

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR LIMESTONE IN

BANDHA AND JAMUNIYA BLOCK SATNA DISTRICT, MADHYA PRADESH

Report submitted under the Mineral (Evidence of Mineral Content) Rules-2015
(Amended up to 2021)

TEXT, ANNEXURE



MINERAL EXPLORATION AND CONSULTANCY LIMITED
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सतना जिला मध्य प्रदेश में बांधा एवं जमुनिया ब्लॉक में चूना पत्थर के प्रारंभिक अन्वेषण का भूवैज्ञानिक प्रतिवेदन

कार्यकारी सारांश

बांधा एवं जमुनिया चूना पत्थर ब्लॉक, जिनका कुल क्षेत्रफल 7.22 वर्ग किमी है, मध्य प्रदेश के सतना जिले की रामपुर बघेलान तहसील में स्थित हैं। इन ब्लॉकों में राष्ट्रीय खनिज अन्वेषण न्यास (NMET) के वित्तपोषण से मिनरल एक्सप्लोरेशन एंड कंसल्टेंसी लिमिटेड (MECL) द्वारा प्रारंभिक अन्वेषण (G3 स्तर) किया गया। इस अन्वेषण का उद्देश्य चूना पत्थर की उपलब्धता, गुणवत्ता, मोटाई, पार्श्वीय निरंतरता तथा संसाधन स्थापित करने की संभावनाओं का मूल्यांकन करना था।

अध्ययन क्षेत्र ऊपरी विंध्यन सुपरग्रुप की नागोद लाइमस्टोन संरचना के अंतर्गत आता है। भूवैज्ञानिक मानचित्रण से यह स्पष्ट हुआ कि सतह पर विद्यमान चूना पत्थर, नागोद लाइमस्टोन के आधारभूत (Basal) स्तर के अपक्षय एवं अपरदन से बचे हुए अवशिष्ट (erosional remnants) भाग हैं। यह चूना पत्थर धूसर से गहरे धूसर रंग का, सघन, सूक्ष्म से मध्यम दानेदार है तथा पेट्रोग्राफिक अध्ययन से इसे मुख्यतः ऊस्पैराइट (Oosparite) के रूप में वर्गीकृत किया गया है, जिसमें ऊऑयड (ooids), पेलाइड (peloids) एवं जैविक अवशेष (bioclasts) स्पैरी कैल्साइट सीमेंट में संलग्न हैं। शैलस्तर लगभग क्षैतिज से मंद प्रवण (gently dipping) हैं तथा इनके साथ शेल की परतें भी संबद्ध रूप से पाई जाती हैं।

अन्वेषण कार्यक्रम के अंतर्गत विस्तृत भूवैज्ञानिक मानचित्रण, DGPS आधारित स्थलाकृतिक सर्वेक्षण, 80.00 मीटर की कुल लंबाई के 04 अन्वेषणात्मक बोरहोल, कोर लॉगिंग, पेट्रोग्राफिक अध्ययन तथा सतही एवं बोरहोल नमूनों का रासायनिक विश्लेषण किया गया। स्थलाकृतिक सर्वेक्षण एवं बोरहोल कॉलर सर्वेक्षण Trimble Catalyst DA2 DGPS द्वारा Survey of India (SOI) CORS Network के KOTAR Base Station (Site Code: KOTA; CORS ID: 50494A001) का उपयोग करते हुए सम्पन्न किया गया। सभी बोरहोलों के लिए विस्तृत ग्राफिकल लिथोलॉग भी तैयार किए गए।

भूवैज्ञानिक मानचित्रण के दौरान एकत्रित 05 ग्रैब नमूनों तथा बोरहोलों से प्राप्त 04 हाफ-कोर नमूनों का WD-XRF (Wavelength Dispersive X-Ray Fluorescence) विधि द्वारा प्रमुख ऑक्साइडों एवं चयनित ट्रेस तत्वों के लिए विश्लेषण किया गया। रासायनिक विश्लेषण से ज्ञात हुआ कि चूना पत्थर मुख्यतः उच्च कैल्शियम (High-Calcium Limestone) श्रेणी का है तथा अधिकांश नमूने भारतीय खान ब्यूरो (IBM) के परिपत्र संख्या C-284/3/CMG/2017 दिनांक 25.04.2018 में निर्धारित मानकों ($\text{CaO} \geq 34\%$ एवं $\text{MgO} \leq 5\%$) को पूरा करते हैं। ट्रेस तत्वों का विश्लेषण सामान्यतः निम्न सांद्रता दर्शाता है तथा किसी भी आर्थिक दृष्टि से महत्वपूर्ण ट्रेस धातु का समृद्धिकरण नहीं पाया गया।

अन्वेषणात्मक ड्रिलिंग से यह स्थापित हुआ कि चूना पत्थर केवल 0.97 मीटर से 1.53 मीटर मोटाई वाले पतले स्तरों के रूप में विद्यमान है तथा इसकी पार्श्वीय निरंतरता अत्यंत सीमित है। किसी भी बोरहोल में अपेक्षित मोटा एवं सतत चूना पत्थर स्तर प्राप्त नहीं हुआ। ड्रिलिंग परिणामों से यह भी स्पष्ट हुआ कि सतह पर दिखाई देने वाले चूना पत्थर के अनावृत भाग, नागोद लाइमस्टोन के आधारभूत स्तर के पृथक-पृथक अपरदित अवशेष हैं, न कि सम्पूर्ण ब्लॉक में फैला हुआ कोई सतत अधःसतही चूना पत्थर निक्षेप।

यद्यपि चूना पत्थर की रासायनिक गुणवत्ता संतोषजनक पाई गई, तथापि इसकी सीमित मोटाई एवं असतत प्रकृति के कारण एक सतत एवं आर्थिक दृष्टि से व्यवहार्य चूना पत्थर निक्षेप स्थापित नहीं किया जा सका। फलस्वरूप, खनिज संसाधन आकलन हेतु आवश्यक भूवैज्ञानिक निरंतरता सिद्ध नहीं हो सकी तथा बंधा एवं जमुनिया ब्लॉकों के लिए किसी भी खनिज संसाधन का आकलन अथवा प्रतिवेदन नहीं किया गया।

समेकित भूवैज्ञानिक, ड्रिलिंग, पेट्रोग्राफिक एवं भू-रासायनिक अध्ययनों के आधार पर यह निष्कर्ष निकाला गया है कि वर्तमान ब्लॉकों में आगे का अन्वेषण तकनीकी दृष्टि से उचित नहीं है। अन्वेषण कार्यक्रम ने अपने उद्देश्य को सफलतापूर्वक पूर्ण करते हुए यह निर्णायक रूप से स्थापित किया कि अध्ययन क्षेत्र में पर्याप्त मोटाई एवं पार्श्वीय निरंतरता वाला चूना पत्थर निक्षेप विद्यमान नहीं है। अतः बंधा एवं जमुनिया चूना पत्थर ब्लॉकों को आगे के अन्वेषण हेतु बंद (Closure) किए जाने की अनुशंसा की जाती है।

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G3) FOR LIMESTONE IN BANDHA AND JAMUNIA BLOCKS SATNA DISTRICT, MADHYA PRADESH

EXECUTIVE SUMMARY

The Bandha and Jamuniya Limestone Blocks, covering a combined area of 7.22 sq. km, are located in Rampur Baghelan Tehsil, Satna district, Madhya Pradesh. The exploration was undertaken by Mineral Exploration and Consultancy Limited (MECL) under the National Mineral Exploration Trust (NMET) at the Preliminary Exploration (G3) stage with the objective of evaluating the occurrence, quality, thickness, and lateral continuity of limestone and assessing its potential for resource establishment.

The study area is occupied by rocks of the Upper Vindhyan Supergroup, represented by the Nagod Limestone Formation. Geological mapping established that the exposed limestone represents the basal horizon of the Nagod Limestone Formation, preserved as isolated erosional remnants. The limestone is grey to dark grey, fine- to medium-grained, compact, and predominantly composed of oosparite and biosparite, with occasional ooids and fossil fragments. Bedding is nearly horizontal with a gentle dip and the limestone is associated with shale horizon.

The exploration programme comprised detailed geological mapping, DGPS-based topographical survey, drilling of four exploratory boreholes (80.00 m), core logging, petrographic studies and chemical analysis of representative bedrock and borehole core samples. Topographical and borehole collar surveys were carried out using a Trimble Catalyst DA2 DGPS integrated with the Survey of India CORS Network using the KOTAR Base Station (Site Code: KOTA; CORS ID: 50494A001). Geological logging of the recovered cores are supplemented by graphical lithologs for all boreholes.

A total of 05 grab samples collected from surface limestone exposures and 04 half-core samples from borehole intersections are analysed by Wavelength Dispersive X-ray Fluorescence (WD-XRF) for major oxides and selected trace elements. The analytical results indicate that the limestone is predominantly high-calcium limestone, with most samples satisfying the Indian Bureau of Mines (IBM) threshold criteria ($\text{CaO} \geq 34\%$ and $\text{MgO} \leq 5\%$) prescribed under IBM Circular No. C-284/3/CMG/2017 dated 25.04.2018. Trace element

analyses revealed generally low concentrations of the analysed elements and no economically significant enrichment of associated trace metals.

Exploratory drilling established that the limestone occurs only as thin horizons ranging from 0.97 m to 1.53 m in thickness with poor lateral continuity. The anticipated thick and persistent limestone body is not encountered in any of the boreholes. The drilling results demonstrate that the surface limestone exposures represent isolated erosional remnants of the basal Nagod Limestone rather than a continuous subsurface limestone deposit extending across the blocks.

Although the limestone is of good chemical quality, the limited thickness and discontinuous nature of the mineralized horizons preclude the establishment of a continuous and economically significant limestone body. Consequently, the geological continuity required for mineral resource estimation could not be demonstrated, and no Mineral Resource has been estimated or reported for the Bandha and Jamuniya Blocks.

Based on the integrated geological, drilling, petrographic, and geochemical investigations, it is concluded that no further exploration is technically justified within the present blocks. The exploration programme successfully achieved its objective by conclusively establishing the absence of a thick, laterally persistent limestone deposit. Accordingly, the Bandha and Jamuniya Limestone Blocks are recommended for closure.

CHAPTER-1

1.0.0 INTRODUCTION

- 1.0.1 Limestone, a sedimentary rock, originated mainly by chemical/biochemical precipitation of carbonate minerals in a variety of depositional environments, ranging from marine to terrestrial. The marine system is either neritic (shelf) or pelagic (open-ocean) (James and Jones, 2016). Most of the limestone in geological history is deposited in neritic system. On the other hand, evidences show that pelagic limestones are in the operation since Jurassic time. Each of these depositional environments is controlled by differences in temperature, salinity, depth of photic zone, siliciclastic input and sediment supply. Warm water with normal salinity and low siliciclastic input favours the formation of limestone within the agitated part of the photic zone (the depth of water to which light penetrates) (James and Jones, 2016). This indicates that most of the limestones are deposited in tropical-subtropical belt, within 30° north and south of Equator (Tucker, 2001). In terrestrial setting carbonates are usually formed in lakes, springs, caves depending upon water temperature and local climate.
- 1.0.2 Calcium carbonate (CaCO_3) in the form of calcite is the predominant mineral constituent of limestone. It also contains some amount of magnesium carbonate (MgCO_3) and $(\text{Ca Mg}(\text{CO}_3)_2)$. Variable amount of terrigenous quartz, clay, pyrite, haematite and chert are also present as non-carbonate minerals, control the quality/grade of limestone.
- 1.0.3 Limestone is a crucial and versatile mineral commodity. There are evidences that it has been in use as construction material from the early days of human civilization. From the Great Pyramids of Giza to the Golden fort of Jaisalmer, many of the world's most beautiful and historical buildings are made up of limestone. In the modern time, limestone is primarily used to manufacture cement. However, the uses of limestone, now a days, have not been confined only to construction material; rather the versatility in its uses in different industries made it a valuable mineral. In Iron & Steel Industry, limestone is used both in blast furnace and steel melting shop as a flux. In chemical industry, limestone is consumed to produce bleaching powder, toothpaste, calcium carbide etc. It is used as a purifier in the sugar industry. Limestone is also consumed by industries like paper, fertilizer and foundry etc.

