

GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3) FOR LIMESTONE IN VADEKHAN AREA, UPLETA TALUKA, RAJKOT DISTRICT, GUJARAT

(T.S.No.41K/01)

(TEXT, ANNEXURES, AND PLATES)

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COMMODITY: LIMESTONE

(Industrial Mineral)

Project Executed by



PRB INFRAPROJECTS PVT.LTD.

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NAGPUR- 440024

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**GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION (G-3) FOR
LIMESTONE IN VADEKHAN AREA, UPLETA TALUKA, RAJKOT DISTRICT,
GUJARAT (T.S.NO.41K/01)**

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**Geological Report on Preliminary Exploration (G-3) For Limestone
in Vadekhan Area, Upleta Taluka, Rajkot District, Gujarat
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**अध्याय-1
कार्यकारी सारांश**

डेखान चूना पत्थर ब्लॉक, जिसका क्षेत्रफल **3.00 वर्ग किलोमीटर** है, गुजरात राज्य के राजकोट जिले के उपलेटा तालुका के वडेखान ग्राम के समीप स्थित है। यह ब्लॉक **क्वाटरनरी आयु के मिलियोलाइट (Miliolite) शैल समूह** का भाग है, जो उच्च कैल्शियम युक्त चूना पत्थर के लिए प्रसिद्ध है तथा सीमेंट एवं अन्य औद्योगिक उपयोगों के लिए उपयुक्त है। यह क्षेत्र राष्ट्रीय राजमार्ग-27 द्वारा सड़क मार्ग से सुगमता से जुड़ा हुआ है, जबकि जाम जोधपुर रेलवे स्टेशन एवं पोरबंदर हवाई अड्डा रेल एवं वायु संपर्क उपलब्ध कराते हैं, जिससे अन्वेषण तथा भविष्य में खनन कार्यों के संचालन में सुविधा प्राप्त होती है।

इस क्षेत्र का चयन गुजरात के **भूविज्ञान एवं खनन आयुक्तालय (CGM)** द्वारा जारी अनापत्ति प्रमाण-पत्र (NOC), **भारतीय भूवैज्ञानिक सर्वेक्षण (GSI)** द्वारा उपलब्ध कराई गई क्षेत्रीय भूवैज्ञानिक जानकारी, CGM द्वारा किए गए प्रारंभिक अन्वेषण तथा **एम/एस पीआरबी इंफ्राप्रोजेक्ट्स प्राइवेट लिमिटेड** द्वारा किए गए प्रारंभिक क्षेत्रीय अन्वेषण के आधार पर किया गया। प्रारंभिक भूवैज्ञानिक अवलोकनों एवं शैल नमूनों के प्रयोगशाला विश्लेषण से लगभग **50 प्रतिशत CaO** तथा कम सिलिका युक्त उच्च गुणवत्ता के रासायनिक श्रेणी के चूना पत्थर की उपस्थिति का संकेत प्राप्त हुआ, जिसके आधार पर व्यवस्थित अन्वेषण आवश्यक माना गया।

"राजकोट जिला, गुजरात के वडेखान ब्लॉक में चूना पत्थर का प्रारंभिक (G3) अन्वेषण" शीर्षक वाली परियोजना को **राष्ट्रीय खनिज अन्वेषण विकास न्यास (NMEDT)** की कार्यकारी समिति की **43वीं बैठक**, दिनांक **14 अगस्त 2025**, में स्वीकृति प्रदान की गई। इस अन्वेषण कार्य को **एम/एस पीआरबी इंफ्राप्रोजेक्ट्स प्राइवेट लिमिटेड** द्वारा **खनिज (खनिज अंतर्वस्तु के साक्ष्य) नियम, 2015** के प्रावधानों के अनुसार चूना पत्थर के खनिजीकरण का सीमांकन, उसकी मोटाई एवं पार्श्वीय विस्तार का निर्धारण, गुणवत्ता का मूल्यांकन तथा भूवैज्ञानिक संसाधनों के आकलन के उद्देश्य से संपादित किया गया।

अन्वेषण कार्यक्रम के अंतर्गत **1:4000 पैमाने पर विस्तृत भूवैज्ञानिक मानचित्रण**, ट्रायल पिटों का उत्खनन, व्यवस्थित डायमंड कोर ड्रिलिंग, भूवैज्ञानिक लॉगिंग, नमूना संग्रहण, प्रयोगशाला विश्लेषण तथा

भूवैज्ञानिक संसाधनों का आकलन किया गया। भूवैज्ञानिक मानचित्रण से मिलियोलाइट चूना पत्थर के सतही वितरण तथा उसके आसपास की शैल संरचनाओं के साथ संबंध स्थापित किए गए। ट्रायल पिटों द्वारा मृदा आवरण के नीचे उथली गहराई पर चूना पत्थर की निरंतरता की पुष्टि हुई।

परियोजना के अंतर्गत **NQ आकार की वायरलाइन डायमंड कोर ड्रिलिंग** द्वारा कुल **13 बोरहोल** खोदे गए, जिनकी कुल ड्रिलिंग लंबाई **98 मीटर** रही। प्राप्त चूना पत्थर सामान्यतः कठोर, सघन, महीन दानेदार एवं विशाल (Massive) प्रकृति का पाया गया, जिसमें कहीं-कहीं पतली मृत्तिका (Clay) की अंतःपरतें भी पाई गईं। अनुकूल ड्रिलिंग परिस्थितियों के कारण **86.37 प्रतिशत कोर रिकवरी** प्राप्त हुई, जिससे मूल्यांकन एवं संसाधन आकलन के लिए विश्वसनीय भूवैज्ञानिक एवं भू-रासायनिक आँकड़े उपलब्ध हुए।

अन्वेषण कार्यक्रम के अंतर्गत व्यापक विश्लेषणात्मक आँकड़े प्राप्त किए गए। कुल **116 प्राथमिक नमूनों**, जिनमें **40 शैल नमूने**, **61 बोरहोल कोर नमूने** तथा **15 ट्रायल पिट नमूने** सम्मिलित थे, का **XRF तकनीक** द्वारा छह प्रमुख ऑक्साइडों के लिए विश्लेषण किया गया। इसके अतिरिक्त गुणवत्ता आश्वासन हेतु **12 चेक नमूनों**, सूक्ष्म तत्वों के विश्लेषण हेतु **15 ICP-MS नमूनों**, विस्तारित रासायनिक विश्लेषण हेतु **09 समिश्र (Composite) नमूनों** तथा संसाधन आकलन हेतु **05 बल्क डेंसिटी नमूनों** का परीक्षण किया गया। विश्लेषण परिणामों से यह स्पष्ट हुआ कि चूना पत्थर की गुणवत्ता समग्र रूप से उत्तम है तथा सीमेंट ग्रेड क्षेत्र उच्च **CaO**, निम्न **MgO** एवं स्वीकार्य **SiO₂** मात्रा से युक्त हैं।

भूवैज्ञानिक, ड्रिलिंग, नमूना, रासायनिक विश्लेषण तथा बल्क डेंसिटी संबंधी आँकड़ों के आधार पर भूवैज्ञानिक संसाधनों का आकलन **थीसन पॉलीगॉन (Thiessen Polygon) विधि** द्वारा किया गया। ग्रेनोफायर क्षेत्र में अवस्थित घाटियों एवं अवसादों में चूना पत्थर निक्षेपों की पृथक् एवं असतत प्रकृति को देखते हुए यह विधि उपयुक्त पाई गई। संसाधनों का वर्गीकरण **खनिज (खनिज अंतर्वस्तु के साक्ष्य) नियम, 2015** के अनुसार **UNFC की Inferred (333) श्रेणी** में किया गया।

अन्वेषण के आधार पर **40 प्रतिशत कटौती के पश्चात 6.14 मिलियन टन** तथा **50 प्रतिशत कटौती के पश्चात 5.11 मिलियन टन** शुद्ध भूवैज्ञानिक संसाधनों का आकलन किया गया। इन संसाधनों में **सीमेंट ग्रेड (R1)**, **ब्लेन्डेबल ग्रेड (R2)** तथा **बेनीफिसिएबल/ब्लेन्डेबल ग्रेड (R3)** चूना पत्थर सम्मिलित है।

सीमेंट ग्रेड (R1) चूना पत्थर निक्षेप का प्रमुख भाग है, जिसका शुद्ध भूवैज्ञानिक संसाधन **4.95 मिलियन टन** है तथा इसकी औसत रासायनिक संरचना लगभग **48.05% CaO**, **0.48% MgO** एवं **8.05% SiO₂** है, जो सीमेंट निर्माण के लिए उपयुक्त है। **ब्लेन्डेबल ग्रेड (R2)** चूना पत्थर का संसाधन **0.83 मिलियन टन** है, जिसकी औसत रासायनिक संरचना **42.91% CaO**, **0.51% MgO** एवं **15.24% SiO₂** है, जबकि

बेनीफिसिएबल/ब्लेन्डेबल ग्रेड (R3) चूना पत्थर का संसाधन **0.35 मिलियन टन** है, जिसकी औसत रासायनिक संरचना **39.06% CaO, 0.47% MgO एवं 20.69% SiO₂** है।

अन्वेषण से यह पुष्टि हुई कि वडेखान ब्लॉक में उच्च गुणवत्ता का **सीमेंट ग्रेड चूना पत्थर** उपलब्ध है, जिसमें उच्च **CaO** तथा निम्न **MgO** की मात्रा पाई जाती है, जो सीमेंट निर्माण एवं अन्य औद्योगिक उपयोगों के लिए उपयुक्त है। यद्यपि चूना पत्थर के निक्षेप स्थानीय रूप से असतत तथा सीमित मोटाई वाले हैं, तथापि संपूर्ण क्षेत्र में खनिजीकरण उत्साहजनक पाया गया। उत्कृष्ट कोर रिकवरी, विश्वसनीय विश्लेषण परिणाम तथा उपलब्ध आधारभूत सुविधाएँ संसाधन आकलन की विश्वसनीयता को और अधिक सुदृढ़ करती हैं।

परियोजना की प्रमुख विशेषताओं में उच्च गुणवत्ता का चूना पत्थर, उत्कृष्ट सड़क, रेल एवं वायु संपर्क, उथली गहराई पर निक्षेप की उपलब्धता, उत्कृष्ट कोर रिकवरी तथा वैधानिक दिशा-निर्देशों का अनुपालन सम्मिलित है। चूना पत्थर निक्षेपों की असतत प्रकृति इसकी प्रमुख सीमा है, जिसके कारण भूवैज्ञानिक संसाधनों के आकलन हेतु थीसिस पॉलीगॉन विधि अपनाई गई।

G3 स्तर के इस अन्वेषण द्वारा चूना पत्थर की उपस्थिति, गुणवत्ता, मोटाई, निरंतरता तथा भूवैज्ञानिक स्वरूप का सफलतापूर्वक निर्धारण किया गया। **Inferred (333)** श्रेणी के संसाधन इस क्षेत्र में पर्याप्त खनिज संभावनाओं का संकेत देते हैं तथा आवश्यक वैधानिक, तकनीकी एवं आर्थिक परीक्षणों के उपरांत वडेखान चूना पत्थर ब्लॉक को खनन हेतु आगे के मूल्यांकन एवं नीलामी के लिए उपयुक्त माना जा सकता है।

CHAPTER-1

EXECUTIVE SUMMARY

The Vadekhan Limestone Block, covering an area of **3.00 sq. km**, is located near Vadekhan Village, Upleta Taluka, Rajkot District, Gujarat. The block forms part of the **Quaternary Miliolite Formation**, which is known for its high-calcium limestone suitable for cement and other industrial applications. The area is well connected by road through NH-27, while Jam Jodhpur Railway Station and Porbandar Airport provide convenient rail and air connectivity, facilitating exploration and future mining operations.

The area was selected for exploration based on the No Objection Certificate issued by the Commissionerate of Geology and Mining (CGM), Gujarat, regional geological information generated by the Geological Survey of India (GSI), reconnaissance investigations carried out by CGM, and preliminary field investigations conducted by **M/s PRB Infraprojects Private Limited**. Initial geological observations and laboratory analysis of bedrock samples indicated the occurrence of high-quality chemical-grade limestone containing approximately **50% CaO** with low silica content, warranting systematic exploration.

The exploration project titled "**Preliminary Exploration (G3) for Limestone in Vadekhan Block, Rajkot District, Gujarat**" was approved by the Executive Committee of the National Mineral Exploration Development Trust (NMEDT) in its **43rd Meeting held on 14 August 2025**. The investigation was carried out by **M/s PRB Infraprojects Private Limited** with the objective of delineating limestone mineralization, assessing its thickness and lateral continuity, evaluating the grade, and estimating geological resources in accordance with the **Mineral (Evidence of Mineral Contents) Rules, 2015**.

The exploration programme comprised detailed geological mapping on **1:4000 scale**, excavation of trial pits, systematic core drilling, geological logging, sampling, laboratory analysis, and resource estimation. Geological mapping established the surface distribution of miliolitic limestone and its relationship with the surrounding formations. Trial pits confirmed the shallow occurrence and persistence of limestone beneath soil cover.

A total of **13 boreholes** were drilled with a cumulative drilling of **98 metres** using **NQ-size wireline diamond core drilling**. The limestone encountered is generally hard, compact, fine-grained, and massive, with occasional thin clay intercalations. Excellent drilling conditions resulted in **86.37% core recovery**, providing reliable geological and geochemical data for evaluation and resource estimation.

The exploration programme generated comprehensive analytical data. A total of **116 primary samples** comprising **40 bedrock samples**, **61 borehole core samples**, and **15 trial pit samples** were analysed for six major oxides using the XRF technique. In addition, **12 check samples** were analysed for quality assurance, **15 samples** were analysed by ICP-MS for trace elements, **09 composite samples** were analysed for extended chemical parameters, and **05 bulk density samples** were tested for resource estimation. Analytical results indicate consistently good limestone quality, with cement-grade zones characterized by **high CaO**, **low MgO**, and acceptable silica values.

Based on geological, drilling, sampling, analytical, and bulk density data, geological resources were estimated using the **Thiessen Polygon Method**, which was considered appropriate due to the isolated and discontinuous nature of the limestone bodies occurring within depressions and valleys over the granophyre terrain. Resources have been classified under the **UNFC Inferred (333) category** in accordance with MEMC Rules, 2015.

The exploration has established **Total Net Geological Resources of 8.872 million tonnes** (considering **40% reduction**) and **7.393 million tonnes** (considering **50% reduction**). The resource consists of Cement Grade (R1), Blendable Grade (R2), and Beneficiable/Blendable Grade (R3) limestone.

The **Cement Grade (R1)** limestone constitutes the major portion of the deposit with **7.47 million tonnes** (considering **40% reduction**) and **6.23 million tonnes** (considering **50% reduction**) of net geological resources having an average composition of approximately **48.54% CaO**, **0.48% MgO**, and **8.05% SiO₂**, making it suitable for cement manufacturing. The **Blendable Grade (R2)** limestone accounts for **0.97 million tonnes** (considering **40% reduction**) and **0.81 million tonnes** (considering **50% reduction**) averaging **43.22% CaO**, **0.50% MgO**, and **14.81% SiO₂**, while the **Beneficiable/Blendable Grade (R3)** limestone constitutes **0.42million tonnes** (considering **40% reduction**) and **0.35million tonnes** (considering **50% reduction**) with an average of **38.09% CaO**, **0.47% MgO**, and **22.08% SiO₂**.

The investigation confirms that the Vadekhan Block contains high-quality cement-grade limestone with favourable chemical characteristics, **including high CaO and low MgO content**, suitable for cement manufacture and other industrial applications. Although the limestone bodies are discontinuous and locally of limited thickness, the mineralization remains consistently encouraging. Excellent core recovery, reliable analytical results, and good infrastructure enhance confidence in the resource estimation.

The project's key strengths include high-quality limestone, good road, rail, and air connectivity, shallow depth of occurrence, excellent drilling recovery, and compliance with statutory guidelines. The discontinuous nature of limestone deposition is the main limitation, and accordingly, the **Thiessen Polygon Method** was adopted for geological resource estimation.

The G3 level exploration successfully established the occurrence, grade, thickness, continuity, and geological disposition of limestone. The **Inferred (333) resources** indicate adequate resource potential, making the Vadekhan Limestone Block suitable for further evaluation and auction for mining, subject to statutory, technical, and economic considerations.

CHAPTER-2
DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION
AGENCY

2.1.0 INVESTIGATING AGENCY

PRB INFRAPROJECTS PRIVATE LIMITED

S1 & S3 3rd Floor, Ratan Height,

Medical Square, Nagpur-440024

**2.2.0 PERSONAL INVOLVED WITH PRELIMINARY EXPLORATION (G3) FOR
LIMESTONE IN VADEKHAN BLOCK, DISTRICT- RAJKOT, GUJARAT.**

Table Showing List of Personnel with Experience

Sr No.	Name of the Person	Designation	Qualification	Experience
1	Mr. M.Chandradas	Project Co-ordinator	M.Sc. Tech (Applied Geology)	>35Yrs
2	Mr. Prem Babu Singh Lodhi	Technical Area Expert Geology	M.Sc. (Geology), PGD (hydrogeology)	>35Yrs
3	Mr. Milind Dhakate	Project Co-ordinator	M.Sc. Tech (Applied Geology)	30Yrs
4	Mr. Maschindra Bhanse	Sr. Geologist	M.Sc. (Applied Geology)	18Yrs.
5	Mr. Anand Harkare	Technical Area Expert Geology	M.Sc. Tech (Applied Geology)	30Yrs
6	Mrs. Priti Pusadkar	Sr. Geologist	M.Sc. (Geology)	12Yrs
7	Mr. Sebin Sebastian	Geologist	M.Sc. (Geology)	3 Yrs
8	Mr. Ankush Shukla	Geologist	M.Sc. (Geology)	1 Yrs
9	Mr. Rajat Raghushe	Surveyor and Drilling Engineer	Civil Engineering	6 Yrs

CHAPTER - 3
TITLE OF THE REPORT & OWNERSHIP

3.1.0 DETAILS OF OWNERSHIP

Table Showing Details of Ownership

S.No.	Title	Details
1	Title of the report	GEOLOGICAL REPORT ON PRELIMINARY EXPLORATION(G-3) FOR LIMESTONE IN VADEKHAN AREA, UPLETA TALUKA, RAJKOT DISTRICT, GUJARAT (T.S.NO.41K/01).
2	Ownership	CGM GUJARAT
3	Name of the Prospector	PRB INFRAPROJECTS PRIVATE LIMITED
4	Address of Prospector	S3 & S4 2nd Floor, Ratan Height, Medical Square, Nagpur-440024
5	E-Mail of the prospector	prbinfraprojects@gmail.com
6	Telephone numbers of prospectors	9422835586

3.2.0 DETAILS ABOUT PERIOD OF PROSPECTING

The G3 stage of exploratory work in the Vadekhan block commenced with geological mapping, started from 9-9-25 and completed on along with exploratory drilling in borehole No. G-VDK BH-1 on 14-3-26 and completed with the closure of borehole No. G-VDK BH-13 on 21-3-26. The analytical/laboratory studies were carried out simultaneously in the inhouse laboratories of PRB and other Govt. /NABL accredited laboratories.

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

3.3.1 Exploration Agency (EA): PRB Infraprojects Private Limited.

3.3.2 Experience:

M/s. PRB Infraprojects Private Limited (established in year 2011), has executed many important exploration projects for Atomic Mineral Directorate, Karnataka State Mineral Development Corporation, Chhattisgarh Mineral Development Corporation and Director Geology and Mining Chhattisgarh. After getting the NABET accreditation, the company has started execution of NMEDT funded exploration projects since 2024. Present status of the NMEDT funded projects awarded to the firm are given in table below.

Sr. No.	Description	W.O. No / Date	Remarks
1	Reconniassance Survey(G4) for Limestone in Bhatiya area in the village Bhatiya-Gokalpur, Dist-Devbhumi Dwarka, in Gujarat state	23/585/2025-NMET/930	Completed
2	Reconniassance Survey (G4) for Iron ore in Nawagarh-Nelsod-Antagarh block in Uttar Bastar Kanker District, Chhattisgarh state.	23/578/2025-NMET/121	Ongoing
3	Preliminary Exploration (G3) for Limestone in Ishwariya block, Gir Somnath District, Gujarat State.	23/633/2025-NMET/184	Ongoing
4	Preliminary Exploration (G3) for Limestone in Vadekhan block Upleta Taluka, Rajkot District, Gujarat.	23/652/2025-NMET/352	Ongoing
5	Preliminary Exploration (G3) For Limestone In Pransla Limestone Block, Upleta, Rajkot, Gujar	23/798/2026-NMET/162	Ongoing
6	Preliminary Exploration (G3) For Limestone Andhariya-Nes Block, Jam Jodhpur Taluka, Jamnagar District, Gujarat.	23/797/2026-NMEDT/161	Ongoing
7	Preliminary Exploration (G-3 stage) for bauxite Nittadgi block, Honnavar taluka,Uttar Kannada district, Karnataka.	23/557/2025-NMET/842	Preclosed due to denial of forest clearance

3.2.3 Experience: Geologist have experience of 3 to more than 35 years.

3.2.4 Qualification of Geologist: M.Sc./M.Sc. Tech (Geology/ Applied Geology).

CHAPTER-4

DETAILS OF THE AREA

4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

- The Vadekhan block is situated in Upleta Taluka of Rajkot district, Gujarat, and lies to the northeast of Vadekhan village. It is well connected by rail, road and air transport, ensuring all weather access for exploration activities
- The nearest railway station is Jam Jodhpur Railway Station, located approximately 20 km from the study area, providing connectivity to regional and intercity routes. The National Highway 27 (NH-27) is the nearest major road which offers efficient road access to the block and connects it with important towns and cities within the state.
- The nearest airport is Porbandar Airport, located at a distance of about 50 km, providing domestic flight connectivity, mainly to major cities such as Ahmedabad and Mumbai.
- This well-developed multimodal connectivity makes the Vadekhan block suitable for field operations, transportation of equipment, and overall exploration logistics.

4.1.1 Size and Shape of the Block

- The Vadekhan block is rectangular in shape and covers an area of 3.00 sq. km. The surface rights of the block primarily belong to the Government. However, approximately 1.43 sq. km area of the block is under claim by a private landowner, who asserts ownership over this portion of the land falling within the block.
- The block falls under Toposheet No. 41 K/01.

THIRD PARTY ISSUE

- The study area of the block is facing third party issue. Shri Harishchandra Raisingh Vada claims that the part of the block area belongs to him and his ownership issue over the said land is pending before the Honourable High court of Gujarat.

4.1.2 GEO CORDINATES OF THE BLOCK

The coordinates of the Vadekhan Limestone block are as shown in the table below.

Table No-4.1
Showing Co-ordinates of Vadekhan Block

Sr No	Block corners	Latitude	Longitude
1	A	21°46'58.34"N	70° 3'44.16"E
2	B	21°47'54.49"N	70° 3'5.72"E
3	C	21°48'6.95"N	70° 3'59.50"E
4	D	21°47'19.17"N	70° 4'37.10"E

4.1.3 LOCATION OF THE BLOCK

The block is situated 15 km NW of Porbandar-Rajkot national Highway No-27 near to Pransla and Vadekhan villages. The block area forms part of SOI toposheet No -41 K/01 within Upleta Taluka, Rajkot district **(Refer plate No. -1 and 2).**

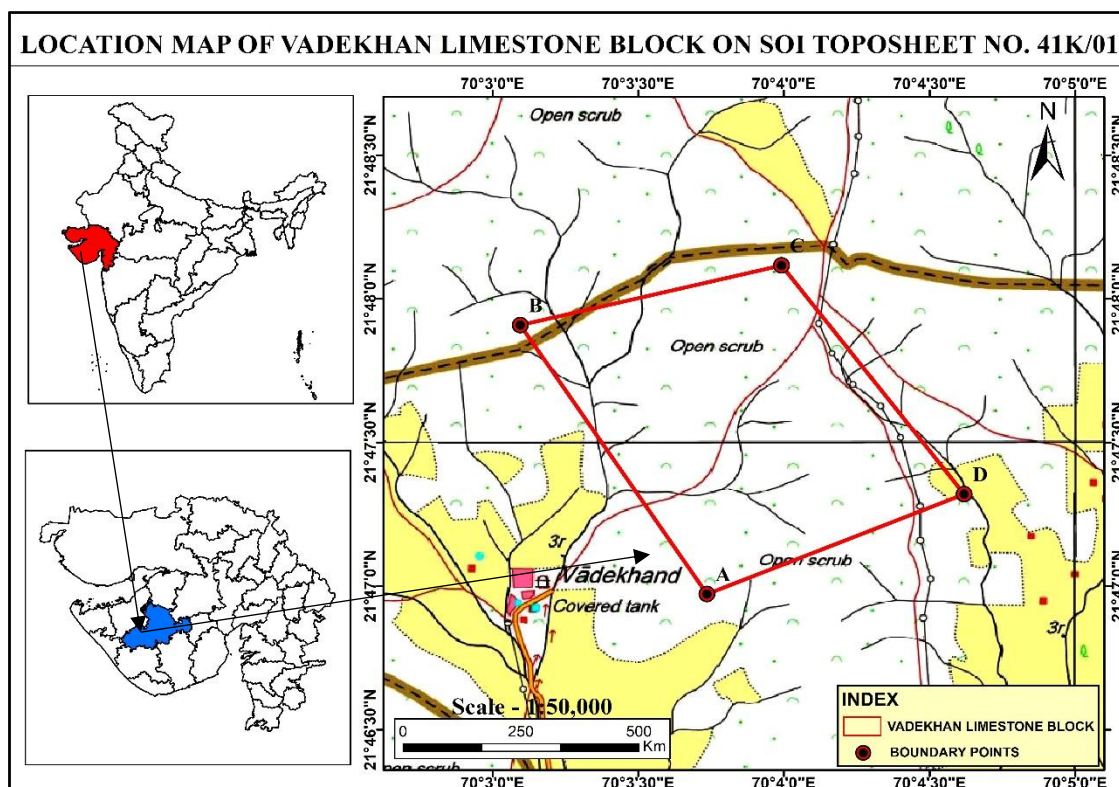


Plate No.-I: Location of Vadekhan Block Limestone Block, Rajkot Gujarat.

