PROPOSAL OF RECONNAISSANCE SURVEY (G-4 STAGE) FOR REE & RM, GLAUCONITE AND PHOSPHORITE, IN DEVISAR (G4) BLOCK, BHUJ TEHSIL, DISTRICT: KACHCHH, GUJARAT (TOPOSHEET: 41E/07, AREA 112.81 SQ.KM)

COMMODITY: REE AND RM

BY

MINERAL EXPLORATION AND CONSULTANCY LIMITED

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SEMINARY HILLS

PLACE: NAGPUR

DATE: 12th FEBRUARY 2024

Summary of the Block for Reconnaissance Survey (G-4 Stage)

GENERAL INFORMATION ABOUT THE BLOCK

	Features	**Details**
	Block ID	DEVISAR (G4) BLOCK
	Exploration Agency	Mineral Exploration and Consultancy Limited (MECL)
	Commodity	REE & RM, Glauconite and Phosphorite
	Mineral Belt	Kachchh Basin
	Completion Period with entire Time schedule to complete the project	10 months
	Objectives	Based on the evaluation of geological data available, the present exploration program has been formulated to fulfill the following objectives. i. To carry out Geological & Structural mapping on 1:12500 scale for identification of REE & RM, Glauconite and Phosphorite, bearing formation (host rock) with the structural features to identify the surface manifestation and lateral disposition of the mineralized zones. ii. To collect bedrock, stream sediment samples (from positive catchment area) for analyses of REEs and only bedrock samples for glauconite to decide further course of exploration program. iii. To identify the REE enriched soil horizon, 10 nos of orientation pitting will be carried out and Trenching/ pitting will be carried out in the glauconite mineralized zone covered by soil identified during mapping and bedrock sampling iv. Auger drilling for REE and scout core drilling for glauconite in case, analytical results of surface/pit/trench samples are positive. The future course of exploration program will be decided after reconnaissance survey (G-4) outcome to G-3/G-2 level of exploration.

		v. To estimate reconnaissance resources of REE & RM, Glauconite and Phosphorite as per UNFC norms and Minerals (Evidence of Mineral Contents) Amendment Rules, 2021 at G-4 level mineral exploration.
	Whether the work will be carried out by the proposed agency or through outsourcing and details thereof. Components to be outsourced and name of the outsource agency	Work will be carried out by the proposed agency.
	Name/ Number of Geoscientists	Three nos. of Geoscientist (2 Field + 1 HQ)
	Expected Field days (Geology) Geological Party Days	Geologist Party Days: 180 (Field) + 60 Days (HQ)
1.	**Location**	

Corner Points	Latitude	Longitude	Area
A	23° 28' 52.798" N	69° 15' 50.517" E	112.81 sq.km
B	23° 28' 57.961" N	69° 18' 10.831" E	
C	23° 26' 47.486" N	69° 18' 15.049" E	
D	23° 26' 51.379" N	69° 20' 1.661" E	
E	23° 27' 57.092" N	69° 19' 58.848" E	
F	23° 28' 3.459" N	69° 22' 54.243" E	
G	23° 26' 57.740" N	69° 22' 57.032" E	
H	23° 27' 0.219" N	69° 24' 5.788" E	
I	23° 28' 5.990" N	69° 24' 4.406" E	
J	23° 28' 9.771" N	69° 25' 49.655" E	
K	23° 26' 0.313" N	69° 25' 55.100" E	
L	23° 25' 48.932" N	69° 20' 39.455" E	
M	23° 23' 7.134" N	69° 20' 46.351" E	
N	23° 23' 8.404" N	69° 21' 21.409" E	
O	23° 21' 31.323" N	69° 21' 25.531" E	
P	23° 21' 23.677" N	69° 17' 55.240" E	
Q	23° 23' 33.106" N	69° 17' 49.686" E	
R	23° 23' 30.535" N	69° 16' 39.576" E	
S	23° 27' 49.381" N	69° 16' 28.396" E	
T	23° 27' 48.088" N	69° 15' 53.324" E	

