Detailed Project Report

Preliminary Exploration (G3) For Limestone In Pathria Block, Sagar And Damoh District, Madhya Pradesh

For
G3 Stage Mineral Exploration Under NMET.

Commodity: Limestone

By

Unised Research Consultants Private Limited

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Place: Kanpur

Date: 22/06/2026

Detailed Proposal:

1. **Block Summary:**

The proposed area forms part of the Nagod and Lameta formations and is located within the Sagar and Damoh districts of Madhya Pradesh. Geologically, the study area comprises limestone of the Nagod Formation, boulder bed, limestone of the Lameta Group, basalt of the Deccan Traps, and recent alluvium/soil. Limestone of the Nagod Formation is predominantly exposed near Kevlari and Sajiya villages, whereas Lameta limestone occurs mainly around Umraho and Jamunia Mal villages. The area is situated approximately 20 km N-NNW of Garhakota town in Sagar District and about 5 km west of Patharia town in Damoh District. The major villages in and around the proposed area include Kevlari, Sajiya, Sasa, Umraho, Tada, Botrai, and Jamuniya Mal. The area lies in the Survey of India Toposheet No. 55M/01. Most of the part of the proposed area is flat lying and covered by agricultural lands, except for some barren lands and around 10 % area covering forest land. Overall, the proportion of human settlements is moderate. The agricultural land is mostly owned by local people.

Background Geology (Regional Geology, Geology of the Block):

The proposed study area lies within the Vindhyan Basin, a prominent Proterozoic basin characterized by its sickle-shaped geometry and ENE–WSW trend. The basin is developed over the Bundelkhand Craton and is structurally bounded by the Son–Narmada Fault to the south and the Great Boundary Fault to the northwest. The Vindhyan Supergroup unconformably overlies the Bundelkhand Granite, indicating a significant break in deposition.

Geologically, the area occupies the central part of the basin and is represented predominantly by lithologies of the Bhander Group, including sandstones, shales, and Nagod limestones, along with Lameta limestone beds and overlying basaltic flows of the Deccan Trap. Regionally, the stratigraphy also includes Upper Rewah Quartzites and Quaternary deposits, reflecting a complex geological history. The Upper Rewah Quartzites are typically massive and coarse-grained, occasionally exhibiting false bedding. The Bhander Sandstones preserve sedimentary structures such as rain prints and desiccation cracks, indicative of subaerial exposure during deposition. Within the Bhander sequence, the Ganurgarh Shales are characterized by brick-red coloration with calcite veining, grading into cream-colored calcilutites. The Bhander Limestones, generally bluish-grey and non-marine in origin, are notable for their high CaO content and constitute a significant target for cement-grade material. The Sirbu Shales occur as thinly laminated khaki to buff-colored units interbedded with quartzitic sandstones. The Lameta Beds display considerable variability in thickness and composition, comprising gritty sandstones, calcareous clays, chert horizons, and mottled limestones containing pinkish sandstone pebbles. Overlying these, the Deccan Trap formations occur as basaltic flows with thickness ranging from approximately 15 m to 100 m. These flows are predominantly massive, with amygdaloidal varieties containing chalcedony and chert, while zeolites are relatively scarce. Mineralogically, the basalts consist of augite, basic andesine to labradorite, chlorite, and magnetite, with occasional occurrences of honey-colored to

reddish glassy material. Notably, these trap formations do not exhibit lateritization in the study area.

Overall, the geological setting reflects a stable cratonic basin with well-preserved sedimentary sequences and overlying volcanic units, providing favorable conditions for limestone exploration and resource assessment.

Table 1: Stratigraphy of the proposed block

Supergroup	Group	Formation	Lithology	Age
Alluvium				Quaternary
Deccan Trap	Malwa	Basalt		Up. Cretaceous to Palaeocene
Lameta		Limestone		Up. Cretaceous
Vindhyan	Bhander	Maihar Fm	Sandstone	Neoproterozoic
		Sirbu Fm	Shale	
		Bundi Hill Fm	Sandstone	
		Nagod Fm	Limestone	
		Ganurgarh Fm	Shale	
	Rewa	Govindgarh Fm	Sandstone	

Mineral potentiality based on geology, geophysics, ground geochemistry etc. Scope for proposed exploration:

