonate vs. Siliciclastic Antagonism:** There is a strong negative correlation between SiO₂ and CaO (approx. -0.69). This is a classic geological indicator of a shifting depositional environment. As the concentration of calcite (CaO) increases, the proportion of detrital quartz and silicates (SiO₂) decreases. This suggests primary facies change from relatively "pure" limestone to more siliceous or argillaceous (Shaly) limestone.
- **Volatiles and Calcification:** A strong positive correlation exists between Loss on Ignition (LOI %) and CaO (approx. $+0.60$). In this geological context, LOI primarily represents the CO₂ released during the calcination of carbonate minerals ($\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$). The high correlation confirms that the CaO in your samples is hosted within carbonates rather than silicate minerals like plagioclase.
- **Detrital Input Markers:** The positive correlation between Al₂O₃ and TiO₂ (approx.

+0.36) indicates the presence of terrigenous clay minerals. Titanium is often hosted in heavy minerals (like ilmenite or rutile) or associated with clay lattices that are transported into the basin from land. This suggests that as more mud/clay was deposited, the supply of titanium-bearing minerals also increased.

- Independent Mineral Phases: The near-zero correlation between Fe_2O_3 and MgO (approx. +0.01) is particularly interesting. It suggests that magnesium is not tied to iron-bearing minerals (like ferroan dolomite or biotite) but likely exists in a separate phase, such as relatively iron-pure dolomite or within the limestone matrix itself, while iron might be concentrated in oxides or sulphides unrelated to the magnesium content.

These relationships indicate a dynamic sedimentary system where the purity of the limestone is modulated by periodic influxes of terrestrial silicates and oxides. The data points toward a transitional environment where carbonate precipitation was frequently interrupted by the deposition of clay and silt-sized detritus.

