GEOLOGICAL REPORT ON
PRELIMINARY EXPLORATION (G–3)
FOR LIMESTONE IN VAYOR BLOCK
(FIELD SEASON-2024-25)
TALUKA: ABDASA
DISTRICT: KACHCHH, GUJARAT

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अध्याय 1

सारांश

गुजरात सरकार के भूविज्ञान और खनन आयुक्त, उद्योग और खान विभाग की अन्वेषण शाखा राज्य में खनिज भंडार स्थापित करने के लिए काम करती है। शाखा ने अतीत में व्यापक अन्वेषण किया है, और पूर्व-विस्तृत खनिज सर्वेक्षण, विस्तृत खनिज सर्वेक्षण और ड्रिलिंग अन्वेषण के माध्यम से विभिन्न स्तरों पर संसाधनों की स्थापना की गई है। इन प्रयासों ने बॉक्साइट, चूना पत्थर, लिग्नाइट, सिलिका रेत, बेंटोनाइट, चाक, ग्रेनाइट और अन्य जैसे कई औद्योगिक रूप से महत्वपूर्ण खनिजों की पहचान की है। अन्वेषण शाखा का मुख्य उद्देश्य राज्य में खनिज संसाधन क्षमता की पहचान करना और नए एमएमडीआर संशोधन अधिनियम, 2015 और खनिज (खनिज सामग्री का साक्ष्य) नियम 2015 के कानूनी ढांचे के तहत भंडार की स्थापना करना है।

गुजरात खनिज अनुसंधान एवं विकास सोसाइटी (जीएमआरडीएस) खनिज उद्योगों को सहायता प्रदान करने तथा भूविज्ञान एवं खनन आयुक्त की देखरेख में खनिज प्रशासन के लिए तकनीकी सहायता प्रदान करने के लिए समर्पित है। जीएमआरडीएस राज्य के भीतर खनिज वस्तुओं और संसाधनों की स्थापना और विकास पर काम करता है। अपने मुख्य मिशन के अलावा, जीएमआरडीएस राज्य की खनिज संपदा के लिए नए खनिज संसाधनों के संचालन में सक्रिय रूप से शामिल है।

फील्ड सीज़न 2023-24 में, गुजरात सरकार के भूविज्ञान और खनन आयुक्त (CGM) की अन्वेषण शाखा ने राष्ट्रीय खनिज अन्वेषण ट्रस्ट (NMET), खान मंत्रालय, भारत सरकार को 2068 हेक्टेयर के कुल क्षेत्र में चूना पत्थर के G3-चरण के अन्वेषण के लिए एक प्रस्ताव प्रस्तुत किया, जिसमें गुजरात के कच्छ जिले के अब्दासा तालुका में वायोर, वागोथ, पधधर, उकीर और करमटा गाँवों के कुछ हिस्से शामिल थे। प्रस्ताव को फरवरी 2024 में NMET द्वारा अनुमोदित किया गया था, जिसके बाद कुल क्षेत्र को व्यवस्थित अन्वेषण के लिए तीन उप-खंडों - वायोर उप-खंड A (189 हेक्टेयर), उप-खंड B (202 हेक्टेयर, और उपखंड C (380 हेक्टेयर) में विभाजित किया गया था।

पश्चिमी भारत में स्थित कच्छ अपनी सक्रिय तह और थ्रस्ट टेक्टोनिज़्म के लिए जाना जाता है, जिसने चूना पत्थर के जमाव सहित भूवैज्ञानिक संरचनाओं और तलछटी अनुक्रमों को प्रभावित किया है। यह क्षेत्र अपनी भूकंपीय गतिविधि के लिए भी जाना जाता है, जिसमें अक्सर भूकंप आते रहते हैं। जुरासिक और इओसीन तलछटों के बीच डेक्कन ट्रैप ज्वालामुखी की उपस्थिति क्षेत्र की भूवैज्ञानिक जटिलता को बढ़ाती है। चूना पत्थर विभिन्न संरचनाओं और युगों में पाया जाता है, जिसमें मियोसीन, ओलिगोसीन, इओसीन और मेसोज़ोइक काल शामिल हैं। इन संरचनाओं में खारी नदी, मनियारा किला, फुलरा और जुमारा संरचनाएँ शामिल हैं। तृतीयक तलछट, जो मुख्य रूप से कच्छ के तटीय मैदानों में उजागर होते हैं, पैलियोजीन और नियोजीन काल के दौरान उथले समुद्री वातावरण में जमा हुए थे। कैल्साइट के रूप में कैल्शियम कार्बोनेट ($CaCO_3$) चूना पत्थर का प्रमुख खनिज घटक है। गैर-कार्बोनेट खनिजों के रूप में मौजूद टेरिजेनस क्वार्ट्ज, क्ले, पाइराइट, हेमेटाइट, चर्ट आदि की परिवर्तनशील मात्रा चूना पत्थर की गुणवत्ता/ग्रेड को नियंत्रित करती है। वायोर ब्लॉक क्षेत्र में पाया जाने वाला चूना पत्थर ओलिगोसीन युग के मनियारा फोर्ट फॉर्मेशन से संबंधित है। इसमें हल्के भूरे से लेकर भूरे रंग के अत्यधिक जीवाश्म चूना पत्थर होते हैं, जिनमें जगह-जगह मिट्टी भी मिली होती है। लिथोलॉजी ज्वारीय समतल, तटीय से लेकर उथले-आंतरिक शेल्फ, समुद्री अतिक्रमणकारी वातावरण की विशेषता है।

वायोर ब्लॉक में अन्वेषण गुजरात खनिज अनुसंधान एवं विकास सोसायटी (जीएमआरडीएस), गांधीनगर द्वारा किया गया था। तीन उप-ब्लॉकों (ए, बी और सी) में, कुल 10 बोरहोल एक व्यवस्थित 800 मीटर × 800 मीटर ग्रिड पर ड्रिल किए गए थे, जो 310 मीटर की संचयी ड्रिलिंग मीटरेज को कवर करते थे। बरामद कोर से, कुल 170 प्राथमिक नमूने तैयार किए गए और रासायनिक विश्लेषण के लिए पेट्रोग्राफी और खनिज रसायन विज्ञान प्रयोगशाला (पीएमसी लैब), गांधीनगर को प्रस्तुत किए गए। सभी कोर ड्रिलिंग नमूनों का प्रमुख और मामूली ऑक्साइडों के लिए विश्लेषण किया गया, जिनमें CaO, MgO, Al_2O_3, SiO_2, Fe_2O_3, SO_3, P_2O_5,

K2O, Na2O, MnO, TiO2 और LOI विशिष्ट गुरुत्व के साथ शामिल थे। विश्लेषण के परिणामों के आधार पर, लिथोलॉजी को संशोधित किया गया, और प्रत्येक बोरहोल के प्रभाव का आकलन करने के लिए थिएसेन पॉलीगॉन पद्धति का उपयोग करके संसाधनों की गणना की गई। इस परियोजना के परिणामस्वरूप, गुजरात की खनिज संपदा में निम्नलिखित खनिज संसाधन स्थापित हुए: वायोर ब्लॉक के तीन उप-खंडों में कुल 65.39 मिलियन टन सीमेंट ग्रेड चूना पत्थर (औसत CaO: 46.91%, MgO: 2.07%, SiO_2: 5.56%, Fe_2O_3: 4.57%) और 43.40 मिलियन टन मार्ल (औसत CaO: 27.71%, MgO: 4.20%, SiO_2: 22.69%, Fe_2O_3: 10.91%)। उप-खंडवार खनिज संसाधन इस प्रकार हैं:

उप-खंड A: अन्वेषण में कोई सीमेंट ग्रेड चूना पत्थर या मार्ल संसाधन स्थापित नहीं हुआ।

उप-ब्लॉक B: 61.28 मिलियन टन सीमेंट ग्रेड चूना पत्थर और 21.56 मिलियन टन मार्ल।

उप-ब्लॉक C: 4.11 मिलियन टन सीमेंट ग्रेड चूना पत्थर और 21.84 मिलियन टन मार्ल।

CHAPTER-1

Executive Summary

The Exploration branch of Commissioner of Geology and Mining, Industries and Mines Department, Government of Gujarat operates to establish mineral resources in the state. The branch has conducted extensive exploration in the past, and resources have been established at various levels through pre-detailed mineral surveys, detailed mineral surveys, and exploration through drilling. These efforts have identified several industrially important minerals such as Bauxite, Limestone, Lignite, Silica sand, Bentonite, Chalk, Granite, and others. The main objective of the Exploration branch is to identify mineral resource potential in the Gujarat and establish reserves under the applicable legislative framework of the new MMDR Amendment Act, 2015 and Mineral (Evidence of Mineral Content) Rules 2015.

The Gujarat Mineral Research & Development Society (GMRDS) is dedicated in supporting the mineral industries and providing technical assistance for mineral administration under the supervision of the Commissioner of Geology & Mining GMRDS works on the establishment and development of mineral commodities and resources within the state. In addition to its core mission, GMRDS is actively involved in conducting new mineral resources for state's mineral wealth.

In the Field Season 2023–24, the Exploration Branch of the Commissioner of Geology and Mining (CGM), Government of Gujarat, submitted a proposal to the National Mineral Exploration Trust (NMET), Ministry of Mines, Government of India, for G3-stage exploration of Limestone over a total area of 2068 hectares/20.68 sq. km, covering parts of Vayor, Vagoth, Padhdhar, Ukir, and Karamta villages in Abdasa Taluka, Kachchh District, Gujarat. The proposal was approved by NMET in February 2024, following which the total area was divided into three sub-blocks — Vayor Sub-block A (189 ha), Sub-block B (202 ha), and Sub-block C (380 ha) — for systematic exploration. The present report integrates exploration findings and resource assessments from all three sub-blocks referred to collectively as the Vayor Block, and presents a consolidated G3-stage Geological Report for the NMET-sanctioned project.

Kachchh, in western India is known for its active fold and thrust tectonism, which has influenced the geological structures and sedimentary sequences, including the Limestone deposits. The region is also known for its seismic activity, with frequent earthquakes. The presence of Deccan Trap volcanics between Jurassic and Eocene sediments adds to the geological complexity of the area. The Limestone is found in various formations and ages,

including Miocene, Oligocene, Eocene, and Mesozoic periods. These formations include the Khari Nadi, Maniyara Fort, Fulra, and Jumara Formations, among others. The Tertiary sediments, exposed mainly in the coastal plains of Kutch, were deposited in shallow marine environments during the Paleogene and Neogene periods. Calcium carbonate (CaCO3) in the form of calcite is the predominant mineral constituent of Limestone. Variable amount of terrigenous quartz, clay, pyrite, haematite, chert etc., present as non-carbonate minerals, control the quality/grade of limestone. The Limestone encountered in the Vayor Block area belongs to the Maniyara Fort Formation of Oligocene age. It consists of Light Grey to grey Highly Fossiliferous Limestone interspersed with clay at places. The lithology is characteristic of tidal flat, littoral to shallow-inner shelf, in a marine transgressive environment.

The exploration in the Vayor Block was undertaken by the Gujarat Mineral Research & Development Society (GMRDS), Gandhinagar. Across the three sub-blocks (A, B, and C), a total of 10 boreholes were drilled on a systematic 800 m × 800 m grid, covering a cumulative drilling meterage of 310 meters. From the recovered core, a total of 170 primary samples were prepared and submitted to the Petrography & Mineral Chemistry Laboratory (PMC Lab), Gandhinagar, for chemical analysis. All core drilling samples were analysed for major and minor oxides, including, CaO, MgO, Al2O3, SiO2, Fe2O3, SO3, P2O5, K2O, Na2O, MnO, TiO2, and LOI along with specific gravity. Based on the analytical results, the lithology was revised, and resources were calculated using the Thiessen Polygon method to assess the influence of each borehole. As a result of this project, the following mineral resources were established in Gujarat's mineral wealth: a total of 65.39 million tonnes of Cement Grade Limestone (average CaO: 46.91%, MgO: 2.07%, SiO_2: 5.56%, Fe_2O_3: 4.57%) and 43.40 million tonnes of Marl (average CaO: 27.71%, MgO: 4.20%, SiO_2: 22.69%, Fe_2O_3: 10.91%) across the three sub-blocks of the Vayor Block. The sub-block wise mineral resources are as follows:

Sub-block A: Exploration did not establish any Cement Grade Limestone or Marl resource.

Sub-block B: 61.28 million tonnes of Cement Grade Limestone and 21.56 million tonnes of Marl.

Sub-block C: 4.11 million tonnes of Cement Grade Limestone and 21.84 million tonnes of Marl.