	Villages	Bhimsar, Aral Moti, Nani Aral, Devisar and Lkhiyavira etc.
	Tehsil/ Taluk	Bhuj
	District	Kachchh

	State	Gujarat
2.	**Area (hectares/ square kilometers)**	
	Block Area	112.81 sq.km.
	Forest Area	The block area is partially under Forest Area and partially Non-Forest area.
	Government Land Area	Data Not Available
	Private Land Area	Data Not Available
3.	**Accessibility**	
	Nearest Rail Head	Nearest railway station to the study area is Bhuj at about 40 km in south east.
	Road	The area is well connected by all-weather metalled roads. National Highway-754K is approx. 02 km from the block area which connects via Deshalpar, Devpar, Nakhatarana, village to Moray village through metalled road. Bhuj Tehsil is about 40 kms (via Devisar-Devpar village) from the block.
	Airport	The nearest airport is Bhuj Airport, located 45 km from proposed block
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	The area is mostly undulated having uneven topography pre-dominantly of small streams of 1st and 2nd order which ultimately drains into streams of higher order. The drainage pattern of area is primarily controlled by its arid environment, tectonic structures, and seasonal rainfall. The region features a mix of radial, dendritic, and trellis drainage, with extensive inland drainage leading to the formation of saline marshes and seasonal water bodies. Bhimsar Dam located estern part of the block which water is useful for irrigation of agricultural land.
	Rivers/ Streams	Bhimsar
5.	**Climate**	
	Mean Annual Rainfall	The climate of Kutch is arid to semi-arid, characterized by hot summers, low and erratic rainfall, and mild winters. Summers

		(March–June) are extremely hot, with temperatures reaching 48°C. The monsoon (July–September) brings low and unpredictable rainfall (200–400 mm annually), often leading to droughts. Winters (November–February) are mild, with temperatures ranging from 8°C to 25°C. The region experiences high evaporation rates, occasional cyclones, and flash floods, with the Rann of Kutch influencing local microclimates.
	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	The maximum temperature in summer is often higher than 48^0C and the minimum is a little lower than 8^0C
6.	**Topography**	
	Toposheet Number	41E/07
	Morphology of the Area	The morphology of Kutch is diverse, shaped by tectonic activity, marine influences, and arid climate. The highest point in the area is 145 m above msl at south of Than Village and lowest elevation is 80m near Aral Moti village. The central and the north eastern part has a flat to slightly undulating topography with isolated hillocks of sandstone.
7	**Availability of baseline geosciences data**	
	Geological Map (1:50K/ 25K)	1:50000 (NGDR)
	Geochemical Map	NGCM (raw) data from Bhukosh was downloaded, stream sediment sample results from NGCM were used to compute LREE, HREE & Total REEs and accordingly geochemical anomaly map is prepared and presented as plates in this proposal.
	Geophysical Map	**Available**
8.	**Justification for taking up Reconnaissance Survey / Regional Exploration**	i). The Kachchh sedimentary basin is a promising target for geological exploration due to its potential for secondary enrichment of rare earth elements (REEs). The enrichment of REE in Kachchh sedimentary basin due to multiple geological

		and geochemical process happens when REE are leached, transported and re-concentrated by weathering, ground water movement or hydrothermal activity. Key justifications include: a). **Economic and Strategic Importance:** REEs are critical for high-tech industries, renewable energy, and defense, reducing India's reliance on imports. b). **Favorable Geological Setting**: The region has REE-rich source rocks (Deccan Traps, granites), ion-adsorbing clays, and past marine transgressions that facilitate REE concentration. • Kachchh basin contains Mesozoic to Cenozoic sedimentary rocks with REE-bearing minerals derived from the Deccan Traps, Precambrian granites and metamorphic rocks of the surrounding regions. • Weathering of these igneous and metamorphic rock, releases REEs which ten accumulate in sediments. • Fluvial and marine processes transport REEs from sourced rock to sedimentary basins. • REE set adsorbed into clay minerals and Fe-Mn oxide. • Kutch basin has experienced multiple sea level fluctuations since the Mesozoic era. • Marine transgressions introduce REE rich sediments and cause chemical precipitation of phosphates (e.g. Monazites) • Regression phases scopes these deposits to weathering and secondary concentration c). **Environmental and Sustainable Benefits:** Secondary REE deposits in clays and sediments require less invasive extraction, making mining more eco-friendly. d). **Technological Feasibility:** Advancements in REE extraction techniques (bioleaching, solvent extraction) enhance economic viability. e). **Scientific Significance:** Exploration can improve understanding of REE enrichment mechanisms and lead to new discoveries.