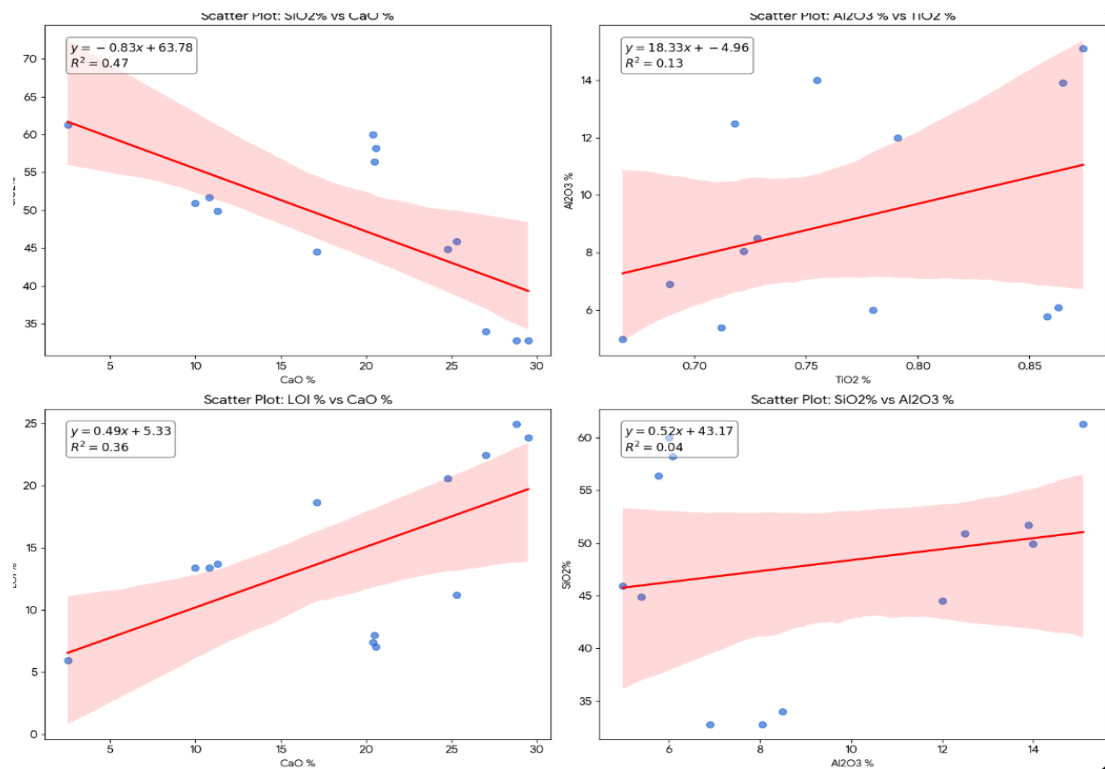


Figure No.15.2 Showing the scatter plots of BH-2 & BH-5 Chemical analysis.

The geological interpretation of these scatter plots provides insight into the depositional environment and the geochemical evolution of the limestone sequences in the Amanganj area. Each regression line mathematically represents a specific geological process:

1. SiO₂ vs. CaO (The Carbonate-Siliciclastic Dilution Trend)

The negative slope in this plot represents the "dilution effect." Geologically, this indicates a competition between two primary sediment sources: biogenic/chemical carbonate precipitation (CaO) and detrital silicate input (SiO₂). Pure Limestone End-member: High CaO and low SiO₂ represent periods of clear, warm, shallow marine conditions favorable for carbonate deposition. Siliciclastic End-member: As SiO₂ increases, it signifies a higher influx of terrigenous material (sand or silt) from a nearby landmass, likely due to increased weathering or sea-level changes. The regression line suggests that for every unit increase in silica, there is a predictable displacement of carbonate matrix.

2. Al₂O₃ vs. TiO₂ (The Detrital Provenance Marker)

The positive correlation here is a hallmark of "immobile element" behavior. Both Aluminum and Titanium are typically associated with the fine-grained clay fraction of a sediment. Since Al is a major component of clay minerals (like kaolinite or illite) and Ti is often hosted within the lattice of these clays or in very stable heavy minerals, their covariance indicates they are being transported together from the same source area. Higher values on this plot indicate "muddier" or more argillaceous intervals within the core, reflecting lower-energy depositional conditions where fine suspended particles could settle.

3. LOI vs. CaO (The Mineralogical Confirmation)

The strong positive regression confirms the mineralogical form of the calcium in your samples. Loss on Ignition (LOI) in these samples is primarily the CO₂ driven off during the thermal decomposition of Calcite (CaCO₃).

The borehole-wise chemical distribution is as follows:

Borehole No. - BH-2:

The chemical analysis of samples from BH-2 (2–13 m depth interval) indicates a highly heterogeneous lithological sequence with alternating carbonate and non-carbonate units. The SiO₂ content ranges from 32.80% to 58.20%, showing dominance of siliceous material in most intervals, particularly between 4–7 m and 10–11 m, where silica exceeds 50%, indicating shale/sandstone intercalations. The Al₂O₃ (4.98–14.00%) and Fe₂O₃ (2.10–9.80%) values are moderate to high, reflecting significant clay and ferruginous impurities. The CaO content

varies from 0.00% to 28.80%, with relatively higher values observed in shallow (2–3 m) and some intermediate depths (7–8 m, 11–13 m), suggesting thin and impersistent carbonate bands. However, these values are still below the threshold for cement-grade limestone. The LOI values (7.06–24.95%) broadly correlate with CaO, confirming variable carbonate content, while MgO remains low (<3%), indicating negligible dolomitization. Overall, BH-2 represents an interbedded argillaceous-siliceous sequence with subordinate limestone lenses, showing poor vertical continuity of carbonate horizons. The chemical signatures clearly indicate that the limestone is impure, discontinuous, and uneconomic, with frequent transitions into shale-rich units.