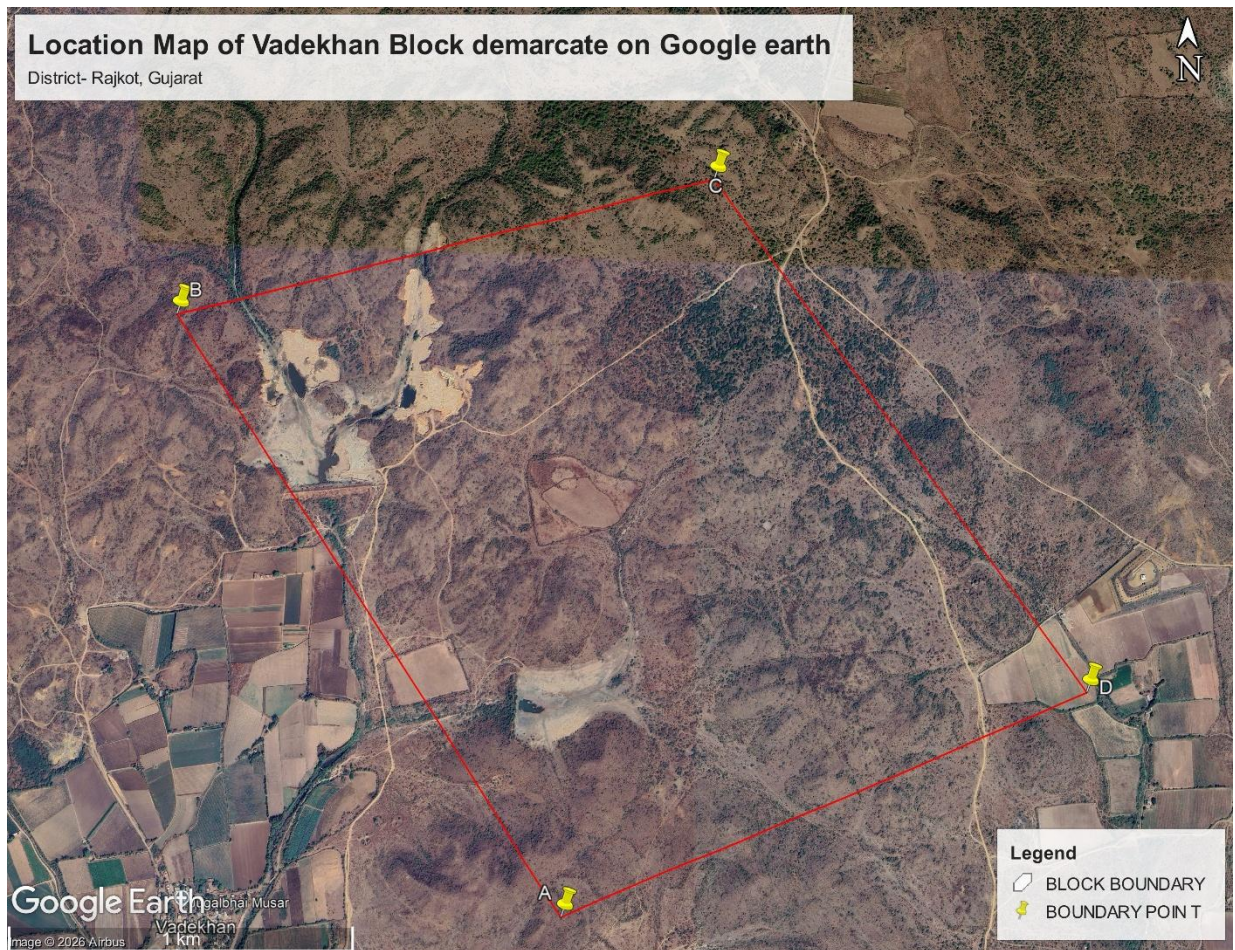


Plate No.-II: Location of Vadekhan Block on Google Earth Image.

CHAPTER-5

PHYSIOGRAPHY AND ENVIRONMENT

5.1.0 PHYSIOGRAPHY

5.1.1 Relief of the Area

The block area forms the southwestern part of the Alech Hills complex, which is characterized by curvilinear ridges separated by narrow intervening valleys. The elevation within the study area ranges from 109 m to 160 m above Mean Sea Level (MSL), giving an overall relief of about 51 m.

5.1.2 Topography

The terrain is generally gently undulating and comprises low mounds, parallel ridges, and shallow valleys with gentle slopes. The landscape shows only minor variations in elevation and lacks prominent high-relief features. The general slope of the area is towards the south, which facilitates natural surface runoff during the monsoon season.

Isolated hillocks are observed locally in the adjoining region, particularly around the Alech Hills. The highest elevation recorded in the surrounding area is about 241 m above MSL in the northeastern part of toposheet 41 K/1, whereas the lowest elevation is around 20 m above MSL within the same toposheet.

5.1.3 Drainage Pattern

No perennial river flows through the study area. The drainage is mainly controlled by first- and second-order seasonal streams that remain dry for most of the year and become active during the monsoon season. The drainage pattern is sub-dendritic in nature, indicating moderate topographic and structural control over surface runoff.

5.2.0 ROAD/RAIL CONNECTIVITY

- The Vadekhan block, located in Upleta Taluka of Rajkot district, Gujarat, is well connected through road, rail, and air networks, ensuring easy accessibility for exploration activities.

- The nearest railway station is Jam Jodhpur, situated approximately 20 km from the block, providing connectivity to nearby towns and major railway routes. Road access to the area is well developed through National Highway-27 (NH-27), which connects the block to important regional and state-level centers.
- The nearest airport is Porbandar Airport, located about 50 km from the block, offering domestic flight connectivity to major cities such as Ahmedabad and Mumbai.
- Overall, the block is well accessible, facilitating efficient transportation of manpower, equipment, and materials required for exploration work.
- The high-tension power transmission line passes through area.

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

- The initial provisional data released by Census India 2011, shows population **3,804,558** for Rajkot District of which male and female were 1,973,153 and 1,831,405 respectively.
- Vadekhan block fall in Upleta (Taluka) of Rajkot District of Gujarat State. Total population of Upleta (Taluka) is 58,775 out of which Males are 30,168 (51%) and Females are 28,607 (49%) The total literacy rate is 71% out of this Males are 51% and females are 49%.

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

- The Vadekhan village has a total population of 500 persons, including 267 males and 233 females, living in 91 families. The sex ratio is 873 females per 1000 males, which is lower than the state average. The child population (0–6 years) is 90 (18.00% of total) with a child sex ratio of 957 which is higher than the state average.
- The overall literacy rate is 58.29%, with male literacy at 68.78% and female literacy at 46.03%, indicating a significant gender gap. Scheduled Castes constitute 27.00% (135 individuals) of the population, while no Scheduled Tribe population is present.
- Out of the total population, 310 individuals are engaged in work, all as main workers. Among them, 138 are cultivators and 113 are agricultural labourers, showing that agriculture is the primary occupation. Overall, the area represents a predominantly agrarian community with moderate population size and relatively low literacy levels.

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

- No historical sites, and archaeological monuments occur within or in nearby area.
- Near the block there is an ashram named Swami Dharam Bandhu Vedic Mission Trust that organizes the Rashtra katha Shivir every year in the month of December, where cultural activities are held and students across the India come here and showcase the culture of their respective state.

5.5.1 FORESTS, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARIES; GRAZING LAND AND GOCHAR LAND WITHIN OR NEAR BY THE AREA WITH DISTANCE FROM PERIPHERY OF THE AREA EXPLORED.

- The Vadekhan exploration block in Rajkot District is free from any forest, wildlife sanctuary, or national park restrictions.
- The nearest protected area is located at a considerable distance, and only minor village grazing lands are present locally.
- Therefore, no environmental or statutory constraints are noticed for exploration activities.

5.5.2 FLORA AND FAUNA

- Except for the central parts of the hills, where moderate to dense vegetation is present, most of the valley areas are under cultivation. The principal crops cultivated in the region are cotton, bajra, jowar, maize, groundnut, and wheat. Sugarcane is also cultivated locally on a limited scale.
- The hill slopes are sparsely covered with acacia trees and thorny bushes. Dense growth of thorny shrubs is observed during the monsoon season, as these are predominantly seasonal in nature. During the summer season, the area becomes dry and largely devoid of vegetation.
- The faunal assemblage of the area includes nilgai (antelope), rabbits, and wild boar's wild cats. Occasional sightings of panthers have been reported. Due to indiscriminate hunting in the past, tigers have been completely eliminated from the area. At present, spotted deer, blackbuck, peacocks, and green pigeons are found in appreciable numbers.

5.5.3 WATERBODIES PRESENT NEAR THE BLOCK

- Two seasonal (ephemeral) streams are present in the northwestern part of the block. These streams flow towards the southwest and join to form a common reservoir within the area, which is currently being subjected to illegal mining activities by local people.
- In addition, one seasonal stream is observed flowing from the eastern part towards the western part of the block, forming a small reservoir near the western boundary. Another short seasonal stream is present near the eastern boundary, flowing from north to south across the block.
- All the streams and drainage channels within the block are seasonal in nature, carrying water only during the monsoon and winter seasons. During the summer season, these streams and rivers remain dry.

5.5.4 CLIMATE

- The area is characterized by a semi-arid coastal climate. The Tropic of Cancer passes through the adjoining district to the north.
- The monsoon is erratic and brings rains for a very short period, from June to August. The annual rainfall ranges from 200 to 400 mm. Historical weather records indicate that the area has experienced repeated drought conditions in the past. July is the rainiest month, and the maximum annual rainfall is received during the south-west monsoon season.
- The lowest temperature in the area is around 20°C in December, while the maximum temperature rises to 44°C during May–June.

5.6.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENT FACTOR

- Various physiographic, social, and environmental factors might affect the viability of a project and the assessment of resources and reserves.
- Physiographic conditions such as topography, slope, drainage pattern, soil thickness, and geological structures (faults, folds, and fractures) influence accessibility, ease of exploration, and continuity of mineral deposits.
- The Upleta–Vadekhan area is characterized by the presence of lime-based product industries and suppliers, supported by nearby major cement companies in the Rajkot region. The area hosts several lime-based and cement-related industries, including

Shakti Cement Pipe Factory, Patel Cement Pipe Industries, JK Lakshmi Cement Ltd., and Raj Cements, in the Rajkot region. This indicates:

- Availability of local construction material industry
- Strong market demand for limestone and cement
- Good infrastructure and industrial linkage
- Presence of no major environment factors such as Sanctuaries, Forest areas are within the buffer zone of 10 kms

CHAPTER 6

INFRASTRUCTURE

The infrastructure of the block is favourable. The study area is surrounded by well-established villages, namely Pransla in the south, Dhank in the east, and Vadekhan in the west. The village economy is predominantly based on agriculture, with groundwater serving as the primary source of irrigation throughout the year. The groundwater level ranges from 20 m to 40 m below the surface. Major crops cultivated in the area include soybean, groundnut, pulses, maize, and wheat. The villagers are largely self-reliant and depend mainly on agriculture and livestock for their livelihood.

6.1.1 Social Infrastructure

Basic social infrastructure is available in and around the study area. Banking and postal facilities are available at Dhank village, located about 8 km from the block, while additional postal services are available at Mervadar village, approximately 5 km away. Educational facilities are provided through government schools in nearby villages such as Mervadar, Tanasava, and Andheriyanesh. Basic healthcare services are available in the surrounding villages, whereas advanced medical facilities are available at Upleta, the nearest taluka headquarters.

6.1.2 Transportation and Communication Facilities

The nearest town is Upleta, located about 25 km from the study area, and it is well connected by all-weather tar roads and GSRTC bus services. The nearest railway station, Upleta Railway Station, is also situated approximately 25 km from the study area. The nearest airport is Porbandar Airport, located about 50 km away. The nearest national highway is the Rajkot–Porbandar Highway (NH-27), situated approximately 15 km from the study area. The study area is accessible through a network of roads connecting the surrounding villages and Upleta town. Communication facilities are available in the surrounding villages.

Eight high-tension power transmission lines are present within the block and provide power supply to the nearby villages.

CHAPTER 7

GEOLOGY

7.1.0 Regional Geology

The volcanic rocks and the hypabyssal igneous intrusions forming the Deccan Traps in Alech Hills (41K/1) are unconformably overlain by the fossiliferous limestone beds known as Miliolite Limestone Formation. The youngest rock unit exposed in the area is a semi-consolidated calcareous tufa exposed in the eastern part of the hills along the stream courses only.

The Miliolite limestone beds are deposited all throughout the hill on the eroded surfaces of the volcanic rocks and the unconformity is clearly marked by a conglomerate bed. The limestone is exposed nearly in all the valleys, streams and even along the steep slopes of the high hills. The basic and acid lava flows along with hypabyssal basic and acid igneous intrusions within them have been included under the Deccan Trap Group. Individual rock types have been considered as separate formational units, although they may have a magmatic relationship.

Broadly the general pattern of distribution of rocks and the contacts between the acid and basic lavas and the granophyre intrusion shows a rough parallelism with the elliptical shape of the hills. Basaltic flows are the oldest rock in the area. These are overlain by a reddish white lava flow showing trachytic texture this in turn is overlain by a purple coloured, aphanitic acid lava which finally grades into the weakly banded rhyolite. Gabbro and dykes of doleritic and gabbroic composition intruded into the lava flows as well as granophyre. The Regional stratigraphy of the area is given in **Table No.7.1**

Table No.-7.1
Showing Regional Stratigraphic Succession of area.
(GSI GUJARAT FS- 2017-18)

Alluvial and Residual soil	Recent
Calcareous tufa	
.....Unconformity.....	
Fossiliferous Limestone Formation	Pleistocene
.....Unconformity.....	
Dolerite and gabbro intrusion	DeccanTrap Complex Eocene to Cretaceous
Granophyre	
Rhyolite flow	
Rhyo-dacite flows	
Basalt flow	

The study area comprises of Deccan trap volcanic rocks overlain unconformably by Miliolite limestone of Pleistocene age. The Deccan trap volcanics include basic and acid lavas intruded by granophyre ring dyke. There are volcanic breccia and younger doleritic and gabbroic dykes. No evidence of metamorphism was observed within the area.

From the structural geology point of view the Alech hill present an interesting and important set up. Both basalts and rhyolites of Patan area show flow layering. The rhyolite flows conformably overlies the basalt. Well-developed joints with vertical to sub vertical dips were observed in different places.

Description of rock type in regional Geology.

Calcareous Tufa

The youngest rock unit in the area is calcareous tufa. It is exposed along the stream beds. The exposures are close to the thick beds of Miliolite limestone. The rock is dirty white in colour, extremely fine grained and overlies all the rocks and boulders in the stream bed. The bottom most surface of these beds has the configuration of the eroded surface. The formation is neither thick nor very extensive, but exposures are limited to the stream courses only and formed by the action of flowing water over the limestone country and subsequent deposition in the nearby channels.

Fossiliferous (Miliolitic) limestone

These rocks closely resemble the Miliolite limestone described from the neighbouring areas of Saurashtra. The limestone beds in Alech hills are very extensively exposed and show considerable variation in the thickness. It can be said that exposures of the fossiliferous limestones occur in almost all the river valleys, streams and minor drainage channels. In

addition, these are exposed on the steep slopes of many high hills. The beds show considerable variation in the strike and dip, from place to place, and even at one place the variation is considerable. This is particularly seen in the smaller pockets. The dip is mostly horizontal but varies maximum up to 10°. The limestone exposed on the hill slopes are dipping at high angles (45°) always towards the present hill slope may be due to blanket type of deposit along hill slopes. Current bedding structures are very common in almost all the major outcrops.

Granophyre

It occurs as a discordant dyke intrusion into the basalt flows. The rock type has been described as granophyre because it is characterized by a predominant graphic intergrowth texture between orthoclase and quartz. Tongues and veins of granophyre are emplaced into the basalt supporting discordant relationship and intrusive nature are clearly seen near Patan-Vadekhan road where large clast of basalts were observed within granophyre.

The rock is pinkish brown to light brown in colour, very hard and medium to fine grained. It is characterized by microlitic cavities which are sometimes filled up by drusy quartz. This indicates the shallow nature of the intrusion. Not much change of granularity is noticed from place to place. The rock shows porphyritic and felsitic texture. Phenocrysts of plagioclase feldspars and clinopyroxene are noticed in a glassy groundmass.

Trachyte Dyke

It occurs as linear features like dyke within the basalt. The extension of these dykes is around 110 m whereas the width is 2 to 7 m and either N-S or E-W trending. The rock is fleshy red to pink in color, very fine to medium grained, large grains of K-feldspars were seen within it.

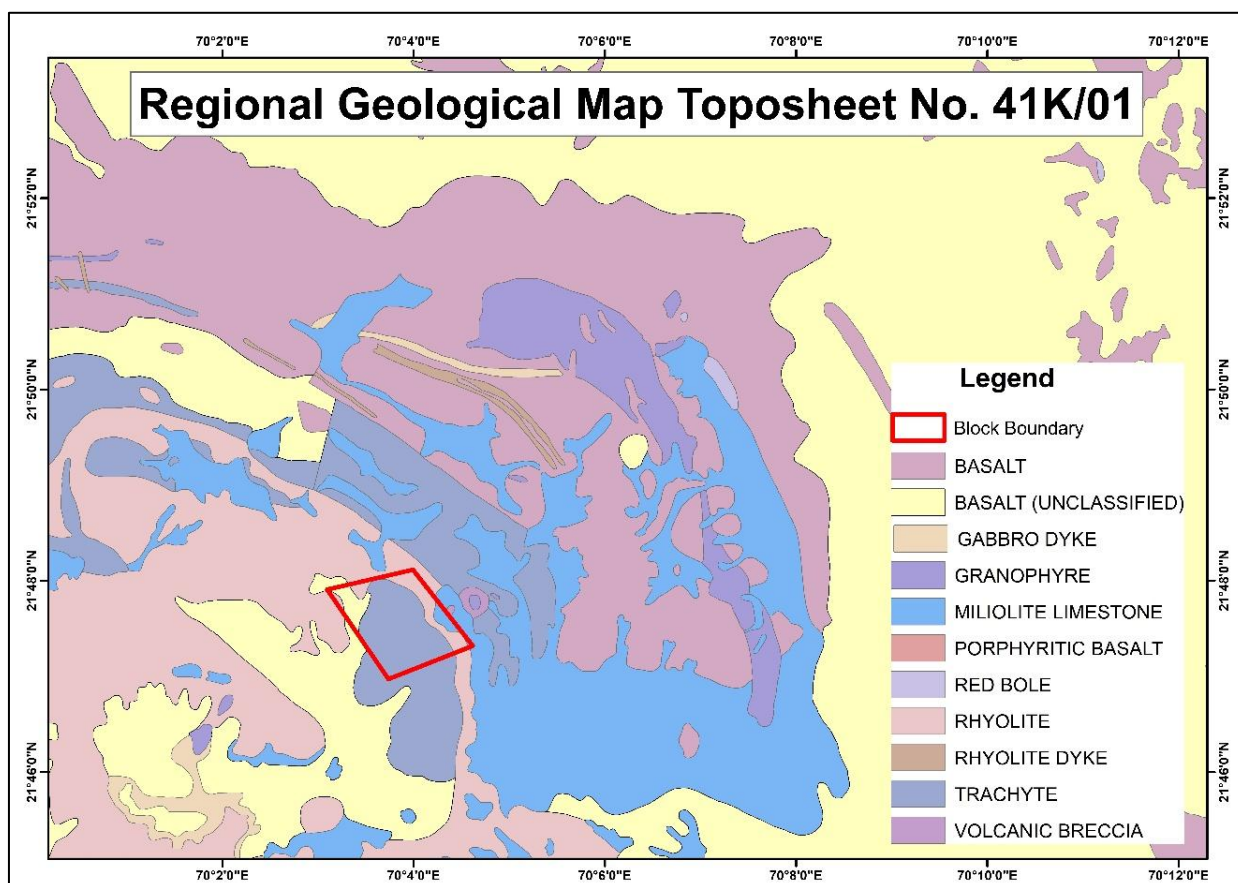
Rhyolite

Acid lavas of the rhyolitic composition are exposed in major portion of the Alech hills. The acid lavas conformably overlie the basalts. The rhyolite shows colour banding with flow characters though in most exposures it is not very well developed. Good outcrops of the banded rhyolite are seen on the hills east and northeast of Patan. The rhyolite has a brecciated or crushed texture with innumerable erratic fractures filled up by light brown ferruginous material. At places rhyolite is light purple in colour, hard, compact and dense. It is porphyritic and very well jointed. The rock is aphanitic to very fine grained and porphyritic, rectangular shaped columnar type jointing is very common. The southern part of the Alech hill, that is South of Patan valley in any ridge the lower part consists of rhyolite while the upper part is made up of the brecciated rhyolite.

Basalt

The basaltic lava flows are the oldest rocks in the area. The nearly flat plains surrounding the Alech hills on all sides are occupied by the basalt. Outcrops of the basalt occur all along the outermost ridges of the Alech hills. The basaltic rocks are dark to greenish black in colour and on weathering produced deep brown to chocolate brown soil. These rocks show variation in granularity from coarse grained doleritic type to extremely fine grained aphanitic glassy variety. The basalts are porphyritic and vesicular with varying size and shape of vesicles. The basalt is typically tholeiitic. The rocks are essentially composed of plagioclase feldspar, green augite and dark opaque ores.

**Plate No.-III: Showing block boundary demarcated on Regional Geological map.
(Source NGDR)**



7.2.0 LOCAL GEOLOGY

Table No 7.2
Showing Local Stratigraphic Succession of area (CGM Gujarat FS:2000-2001

Stratigraphic Succession of the area	
Lithology	Age
Soil Cover / Alluvium	Recent
Miliolitic Limestone	Pliestocene
Chalk	Pliestocene
Limestone	Pliestocene
-----Unconformity-----	
Acidic intrusion/Basalt	Cretaceous to Eocene

Description of lithology

Soil cover and Alluvium

Alluvium is invariably found all over the investigated area as area is highly cultivated. This formation is typical in nature as it is not having particular quality of either black cotton soil or yellowish soil cover. It is mostly consists of brownish soil.

Milliolitic Limestone

The rock varies from pale yellow to yellowish in color. The rock is essentially composed of fossil mitrolina and cemented by calcareous matrix. Sometimes it appears highly pitted and porous due to chemical weathering. The minimum thickness observed in the borehole is 0.61 mts and the maximum thickness observed in the borehole is 12.20 mts. Looking to the chemical result, the CaO percentage varies from minimum 40.64% to 52.82% maximum which can be widely used as cement grade and by way of gradation as chemical grade.

Acidic Intrusion and Basalt

Basalt is the oldest rock formation exposed in the area. It is predominantly melanocratic, fine-grained, hard, and compact in nature however, amygdaloidal and porphyritic varieties are also observed at places, particularly along the foothills. The basalt is overlain by granophyre, which is fine-grained, leucocratic, hard, and compact.

7.2.1 Geology of The Study Area

The surveyed area exhibits a predominant gently undulating topography indicative of a geomorphologically stable region with minimal tectonic disturbances. The terrain is largely uneven with variations in elevation which has facilitated some agricultural activities across the area.

From a geological perspective, the area mainly exposes sedimentary rock formations that display a near-horizontal to gently inclined disposition. This uniformity in bedding reflects a low degree of structural deformation, pointing to a relatively stable tectonic history. The rock units lack pronounced folding, faulting, or other structural complexities, thereby indicating limited structural control over the present landscape.