Brief Summary

Sr. No.	Parameter	Data
01	Name of the Block	Vayor Block
02	Location	Villages: Vayor, Vagoth & Karamta Taluka: Abdasa District: Kachchh
03	Block Area	771 Hectares /7.71 sq. km (Sub Block A: 189 hectares/1.89 sq. km, Sub Block B: 202 hectares/2.02 sq. km, Sub Block C: 380 hectares/3.80 sq. km)
04	Block Boundary Co-ordinates	

Boundary Pillar	DMS (WGS 84)		UTM (Universe Transverse Mercator)	
	Latitude	Longitude	Easting	Northing
Vayor Sub Block-A				
VABP-1	23°26'0.82"N	68°40'57.71"E	467587.00	2591551.86
VABP-2	23°26'0.86"N	68°41'1.52"E	467695.11	2591552.85
VABP-3	23°26'1.40"N	68°41'6.87"E	467846.96	2591569.12
VABP-4	23°26'3.12"N	68°41'6.97"E	467849.91	2591622.01
VABP-5	23°26'3.54"N	68°41'7.47"E	467864.12	2591634.89
VABP-6	23°26'3.61"N	68°41'9.44"E	467920.03	2591636.92
VABP-7	23°26'4.88"N	68°41'9.75"E	467928.91	2591675.96
VABP-8	23°26'5.41"N	68°41'13.35"E	468031.10	2591692.04
VABP-9	23°26'6.20"N	68°41'16.59"E	468123.09	2591716.13
VABP-10	23°25'46.99"N	68°41'55.19"E	469217.14	2591123.05
VABP-11	23°24'57.74"N	68°41'31.30"E	468535.99	2589609.96
VABP-12	23°25'0.89"N	68°41'28.02"E	468443.11	2589707.03
VABP-13	23°25'3.49"N	68°41'29.24"E	468477.90	2589786.91
VABP-14	23°25'6.35"N	68°41'29.06"E	468472.98	2589874.87
VABP-15	23°25'6.25"N	68°41'27.72"E	468434.95	2589871.87
VABP-16	23°25'2.09"N	68°41'26.50"E	468400.05	2589744.02
VABP-17	23°25'8.68"N	68°41'19.01"E	468187.93	2589947.13

	VABP-18	23°25'15.13"N	68°41'12.02"E	467990.00	2590145.91
	VABP-19	23°25'29.11"N	68°41'7.65"E	467866.92	2590576.09
	Vayor Sub Block-B				
	VBBP-1	23°25'49.79"N	68°40'58.58"E	467610.94	2591212.61
	VBBP-2	23°25'17.73"N	68°41'9.13"E	467908.16	2590226.05
	VBBP-3	23°25'13.79"N	68°41'10.27"E	467940.24	2590104.81
	VBBP-4	23°24'52.29"N	68°41'27.66"E	468432.33	2589442.58
	VBBP-5	23°24'39.05"N	68°41'21.52"E	468257.20	2589035.80
	VBBP-6	23°24'24.74"N	68°41'14.65"E	468061.27	2588596.16
	VBBP-7	23°24'45.44"N	68°40'49.06"E	467336.40	2589234.32
	VBBP-8	23°24'52.98"N	68°40'41.85"E	467132.30	2589466.64
	VBBP-9	23°24'56.95"N	68°40'41.28"E	467116.40	2589588.76
	VBBP-10	23°25'24.91"N	68°40'40.56"E	467097.88	2590448.63
	VBBP-11	23°25'47.50"N	68°40'39.17"E	467059.99	2591143.41
	Vayor Sub Block-C				
	VCBP-1	23°24'41.29"N	68°39'46.86"E	261188.84	2591006.35
	VCBP-2	23°24'17.17"N	68°40'42.62"E	467151.70	2588365.37
	VCBP-3	23°24'8.83"N	68°41'8.07"E	467873.46	2588107.31
	VCBP-4	23°24'5.78"N	68°41'7.76"E	467864.45	2588013.53
	VCBP-5	23°24'3.25"N	68°41'8.35"E	467881.03	2587935.70
	VCBP-6	23°24'3.42"N	68°41'11.21"E	467962.21	2587940.75
	VCBP-7	23°23'58.39"N	68°41'13.96"E	468039.93	2587785.90
	VCBP-8	23°23'58.11"N	68°41'12.89"E	468009.54	2587777.35
	VCBP-9	23°23'57.56"N	68°41'12.25"E	467991.34	2587760.48
	VCBP-10	23°23'54.61"N	68°41'12.02"E	467984.62	2587669.77
	VCBP-11	23°23'53.22"N	68°41'12.45"E	467996.73	2587627.00
	VCBP-12	23°23'51.96"N	68°41'13.33"E	468021.62	2587588.20
	VCBP-13	23°23'52.43"N	68°41'15.88"E	468094.03	2587602.50
	VCBP-14	23°23'49.73"N	68°41'17.86"E	468150.05	2587519.35
	VCBP-15	23°23'49.77"N	68°41'18.84"E	468177.87	2587520.52
	VCBP-16	23°23'45.77"N	68°41'20.86"E	468234.94	2587397.39
	VCBP-17	23°23'32.95"N	68°41'22.54"E	468281.77	2587003.05

	VCBP-18	23°23'6.50"N	68°40'49.32"E	467337.04	2586191.72
	VCBP-19	23°23'38.74"N	68°40'19.59"E	466495.38	2587185.05
	VCBP-20	23°24'0.36"N	68°39'58.95"E	465911.07	2587851.25
	VCBP-21	23°24'28.64"N	68°39'50.13"E	465662.76	2588721.49
	VCBP-22	23°24'30.52"N	68°39'40.81"E	465398.38	2588779.92
The boundary of Vayor Sub-blocks A, B, and C was established using DGPS survey in WGS-84 datum. Dual frequency DGPS (Rapid Static and RTK modes) was employed for accurate latitude and longitude determination of each boundary pillar, verified with Total Station, and matched with cadastral maps for accuracy.					
05	Total Area Covered under Geological Exploration	771 hectares/ 7.71 sq. km			
06	No. of Boreholes Drilled	10 Nos. (Sub-block A: 3, Sub-block B: 3, Sub-block C: 4)			
07	Total Meterage Drilled	310 mts (A: 60 m, B: 170 m, C: 80 m)			
08	Borehole Spacing	800 mts x 800 mts			
09	Depth of the Mineralized Zone	39.90 mts to 100 mts			
10	Economic Mineral Resource with Quality	Commodity	Average Thickness	Resource (In million tons)	Quality
		Cement (Portland) Grade Limestone	15.34	65.39	CaO:46.91 %, MgO:2.07 %, SiO_2: 5.56%, Fe_2O_3: 4.57%
		Marl	5.33	43.40	CaO:27.71 %, MgO:4.20 %, SiO_2:22.369%,

					Fe_2O_3:10.91%
11	Average Overburden to Mineralized zone (mts : mts)	2.53			
12	Toposheet No.	41A/11			
13	Topography	Undulating			
14	Average Rainfall	Below 450 mm			
15	Lowest Temperature	7° C (December)			
16	Maximum Temperature	47° C (June)			
17	Nearest Railway station	Naliya Railway station- 21.81 km			
18	Road	Accessible through NH-41 and SH-6			
19	Airport	Bhuj airport- 100.17 km			

CHAPTER-2

Introduction

2.1 Details of the Project:

A proposal for G3 stage Limestone exploration in Vayor Block, Abdasa taluka, Kachchh district, Gujarat was submitted to NMET by Commissioner of Geology and Mining, GOG-Gandhinagar on 20/01/2024.

In the 33rd EC meeting held on 19/02/2024 the matter was discussed and EC approved the project with an estimated cost of Rs. 94.28 Lakh. The sanction order was received on 28/02/2024 and accordingly the work was started on 18/03/2024. Subsequently, CGM Gujarat presented the status of progress and sought a timeline extension for project completion. Based on the review of progress and justification provided, a time extension up to 28th February 2025 was approved during the 39th EC meeting held on 24th January 2025. Further, in view of delays in execution, CGM Gujarat submitted a request for additional time, and the TCC-II recommended approval of a second extension of 6 months, up to 27th August 2025, for the completion of the project.

The exploration proposal for the Vayor Block was initially prepared with a total proposed area of 2068 hectares/20.68 sq. km in Abdasa Taluka, Kachchh District. This proposal was submitted to the National Mineral Exploration Trust (NMET) for G3-stage exploration of limestone and was approved in February 2024. For operational convenience and systematic reporting, the approved area was subsequently subdivided into three sub-blocks – A, B, and C. The total area covered under the revised Vayor Block is 771 hectares/7.71 sq. km, which comprises three non-contiguous sub-blocks: Sub-block A (189 ha/1.89 sq. km), Sub-block B (202 ha/2.02 sq. km), and Sub-block C (380 ha/3.80 sq. km). The present report integrates exploration findings and resource assessments from all three sub-blocks referred to collectively as the Vayor Block, and presents a consolidated G3-stage preliminary exploration was conducted in Vayor Block following NMET guidelines. The Vayor Block falls in the toposheet no. 41A/11 in parts of Vayor, Vagoth, Padhdhar, Ukir, and Karamta villages of Abdasa taluka, Kachchh district. The Preliminary Exploration (G3) for the mineral Limestone in Vayor Block was carried out on a grid of 800 x 800 meters, drilling 10 boreholes comprising a total meterage of 310 meters within the block. The drilling and sampling activities were distributed across the three sub-blocks as follows:

Sub-block A: 3 boreholes were drilled to a cumulative depth of 60 meters, from which 22 core samples were collected for chemical analysis.

Sub-block B: 3 boreholes were drilled to a cumulative depth of 170 meters, from which 117 core samples were collected.

Sub-block C: 4 boreholes were drilled to a cumulative depth of 80 meters, with 31 samples collected.

In total, 10 boreholes were drilled across all sub-blocks, accounting for 310 meters of drilling and 170 core samples, forming the basis for geological interpretation and subsequent resource estimation.

2.2 Investigation Agency:

Commissioner of Geology and Mining, Government of Gujarat, Gandhinagar

2.3 Objective of the investigation:

1. To know the continuity of the mineral body both along the strike and dip.
2. To map the extent of the ore body.
3. To ascertain the grade of Limestone deposit.
4. Ore resource/reserve estimation in accordance with MEMC Rule-2015

2.4 Basis for taking up investigation:

Previously GSI had mapped geological Formation on the scale of 1:50000. The region was primarily investigated by CGM by means of sampling during the 2023-24 year field season and upon completing chemical analysis of the collected rock samples revealed an average CaO content of 43.06%. CGM officials found that the Geological data and Chemical analysis result of the area is very promising and recommended for the further exploration of Limestone mineral. In order to meet the demand of Limestone mineral in cement industries, CGM is planning for ML, which will expedite the auction process & as a result State will get more royalty income as well as industries will be profited. Existing lease area are also present in the surrounding areas of the block, which would testify the Limestone prospectivity of the block, so it can be studied as an extension of the already existing mineable deposits. Thus, the block is suggested for G3 level of exploration.

2.5 Details, nature and quantum of work proposed and achievement:

Sr. No	Item of Work	Original Proposed	Modified	Achieved
1	Topographic Survey & Geological Mapping on 1:4000 scale (Ha)	2068 Ha/ 20.68 sq. km	771 Ha/ 7.71 sq. km	771 Ha/ 7.71 sq. km
2	Boundary and borehole demarcation with DGPS	34	62	62
3	Exploratory Drilling (One conditional BH to confirm the total thickness of limestone)	750 m 30 BHs	310 m 10 BHs	310 m 10 BHs
4	**Laboratory Studies**			
	i) Chemical Analysis; Primary samples for 12 radicals, CaO, MgO, Al_2O_3, SiO_2, Fe_2O_3, SO_3, P_2O_5, K_2O, Na_2O, MnO, TiO_2, and LOI by XRF	750 Core	170 Core	170 Core
	ii) External Check (NABL) samples (10% of Primary samples) for analysis of for 12 radicals, CaO, MgO, Al_2O_3, SiO_2, Fe_2O_3, SO_3, P_2O_5, K_2O, Na_2O, MnO, TiO_2, and LOI by ICP-OES	75	17	17
5	**Physical Studies**			
	a) Petrological Studies	5	5	5
	b) Specific gravity Determinations	75	5	5
6	Report Preparation (5 Hard copies with one soft copy)	1	1	1
7	Preparation of Exploration Proposal (5 Hard copies with a soft copy)	1	1	1

Table: 1 Details, nature and quantum of work proposed and achievement

2.6 Personal involved:

The entire work was carried out by Gujarat Mineral Research and Development Society (GMRDS), a technical arm of Commissioner of Geology and Mining, Gujarat. A team of senior technical officers from GMRDS along with Surveyors, Samplers, Geologists, GIS experts and Chemists are involved in this work.