Borehole No. - BH- 05:

The chemical data from BH-5 (12–46 m depth interval) also indicate predominantly siliceous and argillaceous lithology, with limited carbonate development. The SiO₂ content is consistently high (32.80% to 61.30%), particularly at deeper levels (35–46 m), confirming dominance of silica-rich rocks. The Al₂O₃ values (up to 15.10%) and Fe₂O₃ (3.50–7.04%) further support the presence of clayey and ferruginous materials. The CaO content ranges from 2.52% to 29.50%, with only one sample (33–34 m) showing relatively higher carbonate content (29.50%), while other samples remain low (20% or less), indicating isolated and thin carbonate zones rather than continuous limestone beds. The LOI values (5.93–23.87%) show variability but are generally lower in high-silica zones, reinforcing the interpretation of reduced carbonate content. MgO values (<3.5%) suggest minimal dolomite influence. At deeper levels (45–46 m), the extremely low CaO (2.52%) and high SiO₂ (61.30%) indicate almost complete dominance of non-carbonate lithology, likely shale or siliceous rock. Summarizing the analysis of BH-5 demonstrates a predominantly non-calcareous sequence with sporadic carbonate enrichment, lacking both thickness and continuity required for resource delineation.

CHAPTER – 16

16.0.0 MOISTURE

16.1.0 All the analyses of borehole core samples have been carried out with natural moisture.

CHAPTER – 17

17.0.0 BULK DENSITY

17.1.0 BULK DENSITY ANALYSIS DETAILS

17.1.1 The Bulk density of the bedrock samples was tested at the NABL-accredited Geotechnical Lab (RKCT Lab. Pvt. Ltd.) in Jabalpur. The results showed an average of 2.54 gm/cc bulk density in the 5 BRS samples. Limestone in the core was not encountered therefor Bulk Density of core samples was not done. The details of the Bulk density test results for the BRS samples are provided in Table No. 17.1. Refer Annexure V.

Table No. 17.1: Bulk Density Test Results of Five BRS Samples

S. No	Sample ID	Bulk Density g/cm ³	Latitude	Longitude	Lithology
1	AMANGANJ/BD/S-1	2.6	24° 23' 35.4120" N	80° 11' 53.5563" E	Limestone
2	AMANGANJ/BD/S-2	2.5	24° 23' 40.3245" N	80° 12' 00.3060" E	Limestone
3	AMANGANJ/BD/S-3	2.5	24° 24' 41.6090" N	80° 13' 21.1576" E	Limestone
4	AMANGANJ/BD/S-4	2.5	24° 22' 39.4381" N	80° 09' 20.2459" E	Limestone
5	AMANGANJ/BD/S-5	2.6	24° 22' 39.9577" N	80° 08' 51.1001" E	Limestone

The average bulk density of the Bedrock limestone in the block is determined as 2.54 gm/cc, Bulk density study report is attached as Annexure-V.



Figure No. 17.1 Five BRS hand specimen Samples for Bulk density.

CHAPTER – 18

18.0.0 BENEFICIATION STUDIES

18.1.0 The present exploration has no provision for beneficiation studies.

CHAPTER – 19

19.0.0 RESOURCE ESTIMATION TECHNIQUE

19.1.0 GENERAL

19.1.1 Resource estimation is a fundamental component of geological surveys, aimed at evaluating the size, quality, and commercial potential of rock, minerals, and other materials. The process involves defining mineralization constraints or geological domains, analysing sample data using statistical or geostatistical methods, and applying an appropriate grade interpolation technique. Resource estimation is conducted at every stage of exploration and mining, from initial reconnaissance to advanced feasibility studies. It relies on establishing the continuity of the ore body along its strike, dip, thickness, and grade, all of which are determined through drilling during exploration. Accurate mineral resource estimation requires several key elements: well-founded assumptions, a well-documented database with adequate sampling density, clear delineation of the ore zone, and careful consideration of parameters such as strike length, true width, cut-off grade, and geological interpretation. By systematically evaluating these factors, it is possible to reliably estimate the size, shape, and characteristics of the ore body.