Lithologically, the region is dominated by limestone formations, including miliolitic varieties. The miliolitic limestone represents accumulation of calcareous sand-sized grains formed in high-energy marine settings. These limestone units are often moderately compact to poorly consolidated, depending on their composition and degree of cementation.

The low-lying portions of the area are generally covered with soil, that indicates ongoing weathering and pedogenic processes. The soil development over limestone further suggests a stable land surface with sufficient time for weathering to occur.

Overall, the area reflects a stable geological and geomorphological setting characterized by uniform sedimentary lithology, minimal structural deformation and favourable surface conditions. The combination of flat terrain, fertile soil cover, and consistent rock formations makes the region well-suited for agriculture while also providing insights into its marine depositional history.

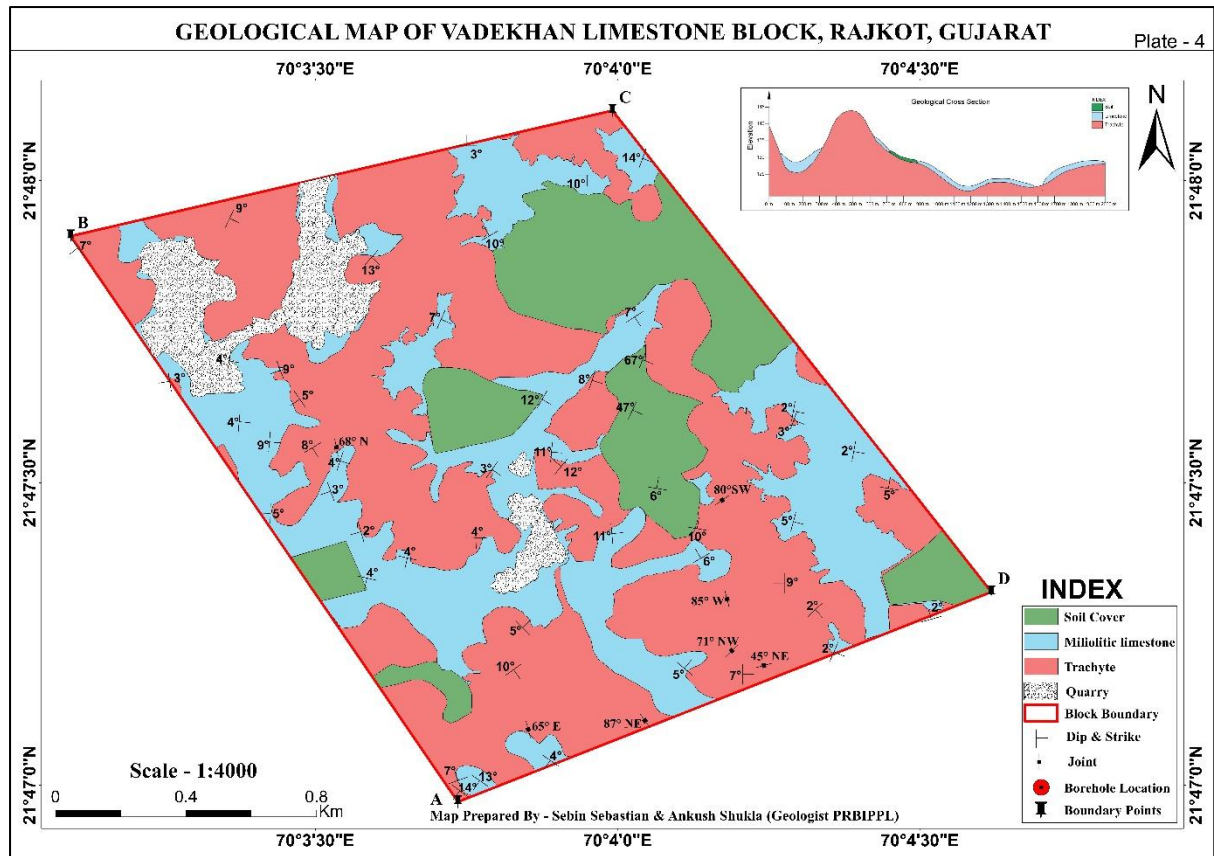


Plate No.-IV: Geological map of Vadekhan Limestone Block

7.2.2 Description of Rock Types in Study Area

The recent soil cover is seen in the North-Western part of the block that supports moderately dense forest over it and the flora mainly present is acacia and small thorny shrubs. While in central part of the block thick soil cover has developed and is under agricultural use. The limestone mapped in the region has been formed due to successive sea transgression followed by regression exposing the miliolitic limestone. The rest of the part in the area or we may say a major portion of the block is covered by volcanics of cretaceous age that contains various mounds of trachyte extended over a large area.

Soil Cover

Soil cover varying from 0.3 m to 0.5 m thickness has been observed in parts of the study area beneath which limestone occurs. The soil cover is not uniformly distributed and is mainly confined to the valley portions. It supports agricultural activities as well as thorny and bushy vegetation. At several locations, limestone fragments and boulders of miliolitic limestone are found embedded within the soil cover. These occurrences are restricted to the surface, and no

continuous limestone bedding has been observed beneath the soil-covered areas. In contrast, most of the limestone-bearing zones are exposed at the surface with little or no soil cover. The spatial distribution of the soil-covered and exposed limestone areas has been clearly delineated and mapped.



Fig. No. 1: Image showing Soil cover in study area in the central part of the block.

Miliolitic Limestone

The limestone is mainly observed in the valley portion of the block and is spread unevenly throughout the area due to uneven nature of paleo valley/basin floor over which these deposits have formed. The deposition does not show consistency. At some places, seasonal streams are present, which also expose the miliolitic limestone.

The colour of the limestone varies from pinkish buff to yellowish buff. The surface-exposed limestone appears greyish black, whereas fresh samples show pinkish to yellowish buff colour. The limestone exposed directly to sunlight is comparatively weaker than the limestone buried beneath the soil cover.

The limestone is light grey to dark grey in colour on the weathered surface and exhibits a rough, uneven and cavernous morphology. The outcrop surface is highly porous and characterized by numerous small solution cavities, vugs and honeycomb-like structures produced due to prolonged chemical weathering and dissolution activity. The rock appears hard, compact and brittle in comparatively fresh portions, while the weathered portions are friable and decomposed along joints and fractures. The outcrops are moderately fractured and jointed, which have acted as channels for percolating groundwater, resulting in the

development of karstic features and secondary porosity. Sparse vegetation and thin residual soil cover are observed over and around the limestone exposures, indicating advanced weathering under subaerial conditions.

The rock is fine-to medium-grained with microcrystalline calcitic composition and fossiliferous content typical of miliolitic limestone. Bioclastic materials and shell fragments may be present within fresh sections. The limestone shows strong effervescence with dilute hydrochloric acid, confirming the dominance of calcium carbonate minerals. Moderate to high porosity occur internally due to dissolution cavities and secondary openings developed during weathering processes. The cavernous morphology, porous texture and solution features collectively suggest prolonged exposure to groundwater action and surface weathering processes characteristic of miliolitic limestone terrain.



Fig. No-2: Outcrop of Miliolitic limestone



Fig. No-3: Outcrop of Miliolitic limestone in nala section.



Fig. No-4: Photograph showing the grain size, effects of chemical weathering and colour variations between the fresh and exposed surfaces of the limestone.

Volcanic rocks

The major part of the study area is covered by volcanics of Cretaceous age comprising trachytic mounds, volcanic breccias, and granophyres. The area indicates intense volcanic activity predominantly felsic in nature with a granophyric texture. The pebbles observed on the ground represent weathered material derived from trachytic mounds. Several small intrusive bodies of volcanic rocks are also present in the area exhibiting two sets of vertical joints.

The basaltic lava flow shows Aa lava flow characters such as irregular, spiny or jagged surface (rough and sharp) angular rubble or fragments called spinose or clinker. At a few places flow direction can be observed in the trachytic hills.

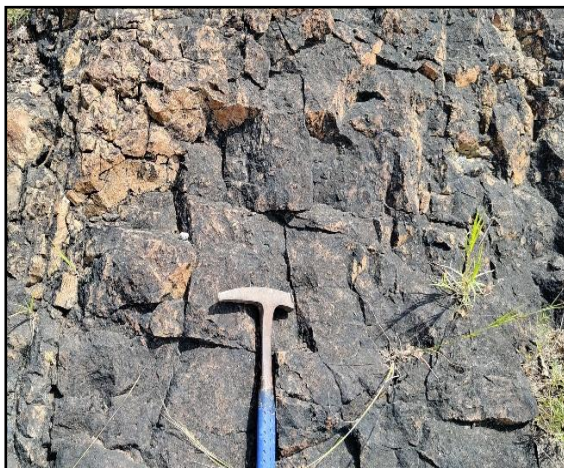


Fig. No-5: Volcanic rock showing two set of vertical Joints and sharp edges.



Fig. No-6: Showing Aa lava flow character like irregular jagged mass and sharp-edged rubble/fragments.

7.3.0 STRUCTURAL DETAILS OF THE STUDY AREA

The topography of the Vadekhan block is a result of structure and denudational processes. The area comprises prominent linear/curvilinear to clustered rhyolitic hills and mounds separated by lower-lying valleys, slopes, and drainage channels. The elevated trachytic mounds and hills, which often act as local watersheds, generally do not exhibit a consistent dip. Instead, they display well-developed vertical joint sets, reflecting the brittle and massive nature of the rock.

The igneous Rhyolitic mounds act as highly competent structural blocks that show distinct brittle deformation rather than dipping flows. The rhyolitic mounds form tight clusters adjoining nearby hills there is an absence of a clear dip direction or trend. Instead, the area is structurally dominated by multiple high-angle fractures and joints (D1 85° W, D2 86° S). Two

set of joints are prominently seen over the trachytic mound which shows vertical to sub vertical dips and also shows cross joints in some outcrops.

In contrast, the surrounding lower slopes, valley fills, and areas adjacent to seasonal streams and reservoirs are underlain by miliolitic limestone. These limestones are generally shallow to moderately dipping (2° to 15°), with varying dip directions, including westerly, southerly, northerly, and easterly indicating deposition in a low-relief environment and multidirectional paleo subbasin floors.

The contact zones between the rhyolite hills and limestone-filled valleys represent significant topographic and structural features and are commonly traceable along hill flanks. At certain locations, opposing dip directions are observed, suggesting the presence of local folding or faulting, possibly related to the emplacement of rhyolitic bodies.

Overall, the rhyolite forms topographically higher, joint-controlled ridges, whereas the limestone occupies lower, gentler slopes and valley floors. The structural disposition of the limestone appears to be influenced by the underlying rhyolitic topography and subsequent tectonic modifications. The trachyte in the area exhibits well-developed joint sets with sub-vertical to vertical dips throughout.

7.4.0 TYPE OF DEPOSIT AND STYLE OF MINERALIZATION OF LIMESTONE

Granular carbonate deposits of Late Pleistocene to Early Holocene age, commonly referred to as 'miliolite limestone' occur in a linear belt, parallel to the southern coast of Saurashtra, India. In the present study area these carbonate deposits are found in select valleys between ridges and mounds of pyroclastic material present in the Deccan trap plateau. Two different depositional histories have been proposed for these sediments. The presence of marine bioclasts led to the postulation of a marine origin for these deposits.

7.5.0 THE EXTENT AND VARIABILITY OF LIMESTONE IN THE STUDY AREA.

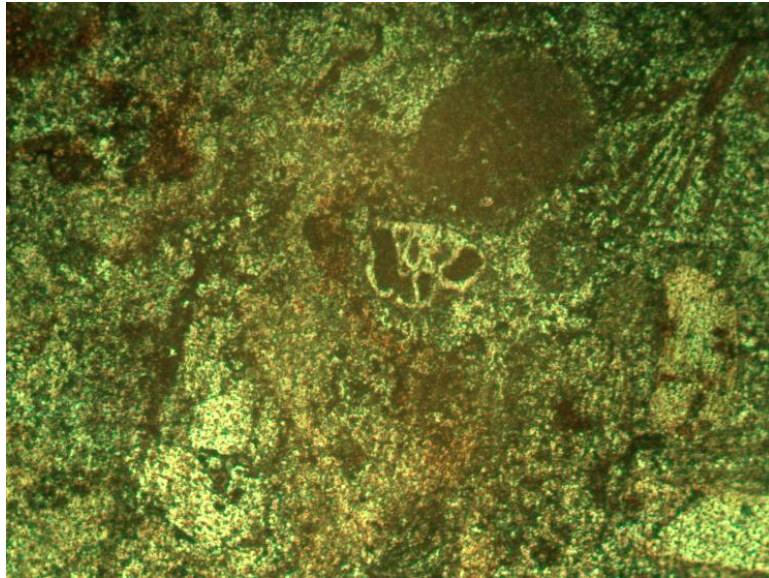
The limestone extends nearly 500 to 600 meters in length toward the eastern and western parts of the block. In the study area, the limestone is entirely controlled by the local topography. The area is part of the Alech Hills, which contain trachytic mounds and granophyric intrusions at irregular intervals. Limestone is mostly deposited in the valley portions and in some places appears only as a thin layer on the flanks. In terms of variations no major differences are observed in the miliolitic limestone except for a color variation seen in the field. The weathered limestone exhibits a yellowish color and is comparatively weaker than the fresh limestone body.

In contrast, the pinkish miliolitic limestone is harder in appearance and more compact than the yellowish variety.

7.6.0 PHOTOMICROGRAPHIC (THIN-SECTION) STUDIES

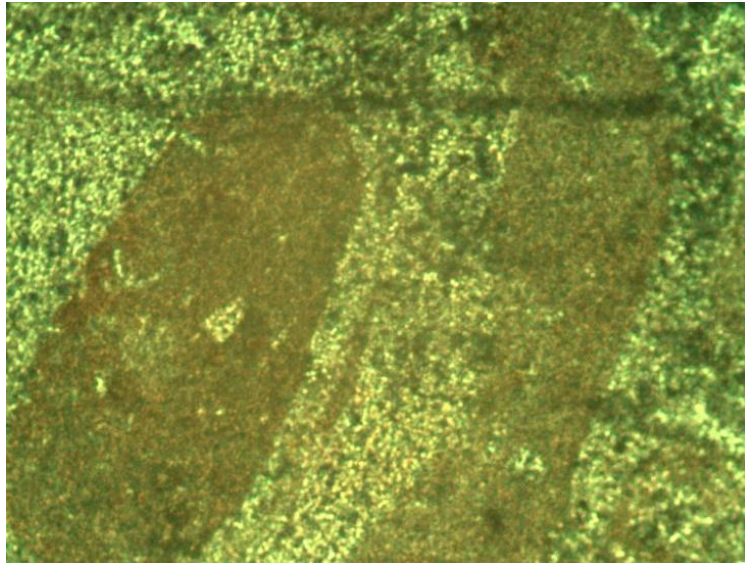
Photomicrographic studies are conducted for 10 samples and the study is reported hereunder.

1. Specimen No.: TS 06A (Magnification 5x)



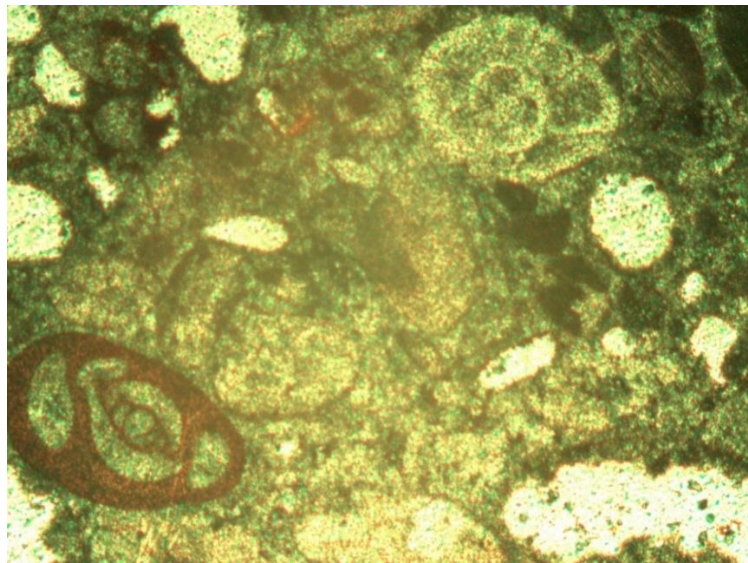
PMG – 1: Photomicrograph showing micritic matrix composed of microcrystalline calcite. Foraminifera cell is showing variegated colors. The presence of dark patches may indicate micritized bioclast. Rock is Biomicrite to Biospirite.

2. Specimen No.: TS 06B (Magnification 5x)



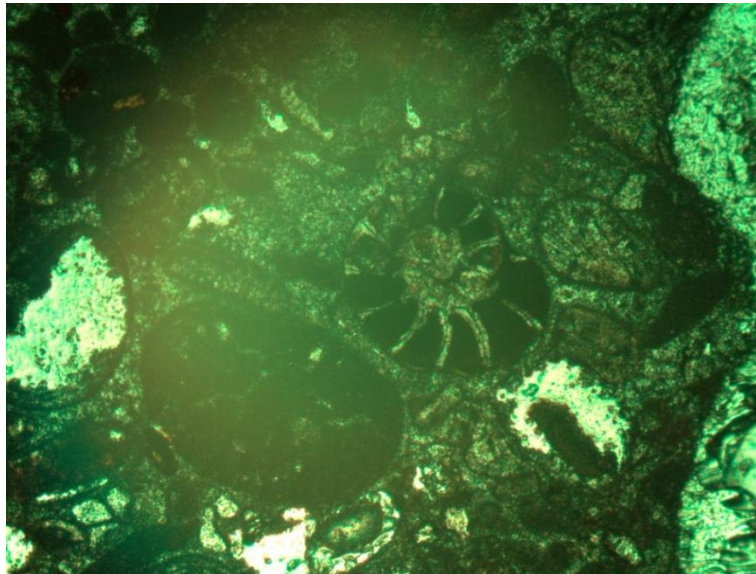
PMG – 2: Photomicrograph showing diagenetic alteration, most likely due to replacement of calcium (Ca) by iron (Fe). Fossiliferous algae are present. This texture points toward a micrite-dominated limestone. This rock may be classified as Micrite

3. Specimen No.: TS 16 (Magnification 5x)



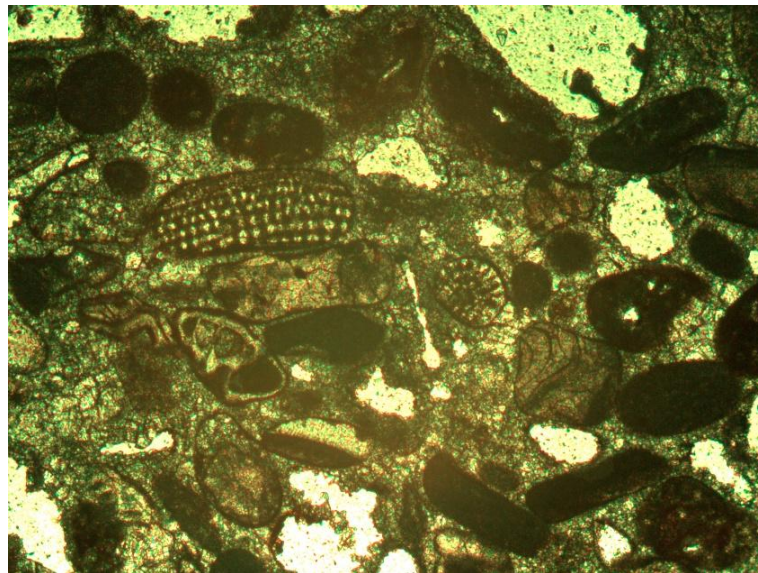
PMG – 3: Photomicrograph showing fossiliferous carbonate rock characterized by abundant bioclasts embedded within micritic matrix. Well preserved ferruginized foraminifera fossil are prominently observed. This rock may be Biomicrite.

4. Specimen No.: TS 14 (Magnification 5x)



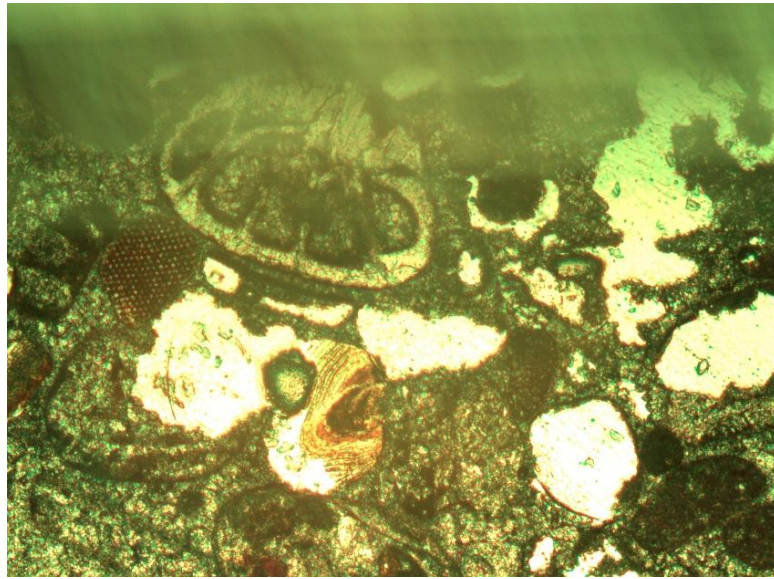
PMG-4: Photomicrograph showing a fossiliferous limestone with well-preserved skeletal remains embedded within a carbonate matrix. The background consists of a mix of micrite and patches of sparry calcite cement, suggesting partial recrystallization during diagenesis. This rock may be Biomicrite.

5. Specimen No.: TS 17(Magnification 5x)



PMG – 5: Photomicrograph showing texture of fossils with abundant fossils with diverse bioclasts embedded within micritic matrix. Several well-preserved skeletal fragments are visible, including elongated and chambered forms resembling foraminifera and shell fragments, Calcitic algae and Astroidea is also well preserved indicating a strong biogenic origin. Rock may be Biomicrite or Biosparite.

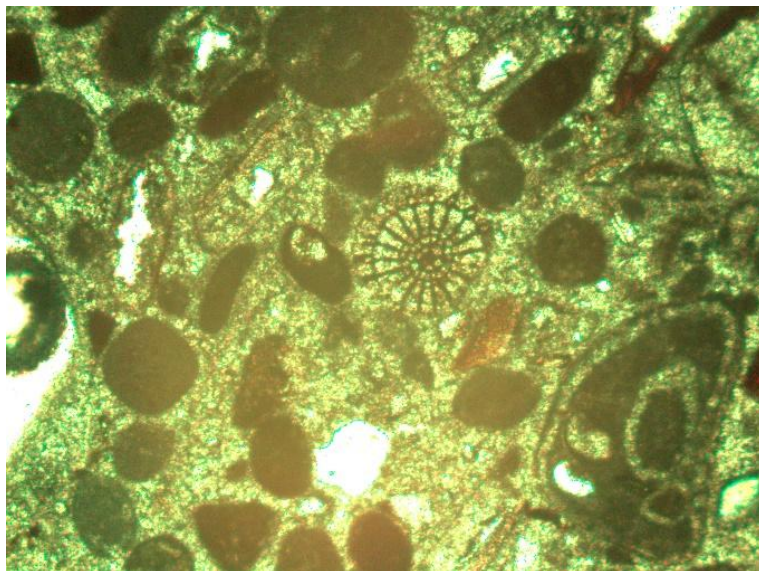
6 Specimen No.: TS 31 (Magnification 5x)



PMG – 6: Photomicrograph showing fossiliferous limestone composed of a dark, micrite matrix. Prominent bioclasts are prominently visible, including depicting rounded to oval forms and chambered structures, which are likely representing skeletal remains such as foraminifera or shell fragments. Astroidea is well preserved in the rock. Rock will be classified as Biomicrite.