Mode of operation of different work components and associated agency:

Sr. No.	Work Components	Involved agencies
01	Survey & Geological Mapping	Departmental by CGM & GMRDS
02	Laboratory Studies	Petrography and Mineral Chemistry Laboratory (PMC), CGM, Gandhinagar, Gujarat
	Samples for XRD	
	Petrographic study	
	Specific gravity	
03	Check samples from External NABL approved laboratory	M/S. Lucid Laboratory, Hyderabad (NABL approved laboratory)
04	Core Drilling	External Drilling agency- M/S. Vinayak Engimech Pvt. Ltd., Ahmedabad
04	Geological Report preparation	GMRDS, Gujarat
05	Preparation of Exploration proposal	CGM, Gujarat
06	Peer review of Exploration report	Exploration Branch - CGM, Gujarat

Table: 2 Mode of operation of different work components and associated agency

CHAPTER-3

Property description

3.1 Title of the Report

Geological Report on Preliminary Exploration (G–3) for Limestone in Vayor Block, Taluka: Abdasa, District: Kachchh, Gujarat.

3.2 Details of the area

The project area falls within parts of Vayor, Vagoth, Padhdhar, Ukir, and Karamta villages in Abdasa Taluka, Kachchh District, Gujarat. The total area covered under the Vayor Block is 771 hectares/7.71 sq. km, which comprises three non-contiguous sub-blocks: Sub-block A (189 ha/1.89 sq. km), Sub-block B (202 ha/ 2.02 sq. km), and Sub-block C (380 ha/ 3.08 sq. km). These areas were delineated within the original NMET-approved exploration area of 2068 hectares/20.68 sq. km based on geological evaluation and operational feasibility.

3.2.1 Survey of India Toposheet number

The block area falls under the 'Survey of India Topo sheet No. 41A/11 on R.F. 1:50000/ Representative Scale with division of 1000m-500m-0m-500m-1000m on cm grid of Abdasa Taluka of Kachchh district, Gujarat. A map showing area on toposheet can be referred for the same (i.e. Plate-3).

3.2.2 Geo-coordinates of the Vayor Block boundary and drilled boreholes

The sheet of coordinates of Block boundary has given as separate annexure-6.

Sr. No.	Boundary Pillar	DMS (WGS 84)		UTM (Universe Transverse Mercator)	
		Latitude	Longitude	Easting	Northing
Vayor Sub Block-A					
1	VABP-1	23°26'0.82"N	68°40'57.71"E	467587.00	2591551.86
2	VABP-2	23°26'0.86"N	68°41'1.52"E	467695.11	2591552.85
3	VABP-3	23°26'1.40"N	68°41'6.87"E	467846.96	2591569.12

4	VABP-4	23°26'3.12"N	68°41'6.97"E	467849.91	2591622.01
5	VABP-5	23°26'3.54"N	68°41'7.47"E	467864.12	2591634.89
6	VABP-6	23°26'3.61"N	68°41'9.44"E	467920.03	2591636.92
7	VABP-7	23°26'4.88"N	68°41'9.75"E	467928.91	2591675.96
8	VABP-8	23°26'5.41"N	68°41'13.35"E	468031.10	2591692.04
9	VABP-9	23°26'6.20"N	68°41'16.59"E	468123.09	2591716.13
10	VABP-10	23°25'46.99"N	68°41'55.19"E	469217.14	2591123.05
11	VABP-11	23°24'57.74"N	68°41'31.30"E	468535.99	2589609.96
12	VABP-12	23°25'0.89"N	68°41'28.02"E	468443.11	2589707.03
13	VABP-13	23°25'3.49"N	68°41'29.24"E	468477.90	2589786.91
14	VABP-14	23°25'6.35"N	68°41'29.06"E	468472.98	2589874.87
15	VABP-15	23°25'6.25"N	68°41'27.72"E	468434.95	2589871.87
16	VABP-16	23°25'2.09"N	68°41'26.50"E	468400.05	2589744.02
17	VABP-17	23°25'8.68"N	68°41'19.01"E	468187.93	2589947.13
18	VABP-18	23°25'15.13"N	68°41'12.02"E	467990.00	2590145.91
19	VABP-19	23°25'29.11"N	68°41'7.65"E	467866.92	2590576.09
Vayor Sub Block-B					
20	VBBP-1	23°25'49.79"N	68°40'58.58"E	467610.94	2591212.61
21	VBBP-2	23°25'17.73"N	68°41'9.13"E	467908.16	2590226.05
22	VBBP-3	23°25'13.79"N	68°41'10.27"E	467940.24	2590104.81
23	VBBP-4	23°24'52.29"N	68°41'27.66"E	468432.33	2589442.58
24	VBBP-5	23°24'39.05"N	68°41'21.52"E	468257.20	2589035.80
25	VBBP-6	23°24'24.74"N	68°41'14.65"E	468061.27	2588596.16
26	VBBP-7	23°24'45.44"N	68°40'49.06"E	467336.40	2589234.32
27	VBBP-8	23°24'52.98"N	68°40'41.85"E	467132.30	2589466.64

28	VBBP-9	23°24'56.95"N	68°40'41.28"E	467116.40	2589588.76
29	VBBP-10	23°25'24.91"N	68°40'40.56"E	467097.88	2590448.63
30	VBBP-11	23°25'47.50"N	68°40'39.17"E	467059.99	2591143.41
Vayor Sub Block-C					
31	VCBP-1	23°24'41.29"N	68°39'46.86"E	261188.84	2591006.35
32	VCBP-2	23°24'17.17"N	68°40'42.62"E	467151.70	2588365.37
33	VCBP-3	23°24'8.83"N	68°41'8.07"E	467873.46	2588107.31
34	VCBP-4	23°24'5.78"N	68°41'7.76"E	467864.45	2588013.53
35	VCBP-5	23°24'3.25"N	68°41'8.35"E	467881.03	2587935.70
36	VCBP-6	23°24'3.42"N	68°41'11.21"E	467962.21	2587940.75
37	VCBP-7	23°23'58.39"N	68°41'13.96"E	468039.93	2587785.90
38	VCBP-8	23°23'58.11"N	68°41'12.89"E	468009.54	2587777.35
39	VCBP-9	23°23'57.56"N	68°41'12.25"E	467991.34	2587760.48
40	VCBP-10	23°23'54.61"N	68°41'12.02"E	467984.62	2587669.77
41	VCBP-11	23°23'53.22"N	68°41'12.45"E	467996.73	2587627.00
42	VCBP-12	23°23'51.96"N	68°41'13.33"E	468021.62	2587588.20
43	VCBP-13	23°23'52.43"N	68°41'15.88"E	468094.03	2587602.50
44	VCBP-14	23°23'49.73"N	68°41'17.86"E	468150.05	2587519.35
45	VCBP-15	23°23'49.77"N	68°41'18.84"E	468177.87	2587520.52
46	VCBP-16	23°23'45.77"N	68°41'20.86"E	468234.94	2587397.39
47	VCBP-17	23°23'32.95"N	68°41'22.54"E	468281.77	2587003.05
48	VCBP-18	23°23'6.50"N	68°40'49.32"E	467337.04	2586191.72
49	VCBP-19	23°23'38.74"N	68°40'19.59"E	466495.38	2587185.05
50	VCBP-20	23°24'0.36"N	68°39'58.95"E	465911.07	2587851.25
51	VCBP-21	23°24'28.64"N	68°39'50.13"E	465662.76	2588721.49

52	VCBP-22	23°24'30.52"N	68°39'40.81"E	465398.38	2588779.92

Table: 3 Coordinates of corner points of Vayor Block boundary

Sr. No.	BH ID	R.L. (m)	DMS (WGS 84)		UTM (Universe Transverse Mercator)	
			Latitude	Longitude	Easting	Northing
Vayor Sub Block-A						
1	VABH-1	40.00	23°25'55.40"N	68°41'15.00"E	468077.25	2591384.11
2	VABH-2	44.00	23°25'37.10"N	68°41'34.50"E	468629.38	2590820.16
3	VABH-3	36.00	23°25'21.60"N	68°41'17.00"E	468131.75	2590344.57
Vayor Sub Block-B						
4	VBBH-2	41.00	23°25'42.10"N	68°40'56.10"E	467540.04	2590976.28
5	VBBH-5	44.00	23°24'55.90"N	68°41'01.60"E	467693.00	2589555.20
6	VBBH-7	28.00	23°24'43.80"N	68°41'15.60"E	468089.50	2589182.24
Vayor Sub Block-C						
7	VCBH-1	48.00	23°24'23.00"N	68°40'18.90"E	466478.89	2588546.17
8	VCBH-2	31.00	23°24'05.00"N	68°40'34.40"E	466917.56	2587991.64
9	VCBH-3	43.00	23°23'46.80"N	68°40'58.30"E	467594.67	2587430.45
10	VCBH-4	44.00	23°23'25.40"N	68°40'41.00"E	467102.17	2586773.45
The boundary and boreholes of Vayor Sub-blocks A, B, and C was established using DGPS survey in WGS-84 datum. Dual frequency DGPS (Rapid Static and RTK modes) was employed for accurate latitude and longitude determination, verified with Total Station, and matched with cadastral maps for accuracy.						

Table: 4 Coordinates of drilled boreholes of Vayor Block

3.2.3 Location and Accessibility

The project area falls in parts of Vayor, Vagoth & Karamta villages of Abdasa taluka, Kachchh District, Gujarat. District headquarter is situated at Bhuj. The area is accessible through NH-41 and SH-6. A Key and Location plan can be referred for the same (i.e. Plate-1).The nearest airport from the study area is Bhuj airport which is around 100.17 Km away from the Vayor Block. Nearest Railway station is Naliya which is approx. 21.81 km away from the Vayor Block. An aerial view of study area map of Vayor Block has been also given (i.e. Plate-2).

3.2.3 Climate

The climate is typically arid with negligible rainfall. There is not much of vegetation - cover over greater part of the study area. The low dipping beds form wide outcrop over rather flat terrain permitting collection of larger number of fossiliferous samples. The summer months are not suitable for field work due to extreme temperatures. The period from November to March is most suitable for carrying out systematic field work in this arid region. The temperature in Kachchh District ranges from 44° C higher in the summer and 7° C lowest in the winter. The average temperature during summer is 38° C, while in winter is around 20° C. The average annual rainfall is below 450 mm.

3.2.4 Flora and Fauna

Climate has a direct bearing on the life of this area. Xerophytes dominate over all other plants in this area and are concentrated along topographic lows. The flora is mostly dominated by the thorny bushes of *Acacia nilotica* (Acacia), *Commiphorawightii*(Guggal), *Senegalia catechu* (Khair) and sacculants like *Cactaceae*(Cactus). Major crop of cultivated in the area is *Pennisetumglaucum* (Bajra). Although rain comes after several years, regular cultivation is being carried out in parts of the low areas with the help of ground water.

Common fauna includes desert dweller reptiles which inhabit rocky areas. These are *Uromastyx* (spiny tailed lizards) and *Serpentes*(snakes), *Pseudomysdesertor (*desert rodents), *Oryctolaguscuniculus* (rabbits) and *Erethizontidae* (porcupines). Other animals include*Cervidae* (deer), *Camelus* (camel), *Boselaphustragocamelus* (nilgai), *Bubalusarnee*(Wild Buffalo) and *Susscrofa*(Wild Boar). *Perdixperdix*(Grey Partridges) are common bird in the area.

3.2.5 Drainage

Studying the drainage system is essential for gaining insights into geomorphology and structural fabrics of the area. No perennial river or stream is present in the area. Though, small ephemeral water bodies are found occurring in the relatively low relief areas. The general drainage pattern of the area is characterized by sub-dendritic pattern. No perennial river or water reservoir falls inside the block.

3.2.6 Infrastructure

The local infrastructure, such as bus stop, hotels/restaurants, primary health centers, school, and temples are present within the periphery of 6-10 km from Vayor Block. The Kachchh district covers an area of 45,674 km^2 and population of the district is 20,92,371 as per 2011 census. Padhdhar, Ukir, Karamta are the nearby villages to Vayor Block. This Block is located around 100.84 Km towards west from district headquarters Bhuj and around 401.56 Km from state capital Gandhinagar. Abdasa is around 20.26 Km far from this block. Ultratech Cement Limited is located at around 1.31 Km NE from the block area. Sanghi Industries Ltd. Cement plant is located at about 12.62 km towards NW of the block area.