19.1.2 Drilling of two boreholes, designated BH-2 and BH-5, did not encounter any Limestone zones in this block. As a result, no mineralized intervals were identified within these boreholes, and consequently, no resource estimation was carried out for these locations. The absence of Limestone in BH-2 and BH-5 suggests that the ore-bearing horizon may be laterally discontinuous within the study area, or that these boreholes were positioned outside the extents of the mineralized zones. This outcome highlights the importance of detailed geological interpretation and the need for adequate drilling density to accurately delineate the spatial distribution and continuity of the Limestone deposits. During the course of geological investigations, limestone was observed only sporadically in the form of small lensoidal bodies occurring in patches. The exposed limestone bands exhibited very limited lateral continuity and thickness, generally ranging from 0.20 m to 0.50 m, as observed in surface cuttings and well sections. Considering the restricted occurrence, insignificant thickness, and poor lateral persistence of the limestone horizons, no pitting or trenching was undertaken, as such investigations were not envisaged under the approved exploration programme / NQT. Based on field observations, the limestone occurrences are not considered economically viable for resource evaluation. Consequently, no resource estimation of limestone has been carried out in the present study.

CHAPTER – 20

20.0.0 REPORTING OF RESOURCE

20.1.0 RESOURCE ESTIMATION

20.1.1 Resource estimation is a fundamental component of geological surveys, aimed at evaluating the size, quality, and commercial potential of rock, minerals, and other materials. The process involves defining mineralization constraints or geological domains, analysing sample data using statistical or geostatistical methods, and applying an appropriate grade interpolation technique. Resource estimation is conducted at every stage of exploration and mining, from initial reconnaissance to advanced feasibility studies. It relies on establishing the continuity of the ore body along its strike, dip, thickness, and grade, all of which are determined through drilling during exploration. Accurate mineral resource estimation requires several key elements: well-founded assumptions, a well-documented database with adequate sampling density, clear delineation of the ore zone, and careful consideration of parameters such as strike length, true width, cut-off grade, and geological interpretation. By systematically evaluating these factors, it is possible to reliably estimate the size, shape, and characteristics of the ore body.

20.1.2 Drilling of two boreholes, designated BH-2 and BH-5, did not encounter any Limestone zones in this block. As a result, no mineralized intervals were identified within these boreholes, and consequently, no resource estimation was carried out for these locations. The absence of Limestone in BH-2 and BH-5 suggests that the ore-bearing horizon may be laterally discontinuous within the study area, or that these boreholes were positioned outside the extents of the mineralized zones. This outcome highlights the importance of detailed geological interpretation and the need for adequate drilling density to accurately delineate the spatial distribution and continuity of the Limestone deposits. During the course of geological investigations, limestone was observed only sporadically in the form of small lensoidal bodies occurring in patches. The exposed limestone bands exhibited very limited lateral continuity and thickness, generally ranging from 0.20 m to 0.50 m, as observed in surface cuttings and well sections. Considering the restricted occurrence, insignificant thickness, and poor lateral persistence of the limestone horizons, no pitting or trenching was undertaken, as such investigations were not envisaged under the approved exploration programme / NQT. Based on field observations, the limestone occurrences are not considered economically viable for resource evaluation. Consequently, no resource estimation of limestone has been carried out in the present study.

CHAPTER – 21

21.0.0 SUMMARY AND RECOMMENDATIONS

21.1.0 SUMMARY

21.1.1 Report on Reconnaissance Survey (G4-Stage) for Limestone in and around Amanganj-Gunnor-Pawai Area, Panna District, Madhya Pradesh. **Executing Agency:** Engeotech Consultant **Year:** 2026 **Toposheet Numbers:** 63D/03 & 63D/07 **Exploration Stage:** UNFC G4 (Reconnaissance)

2.1.1.2 The exploration initiative was undertaken by Engeotech Consultant under the National Mineral Exploration Trust (NMET) / NMEDT programme. The primary objective of this investigation was to conduct a UNFC G4-Stage reconnaissance survey to assess the potential for economic limestone deposits within the Amanganj-Gunnor-Pawai block, located in the Panna District of Madhya Pradesh.

2.1.1.3 The investigated area covers a substantial footprint of 93.13 square kilometres. The project was designed to delineate the lateral and vertical extent of limestone mineralization, assess its grade, evaluate its suitability for industrial applications (primarily cement manufacturing), and determine if the block warranted further, more intensive, G3-stage exploration.