		ii). NGCM raw data from NGDR was downloaded and stream sediment sample results from that was used for creating LREE, HREE & Total REE geochemical anomaly map which is presented as plates with this proposal. A clear high geochemical anomaly has been observed in those plates. In the proposed block 26 stream sample were collected by GSI, out of 26 samples 6 stream samples shows Total REE (TREE) of more than 1000 ppm. The maximum TREE value in the proposed block observed upto **95255 ppm**. HREE and LREE values vary from **38.9 ppm to 3260** ppm and **176 ppm to 91995 ppm** respectively. The concentration of HREE is lesser than that of LREE in the proposed block. Also, NGCM data suggests the presence of Glauconite in the proposed block. Values of K2O is varying between 1.21% - 3.06%. iii). Today most of the potash demand is met through bedded marine evaporite deposits such as sylvite, carnalite, kainite, polyhalite, surface and sub-surface potash-rich brines. India is fully dependable on import to meet the requirement of Potash. It is considered necessary to look for non-traditional source of potash such as glauconitic sandstone and potash rich shales. Hence, potash recovery from glauconitic sandstone is essential. iv). Glauconite comes in the category of critical minerals and Government of India is presently focusing and simultaneously carrying out the auctioning of potential Critical and Strategic Mineral blocks. So, the exploration of Glauconite prospects of the country is the need of the hour. iv). Given growing REE and potash demand, favorable geology, and sustainable extraction potential, systematic exploration in proposed block is essential for resource security and economic development and based on the result of NGCM data, proposed block may be taken for Reconnaissance Survey (G-4 Stage) to identify the source for REE & RM, Glauconite

		and Phosphorite and to be establish the resources for auction this block.

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1.0.0 INTRODUCTION

1.0.1 Rare earths are characterized by high density, high melting point, high conductivity and high thermal conductance. These unique properties i.e., distinctive electrical, metallurgical, catalytic, nuclear, magnetic and luminescent properties make them indispensable for a variety of emerging high end and critical technology applications relevant to India's energy security i.e., clean energy technology, defense, civilian application, environment and economic areas. Demand for REE is expected to continue to grow, especially because of their use in low carbon technology. The ever-increasing demand for these Rare Metals and REE necessitates a concerted effort to augment the resource position of our country.

1.0.2 A study, conducted by the Council on Energy Environment and Water, identified 12 minerals out of 49 that were evaluated as 'most critical' for India's manufacturing sector by Vision 2030 which makes more thrust for exploration in Strategic Mineral, Precious Metals, Platinum Group of Elements by Government of India.

1.0.3 Along with nitrogen and phosphorus, potassium is one of the most essential macronutrients and is required in agriculture in relatively large amounts for plant's healthy growth. After the growing recognition of potassium as one of the key nutrient in plant growth, subsequent development of potash industry was resulted. Reaching an estimated value of one million tonnes in 1921, production of potassium continues to increase consistently and reach to almost 34.6 million tonnes in 2013 (United State Geological Survey, 2013a, 2013b) expecting to raise 37.8 million tons in 2022 with the growth rate of about 2.9% annually (Rawashdeh et al., 2016).

1.0.4 Today most of the potash demand is met through bedded marine evaporite deposits such as sylvite, carnalite, kainite, polyhalite, surface and sub-surface potash-rich brines. These minerals are mixture of soluble salts, mainly potassium chloride or sulfates. More than 90% of these deposits are mainly concentrated in countries like Canada, Russia, Belarus, Brazil, China, Chile, Germany and USA (Anderson, 1985; The New York Times Editorial Board, 2013; Rawashdeh and Maxwell, 2014) on which rest of the world is dependent for supply of potash fertilizer.