Systematic geological mapping of parts of Sagar District was undertaken by K. Rajarajan during the field seasons 1956–57, 1960–61, and 1978. He mapped the Vindhyan sedimentary sequence along with the Lameta Group and the Deccan Basalt occurring in the area. According to his observations, the lithological units include upper Rewa quartzites, Bhander sandstones, shales and limestones, Lameta beds, and the Malwa Traps. The collected representative samples of Nagod limestone belonging to the Bhander Group to assess their grade. Analytical results of five limestone samples collected near Garhakota town indicated CaO contents ranging from 35.01% to 50.13%, with MgO not detected. SiO_2 values ranged from 4.40% to 26.20%, Al_2O_3 from 0.52% to 2.51%, Fe_2O_3 from 3.93% to 9.46%, and loss on ignition (LOI) from 27.81% to 40.07%. Vishwakarma and Kumar carried out a National Geochemical Mapping (NGCM) project in toposheets 55M/01 and 55M/03 during the field season 2021–22. Their study reported CaO values in the area ranging from 0.34% to 12.19%.

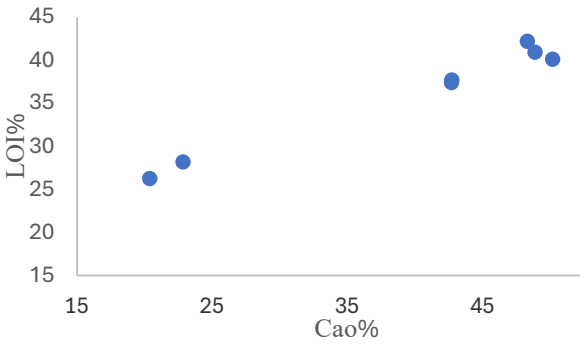
A reconnaissance survey conducted by Yadav and Sahoo during the field season 2023–24 in the Garhakota and Patharia areas of Sagar and Damoh districts focused on evaluating the economic potential of limestone mineralization within the Nagod and Lameta formations. Chemical analyses

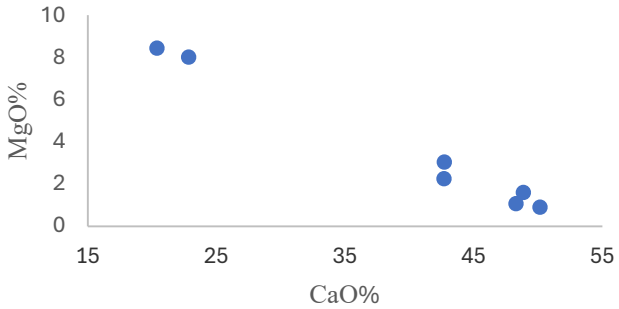
of 100 samples collected during the survey provided important insights into the mineral composition. The CaO content in calcareous sandstone ranged from 21.26% to 29.09%, while limestone samples from the Nagod and Lameta formations recorded CaO values of up to 47.96% and 47.89%, respectively. Further reconnaissance work during the field season 2023–24 by Karmi and Nayak indicated that the Nagod Formation, exposed mainly near Kevlari and Sajiya villages, comprises stromatolitic limestone, massive grey limestone, and yellowish-brown laminated limestone. Detailed field observations and sampling revealed that the massive grey limestone is characterized by relatively low silica content, whereas the stromatolitic and laminated limestones contain higher silica concentrations. The overlying Lameta limestone of the Lameta Group is gritty and cherty in nature and exhibits higher silica content. This sequence is overlain by the Deccan Trap basalts. Systematic sampling and analyses, including bulk rock samples (BRS), pit samples (PTS), and channel samples, indicate appreciable CaO concentrations, moderately high SiO_2 values, and balanced MgO content, underscoring the economic potential of limestone in the region. The identification of distinct limestone grades suitable for white cement, Portland cement, and blendable or beneficiable cement represents a significant outcome of the study, highlighting the scope for diversified industrial utilization.

Recent chemical analyses conducted by us on seven representative samples collected from BRS and pits/well indicate significant compositional variability within the proposed limestone block. The CaO content ranges widely from 22% to 50%, reflecting the presence of both low-grade and high-grade limestone horizons. Similarly, MgO values vary between 0.89% and 8.01%, suggesting localized development of dolomitic phases. The silica (SiO_2) content shows considerable fluctuation from 6.52% to 37.28%, indicating varying degrees of impurity and potential intercalation of siliceous material. The Loss on Ignition (LOI) values range from 26.30% to 42.20%, further supporting heterogeneity in carbonate content and mineral composition (Table 2).