2.1.1.4 The project area lies within the geologically significant Vindhyan Basin, a major sedimentary basin in central India known for its vast deposits of sandstone, shale, and limestone. The regional stratigraphy is dominated by the Vindhyan Supergroup, which represents a prolonged period of shallow marine to fluvial sedimentation.

2.1.1.5 Locally, the investigated block falls within the Bhander Group, with surface and subsurface lithology predominantly exposing the Sirbu Shale Formation. The field investigations revealed that limestone in this specific block does not occur as massive, continuous beds. Instead, the limestone is present merely as minor, lenticular bodies and thin bands. The thickness of these limestone bands is highly restricted, generally ranging from only 0.2 to 0.5 meters. Furthermore, these limestone lenses are heavily intercalated with surrounding host rocks, primarily shale and shaly sandstone, severely disrupting their lateral continuity.

2.1.1.6 To systematically evaluate the block, Engeotech Consultant employed a multi-disciplinary exploration strategy combining surface mapping, geochemical sampling, and subsurface drilling.

2.1.1.7 Systematic surface mapping was executed on a large scale of 1:12,500. This mapping aimed to delineate lithological contacts, identify structural controls, and map the surface expressions of the limestone lenses.

2.1.1.8 To understand the vertical profile and test the depth persistence of the surface outcrops, two vertical scout boreholes (designated as BH-2 and BH-5) were drilled. Each borehole was drilled to a depth of 50 meters, resulting in a cumulative drilling quantum of 100 meters. The drilling operations achieved an average core recovery of 82%, which is considered moderate to good and provided reliable physical samples for the subsurface lithological profile.

2.1.1.9 During the surface mapping phase, 27 representative bedrock samples were collected across the block. Additionally, 5 specialized samples were extracted for detailed petrographic studies to understand the microscopic mineralogy and texture of the rocks.

2.1.1.10 The 5 samples subjected to thin-section petrography revealed that the limestone is predominantly composed of the mineral calcite, exhibiting textures ranging from micritic (fine-grained mud) to sparitic (coarser crystalline cement). Crucially, the petrographic study highlighted strong evidence of post-depositional diagenetic modifications. The samples exhibited numerous microfractures and a significant presence of localized argillaceous (clay-rich) and siliceous (quartz-rich) impurities integrated within the carbonate matrix.

2.1.1.11 The core and bedrock samples were analysed using Energy Dispersive X-Ray Fluorescence (EDXRF) to determine the concentration of major and minor oxides. The geochemical results were largely unfavourable for economic exploitation:

2.1.1.12 The analytical data revealed a highly heterogeneous lithology with highly inconsistent carbonate purity. Low Calcium Oxide (CaO): The defining metric for limestone, CaO, was found to be generally low to moderate, failing to meet the minimum thresholds required for cement-grade limestone. High Impurities: The samples showed remarkably high levels of silica (SiO₂) and alumina (Al₂O₃) contamination.

2.1.1.13 Statistical analysis of the geochemical data showed a strong negative correlation between CaO and SiO₂. This indicates heavy dilution of the limestone by siliciclastic input (sand and clay) during the original depositional phase in the Sirbu Shale environment.

2.1.1.14 Under the United Nations Framework Classification (UNFC) for solid minerals, this exploration program successfully fulfilled the criteria for a G4 (Reconnaissance) study. However, the geological and geochemical realities of the block severely limit its economic potential. Because the limestone bands are too thin (0.2–0.5m), lack lateral persistence, are heavily intercalated with barren shale, and possess a chemical grade severely diluted by silica and alumina, they cannot be considered economically viable. Consequently, the criteria for defining a mineral resource were not met, and no formal resource estimation (in terms of tonnage) could be calculated or justified for this block.

21.2.0 RECOMMENDATIONS

21.2.1 Based on the integrated interpretation of geological, geochemical, petrographic, and drilling data generated during the present reconnaissance (G4 stage) investigation in the Amanganj–Gunnor–Pawai Block, it is recommended that the area be advanced to a systematic prospecting level (G3 stage) through closer grid-based drilling. The current dataset, limited to two boreholes (BH-2 and BH-5), is inadequate to capture subsurface variability; hence, a tighter drilling grid designed on refined geological targets is essential to delineate any localized or discontinuous limestone horizons that may not have been intersected at the present spacing.