CHAPTER-4

Previous work

Previously Geological Survey of India had carried out geological mapping on 1:50000 scale, revealing the geological potential limestone in the area. During preliminary field appraisal carried out by CGM Gujarat, a total of 15 grab samples were collected across the broader Vayor Block area, prior to sub-division into Blocks A, B, and C. These samples indicated promising CaO values with average of 43.07%, suggesting potential for cement-grade limestone. Accordingly, the analytical results of these samples are as follows:

Chemical Composition (%)											
Sr. No.	**SiO_2**	**Al_2O_3**	**Fe_2O_3**	**TiO_2**	**CaO**	**MgO**	**Na_2O**	**K_2O**	**P_2O_5**	**SO_3**	**LOI**
1	10.4	2.79	7.50	0.22	43.07%	1.15	0.09	0.32	0.16	0.07	33.62
2	6.1	2.07	10.83	0.18	43.99	0.59	0.07	0.26	0.17	0.09	34.76
3	6.3	1.1	9.35	0.1	47.03	0.51	0	0.19	0.28	0.12	34.03
4	16.71	3.69	9.19	0.38	41.44	0.74	0.12	0.53	0.13	0.07	26.29
5	12.1	3.35	19.02	0.27	35.72	0.87	0.1	0.45	0.37	0	26.82
6	20.58	2.42	9.73	0.3	41.5	0.57	0.11	0.34	0.12	0.07	23.44
7	13.57	4.45	2.44	0.16	41.51	1.15	0.06	0.19	0.08	0.02	36.25
8	9.5	2.15	9.16	0.18	43.3	0.66	0.09	0.22	0.4	0.1	33.37
9	6.95	1.9	8.23	0.17	46.12	0.49	0.08	0.21	0.35	0.09	34.52
10	4.58	1.24	2.16	0.06	50.89	0.62	0.06	0.08	0.03	0.02	40.51
11	14.56	3.54	6.4	0.38	43.27	0.55	0.11	0.57	0.05	0.07	29.89
12	11.43	1.99	2.22	0.1	45.91	0.68	0.05	0.1	0.07	0.02	36.68
13	7.87	3.24	6.5	0.19	34.26	7.42	0.12	0.42	0.05	0.12	39.37
14	11.19	3.36	11.37	0.31	40.57	0.74	0.1	0.48	0.13	0.07	31.18
15	9.84	5.05	3.53	0.32	42.84	0.67	0.12	0.61	0.06	0.05	36.67

During F. S: 1983-84, Shri G. Vijayasarathi & Shri A.B. Sabale, Geologists (Jr.), GSI, had carried out systematic mapping of the toposheets no. 41A/10, 41A/11 and 41A/15 covering an area about 620 sq Km was mapped on 1:50000 scale in the western part of Kutch district comprising of Tertiary rocks.

During F. S: 1984-85, Shri G. Vijayasarathi & Shri A.B. Sabale, Geologists (Jr.), GSI, had carried out systematic mapping of the toposheets no. 41A/11 and 41A/15 covering an area about 434 sq Km was mapped on 1:50000 scale in the western part of Kutch district comprising of Tertiary rocks.

Ultratech Cement's mining lease is located approximately 3.3 kilometers to the east of the proposed Vayor Block. The lease is in active operation and lies within the same geological domain, indicating favorable conditions for limestone mineralization in the region. The presence of this nearby working lease supports the limestone prospectivity of Vayor Block and underlines the geological continuity of the limestone-bearing formations. Combined with grab sample results and regional geology, this provides a strong basis for undertaking G3-stage exploration to assess the potential extension of the limestone deposit within the block.

Details of Aero-geophysical and Geophysical mapping

Systematic regional gravity and magnetic surveys were carried out in toposheet nos. 41A/11 in parts of Abdasa taluka, Kachchh district, Gujarat under National Geophysical Programme (NGPM) of GSI. The Bouguer gravity contour map shows values ranging from +5 mGal to -5 mGal with an overall variation of 10 mGal and the magnetic contour map shows values ranging from +404 nT to -46 nT with an overall variation of 450 nT.

CHAPTER-5

Geology of the area

The Kachchh basin preserves about 2000 to 3000 m thickness of Mesozoic sediments and about 1000 m thickness of Cenozoic sediments (Biswas, 1977, 1982). The Tertiary rocks are exposed along the coastal belt of southern and western Kachchh, bordering the Mesozoic rocks. The Quaternary sediments consist of a wide variety of sediments, ranging from marine to fluvial, laccustrine and aeolian deposits. In the coastal plains the late Quaternary deposits mostly consist of alluvium and calcreted or ferricreted loose sediments, covering the older deposits. The exposed Tertiary sediments are mostly littoral to shallow marine shelf sediments, deposited in the peripheral and intervening structural lows that border the Mesozoic uplift areas.

Mesozoic Stratigraphy: The Mesozoic rocks of Kachchh were first mapped by Wynne (1872), who classified the sequence into the upper and the lower Jurassic groups. Further subdivided, namely, the Pachham, the Chari, the Katrol and the Umia Series. The litho-statigraphic sequence of the mainland is divided into four formations, named as the Jhurio (Jhura), Jumara, Jhuran and Bhuj formations. The major lithological characteristics of these formations is a thick sequence of limestone and shales with bands of 'golden oolites'. The type section occurs in Jhurio hill, in the north-central Mainland. The upper part of the formation is made up of thinly bedded white to cream coloured limestones (pelmicrite and biomicrite), with thin bands of 'golden oolite'. The middle part is composed of thick beds of grey-yellow weathered shales, alternated with thick beds of golden oolitic limestones. The lower part comprises of thin beds of yellow and grey limestones. The formation ranges from Bathonian to lower Callovian. Jumara Formation is thick argillaceous, conformably overlying the Jhurio Formation. The formation is characterized by monotonous olive-grey gypseous laminated shales with thin red ferruginous bands. The Jumara formation ranges age between Callovian and Oxfordian. Jhuran Formation comprises of a thick sequence of alternating beds of sandstones and shales. Bhuj Formation is named after its type locality around Bhuj. This formation is characterized by a huge thickness of non-marine sandstones of uniform character. These rocks occupy about 3/4th of the total area of the Mesozoic outcrop in Mainland Kachchh. ln the south, Deccan Trap rests on the eroded undulating surface of this formation. The sediments represent deltaic deposits with distal part of the large

Cretaceous delta front towards the west and the proximal part to the east in the direction of the land. Lower Cretaceous time range is fixed for this formation. The Deccan Tarps forms a more or less linear outcrop extending across the mainland with a maximum width of about 10 km in the east near the town of Anjar, and gradually tapering westward. Lava flows are dominantly tholeiitic basalts, occupying the southern and southwestern slopes of the central highland.

Tertiary Stratigraphy: Biswas (1974) proposed a revised stratigraphy and established that the Tertiary sediments in Kachchh were deposited on the eroded surface of the Deccan Trap and the Mesozoic sedimentaries. Deposition started with a marine transgression during Lower Eocene and ended in Pliocene. During Paleogene, deposition was restricted to the western part of the Kachchh Mainland, the thickest parts being exposed in the southwestern coastal plain which was the deepest part of the basin. The following is a brief summary of the Tertiary formations as described by Biswas (1974). Madh Series: The type area of the rocks of this series is the well-known village of Matano-Madh in western Kachchh. It consists of volcanoclastic sediments deposited in variable environments, ranging from fluviatile to littoral. Berwali Series: The series is divisible into two stages, the lower consisting of gypseous and ochreous clays and marl containing several varieties of mollusks and foraminifers, and is seen in KakdiNadi section (Kakdi Stage), and the upper stage is well exposed in Babia hill in western Kachchh comprising a fossiliferous fragmental limestone with a basal calcareous clay bed (Babia Stage). Bermati Series: This series forms a well exposed continuous belt south of Abdasa in northwestern Kachchh. It is divisible into two stages; the lower Ramania stage consists of greenish-grey marl and argillaceous limestone with a basal boundary clayey marl bed deposited in an epineritic environment of a slowly regressive sea (Biswas,1974). Khari Series: This series overlies unconformably the Bermoti series and is well exposed in the cliffy banks of the Khari River in southwestern Kachchh. The Khari series is made up of two distinct stages distinguishable. The lower Aida stage is composed of variegated siltstone, the lower 16 m of which is barren, but the upper part contains Lower Burdigalian fossil assemblage. The upper part of the series, the Vinjhan Stage consists of grey to khakhi-coloured gypseous clay with hard marl bands packed with fossils. This stage forms the main bulk of the Lower Miocene of Kachchh. The clays of this stage 16 contain a rich assemblage of Upper Burdingalian fossils. As the Khari series is seen overlapping the Deccan Trap directly, it suggests that

this marine transgression was the most powerful one in the history of the Tertiary sedimentation in Kachchh. Kankawati Series: Well exposed around Kankawati River between Sandhan and Vinjhan, this series consists of grey micaceous and calcareous sandstone, lenticular bands of conglomerate containing abundant foraminifers. Kachchh basin is geotechnically divided into three sub basins, while as per the chronology and lithology there are three groups.

1. Hard rock like limestones, shales, and sandstones of Mesozoic age
2. Volcanisam, limestones and sandstones of Tertiary age
3. Alluvium, coastal plains, river terraces, aeolian pockets, Rann and Banni sediments etc are unconsolidated loose quaternary formation

The regional geology of the area is as follows:

Age	**Formation**	**Litho-units/Rock Type**
Holocene	Rann Formation	Rann clay and deposits
	Jantral Formation	Unstabilized sand sheet and sand dune deposit
Lower Pleistocene	Kothara Formation	Pebbly sandstone, conglomerate gravel and sand
Pliocene	Sandhan Formation	Micaceous sandstone, siltstone, conglomerate and calcareous clay with marl
Lower to Middle Miocene	Gaj Formation	Shale interbedded with fossiliferous limestone and marl
Upper Oligocene to Lower Miocene	Khari Nadi Formation	Variegated siltstone and gyspeous claystone
Middle to Upper Oligocene	Maniyara Fort Formation	Calcareous and gyspseous claystone/siltstone, clay, coral limestone and sandstone
Middle Eocene	Fulra Formation	Foraminiferal limestone, glauconitic shale and clay
Lower Eocene	KakdiNadi Formation	Gypseous, lignite- bearing shale, fossiliferous nodular limestone and clay, ferruginous shale and clay with intercalated marl
Palaeocene	Matanomadh Formation	Laterite, sandstone, conglomerate and bentonitic and kaolinitic clay

Upper Cretaceous to Eocene	Deccan Volacanics	Extrusive	Andesitic trachyte
		Intrusive	Olivine gabbro, basalt, and dolerite dyke
		Extrusive	Basalt flows with intertrappen sediments
Cretaceous	Bhuj Formation		Glauconitic and burrowed sandstone, siltstone, shale, limestone, marl, conglomerate, ironstone and clay with marine and plant fossil
Upper Jurassic to Lower Cretaceous	Katrol Formation		Shale, fossiliferous sandstone, marl and conglomerate
Middle to Upper Jurassic	Chari Formation		Gypseous shale, siltstone and conglomerate with phosphatic nodule, oolitic limestone
Middle Jurassic	Pachchham Formation		Gypseous shale, siltstone, limestone, sandstone and conglomerate

Table: 5-Regional Geology of the Area(Geology and Mineral Resources of Gujarat, Daman and Diu, GSI 2001)

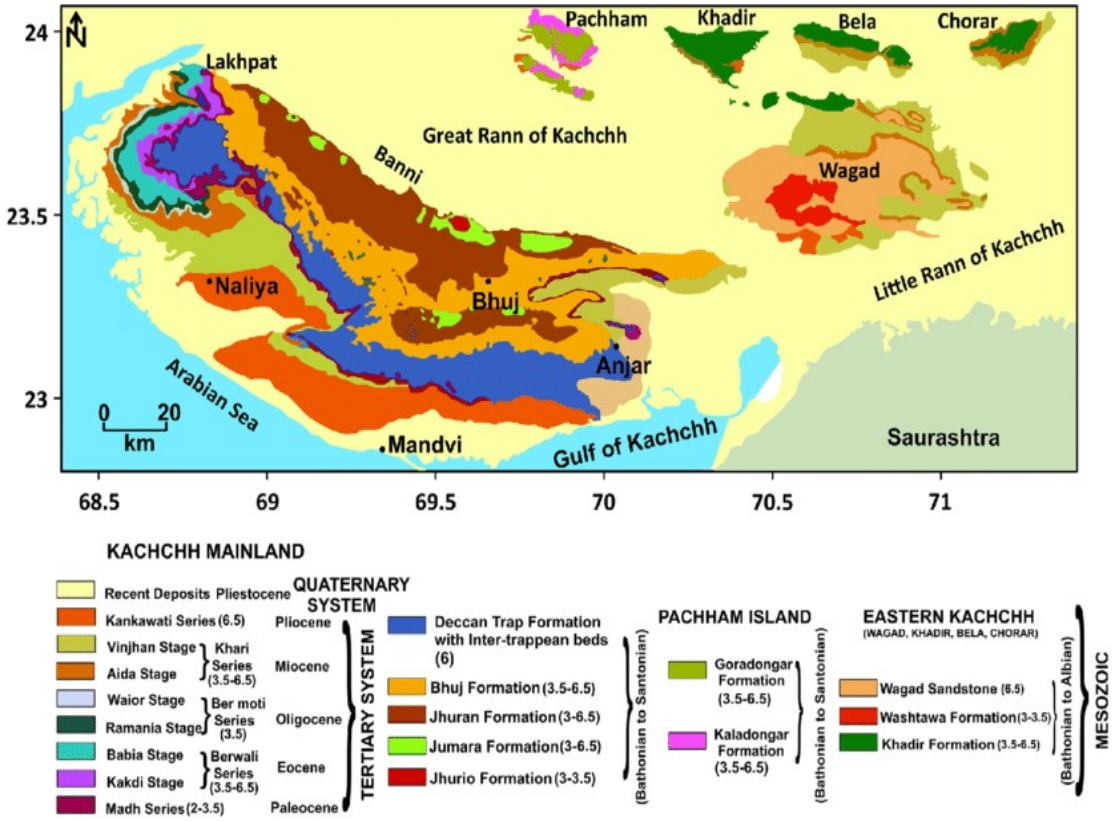


Figure 1(Regional Geological map of the Kachchh Rift Basin after Biswas and Deshpande 1970)

Geology of the Vayor Block

With the help of core-drilling, sampling and data assessment of the Vayor Block local geological successions of the area are given as below:

Age	Formation	Litho-units/Rock Type
Holocene	Recent to Sub-Recent	Brownish top soil with clay
Lower Miocene	Khari Nadi Formation	Variegated fossiliferous clays and few thin impure marl, limestone
Oligocene	Maniyara Fort Formation	Fossiliferous limestone, with intrebeds of marl and calcareous clays

Table: 6-Local Geology of the Study Area

Soil: It is the youngest unit exposed in the Vayor Block, which is brownish to black in colour, with fine to medium grain size. It is composed of calcareous and clayey material with traces of fossils. Soil layer having thickness range from 0.00 m to 2.00 m.