1.0.5 In order to sustain crop production and to ensure self-sufficiency, exploration and investigation of alternative resource for potassium such as K-bearing silicates could be one of the options to meet the future demand (Manning, 2010; Manning, 2012; Ciceri et al., 2015).

1.0.6 In absence of mineable evaporite potash deposit in India, it was considered necessary to look for non-traditional source of potash such as glauconitic sandstone and potash rich shales. In many countries deficient in the conventional evaporite deposits insoluble potash used 'to be extracted out of silicate and non silicate minerals. Thus alunite in Bulla dealah in New castle, (Australia) containing 5% to 10%. K2O was commercially exploited. Extraction of potassium from shales has also been discussed by Everest et al. (1964), similarly glauconite has been used in USSR as a source of potassium fertilizer's (GSI, CGPB report, 1978 p. 94).

1.0.7 Out of different non-conventional sources, glauconitic sandstones deposits are available in plenty and are considered as one of the indigenous resources for potassium in India. India has vast reserves of more than 3,000 million tonnes of glauconitic sandstone containing 4 to 8% K2O occurring in States like Madhya Pradesh, Uttar Pradesh, Bihar. Chhattisgarh, Rajasthan and Gujrat (Kumar and Bakliwal, 2005).

1.1.0 BACKGROUND

1.1.1 The Exploration for strategic, critical, rare metals, rare earths elements, PGE and precious metals is given top priority by Govt. of India after amendment of MMDR act 2015. Keeping this in view, the present proposal is being put up for Reconnaissance Survey (G-4) for REE & RM, Glauconite and Phosphorite in Devisar (G4) Block, in Bhuj tehsil of Kachchh District, Gujarat (area 112.81 sq.km).

1.2.0 LOCATION AND ACCESSIBILITY

1.2.1 The proposed Devisar Block lies in in Bhuj tehsil of Kachchh District, Gujarat and falls in the Survey of India Toposheet No 41E/07. Bhimsar, Aral Moti, Nani Aral, Devisar and Lkhiyavira etc. are the villages falling in the proposed area. The area is well connected by all-weather metalled roads. National Highway-754K is approx. 02 km from the block area which connects via Deshalpar, Devpar, Nakhatarana, village to Moray village through metalled road. Bhuj Tehsil is about 40 kms (via Devisar-Devpar village) from the block. Bhuj is nearest railway station located at 40 km south east from the proposed block. The nearest airport is Bhuj Airport, located 45 km from proposed block.

1.3.0 PHYSIOGRAPHY, DRAINAGE AND CLIMATE:

1.3.1 The morphology of Kutch is diverse, shaped by tectonic activity, marine influences, and arid climate. The highest point in the area is 145 m above msl at south of Than Village and lowest elevation is 80m near Aral Moti village. The central and the north eastern part has a flat to slightly undulating topography with isolated hillocks of sandstone.

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1.5.0 The climate of Kutch is arid to semi-arid, characterized by hot summers, low and erratic rainfall, and mild winters. Summers (March–June) are extremely hot, with temperatures reaching 48°C. The monsoon (July–September) brings low and unpredictable rainfall (200–400 mm annually), often leading to droughts. Winters (November–February) are mild, with temperatures ranging from 8°C to 25°C. The region experiences high evaporation rates, occasional cyclones, and flash floods, with the Rann of Kutch influencing local microclimates..

1.4.0 FLORA & FAUNA:

Kutch's vegetation includes thorny shrubs, grasslands, and mangroves. Key species include Prosopis juliflora, Acacia nilotica, Salvadora persica, and Ziziphus mauritiana. The region also has extensive mangroves (Avicennia marina) and salt-tolerant plants.