- 1.0.4 The total reserves/resource of limestone of all categories and grades as per NMI (National Mineral Inventory) data based on UNFC (United Nations Framework Classification) system as on 1.4.2015 (Mineral Year Book 2020) have been estimated at 203,224 million tonnes, of which 16,336 million tonnes (8%) are placed under reserves category and 1,86,889 million tonnes (92%) are under resource category. Karnataka is the leading state having 27% of the total resource followed by Andhra Pradesh and Rajasthan (12% each), Gujarat (10%), Meghalaya (9%), Telangana (8%), Chhattisgarh and Madhya Pradesh (5% each) and remaining 12% by other states. Grade wise, Cement Grade (Portland) has leading share of about 70% followed by Unclassified Grades (12%) and BF Grade (7%). Remaining (11%) are different Grades.
- 1.0.5 The production of limestone in 2019-20 was 359 million tonnes, decreased marginally by about 5.43% as compared to that of the previous year. There were 659 reporting mines in 2019-20 as against 725 during the previous year. Thirty mines each producing more than 3 million tonnes per annum contributed 42% of the total production of limestone in 2019-20. The share of 26 mines each in the production range of 2 to 3 million tonnes was 17% of the total production. About 19% of the total production was contributed by 51 mines each producing 1 to 2 million tonnes annually. The remaining 22% of the total production was reported by 552 mines and three associated mines during the year. Ten principal producers contributed about 54% of the total production. About 2.82% of the production was reported by public sector mines as against 2.88% in the previous year. About 97% of the total production of limestone during 2019-20 was of cement grade, 2% of iron & steel grade and the rest 1% of chemical grade (As per Mineral Year Book 2020 by Indian Bureau of Mines).
- 1.0.6 Rajasthan was the leading producing state accounting for 20% of the total production of limestone, followed by Madhya Pradesh (13%), Andhra Pradesh & Chhattisgarh (12% each), & Karnataka (10%), Tamil Nadu & Telangana (7% each), Gujarat (6%) and the remaining 13% was contributed by Assam, Bihar, Himachal Pradesh, Uttarakhand of Jammu and Kashmir, Jharkhand, Kerala, Maharashtra, Meghalaya, Odisha and Uttar Pradesh. (As per Mineral Year Book 2020 by Indian Bureau of Mines)
- 1.0.7 India was the second largest cement producing country in the world after China. In 2019-20, the total consumption of limestone, as reported by different industries was

328.62 million tonnes registering negative growth of 0.87% over that of preceding year. Cement was the major consuming industry accounting for 308.66 million tonnes (94%) consumption, followed by iron & steel 12.68 million tonnes (4%) and chemical 5.29 million tonnes (2%). The remaining consumption was reported by aluminium, alloy steel, sugar, paper, fertilizer, glass, metallurgy, foundry, etc. (As per Mineral Year Book 2020 by Indian Bureau of Mines)

- 1.0.8 Exports of limestone decreased marginally by 3%, i.e., 3.76 million tonnes in 2019-20 from 3.88 million tonnes in the previous year. Limestone was mainly exported to Bangladesh (97%) & United Kingdom (1%). In 2019-20 the import of limestone increased marginally by 5% to 25.64 million tonnes. Limestone was mainly imported from UAE (80%), Oman (12%), Vietnam (4%), Malaysia (3%), & other countries (1%). (As per Mineral Year Book 2020 by Indian Bureau of Mines).
- 1.0.9 The National Mineral Policy, 2019 emphasizes systematic mineral exploration, scientific resource estimation, sustainable mining and value addition. The National Mineral Exploration Trust (NMET) supports regional and detailed exploration to augment the national mineral inventory, while agencies such as the Geological Survey of India (GSI), Indian Bureau of Mines (IBM), State Directorates of Geology and Mining (DMGs) and Mineral Exploration and Consultancy Limited (MECL) and National Private Exploration Agencies (NPEA) play key roles in exploration and resource assessment. The current policy framework encourages scientific exploration, resource augmentation, beneficiation, digital geological databases and sustainable mineral development.
- 1.0.10 The Bandha and Jamunia Block is located within the Vindhyan Basin, one of India's most important carbonate provinces, where the Nagod Limestone Formation hosts extensive cement-grade limestone deposits. The Satna region is a well-established cement manufacturing hub, reflecting the occurrence of laterally persistent and high-quality limestone horizons. The block was selected for systematic exploration based on its favourable regional geological setting, the occurrence of limestone exposures within and around the block, proximity to existing limestone-bearing formations and cement industries, and the growing demand for cement-grade limestone in central India. The exploration is intended to delineate the thickness, quality and lateral continuity of the

limestone and to establish mineral resources conforming to UNFC standards for future scientific mining and mineral block development.

CHAPTER-2

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

2.1.0 INVESTIGATING AGENCY

2.1.1 The block is explored by Mineral Exploration And Consultancy Limited (formerly Mineral Exploration Corporation Limited)-MECL during field execution from May 2026 to June 2026 and the exploration programme is funded by National Mineral Exploration Trust (NMET). MECL was established as an autonomous Public Sector Company in October 1972, under the administrative control of Ministry of Mines, Government of India for systematic exploration of minerals, to bridge the gap between the initial discovery of a prospect and its eventual exploitation.

2.1.2 Experience: MECL has successfully completed more than 1777 exploration projects and geological reports across the country and has established approximately 234.98 billion tonnes of mineral resources/reserves (as on May 2026). These include a wide range of strategic, critical, metallic, non-metallic and energy minerals such as coal, lignite, bauxite, copper, gold, lead-zinc, iron ore, limestone, manganese, magnesite, chromite, fluorspar, tungsten, potash, glauconite, rare earth elements (REE), and several other industrial minerals.

2.1.3 MECL's registered address is:

Mineral Exploration And Consultancy Limited
(Formerly Known as Mineral Exploration Corporation Limited)
(A PSE under Ministry of Mines, Govt. of India)
Dr. Babasaheb Ambedkar Bhawan, Highland drive road, Seminary Hills,
Nagpur- 440006, Maharashtra, India.

2.2.0 QUALIFIED PERSONS

Exploration agency: Mineral Exploration and Consultancy Limited

Experience: 53 Years, Since 1972

Email: cmd@mecl.gov.in; gm-exploration@mecl.gov.in

List of qualified persons involved in the project are tabulated below:

Table 2.1
List of qualified persons involved in exploration in the Bandha and Jamuniya Blocks
Satna District, Madhya Pradesh

Sl No.	Name
1	Shri Shrikant Sharma, HoD (Exploration)
2	Shri S. K. Satpathy, Sr. Manager (Geology)
3	Shri Rishabh Kumar, Manager (Geology), Project Management.
4	Shri Dileep Pandey, Asst. Manager (Geology)
7	Shri Rohit Sharma, Manager (Chemical Lab.)
8	Shri Sayantan Pal, Manager (Geology), Petrology Lab.

CHAPTER-3

3.0.0 TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

“GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3 STAGE) FOR LIMESTONE IN BANDHA AND JAMUNIA BLOCKS SATNA DISTRICT, MADHYA PRADESH”

3.1.1 Ownership: Government of Madhya Pradesh

3.1.2 Name of Prospector: MINERAL EXPLORATION AND CONSULTANCY LIMITED
(Formerly Mineral Exploration Corporation Limited)
A Govt. of India Enterprise; A Miniratna-I CPSE
Ministry of Mines, Govt. of India.

3.1.3 Address of Prospector: Mineral Exploration And Consultancy Limited
(Formerly Known as Mineral Exploration Corporation Limited)
(A PSE under Ministry of Mines, Govt. of India)
Dr. Babasaheb Ambedkar Bhawan, Highland drive road,
Seminary Hills, Nagpur- 440006, Maharashtra, India.

3.1.4 E-mail of Prospector: cmd@mecl.gov.in; gm-exploration@mecl.gov.in

3.1.5 Telephone numbers of Prospector: 0712-2510289; 0712-2511829

3.2.0 DETAILS ABOUT PROJECT AND PERIOD OF PROSPECTING

3.2.1 The Vindhyan Basin of central India hosts one of the largest and most important Proterozoic sedimentary successions in the country and constitutes a major repository of high-grade limestone resources. Within the basin, the Satna and Rewa districts of Madhya Pradesh are particularly well known for their extensive development of limestone.

3.2.2 The Bandha and Jamuniya blocks, located in Rampur Baghelan Tehsil of Satna district, Madhya Pradesh, were selected for detailed exploration based on the encouraging results obtained during the reconnaissance survey carried out in the area. The reconnaissance studies included the collection of representative grab samples and their chemical analysis to assess the quality and extent of the limestone mineralization. These investigations established the presence of limestone occurring as isolated outcrops within the area, warranting further evaluation.

- 3.2.3 The detailed exploration proposals for the Bandha and Jamuniya blocks were initially prepared and submitted separately to NMEDT. These proposals were considered during the 85th meeting of the Technical Cum Cost Committee -I (TCC-I), NMEDT, held on 27th November, 1st December, and 5th December 2025. During the deliberations, the Committee recommended that both adjoining blocks be taken up as a single exploration project, considering their contiguous nature, while providing for the preparation of two separate Geological Reports to facilitate future mineral auction. Further, the proposal was discussed before the 3rd Project Sanctioning Committee (PSC) meeting held on 31st December 2025, where it was approved. Formal administrative approval was subsequently conveyed vide Office Memorandum No. F. No. 23/712/2025-NMEDT/701 dated 08.01.2026. Copy of the project approval is provided as **Annexure I**.
- 3.2.4 Field activities commenced in May 2026 and were completed in June 2026. The exploration programme comprised topographical survey, geological mapping, exploratory core drilling, collection of drill core samples, and their chemical analysis. The drilling investigation established that the limestone exposed at the surface does not represent the main limestone formation. Instead, the surface exposures constitute only remnant basal limestone horizons, while the overlying limestone sequence has been removed by prolonged weathering and erosion. Consequently, the exploration failed to establish the presence of a thick, laterally persistent limestone body within the investigated blocks.
- 3.2.5 The outcomes of the exploration programme were discussed during the 33rd meeting of the Technical Cum Cost Committee-II (TCC-II) held on 21st and 22nd July 2026, wherein the Committee recommended premature closure of the project due to insignificant limestone resource potential. The Committee also recommended submission of a single Geological Report covering both the Bandha and Jamuniya blocks.
- 3.2.6 Accordingly, a Draft Geological Report was prepared and peer-reviewed by Shri Subhash Yadav, Ex-Director, GSI. The comments and recommendations received during the peer review were duly incorporated, and the Final Geological Report has subsequently been prepared and submitted to the concerned authority.

CHAPTER-4

4.0.0 DETAILS OF THE AREA

4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

4.1.1 The Bandha and Jamuniya limestone exploration blocks are located in Rampur Baghelan tehsil, Satna district, Madhya Pradesh. The blocks lie between latitudes 24°27'00.48174"N and 24°29'09.92674"N and longitudes 81°01'16.20531"E and 81°02'51.97793"E (WGS 84). The Bandha and Jamuniya blocks cover areas of 3.54 sq. km and 3.68 sq. km, respectively, and fall within Survey of India Toposheet No. 63H03. The location map of the exploration blocks is presented in **Plate-I**, while the Google Earth image showing the location of the blocks with respect to the surrounding major towns/cities is given as **Text Figure 4.1**.

4.1.2 The Bandha and Jamuniya limestone exploration blocks are well connected by a network of village roads, providing easy access to different parts of the area throughout the year. The blocks are located approximately 4 km south of National Highway (NH)-39 and about 6 km west of National Highway (NH)-30, ensuring convenient road connectivity to the nearby towns and cities. Rampur Baghelan, the nearest tehsil headquarters, lies about 4 km north of the blocks. The blocks are situated approximately 25 km northeast of Satna, the district headquarters, and about 30 km southwest of Rewa.