21.2.2 In view of the likely lateral discontinuity of limestone units, additional boreholes should be strategically located based on improved geological models integrating stratigraphy of the Sirbu Formation and structural controls. Concurrently, high-resolution geological mapping at a 1:4,000 scale (or larger) is recommended to accurately define lithological contacts, bedding attitudes, joint/fracture patterns, and other structural features that may govern the occurrence and preservation of carbonate horizons.

21.2.3 To supplement direct subsurface information, application of suitable geophysical techniques such as Electrical Resistivity Tomography (ERT) and seismic refraction surveys is recommended, particularly in areas with poor outcrop exposure. These methods will assist

in delineating lithological contrasts and identifying potential limestone-bearing zones, thereby optimizing drill targeting and reducing exploration uncertainty.

The observed low average core recovery (82%) indicates drilling challenges in highly fractured and weathered formations; therefore, improvement in drilling methodology is essential. Adoption of triple-tube core barrels, optimized drilling parameters, and appropriate drilling fluids (where feasible) is recommended to enhance core recovery and improve the reliability of geological and geotechnical data.

21.2.4 An expanded geochemical sampling program, including bedrock, trench, and channel samples, is recommended to strengthen the analytical database and to better understand spatial variations in CaO and associated oxides. In parallel, detailed petrographic and mineralogical studies should be continued to refine interpretations of diagenetic processes, impurity distribution, and carbonate quality, which are critical for determining industrial suitability.

21.2.5 Considering the current geochemical results, which indicate low and inconsistent CaO values with elevated silica and alumina content, the material does not meet cement-grade specifications. However, localized evaluation for low-grade applications such as construction aggregate or other minor industrial uses may be explored where feasible.

21.2.6 Finally, it is recommended that exploration efforts be extended to adjacent geologically favourable blocks within the Vindhyan Basin where thicker, more continuous, and higher-grade limestone horizons are known to occur. Such regional reassessment, supported by integrated geological, geophysical, and geochemical approaches, may improve the likelihood of identifying economically viable deposits.

CHAPTER – 22

22.0.0 PLATES AND MAPS

- 22.1.0** Plate-I Location map of Amanganj-Gunnor-Pawai Block, Panna District, Madhya Pradesh
- 22.2.0** Plate-II Location map of Amanganj-Gunnor-Pawai Block on Toposheet
- 22.3.0** Plate-III Location map of Amanganj-Gunnor-Pawai Block on the District Resource Map
- 22.4.0** Plate-IV Topographic Map of Amanganj-Gunnor-Pawai Block
- 22.5.0** Plate-V Geological Map of Amanganj-Gunnor-Pawai Block
- 22.6.0** Plate-VI Geological Cross-section Map of BH-2 & BH-5
- 22.7.0** Plate-VII Location Map of Bedrock Sample
- 22.8.0** Plate-VIII Proposed Borehole Location Map
- 22.9.0** Plate-IX Drilled Borehole Location Map

CHAPTER – 23

23.0.0 ANNEXURE / ENCLOSURES TO THE REPORT

23.1.0 The report includes all the relevant annexures and maps/ plans, sections, and photographs, etc. List of annexures, tables, maps/plans/sections, photographs, text figures etc., is provided before the start of the text and part of the Geological Report.

CHAPTER –24

24.0.0 ANY OTHER INFORMATION

24.1.0 UTILISATION ASPECTS AND MINEABILITY (AS PER NATIONAL COUNCIL FOR CEMENT AND BUILDING MATERIALS)

24.1.1 The specifications of limestone for various industrial used are as follows

1. CEMENT INDUSTRY SPECIFICATION

Table No. 24.1 Cement Industry Specification for Limestone

CaO	:	44% (min.) to 46%
MgO	:	3.50% (max.)
SiO ₂	:	16% (max.)
Al ₂ O ₃	:	2 (max.)
Fe ₂ O ₃	:	2% (max.)
SO ₃	:	1.75% (max.)