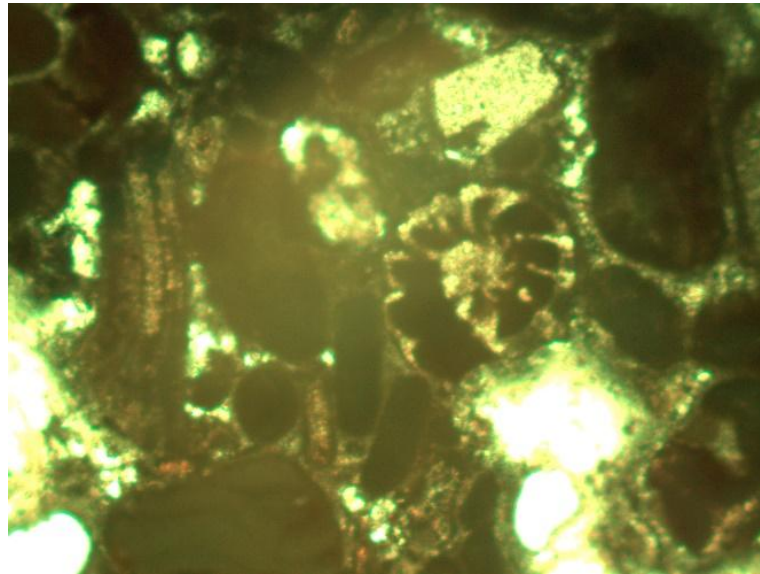
7. Specimen No.: TS 45 (Magnification 5x)

PMG – 7: Photomicrograph showing a fossiliferous limestone with a micritic matrix. A well-



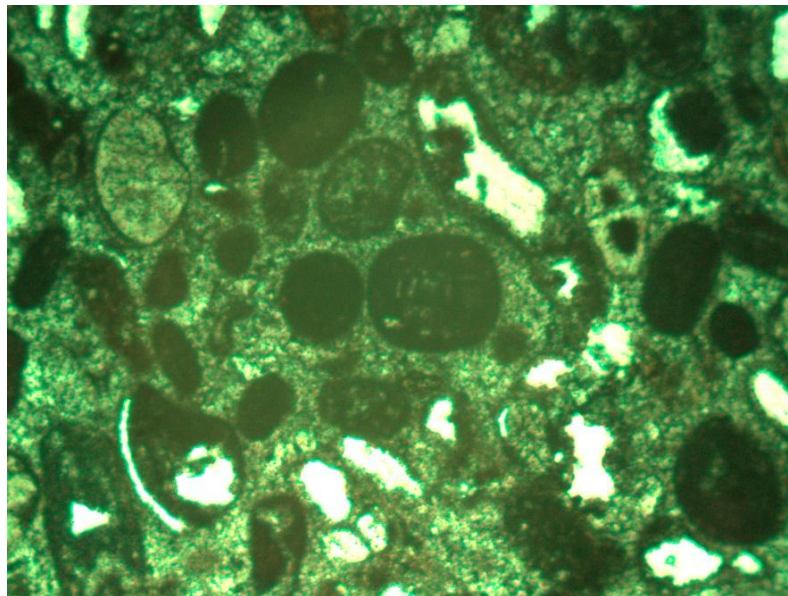
preserved echinoderm displaying radial symmetry is present. The darker rounded grains are interpreted as micritized ooids, which are common in oolitic limestone. This rock may be Biomicrite.

8. Specimen No.: TS 47 (Magnification 5x)



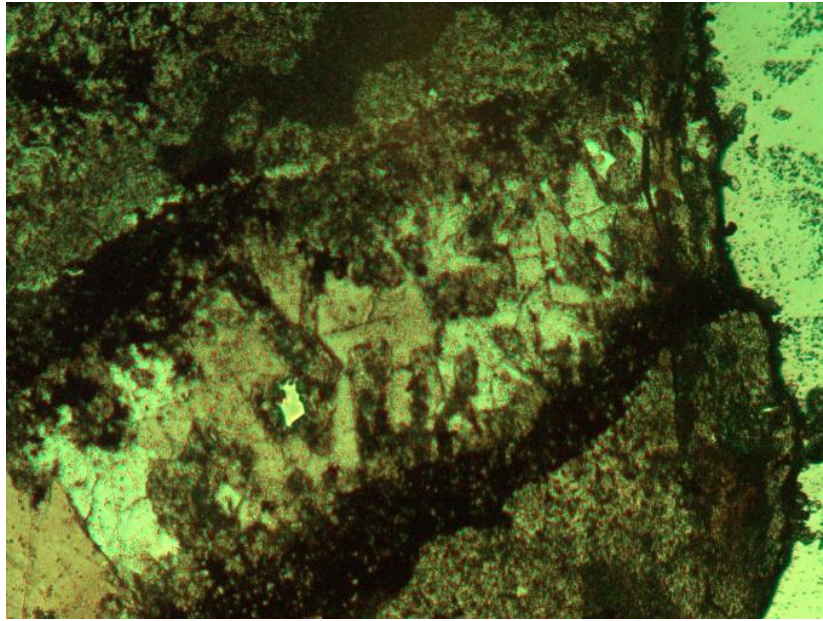
PMG – 8: Photomicrograph showing a fossiliferous limestone with a dark, fine-grained micritic matrix and Foraminifera Fossil. Numerous bioclasts of varying shapes (elongated, rounded, and chambered radial) including a distinct fossil structure are present which suggesting skeletal remains of marine organisms. This rock may be Biomicrite.

9. Specimen No.: TS 52 (Magnification 5x)



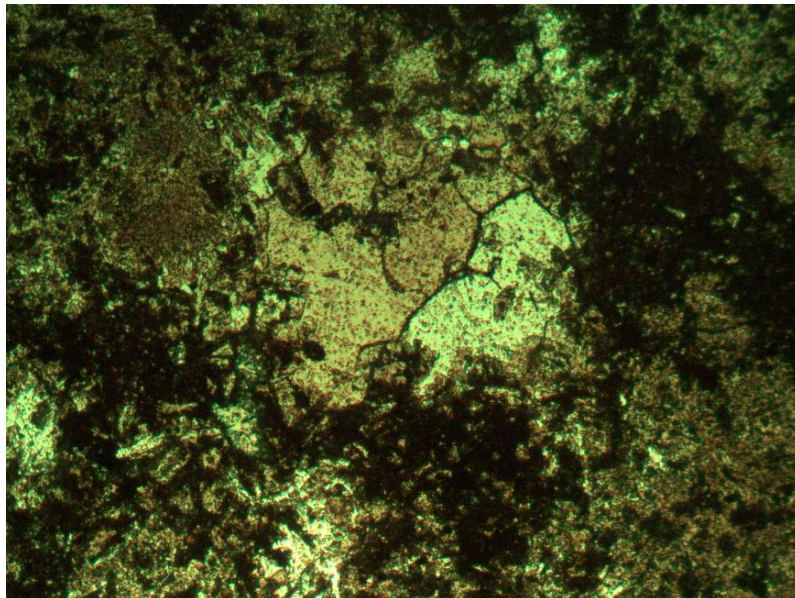
PMG–9: Photomicrograph showing an oolitic limestone, characterized by numerous rounded to sub-rounded ooids embedded in a fine micritic matrix. The presence of ferruginous content, giving the rock a slightly stained appearance. Limestone in thin section can be Biomicrite

10. Specimen No.: TS 10 (Magnification 5x)



PMG – 10: Photomicrograph showing A prominent feature is a siliceous vein or patch cutting across the section. Ferruginous Quartzitic Laminated Calcite and dark elongated patch is showing Ferruginous mineralization. Quartz showing wavy extension and calcite is finally crystallized

11. Specimen No.: TS 9 (Magnification 5x)



PMG – 11: Photomicrograph showing fine-grained dark micritic matrix within which larger, light-coloured sparry Quartz megacryst is developed. Dark patches that may represent micrite-rich zones, organic matter, or opaque mineral impurities.

Findings on the basis of this section studies:

The Vadekhan limestone is predominantly a fine-grained, micrite-dominated and highly fossiliferous carbonate rock indicating deposition under low-energy shallow marine conditions. The rock mainly consists of a microcrystalline calcite matrix containing abundant bioclasts such as foraminifera, algae, echinoderms, gastropods, and occasional ooids, reflecting strong biogenic activity. Texturally it is largely biomicrite with occasional biosparite where sparry calcite suggests partial recrystallization. The limestone has undergone moderate diagenesis, including micritization, ferruginization (Ca replaced by Fe), silicification (siliceous veins and quartz patches) and development of sparry calcite and quartz crystals. Dark patches represent micrite-rich zones or impurities and the presence of ferruginized algae suggests a benthic depositional environment. Overall, the rock shows biogenic origin with subsequent diagenetic modification.

CHAPTER -8

PREVIOUS EXPLORATION

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

Work Done by GSI

- **S. V. Dave (1985–1987)** reported the occurrence of chalk deposits for the first time in the area and demarcated three chalk pockets during detailed investigation in Upleta Taluka.
- **R. C. Mody (1988–1989)** carried out a Pre-Detailed Mineral Survey in parts of Upleta and JamJodhpur Talukas and identified chalk and limestone occurrences, recommending further detailed exploration.
- **Dey and A. R. V. Chowdhary (1991–1993)** conducted detailed geological mapping over ~200 sq. km and identified basalt, gabbro, granophyre, rhyolite, and trachyte forming a ring structure. Geochemical studies indicated Au values ranging from <10 ppb to 70 ppb, with higher values at chert vein intersections near Andheriya Nes.
- **K. B. Pandya (1999–2000)** further confirmed the presence of chalk deposits and delineated additional chalk-bearing zones.
- **M. K. Joshi (2000–2001)** carried out detailed drilling investigations in Pransala and Amrapar areas and established reserves of approximately 12 million tonnes of chalk and 5.73 million tonnes of limestone.
- **J. H. Vayeda (2004–2005)** extended drilling investigations in adjoining areas and estimated reserves of about 37.36 million tonnes of chalk and 83.69 million tonnes of limestone.
- **Jnana Ranjan Behera and Saikat Bhakta (2017–2018)** carried out a Reconnaissance Survey (G4 level) for gold and associated minerals in Jam Jodhpur Block (Alech Hills), confirming favourable geological conditions and identifying structurally controlled zones for mineralization.

Work Done by Others

- **Fedden (1884)** presented the earliest account of the regional geology of the Kathiawar Peninsula and reported the occurrence of compact felsitic rocks within the Deccan Trap terrain. He also identified the association of acidic volcanic rocks in the Alech Hills igneous complex.
- **Adye (1914–1917)** carried out detailed petrological studies of felsites, granophyres, and rhyolites from Porbandar and Navanagar regions.
- **Ghosh (1936)** contributed to the understanding of lithology and regional geology of the area.
- **B. C. Roy (1941)** worked on the regional geology and contributed to lithological understanding of the area.
- **H. Crookshank (1940)** carried out further geological investigations and refined the structural interpretation of the region.
- **P. Duncum and W. P. Sladen (1942)** contributed to the understanding of lithology and structural framework of the Deccan Trap terrain.
- **Auden (1949)** described dyke intrusions within the Deccan Trap terrain and referred the Alech Hills volcanic rocks as granophyres.
- **Shekhar and Mukul (1966)** reported the occurrence of quartz monzonite dykes within basalt, showing petrological similarity to granophyres.
- **Bandopadhyay (1973–1975)** conducted detailed geological investigations and proposed a central subsidence structure with development of ring fractures subsequently filled by acidic intrusions.
- **Bose (1980)** suggested that alkaline rock suites in the Deccan volcanic province are restricted to western India and are controlled by tectonic features such as fracture systems and plume-related activity

CHAPTER-9
DETAILS OF AERIAL, GROUND GEOPHYSICAL AND
GEOCHEMICAL SURVEY

**9.1.0 DETAILS OF AERIAL, GROUND GEOPHYSICAL AND GEOCHEMICAL
SURVEY TAKEN UP AND THEIR RESULTS.**

9.1.1. During the current exploration program, no Aerial/Geophysical surveys were carried out.

CHAPTER - 10

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 OBJECTIVES OF INVESTIGATION

The exploration programme was undertaken with the following objectives: -

- To delineate the surface occurrence of limestone along both strike and dip directions through geological mapping on 1:4000 scale including collection and analysis of bedrock samples.
- To excavate trial pits of 15 cu m capacity during the first phase to assess the depth persistence of the limestone formation.
- In the second phase, based on the outcome of geological mapping and trial pit investigations, core drilling was proposed on 400 m × 400 m grid pattern and intervals ranging from 400m to 800m as per approval of the Technical Committee of NMEDT.
- To estimate the in-situ resources of different grades of limestone and prepare the Geological Report (GR).
- To carry out mineral exploration activities in accordance with the provisions of MEMC (Minerals Evidence of Mineral Contents) Rules, 2015, Mineral (Auction) Rules, 2015, and MMDR Amendment Act 2015 thereby facilitating the Government of Gujarat in auctioning of the block.

10.2.0 DETAILS OF WORK

After receipt of approval from the National Mineral Exploration and Development Trust (NMEDT) vide F. No. 23/652/2025-NMET/352 dated 04 September 2025 with an approved cost of Rs. 68,61,237/- PRB Infraprojects Private Limited undertook exploration activities in the Vadekhan block.

The exploration work was carried out as per the approved exploration programme. Details regarding the nature scope proposed quantum of work and actual achievements are furnished in **Table No -10.1.**

Table No- 10.1
Quantum of Work - Proposed Vs Achieved Vadekhan Block, District-Rajkot, Gujarat

Sr.No.	Item of Work	Unit	Proposed quantum	Achieved
1	Topographic Survey with 2m contour interval Geological Mapping (1:4000) Scale	Sq. Km	3.00	3.00
2	DGPS Survey BH fixation and RL determination. (10+3 BHP + 4 BP)		14	14+3
3	Pitting /Drilling			
a	I Phase			
	Pitting (trial pits)	CU.M	15	15
b	II Phase			
	Core Drilling 800x800 grid 13 BH	M	100Mtr	98Mtr
4	Chemical Analysis			
a	Chemical Analysis core samples for 6 radicals i.e. CaO, MgO, Al ₂ O ₃ , SiO ₂ , Fe ₂ O ₃ and LOI	Nos.	100	61
b	Chemical Analysis Surface (BRS)/pit samples for 6 radicals i.e. CaO, MgO, Al ₂ O ₃ , SiO ₂ , Fe ₂ O ₃ and LOI	Nos.	40+15=55	55
c	External Check Samples	Nos.	16	12
d	Composite Samples For 12 radicals (CaO, MgO, Al ₂ O ₃ , SiO ₂ , Fe ₂ O ₃ , SO ₃ , P ₂ O ₅ LOI, MnO ₂ , K ₂ O, Na ₂ O and Cl.)	Nos	15	09
e	ICP-OES/ICP-MS (sequential technique) sample package for 34 elements i.e.16 other elements viz. Li, Ga, In, Be, Ge, Mo, Cr, Ta, W, Ba, Co, Rb, Sr, Zr, Nb, Ni,18REE viz. La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sc, Y:02Actinides viz. U, Th (Per BH 1Sample)	Nos.	15	15
5	Petrographic / Mineragraphic Study			
a	Preparation of thin sections	Nos	10	10
b	Petrographic study report	Nos	10	10
c	Digital Photographs	Nos.	10	10
6	Geotechnical Study			
a	Specific Gravity Determinations	Nos.	5	5

Core drilling was carried out in-house by PRB Infraprojects Private Limited as per SoC Item No. 2.2.1.1(b), approved vide OM File No. 23/652/2025-NMEDT/352 dated 04 September 2025 issued by NMEDT.

Exploratory drilling commenced during Phase-II with borehole G-VDK-BH-01 on 14.03.2026 in the Vadekhan Block and was completed with the closure of borehole G-VDK-BH-13 on 21.03.2026. Although **10 boreholes** were originally proposed in the approved exploration scheme, a total of **13 boreholes** were ultimately drilled **based on the discussions held with the Committee** during the course of exploration. The limestone mineralization in the block is confined to valley portions and occurs as isolated, discontinuous bodies exhibiting highly variable thickness and depth. In view of this geological disposition, **three additional boreholes** were drilled at suitable locations where limestone mineralization was encountered to ensure proper delineation of the mineralized zones and to establish their thickness, lateral continuity, and geological disposition. The allied field works, including surveying, drilling, and borehole core sampling, were carried out simultaneously. The total core sampling achieved was lower than the targeted quantity because samples were collected only from the mineralized zones. Analytical and laboratory studies were also carried out simultaneously in NABL accredited laboratories.

10.3.0 EXPLORATION ACTIVITIES TAKEN UP BY PRB

Exploration activities comprising geological mapping, topographical survey on 1:4000 scale with 2m contour interval over an area of 3.00 sq. km exploratory drilling and associated analytical works were carried out by PRB Infraprojects Private Limited. The exploration work commenced on 09.09.2025 and was completed on 03.07.2026.

10.3.1 Geological Mapping

A detailed topographic survey of the study area was carried out on a scale of 1:4000 with contour intervals of 2m and 4m. Topographically the study area is highly undulating with elevations ranging from a minimum of 120 MSL to a maximum of 241 MSL.

A total of four seasonal streams is present within the block. Two major seasonal streams occur in the northwestern part of the block each having a maximum depth of about 5 m and forming large water reservoirs during the monsoon season. One seasonal stream

traverses the central part of the block from east to west and forms a small water reservoir. Another seasonal stream originates near the eastern boundary of the block and flows in a northwest–southeast direction.

Two limestone quarries are present in the northwestern part of the block and are disconnected from each other with depths varying from 4m to 6m. One additional limestone quarry is located in the central part of the block. Broad lithological units and litho-contacts were mapped with the help of handheld GPS. Structural features such as bedding, folds, and joints were recorded using Brunton Compass. The general strike of the litho-units varies irregularly due to the deposits are formed in the valleys of the trachytic mounds, with dip angles ranging from 2^0 to 10^0 . The field observations and structural readings were plotted on the topographical map (**Refer Plate No. V**).

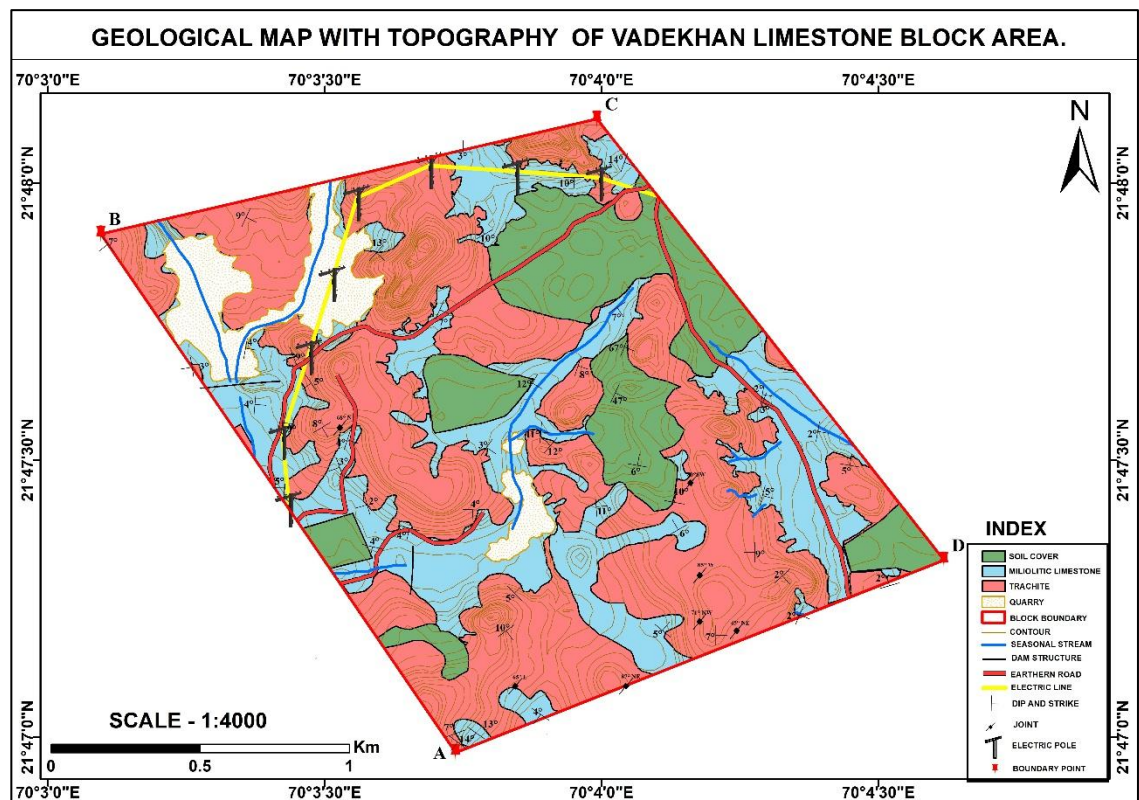


Plate No.-V: Geological Map with Topography of Vadekhan Limestone Block

10.3.2Pitting

Prior to the commencement of drilling operations 15 trial pits were excavated across the Vadekhan Limestone Block to verify the subsurface continuity and surface deposition of the limestone deposit. The trial pits exposed limestone beneath a thin soil cover varying from 0.3m to 1.0m thickness thereby confirming the presence and lateral continuity of the limestone horizon at shallow depths. The information

obtained from these pits was instrumental in understanding the nature of the overburden, validating the surface geological mapping and optimizing the locations of exploratory boreholes. The locations, depth and detailed lithological characteristics of the trial pits are shown in **Table No -10.2 and Plate No-V**.

Table No- 10.2 Pit Location of Vadekhan Limestone Block

PIT No.	Elevation (MSL)	Depth Achieved(m)	Latitude	Longitude
PIT-1	120	1	21°47'24.34"N	70° 4'21.56"E
PIT-2	121	0.2	21°47'34.00"N	70° 4'21.00"E
PIT-3	138	1	21°48'2.00"N	70° 4'1.00"E
PIT-4	130	1.5	21°47'59.59"N	70° 3'49.11"E
PIT-5	130	1	21°47'49.52"N	70° 3'54.61"E
PIT-6	129	0.5	21°47'41.00"N	70° 3'39.00"E
PIT-7	116	0.4	21°47'34.00"N	70° 3'24.00"E
PIT-8	116	1	21°47'25.00"N	70° 3'32.00"E
PIT-9	114	1.7	21°47'21.00"N	70° 3'35.00"E
PIT-10	118	1	21°47'40.52"N	70° 3'22.37"E
PIT-11	118	0.4	21°47'2.00"N	70° 3'52.00"E
PIT-12	120	1.3	21°47'12.00"N	70° 3'58.00"E
PIT-13	121	1.5	21°47'12.00"N	70° 3'60.00"E
PIT-14	118	1.5	21°47'19.00"N	70° 3'53.00"E
PIT-15	130	1	21°47'35.28"N	70° 3'52.73"E

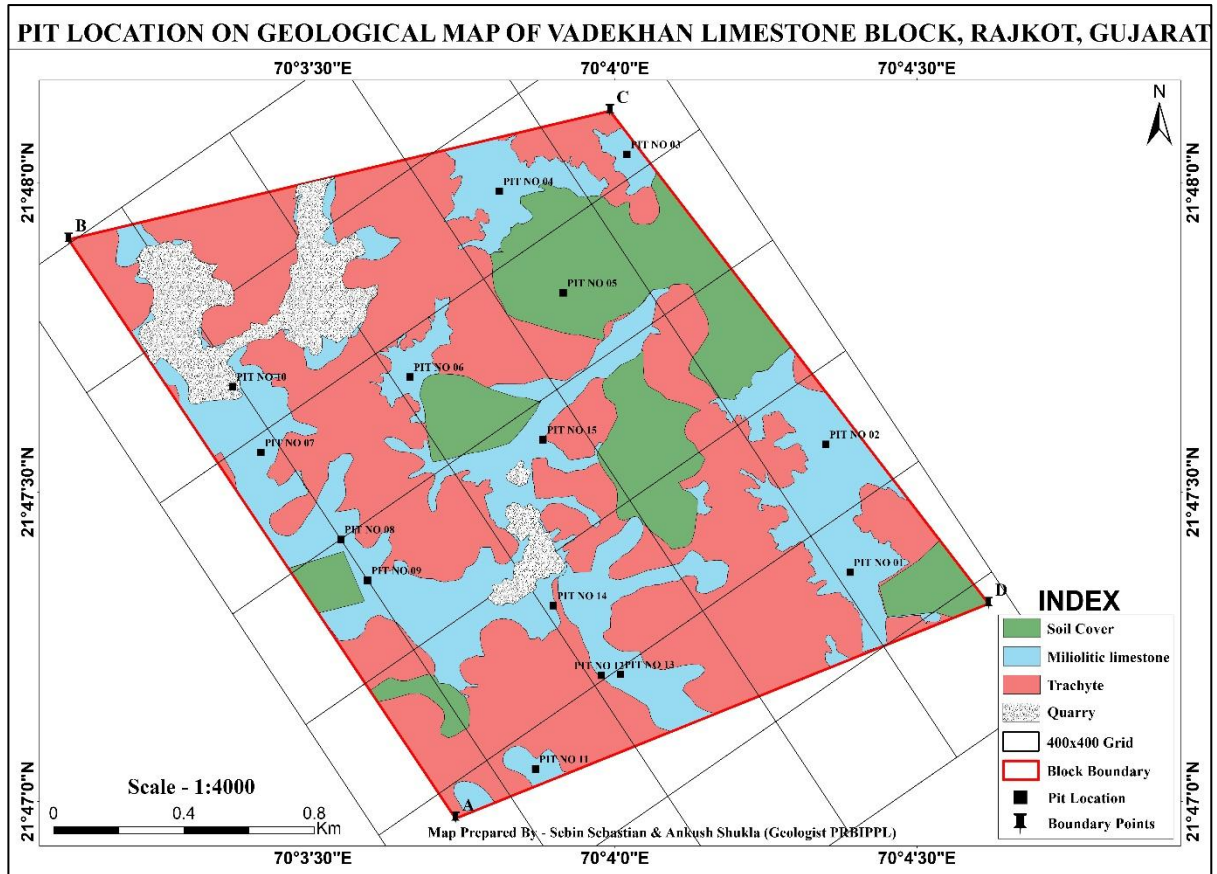


Plate No. VI: Pit Location in Vadekhan Limestone Block

Summary of Trial Pit Investigation – Vadekhan Limestone Block

A total of 15 trial pits were excavated across the Vadekhan Limestone Block to evaluate the nature, thickness, and continuity of the limestone horizon. The pits attained depths ranging from 0.2 m to 2.0 m depending on excavation feasibility and rock hardness.