4.1.3 Details of the boundary corner points of the blocks are given in the tables below:

Table 4.1
DGPS co-ordinates (WGS-84) of the boundary corner points of Bandha Block, Satna district, Madhya Pradesh

BANDHA BLOCK					
POINT ID	WGS84 (DMS)		WGS84 (UTM44N)		RL (m)
	LATITUDE (N)	LONGITUDE (E)	EASTING (m)	NORTHING (m)	
A	N24°29'07.98075"	E81°02'19.23436"	503918.899	2707985.962	318.091
B	N24°29'09.92674"	E81°01'35.67151"	502692.765	2708045.523	328.476
C	N24°28'58.14079"	E81°01'16.20531"	502144.926	2707682.942	330.446
D	N24°27'59.52975"	E81°01'35.90363"	502699.715	2705880.409	328.582
E	N24°28'27.35765"	E81°02'49.46021"	504770.063	2706736.829	315.755

Table 4.2
DGPS co-ordinates (WGS-84) of the boundary corner points of Jamuniya Satna district, Madhya Pradesh

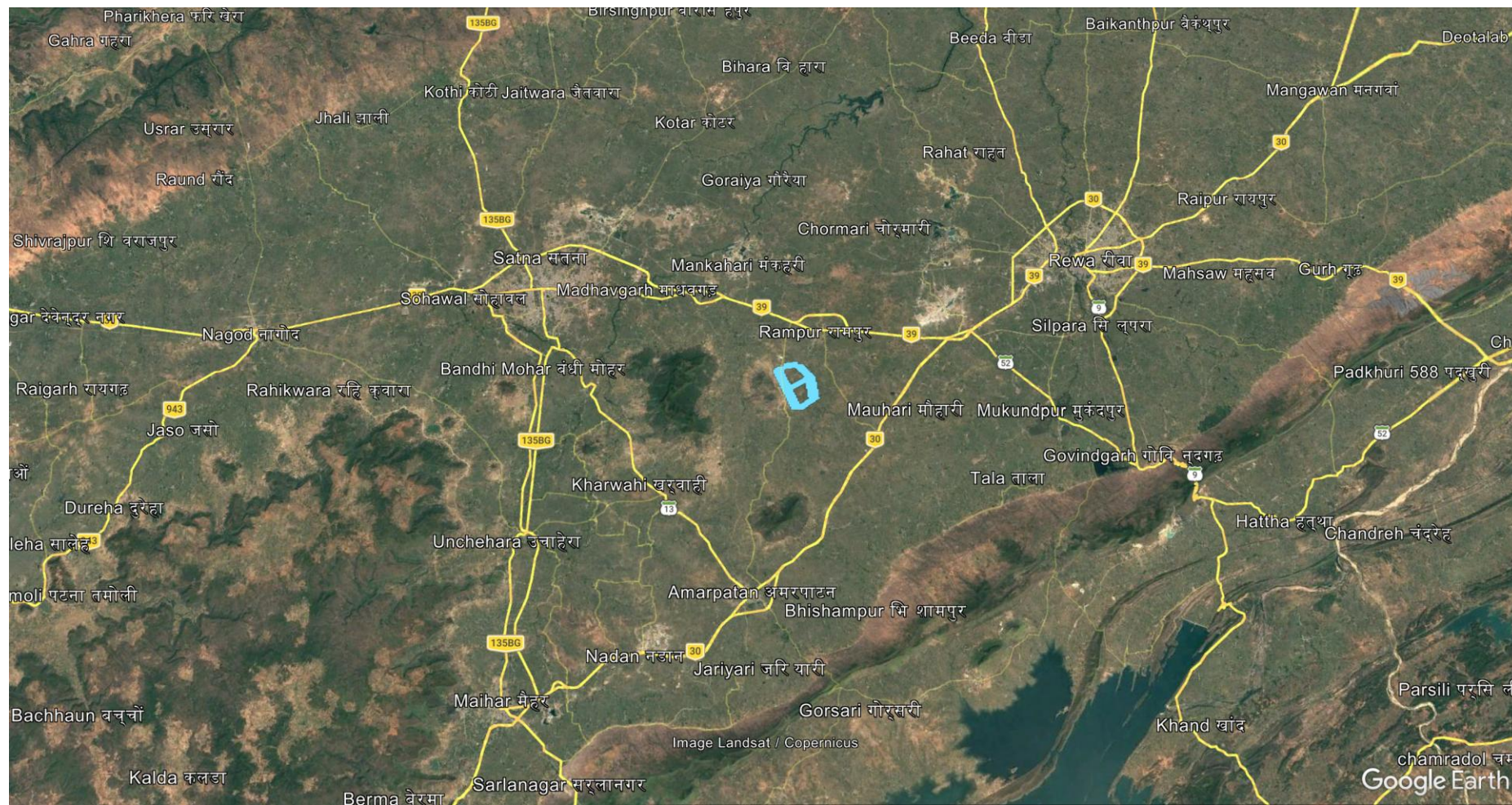
JAMUNIYA BLOCK					
POINT ID	WGS84 (DMS)		WGS84 (UTM44N)		RL (m)
	LATITUDE (N)	LONGITUDE (E)	EASTING (m)	NORTHING (m)	
A	N24°29'09.92674"	E81°01'35.67151"	502692.765	2708045.523	328.476
B	N24°28'58.14079"	E81°01'16.20531"	502144.926	2707682.942	330.446
C	N24°27'59.52975"	E81°01'35.90363"	502699.715	2705880.409	328.582
D	N24°28'27.35765"	E81°02'49.46021"	504770.063	2706736.829	315.755

4.2.0 DETAILS OF THE AREA WITH LAND USE

4.2.1 Mostly the block is occupied by agricultural lands.

4.3.0 MINERAL (s) UNDER INVESTIGATION

4.3.1 Limestone



Text Figure: 4.1 Google image showing location of Bandha and Jamuniya blocks, located in Rampur Baghelan Tehsil of Satna district, Madhya Pradesh

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 Bandha and Jamuniya exploration blocks along with the surrounding areas form part of the Vindhyan Plateau and is characterized by gently undulating terrain with isolated low ridges developed over sedimentary rocks of the Vindhyan Supergroup. Satellite imagery indicates that the landscape is dominated by cultivated fields with scattered village habitations, seasonal drainage channels and sparse tree cover. The block area is entirely covers revenue agricultural land.

5.1.2 The physiographic setting reflects mature erosional topography with broad interfluves and shallow valleys. Land use is predominantly agricultural with seasonal cropping supported by monsoon rainfall and local water harvesting structures. No major industrial activity is present within the block, and the environmental setting is typical of the rural plateau landscape of eastern Satna District.

5.1.3 Topography of the area indicates a gently undulating relief with elevations generally ranging from about 332 mRL to 314 mRL. Local relief is moderate, and no steep escarpments occur within the block although plateau margins and residual ridges occur in the surrounding Vindhyan terrain.

5.1.4 The drainage pattern is predominantly dendritic to sub-dendritic. Seasonal nalas drain mainly towards the north and northeast before joining the Tamas River drainage system within the Ganga Basin. Small village ponds and irrigation tanks occur in the block and surrounding villages, whereas no major reservoir is situated within the exploration block.

5.2.0 ROADS, RAILWAY TRACK, ELECTRIC TRANSMISSION LINE AND TELEPHONE LINE

5.2.1 The block is approachable through village roads connected to Rampur Baghelan and Satna. State Highway links are available within a few kilometers, while National Highway NH-30 passing through Satna provides regional connectivity

5.2.2 Satna Railway Station, located on the Howrah–Prayagraj–Mumbai corridor, is the nearest major railway station and junction. Satna also serves as the principal logistics centre. The nearest airport is Satna which is 31km from the block, while Prayagraj Airport is another important regional airport at distance of 190 km. High-voltage transmission lines occur in the district, ensuring power availability in nearby villages. Mobile and broadband telecommunication services are available through major service providers.

5.3.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.3.1 According to the Census of India 2011, Satna District had a population of about 2.22 million comprising approximately 1.17 million males and 1.05 million females, showing growth over the 2001 Census. The district is predominantly rural, with agriculture forming the principal occupation. Literacy exceeds 72%, with male literacy substantially higher than female literacy. The district sex ratio is about 927 females per 1000 males, and the population density is about 297 persons per km².

5.3.2 Administratively, Satna district comprises several subdivisions and tehsils including Rampur Baghelan. Numerous Gram Panchayats and revenue villages fall within the development blocks. Rampur Baghelan and Satna town provide educational, medical, banking, marketing and administrative services for the surrounding villages.

5.4.0 HISTORICAL SITES AND ARCHAEOLOGICAL MONUMENTS, PLACES OF WORSHIP, PUBLIC UTILITIES ETC.

5.4.1 No Archaeological Survey of India protected monument is known within the exploration block. Likewise, no notified archaeological remains have been identified within the proposed exploration area based on available secondary information.

5.4.2 Nearby villages contain local temples and community places of worship. Government schools, Anganwadi centres, primary health facilities, Panchayat buildings and drinking-water supply infrastructure are available in the surrounding settlements.

5.5.0 FORESTS, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARIES ETC.

5.5.1 The exploration block is entirely situated over revenue agricultural land and does not fall within Reserved Forest or Protected Forest. No diversion of forest land is envisaged for the proposed exploration activities.

5.5.2 No National Park, Wildlife Sanctuary or Eco-sensitive Zone occurs within the block.

5.6.0 FLORA AND FAUNA WITHIN AND NEARBY

5.6.1 The regional vegetation corresponds to Tropical Dry Deciduous Forest occurring in patches outside the cultivated landscape. Common tree species include teak, tendu, mahua, palash, neem, babul and ber. Agricultural vegetation consists mainly of wheat, paddy, gram, mustard and pulses depending upon the season.

5.6.2 Common fauna reported from the district include jackal, fox, hare, mongoose, nilgai, wild boar and common reptiles together with widespread resident birds. No notified wildlife corridor passes through the block, and no Schedule-I species have been specifically reported from the agricultural block area.

5.7.0 WATER BODIES SUCH AS RIVER, NALA, STREAM, RESERVOIR, ETC

5.7.1 The area is drained by seasonal first- and second-order nalas active during the southwest monsoon. These streams ultimately contribute to the Tamas River drainage. Village ponds and irrigation tanks constitute the principal perennial water bodies supporting agriculture and domestic requirements.

5.7.2 No perennial river flows through the exploration block itself, and no major reservoir occupies the block area.

5.8.0 CLIMATIC CONDITIONS

5.8.1 The climate is tropical monsoonal with three distinct seasons comprising summer, monsoon and winter. Summer temperatures generally range from about 30°C to 45°C, whereas winter temperatures range from about 7°C to 25°C. Average annual rainfall is approximately 1000-1100 mm, most of which is received during June to September under the southwest monsoon.

- 5.8.2 Exploration activities such as mapping, trenching and drilling are best undertaken during the post-monsoon and winter seasons when ground conditions and accessibility are favourable.

CHAPTER 6

6.0.0 INFRASTRUCTURE

6.0.1 The Bandha and Jamuniya limestone exploration blocks are located in Rampur Baghelan Tehsil of Satna District, Madhya Pradesh, in an area supported by well-developed physical and social infrastructure. Rampur Baghelan, situated about 4 km north of the blocks, serves as the nearest administrative and commercial centre, providing essential facilities such as banks, post office, police station, fuel stations, markets, and accommodation. The district headquarters, Satna, located approximately 25 km from the blocks, is a major urban and industrial centre with well-established educational institutions, hospitals, government offices, railway connectivity, and commercial establishments. Rewa, about 30 km away, provides additional higher-order infrastructure, including tertiary healthcare facilities, universities, and major commercial services. The region is connected by a reliable electricity network, mobile and internet connectivity, and an all-weather road network, ensuring uninterrupted communication and logistical support. The availability of skilled and unskilled manpower, repair workshops, construction materials, and other essential services in the nearby towns facilitated the smooth execution of exploration activities.