Table 2: Geochemical analysis results (by Unised Research Consultants Pvt Ltd)

Sample No	CaO%	MgO%	SiO2%	LOI%
SAMPLE NO- URC/PTB/BRS1	48.858	1.589	7.21	40.95
SAMPLE NO- URC/PTB/BRS2	42.695	2.244	16.04	37.42
SAMPLE NO- URC/PTB/PT2	42.704	3.033	14.33	37.72
SAMPLE NO- URC/PTB/PT3	48.290	1.067	6.91	42.20
SAMPLE NO- URC/PTB/PT5	50.153	0.890	6.52	40.12
SAMPLE NO- URC/PTB/PT6	20.374	8.440	37.28	26.30
SAMPLE NO- URC/PTB/PT7	22.827	8.010	36.50	28.20





This broad range in chemical parameters, particularly the substantial variation in CaO, clearly indicates a heterogeneous distribution of limestone quality across the block. Such variability necessitates a systematic and detailed exploration program to accurately delineate and classify different grades and types of limestone. The proposed detailed exploration will therefore focus on close-spaced drilling, systematic sampling, and comprehensive geochemical analysis to establish the spatial distribution of various limestone categories, enabling precise resource estimation and effective mine planning.

Recommendations of G4 stage Mineral Exploration Report: Final Report on Reconnaissance Survey for Limestone of Nagod and Lameta Formation in Sasa, Sajnipur, Bamhorikhurd And Khahamau Area, Sagar and Damoh Districts, Madhya Pradesh (Stage-G4). FSP ID: M2ASMIF-MEP//CR/SU-MP-BHO/2023/52132, Report for Field Season: 2023-24 (GSI).

Objectives: To delineate the occurrence, lateral extent, thickness, and estimate grade of limestone within the block and identify potential zones for detailed (G2) exploration.

2. **Previous Work**

Attach the complete Previous Geological Report G4 stage for G3 stage projects: Attached

Previous Exploration in adjoining area (Regional area); All the samples (bedrock), borehole locations should be plotted on the geological map and analytical data should be discussed briefly:

G3 exploration for limestone in Botrai blocks, Patharia tehsil, Damoh District, Madhya Pradesh, was carried out by GSI in 2023-24. This block is situated at the N and NE sides of the proposed block and it covers 3.68 sq km of Toposheet No. 55M/01. BRS, PCS and drill hole samples were collected for the chemical analysis. All BRS showed a range of CaO 1.77% to 49.73%, MgO 0.16% to 10.47%, and SiO2 5.92% to 92.34%, whereas PCS showed a range of CaO 24.78% to 45.84%, MgO 0.7% to 7.34% and SiO2 13.04 % to 26.94%. The analytical result of the core sample shows encouraging value at shallow depths in the boreholes. All core samples have a range of CaO 1.59% to 45.81%, MgO from 1.09% to 16.45%, and SiO_2 from 8.35% to 61.45%. The value shows that limestone is highly siliceous, represented as silicious limestone in the block. Based on these values, the limestone resource has been estimated at 40.397 MT, which consists of Cement (Portland), Cement (blendable/Beneficiable), and Blendable grades of limestone in the block.

Previous Exploration in the proposed block area: All the samples (bedrock), borehole locations should be plotted on the geological map and analytical data should be discussed briefly:

The reconnaissance survey was conducted by GSI in FS 2023-24 (FSPMIS Id: M2ASMIF-MEP//CR/SU-MP-BHO/2023/52132) has provided significant insights into the limestone resources within the Nagod and Lameta formations in the Proposed block. The mapping of the 100

sq.km area at a 1:12500 scale using the SOI toposheet no. 55M/01 has laid the groundwork for a systematic investigation, revealing the geological complexity and resource potential of the region. The systematic sampling and analysis, including BRS, PTS, and channel samples, have identified distinct limestone grades suitable for white cement, portland cement, and blendable/beneficiable cement is a significant outcome, indicating the potential for diverse industrial applications, where CaO concentration shows positive correlation with LOI and negative correlation with SiO2 which indicates that the LOI is composed of mainly carbonate minerals.

3. **Block description**

Block Corner points / Cardinal Points	Latitude	Longitude
A	23°54'54.74"N	79°9'06.53"E
B	23°54'14.85"N	79°9'05.28"E
C	23°54'16.88"N	79°4'42.73"E
D	23°55'54.86"N	79°4'44.07"E
E	23°55'54.88"N	79°5'59.77"E
F	23°55'33.12"N	79°5'59.43"E
G	23°55'31.05"N	79°5'59.43"E
H	23°55'25.25"N	79°7'9.75"E

4. **Planned Methodology**

A. Desk Study

- Review geological maps, reports, satellite imagery, and previous exploration data.