Clay:

Clay encountered in the Vayor Block belongs to the Khari Nadi Formation. The clay exhibits greyish black to bluish grey, yellowish brown and greenish black colors. It is extremely fine grained, soft with slightly calcareous and fossiliferous in nature. Sometimes referred as variegated clay.

Limestone:

The Limestone of Maniyara Fort Formation is encountered in Vayor Block. The Limestone typically exhibits dirty white to greenish-grey color, fine to medium grained, compact, and highly fossiliferous. At some places limestone found in fragmented and in fractured form mixed with clay. Distinct effervescence of CO_2 with dilute HCl indicates its calcareous nature. The thickness of the Limestone varies in different part of the Vayor Block. Limestone encountered in three drilled boreholes in the study area ranging in thickness from 1.52 m to 39.02 m across the boreholes.

Marl:

Marl associated with Limestone encountered in four drilled boreholes in the present study area. It is a non-clastic sedimentary rock composed primarily of fine to medium-grained, greyish-colored calcium carbonate mineral. The thickness of the marl ranges from 3.70 m to 8.94 m across the boreholes within the Vayor Block.

CHAPTER-6

Activity during the period (Geoscience investigation)

6.1 Geological Mapping:

The DGPS survey in Vayor Block was carried out with Triangulation have been laid down during G3 level exploration in the study area with the help of DGPS. Boreholes were fixed on the ground at 800 x 800 m grid interval. The block boundary as provided by the CGM, was surveyed by DGPS and Total Station in WGS-84 Datum. In the DGPS Survey report, the details of location, identification and demarcation of area, methodology of Topographic Survey and methodology adopted for vectorized cadastral map have been provided. DGPS Survey was carried out by two methods: 1) Rapid Static Mode and 2) Real Time Kinematic mode. To carry out this survey Dual Frequency Sokkia (GSX2) DGPS, Total station Theodolite CHCNAV Total Station (CTS-112R4 Make) and Electronic Total Station (ETS) Theodolite equipment's were used in various stage of Topographic survey. After topographic survey, draft drawing was generated at site and a complete topographical representation was drawn with the help of AutoCAD. List of boundary pillar points of the block boundary along with the co-ordinates are given in annexure-6.

Geological mapping was carried out over a total area of 771 hectares/7.71 sq. km, covering Sub-blocks A (189 ha/1.89 sq. km), B (202 ha/2.02 sq.km), and C (380 ha/3.80 sq. km) through systematic traverses. A major portion of the block is covered with soil and alluvium, restricting surface exposures. Limestone exposures were very limited, though a few nala cuttings and isolated hard rock mounds were observed. These limited exposures supported preliminary lithological correlation and provided guidance for borehole positioning.

Fig. 2 Limestone Outcrops of the Vayor Block, Kachchh.

Structure

General structure of the block is deciphered on the exploratory boreholes drilled. The Tertiary rocks of the area are horizontal to sub horizontal and are not affected by any major diastrophic movements within the block. Bedding can be easily identified as compositional and color differences in the Limestone and Clays. No major faults or joints are encountered in the study area.

Metamorphism

No metamorphism has taken place in the proposed block. The stratigraphy encountered in the block is of marine sedimentary origin.

6.2 Mineralogy of the ore zones:

A total of 05 samples have been subjected to megascopic and microscopic study. The results are as below:

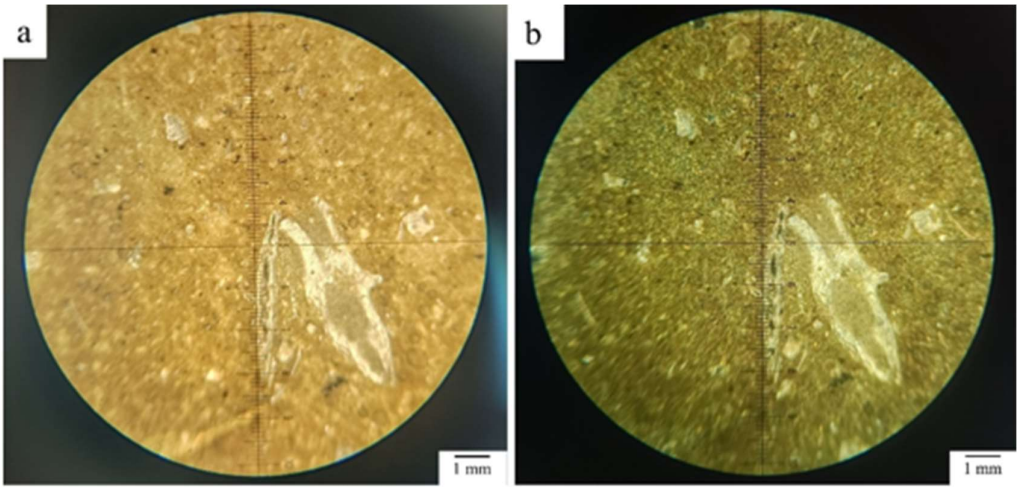
1. **Name of Rock:** Fossiliferous Clay

Megascopic study

The rock is Green, extremely fine-grained, soft with slightly calcareous nature. Fossil fragments may be visible on fresh surfaces.

Microscopic Study

The rock under observation is extremely fine-grained with a yellowish colour in plane-polarized light and dark green to isotropic appearance in cross-polars. Highly fossiliferous with microfossils embedded in a clayey to micritic matrix, indicative of a low-energy marine depositional environment.



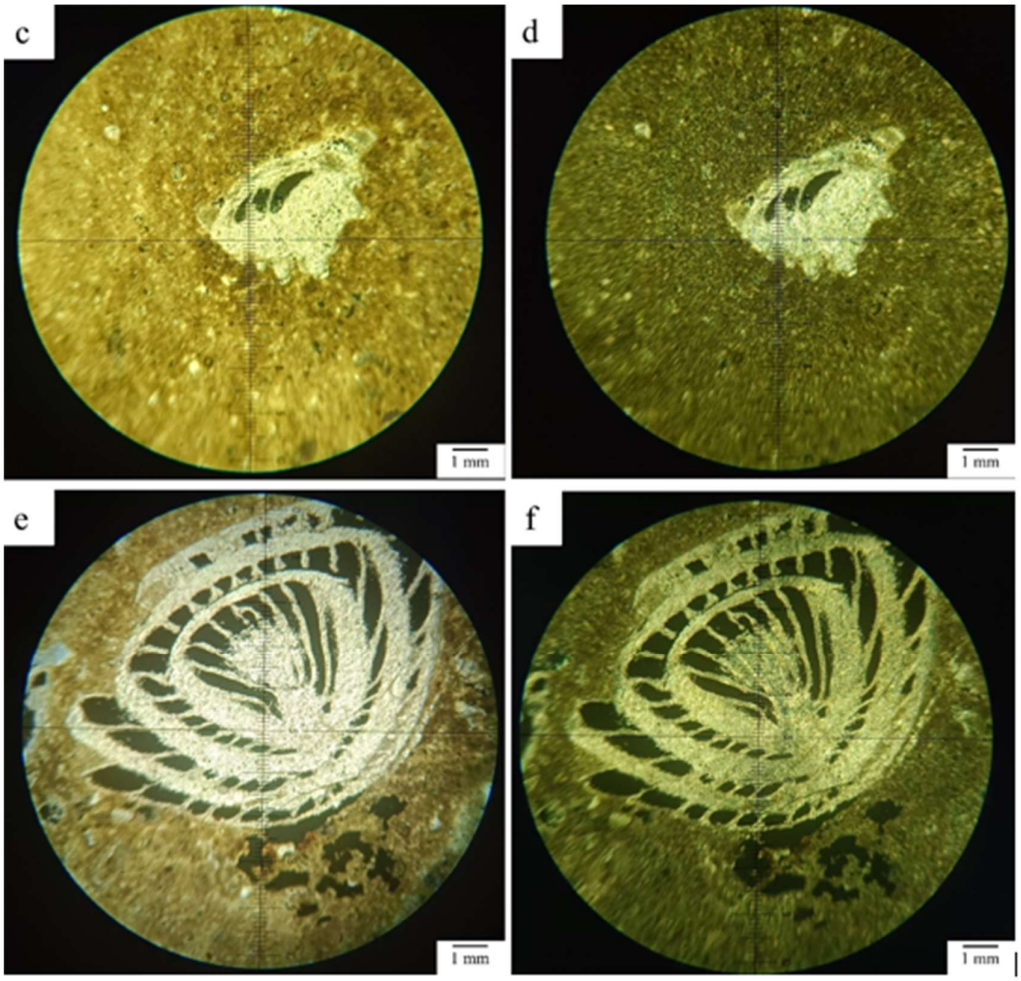


Figure 3: *(a, c, e) Photomicrograph of Fossiliferous Clay (ppl) and Photomicrograph of Fossiliferous Clay (b, d, f) in (xpl)*

2. Name of Rock: Argillaceous Limestone

Megascopic study

The rock is Light green in colour, fine-grained, compact, and highly fossiliferous. Distinct effervesces of CO_2 with dilute HCl indicates its calcareous nature. Minute fossil shells of bivalves and others. Displays solution cavities on the surface.

Microscopic Study

The rock under observation is composed of fine-grained micritic matrix with abundant fossil fragments, including bivalves and bryozoans. Presence of quartz grains and solution features suggest diagenetic modification. Texture is non-clastic - homogenous and fine-grained, confirming the argillaceous nature of the limestone.