CHAPTER 7

7.0.0 GEOLOGY OF THE AREA

7.1.0 REGIONAL GEOLOGY

- 7.1.1 The study area falls in **Satna district, Madhya Pradesh**, and forms part of the **Vindhyan Basin**, one of the largest Proterozoic Sedimentary Basins of the Indian shield. The area is occupied predominantly by the **Upper Vindhyan Succession** belonging to the **Vindhyan Supergroup**, which unconformably overlies the Archaean–Paleoproterozoic crystalline basement. The Vindhyan sediments in the region comprise a thick sequence of relatively undeformed, horizontally to gently dipping arenaceous, argillaceous and calcareous rocks deposited in a stable intracratonic basin. Location of the blocks in regional geological map is provided in the **Plate-II**
- 7.1.2 The Vindhyan Supergroup has traditionally been subdivided into four major groups in ascending stratigraphic order, namely **Semri, Kaimur, Rewa and Bhandar Groups** (Table 7.1). The **Semri Group** constitutes the Lower Vindhyan succession, whereas the **Kaimur, Rewa and Bhandar Groups** collectively represent the Upper Vindhyan succession. These groups are further subdivided into several formations based on their lithological characteristics and regional correlation (Shastry & Moitra, 1984; Bhattacharyya, 1993).
- 7.1.3 Within Satna district, the **Bhandar Group** forms the most widespread and economically significant unit. It comprises, in ascending order, the **Ganurgarh Shale, Nagod Limestone (Bhandar Limestone), Sirbu Shale and Upper Bhandar (Maihar) Sandstone**. The **Nagod Limestone Formation** is extensively exposed in the Satna–Maihar region and constitutes one of the most important limestone horizons of central India, supporting several large cement industries. The overlying **Maihar Sandstone**, also referred to as the **Upper Bhandar Sandstone** (Bhattacharyya, 1993), forms prominent mesas, escarpments and cliffs of the Bhandar Plateau.
- 7.1.4 The **Semri Group** is represented by alternating sequences of sandstone, shale, porcellanite and limestone exposed mainly in the southern and northern parts of Satna district. The **Rohtas Limestone** is light grey to grey, fine-grained, compact and well bedded. The **Kaimur Group** consists predominantly of thick-bedded, massive, fine-

grained quartzitic sandstone with subordinate shale horizons. Rocks of the **Rewa Group** comprise sandstone, shale and conglomerate, forming extensive plateau surfaces and escarpments.

- 7.1.5 The **Bhander Group** is characterized by shale, limestone and sandstone. The **Nagod Limestone** is fine-grained, hard, compact, thinly bedded to massive and locally stromatolitic. The overlying **Upper Bhander Sandstone** consists of purple to reddish-brown, fine- to medium-grained, well-sorted sandstone interbedded with splintery shale and siltstone. These rocks form the characteristic cliffs and tablelands of the region.
- 7.1.6 Younger continental deposits of the **Lameta Formation** occur locally as isolated patches resting unconformably over the Vindhyan rocks. This formation consists mainly of sandstone, shale and calcareous beds with a thickness varying from **15 m to 80 m**. Extensive **laterite** caps occur over the Bhander Group and Upper Rewa Sandstone, attaining a maximum thickness of about **20 m**. Quaternary alluvium occupies the river valleys and low lying plains.
- 7.1.7 The regional stratigraphic succession adopted for the present study follows the Geological Survey of India (GSI) classification and is presented in **Table 7.1**.

Table 7.1
Regional Stratigraphy

Modified after Geological Survey of India (GSI), incorporating the stratigraphic nomenclature of Pandey et al. (2023/2024)

Age	Supergroup	Group	Formation	Lithology
Neoproterozoic	Vindhyan Supergroup	Bhander	Maihar Sandstone	Sandstone, siltstone
			Sirbu Shale	Shale, mudstone
			Bhander Limestone	Limestone, shale
			Ganurgarh Shale	Shale, calcareous siltstone
Upper Mesoproterozoic		Rewa	Upper Rewa Sandstone	Sandstone
			Jhiri Shale	Shale, fine sandstone
			Lower Rewa Sandstone	Sandstone, siltstone
			Panna Shale	Shale
Kaimur		Dhandraul Quartzite	Quartzite	
		Mangesar Formation	Sandstone and shale	

			Bijaigarh Shale	Black shale
			Ghaghar Sandstone	Sandstone and shale
			Susnai Breccia	Brecciated sediments
			Sasaram Formation	Sandstone and mudstone
Lower Mesoproterozoic to Paleoproterozoic		Semri		Limestone, dolostone, shale, sandstone, porcelanite
Unconformity				
Mahakoshal, Aravalli, Bundelkhand Granite				

7.2.0 REGIONAL STRUCTURE

7.2.1 The Vindhyan Supergroup in the Satna region represents one of the least deformed Proterozoic sedimentary successions of India. The rocks are generally **sub-horizontal to gently dipping**, with regional dips varying between **1° and 5°**, commonly towards the north or northeast. Primary sedimentary structures such as bedding, lamination, ripple marks, mud cracks and stromatolitic structures are well preserved, indicating only mild tectonic disturbance after deposition.

7.2.2 The region is essentially a **platformal sedimentary terrain** with broad homoclinal disposition of strata. Major folding is absent, although gentle warping and regional tilting are locally observed. Joint systems are well developed, comprising two to three prominent sets trending predominantly **NE-SW, NW-SE and E-W**, which influence weathering, drainage development and local quarrying operations.

7.2.3 Several regional lineaments interpreted from satellite imagery and geological mapping trend mainly in the **NE-SW and NW-SE directions**, representing basement controlled fractures that have influenced sedimentation and later geomorphic evolution. However, large scale faulting is uncommon within the Bhandar succession, and displacement along mapped faults is generally minor.

7.3.0 METAMORPHISM IN THE REGION

7.3.1 The Vindhyan sedimentary succession of the Satna region is **essentially unmetamorphosed**. The rocks retain their original sedimentary textures, structures and primary mineralogical characteristics, indicating deposition under stable cratonic conditions followed by very low tectono-thermal alteration.

7.3.2 The limestones have undergone only **diagenetic processes**, including compaction, recrystallization and local silicification. Stromatolitic structures, laminations and sedimentary bedding are exceptionally well preserved. Sandstones exhibit varying degrees of silica and calcite cementation but do not show evidence of even regional metamorphism less than the greenschist facies.

7.3.3 Overall, the Vindhyan sediments belong to the **diagenetic to very low-grade anchizonal metamorphic conditions**, and no significant thermal or regional metamorphic overprint has been reported from the Satna region.

7.4.0 REGIONAL MINERALISATION

7.4.1 The Vindhyan Supergroup hosts several economically important mineral deposits, making the Satna region one of the major mineral-producing belts of central India.

7.4.2 The most significant mineral resource is the **Nagod (Bhander) Limestone**, which occurs extensively in Satna, Maihar, Katni and Damoh districts. The limestone is of high chemical purity and forms the principal raw material for numerous cement plants established in the region.

7.4.3 The **laterite profile** developed over the Vindhyan plateau hosts economically workable **bauxite deposits**, particularly in Satna and Rewa districts. These deposits are formed through prolonged tropical weathering and lateritization of the Vindhyan rocks.

7.4.4 The **Kaimur Group** is regionally associated with the **diamond bearing kimberlite and lamproite fields of Panna**, while occurrences of **lead-zinc mineralization** have been reported from parts of Damoh district. Sandstones of the Vindhyan succession also provide excellent building stone and dimension stone resources, whereas shale units are locally utilized in cement manufacture and brick industries.

7.4.5 Within the present study area, the principal mineralization is represented by the **Nagod Limestone Formation**, which constituted the exploration target. The limestone occurs as laterally persistent, fine-grained, compact, thinly bedded to massive horizons with local stromatolitic development. Its regional continuity, favourable chemical

composition and extensive distribution make it one of the most important industrial limestone formations of the Vindhyan Basin.

7.5.0 GEOLOGY OF THE BLOCK

7.5.1 Bandha (3.54 sq km) and Jamuniya (3.68 sq km) limestone blocks are situated in the Nagod Limestone Formation of the Upper Vindhyan Supergroup. Geological mapping revealed that approximately **90% of the area is concealed under soil and agricultural cover**, with bedrock exposed only as isolated limestone pavements and scattered outcrops. The geological map also shows that limestone exposures are discontinuous and occur as small patches separated by extensive soil-covered terrain.

7.5.2 Due to the discontinuous nature of the exposures, **continuous limestone bands could not be delineated**, and the **true strike length of the limestone body could not be established**. Contacts between limestone and associated shale are largely concealed beneath soil cover, making direct mapping of lithological boundaries difficult. The exposed limestone represents only remnant erosional pavements preserved after prolonged weathering and denudation of the Nagod Formation. Geological map of the area is provided as Plate III.

7.5.3 The local stratigraphic succession within the **Bandha and Jamuniya Blocks**, from older to younger, comprises **Nagod Limestone with subordinate ferruginous shale (Ganurgarh Shale)**, overlain by **soil and recent surficial deposits**.

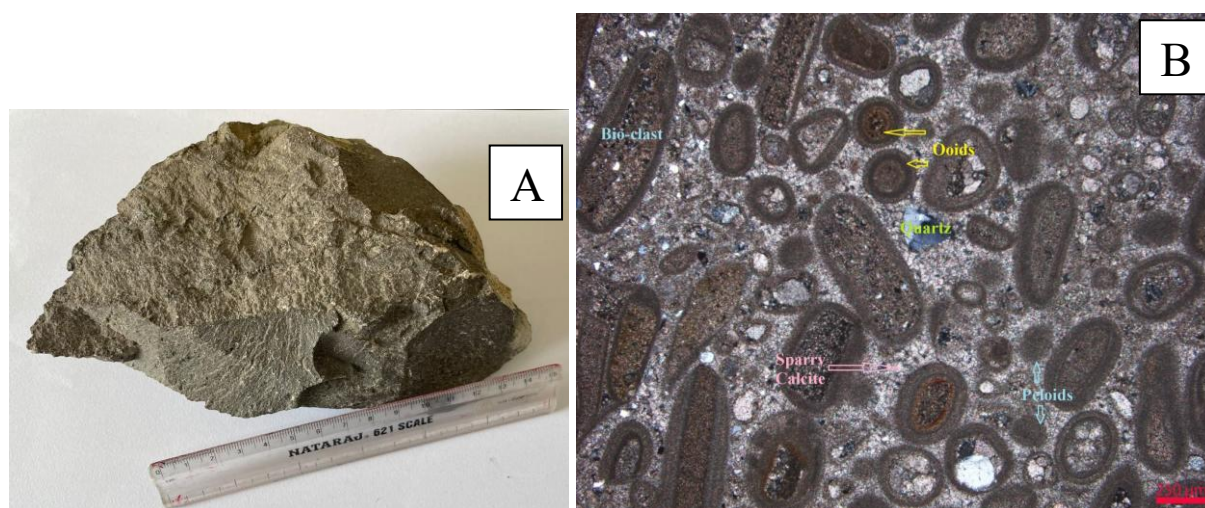
7.6.0 DESCRIPTION OF ROCK TYPES

7.6.1 **Top soil:** Soil is the most extensive surficial unit in the exploration blocks, covering nearly **90% of the total area**. The soil is generally brown to reddish brown, silty to clayey, locally mixed with weathered limestone fragments. Agricultural fields occupy most of the gently undulating terrain, whereas thicker soil accumulation is observed over low-lying areas and along drainage courses. The extensive soil mantle conceals the bedrock over most of the blocks, resulting in only isolated rock exposures. Consequently, lithological contacts and continuity of limestone horizons cannot be observed directly in the field.