The investigation revealed that the block is predominantly underlain by Miliolitic Limestone. A thin to moderate cover of soil, generally ranging from negligible thickness to about 1.0 m was encountered in most pits, particularly in agricultural fields. Beneath the soil cover weathered limestone comprising loose, friable, gritty and porous material was commonly observed. The weathered zone generally extends up to 1.5 m depth and is characterized by yellowish, buff and pinkish-buff colours. In several pits, limestone boulders intermixed with soil indicate in-situ weathering of the parent rock.

Hard, compact limestone was encountered at depth in most pits, confirming the persistence of a continuous limestone horizon across the block. The limestone is generally medium to fine grained, moderately to highly porous and exhibits strong effervescence with dilute

hydrochloric acid confirming its calcareous nature. Localized occurrences of calcarenitic and gritty limestone facies were observed near old quarry workings.

Overall, the trial pit investigation confirms the presence of a laterally extensive Miliolitic Limestone deposit with favourable geological characteristics. The continuity of hard limestone beneath the weathered zone indicates good potential for limestone resource development within the block. Following images showing Pit in the study area.



Fig. No.7 -Pit 14 attained a depth of 1.5 m and comprises 1.0 m of soil cover followed by 0.5 m of loose miliolitic limestone. Hard, compact yellowish miliolitic limestone occurs below, exhibiting a medium- to fine-grained, closely packed texture.



Fig No.8: - Pit 12 comprises 1.3 m of loose soil cover overlying hard, porous miliolitic limestone. Medium- to fine-grained, hard pinkish miliolitic limestone is exposed at the bottom.



Fig. No. 9: - Pit 03 attained a depth of 1.0 m and comprises loose, gritty yellowish limestone with occasional limestone boulders. At greater depth, limestone boulders embedded in soil are encountered. The limestone is medium- to fine-grained and exhibits abundant voids and interconnected pores.



Fig. No. 10 - Pit 01 in Vadekhan block attained a depth of 1.0 m, in which 0.5m soil cover after that hard compact limestone encountered.



Fig. No. 11 - Showing Image of Pit-09 in Vadekhan 1.7m depth limestone.

10.3.3 Exploratory Drilling

Topographical survey, exploratory drilling and borehole core sampling were carried out concurrently during the course of investigation. The analytical and laboratory studies were conducted at Inspectorate Griffith India Private Limited a NABL accredited laboratory. Core samples recovered from the exploratory boreholes were systematically logged based on geological parameters such as grain size, rock type, lithology, structural features and mineralogical characteristics. The detailed summarized lithologs are enclosed as **Annexure 1**.

Limestone bands were encountered in all 13 boreholes drilled within the Vadekhan Block. The borehole coordinates along with Reduced Levels (RL) were determined using the WGS-84 datum.

The drilling programme commenced with borehole **G-VDK-BH1** on 14.03.2026 and was completed with borehole **G-VDK-BH13** on 21.03.2026. The details of boreholes drilled are furnished in **Table No-10.3**

Table No: 10.3
Details of section-wise boreholes drilled in Vadekhan Block Rajkot District
Gujarat State.

Sr.No.	Borehole Id	Latitude	Longitude	Total Depth (m)	RL (m)
1	G-VDK-BH-01	21°47'22.66" N	70°4'23.17" E	10.5	126
2	G-VDK-BH-02	21°47'34.43" N	70°4'20.80" E	9	135
3	G-VDK-BH-03	21°47'54.33" N	70°4'4.85" E	5	133
4	G-VDK-BH-04	21° 48' 3.3" N	70° 4' 0.88" E	7	139
5	G-VDK-BH-05	21° 47' 56.9" N	70° 3' 48.81" E	9	142
6	G-VDK-BH-06	21° 47' 41.96"N	70° 3' 39.63" E	3	131
7	G-VDK-BH-07	21° 47' 31.8" N	70° 3' 48.00" E	5	131
8	G-VDK-BH-08	21° 47' 19" N	70° 3' 57.1" E	5	126
9	G-VDK-BH-09	21° 47' 11.16"N	70° 4' 4.52" E	6	126
10	G-VDK-BH-10	21° 47' 34.5" N	70° 3' 24.9" E	12	123
11	G-VDK-BH-11	21° 47' 25.5" N	70° 3' 32.9" E	12	118
12	G-VDK-BH-12	21° 47' 17.8" N	70° 3' 44.1" E	9	123
13	G-VDK-BH-13	21° 47' 39.7" N	70° 3' 55.5" E	6.5	139

10.3.3.1 A comprehensive Quality Assurance and Quality Control (QA/QC) protocol was implemented during drilling, sampling, sample preparation and analytical stages to ensure the accuracy and reliability of the geochemical data. Core samples obtained from NQ size diamond drilling were geologically logged and sampled at nominal 1.0 m intervals or based on lithological boundaries to ensure representativeness of the mineralized horizon. The core was systematically split and representative half-core samples were collected for analysis while the remaining half was retained for reference. All samples were properly labelled, sealed, and transported to the Chemical Laboratory. A total of 116 primary samples were analysed for 6 radicals major oxides including CaO, MgO, SiO₂, Al₂O₃, Fe₂O₃, and Loss on Ignition (LOI).

As part of the QA/QC programme approximately 10% of the samples (12 samples) were submitted to an independent external laboratory **Shiva Analytical India Private Limited** for check analysis to assess analytical precision and accuracy. The QA/QC procedures adopted during sampling preparation and analysis are considered adequate for the level of exploration (G3) and provide confidence in the geological interpretation and resource estimation.

- 10.3.3.2** In the Vadekhan Block two geological cross-sections were prepared one along the strike in the NW–SE direction and the other across the strike in the E–W direction. Totally 13 boreholes were considered for the preparation geological cross section and all these (13) boreholes intersected limestone zones.

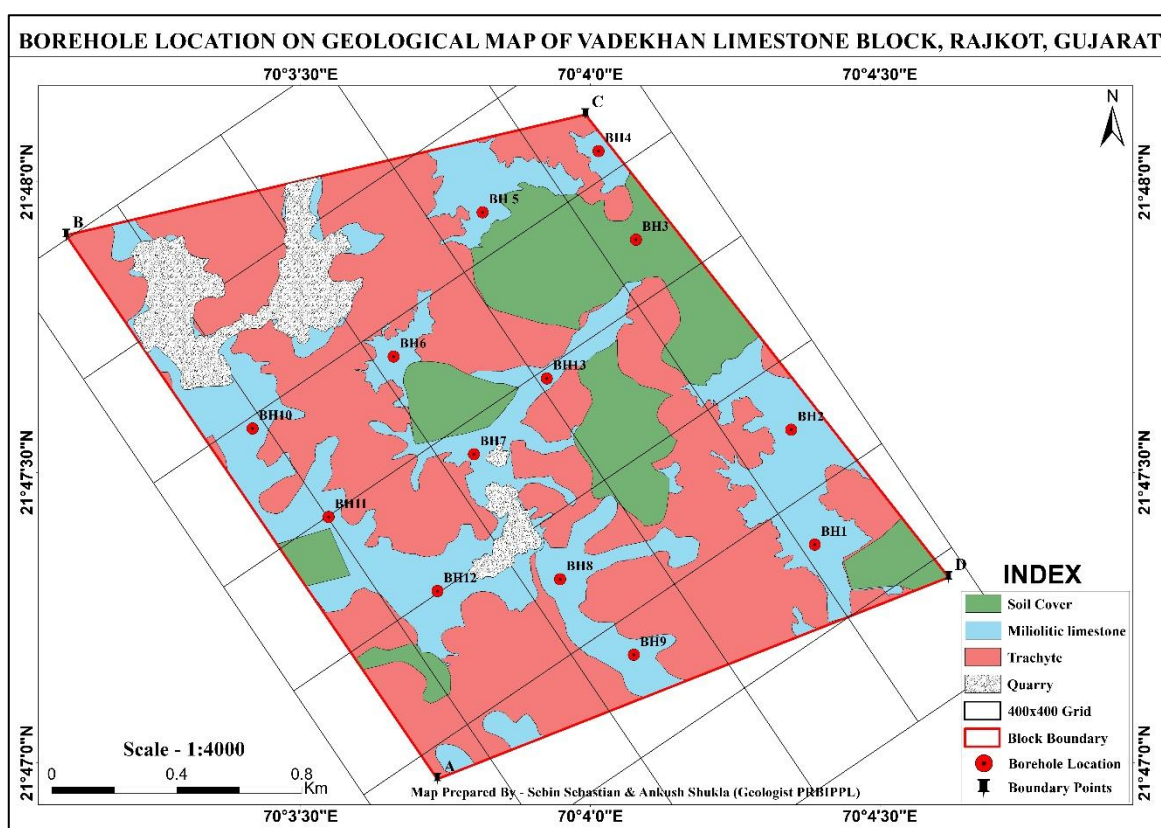


Plate No. VII: Borehole location on Geological Map of Vadekhan Limestone Block, Rajkot, Gujarat.

CHAPTER-11

LOCATION DATA POINTS

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

- The area lies northeast of Vadekhan village in Upleta Taluka, Rajkot district, Gujarat and is reasonably accessible via rail, road, and air transport. The nearest railhead is Jam Jodhpur Railway Station located approximately 20 km from the area providing connectivity to regional and intercity routes. National Highway 27 (NH 27) is the nearest major highway offering efficient road access to the block area and linking it with key towns and cities in Gujarat. The closest airport is Porbandar Airport situated about 50 km away which provides domestic flight services primarily connecting to larger cities like Ahmedabad and Mumbai. This multimodal access makes Vadekhan suitable for field activities, transportation of equipment and exploration logistics.
- The Topographical survey, Borehole location and Block Boundary demarcation in this block has been carried out by the CHCNAV i89 Instrument.
- The Survey of India (SOI) base station was utilized for Topographical survey, Borehole fixation and Block Boundary demarcation. The base stations used from the Survey of India CORS network.
- The coordinates of the SOI base station are provided in **Table No: 11.**

Table No-11.1
Showing the R.L & Coordinates of the SOI CORS Base Point

Base Station	Latitude	Longitude	Easting (m)	Northing (m)	RL (m)
SURVEY OF INDIA BASE STATION	21.769083° N	70.074417° E	2409666.390	611003.978	199.188

11.2.0 TECHNICAL SPECIFICATIONS OF DGPS

- **Make:** CHCNAV
- **Model:** CHCNAV i89
- **Year:** 2025

11.3.0 BASELINE PROCESSING RESULTS:

Total Six Block boundary points has been fixed by PRBIPPL as part of present G3 stage exploration. Co-ordinates and Reduced level (RL) of the borehole are given in **Table-10.3** and also shown in **Plate No-VI**.

11.4.0 QUALITY AND ADEQUACY OF TOPOGRAPHIC CONTROL

Topographic control for the exploration area was established using Differential Global Navigation Satellite System (DGPS/GNSS), ensuring high positional accuracy for all survey observations. Adequate topographic control points and data density were maintained to accurately depict the terrain, exploration features, and cultural details on the topographic map. The survey data were processed and compiled to generate an Excel-based point list, which is appended to this report. The survey was carried out by qualified survey personnel in accordance with the prevailing standard survey procedures, ensuring the quality, accuracy, and adequacy of the topographic control for geological mapping and exploration activities.

CHAPTER-12

SAMPLING TECHNIQUES

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

- The present work was formulated to undertake **Preliminary Exploration (G3 Stage)** for limestone in the Vadekhan Block. A total of **40 bedrock samples** and **15 pit samples** were collected from the block for Chemical analysis.
- Exploratory drilling of **98m** was carried out through **13 boreholes** to assess the subsurface continuity and quality of the limestone horizon. Sampling and analytical work were undertaken on all identified limestone-bearing intervals encountered in surface exposures, pits and boreholes. Sample intervals were delineated based on detailed geological observations considering lithological variations and the characteristics of the mineralized zones. Generally, a sampling interval of **1.0 m** was maintained for borehole core sampling however, the interval was modified wherever necessary to honour lithological contacts and changes in rock characteristics thereby ensuring representative sampling of the mineralized horizons.
- Borehole core sampling was carried out in the presence of a qualified geologist and a sampling technician. The geologist identified and marked the limestone-bearing zones for sample preparation and the samples were generated under the supervision of the sampling technician. The recovered core was longitudinally split into two equal halves to ensure uniform distribution of the material. One half of the core was preserved in the core box for record and future reference while the other half was processed for laboratory analysis. Core recovery exceeded **86.37% in nearly all boreholes**, thereby providing a reliable and representative profile of the subsurface lithology.
- Based on the recovered core, a total of **61 primary borehole core samples** were generated for chemical analysis. The samples were crushed, pulverized, and sieved to a particle size of **(-150) microns**. The prepared material was thoroughly homogenized through repeated mixing, followed by coning and quartering to obtain representative analytical samples. All stages of sample preparation were carried out using standardized industry practices under appropriate supervision. Sample preparation equipment was regularly cleaned and maintained to prevent contamination and ensure consistency and reliability of analytical results.

- The primary samples were analyzed for major oxides, namely **CaO, MgO, SiO₂, Fe₂O₃, Al₂O₃ and Loss on Ignition (LOI)** using the **XRF method**. In addition, **10 samples** were selected for **petrographical studies**, while **5 borehole samples** were tested for Specific Gravity determination. Again **09 Composite samples** were tested for 12 radicals by XRF methods. To assess the quality and reliability of analytical data, **12 External Check Samples** were also generated and analysed. **15 ICP-MS** samples were analysed, Further, fifteen 15 pit samples were analysed, showing as part of the quality control programme.
- The entire sampling, sample preparation, handling, storage, and dispatch process was carried out under the supervision of qualified geological personnel following standardized procedures. The adopted sampling methodology, sample preparation techniques and quality control measures are considered appropriate for **Preliminary Exploration (G3 Stage)** and ensured the generation of representative accurate, and reliable geological and geochemical data for resource assessment of the Vadekhan Limestone Block.

CHAPTER-13

DRILLING TECHNIQUES AND DRILL SAMPLING EMPLOYED

13.0.1 DRILLING TYPES AND DETAILS

- The core drilling was carried out inhouse by M/S PRBIPPL. Total 13 nos. of vertical boreholes were drilled with a cumulative meterage of **98m** and other associated geological analytical works in the Vadekhan block. The header details of boreholes are given in **Annexure 3**.
- The drilling operations in the block were carried out using a tractor-mounted hydraulic drilling rig. All boreholes were drilled in NQ size using the triple-tube barrel wireline wet core drilling method. Drilling was conducted in NQ size up to the planned total depth of each borehole using NQ diamond bits and continued until the completion and closure of the respective boreholes.
- The quality of drilling was continuously monitored and maintained throughout the drilling operations. Upon completion, all boreholes were properly plugged and sealed with cement plugs in accordance with standard drilling practices.



Fig. No. 12: Photograph showing plugging of borehole after completion of drilling.

- All the exploratory boreholes drilled in the block, namely G-VDK-BH1 to G-VDK-BH13 are vertical in nature. The boreholes have been drilled to varying depths depending upon the encountered depth of the shallow volcanic basement across the block. As the drilling depths are relatively shallow and no significant deviation was observed during drilling, deviation surveys were not carried out for these boreholes.

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

- The core samples have been recorded properly and the detailed run wise litholog and summarized concise lithologs for boreholes are given in **Annexure-1**. The logging of run wise core as well as the cuttings from boreholes have helped in discerning the physical characters like colour, shape, size and nature of the mineralisation as well as texture, structural features and identification of different litho units.
- Core recovery with reference to the lithologies are properly recorded and represented in **Annexure-1**
- The mineralised zones /length recorded during the geological core logging have been sampled for limestone analysis consisting 6 radicals by XRF method i.e. SiO₂, CaO, Al₂O₃, Fe₂O₃, MgO and LOI.
- The primary samples were marked within the mineralized zones intersected in the boreholes based on visual inspection and lithological characteristics. In general, the sample length was maintained at 1.00 m however, it varied in certain instances due to variations in lithology type and concentration of mineralization. The details of analysis of the primary core samples are provided in **Annexure-3**.

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

- The drilling has been done by NQ size diamond drill bit with single barrel wire line, wet core drilling method. The polymer was used as drilling fluid to flush out the cuttings and stabilize the borehole wall. The drilling fluid also works as a coolant to avoid burning of drill bits. Proper core recovery of more than 86.37% was maintained in limestone by using double tube core barrel, however in case of weathered, loose and fractured zone and in solution cavities, the core recovery was low. Whenever core recovery is less, the grade of the recovered portion has been extrapolated over the non-recovered section. However, all the precautions like modulated water pressure, proper

liner, optimum head pressure and the hands of an expert drilling technician had been taken to maintain the quality of drilling. To ensure representative sampling, core samples were collected only from the mineralized limestone horizons. Clay bands and other non-mineralized intervals were excluded from sampling; hence, the total number of core samples collected was lower than the planned target.

13.4.0 WHETHER THE RELATIONSHIP EXISTS BETWEEN SAMPLE RECOVERY AND GRADE

No significant relationship has been observed between sample recovery and grade of limestone.

CORE LOGGING

The core recovered by drilling was logged systematically in detail describing lithological units with mineralisation details that can be observed by visual inspection. The details of lithology, grain size, colour, texture, structural feature presence of intercalations and cavities have been recorded. Wherever the recovery is less than 100% extrapolations of drilled depth were done on proportionate basis considering the physical characteristics of individual units recovered. All the cores were kept and preserved properly in the GI core boxes of specifications given by NMEDT following “Book pattern”. The detailed run wise lithologs for boreholes are given in **Annexure-1**.

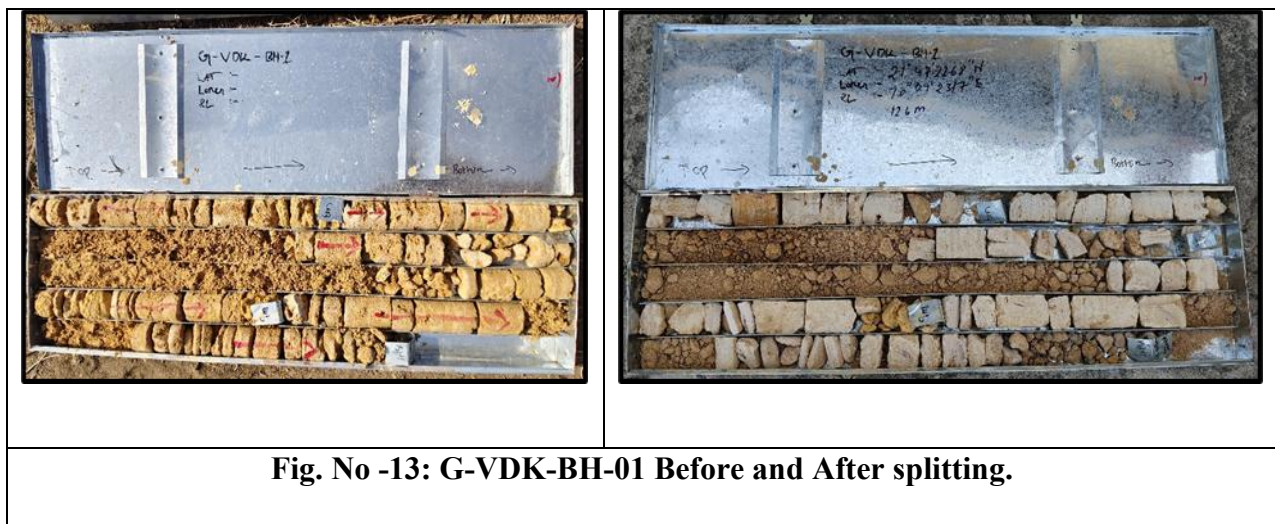


Fig. No -13: G-VDK-BH-01 Before and After splitting.



Fig. No.14: G-VDK-BH-09 Before and After splitting.



Fig. No-15: G-VDK-BH- 10 Before and After splitting.



Fig. No-16: G-VDK-BH- 13 Before and After splitting.

SUMMARISED LITHOLOGS OF BOREHOLES

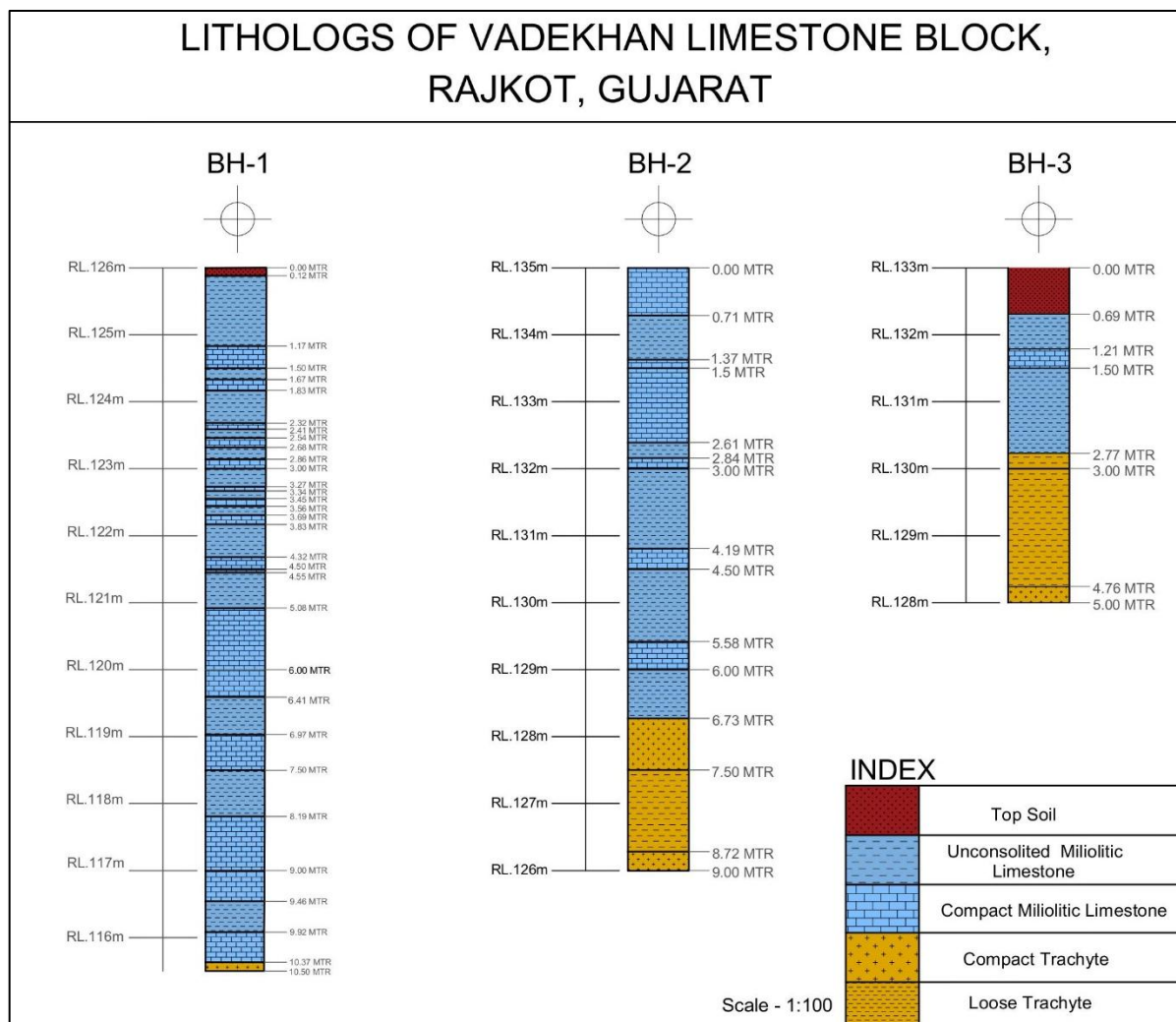
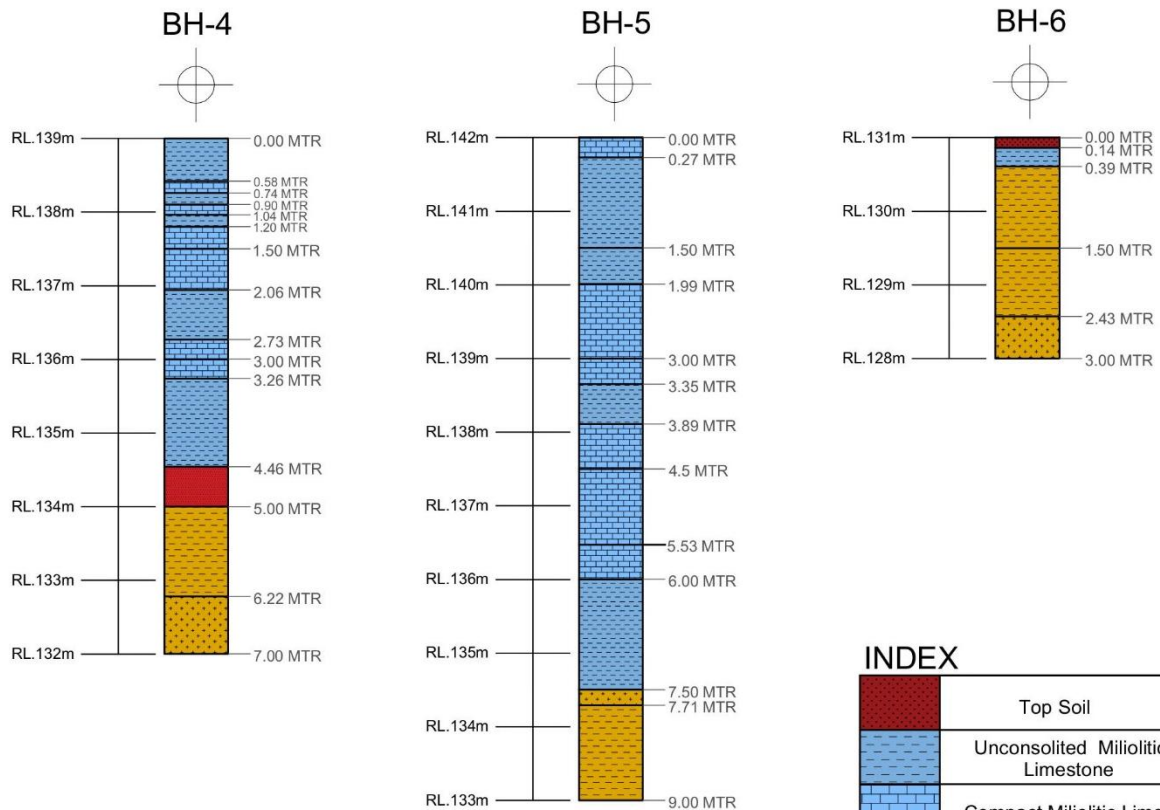


Plate No. VIII(A): Lithologs of Borehole – 1, 2 and 3.