Fauna: The region is home to iconic wildlife, including: **Mammals**: Indian Wild Ass, Chinkara, Desert Fox, Indian Wolf, and Nilgai. **Birds:** Greater & Lesser Flamingos, Common & Demoiselle Cranes, Indian Bustard, and Peregrine Falcon. **Reptiles:** Indian Star Tortoise, Monitor Lizard, and Saw-scaled Viper.

2.0.0 REGIONAL GEOLOGY

2.0.1 The Kutch Basin in Gujarat is a failed rift basin formed during the breakup of Gondwana (Jurassic–Cretaceous). It is tectonically active, with major faults like the Kutch Mainland Fault (KMF) and has experienced multiple marine transgressions and regressions. It is a unique geological province known for its complex tectonic history, diverse sedimentary

formations, and rich fossil records and has experienced multiple marine transgressions and regressions.

2.0.2 Regionally, proposed block falls in the Northern part of Kachchh Basin and lithostratigraphically forms part of Katrol Formation belonging to Late Jurassic - Early Cretaceous age. The Rann of Kachchh and Kachchh Peninsula covered an area of 45612 sq km in north western parts of our country. Physiographically, Kachchh is divided mainly into hill ranges, gently sloping peripheral coastal tracts and dissected coastal erosional plains, and younger deltaic plains, tidal flats, spits and marginal accretionary zones.

2.0.3 Kachchh, peri-cratonic rift basin of western India, represents a complete sequence of strata ranging in age from Middle Jurassic to Holocene (Fig.5.1). The Mesozoic and Cenozoic rocks of Kachchh are separated by a period of non-deposition, followed by diastrophism, erosion and volcanism, during the close of Cretaceous period. The Mesozoic rocks consist of marine sediments from Bathonian to Tithonian (Portlandian) and non-marine sediments in Cretaceous. These sediments were deposited in a sheltered gulf in sub littoral to deltaic environments in two major cycles: Middle Jurassic transgressive cycle and Late Jurassic-Early Cretaceous regressive cycle (Biswas, 1981). These sediments were laid down on a Precambrian granitic basement which is exposed only in the Nagar Parkar Hills in Pakistan. The Mesozoic sediments were uplifted, folded, intruded and covered by the Late Cretaceous-Early Palaeocene Deccan trap. The terrestrial volcano-clastic sediments represent the Palaeocene sediments while the Early Eocene transgression and subsequent Tertiary deposits filled the peripheral lows bordering the Mesozoic highs as well as the lows between them.

2.0.4 The Mesozoic sediments of Kachchh are represented by Pachchham, Chari, Katrol and Umia Formations (after Krishnan, 1982). Krishnan (1982) classified the Mesozoic succession of Kachchh as presented in the below table-

Table -1 Regional Stratigraphic sequence of Litho units (after Krishnan, 1982).

Age	Unit	Sub-division	Lithology
Post-Aptian	UMIA (1000 m)	Bhuj beds (Umia Plant beds)	Sandstone and shale
Aptian		Ukra beds	Marine calcareous shale
Upper Neocomial		Umia beds	Barren sandstone and shale
Valanginian		Trigonia beds	Barren sandstone
Upper Tithonian		Umia ammonite beds	Shale and sandstone
Middle Tithonian	KATROL (300 m)	Upper Katrol Shales	Shale
Middle Tithonian		Gajansar beds	Shale
Lower Tithonian		Upper Katrol (Barren)	Sandstone
Middle Kimmeridgian		Middle Katrol	Red sandstone
Upper Oxfordian		Lower Katrol	Sandstone, shale, marl

Age	Unit	Sub-division	Lithology
Oxfordian	CHARI (360 m)	Dhosa Oolite	Green and brownoolitic limestone
U. Callovian		Athleta beds	Marl and gypseous shale
Middle Callovian		Anceps beds	Limestone and marl
Middle Callovian		Rehmani beds	Yellow limestone
Lower Callovian	PATCHAM (300 m)	Macrocephalus beds	Shales with calcareous bands and golden oolites
Lower Callovian		Coral bed	Shale and limestone
Lower Callovian to Bathonian		Patcham shell limestone Patcham basal beds (Kuar Bet beds)	Limestone, shale and marl