B. Geological Mapping

- Broad-scale mapping (1:5,000 or 1:2,000)
- Identify limestone outcrops, lithology, bedding, and structures.

C. Surface Sampling

- Grab and channel sampling from outcrops
- Preliminary chemical analysis (CaO, MgO, SiO_2, etc.)

D. Pitting and Trenching

- Expose sub-surface limestone where outcrop is poor

- Systematic sampling of trenches/pits

E. Geophysical Survey (if required)

- Resistivity/seismic methods to understand thickness and continuity

F. Exploratory Drilling

- Grid-based drilling (800 m × 800 m)
- Vertical boreholes to intersect full limestone thickness

G. Core Logging and Sampling

- Lithological and structural logging
- Systematic core sampling (1–2 m intervals)

H. Laboratory Analysis

- Chemical analysis for grade classification

I. Data Integration and Interpretation

- Correlate surface and subsurface data
- Prepare geological sections and maps

J. Preliminary Resource Estimation

- Broad estimation based on limited data

I. Reporting

- Prepare G3 report with recommendations for G2 exploration

5. **Nature Quantum and Target: Attached**

SN	Description of Work	Unit	Quantity (Indicative)
1	Topographic Survey (1:5,000 or 1:2,000) Geological Mapping (1:5,000 or 1:2,000)	Sq Km Sq Km	15.2 15.2
2	DGPS Survey	Points	28
3	Drilling	m	600
4	Samples	Nos	255
5	Analysis	Nos	255
6	Petrographic Studies	Nos	10
7	Geological Report Preparation	Nos	1

References

1. Karmi, S., Nayak, S.K., 2023-24. Reconnaissance Survey for Limestone of Nagod and Lameta Formation in Sasa, Sajnipur, Bamhorikhurd and Khahamau area, Sagar And Damoh District, Madhya Pradesh. Geological Survey of India, 2023-24.

2. Mallet, F.R., On the Vindhyan Series as exhibited in the northwestern and central provinces of India. Memoirs of the Geological Survey of India, 1869.

3. Oldham, T., Remarks on the classification of the rocks of central India, resulting from the investigations of the Geological Survey. Journal of the Asiatic Society of Bengal, 1856.

4. Rajarajan, K., Geology of Sagar District and western part of Damoh district, Madhya Pradesh. Memoirs of the Geological Survey of India, 1978.

5. Yadav, D.K., Sahoo, B., Reconnaissance Survey to search for limestone of Nagod and Lameta Formation in Garhakota and Pathria area, Sagar and Damoh District, Madhya Pradesh. Geological Survey of India, 2023-24.

Annexure 2A

Preliminary Exploration (G3) for Limestone in Patharia Block, Districts: Sagar and Damoh, Madhya Pradesh . Area 15.2 sq. km , Total Drilling:600 m (Tentative), No. of BH: 20 nos. (Tentative) , Average borehole depth range: 30 m, Schedule timeline- 10 months,
Review: After 3 and 6 Months

S. No.	Item of Work *	Unit *	Rates as per NMEDT SoC 2025-26		Estimated Cost of the Proposal		Remarks
			SoC-Item No. *	Rates as per SoC * (a)	Qty. (b)	Total Amount (Rs) (a*b)	Drilling plan to be finalised after review of 1st phase of work. Mapping and surface sampling to be completed in 1st phase
A	**Geological Mapping with contouring, Other Geological Work & Surveying**						
i	Geological mapping and contouring, (1:4000 scale)	Sq. km.	**1.1**	18,300	**15.2**	278,160	
ii	Charges for Geologist per day for **Field**	day	**1.2.1a b**	14,500	**100**	1,450,000	For mapping, drilling, sampling and core logging
iii	b. Labours Charges	day	**5.8**	556	**200**	111,200	
iv	c. Charges for Geologist per day **(HQ)**	day	**1.2.1a a**	10,500	**30**	315,000	
v	e. Charges for one Sampler per day	one sampler per day	**1.2.1b**	7,850	**35**	274,750	
vi	b. Labours Charges (for samplers)	day	**5.8**	556	**140**	77,840	
	Sub Total-A					**2,506,950**	
B	**Survey work**						
i	Charges for one surveyor per day (topographic survey 1:4000 Scale)	day	**1.3.1**	10,500	**45**	472,500	
ii	Labour (4 Nos.)	day	**5.8**	556	**180**	100,080	
iii	Demarcation of lease boundary, Fixation of Borehole and determination of co-ordinates &	Per Point of observation	**1.3.2**	24,000	**28**	672,000	20 BH + 8 Cardinal points