Cross Section of Boreholes of Vadekhan Limestone Block- Plate -VIII

LITHOLOGS OF VADEKHAN LIMESTONE BLOCK, RAJKOT, GUJARAT



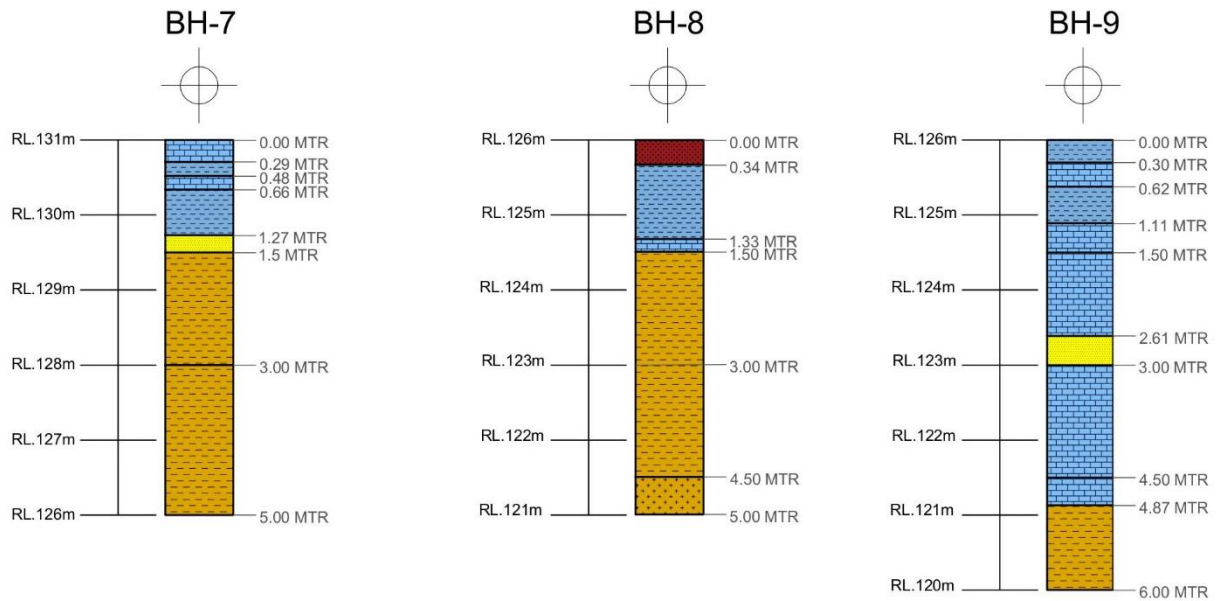
INDEX

	Top Soil
	Unconsolidated Mililitic Limestone
	Compact Mililitic Limestone
	Reddish Brown Clay
	Compact Trachyte
	Loose Trachyte

Scale - 1:100

Plate No. VIII(B): Lithologs of Borehole – 4, 5 and 6.

LITHOLOGS OF VADEKhan LIMESTONE BLOCK, RAJKOT, GUJARAT



INDEX

	Top Soil
	Unconsolidated Miliolitic Limestone
	Compact Miliolitic Limestone
	Compact Trachyte
	Loose Trachyte
	Pale Yellowish clay

Scale - 1:100

Plate No. VIII(C): Lithologs of Borehole – 7, 8 and 9

LITHOLOGS OF VADEKHAN LIMESTONE BLOCK, RAJKOT, GUJARAT

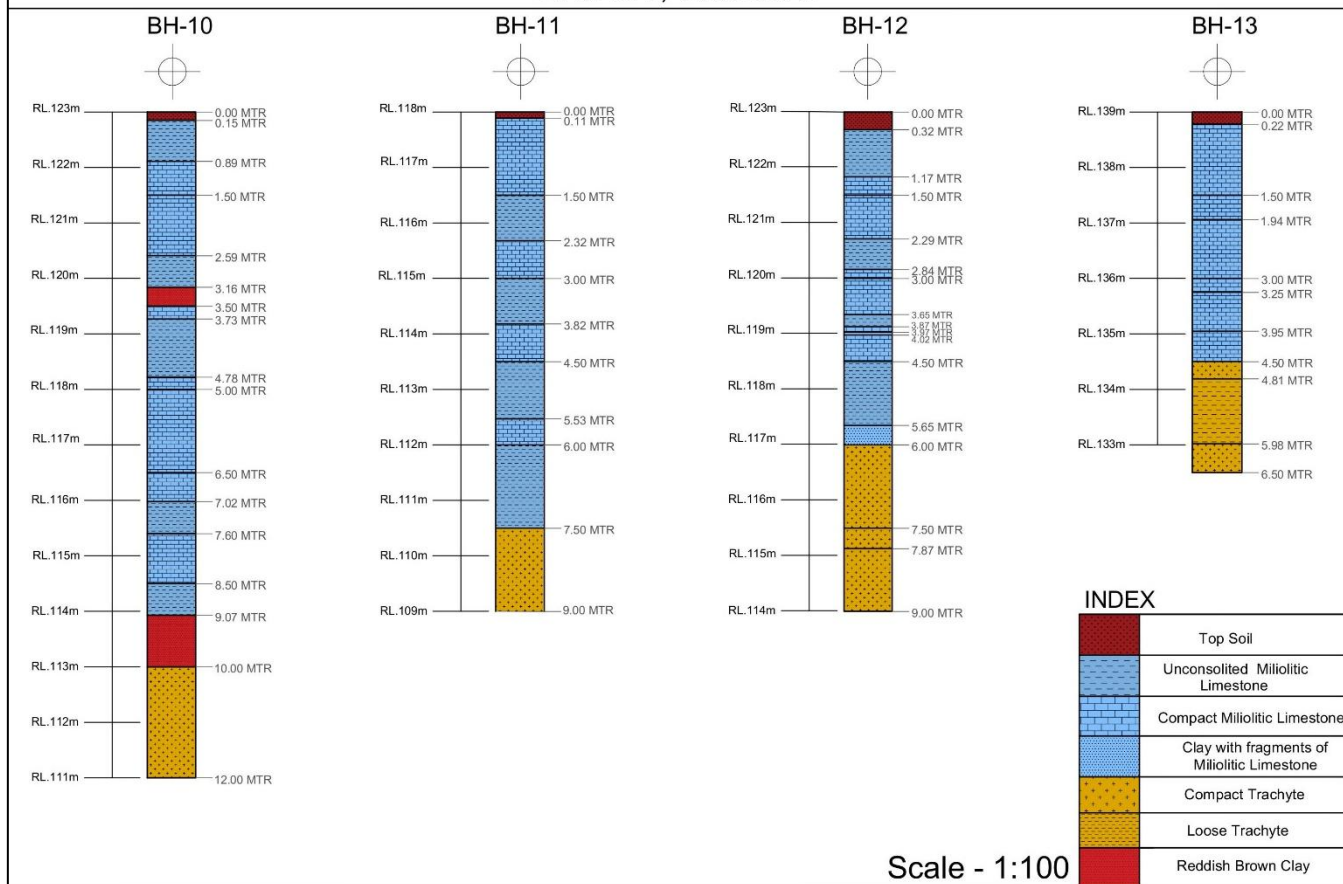


Plate No. VIII(D): Lithologs of Borehole – 10, 11, 12 and 13

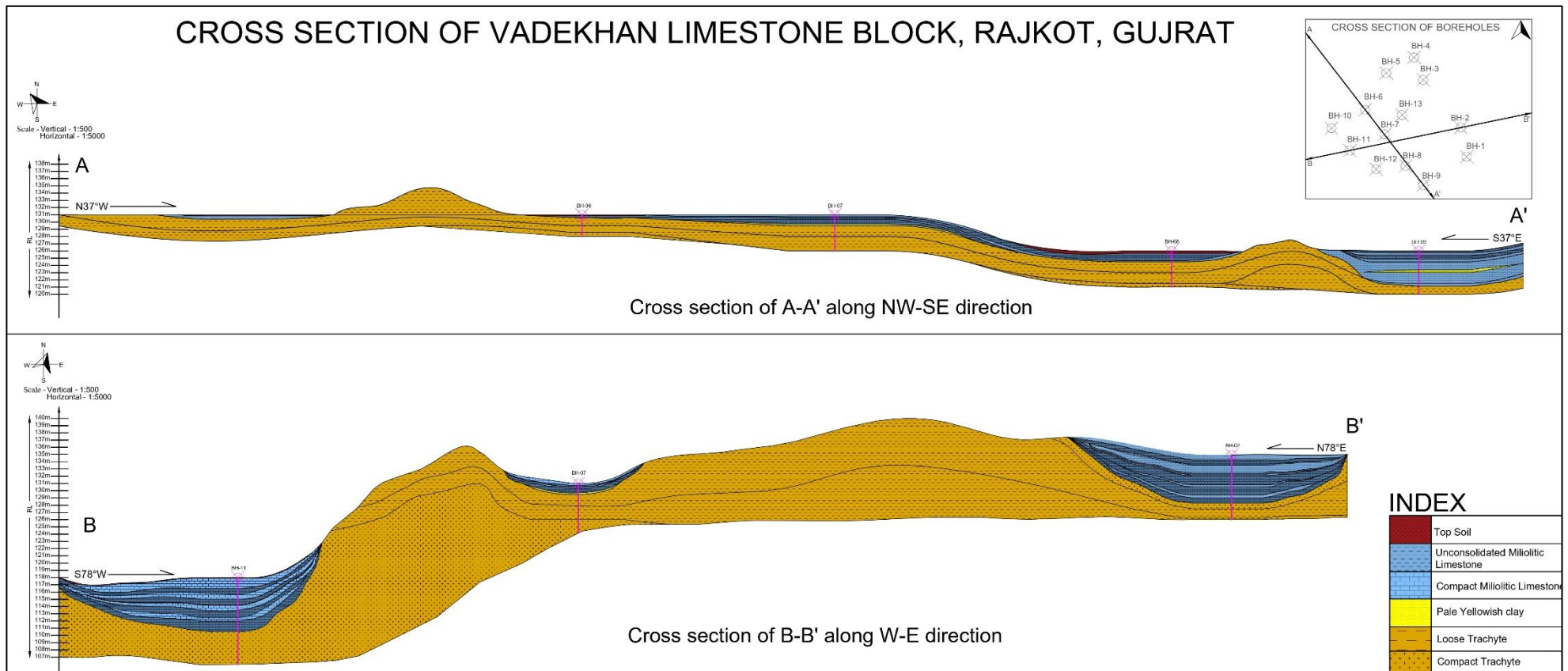


Plate No. IX: Cross Section of Boreholes of Vadekhan Limestone Block

CHAPTER – 14

SUB SAMPLING TECHNIQUES AND SAMPLE PREPARATIONS

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

Core sampling and chemical analysis were carried out for the entire mineralized zones/lengths intersected in the drilled boreholes. Based on visual inspection, samples were delineated within the limestone-bearing zones. The mineralized core was split into two equal halves using a core splitter in such a manner that the concentration of ore minerals remained uniform in both halves. One half of the core sample was crushed to 150 mesh size, and an approximately 600 gm representative sample was prepared by gradual size reduction through the coning and quartering method using a crusher and pulveriser. Thereafter, two sample pouches each weighing 200 gm were prepared. One sample pouch was analysed at the **Inspectorate Griffith India Pvt. Ltd. Gandhidham, Gujarat** for limestone analysis of major oxides. External check samples were also sent to the **Shiva Analytical India Pvt. Ltd. Bengaluru** for analysis. The remaining 200 gm portion of the sample was preserved for future purposes, including composite sample analysis etc.

14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

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

14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

Primary core samples were collected from the entire mineralized zones intersected in the drilled boreholes, and the samples were prepared with utmost care following standard sampling procedures. A total of 116 primary samples (61 Borehole Samples, 40 Bedrock Samples, and 15 Pit Samples) were collected and analysed. The CaO content of the 40 Bedrock Samples ranged from 46.23% to 53.41%, the 61 Borehole Samples from 30.53% to 52.27%, and the 15 Pit Samples from 42.55% to 52.32%.

A total of 9 composite samples were prepared and analyzed for 12 major oxides/radicals by the XRF method. Standard sampling procedures were followed under the supervision of a qualified sampling technician to ensure sample quality. Similarly, 12 External Check samples were prepared under the supervision of a qualified sampling technician following standard sampling procedures and analysed for 6 radicals and 15 ICP-MS samples for 34 radicals at an NABL-accredited laboratory, wherein the maximum Sr value recorded is 1193.29 ppm.

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

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

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

The primary samples have been prepared 150 mesh size and all the other samples have been prepared from primary samples. As per the previous studies in the area 150 mesh size is appropriate for the analysis of limestone etc. mineralization in the block area.



Fig. No. 17: Showing sample preparation

CHAPTER-15

QUALITY OF ASSAY DATA AND LABORATORY TESTS

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

15.1.1 The primary samples 116 from limestone mineralization have been analyzed for 06 radicals i.e., CaO, MgO, Al₂O₃, SiO₂, Fe₂O₃ and LOI by XRF Chemical Laboratory of Inspectorate Griffith India Pvt.Ltd, Gandhidham, Gujarat, NABL accredited Laboratory.

15.2.0 STANDARD OPERATING PROCEDURE (SOP) FOR THE ANALYSIS BY INSPECTORATE GRIFFITH INDIA PVT.LTD, GANDHIDHAM, GUJARAT. CHEMICAL ANALYSIS

1. Fusion Bead (using XRF)
2. XRF (Rigaku ZSX Primus IV)
3. CRM used- IPT-44

Procedure for Preparation of Fusion Bead:

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

- (i) Weigh accurately 1 gms of sample and used 10 gms of Lithium Tetraborate Meta borate acid as a binder.
- (ii) Press the mixer in a fusion bead machine for making of bead.
- (iii) Calibrate the XRF equipment using known standards for elements present in limestone (Calcium, Magnesium etc)
- (iv) Ensure the instrument is set up correctly according to standard guidelines
- (v) Place the prepared Fusion Bead into the sample holder
- (vi) Ensure the sample cup is positioned correctly in the instrument for carrying out analysis
- (vii) Start the XRF analysis using software and initiate the analysis process automatically.
- (viii) Allow the XRF instrument to scan the sample. It will emit X-rays onto the sample, causing the atoms to emit fluorescence.

- (ix) Record the results in a report, including elemental concentrations and any relevant information about the analysis conditions.
- (x) Intermediate check also performed using bead with inbuilt software.

LOSS ON IGNITION

WCL procedure for determination of LOI

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

15.3.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.3.1 In order to ensure the accuracy of the analyzed samples, **IPT-44** has been used as certified reference material. The Certified Reference Material (CRM) was processed under similar conditions as samples and run after every 20 samples.

15.3.2 A total 12 nos. of external check samples have been analyzed by Shiva analytical India Private Limited, laboratory, Bangaluru, for 06 radicals by XRF methods, however 4 radicals i.e. **CaO, MgO and SiO₂, Fe₂O₃** analysis have been statically comparing to check the reliability of chemical analysis and the results are given in **Annexure IV**. Statistical comparison has been furnished below in the following **Table No.15.1.** and corresponding **Figure No.18.**

Table No.-15.1

Comparison of Primary and External Check Sample of Cao%, MgO%, Fe2O3%, SiO2

Sample id	Primary Sample CaO%	External Sample CaO%	Difference	Percentile %	Primary Sample MgO%	External Sample MgO%	Difference	Percentile %	Primary Sample Fe2O3 %	External Sample Fe2O3 %	Difference	Percentile %	Primary Sample SiO2%	External Sample SiO2%	Difference	Percentile %
VDK-BHS-06	50.56	49.90	0.66	0.33	0.49	0.22	0.27	0.0013	1.82	2.06	-0.24	0.0043	4.93	4.27	0.66	0.0325
VDK-BHS-12	52.27	50.65	1.62	0.85	0.41	0.42	-0.01	0.0000	1.12	1.32	-0.20	0.0022	3.57	4.14	-0.57	0.0203
VDK-BRS-14	50.05	50.38	-0.33	0.16	0.42	0.47	-0.06	0.0002	0.54	0.87	-0.33	0.0018	5.03	5.43	-0.40	0.0200
VDK-BRS-16	53.20	52.14	1.06	0.56	0.33	0.41	-0.08	0.0003	0.57	0.90	-0.33	0.0019	2.70	2.78	-0.08	0.0022
VDK-BRS-17	53.07	52.59	0.48	0.26	0.33	0.39	-0.06	0.0002	0.60	0.96	-0.36	0.0022	2.16	2.49	-0.33	0.0071
VDK-BHS-24	30.53	30.57	-0.04	0.01	0.42	0.45	-0.03	0.0001	2.72	3.15	-0.43	0.0117	32.85	32.13	0.72	0.2365
VDK-BHS-36	52.15	52.13	0.02	0.01	0.36	0.38	-0.02	0.0001	0.76	1.01	-0.25	0.0019	3.84	2.74	1.10	0.0420
VDK-BRS-37	51.32	51.06	0.26	0.14	0.40	0.49	-0.09	0.0004	0.65	1.05	-0.40	0.0026	3.43	3.80	-0.37	0.0127
VDK-BHS-41	51.45	51.15	0.30	0.16	0.36	0.39	-0.03	0.0001	0.78	1.01	-0.23	0.0018	5.04	3.84	1.20	0.0603
VDK-BHS-59	36.29	36.89	-0.60	0.22	0.44	0.45	-0.01	0.0001	2.64	3.16	-0.52	0.0137	24.89	23.22	1.67	0.4151
VDK-PIT-07	52.32	52.27	0.05	0.02	0.37	0.30	0.07	0.0003	0.63	0.65	-0.02	0.0001	3.51	2.72	0.79	0.0277
VDK-PIT-11	42.55	43.36	-0.81	0.35	0.56	0.58	-0.02	0.0001	1.65	2.07	-0.42	0.0069	15.97	14.38	1.59	0.2539

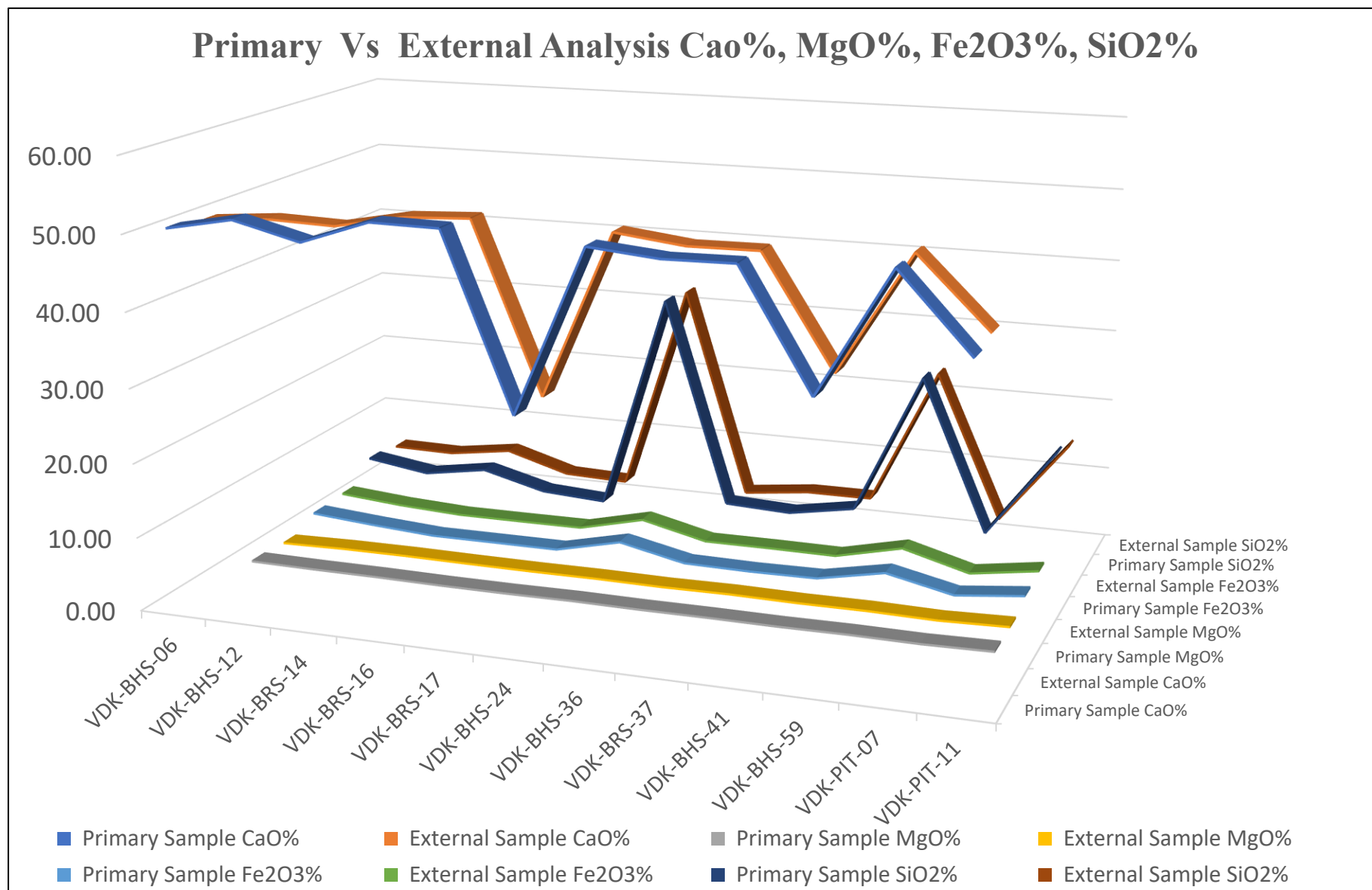


Fig.No. 18 – Graphical Representation of Primary Vs External Check Analysis Cao%, MgO%, Fe₂O₃%, SiO₂%

15.3.3 It has been observed that: -

- The Primary and External laboratory analyses for **CaO, MgO, Fe₂O₃, and SiO₂** show good agreement, with only minor variations between the corresponding values, indicating satisfactory analytical precision and reproducibility.
- The graphical comparison indicates that the trends of the Primary and External analyses are comparable for all the major oxides, confirming consistency between the two laboratories.
- The differences observed between the Primary and External analyses are random in nature and lie within acceptable analytical limits, with no systematic positive or negative bias.
- The inverse relationship between **CaO** and **SiO₂** is consistently reflected in both datasets, representing the natural compositional variation of the limestone samples.
- The external check results validate the reliability and quality of the primary analytical data,
- indicating that the chemical analysis is suitable for geological interpretation and resource estimation.