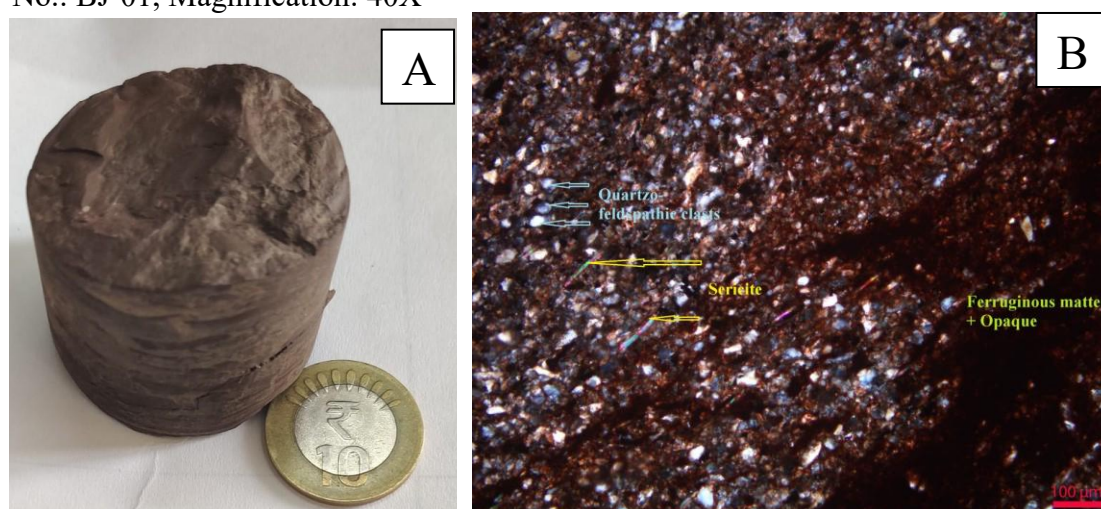
7.6.2 **Limestone:** It forms the principal lithological unit exposed within both blocks. Field exposures are highly discontinuous and occur as isolated pavements, small low-relief outcrops and scattered bouldery exposures. Most exposures are flat lying and weathered, rarely exceeding a few tens of metres in lateral continuity. The limestone is generally grey to dark grey, fine-grained, hard and compact, displaying smooth weathered surfaces. Fresh surfaces exhibit a strong effervescence with dilute hydrochloric acid. No continuous limestone ridge or laterally persistent bed could be established during geological mapping due to extensive soil cover. The observed limestone exposures represent erosional remnants of the basal part of the Nagod Limestone Formation, whereas the upper portions of the formation have largely been removed by prolonged weathering and erosion. Field Photographs of the limestone exposures are provided in the Field Photograph 7.1. Petrographic examination of sample indicates that the limestone consists predominantly of calcite with minor quartz, clay minerals, feldspar and chlorite, along with accessory opaques and glauconite. Microscopically, the rock is composed of abundant ooids, peloids and bioclasts embedded within a sparry calcite matrix, with quartz commonly occurring at the nuclei of ooids. Sparry calcite occurs as coarse crystalline cement filling the intergranular spaces between carbonate grains. The sparry cement binds the ooids and allochems, producing a grain-supported texture and indicating post-depositional cementation during diagenesis. The specimen is classified as an oosparite, indicating deposition in a shallow marine, high-energy carbonate environment. The corresponding Pmg 7.1 clearly illustrates rounded ooids, peloids and bioclasts enclosed within sparry calcite cement.

7.6.3 **Shale:** Shale occurs as a subordinate lithological unit associated with limestone but is poorly exposed within the exploration blocks. Field occurrences are mostly represented by isolated weathered exposures, while additional shale horizons are encountered in the exploratory boreholes. The shale samples recovered from drilling are subjected to petrographic examination to establish their mineralogical composition and texture. The shale is dark brown to reddish brown, very fine grained and thinly laminated. Weathering imparts a ferruginous appearance. Petrographic study of sample BJ-02 (MJBH-01, Depth: 27.05m to 27.10m) reveals that

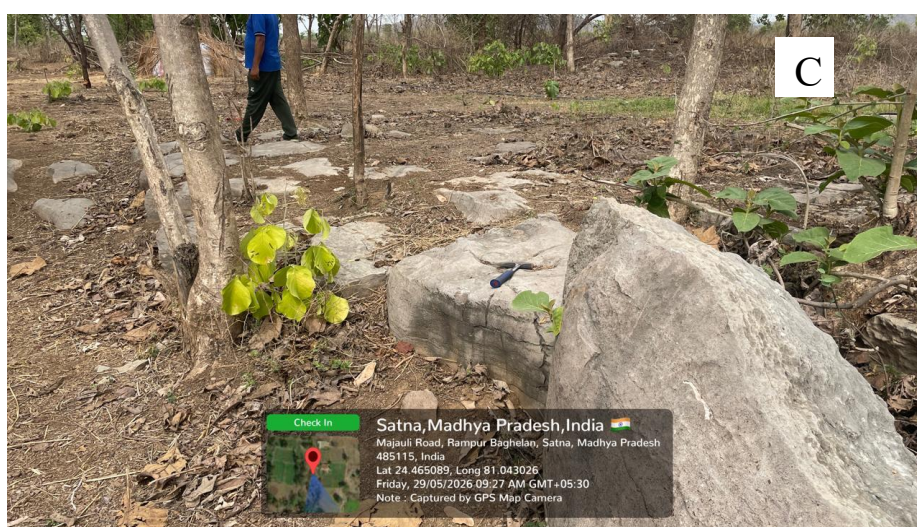
the rock is composed mainly of quartz with ferruginous matter, feldspar, clay minerals, opaques, sericite and accessory glauconite. Quartz and feldspar occur predominantly as silt-sized clasts, while ferruginous material forms reddish patches and thin sub-parallel bands. The rock is classified as ferruginous shale. The associated photomicrograph shows silt-sized quartz-feldspar grains embedded in a ferruginous matrix together with fine sericite flakes. Core photograph and photomicrograph of shale



A) Field Photograph 7.1(A)- Hand specimen of limestone (Sample No.: BJ-01, Loc. 24°28'04.81"N, 81°02'29.00"E) **B) Pmg-1**- Photomicrograph showing presence of oolites, peloids and bio-clasts in sparry calcite matrix in oosparite as seen under crossed nicols. Sample No.: BJ-01, Magnification: 40X



A) Field Photograph 7.2(A) Core Sample of limestone (Sample No.: BJ-02, MJBH-01, Depth: 27.05-27.10 m) **B) Pmg-2**- Photomicrograph showing presence of oolites, peloids and bio-clasts in sparry calcite matrix in oosparite as seen under crossed nicols. Sample No.: BJ-01, Magnification: 40X.



Field Photograph: 7.3 A) Limestone exposure in the southern part of the Jamuniya Block B) Limestone exposure in the Northern part of the Bandha Block C) Limestone exposure in the southern part of the Jamuniya Block

7.7.0 STRUCTURE

- 7.7.1 Structural information obtained from geological mapping is limited owing to the discontinuous nature of rock exposures. Most limestone outcrops occur as flat pavements or isolated weathered exposures separated by extensive soil cover. Consequently, continuous bedding planes suitable for measuring consistent strike and dip are rarely exposed. The major structural characteristics observed during mapping are: True strike length of the limestone horizon could not be established because exposures are discontinuous. Bedding is generally sub-horizontal to gently dipping wherever measurable, consistent with the regional disposition of the Upper Vindhyan sedimentary succession. No significant folding, faulting or major structural disturbances are recognized within the exposed portions of the blocks. The geological and topographical maps also indicate that limestone exposures occur as isolated patches distributed within a broad soil covered terrain, corroborating the field observations.

7.8.0 METAMORPHISM

- 7.8.1 The Vindhyan sedimentary rocks exposed in the Bandha and Jamuniya Limestone Blocks are essentially unmetamorphosed and retain their primary sedimentary characteristics. The limestone preserves its original textures, bedding and primary mineralogical features, indicating deposition under stable cratonic conditions with negligible tectono-thermal alteration.
- 7.8.2 The limestone has undergone mainly diagenetic modifications, including compaction, recrystallization and local silicification. No significant evidence of regional or thermal metamorphism has been observed in the study area. Overall, the rocks are considered to have experienced diagenetic to very low-grade/anchizonal conditions, with their primary sedimentary characteristics largely preserved.

7.9.0 MINERALISATION

- 7.9.1 The exploration blocks host limestone of the Nagod Limestone Formation as the principal lithological unit. Surface mineralization is represented by scattered, isolated limestone pavements and small discontinuous outcrops exposed through an extensive soil cover. The limestone is grey to dark grey, fine-grained, hard and compact, occurring as weathered pavements and low-relief outcrops. No visible sulphide mineralization, silicification, dolomitization, cavity filling, secondary carbonate veining

or other economically significant mineralization is observed either in surface exposures or under petrographic examination.

CHAPTER-8

8.0.0 PREVIOUS WORK

8.1.0 DETAILS OF PREVIOUS EXPLORATION CARRIED OUT BY OTHER AGENCIES

- 8.1.1 Since the middle of the 19th Century, many geologists such as Medlicott (1860), Mellet (1869), and Oldham (1851) have studied the Vindhyan Basin.
- 8.1.2 Oldham divided the Upper Vindhyan into three parts — Kaimur, Rewa, and Bhandar. Later, the Geological Survey of India (GSI) carried out more detailed studies on limestone deposits in the Rewa–Satna region.
- 8.1.3 The GSI, M.P. Circle, Bhopal, conducted investigations for flux-grade limestone in the Rewa–Satna area during the 1966–67 field season under Shri D.R.S. Mehta, Superintending Geologist, and Shri P.K. Ramam, Geologist. An area of about 425 sq. km was geologically mapped on a 1:63,360 scale (Topo Sheet No. 63H3), and 85 groove samples were collected from outcrops and nala exposures. The study delineated two distinct flux-grade horizons within the Bhandar Limestone Formation (Upper Vindhyan) — a Lower Band (8–11 m thick) comprising mainly flux-grade limestone, and an Upper Band (12–21 m thick) showing variable quality from flux to cement grade. The Lower Band extends ~50 km with ~400 m average width, and the Upper Band extends ~53 km with ~300 m average width, both striking ENE–WSW with gentle southerly dips. Based on surface data, inferred resources were estimated at 340 million tonnes in the Lower Band and 190 million tonnes in the Upper Band. The investigation concluded that the area holds substantial reserves of flux-grade limestone (blast-furnace and open-hearth grades) requiring detailed drilling for proving minable reserves. Development of transport connectivity between Satna and Rewa and utilization of upper and purple bands for cement and lime industries were also recommended.
- 8.1.4 The Directorate of Geology and Mining (DGM), Madhya Pradesh, also conducted surveys to locate good-quality (high-grade) limestone in the Nagod area. When the limestone deposits of the M.P. State Mining Corporation began to decline, the DGM started new detailed exploration work based on the recommendations of S.S. Mishra (1974–75).

8.1.5 GSI investigated around Rampur and Ramasthan areas of Satna district from October 1975 to September 1976. About 200 sq. km area was mapped on a 1:63,360 scale. The rocks found in this region belong to the Bhandar Group of the Vindhyan Supergroup. In this area, a dark grey limestone bed of 8m to 13.5 m thickness (known as Lower Nagod Limestone) was identified. The limestone is of flux to cement grade, and an estimated 17.05 million tonnes of limestone reserves were recorded in the Ramasthan Block. At present, mining activities are being carried out in nearby areas, and the limestone is used for cement manufacturing. The nearest cement plants with working quarries are:

1. Satna Cement Works (30 km)
2. B.P. Birla Cement Plant, Maihar (40 km)
3. Prism Cement Plant (50 km)

8.1.6 The MECL also conducted systematic exploration at G-4, G-3, and G-2 levels in and around Satna district, and submitted geological reports to the Government of Madhya Pradesh and NMET. Between 2016 and 2018, the blocks explored by MECL under NMET funding include Ghunchihai, Naubasta-Kollard, Jamodi-Mahanna and Piparahat-Kubri Blocks which are successfully auctioned. Summary of the works by MECL is presented in the following paragraphs:

8.1.7 The General Exploration (G-2) of the Jamodi-Mahanna Limestone Block (Part-B), Tehsil Raghuraj Nagar, district Satna, Madhya Pradesh, was carried out by Mineral Exploration Corporation Limited (MECL), Nagpur, on behalf of NMET and DGM, Madhya Pradesh, during May 2018 to October 2019. The work included geological and topographical mapping over 9.0 sq. km, systematic core drilling of 2037.50 m in 53 boreholes (17 at G-3 and 36 at G-2 level), and detailed sampling with laboratory studies. Two cement-grade limestone zones (Zone-I and Zone-II) of the Bhandar Limestone Formation were delineated, having thicknesses ranging from 2.0 m to 16.0 m and 2.0 m to 14.6 m respectively. The limestone is of cement grade, with average composition of CaO 43.95–44.30%, MgO 1.80–2.54%, and SiO₂ 8.82–9.68%. The total in-situ resource is estimated at 90.29 million tonnes (UNFC 332) over an area of 8.66 sq. km. The deposit shows gentle southerly dip (1°–3°) with lateral continuity. MECL recommended upgrading the block to G-1 level through detailed drilling for mineable reserve estimation.