Lime Saturation Factor
(LSF)
$$\frac{\text{CaO}}{2.8 (\text{SiO}_2) + 1.2 (\text{Al}_2\text{O}_3) + 0.65 (\text{Fe}_2\text{O}_3)}$$

(ideal to be at 0.66 to 1.02)

Silica Modules =
$$\frac{\text{SiO}_2}{\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3} = \text{ideal at (1.2 to 4.0)}$$

Iron Modules =
$$\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3 = \text{ideal at (1.7 to 2.4)}$$

Hydraulic Modules =
$$\frac{\text{Al}_2\text{O}_3}{\text{Fe}_2\text{O}_3} = \text{ideal at (0.65 (min.))}$$

2. B. I. S. (BUREAU OF INDIAN STANDARDS) SPECIFICATION

**Table No. 24.2 B. I. S. (Bureau of Indian Standards)
Specification for Limestone**

CaO (Min)	42%
MgO (Max.)	2.50%
SiO ₂ (Max.)	15%
P ₂ O ₅ (Max.)	1.50%
FeS ₂ (Max.)	2%

3. **IRON AND STEEL INDUSTRY:**

**Table No. 24.3 Iron and Steel Industry for
Specification for Limestone**

Elements	BF Grade	SMS Grade	LD Grade
CaO	42% (Min.)	48% (Min.)	52% (Min.)
MgO	4% (Max.)	3% (Max.)	2% (Max.)
SiO ₂	9% (Max.)	4% (Max.)	1% (Max.)
SiO ₂ + Al ₂ O ₃	11.5% (Max.)	-	-
Total Insoluble	12%	-	-
Acid Insoluble	-	6.5% (Max.)	-

4. **CHEMICAL INDUSTRY SPECIFICATION**

BIS Specifications (IS:3204-1978, Reaffirmed- 2003)

Table No. 24.4 Chemical Industry Specification for Limestone

Characteristics	Requirement in percent by mass for			
	Calcium carbide	Bleaching Powder	Caustic soda	Sugar
CaO (Min.)	54.0	54.0	53.0	50.0
MgO (Max.)	0.8	2.0	1.0	1.0
SiO ₂ (Max.)	1.0	0.75	-	2.0
Fe ₂ O ₃ (Max.)	0.25	0.15	-	-
Mn ₂ O ₃ (Min.)	-	0.06	-	-
CO ₂ (Min.)	42.00	42.00	42.00	41.00
Loss on Ignition (LOI)	46.00	46.00	46.00	44.00
S (Max.)	0.10	-	-	-
P (Max.)	0.01	-	-	-
Al ₂ O ₃ + Fe ₂ O ₃ (Max.)	0.50	-	-	1.5
SiO ₂ + Al ₂ O ₃ + Fe ₂ O ₃ (Max.)	-	-	3.0	-

5. **FERTILIZER INDUSTRY SPECIFICATION**

CaCO₃ + MgCO₃ : 85 % (Min)

SiO₂ : 5% (Max.)

6. **GLASS INDUSTRY SPECIFICATION**

CaCO ₃	: 94.5%
CaCO ₃ +MgCO ₃	: 97.5%
Fe ₂ O ₃	: 0.20% (Max)

BIS Specifications (IS:997-1973, Reaffirmed-1998)

CaO	: 53.0 %
SiO ₂	: 2.5 %
Fe ₂ O ₃	: 0.10 %
CaO + MgO	: 54.50 %

7. **FOUNDRY INDUSTRY SPECIFICATION**

BIS Specifications (IS:4149-1978, Re-affirmed-2008)

Table No: 24.5 Foundry Industry Specification for Limestone

Characteristics	Grade-1	Grade-2	Grade-3
CaO (Min.)	52 %	50 %	45 %
SiO ₂ (Max)	1.5 %	3 %	5 %
R ₂ O ₃ (Al ₂ O ₃ + Fe ₂ O ₃) Max.	1 %	1 %	2 %
MgO	2 %	3 %	5 %
Insoluble matter	0.5	1	2
Sulphur and Phosphorus	Traces	Traces	Traces