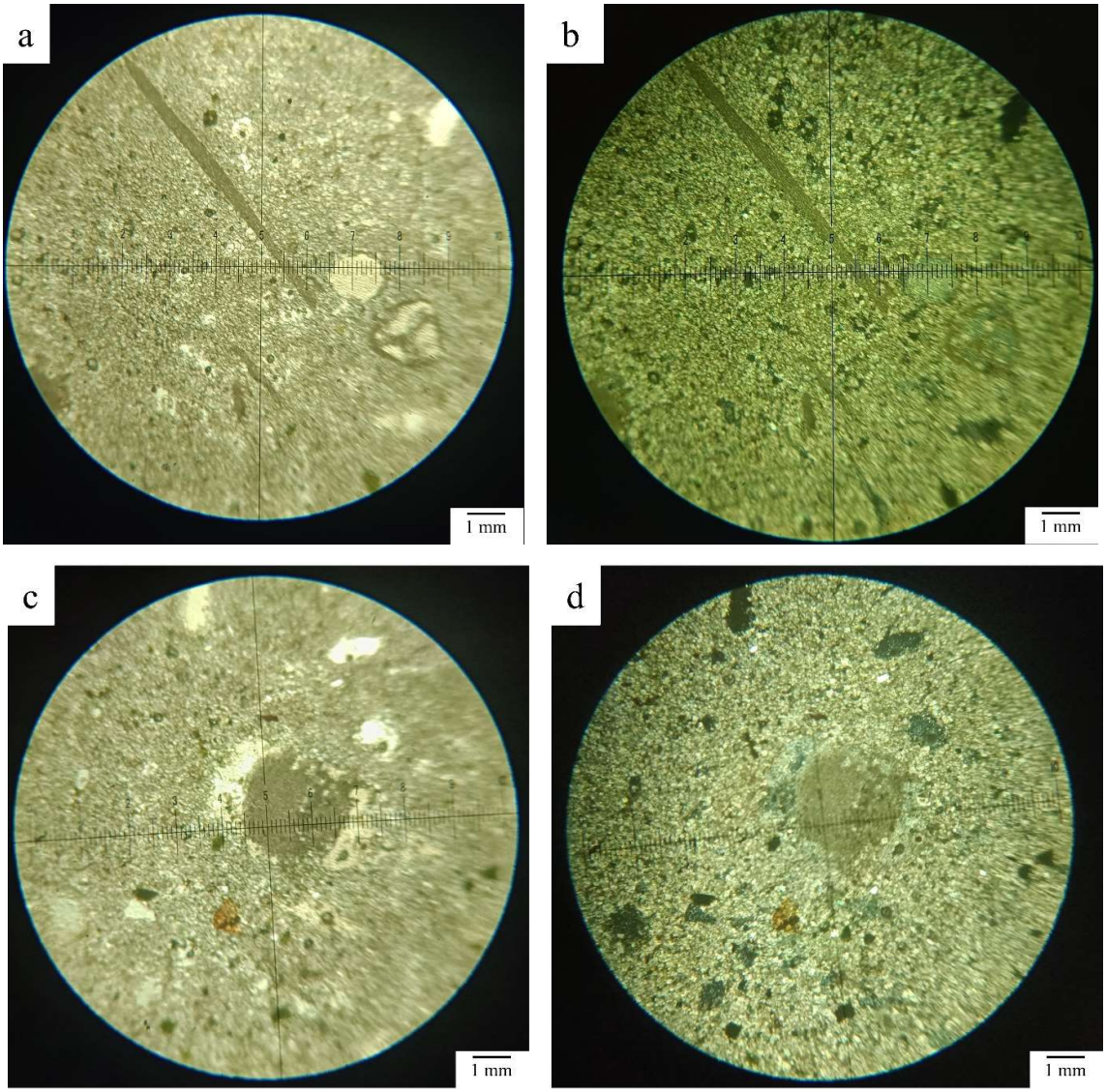


Figure 4. (a, c) *Photomicrograph of Argillaceous Limestone* (ppl) and (b, d) *Photomicrograph of Argillaceous Limestone (xpl)*

3. Name of Rock: Bio-Micrite

Megascopic study

The rock is greyish in colour with a medium grain texture. Distinct effervesces of CO_2 with dilute HCl indicates its calcareous nature. Fossils are visible as small fragments of bivalves and imprints.

Microscopic Study

The rock under observation is calcareous matrix dominated by fine grains of calcite - micrite. Numerous fossils of bivalves, bryozoa, and foraminifera are present, indicative of a biologically rich shallow marine environment. Texture is non-clastic with a high fossil content.

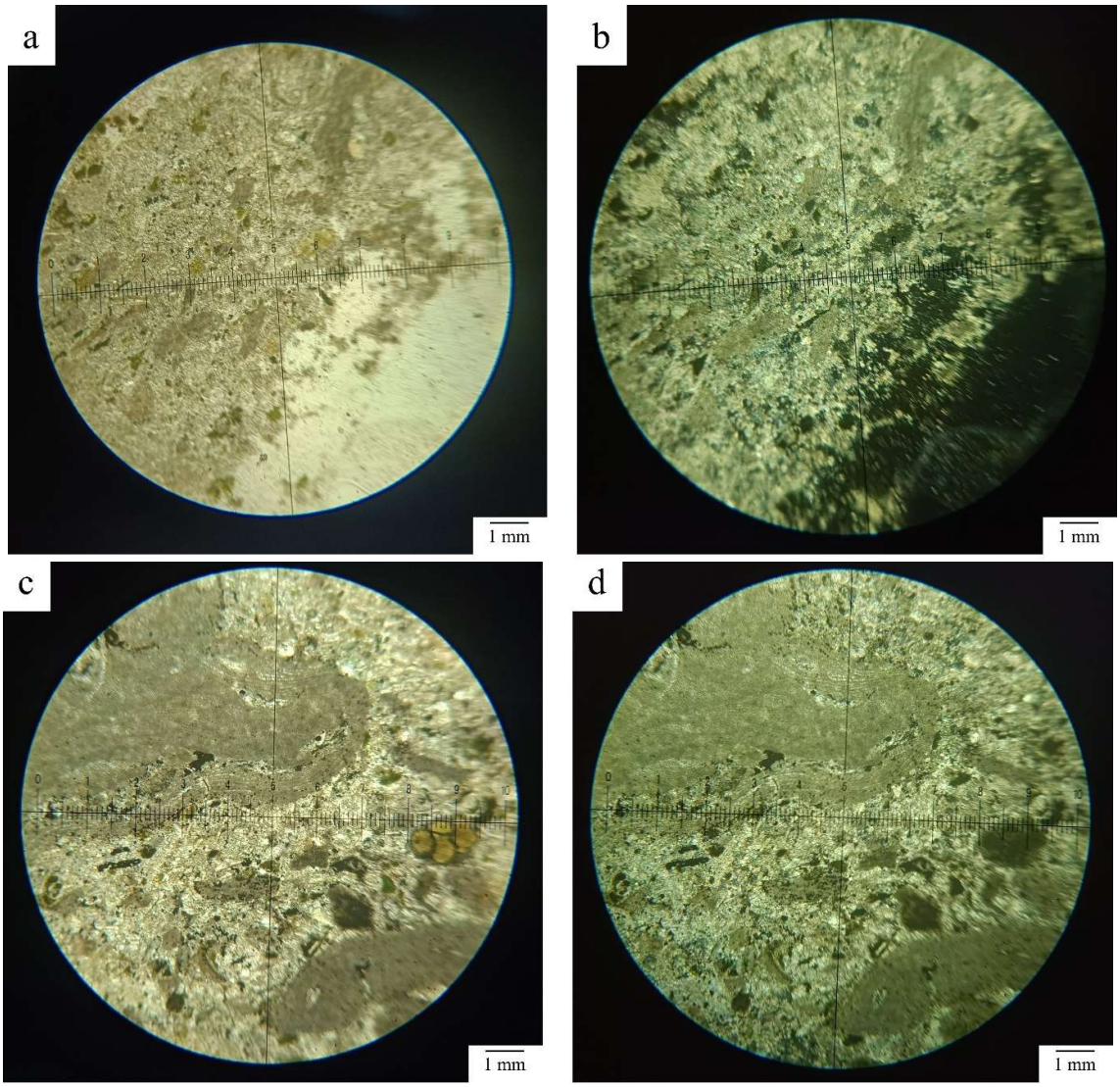


Figure 5. (a, c) *Photomicrograph of Biomicrite (ppl) and (b, d) Photomicrograph of Biomicrite (xpl)*

4. Name of Rock: Argillaceous Limestone

Megascopic study

The rock is yellow in colour, fine-grained, compact, and hard. Effervesces of CO_2 with dilute HCl indicates its calcareous nature. Contains visible fossils, especially of gastropods.

Microscopic Study

The rock under observation is Non-clastic, extremely fine-grained micritic matrix of calcite with embedded fossils, primarily gastropods. In plane-polarized light, appears yellowish to brownish (suggesting slight ferruginous nature), which remains isotropic in cross-polarized light.

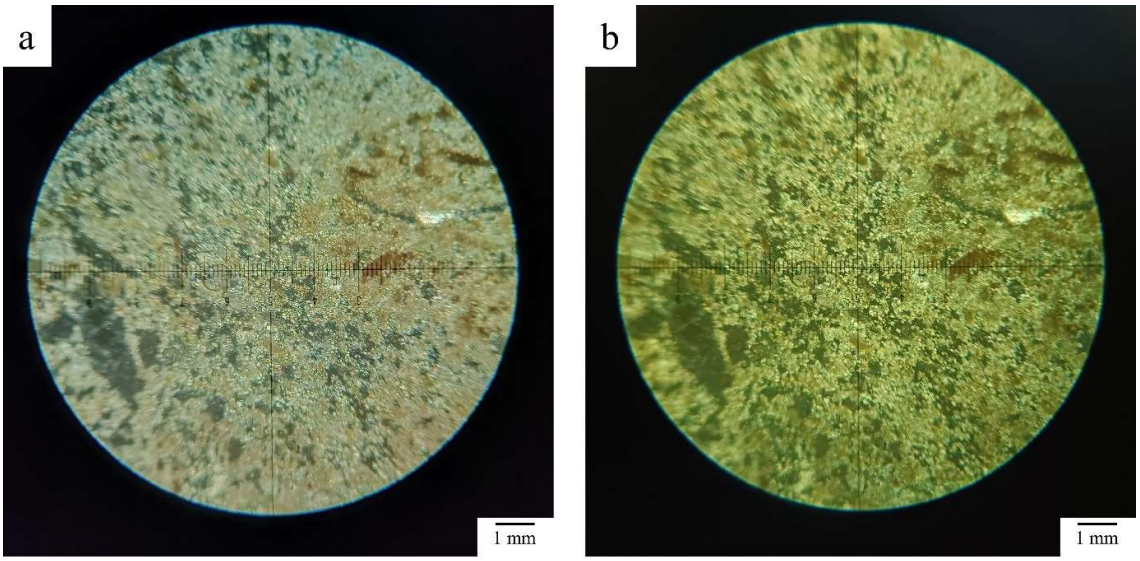


Figure 6. (a) *Photomicrograph of Argillaceous Limestone* (ppl) and (b) *Photomicrograph of Argillaceous Limestone (xpl)*

5. Name of Rock: Bio-Micrite

Megascopic study

The rock is Yellow in colour, medium-grained, highly fossiliferous. Distinct effervesces of CO2 with dilute HCl indicates its calcareous nature. Displays compact structure with visible shell fragments.

Microscopic Study

The rock under observation is onsists of microcrystalline calcite (micrite) with numerous embedded fossils including foraminifera, bryozoa, and gastropods. Some quartz grains present, generally sub-angular, floating in the calcareous matrix. Overall, the rock is well-cemented and biologically rich.

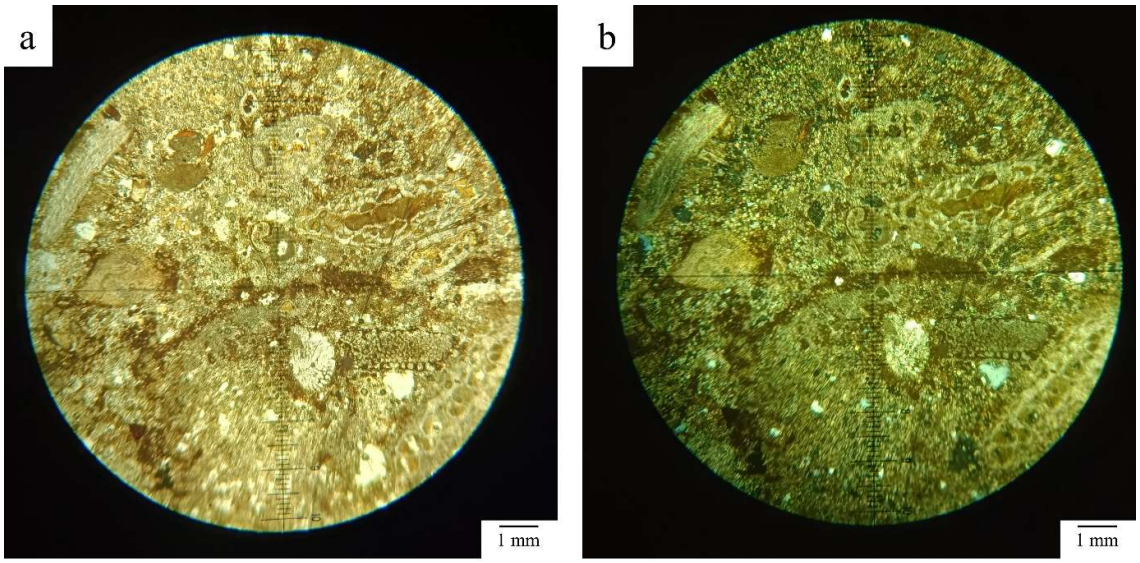


Figure 7. (a) *Photomicrograph of Biomicrite (ppl) and (b) Photomicrograph of Biomicrite (xpl)*

6.3 Sampling:

The selected recovered core was arranged properly in core boxes of 1 m long with 5 riffles covered with lid. Each run was marked properly by plastic tag and the core boxes were numbered properly.