- 8.1.8 The General Exploration (G-2) of the Naubasta–Kolard Limestone Block, Tehsil Nagod, district Satna, Madhya Pradesh, was carried out by Mineral Exploration Corporation Limited (MECL), Nagpur on behalf of NMET and DGM, Madhya Pradesh during May 2018 to October 2019. The work was executed under the guidance of Shri B.P. Raturi, GM (Exploration & Geological Services), assisted by Shri M.N. Sahay, Shri P.P. Kulkarni, and Shri N.K. Pala with their technical teams. Activities included geological mapping (15.90 sq. km), topographical survey, systematic core drilling of 48 boreholes (2273 m), and extensive chemical, petrographic, and XRD studies. Exploration delineated two cement-grade limestone zones (Zone-I and Zone-II) of the Bhandar (Nagod) Limestone Formation, having thicknesses from 0.8 m to 9.0 m. The limestone is of cement grade, averaging CaO 44.78%, MgO 1.47–2.40%, and SiO₂ 9.70–10.65%. The net in-situ resource was estimated at 166.05 million tonnes (UNFC 332) over 15.90 sq. km, with a gentle southerly dip (3°–5°) and lateral continuity. The report recommends upgradation to G-1 level by close-spaced drilling to establish mineable reserves for cement industry utilization.
- 8.1.9 The block and the surrounding area were covered under NGCM programme of GSI and outcomes of the same is available on the National Geo-Data Repository (NGDR) portal. From the available data no anomalous values of any elements have been observed.

CHAPTER-9

9.0.0 GEOPHYSICAL SURVEY

- 9.1.0** In the recent exploration programme no geophysical survey has been carried out. However, the area was covered under NGPM programme where only gravity survey carried out.

CHAPTER-10

10.0.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 INTRODUCTION

10.1.1 The investigation in the Bandha and Jamuniya Limestone Blocks is undertaken to evaluate the limestone potential at the **G3 (General Exploration)** stage in accordance with the **Mineral (Evidence of Mineral Contents) Rules, 2015 (MEMC Rules)** and the **UNFC** guidelines. The programme is designed to establish the geological framework of the area, delineate the occurrence and continuity of limestone through integrated geological mapping and exploratory drilling, assess the quality and thickness of the limestone horizon, and evaluate its resource potential. The study also aimed to generate geological, analytical and petrographic data for assessing the feasibility of resource estimation and determining the scope for further exploration.

10.2.0 OBJECTIVES OF INVESTIGATION

10.2.1 The present exploration program at G3 stage had been formulated on the basis of the outcomes of previous work to fulfill the following objectives:

- i. Delineate the spatial distribution of limestone and associated lithological units through detailed geological mapping.
- ii. Assess the lateral and vertical continuity, thickness and geometry of the limestone horizon by exploratory drilling.
- iii. Establish the subsurface geological succession and lithological contacts concealed beneath extensive soil cover.
- iv. Determine the chemical quality and petrographic characteristics of the limestone and associated shale through laboratory investigations.
- v. Generate geological and analytical data for mineral resource estimation in accordance with MEMC Rules and UNFC guidelines.
- vi. Evaluate the continuity, grade and resource potential of the limestone deposit and assess its suitability for further exploration and possible economic exploitation.

10.2.2 The investigation objectives are achieved through detailed geological mapping, petrographic studies, chemical analysis and drilling of four (04) exploratory boreholes. However, the drilling results established that the limestone occurs only as thin, discontinuous horizons intercalated with shale and other sedimentary rocks. The

boreholes did not establish the presence of a thick, laterally persistent limestone body, confirming that the scattered surface exposures represent isolated erosional remnants rather than a continuous deposit. Consequently, no economically significant limestone resource could be delineated within the exploration blocks, and the exploration programme was concluded with the recommendation that no further exploration in the present blocks is technically justified.

10.3.0 DETAILS OF EXPLORATION ACTIVITIES TAKEN UP

10.3.1 To meet the above objectives, activities mentioned in the following table were planned. The table also shows a comparison between approved and achieved quantum in the block.

Table 10.1

Quantum of work approved vs achieved in Bandha and Jamuniya Blocks (G3), Satna District, Madhya Pradesh

Sl. No.	Description and Nature of Work	Unit	Proposed Quantum	Achieved Quantum
A	GEOLOGICAL WORK AND SURVEYING			
1	Geological Mapping (1:4000 scale)	sq km	7.22	7.22
i	Topographical Survey (1:4000 scale)	sq km	7.22	7.22
iii	DGPS survey Boreholes and Block boundary corner points	Nos	19 (12 BHs and 07 boundary points)	11 (04 BHs and 07 Boundary Points)
B	EXPLORATORY DRILLING			
1	Drilling up to 300m (Soft Rock)	m	1000	80
C	LABORATORY STUDIES			
1	Chemical Analysis			
i	Major oxides (WD XRF)-During mapping	Nos.	10	5
ii	Borehole primary samples Major oxides (WD XRF)	Nos.	950	4
iii	External (10%) Check samples	Nos.	95	NIL
2	Petrological Studies		6	2
i	Bulk Density	Nos.	4	NIL
D	Report Preparation (5 Hard copies with a soft copy)	Nos.	2	1

- 10.3.2 The proposed quantum of exploration could not be fully achieved as drilling confirmed that the limestone horizon is only about 1 m to 1.5 m thick and is immediately underlain by Ganurgarh Shale, eliminating the justification for further drilling.

10.4.0 SURVEY

- 10.4.1 The entire survey work was carried out using a Differential Global Positioning System (DGPS) (Make: Trimble GNSS System; Model: Catalyst DA2) integrated with the Survey of India (SOI) Continuously Operating Reference Station (CORS) network. The SOI CORS base station KOTAR (Site Code: KOTA; CORS ID: 50494A001) is utilized as the reference station for all DGPS observations. Topographic surveying, including contouring, is carried out over the entire Bandha and Jamuniya Blocks at a 2 m contour interval. The coordinates and Reduced Levels (RLs) of all block boundary corner points and borehole collars are accurately determined using the DGPS. In addition, surface features such as roads, village boundaries, temples/mosques, ponds, rivers/nalas, and other prominent features were surveyed and incorporated into the topographical map, which is presented as **Plate-IV**. Details of the block boundary corner points are provided as **Annexure II**.

10.5.0 GEOLOGICAL MAPPING

- 10.5.1 MECL carried out detailed geological mapping on 1:4000 scale, by taking traverses for both the blocks. Lithological units and litho contacts have been mapped with the help of DGPS instrument. Attitude and structural features of rocks like bedding, foliation and joints are recorded by Brunton Compass. The geological map was prepared by plotting the different litho units and structural features i.e., strike & dip of foliations. Geological map of the area is provided as Plate III. Systematic geological traverses were carried out between and around the exposed outcrops, with examination of float material, lithological fragments and surface geological characteristics. Based on these observations and the continuity of lithological units between adjoining exposures, the contacts concealed beneath the soil cover were interpreted and projected on the geological map.

10.6.0 BEDROCK SAMPLE

- 10.6.1 A total of **05 bedrock (grab) samples** were collected during the course of geological mapping from representative limestone exposures encountered within the exploration

block. The samples are collected to assess the chemical characteristics of the exposed limestone and to evaluate its suitability and variability with respect to major oxide composition. Each sample was selected from fresh, unweathered rock exposures, as far as practicable, to ensure that the analytical results represent the in-situ lithology.

10.6.2 The collected samples are submitted for chemical analysis by the **WD-XRF (Wavelength Dispersive X-Ray Fluorescence)** method for determination of major oxides, along with selected trace elements and **Loss on Ignition (LOI)**. The analytical results provide preliminary geochemical information on the quality of the exposed limestone and serve as supportive data for correlating surface geology with subsurface exploration findings. Details of the bedrock sample locations and their chemical assay results are presented in Table 10.2 and in Annexure V.

10.6.3 The chemical assay results indicate that the exposed limestone is of high-calcium quality, with CaO values ranging from 47.28% to 51.08% and MgO values from 0.69% to 2.90%. All the analyzed samples satisfy the IBM threshold criteria for limestone ($\text{CaO} \geq 34\%$ and $\text{MgO} \leq 5\%$), indicating good chemical quality of the surface exposures.

Table 10.2

Summary of the Chemical Analysis of surface samples in Bandha and Jamuniya Block, Satna District, Madhya Pradesh

Sl No.	Sample No	Latitude	Longitude	CaO %	SiO ₂ %	MgO %	Al ₂ O ₃ %	Fe ₂ O ₃ %
1	BDH-01	24° 28' 43.00" N	81° 02' 08.00" E	48.03	5.91	2.90	1.51	0.78
2	BDH-02	24° 28' 54.14" N	81° 01' 37.06" E	50.18	4.33	2.23	1.01	0.56
3	JAM-01	24° 28' 01.00" N	81° 02' 33.00" E	50.86	5.75	0.69	1.09	1.17
4	JAM-02	24° 27' 56.00" N	81° 02' 34.00" E	51.08	4.89	0.72	1.17	1.13
5	JAM-03	24° 27' 28.00" N	81° 02' 33.00" E	47.28	9.67	1.29	2.35	1.41

10.7.0 TRENCHING/PITTING

10.7.1 No pitting or trenching was carried out during the present exploration. Moreover, pitting and trenching were not included in the approved scope of work, as the primary objective of the investigation is to assess the subsurface continuity, thickness, and quality of the limestone through exploratory drilling.

10.8.0 DRILLING

- 10.8.1 A total of **04 exploratory boreholes** were drilled in the **Bandha and Jamuniya limestone blocks** to investigate the subsurface disposition, thickness, lateral continuity, and quality of the limestone encountered at the surface. The boreholes are strategically located based on the geological mapping and surface geological observations so as to evaluate the persistence of the limestone horizon beneath the surface. Drilling is carried out using **diamond core drilling**, and continuous core recovery facilitated detailed geological logging, lithological correlation, and systematic sampling of the intersected lithological units. The drilling programme generated valuable subsurface geological information, which was utilized to assess the continuity and resource potential of the limestone.
- 10.8.2 A total of 80.00 m of conventional diamond core drilling is completed through 04 boreholes across the Bandha and Jamuniya blocks using MECL Drill Rig MEC-347 (Model: RD-60). The drilling programme commenced on 14.05.2026 and completed on 25.05.2026. The boreholes could not be advanced to the initially targeted depths, as the anticipated thick is not encountered, and continuation of drilling beyond the geological objective is not considered technically justified. The recovered cores are systematically logged for lithology, structure, weathering, and other geological features, followed by sampling of the limestone intersections for laboratory analysis. The details of the boreholes, including collar coordinates, depth, inclination, azimuth, and lithological intersections, are furnished in Annexure II and summarized in Table 10.3.
- 10.8.3 The drilling results revealed that the limestone occurs as thin, discontinuous lenses and bands. The anticipated thick is not encountered in any of the boreholes, thereby indicating that the exposed limestone represents isolated remnant occurrences rather than an extensive subsurface deposit. Consequently, the exploration programme concluded that the block does not possess the geological continuity necessary for resource estimation or further exploration.

Table- 10.3

Details of Boreholes drilled in Bandha and Jamuniya Blocks, Satna District, Madhya Pradesh

SL NO	BH. NO.	WGS84 (DMS)		REDUCED LEVEL (m)	TOTAL DEPTH (m)	TYPE
		LATITUDE	LONGITUDE			
1	MJBH-01	N24°27'34.16367"	E81°02'35.43673"	319.342	34.00	Vertical
2	MJBH-02	N24°28'11.85899"	E81°02'38.49765"	318.041	20.00	Vertical
3	MJBH-03	N24°28'49.87315"	E81°01'32.04932"	327.253	16.00	Vertical
4	MJBH-04	N24°28'15.75113"	E81°01'40.90377"	325.475	10.00	Vertical

10.9.0 CORE LOGGING

10.9.1 The recovered drill cores are systematically logged by immediately after core recovery. Core logging included recording of lithology, colour, grain size, texture, mineralogical characteristics, weathering, structural features, core recovery, The limestone horizons are identified and their depth, thickness, contacts, and mode of occurrence are recorded in the borehole logs. The geological logging formed the basis for demarcation of sampling intervals, lithological correlation between boreholes, and interpretation of the subsurface geological setting. Detailed logs of the boreholes is provided as **Annexure VI**.

10.9.2 The geological information recorded during core logging has been presented in the form of graphical lithologs for all four boreholes (**Plate-V**), which formed the basis for lithological correlation and interpretation of the subsurface geology.

10.10.0 CHEMICAL ANALYSIS OF BOREHOLE CORE SAMPLES

10.10.1 A total of 04 half-core samples collected from the limestone intersections encountered in the boreholes are analysed by the Wavelength Dispersive X-ray Fluorescence (WD-XRF) method for major oxides and 14 selected trace elements. The objective of the analysis was to evaluate the chemical quality and compositional characteristics of the limestone at depth, assess its industrial suitability, and correlate the subsurface chemistry with the surface exposures.