15.4.0 SECURITY AND CHAIN OF CONTROL OF SAMPLES SHOULD BE CLEARLY MENTIONED

The samples have been prepared at centralized mechanized sampling unit with proper labelling and tag and sent to chemical laboratory in supervision of qualified sampling technician. At the sampling unit, standard procedure has been followed and all the precautionary measures have been taken to avoid the contamination. The sampling unit is separate from the chemical laboratory, so there is no chance of contamination.

CHAPTER - 16

MOISTURE

16.1.0 All the analysis of borehole core samples has been carried out with natural moisture.

CHAPTER – 17
BULK DENSITY/SPECIFIC GRAVITY

17.1.0 SPECIFIC GRAVITY

17.1.1 A total of 05 samples is conducted for Specific Gravity studies and the results are tabulated here under.

Table No- 17.1
Showing Specific Gravity of Vadekhan limestone block

Sr.No.	Sample No.	Specific Gravity
1	VDK-BD-01	2.65
2	VDK-BD-02	2.59
3	VDK-BD-03	2.64
4	VDK-BD-04	2.63
5	VDK-BD-05	2.68
	AVERAGE TOTAL	2.638

17.1.2 The average Specific Gravity of the limestone zones in the block is determined as **2.638** which has been utilised for the resource estimation. specific gravity study report is presented in **Annexure 7**.

CHAPTER – 18
BENEFICIATION STUDIES

18.1.0 The present exploration has no provision for beneficiation studies

CHAPTER – 19

RESOURCE ESTIMATION TECHNIQUE

19.1.0 GENERAL

Resource estimation is a critical component of mineral exploration, as it provides a quantitative assessment of the quantity and quality of mineral resources available within a deposit. The objective of resource estimation is to determine the geological resources of the mineralized body based on exploration data such as drilling, sampling, geological mapping and laboratory analysis.

For the Vadekhan Limestone Block, the **Thiessen Polygon Method** has been modified and adopted for resource estimation. This method is particularly suitable where the mineralized bodies occur as isolated or discontinuous pockets and where lateral continuity between boreholes cannot be confidently established. The method provides a realistic estimate of resources by assigning an area of influence around each borehole based on its spatial location. The thickness and grade of each mineralized zone intersected in the borehole have been considered as it is for the entire influence area of the borehole. The influence area has been taken for the whole area of the limestone outcrop instead of restricting to the polygon containing borehole only.

- 19.1.1** Grades and Resource have been assessed on the basis of end-use grade classification given by IBM's National Mineral Inventory (NMI) in following three categories i) Threshold grade (≥ 34 to $< 38\%$ CaO) in addition to ii) Blendable grade (≥ 38 to $< 44\%$ CaO, $< 5\%$ MgO and $< 18\%$ SiO₂) and iii) Cement grade ($\geq 44\%$ CaO, $< 3.5\%$ MgO and $< 16\%$ SiO₂).
- 19.1.2** Further Resource have been estimated and categorized as per UNFC and placed as **Inferred Resource (333) category has been calculated by Thiessen's polygonal method.**

19.2.0 ASSUMPTIONS FOR RESOURCE ESTIMATION

For limestone grade categorization into cement, blendable and threshold grade, CaO has been considered strictly. For other radicals like in case of MgO and CaO, slight variation on higher side is also considered.

Resource estimated for Cement grade limestone CaO $\geq 44\%$, 3.5% MgO (Max) and 16% SiO₂ (Max), Blendable Grade CaO $\geq 38\%$ to $< 44\%$, 5.00% MgO (Max) and 18%

SiO₂ (Max) and Threshold grade limestone is CaO% $\geq 34\%$ to $< 38\%$ and 6.00% MgO (Max) are considered for the assessment of limestone resource

- The zones of different grades have been demarcated from the values of primary sample analysis as per cut-off limits by End Use Grade specifications by IBM for CaO, MgO and SiO₂. The minimum cumulative thickness of 1.00m of all grades has been considered for resource calculation in methods.
- The exploration scheme was formulated for G-3 level exploration after completing the exploration program, which involved drilling 13 boreholes VDK-BH-1 to VDK-BH-13 in Vadekhan block.
- The limestone body is irregular and discontinuous within the block. Therefore, resource estimation has been carried out using the polygon cum outcrop method.
- The average specific gravity of limestone has been taken as 2.638, based on the analysis of five limestone samples carried out at the Inspectorate Griffith India Private Limited Laboratory, Gandhidham, Gujarat. This value has been used for the computation of resources for Cement-grade, blendable, beneficiable-blendable, and **Threshold-Grade** limestone.
- A deduction of 40% and 50% from Gross in-situ resource has been made to arrive at Net-in-situ resource by polygon method for unseen geological factors i.e. volume of ore body, nature of core, recovery factor, cavities/caverns and other structural features.
- Polygonal resource is calculated for Cement, Blendable and Threshold grades for thickness of limestone zone of respective grades encountered in each borehole is enclosed as **Annexure 11A, 11B and 11C** for Polygonal resources.

19.2.1 Evaluation Of Mineralisation Zones

- The mineralized thickness of the limestone was determined from detailed lithological logging of boreholes. Only those intervals satisfying the prescribed grade specifications were considered for resource estimation. The thickness of mineralized limestone encountered in each borehole was assigned to the corresponding Thiessen polygon/outcrop.
- The geological interpretation revealed that limestone deposition is controlled by valley morphology, wherein the maximum accumulation occurs within the central portion of the valley and gradually tapers towards the margins. Consequently, the thickness distribution is highly variable and non-uniform across the deposit.

- A total of **61** core samples were generated from **98 m** of core drilling conducted across 13 exploratory boreholes. Out of these, boreholes **BH-01, BH-02 BH-4, BH-9, BH-10, BH-11, BH- 12, BH-13** intersected limestone of **Cement Grades**. **BH-5, BH-7, BH-8** predominantly **Blendable Grade**, **BH-3** fall under only **Blendable Grade**, and **BH-5** representing **Beneficial -Blendable Grade**.

19.2.2 Resources Estimation Methods

The limestone deposit in the Vadekhan Block occurs within valley depressions and exhibits considerable variation in both strike and dip directions owing to the irregular nature of deposition and the undulating paleo-topography of the area. In view of this complex geometry, detailed geological mapping was carried out on a 1:4000 scale to accurately delineate the surface extent and distribution of the limestone deposit.

The mapping exercise enabled precise demarcation of the limestone outcrops and their spatial continuity within the block. To establish the subsurface continuity and determine the thickness variation of the deposit, a total of 13 boreholes were drilled at suitable locations across the mineralized zone. The details of the boreholes, including their coordinates, Reduced Levels (R.L.) and depths, are furnished in **Table No.10.3**.

Based on the integrated interpretation of surface geological mapping, borehole lithological data, and analytical results, the lateral extent and thickness of the limestone deposit were established. Subsequently, the Thiessen Polygon Method was adopted for resource estimation, wherein individual areas of influence were assigned to each borehole and the resources were computed using the polygonal/outcrop area, mineralized thickness, and bulk density data. This method was considered appropriate in view of the discontinuous nature of the limestone bodies and the variable thickness distribution within the valley-controlled depositional environment.

19.3.0 PARAMETERS OF RESOURCE ESTIMATION

19.3.1 Sampling Procedure

The primary samples have been collected as per the litho-contact and sample length of one meter has been taken, however due to lithological variations in some instances the sample length was also taken less than 1m, but resource has not been calculated for the zones which are less than 1m. Samples from bore hole cores were crushed to (-) 150

mesh size, cone and quartered, thoroughly mixed and representative samples of 200g were prepared and sent to laboratory for analysis of 6 radicals by XRF methods i.e. CaO, MgO, Al₂O₃, SiO₂, Fe₂O₃, and LOI at Chemical Laboratory Inspectorate Griffith India Private Limited Laboratory Gandhidham Gujarat, and results were obtained to delineate the ore zones.

19.3.2 Chemical Analysis

A total of 116 primary samples collected from the Vadekhan Block were analyzed for six major radicals. These comprised 40 Bedrock Samples (BRS) and 15 Pit Samples, the analytical results of which are enclosed as **Annexure-2** and **Annexure-8**, respectively. In addition, 61 core samples obtained from 13 boreholes (VDK-BH-1 to VDK-BH-13), drilled by PRB Infraprojects Private Limited, Nagpur, were also analyzed, and the results are enclosed as **Annexure-3**. Further, 12 external check samples were sent to **Shiva Analytical India Private Limited, Bengaluru**, for analysis, and the analytical results are enclosed as **Annexure-4**. Considering the open cast potentiality of the block, the minimum workable thickness / minimum stopping width of 1.00 m and minimum non ore parting of 1.00 m is considered for resource estimation.

19.4.0 Overburden

A thin and discontinuous soil cover of 0.3–0.5 m thickness occurs locally within the study area, predominantly in the valley portions, overlying the limestone. The soil supports sparse agricultural and thorny bushy vegetation and, at places, contains embedded fragments and boulders of miliolitic limestone confined to the surface. No continuous limestone bedding is observed beneath the soil-covered areas. However, the majority of the limestone-bearing zones are exposed with little or no soil cover. The distribution of soil-covered and exposed limestone areas has been delineated and mapped in **Plate No-IV**.

19.5.0 METHODOLOGY

Thiessen Polygon Method was adopted for resource estimation, wherein individual areas of influence were assigned to each borehole and the resources were computed using the polygonal area, mineralized thickness, and bulk density data. This method was considered appropriate in view of the discontinuous nature of the limestone bodies and the variable thickness distribution within the valley-controlled depositional environment.

The Thiessen Polygon Method, also known as the Nearest Neighbour Method, is based on the principle that each borehole represents the geological characteristics of the area nearest to it. The method divides the mineralized area into a series of polygons around each borehole such that every point within a polygon is closer to its corresponding borehole than to any other borehole.

The geological parameters such as thickness, grade, and bulk density observed in a borehole are assumed to represent the entire area enclosed by its respective polygon. Resources are estimated independently for each polygon and subsequently aggregated to derive the total geological resource. This method is suitable for preliminary exploration (G-3) level investigations where borehole density is moderate and geological continuity cannot be established with a high degree of confidence.

19.5.1 Methodology Adopted in Thiessen's Polygonal Method of Resource Estimation

The main objective of this method is to demarcate the area of influence of the limestone intersected by a particular borehole. The influence area has been obtained by constructing polygons by drawing perpendicular bisector of triangles, rectangles that connect the adjoining boreholes. In the individual Thiessen Polygons generated, only the limestone-bearing area has been considered for resource estimation, whereas the non-mineralized area has been excluded from the resource calculation. The area of the influence of zones has been ascertained by GIS software. The area of non-development of respective zones is shown on the resource plan. The height of polygons is the cumulative thickness of limestone horizon/bands encountered by the corresponding borehole. The entire limestone body in block is divided into 13 number of polygons. The grade wise borehole wise resource estimation by Polygon method for possible limestone i.e. Cement grade, Blendable Grade and Beneficial to Blendable limestone grades of this block are calculated. The grade assigned to the polygon blocks is same as the weighted average grade of the

corresponding boreholes. The area of non- development of particular grade in borehole has been deducted.

19.5.2 Database Used for Resource Estimation

The resource estimation was carried out using the following exploration data generated during the investigation:

- i) Geological mapping data.
- ii) DGPS surveyed borehole collar coordinates.
- iii) Borehole lithological logs.
- iv) Chemical analytical data of limestone samples.
- v) Bulk density measurements.
- vi) Geological cross-sections and plans.
- vii) Topographical survey data.

The above datasets were integrated and interpreted to delineate mineralized limestone zones and estimate the geological resources.

19.5.3 Preparation of Thiessen Polygons

The Thiessen polygons were prepared using the borehole collar coordinates plotted on the geological plan.

The procedure adopted is summarized below:

- i) All boreholes were plotted using DGPS coordinates.
- ii) Adjacent boreholes were connected by straight lines to form a network of triangles.
- iii) Perpendicular bisectors were drawn for each connecting line.
- iv) The intersection of the perpendicular bisectors generated closed polygons around individual boreholes.
- v) The resultant polygons defined the area of influence of each borehole.
- vi) The polygon boundaries were subsequently constrained within the mineralized zone limits and geological boundaries.

The area enclosed by each polygon was calculated using GIS software and utilized for resource estimation.

19.5.4 Estimation of Polygonal Area

The area of influence of each borehole was determined through Thiessen polygon construction.

The actual limestone outcrop area contained within each polygon was measured using GIS software and expressed in square metres (m²).

The polygon area thus obtained represents the areal extent of limestone influenced by the respective borehole.

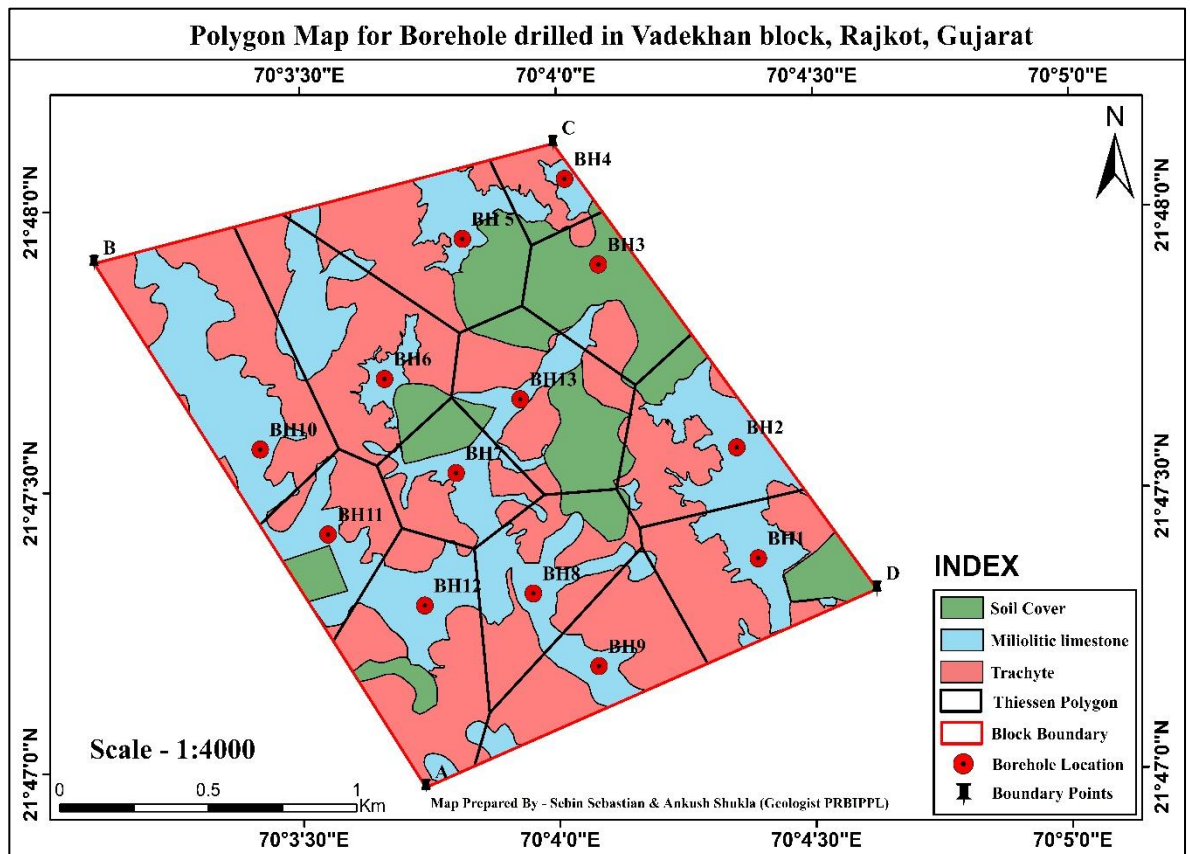


Plate No. X: Geological map using Thiessen's Polygon Method Showing influence area of borehole calculated using Thiessen's Polygon method.

Table 19.1
Table showing the surface area of influence for the mineralized are of each borehole.

BH No.	Polygon Bo.	Surface area of Limestone (Sq. Km)
BH-1	POLYGON-1	0.066306
BH-2	POLYGON-2	0.108011
BH-3	POLYGON-3	0.008583
BH-4	POLYGON-4	0.026202
BH-5	POLYGON-5	0.070756
BH-6	POLYGON-6	0.108833
BH-7	POLYGON-7	0.063827
BH-8	POLYGON-8	0.102252
BH-9	POLYGON-9	0.039268
BH-10	POLYGON-10	0.071968
BH-11	POLYGON-11	0.071149
BH-12	POLYGON-12	0.088273
BH-13	POLYGON-13	0.058636
Total		0.88

19.5.5 Volume Estimation

The volume of limestone within each polygon was calculated using the following formula:

$$\text{Volume (m}^3\text{)} = \text{Polygon Area (m}^2\text{)} \times \text{Average Mineralized Thickness (m)}$$

Where:

- Polygon Area = Area of influence of the borehole.
- Average Mineralized Thickness = Thickness of limestone established from drilling and pitting data.

The total geological volume was obtained by summing the volumes of all individual polygons.

Table 19.2
Showing surface area and the thickness of the limestone deposit.

BH.No.	Polygon Bo.	Surface area of Limestone (Sq. Km)	Thickness (m)
BH-1	POLYGON-1	0.066306	10.25
BH-2	POLYGON-2	0.108011	6.73
BH-3	POLYGON-3	0.008583	2.08
BH-4	POLYGON-4	0.026202	4.46
BH-5	POLYGON-5	0.070756	7.50
BH-6	POLYGON-6	0.108833	0.25
BH-7	POLYGON-7	0.063827	1.27
BH-8	POLYGON-8	0.102252	1.16
BH-9	POLYGON-9	0.039268	4.48
BH-10	POLYGON-10	0.071968	8.58
BH-11	POLYGON-11	0.071149	7.39
BH-12	POLYGON-12	0.088273	5.68
BH-13	POLYGON-13	0.058636	4.28
Total		0.88	64.11

19.5.6 Tonnage Estimation

The geological resource tonnage was estimated by multiplying the volume of limestone by the average bulk density determined from laboratory studies.

$$\text{Geological Resource (Tonnes)} = \text{Volume (m}^3\text{)} \times \text{Bulk Density (t/m}^3\text{)}$$

Where:

- Volume = Estimated limestone volume.
- Bulk Density = Average bulk density of limestone.

The total geological resources were computed separately for Cement Grade, Blendable Grade, and Beneficiable–Blendable Grade limestone.

Specific Gravity

A total of five nos. of limestone core samples from boreholes were subjected to specific gravity determination by Calliper Method in Inspectorate Griffith India Private Limited, Gandhidham Gujarat. The average specific gravity of these five samples has been determined as **2.638 gm/cc** and the same have been considered for estimation of resources. The results of specific gravity determination are calculated in **Annexure-7**. Minimum thickness of 2m for the demarcated grade was considered for resource estimation.

19.5.6 Application of Reduction Factors

The Thiessen Polygon Method assumes that the thickness encountered in a borehole is representative of the entire polygonal area. However, geological observations in the Vadekhan Limestone Block indicate that the limestone bodies occur within valley depressions where the deposit exhibits a lensoidal morphology.

The limestone thickness is generally highest towards the central portions of the valleys and progressively decreases towards the peripheral margins. Since the actual geometry of the deposit cannot be fully represented by borehole intersections alone, application of reduction factors is necessary to account for the uncertainty associated with thickness variation and continuity within the polygonal areas.

Accordingly, reduction factors of **40% and 50%** were applied to the gross geological resources estimated by the Thiessen Polygon Method.

The reduced resource estimates represent more realistic and conservative assessments of the potentially mineable limestone resources considering:

- i) Irregular valley-controlled deposition.
- ii) Gradual thinning of limestone towards valley margins.
- iii) Discontinuous nature of limestone bodies.
- iv) Geological uncertainty between borehole intersections.
- v) Variability in thickness and lateral continuity.

The resources after application of 40% and 50% reduction factors have been reported separately to provide a range of realistic resource scenarios.

Table 19.3
Showing tonnage calculated by considering 40% & 50% reduction of thickness and covering surface area of limestone

BH No.	Polygon No.	Sp.Gravit y	Surface area of Limestone (Sq. Km)	Thickness (m)	Reduction factor 40% of Thickness				Reduction factor 50% of Thickness			
					Reduction	Thickness after 40%	volume	Tonnage	Reduction	Thickness after 50% reduction	volume	Tonnage
BH-1	POLYGON-1	2.638	0.071149	10.25	4.10	6.15	437566.35	1154300.03	5.13	5.13	364638.63	961916.69
BH-2	POLYGON-2	2.638	0.110990	6.73	2.69	4.04	448177.62	1182292.56	3.37	3.37	373481.35	985243.80
BH-3	POLYGON-3	2.638	0.008583	2.08	0.83	1.25	10711.58	28257.16	1.04	1.04	8926.32	23547.63
BH-4	POLYGON-4	2.638	0.026202	4.46	1.78	2.68	70116.55	184967.46	2.23	2.23	58430.46	154139.55
BH-5	POLYGON-5	2.638	0.070735	7.50	3.00	4.50	318307.50	839695.19	3.75	3.75	265256.25	699745.99
BH-6	POLYGON-6	2.638	0.108833	0.25	0.10	0.15	16324.95	43065.22	0.13	0.13	13604.13	35887.68
BH-7	POLYGON-7	2.638	0.063827	1.27	0.51	0.76	48636.17	128302.23	0.64	0.64	40530.15	106918.52
BH-8	POLYGON-8	2.638	0.102252	1.16	0.46	0.70	71167.39	187739.58	0.58	0.58	59306.16	156449.65
BH-9	POLYGON-9	2.638	0.054047	4.48	1.79	2.69	145278.34	383244.25	2.24	2.24	121065.28	319370.21
BH-10	POLYGON-10	2.638	0.192866	8.58	3.43	5.15	992874.17	2619202.06	4.29	4.29	827395.14	2182668.38
BH-11	POLYGON-11	2.638	0.071149	7.39	2.96	4.43	315474.67	832222.17	3.70	3.70	262895.56	693518.47
BH-12	POLYGON-12	2.638	0.099180	5.68	2.27	3.41	338005.44	891658.35	2.84	2.84	281671.20	743048.63
BH-13	POLYGON-13	2.638	0.058636	4.28	1.71	2.57	150577.25	397222.78	2.14	2.14	125481.04	331018.98
Total			1.04	64.11	25.64	38.47	3363217.98	8872169.031	32.06	32.06	2802681.65	7393474.193
Figures in million tonnes								8.872169031				7.393474193

Table No-19.4
Showing tonnage calculated by considering 40% & 50% reduction of thickness and covering surface area of limestone & soil

BH No.	Polygon No.	Sp.Gravit y	Surface area of Limestone (Sq. Km)	Surface area of Soil (Sq. Km)	Total Surface Area (Sq. Km)	Thicknes s (m)	Reduction factor 40% of Thickness				Reduction factor 50% of Thickness			
							Reduction	Thicknes s after 40%	volume	Tonnage	Reduction	Thicknes s after 50%	volume	Tonnage
BH-1	POLYGON-1	2.638	0.071149	0.040838	0.111987	10.25	4.10	6.15	688720.05	1816843.49	5.13	5.13	573933.38	1514036.24
BH-2	POLYGON-2	2.638	0.110990	0.028557	0.139547	6.73	2.69	4.04	563490.79	1486488.69	3.37	3.37	469575.66	1238740.58
BH-3	POLYGON-3	2.638	0.008583	0.136456	0.145039	2.08	0.83	1.25	181008.67	477500.88	1.04	1.04	150840.56	397917.40
BH-4	POLYGON-4	2.638	0.026202	0.008084	0.034286	4.46	1.78	2.68	91749.34	242034.75	2.23	2.23	76457.78	201695.62
BH-5	POLYGON-5	2.638	0.070735	0.067667	0.138402	7.50	3.00	4.50	622809.00	1642970.14	3.75	3.75	519007.50	1369141.79
BH-6	POLYGON-6	2.638	0.108833	0.021542	0.130375	0.25	0.10	0.15	19556.25	51589.39	0.13	0.13	16296.88	42991.16
BH-7	POLYGON-7	2.638	0.063827	0.031237	0.095064	1.27	0.51	0.76	72438.77	191093.47	0.64	0.64	60365.64	159244.56
BH-8	POLYGON-8	2.638	0.102252	0.025275	0.127527	1.16	0.46	0.70	88758.79	234145.69	0.58	0.58	73965.66	195121.41
BH-9	POLYGON-9	2.638	0.054047	-	0.054047	4.48	1.79	2.69	145278.34	383244.25	2.24	2.24	121065.28	319370.21
BH-10	POLYGON-10	2.638	0.192866	-	0.192866	8.58	3.43	5.15	992874.17	2619202.06	4.29	4.29	827395.14	2182668.38
BH-11	POLYGON-11	2.638	0.071149	0.023485	0.094634	7.39	2.96	4.43	419607.16	1106923.68	3.70	3.70	349672.63	922436.40
BH-12	POLYGON-12	2.638	0.099180	0.020861	0.120041	5.68	2.27	3.41	409099.73	1079205.08	2.84	2.84	340916.44	899337.57
BH-13	POLYGON-13	2.638	0.058636	0.107667	0.166303	4.28	1.71	2.57	427066.10	1126600.38	2.14	2.14	355888.42	938833.65
Total			1.04	0.51	1.55	64.11	25.64	38.47	4722457.15	12457841.95	32.06	32.06	3935380.96	10381534.96
Figure in million tonnes										12.46	10.38			

19.6.0 GRADE WISE CATEGORISATION OF RESOURCES

- For limestone, grade categorization into cement, blendable and threshold grade, CaO has been considered strictly. For other radicals like in case of MgO and CaO, slight variation on higher side is also considered.
- Resource estimated for Cement grade limestone $\text{CaO} \geq 44\%$, 3.5% MgO (Max) and 16% SiO_2 (Max), Blendable Grade $\text{CaO} \geq 38\%$ to $<44\%$, 5.00% MgO (Max) and 18% SiO_2 (Max) and Threshold grade limestone is $\text{CaO} \geq 34\%$ to $<38\%$ and 6.00% MgO (Max) are considered for the assessment of limestone resource

Table 19.5
Showing grade wise classification criteria for limestone

Grade Category	CaO (%)	MgO (%)	SiO ₂ (%)
Cement Grade	>44.00	≤ 3.50	≤ 16.00
Blendable Grade	>38.00 to <44.00	≤ 5.00	16.00–18.00
Threshold Grade	≥ 34.00	≤ 6.00	≤ 18.00
Beneficiable–Blendable Grade	>38.00 to <44.00	≤ 5.00	>18.00

The grade wise classification has been conducted after the detailed classification of the chemical analysis results variation with respect to the depth. The total quantity and quality of the deposit in Vadekhan Limestone block is shown below.