Then core containing mineral was cut vertically from the centre with the help of core splitter dividing it into two equal halves. One half of core was kept aside for preservation purpose and other half was crushed upto desired mesh size of 200 mesh. Then coning and quartering was done for representative sample. Sampling was done to understand the quality of Limestone encountered in boreholes.

Samples were collected during this exploratory drilling programme and sent to Petrography and Mineral Chemistry Lab, Gandhinagar for chemical analyses.

Details of interpreted ore zones based on geological investigation

The delineation of Limestone-bearing zones within Vayor Block is based on the results of systematic core drilling and geological logging. A total of three boreholes were drilled on a 800 × 800 meters grid, generating lithological logs and chemical analysis data, which were used to identify the depth, thickness, and grade variation of the Limestone. Based on these subsurface investigations, Limestone was encountered, varying in thickness, often intercalated with clay or marl layers. The interpretation of ore zones was guided by lithological continuity, core recovery, and CaO/MgO content, which together help assess the prospectivity and economic potential of the limestone within the block.

Geophysical exploration

The ground Geophysical exploration was not carried out during the G3 stage of exploration at Vayor Block.

Geochemical exploration

Geochemical exploration was not carried out during the G3 stage of exploration at Vayor Block.

CHAPTER-7

Integration of Geology, Geo physics and Geochemical exploration and interpretation

The investigation here was conducted at the G3 stage, and since it involves limestone- a bedded deposit, no geophysical components were planned. Since the area exhibits bedded deposits of regular habit type of deposit, such type of integration and interpretation work is not significant.

CHAPTER-8

Mineral Prospect

Kachchh is a mineral rich region with very large reserves of Lignite, Bauxite, Gypsum, Limestone, and Bentonite. Kachchh district is one of the preferred destinations for most of the mineral based industries and other minerals.

As per the regional geology of the area, the formations are non-deformed and sedimentary formations of each period from Mesozoic rest unconformable over the previous one. This shows the periodic invasion and regression of sea. The surface of the study area is covered by the recent sediments which is underlain by the Oligocene-Miocene deposits.

Limestone is a sedimentary rock composed primarily of calcium carbonate ($CaCO_3$) in the form of mineral calcite. It most commonly forms in clear, warm, shallow marine waters. It is usually an organic sedimentary rock that forms from the accumulation of shell, coral, algal, and fecal debris. It can also be a chemical sedimentary rock formed by the precipitation of calcium carbonate from lake or ocean water. The Limestone encountered in the block belongs to Maniyara Fort Formation.

The Maniyara Fort Formation in Kachchh, India, is an Oligocene-aged sedimentary formation known for its carbonate deposits, specifically limestone, and is part of the Cenozoic sequence in the Kachchh Basin. It overlies the Fulra Limestone Formation and is overlain by the Khari Nadi Formation. The formation is characterized by different members, including the Lumpy Clay Member, Coral Limestone Member, and Bermoti Member. Along with Limestone, Marl is encountered at places. Marl is an impure low grade Limestone. It is defined as a lime-rich mud that contains variable amounts of clays and silt. The proportion of CaO is lower than that of Limestone.

Due to wide reserves of Limestone, major cement plants like Sanghi Cement, Ultratech Cement, JP Cement, Reliance ADG Cement etc. have started in Kachchh. Sanghi Cement plant with a capacity of 4.1 million tonnes per annum located in Kachchh is one of the largest single location cement plant in India.

The exploration on G3 stage within the block has exhibited promising deposit of limestone mineral with high CaO values. This will further cater the need to fulfill the demand of Limestone in cement industries, which will generate more revenue for the State.

CHAPTER-9

Subsurface Exploration (Drilling)

9.1 Spacing of the Boreholes:

A G-3 stage exploration was carried out in this block and as per guideline of MEMC rule, 2015 and its amendments, the spacing between two boreholes in case of bedded stratiform and tabular deposits of regular habit is 800 mts x 800 mts. Accordingly M/s Vinayak Engimech Private Limited have planned and carried out drilling through 10 nos. of exploratory boreholes at a grid interval of 800 mts x 800 mts in this block with a cumulative meterage of 310.00 meters.

Sr. No.	BH ID	R.L. (m)	DMS (WGS 84)		UTM (Universe Transverse Mercator)	
			Latitude	Longitude	Easting	Northing
Vayor Sub Block-A						
1	VABH-1	40.00	23°25'55.40"N	68°41'15.00"E	468077.25	2591384.11
2	VABH-2	44.00	23°25'37.10"N	68°41'34.50"E	468629.38	2590820.16
3	VABH-3	36.00	23°25'21.60"N	68°41'17.00"E	468131.75	2590344.57
Vayor Sub Block-B						
4	VBBH-2	41.00	23°25'42.10"N	68°40'56.10"E	467540.04	2590976.28
5	VBBH-5	44.00	23°24'55.90"N	68°41'01.60"E	467693.00	2589555.20
6	VBBH-7	28.00	23°24'43.80"N	68°41'15.60"E	468089.50	2589182.24
Vayor Sub Block-C						
7	VCBH-1	48.00	23°24'23.00"N	68°40'18.90"E	466478.89	2588546.17
8	VCBH-2	31.00	23°24'05.00"N	68°40'34.40"E	466917.56	2587991.64
9	VCBH-3	43.00	23°23'46.80"N	68°40'58.30"E	467594.67	2587430.45
10	VCBH-4	44.00	23°23'25.40"N	68°40'41.00"E	467102.17	2586773.45
The boreholes of Vayor Sub-blocks A, B, and C was established using DGPS survey in WGS-84 datum. Dual frequency DGPS (Rapid Static and RTK modes) was employed for accurate latitude and longitude determination, verified with Total Station, and matched with cadastral maps for accuracy.						

Table: 7 Coordinates of drilled boreholes of Vayor Block

9.2 Methodology of drilling with details of type of drilling:

Drilling technique and drill sampling employed:

i) Drill type (eg. core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc.) and details (eg. core diameter, triple or standard tube)

Core drilling was carried out by GMRDS through M/s Vinayak Engimech Private Limited. Drilling in the Vayor Block was carried out during November 2024 by deploying hydraulic core drill rigs using NQ diamond bits with core diameter of 47.6 mm. Double tube core barrels were used to obtain maximum core recovery.

ii) Whether core and chip sample recoveries have been properly recorded and results assessed

Core recovery of every run of drilling for all the drilled boreholes was recorded properly. The core recovery of the boreholes drilled for limestone and marl in the area is varying from 87.67% to 94.94% and is considered to be well within acceptable limit for resource/reserve estimation purposes. There is minimal core loss due to washing of clay intercalations, loose and fractured formation etc.

iii) Measures taken to maximize sample recovery and ensure representative nature of samples.

In order to maximize the core recovery, the rate of penetration, bit pressure and speed of rotation was controlled while drilling and more significantly in the fractured/loose formation and at depth. Sufficient numbers of core barrels were maintained at site and were regularly checked for any undue bends.

iv) Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material

The core recovery in Limestone and Marl is 87.67% to 94.94% hence grade analyzed for limestone is reliable.

v) Logging: Whether core and chip samples have been logged to a level of detail to support appropriate Mineral Resources estimation, mining studies and metallurgical studies

The entire core recovered by drilling was logged systematically in detail describing lithological units that can be observed by visual inspection. The details of lithology, grain size, colour, texture, structural features, presence of intercalations and cavities have been recorded. Wherever the recovery is less, 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 PVC core boxes of specifications given by NMET following "Book Pattern". The core logging has well correlated with the chemical analysis of individual samples and will support the mineral resource estimation and mining studies.

vi) Discussion on the analysis results of handheld X-ray fluorescence (XRF), if used in the investigation

Handheld X-ray fluorescence (XRF) was not used by GMRDS for analysis during investigation.

9.3 Methodology of core zone sampling and sample preparation:

i) If core, whether cut or sawn and whether quarter, half or all core taken

The cores recovered from the boreholes after logging were split longitudinally into two halves by core splitter. One half of the split core was kept in the core box while the other half was subjected to sampling.

ii)

a) If non-core, whether riffled, tube sampled, rotary split etc. and whether sampled wet or dry

Only core samples were collected from the boreholes drilled in the area during exploration.

b) For all sample types, the nature, quality and appropriateness of the sample preparation technique

For sampling the ore zone, the drilled cores were logged, sample numbers were marked and then split longitudinally to equal halves. One half was kept for core repository. The other half of the split cores was crushed to 200-mesh size. The weight of the crushed core samples varied from 2 to 4 kg depending upon the sample length and recovery. After coning and quartering of the crushed 200-mesh size fraction, individual samples of about 500 gm samples each were sent to Petrography and Mineral Chemistry Laboratory, CGM, Gandhinagar for further processing and chemical analysis.

iii) Quality control procedures adopted for all sub-sampling stages to maximize representation of samples

Before and after preparation of each sample, the crusher, pulverizer, pestle & mortar, sieves and sample trays were properly cleaned to avoid intermixing of samples. The

samples were packed properly to avoid entry of any foreign material as well as moisture. The samples were properly labeled for easy identification.

iv) Measures taken to ensure that the sampling is representative of the in-situ material collected

Prior to drilling, each borehole was given a unique label for easy identification. The core retrieved from the drill holes was stored in PVC core boxes. For easy identification and traceability, the core was preserved from the left to the right side of the box with increasing depth and the core was marked with an arrow giving down the hole direction. Separator plates were inserted at the end of each run. The length of the borehole at the end of each run was also marked on the inserted separator plates. Loose soil /sludge collected in the course of drilling was packed in polythene, properly marked and kept at their respective depth. The core boxes were marked properly on the top, inner side of the lid and the front side giving details like, drill hole number, box number, indicating meterage i.e. From.....m to ....m. The core boxes were properly preserved and stored for protection from inclement weather and any other damage. The above procedures ensure the representation of the material collected at each place in the area in terms of its location, depth and litho-unit sample.

v) Whether sample sizes are appropriate to the grain size of the material being sampled

The individual core samples were formulated for a linear length of 0.31 to 5.20 m. Each sample was subjected to crushing, coning and quartering by applying the standard method of size and weight reduction. The crushed sample was finally pulverized to 200-mesh size to prepare sample pellets. The pellets were then used in XRF for chemical analysis.

Since entire mineralized area has been sampled and analyzed and in view of the homogenous quality of the limestone the sample size is appropriate to the grain size.

9.4 Chemical analysis and Laboratory procedure:

a) The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total

The cores recovered from the boreholes after logging were split longitudinally into two halves. One half of the split core was kept in the core box while the other half was subjected to sampling. Sampling intervals were marked after identifying the different litho-units in the process of core logging.

The individual core samples were formulated for a varied linear length of 0.31 to 7.00 m. The sample length varied depending upon the change in lithology or physical appearance.

A total of 170 nos. of core samples were analyzed for major and minor oxides i.e. LOI, SiO_2, Al_2O_3, Fe_2O_3, CaO, MgO, Na_2O, K_2O, TiO_2 and SO_3.

b) Nature of quality control procedures adopted (e.g. standard, blanks, duplicates, external laboratory checks) and whether acceptable level of accuracy (i.e. lack of bias) and precision has been established

The samples have been analyzed in the laboratory by wet chemical and instrumental method following standard procedures.

c) Check analysis of at least 10% of samples may be analyzed from third party National Accreditation Board for Testing and Calibration Laboratories (NABL) accredited or Department of Science and Technology (DST) or Bureau of Indian Standards (BIS) recognized laboratories or government laboratories for assessing the acceptable level of accuracy.

The check analysis of 17 samples have been analyzed from NABL approved laboratory LUCID Laboratories Pvt. Ltd., Hyderabad. The analysis has been attached as Annexure-7.

Moisture

Whether the tonnages are estimated on a dry basis or with natural moisture and the method of determination of moisture content whether assumed or determined. If assumed, the basis for the assumptions. If determined, the method used, whether wet or dry, the frequency of measurements, the nature, size and representativeness of the samples

The laboratory tests are also carried out for specific gravity measurements on limited number of core samples on air dried basis. The specific gravity for Limestone varies from 2.66 to 2.71. The specific gravity of 2.69 are considered for estimation of resources of cement grade limestone. The specific gravity of 2.69 is considered for estimation of resources of Marl.

CHAPTER-10

Geotechnical studies on borehole core samples of mineralized zone, hanging wall and foot wall side

The Geological mapping and exploration result are indicating hard surficial Limestone deposit from depth of 48 to 100 meters across boreholes and as such the mining activity involved will be an open cast mining method and such type of studies are not required in this block.

CHAPTER-11

Resource Estimation

Based on exploration data, resource estimation was done for Limestone. Based on analysis result of CaO % and MgO %, Limestone is categorized as Cement Grade Limestone.