10.10.2 The analytical results indicate that the limestone exhibits CaO values ranging from 39.29% to 51.81%, MgO from 1.10% to 5.01%, SiO₂ from 3.05% to 13.23%, Al₂O₃

from 0.83% to 3.51%, Fe₂O₃ from 0.52% to 1.39%, and LOI from 35.30% to 41.90%. Three of the four borehole samples satisfy the threshold values prescribed by IBM vide Circular No. C-284/3/CMG/2017 dated 25.04.2018 (CaO $\geq$ 34% and MgO $\leq$ 5%) and the analysed borehole samples are classified as high grade limestone, except sample MJBH-01/1, which contains MgO of 5.01%, marginally exceeding the prescribed limit. The relatively higher SiO₂, Al₂O₃, and Fe₂O₃ contents in MJBH-01/1 indicate the presence of siliceous and argillaceous impurities, whereas the remaining borehole samples represent comparatively purer limestone.

10.10.3 The concentrations of the analysed trace elements (Mn, Sr, Rb, Ba, Zr, Nb, Y, Mo, Ni, Th, U, V, Sc, and Li) are generally low, with Mo and Ni remaining below the detection limit in all the samples. No anomalous enrichment of trace elements was observed, indicating that the limestone is geochemically simple and free from any significant trace element mineralization.

10.10.4 Overall, the borehole samples demonstrate good chemical quality; however, the drilling programme established that the limestone occurs only as thin horizons (0.97 m to 1.53 m thick) with poor lateral continuity. Consequently, despite the favourable chemical composition, the limestone does not constitute a thick and laterally persistent deposit suitable for resource estimation within the exploration blocks. Chemical results of borehole core samples and other details are provided in the **Annexure VII**.

10.11.0 PETROGRAPHIC STUDIES

10.11.1 A total of 2 nos of samples from exposed limestone on the surface and core from the shale unit were subjected to petrographic studies at Petrology Laboratory, MECL Nagpur. Thin sections were prepared and petrographic studies of the same were carried out using Leitz and Ortholux II microscopes to know the mineral composition, texture, characteristics of individual minerals and the rock type. Litho-units identified by petrographic studies are limestone and ferruginous shale. Details of the petrographic study of samples are provided in **Annexure VIII** and in the following Table.

Table 10.4
Details of the Petrographic Samples in Bandha and Jamuniya Blocks, Satna district,
Madhya Pradesh.

Sl. No.	Sample No.	Latitude	Longitude	Remarks
1	BJ-01	24° 28' 4.81" N	81° 02' 29.00"E	Limestone (oosparite)
2	BJ-02	MJBH-01, Depth: 27.05-27.10m		Ferruginous shale.

10.12.0 DATA SPACING FOR REPORTING OF EXPLORATION RESULTS

10.12.1 The exploratory boreholes were strategically located across the Bandha and Jamuniya blocks to evaluate the subsurface occurrence, thickness, lateral continuity, and quality of the limestone horizons identified during geological mapping. Following the intersection of limestone in the first borehole, the subsequent boreholes were systematically positioned at different locations across both blocks to assess the lateral persistence and continuity of the limestone over the entire exploration area. The drilling data, integrated with surface geological observations, provided adequate information to interpret the geological disposition and continuity of the limestone. The borehole intersections established that the limestone occurs as thin and discontinuous horizons across the blocks. Accordingly, the adopted borehole spacing and distribution were adequate to evaluate the geological continuity and delineate the nature and extent of the limestone occurrence within the exploration area.

10.12.2 The adopted borehole spacing and distribution satisfy the requirements of G3 level exploration, considering the nearly horizontal disposition of the limestone horizon. The systematic distribution of boreholes across the exploration blocks provided adequate geological information to evaluate the thickness, lateral continuity, and quality of the limestone.

10.13.0 OUTCOME OF THE INVESTIGATION TAKEN UP

10.13.1 The limestone mineralization in the Bandha and Jamuniya blocks is confined to the Nagod Limestone Formation of the Upper Vindhyan Supergroup and occurs as isolated, discontinuous surface exposures preserved as remnant outcrops after prolonged weathering and erosion. The limestone is grey to bluish-grey, fine- to

medium-grained, compact and hard, with occasional oolitic and stromatolitic textures. Petrographically, it is predominantly oosparite, comprising ooids cemented by sparry calcite, indicating deposition in a shallow marine, high-energy environment. The limestone occurs as thin, stratabound and discontinuous bands/lenses intercalated with shale. Chemical analysis indicates high-calcium limestone, with CaO ranging from **47.28% to 51.08%** and MgO from **0.69% to 2.90%**, satisfying the IBM threshold criteria ($\text{CaO} \geq 34\%$ and $\text{MgO} \leq 5\%$). However, exploratory drilling established that the limestone lacks thickness and lateral continuity at depth, indicating that the mineralization is restricted to localized occurrences and is not of economic significance.

CHAPTER-11

11.0.0 LOCATION OF DATA POINTS

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

11.1.1 The topographic and cadastral survey of the Bandha and Jamuniya Limestone Blocks is carried out using a Trimble GNSS System (Model: Catalyst DA2) operating with the Survey of India (SOI) Continuously Operating Reference Station (CORS) Network. Surface features, including roads, drainage, water bodies, village boundaries, and other prominent landmarks, were surveyed. The coordinates and Reduced Levels (RLs) of the block boundary cardinal points (05 in Bandha Block and 04 in Jamuniya Block) were accurately determined using DGPS (**Annexure IV**). Based on the DGPS survey data, the topographical map of the study area was prepared with a 2 m contour interval (Plate-IV). The positional (horizontal) and elevation accuracies of the survey conform to the specifications of the SOI CORS-based GNSS positioning system.

11.1.2 The collar survey of all 04 exploratory boreholes was also carried out using the Trimble GNSS System (Model: Catalyst DA2) connected to the SOI CORS Network (**Annexure IC**). The borehole collar coordinates and Reduced Levels (RLs) were determined with reference to the SOI base station. The coordinates of the base station utilized for the DGPS survey are presented in the following table.

Table: 11.1

Details of Base Station for Survey in Bandha and Jamuniya Blocks, Satna District, Madhya Pradesh

Sl No.	Base Station	Latitude (WGS-84)	Longitude (WGS-84)	RL (m)
1	BASE-SOI (KOTA)	N24°42'14.53187"	E81°00'13.78116"	241.532

11.2.0 QUALITY AND ADEQUACY OF TOPOGRAPHIC CONTROL

11.2.1 The topographic control for the exploration area was established using the Trimble Catalyst DA2 GNSS System integrated with the Survey of India CORS Network. The survey covered all essential surface features, contour points, block boundaries, and borehole collar locations, providing an accurate geospatial framework for geological

mapping and exploration activities. The system provides a horizontal positional accuracy of approximately 10 mm and a vertical (elevation) accuracy of approximately 20 mm under SOI CORS-based survey conditions. Based on the DGPS data, a detailed topographical map of the Bandha–Jamuniya Limestone Block is prepared on a 1:4,000 scale, which served as the base map for geological mapping, drilling, and interpretation of exploration results. The detailed topographical map of the blocks has been prepared on 1:4,000 scale and provided as **Plate IV**.

CHAPTER-12

12.0.0 SAMPLING TECHNIQUE

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

12.1.1 A total of 05 grab samples are collected from representative fresh limestone exposures encountered during geological mapping. The samples were collected after removing the weathered surface to ensure that they represented the in-situ lithology. Representative sampling locations were selected to cover the exposed limestone occurrences within the exploration blocks. Due care is taken up to avoid contamination, weathered material, and mixing with adjacent lithologies during sample collection. Approximately 2–3 kg of material is collected for each sample, properly labelled, packed in clean cotton bags, and dispatched to the laboratory for chemical analysis. The adopted grab sampling procedure provided representative samples for assessing the chemical characteristics of the exposed limestone.

12.1.2 A total of 04 half-core samples are collected from the limestone intersections encountered in the 04 boreholes. The sample intervals were determined based on the total thickness of the limestone intersected in each borehole. After detailed geological logging, the core is marked according to lithological boundaries, and each sample interval was longitudinally split into two equal halves using a core cutting machine. One half of the core is collected for chemical analysis, while the remaining half is retained in the core boxes as a permanent reference. The half-core samples are properly labelled, securely packed, and dispatched to the laboratory for chemical analysis. The adopted sampling procedure ensured representative sampling of the limestone intersections and maintained sample integrity throughout the analytical process.

CHAPTER-13

13.0.0 DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

13.1.1 MECL drilled 04 no of boreholes with a total meterage of 80m, the details of boreholes drilled by MECL are given in Annexure-IV and summary of borehole is given in Table-10.3.

13.1.2 Drilling in the blocks are carried out by deploying RD 60 conventional drills (MEC 347). Core recovery of more than 90% was achieved except in soil and weathered zone. Wet drilling method was adopted. After closure, all the boreholes have been properly plugged and sealed with cement pillars. Drill cores samples were preserved in core boxes to protect them from physical damage and to maintain their integrity for scientific investigation. Book pattern style was adopted to keep the cores in the boxes

13.1.3 Q series induction hardened NQ rods and double-tube diamond core bits were used for the drilling. The outer diameter (OD) of the drill rods is 69.9 mm and inner diameter (ID) is 60.3 mm and that of bit (OD) is 75.44 mm & 47.75 mm (ID). The diameter of recovered core is 47.60 mm.

13.1.4 Limestone intersections encountered in the boreholes are sampled by longitudinally splitting the core into two equal halves using a core cutting machine. One half-core is collected for chemical analysis, while the remaining half was preserved in the core boxes as a permanent reference. Sample intervals were demarcated based on the total thickness of the limestone intersected in each borehole, ensuring representative sampling of the mineralized horizons.

CHAPTER-14

14.0.0 SUB SAMPLING TECHNIQUES AND SAMPLE PREPARATION

14.1.0 SAMPLE PROCESSING FOR CHEMICAL ANALYSIS

- 14.1.1 During sample preparation, adherence to standard operating procedures is paramount. Samples are powdered to -200 mesh size using sample crusher, Pulveriser, mortar and pestle. Rigorous cleaning procedures for all the instruments used in sample processing including sample tray, brush, and all tools, are implemented after each sample is processed, maintaining a contamination-free environment.
- 14.1.2 Standard sampling procedure adopted and the samples are prepared at centralized sampling unit at MECL, Nagpur.
- 14.1.3 The bedrock grab samples and half-core samples collected from the limestone intersections in the boreholes are transported to the laboratory for sample preparation. The samples are cleaned and dried, where necessary, and subsequently crushed to the required size using a jaw crusher. The crushed material was thoroughly homogenized and reduced to a representative sub-sample by the coning and quartering method. The representative sub-sample was then pulverized to –200 mesh in a pulverizer to obtain a homogeneous powder. The pulverized samples were used for determination of major oxides, selected trace elements, and Loss on Ignition (LOI) by the WD-XRF method.
- 14.1.4 In accordance with the standard sampling procedures, it has been observed that smaller particle size leads to higher homogeneity of samples as well as higher dissolvability during chemical analysis. As a result, samples have been reduced to -200 mesh size for chemical analysis.

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 Laboratory Procedure for samples: The chemical analyses of primary samples have been carried out in MECL's Chemical laboratory for determining CaO%, MgO%, SiO₂%, Fe₂O₃%, Al₂O₃%, SO₃%, P₂O₅%, K₂O%, Na₂O%, LOI% and 14 trace elements

15.2.0 STANDARD OPERATING PROCEDURE FOR THE ANALYSIS BY MECL LAB, NAGPUR

15.2.1 The chemical analysis of the limestone samples is carried out using the Wavelength Dispersive X-ray Fluorescence (WD-XRF) technique. Prior to analysis, the samples were pulverized to –200 mesh to obtain a homogeneous powder. The pulverized material is thoroughly mixed and prepared as pressed pellets by applying a pressure of 15–35 tonnes, ensuring a stable and uniform surface for analysis. During analysis, the prepared pellet was irradiated with primary X-rays, causing the constituent elements to emit characteristic secondary (fluorescent) X-rays. The sample was rotated during analysis to accurately diffract each characteristic wavelength in accordance with Bragg's Law. The emitted X-rays were detected by the spectrometer, and the position and intensity of the characteristic peaks were measured to determine the elemental composition, with the analytical results reported as major oxides along with selected trace elements. Photograph of WD-XRF instrument (Rigaku, Japan) at Chemical Lab, MECL, Nagpur have been represented in the following Photo 14.1.