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	Reduced Level (RL) of the boreholes by DGPS						
	Sub Total-B					**1,244,580**	
C	**Trenching/Pitting**						
	Excavation of Pitting, Nos of Pits - 15*(2x2x3m = 180 Cu.m)	per cu.m	2.1.2	4,725	180	850500	
				Sub-Total C		**850500**	
D	**DRILLING (Outsource)**						
1	Drilling (Soft Rock)	Per m	**2.2.1.1c**	5,500	**600**	3,300,000	
2	Construction of concrete Pillars (12" *12" *30")	Per Borehole	**2.2.7**	2,000	**20**	40,000	
3	Borehole plugging by cement.	Per Borehole	**2.2.8**	10,000	**20**	200,000	
4	Land/Crop compensation	Per Borehole	**5.6**	30,000	**20**	600,000	As per actuals with maximum ceiling of 30000 per BH
5	Drill Core preservation	Per m	**5.3**	1,590	**225**	357,750	1 complete BH + mineralised zone
	Sub Total-D					**4,497,750**	
E	**Laboratory Studies**						
1	**Chemical Analysis**						
i	Analysis of Major Oxides by WD-XRF	Nos.	**4.1.17a**	4,200	**255**	1,071,000	30 PTS + 25 BRS+ 200 Core Samples
	External Check samples for Major Oxides by WD- XRF (10%)	Nos.	**4.1.17a**	4,200	**26**	109,200	
2	**Physical, Petrological & Mineralogical studies**						
i	Preparation of thin section	Nos.	**4.3.1**	500	**10**	5,000	
ii	Complete Petrographic report of rock sample along with digital photographs	Nos.	**4.3.4**	2800	**10**	28,000	
	Bulk Density		**4.8.3**	2500	**5**	12,500	
	Sub Total-E					**1,225,700**	
	Total Outsourced Components					**3,300,000**	
E	**Tendering Cost**	**5.9**				**66,000**	
F	**Technical Supervion Cost for outsourced Components**	**6**				**330,000**	

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29.05.26

G	**TOTAL**					**10,721,480**	
H	**Preparation of Exploration Proposal**		**5.1**	2% of approved project cost or 5 lakh whichever is lower		214,430	
I	**Geological Report Preparation**	**5 Hard copies with a soft copy**	**5.2 (ii)**	Total cost exceeding 50 lakh but less than 150 lakh		250,000	
J	**Peer review**	Per review	--		--	30,000	As per EC decision
K	**Total Estimated Cost without GST**					**11,215,910**	
L	**Provision for GST (18% of K)**					**2,018,864**	
M	**Total Estimated Cost with GST**					**13,234,773**	
	or Say Rs. In Lakhs					**132.35**	
Note:							
1	**Strict adherence to the Ministry of Finance's and GFR guidelines is mandatory. Every transaction must adhere to GFR rule 21.**						
2	**In case of delay/non- performance, the appropriate action will be taken by competent authority against delinquent agency as per prevailing govt. of India rules/guidelines on procurement.**						
3	**If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMET SoC and Item no. 6 of NMET SoC. In case of execusion of the project by NEA on its own, a Certifiate regarding non outsourcing of any component/project is required.**						
4	**Necessary efforts should be made to minimize any adverse impact on the environment during exploration activities.**						
5	**Any item of work not mentioned above shall be added as per SoC.**						
6	**All the Geological Reports and data are to be uploaded on NGDR as per MERT template by the agency**						

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Annexure 2B

Time Schedule/ Action Plan for Preliminary Exploration (G3) for Limestone in Patharia Block, Districts: Sagar and Damoh, Madhya Pradesh

S. No.	Activities	Months										
		1	2	3	Review	4	5	6	Review	7	8	9	10
1	Camp Setting												
2	Geological Mapping & Sampling												
3	Pitting/Trenching												
4	Surface Drilling (1 rigs)												
5	Survey Party days												
6	Geologst Man days												
7	Sampler Man days												
8	Camp Winding												
9	Laboratory Studies												
10	Report Writing with Peer Review												