Grades and Resource have been assessed on the basis of end-use grade classification given by IBM's National Mineral Inventory (NMI) and Threshold value of minerals, Indian Mineral yearbook 2022, Volume – III Mineral Reviews – Limestone and Other Calcareous minerals, , IBMS, Ministry of Mines, Govt. Of India, October 2024 in following categories:

Table: 8: Specifications of Limestone grades by IBM

Grade	CaO %	MgO % (Max)	Fe_2O_3 % (Max)
Chemical	> 52	–	≤ 0.25
Limestone [Cement Grade (blendable/beneficiable, portland)]	34-52	≤ 5.00	–
Marl	20-34	–	–

The following parameters and assumptions have been taken into consideration for resource estimation: -

1. In each borehole area of influence has been considered for resource calculation, as the mineral deposit is of regular habit.
2. Tonnage is estimated on dry basis, after removing moisture content. If sludge chemical analysis results show promising lithology then sludge analysis lithology calculated for resource estimation.
3. Average cumulative thickness is taken for each borehole fall under different category regions, i.e., G3.
4. As per MEMC guidelines for the deposits of Regular habit, the area covered by wide spaced bore holes with bore holes spacing is 800 m are marked for G3 category resource.

5. Specific Gravity has been estimated grade wise and average specific gravity for Limestone [Cement Grade (blendable/beneficiable, portland)] is 2.69 and for Marl it is 2.69 in Vayor Block.
6. Recovery loss has not been considered.
7. Total resources estimated here are insitu resources.
8. Clay part intersected in between the Limestone [Cement Grade (blendable/beneficiable, portland)] were not considered for resource estimation, for calculating average thickness and for estimating average grade of mineralized zone.
9. No cut off was fixed for thickness for delineation of mineralized zone Cement Grade Limestone.
10. To separate out different grades of Limestone and Marl, CaO % &MgO % values has been considered.

The method of chemical analysis of samples and elements to be analyzed were decided by the state government and analysis results were given by State government which is accepted for the estimation of average grade of Limestone.

Resource estimation has been done by using an Arc GIS Software. Area of influence of each borehole is estimated by considering the multiplication of length and width of rectangle covered by the borehole of Limestone [Cement Grade (blendable/beneficiable, portland)] specific gravity etc. and the classification of the estimated resource was done as per MEMC guidelines. The length, width and thickness of Cement Grade Limestone and Marl is considered in meters. The total area covered under the Vayor Block is 771 hectares/7.71 sq. km, which comprises three non-contiguous sub-blocks: Sub-block A (189 ha/1.89 sq. km) Sub-block B (202 ha/2.02 sq.km) and Sub-block C (380 ha/3.80 sq. km). The various terms expressed for computation of resource are mentioned in short term as below:

L x W (or A) x Th x Sp. Gr. = R

Where;

L	= Length in m	Sp. Gr.	=Specific Gravity
W	= Width (in m)	R	=Resources in Tonnes
A	= Area in m^2	Th	=Thickness (in m)

Average grade of Limestone i.e. Cement Grade (blendable/beneficiable, portland) was calculated. In this method the average value of thickness of each grade, CaO% and MgO% values were taken borehole wise. Then average value of these previously taken values was calculated for average grade of cement grade Limestone and Marl.

11.1 Reporting of resources:

The resources have been categorized under Inferred Mineral Resource (333) category considering the drilling grid of boreholes drilled in the area.

The summary of total litho-unit zone wise in-situ resource across the three sub-blocks of the Vayor Block under various categories as per Minerals (Evidence of Mineral Contents) Rules 2015 and its amendments is presented in Table 9:

Litho-Unit	Sub-block	In-situ Resources at G3 (million tonnes) – UNFC 333
Cement Grade Limestone	Sub-block A	0.00
	Sub-block B	61.28
	Sub-block C	4.11
	Total	**65.39**
Marl	Sub-block A	0.00
	Sub-block B	21.56
	Sub-block C	21.84
	Total	**43.40**

Table: 9-In-situ resources of Vayor Block, Kachchh

The resource estimation has been carried out for the entire Vayor Block (comprising Sub-blocks A, B, and C). Each sub-block has been explored and resource estimation performed accordingly, using Thiessen polygon method and vertical interval segmentation (0–20 m, 20–40 m, and 40+ m). The resources are reported under the Inferred Category (UNFC 333) as per MEMC Rules 2015 and its amendments.

The total estimated resources of Limestone and Marl across the three sub-blocks of the Vayor Block subdivided into depth intervals are provided below:

Depth Interval (m)	Mineral	Resources (million tonnes)
0-20	Cement Grade Limestone	4.11
20-40	Cement Grade Limestone	–
40 +	Cement Grade Limestone	61.28
Total		**65.39**
0-20	Marl	21.84
20-40	Marl	–
40 +	Marl	21.56
Total		**43.40**

Table 10: Depth Interval-wise Mineral Resource Estimation for Limestone and Marl

The average quality of individual litho-unit zone is given in Table 11:

Litho-Unit	Chemical Composition (%)											
	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	P_2O_5	MnO	SO_3	LOI
Cement Grade Limestone	5.28	1.88	4.55	0.33	47.15	2.08	0.48	0.24	0.03	0.05	0.58	37.01
Marl	19.89	6.03	10.98	0.85	29.12	4.39	1.19	1.03	0.08	0.12	1.17	24.45

Table: 11-Average quality of individual litho-unit zone

The block-wise estimation of in-situ resources for Cement Grade Limestone and Marl has been carried out separately for Sub-blocks A, B, and C of the Vayor Block. The following tables present the depth-wise classification of resources for each sub-block under the Inferred Mineral Resource category (UNFC 333):

Mineral Resource Estimation for Vayor Sub-block A at G3		
Depth Interval (m)	**Mineral**	**Resources (million tonnes)**
0-20	Cement Grade Limestone	–
20-40	Cement Grade Limestone	–
40 +	Cement Grade Limestone	–
Total		–
0-20	Marl	–
20-40	Marl	–
40 +	Marl	–
Total		–

Table 12: Depth Interval-wise Mineral Resource Estimation for Vayor Sub-block A

Mineral Resource Estimation for Vayor Sub-block B at G3		
Depth Interval (m)	**Mineral**	**Resources (million tonnes)**
0-20	Cement Grade Limestone	–
20-40	Cement Grade Limestone	–
40 +	Cement Grade Limestone	61.28
Total		**61.28**
0-20	Marl	–
20-40	Marl	–
40 +	Marl	21.56
Total		**21.56**

Table 13: Depth Interval-wise Mineral Resource Estimation for Vayor Sub-block B

Mineral Resource Estimation for Vayor Sub-block C at G3		
Depth Interval (m)	**Mineral**	**Resources (million tonnes)**
0-20	Cement Grade Limestone	4.11
20-40	Cement Grade Limestone	–
40 +	Cement Grade Limestone	–
Total		**4.11**
0-20	Marl	21.84
20-40	Marl	–
40 +	Marl	–
Total		**21.84**

Table 14: Depth Interval-wise Mineral Resource Estimation for Vayor Sub-block C

The detail of litho-unit zone wise and level wise insitu resources is enclosed as Annexure-1. The resource discussed above, portrays an overall picture of the available resources within the block area and does not entail the mineability of the deposit. Following observations could be drawn from the In-situ resources discussed above.

A total of 65.39 million tonnes in-situ resource of cement grade Limestone and 43.40 million tonnes in-situ resource of Marl is available within Vayor Block area under 333 category of UNFC G3 stage.

Interpretation of Isopach map: Limestone

The isopach map of Cement Grade Limestone in the Vayor Block reveals significant spatial variation in Limestone thickness. The maximum thickness of 39.02 meters is recorded at borehole VBBH-7, located in the southeastern part of sub-block B, indicating a well-developed mineralized zone. A moderate Limestone thickness of 5.48 meters is observed at VBBH-5, situated central part of sub-block B, suggesting a thinning trend toward that direction. Marginal development of Limestone is seen in VCBH-2 (1.52 m), located in Sub-block C, indicating localized mineralization. All other boreholes show no Limestone development, particularly in Sub-blocks A and C. This pattern suggests the cement-grade limestone is localized primarily in Sub-block B, with rapid thinning toward the central areas and a thin patch developed in sub-block C.

Interpretation of Isopach map: Marl

The isopach map of Marl indicates a moderately distributed zone of Marl mineralization in parts of the Vayor Block. The maximum thickness of 8.94 meters is found at borehole VBBH-7, located in Sub-block B, while borehole VBBH-5 in the north-central part of the block shows a Marl thickness of 4.62 meters, indicating a reasonably developed marl zone around the central and southern part of sub-block B. In sub-block C, Marl is present in VCBH-2 (3.7 m) and VCBH-3 (4.05 m), pointing to scattered development. The rest of the boreholes, including all of Sub-block A and VCBH-1 & VCBH-4 in Sub-block C, do not record any Marl thickness. This spatial pattern suggests Marl deposition is moderate but discontinuous, with better development around borehole VBBH-7 and parts of Sub-block C, showing a gradual increase general trend towards southeast direction

CHAPTER-12

Core preservation

After completion of the drilling work, core boxes were carefully shifted to Vayor camp where sampling was carried out. Half-splitted cores were taken for sampling purpose and remaining half cores were stored in core boxes. On completion of all the field investigation, the core boxes were handed over in safe custody of Senior Geologist, Kachchh.

CHAPTER-13

Conclusion and recommendation

The current exploration was taken up to access the Limestone resources in the Vayor block considering the industrial needs for Limestone. The investigation has provided valuable insights into its geological characteristics, quality and potential resource in the block. The comprehensive analysis revealed that Vayor Block Limestone exhibits desirable physical and chemical properties, including high calcium carbonate content and low impurities, which make it a viable material for various industrial applications, particularly in cement production, construction, and the manufacture of lime.

Exploration was carried out over three sub-blocks (A, B, and C), covering a cumulative area of 771 hectares/7.71 sq. km. A total of 10 boreholes were drilled across the block on an 800 m × 800 m grid, with a cumulative meterage of 310.00 meters. A comprehensive chemical analysis was performed on 170 core samples and 17 check samples to evaluate the grade characteristics of the mineralized zones. Additionally, five petrographic samples were examined to support lithological interpretation and mineral characterization. Based on the analytical results and current industrial demand, the Limestone resources have been classified into Limestone [Cement Grade (blendable/beneficiable, portland)] and Marl above threshold/low-grade limestone.

The Vayor Block has been explored at a wide 800 m × 800 m grid, and the depth variation and lateral continuity of mineralized zones remain to be confirmed.

In consideration of nature of occurrence of Limestone the Vayor Block can be categorized as "Bedded Stratiform and Tabular deposit of regular habit as Minerals (Evidence of Mineral Contents) Rules 2015 and its amendments.

A total of 65.39 million tonnes of Cement Grade Limestone with average CaO 46.91% and 43.40 million tonnes of Marl with average CaO 27.71% have been estimated in the Vayor Block under the UNFC 333 category. These results indicate significant potential for further exploration and eventual exploitation, subject to confirmation through detailed studies in subsequent phases.

The sub-block wise breakup of these resources is as follows:
Sub-block A: Exploration did not establish any Cement Grade Limestone or Marl resource
Sub-block B: 61.28 million tonnes of Cement Grade Limestone and 21.56 million tonnes of Marl. Sub-block C: 4.11 million tonnes of Cement Grade Limestone and 21.84 million tonnes of Marl.

In view of the above, the block is recommended for further auction process.

CHAPTER-14
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CHAPER-15

Locality Index

Name of village	Latitude	Longitude
Vayor	23°25'3.85"N	68°41'48.24"E
Vagoth	23°24'2.46"N	68°41'30.59"E
Karamta	23°23'9.28"N	68°40'2.56"E
Ukir	23°22'22.54"N	68°42'7.52"E
Kharai	23°27'3.19"N	68°41'6.74"E
Pakho	23°26'19.42"N	68°38'41.89"E
Sarangvado	23°26'30.65"N	68°43'1.13"E

Table: 15-Locality index

ABBREVIATIONS USED

SL. No.	Abbreviation	Full form
1	CGM	Commissioner of Geology and Mining
2	GSI	Geological Survey of India
3	GMRDS	Gujarat Mineral Research & Development Society
4	F.S.	Field Season
5	NMET	National Mineral Exploration Trust
6	TCC	Technical cum Cost Committee
7	EC	Executive Committee
8	UNFC	United Nation Framework Classification
9	NMI	National Mineral Inventory
10	IBM	Indian Bureau of Mines
11	NABL	National Accreditation Board for Testing and Calibration Laboratories
12	MEMC	Minerals (Evidence of Mineral Contents)
13	MMDR	Mines & Minerals (Development and Regulation)
14	NH	National Highway
15	SH	State Highway
16	WGS-84	World Geodetic System-84
17	DGPS	Differential Global Positioning System
18	DMS	Degree Minute Second
19	XRF	X-ray Fluorescence
20	ML	Mining Lease
21	R.L.	Reduced Level