Table No- 19.6
Showing the grade wise total reserves with average CaO, MgO& SiO₂ in Vadekhan Limestone Block

Grade Category	Resource Category	Gross Geol.Res. (Mil. tons)	Net Geol. Res. (40% reduction) (Mil. tons)	Net Geol. Res. (50% reduction) (Mil. tons)	Avg. CaO	Avg. MgO	Avg. SiO ₂
Cement Grade (R1)	333	12.46	7.47	6.23	48.54	0.48	8.05
Blendable Grade(R2)	333	1.62	0.97	0.81	43.22	0.50	14.81
Beneficiable – Blendable Grade(R3)	333	0.71	0.42	0.35	38.09	0.47	22.08
Total R₁+R₂+R₃		14.79	8.87	7.39			

CHAPTER – 20

REPORTING OF RESOURCE

20.1.0 RESOURCE ESTIMATION

20.1.1 The limestone resources have been estimated grade-wise, borehole-wise and section-wise using the **Thiessen Polygon Method** based on the various mineralized zones intersected in the boreholes and the specifications and assumptions outlined earlier. Resource estimation has been carried out for each borehole and corresponding cross-sections considering the thickness and grade of limestone encountered. The estimated resources have been classified according to resource category and limestone grade. Detailed grade-wise and category-wise resource estimates derived through the polygonal method are presented in the respective **Annexures. 11 A, 12 B, 13 C.**

20.1.2 The total gross in-situ resources of limestone are broadly categorized under inferred resource category. The details of the same are furnished in the following tables for Vadekhan Limestone block.

Table No: 20.1
Summary of Cement Grade Limestone Resource of Vadekhan Limestone Block

BH No.	Polygon No.	Surface area of Limestone (Sq. Km)	Category	100% Thickness calculation	Volume	Sp.Gravity	Tonnage	Reduction factor 40% of Thickness				Reduction factor 50% of Thickness			
				Thickness (m)				Reduction	Thickness after 40% reduction	volume	Tonnage	Reduction	Thickness after 50% reduction	volume	Tonnage
BH-1	POLYGON-1	0.071149	Cement Grade	10.25	729277.25	2.638	1923833.39	4.10	6.15	437566.35	1154300.03	5.13	5.13	364638.63	961916.69
BH-2	POLYGON-2	0.110990	Cement Grade	6.00	665940.00	2.638	1756749.72	2.40	3.60	399564.00	1054049.83	3.00	3.00	332970.00	878374.86
BH-4	POLYGON-4	0.026202	Cement Grade	2.84	74413.68	2.638	196303.29	1.14	1.70	44648.21	117781.97	1.42	1.42	37206.84	98151.64
BH-5	POLYGON-5	0.070735	Cement Grade	4.70	332454.50	2.638	877014.97	1.88	2.82	199472.70	526208.98	2.35	2.35	166227.25	438507.49
BH-9	POLYGON-9	0.054047	Cement Grade	3.33	179976.51	2.638	474778.03	1.33	2.00	107985.91	284866.82	1.67	1.67	89988.26	237389.02
BH-10	POLYGON-10	0.192866	Cement Grade	8.58	1654790.28	2.638	4365336.76	3.43	5.15	992874.17	2619202.06	4.29	4.29	827395.14	2182668.38
BH-11	POLYGON-11	0.071149	Cement Grade	7.39	525791.11	2.638	1387036.95	2.96	4.43	315474.67	832222.17	3.70	3.70	262895.56	693518.47
BH-12	POLYGON-12	0.099180	Cement Grade	4.00	396720.00	2.638	1046547.36	1.60	2.40	238032.00	627928.42	2.00	2.00	198360.00	523273.68
BH-13	POLYGON-13	0.058636	Cement Grade	2.78	163008.08	2.638	430015.32	1.11	1.67	97804.85	258009.19	1.39	1.39	81504.04	215007.66
Total		0.75		49.87	4722371.41		12457615.78	19.95	29.92	2833422.85	7474569.47	24.94	24.94	2361185.71	6228807.89
Figures In Million Tonnes							12.46				7.47				6.23

The total geological resources of Cement Grade limestone estimated in the Vadekhan Limestone Block amount to **12.46 million tonnes** based on 100% thickness consideration. Applying reduction factors of 40% and 50% to account for geological uncertainties yields estimated resources of **7.47 million tonnes** and **6.23 million tonnes**, respectively. The resource estimation has been carried out using the Thiessen Polygon Method based on borehole data and geological continuity established during exploration. Section-wise, borehole-wise, and zone-wise Reconnaissance (G4) and Inferred (G3) resources of Cement Grade limestone for the Vadekhan Limestone Block are furnished in **Annexure No. 11 A (Refer Table No. 20.**

Table No: 20.2

Summary of Blendable Grade Limestone Resource of Vadekhan Limestone Block

BH No.	Polygon No.	Surface area of Limestone (Sq. Km)	Category	100% Thickness calculation	Volume	Sp.Gravity	Tonnage	Reduction factor 40% of Thickness				Reduction factor 50% of Thickness			
				Thickness (m)				Reduction	Thickness after 40% reduction	volume	Tonnage	Reduction	Thickness after 50% reduction	volume	Tonnage
BH-2	POLYGON-2	0.110990	Blendable Grade	0.73	81022.70	2.638	213737.88	0.29	0.44	48613.620	128242.73	0.37	0.37	40511.35	106868.94
BH-3	POLYGON-3	0.008583	Blendable Grade	2.08	17852.64	2.638	47095.26	0.83	1.25	10711.584	28257.16	1.04	1.04	8926.32	23547.63
BH-4	POLYGON-4	0.026202	Blendable Grade	1.16	30394.32	2.638	80180.22	0.46	0.70	18236.592	48108.13	0.58	0.58	15197.16	40090.11
BH-5	POLYGON-5	0.070735	Blendable Grade	1.30	91955.50	2.638	242578.61	0.52	0.78	55173.300	145547.17	0.65	0.65	45977.75	121289.30
BH-6	POLYGON-6	0.108833	Blendable Grade	0.25	27208.25	2.638	71775.36	0.10	0.15	16324.950	43065.22	0.13	0.13	13604.13	35887.68
BH-7	POLYGON-7	0.063827	Blendable Grade	1.27	81060.29	2.638	213837.05	0.51	0.76	48636.174	128302.23	0.64	0.64	40530.15	106918.52
BH-8	POLYGON-8	0.102252	Blendable Grade	1.16	118612.32	2.638	312899.30	0.46	0.70	71167.392	187739.58	0.58	0.58	59306.16	156449.65
BH-12	POLYGON-12	0.099180	Blendable Grade	1.68	166622.40	2.638	439549.89	0.67	1.01	99973.440	263729.93	0.84	0.84	83311.20	219774.95
Total		0.59		9.63	614728.42		1621653.57	3.85	5.78	368837.05	972992.14	4.82	4.82	307364.21	810826.79
Figures In Million Tonnes							1.62				0.97				0.81

The total geological resources of Blend Grade limestone estimated in the Vadekhan Limestone Block amount to **1.62** million tonnes based on 100% thickness consideration. Applying reduction factors of 40% and 50% to account for geological uncertainties yields estimated resources of **0.97** million tonnes and **0.81** million tonnes, respectively. The resource estimation has been carried out using the Thiessen Polygon Method based on borehole intersections and the geological continuity established during exploration. Section-wise, borehole-wise, and zone-wise Reconnaissance (G4) and Inferred (G3) resources of Blendable Grade limestone for the Vadekhan Limestone Block are furnished in **Annexure No. 11 B (Refer Table No. 20.2)**.

Table No: 20.3
Summary of Blendable - Beneficial Grade Limestone Resource of Vadekhan Limestone Block

BH No.	Polygon No.	Surface area of Limestone (Sq. Km)	Category	100% Thickness calculation	Volume	Sp.Gra vity	Tonnage	Reduction factor 40% of Thickness					Reduction factor 50% of Thickness				
				Thickness (m)				Reducti on	Thickness after 40% reduction	volume	Sp.Gr avity	Tonnage	Redu ction	Thickness after 50% reduction	volume	Sp.Gr avity	Tonnage
BH-4	POLYGON-4	0.026202	Beneficial – Blendable Grade	0.46	12052.92	2.638	31795.60	0.18	0.28	7231.75	2.638	19077.36	0.23	0.23	6026.46	2.638	15897.80
BH-5	POLYGONE-5	0.070735	Beneficial – Blendable Grade	1.50	106102.50	2.638	279898.40	0.60	0.90	63661.50	2.638	167939.04	0.75	0.75	53051.25	2.638	139949.20
BH-9	POLYGONE-9	0.054047	Beneficial – Blendable Grade	1.15	62154.05	2.638	163962.38	0.46	0.69	37292.43	2.638	98377.43	0.58	0.58	31077.03	2.638	81981.19
BH-13	POLYGONE-13	0.058636	Beneficial – Blendable Grade	1.50	87954.00	2.638	232022.65	0.60	0.90	52772.40	2.638	139213.59	0.75	0.75	43977.00	2.638	116011.33
Total		0.15		4.61	268263.47		707679.03	1.84	2.77	160958.08		424607.42	2.31	2.31	134131.74		353839.52
Figures In Million Tonnes							0.71					0.42					0.35

The total geological resources of Low-Grade (Beneficial) limestone estimated in the Vadekhan Limestone Block amount to **0.71** million tonnes based on 100% thickness consideration. Applying reduction factors of 40% and 50% to account for geological uncertainties yields estimated resources of **0.42** million tonnes and **0.35** million tonnes, respectively. The resource estimation has been carried out using the Thiessen Polygon Method based on borehole intersections and the geological continuity established during exploration.

Section-wise, borehole-wise, and zone-wise Reconnaissance (G4) and Inferred (G3) resources of Low-Grade limestone for the Vadekhan Limestone Block is furnished in **Annexure No.-11C**. **(Refer Table No. 20.3)**.

20.1.3 Reliability of Resource Estimation

The reliability of the limestone resource estimated in the Vadekhan Limestone Block is considered to be high to moderate commensurate with the level of exploration carried out under the G3 (Preliminary Exploration) stage. The resource estimation is based on geological mapping, borehole data, lithological logging and chemical analyses of representative core samples. A total of 13 boreholes were drilled to establish the continuity, thickness and grade distribution of the limestone horizons. Resource estimation has been carried out using the Thiessen Polygon Method which assigns an area of influence to each borehole and is an accepted method for preliminary-stage evaluations.

To account for geological uncertainties arising from variations in thickness, lateral continuity, and grade distribution, resource estimates have also been computed after applying 40% and 50% reduction factors. The predominance of **Cement Grade** limestone supported by consistent geological and analytical data from the boreholes enhances confidence in the overall resource estimate. However, owing to the wide borehole spacing and preliminary nature of exploration, the resources are classified under Inferred (333) category and their reliability may be further improved through detailed exploration with closer-spaced drilling and additional sampling.

CHAPTER – 21

SUMMARY AND RECOMMENDATION

21.1.0 SUMMARY

21.1.1 The Vadekhan Block for Preliminary Exploration (G-3 stage) for limestone which lies in the Upleta taluka, Rajkot District, Gujarat State. It falls in parts of the Survey of India Toposheet No. 41 K/01. The block was investigated through detailed geological mapping, borehole drilling, core logging, and geochemical analysis to assess the occurrence, quality, and resource potential of limestone.

21.1.2 Detailed geological mapping on a scale of 1:4000 was carried out in the block. The limestone deposit occurs predominantly within valley portions and exhibits variable strike and dip due to depositional and geomorphological controls. The surface extent of the limestone has been accurately delineated through geological mapping and validated through subsurface exploration.

21.1.3 The limestone exposed in the block is predominantly miliolitic limestone, characterized by cream to yellowish-white colour, fine- to medium-grained texture and the presence of cavities and pores. Fresh surfaces exhibit light cream coloration whereas weathered surfaces show buff to brownish-yellow shades.

21.1.4 A thin soil cover ranging from 0.3 m to 0.5 m is observed locally in valley portions. The soil cover is discontinuous and supports agricultural activities and sparse thorny vegetation. In most limestone-bearing areas the limestone is exposed at the surface with negligible overburden. To establish the subsurface continuity, thickness, and grade distribution of the limestone, 13 boreholes were drilled within the block. All boreholes intersected limestone zones of varying thickness and grade. The borehole locations, geological sections, and lithological details have been utilized for resource estimation (Refer Plate no-VIII(A), VIII(B), VIII(C), VIII(D), and IX).

21.1.5 The limestone encountered in the boreholes comprises Cement Grade, Blendable Grade, and Blendable-Beneficiable Grade limestone. The resource estimation was carried out using the Thiessen Polygon Method based on borehole intersections, geological

continuity, and analytical data. Grade-wise, borehole-wise, and section-wise resources have been estimated under appropriate UNFC category (333)

21.1.6 Representative core samples collected from the boreholes were analysed for major oxide constituents including CaO, MgO, Al₂O₃, SiO₂, Fe₂O₃ and LOI. The analytical results indicate that Cement Grade limestone constitutes the major portion of the deposit, with subordinate Blendable Grade and Beneficial-Grade limestone resources. The resource estimation indicates the presence of substantial Cement Grade limestone with limited quantities of Blendable Grade and Beneficial Grade limestone. The estimated geological resources are summarized below-

Table no 21.1
Showing the grade wise total reserves with average CaO, MgO & SiO₂ in Vadekhan Limestone Block

Grade Category	Resource Category	Gross Geol. Res. (Mil. tons)	Net Geol. Res. (40% reduction) (Mil. tons)	Net Geol. Res. (50% reduction) (Mil. tons)	Avg. CaO	Avg. MgO	Avg. SiO ₂
Cement Grade (R1)	333	12.46	7.47	6.23	48.54	0.48	8.05
Blendable Grade (R2)	333	1.62	0.97	0.81	43.22	0.50	14.81
Beneficial – Blendable Grade (R3)	333	0.71	0.42	0.35	38.09	0.47	22.08
Total R₁+R₂+R₃		14.79	8.87	7.39			

21.1.7 The resources of the Vadekhan Limestone Block have been estimated under **Inferred (333) category** based on geological evidence, borehole intersections and analytical results. Detailed section-wise, borehole-wise and zone-wise resource calculations are furnished in the relevant chapter. (Refer Chapter- 19).

21.2.0 CONCLUSION AND RECOMMENDATIONS

- The Vadekhan Limestone Block contains an estimated **12.46 million tonnes** of Cement Grade limestone, constituting the major resource of the deposit. In addition, **1.62 million tonnes** of Blendable Grade limestone and **0.71 million tonnes** of Beneficial Grade

limestone have been established. Thus, the total geological resource of all grades is estimated at **14.79 million tonnes** based on 100% thickness consideration.

- The Total Geological Net in-situ Resource (**considering a 40% reduction factor**) for Cement Grade is estimated at **7.47 million tonnes** with an average grade of 48.05% CaO, 0.48% MgO, and 8.05% SiO₂. The Total Geological Net in-situ Resource of Blendable grade is **0.97 million tonnes** with an average grade of 42.91% CaO, 0.51% MgO, and 15.24% SiO₂. Additionally, Beneficiable-Blendable grade resources of **0.42 million tonnes** with an average grade of 39.06% CaO, 0.47% MgO, and 20.69% SiO₂ have been established. The combined total net geological resource for all grades is **8.87 million tonnes**.
- The net in-situ Resource (**considering a 50% reduction factor**) for Cement Grade is estimated at **6.23 million tonnes** with an average grade of 48.05% CaO, 0.48% MgO, and 8.05% SiO₂. The Total Geological Net in-situ Resource of Blendable grade is **0.81 million tonnes** with an average grade of 42.91% CaO, 0.51% MgO, and 15.24% SiO₂. Additionally, Beneficiable-Blendable grade resources of **0.35 million tonnes** with an average grade of 39.06% CaO, 0.47% MgO, and 20.69% SiO₂ have been established. The combined total net geological resource for all grades is **7.39 million tonnes**.
- The resource estimation has been carried out in accordance with the provisions of the Minerals (Evidence of Mineral Contents) Rules, 2015, MMDR Amendment Act, 2015, Mineral Auction Rules, 2015 and subsequent amendments thereto. Geological mapping, drilling, sampling, and resource estimation have been undertaken following accepted exploration practices and UNFC guidelines.
- The exploration has successfully established the presence, continuity, thickness, and quality of limestone within the block. The delineated resources provide a reliable basis for future mine planning, feasibility studies and consideration of the block for mineral concession or auction by the Gujarat State Government. The predominance of Cement Grade limestone indicates good potential for utilization in the cement industry. The limited quantity of Blendable Grade and Beneficiable Grade limestone may be suitably blended or selectively mined depending upon end-use requirements.

CHAPTER -22

PLATES AND MAPS

22.1.0 LIST OF PLATES

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CHAPTER - 23
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12	Statement showing the Grade Wise Reserves with Average Cao, MgO, SiO ₂ in Vadekhan Limestone Block.
13	Peer Reviewer Comments and Compliances

CERTIFICATE FROM THE QUALIFIED PERSON WITH NAME,
DATE AND SIGNATURE

Title of the Report: Geological Report on Preliminary Exploration
G-3) For Limestone in Vadekhan Area, Upleta Taluka,
Rajkot District, Gujarat
(T.S.No.41k/01)

This is to certify that the Preliminary Exploration (G3) for Limestone in the Vadekhan Block, Upleta Taluka, Rajkot District, has been carried out by PRB Infraprojects Private Limited, in accordance with the technical standards, procedures and guidelines prescribed under the NMEDT-approved Exploration Methodology for G3 stage exploration.

The exploration work, comprising geological mapping, exploratory drilling, core logging, sampling, sample preparation, chemical analysis, QA/QC procedures, and geological data processing, was executed under the supervision of qualified geologists and technical personnel of PRB Infraprojects Limited.

The Geological Report has been prepared by PRB Infraprojects Private Limited based on the exploration data generated during the course of investigation and in conformity with the applicable guidelines and reporting standards for mineral exploration. The report adheres to the Minerals (Evidence of Mineral Contents) Rules, 2015, framed under the Mineral (Auction) Rules, 2015, as amended up to 2021



NAME: Mr. M. Chandradas (PC)



Mr. Prem Babu Singh Lodhi(TAE)

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DATE:

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		Shiva Analyticals India Pvt. Ltd. Bangalore Karnataka (External check Sample)
7	Petrographic Studies	Ms. Sakshi Mahule (Geology) Ms. Pallavi Dhapodkar (Geology)
8	Documentation	Priti N. Pusadkar (Geology)
9	Reprography and Printing	Vaishnavi Thakare (Geology)

LOCALITY INDEX

Locality	Latitude	Longitude	Toposheet No.
Pransla	21°45'4.74"N	70° 4'48.31"E	41 K/01
Dhank	21°46'21.44"N	70° 8'11.94"E	41 K/01
Paradva	21°46'5.42"N	70° 1'56.82"E	41 K/01
Malvada	21°49'5.70"N	70° 4'5.44"E	41 K/01

REFERENCE

- Carter, H.J. (1849) On foraminifera, their organization and their existence in fossilized state in Arabia, Sindh, Kutch and Kathiawar. *Journal of the Royal Asiatic Society of Bombay*, 3, 158–173.
- Fedden, F.B. (1884) Geology of Kathiawar Peninsula. *Memoirs of the Geological Survey of India*, 21, 41–48.
- Blake, J.F. (1897) Superficial deposits in Kutch. *Quarterly Journal of the Geological Society of London*, 53, 223–243.
- Chapman, F. (1900) Consolidated aeolian sands of Kathiawar. *Quarterly Journal of the Geological Society of London*, 56, 584–589.
- Evans, W. (1900) Mechanically formed limestone from Junagadh (Kathiawar) and other localities. *Quarterly Journal of the Geological Society of London*, 56, 559–583.
- Sayles, R.W. (1931) Bermuda during the ice age. *Proceedings of the American Academy of Arts and Sciences*, 66, 381–467.
- Folk, R.L. (1959) Practical petrographic classification of limestones. *AAPG Bulletin*, 43, 1–38.
- Biswas, S.K. (1971) Miliolite rocks of Kutch and Kathiawar (Western India). *Sedimentary Geology*, 5, 147–164.
- Lele, V.S. (1973) The miliolite limestone of Saurashtra, western India. *Sedimentary Geology*, 10, 301–310.
- Sperling, C.H.B. and Goudie, A.S. (1975) The miliolite of western India: a discussion of the aeolian and marine hypotheses. *Sedimentary Geology*, 13, 71–75.

- Lele, V.S. (1975) the miliolite of western India – a reply. *Sedimentary Geology*, 13, 77–80.
- Fairbridge, R.W. and Johnson, D.L. (1978) Eolianite. In: *The Encyclopedia of Sedimentology* (Eds. R.W. Fairbridge and J. Bourgeois), pp. 279–282. Dowden, Hutchinson and Ross, Stroudsburg, Pennsylvania.
- Gardner, R.A.M. (1983) Aeolianite. In: *Chemical Sediments and Geomorphology: Precipitates and Residua in the Near-Surface Environment* (Eds. A.S. Goudie and K. Pye), pp. 265–300. Academic Press, London.
- Fairbridge, R.W. (1995) Eolianites and eustasy: early concepts on Darwin's voyage of HMS Beagle. *Carbonates and Evaporites*, 10, 92–101.
- Brooke, B. (2001) The distribution of carbonate eolianite. *Earth-Science Reviews*, 55, 135–164.
- Abegg, F.E., Loope, D.B. and Harris, P.M. (2001) Carbonate eolianites—depositional models and diagenesis. In: *Modern and Ancient Carbonate Eolianites: Sedimentology, Sequence Stratigraphy and Diagenesis* (Eds. F.E. Abegg, P.M. Harris and D.B. Loope), SEPM Special Publication, 71, 17–30.
- Loope, D.B. and Abegg, F.E. (2001) Recognition and geologic preservation of ancient carbonate eolianites. In: *Modern and Ancient Carbonate Eolianites: Sedimentology, Sequence Stratigraphy and Diagenesis* (Eds. F.E. Abegg, P.M. Harris and D.B. Loope), SEPM Special Publication, 71, 3–16.
- Le Guern, P. and Davaud, E. (2005) Recognition of ancient carbonate wind deposits: lessons from a modern analogue, Chrissi Island, Crete. *Sedimentology*, 52, 915–926.
- Shrivastava, P.K. (1968) Petrography and origin of miliolite limestone of western Saurashtra coast. *Journal of the Geological Society of India*, 9, 88–96.