8. CEMENT, IRON AND STEEL AND CHEMICAL INDUSTRY
SPECIFICATION

Table No: 24.6 Cement, Iron and Steel and Chemical Industry Specification for Limestone

Constituents	Cement Industry (Specification)	Iron and Steel Industry (Specification)			Chemical Industry BIS Specifications (IS:3204-1978, Reaffirmed-2003)			
					Requirement in percent by mass for			
		BF Grade	SMS-OH Grade	SMS-LD	Calcium carbide	Bleaching Powder	Caustic soda	Sugar
CaO (Min.)	44% (Min.) to 48% (Max)	42% (Min.)	48% (Min.)	52% (Min.)	54.0	54.0	53.0	50.0
MgO	3.50% (Max.)	4%	3%	2%	0.8	2.0	1.0	1.0
SiO ₂ (Max.)	16 % (Max.)	9%	4%	1%	1.0	0.75	-	2.0
Fe ₂ O ₃	2% (Max.)				0.25	0.15	-	-
Mn ₂ O ₃	--	--	--	--	--	0.06	-	-
CO ₂ (Min.)	--	--	--	--	42.00	42.00	42.00	41.00
Loss on Ignition	--	--	--	--	46.00	46.00	46.00	44.00
S (Max.)	--	--	--	--	0.10	-	-	-
P (Max.)	--				0.01	-	-	-
Al ₂ O ₃ + Fe ₂ O ₃	2%				0.50	-	-	1.50
SiO ₂ + Al ₂ O ₃ + Fe ₂ O ₃	--	11.50% (Max.)			-	-	3.00	-
Acid Insoluble			6.50% (Max.)					

CHAPTER – 25

25.0.0 CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE, AND SIGNATURE

This is to certify that a Geological report has been prepared in respect of the Recommence Report (G4 stage) for Limestone in Amanganj Gunnor Pawai Block, District: Panna, Madhya Pradesh. The report was prepared by ENGEOTECH CONSULTANT, Jabalpur, on behalf of the National Mineral Exploration and Development Trust (NMEDT). The report adheres to the Minerals (Evidence of Mineral Contents) Rules, 2015, as specified under the Mineral Auction Rules, 2015 and amended up to 2021.

NAME: Indraneel Dawande

DESIGNATION: Project Coordinator

DATE: 30-06-2026

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ABBREVIATIONS USED

SL. No.	Abbreviation	Full form
1	GSI	Geological Survey of India
2	NMEDT	National Mineral Exploration and Development Trust
3	TCC	Technical cum Cost Committee
4	EC	Executive Committee
5	DMG	Directorate of Geology & Mines
6	UNFC	United Nation Framework Classification
7	NMI	National Mineral Inventory
8	NABL	National Accreditation Board for Testing and Calibration Laboratories
9	F.S.P.	Field Season Programme
10	MEMC	Minerals (Evidence of Mineral Contents)
11	MMDR	Mines & Minerals (Development and Regulation)
12	NH	National Highway
13	WGS-84	World Geodetic System-84
14	UTM	Universal Transverse Mercator
15	RL	Reduced Level
16	Cu.m	Cubic Meter
17	DGPS	Differential Global Positioning System
18	DMS	Degree Minute Second
19	M / m	Meter
20	mt	Million Tonne
21	Sq. km/sq.km	Square Kilometre
22	M. Sc.	Master of Science
23	M. Sc. (Tech.)	Master of Science in Technology
24	NDDP	Net District Domestic Product
25	mRL	Reduced Level in metre
26	R.F.	Reserve Forest
27	XRF	X-ray Fluorescence
28	ML	Mining Lease
29	CRM	Certified Reference Material
30	MMT	Million Metric Tonnes
31	GGR	Gross Geological Resources
32	NGR	Net Geological Resources
33	Geol. Res. (Mil. tons)	Geological Resources (Million tons)
34	MT	Million Tonnes
35	RQD	Rock Quality Determination
36	PSC	Project Sanctioning Committee