15.3.0 STANDARD OPERATING PROCEDURE FOR THE DETERMINATION OF LOSS ON IGNITION (L.O.I.) AT MECL LAB

15.3.1 Loss on Ignition (LOI) is determined by accurately weighing **1.0 g** of the dried pulverized sample into a clean silica or platinum crucible. The crucible containing the sample was initially placed in a muffle furnace at a temperature below **300°C**, after which the temperature is gradually increased to **1000°C** and maintained for approximately **30 minutes**. Following ignition, the crucible is removed, cooled in a desiccator to room temperature, and reweighed. The decrease in sample weight after

ignition is attributed to the loss of volatile constituents, and the **Loss on Ignition (LOI)** is calculated as the percentage weight loss relative to the original sample weight using the expression: $\text{LOI (\%)} = (\text{Loss in weight} / \text{Original sample weight}) \times 100$.



Photo 14.1: Photograph showing WD-XRF instrument (Rigaku, Japan) at Chemical Lab, MECL, Nagpur

15.4.0 ACCURACY OF SAMPLING PROCEDURE: The grade estimates of the deposit are based on the results of samples. Each sample undergoes the process of sample preparation and analysis. Since, sampling and analysis are two complimentary links of quality estimation chain, the possible source of errors, if any, could be from the bias in sample preparation and inaccuracies in assaying or both. The sampling was carried out by observing prevailing standard procedure. Thus, the reliability of the sampling process is very high and has not been compromised at any stage.

15.5.0 PRIMARY AND CHECK SAMPLE STUDIES OF TRENCH AND BOREHOLE SAMPLING

15.5.1 External check sample analysis is not carried out, as only 09 primary samples (05 bedrock samples and 04 borehole core samples) are only generated during the investigation. The limited number of analytical samples resulted from the restricted occurrence of limestone intersected during exploration. Under such circumstances, external check analyses would not have provided a statistically meaningful assessment

of analytical precision or laboratory bias. All primary samples were analysed in the MECL laboratory following the prescribed sample preparation and analytical procedures to ensure the reliability of the analytical results.

15.6.0 SECURITY AND CHAIN OF CONTROL OF SAMPLES

- 15.6.1 The security and chain of control of samples from the field unit to sampling unit and finally to the chemical laboratory undergoes through a meticulous and well-organized process. The samples are prepared at centralized mechanized sampling unit under the supervision of qualified sampling technician. The samples are meticulously labeled and tagged before being sent to the chemical laboratory under the direct supervision of the technician. During transportation, the samples were securely sealed in bags, and the integrity of the seals was verified at the sampling unit before the bags are opened. Adhering to standard procedures, the sampling unit implemented robust precautionary measures to prevent any potential contamination, ensuring the reliability of the sample analysis. Additionally, the remaining samples are appropriately preserved and tagged for future reference, highlighting a commitment to maintaining a secure and traceable chain of control under the company's custody. At the sampling unit, standard procedure is followed and all the precautionary measures are taken to avoid contamination. The sampling unit is separate from the chemical laboratory, so there is no chance of contamination.

CHAPTER-16

16.0.0 MOISTURE

- 16.1.0** Moisture determination is not carried out, as it is not required for routine chemical characterization of hard-rock limestone samples. All samples were dried prior to crushing, pulverization, and analysis, and the analytical results are reported on a dry weight basis.

CHAPTER-17

17.0.0 BULK DENSITY

- 17.1.0 Bulk density determination is not carried out, as exploratory drilling established that the limestone occurs as thin, discontinuous horizons with limited lateral continuity. Consequently, determination of bulk density is not considered necessary.

CHAPTER-18

18.0.0 BENEFICIATION STUDIES

- 18.1.0 Beneficiation studies are not carried out, as they are not included in the approved scope of work. Moreover, exploratory drilling established that the limestone occurs as thin, discontinuous horizons with limited lateral continuity and no representative bulk sample suitable for beneficiation studies is available

CHAPTER-19

19.0.0 RESOURCE ESTIMATION TECHNIQUE

- 19.1.0 Resource estimation techniques are not applied, as exploratory drilling established that the limestone occurs as thin, discontinuous horizons with limited lateral continuity. The exploration programme did not delineate a continuous mineralized body of sufficient extent to warrant resource estimation. Accordingly, no mineral resource estimation is attempted.

CHAPTER-20

20.0.0 REPORTING OF RESOURCES

- 20.1.0 No Mineral Resource has been estimated or reported for the Bandha and Jamuniya Limestone Blocks. Exploratory drilling established that the limestone occurs as thin, discontinuous horizons with limited lateral continuity, and the geological continuity required for resource estimation could not be demonstrated.

CHAPTER-21

21.0.0 SUMMARY AND RECOMMENDATIONS

21.1.0 SUMMARY

21.1.1 The Bandha and Jamuniya Limestone Blocks, covering a combined area of 7.22 sq. km in Rampur Baghelan Tehsil, Satna district, Madhya Pradesh, are investigated under the Preliminary Exploration (G-3) stage to assess the subsurface continuity, thickness, and quality of the limestone exposed at the surface. The exploration programme comprised detailed geological mapping, DGPS survey, drilling of 04 exploratory boreholes (80 m), core logging, petrography, and chemical analysis of representative samples.

21.1.2 Surface samples indicated that the exposed limestone is of high grade, satisfying the IBM threshold criteria for limestone. However, exploratory drilling established that the limestone occurs only as thin, discontinuous lenses and bands with poor lateral continuity. The anticipated thick and persistent limestone horizon is not encountered in any borehole, demonstrating that the surface exposures represent isolated erosional remnants of the basal Nagod Limestone rather than a continuous subsurface deposit. Consequently, no mineral resource could be delineated or estimated for the blocks.

21.1.3 The exploration programme successfully fulfilled its objective of evaluating the limestone potential of the blocks and conclusively established the absence of a geologically continuous and economically significant limestone body. Accordingly, the project was recommended for premature closure by the Technical Cum Cost Committee-II, NMEDT and no further resource evaluation was considered feasible.

21.2.0 RECOMMENDATIONS

21.2.1 Based on the results of geological mapping, drilling, and laboratory investigations, no further exploration is recommended within the present Bandha and Jamuniya Blocks. As exploratory drilling conclusively established the absence of a thick, laterally persistent limestone body and no mineral resource could be delineated, continuation of exploration in the present blocks is not technically or economically justified. The trace element analyses indicate that the limestone is chemically suitable from the perspective of deleterious trace constituents and do not reveal any economically significant enrichment of associated trace elements. Hence, no additional exploration targeting

trace element mineralization is recommended. The blocks may therefore be closed for further exploration.

CHAPTER-22

22.0.0 PLATES AND MAPS

- 22.1.0 Location Map of the block showing various topographic and physiographic features on SoI toposheet is given as Plate-I (Not to Scale).
- 22.1.1 Regional Geological Map (Not to Scale) as Plate II
- 22.1.2 Geological Map of blocks on 1:4000 is given as Plate III.
- 22.1.3 Topographical Map on 1:4000 is given as Plate IV
- 22.1.4 Graphical Litholog of Boreholes on 1:100 as Plate V

CHAPTER-23

23.0.0 ANNEXURE / ENCLOSURES TO THE REPORT

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

CHAPTER-24

24.0.0 ANY OTHER INFORMATION

24.1.0 List of Abbreviation and their full forms

SL No	Abbreviation	Full Form
1	Al ₂ O ₃	Aluminium Oxide
2	ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
3	Ba	Barium
4	BIS	Bureau of Indian Standards
5	BX	B-X Size Diamond Core
6	CaO	Calcium Oxide
7	CGWB	Central Ground Water Board
8	Co	Cobalt
9	CORS	Continuously Operating Reference Station
10	CPCB	Central Pollution Control Board
11	Cr	Chromium
12	Cu	Copper
13	DEM	Digital Elevation Model
14	DGPS	Differential Global Positioning System
15	ESA	European Space Agency
16	Fe ₂ O ₃	Ferric Oxide
17	FSI	Forest Survey of India
18	GSI	Geological Survey of India
19	G3	Preliminary Exploration Stage

SL No	Abbreviation	Full Form
35	Nb	Niobium
36	NH	National Highway
37	Ni	Nickel
38	NMEDT	National Mineral Exploration And Development Trust
39	NRSC	National Remote Sensing Centre
40	NX	N-X Size Diamond Core
41	P ₂ O ₅	Phosphorus Pentoxide
42	PSC	Project Sanctioning Committee
43	PWD	Public Works Department
44	QA/QC	Quality Assurance / Quality Control
45	Rb	Rubidium
46	RL	Reduced Level
47	RQD	Rock Quality Designation
48	Sc	Scandium
49	SiO ₂	Silicon Dioxide
50	SOI	Survey of India
51	SOP	Standard Operating Procedure
52	Sr	Strontium
53	SRTM	Shuttle Radar Topography Mission

SL No	Abbreviation	Full Form
20	GPS	Global Positioning System
21	IBM	Indian Bureau of Mines
22	ICP-MS	Inductively Coupled Plasma–Mass Spectrometry
23	IMD	India Meteorological Department
24	ISRO	Indian Space Research Organisation
25	K ₂ O	Potassium Oxide
26	Li	Lithium
27	LOI	Loss on Ignition
28	m	Metre
29	MgO	Magnesium Oxide
30	Mn	Manganese
31	MnO	Manganese Oxide
32	Mo	Molybdenum
33	MoEF&CC	Ministry of Environment, Forest and Climate Change
34	MSI	Multispectral Instrument

SL No	Abbreviation	Full Form
54	TCC	Technical-cum-Cost Committee
55	Th	Thorium
56	TiO ₂	Titanium Dioxide
57	U	Uranium
58	UNFC	United Nations Framework Classification for Resources
59	USGS	United States Geological Survey
60	V	Vanadium
61	WD-XRF	Wavelength Dispersive X-Ray Fluorescence
62	WGS-84	World Geodetic System 1984
63	WRIS	Water Resources Information System
64	Y	Yttrium
65	Zn	Zinc
66	Zr	Zirconium
66	Zr	Zirconium

CHAPTER-25

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME, DATE AND SIGNATURE

This is to certify that geological report has been prepared on preliminary exploration (G-3) for Limestone in Bandha and Jamuniya Blocks, Satna district, Madhya Pradesh by Mineral Exploration and Consultancy Limited (MECL) on behalf of National Mineral Exploration and Development Trust. The report has been prepared in accordance with the Minerals (Evidence of Mineral Contents) Rule 2015 specified under Mineral Auction Rule, 2015 and amended up to 2021.

NAME: **SHRIKANT SHARMA**

DESIGNATION: **HoD (EXPLORATION)**

DATE: 25.08.2026

**LIST OF PERSONNEL ASSOCIATED WITH BANDHA AND JAMUNIYA BLOCKS,
SATNA DISTRICT, MADHYA PRADESH**

Overall guidance	Shri Shrikant Sharma, HoD (Exploration)
Overall Planning, Co-ordination & Supervision	Shri S. K. Satapathy, Sr. Manager (Geology)
Project Management	Shri Rishabh Kumar, Manager (Drilling) / Project Manager
Physical Execution of work	
a) Geology	Shri Dileep Pandey, Asst. Manager (Geology)
b) Survey	Shri Gourav Banik, Surveyor
c) Drilling Supervision	Shri Dileep Pandey, Asst. Manager (Geology)
Sample Processing	Shri Ankush Haridas Wagh, Sr. Technician (Sampling)
Chemical Laboratory	Shri Rohit Sharma, Manager (Chemical Lab)
	Dr. Deepti Rahangdale, Manager (Chemical Lab)
Petrographic Studies	Shri Sayantan Pal, Manager (Geology)
Documentation	Shri S. K. Satapathy, Sr. Manager (Geology)
Reprography and Printing	Shri Durgesh Devarshee, Assistant Survey & Map Officer
Hindi Translation	Shri Shreekant Rai, Hindi Officer

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