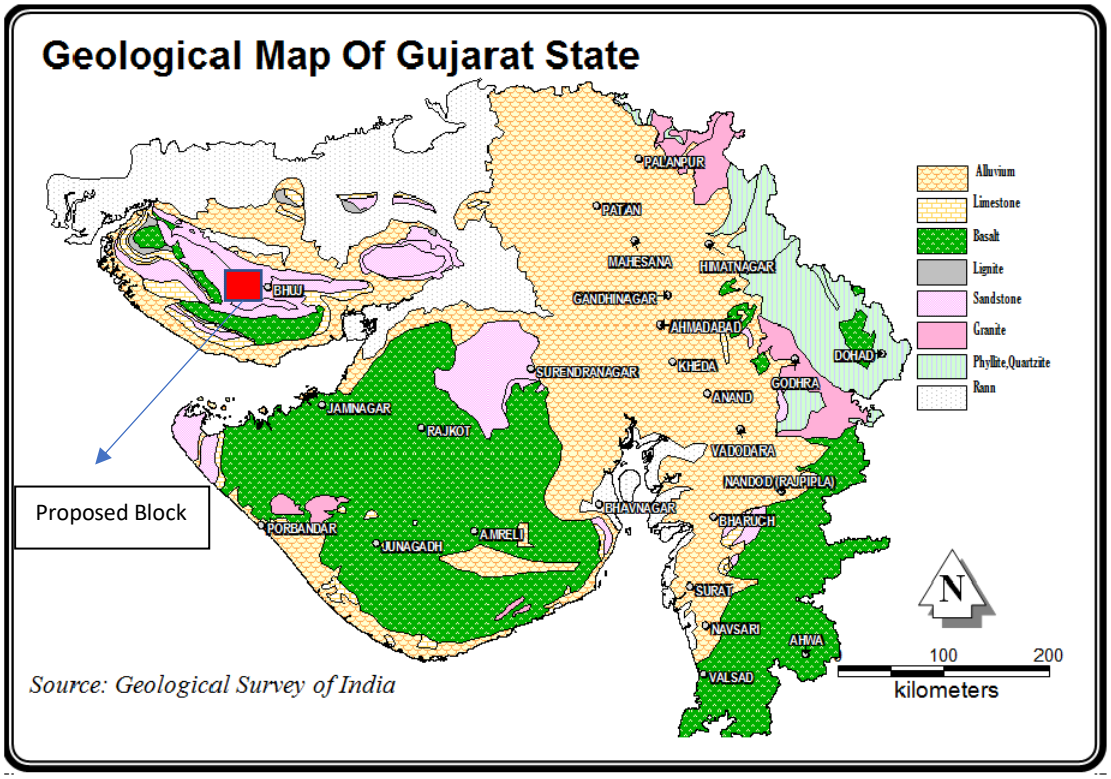

Fig:1 Geological Map of the Geological map of Gujarat

2.1.0 GEOLOGY OF THE BLOCK

2.1.1 The study area consists of a stratigraphic sequence ranging from the Late Jurassic to the Pleistocene. The youngest unit is the Pleistocene Miliolite Limestone of the Porbandar Group, composed primarily of miliolite limestone, indicative of shallow marine depositional environments. Beneath this lies the Late Cretaceous-Palaeocene Deccan Trap, associated with the Kachchh Group, consisting predominantly of dolerite, representing extensive volcanic activity during this period.

2.1.2 Further down, the Early Cretaceous Bhuj Formation consists of sandstone, suggesting a fluvial or deltaic depositional environment. Below this, ferruginous sandstone and grit layers indicate a period of significant iron-rich sediment deposition, possibly influenced by oxidation processes. The deeper layers consist of feldspathic sandstone and grit, highlighting early sedimentary processes before the later depositional and volcanic episodes.

2.1.3 The oldest unit in the sequence is the Late Jurassic to Early Cretaceous Katrol Formation, composed of gypseous shale and calcareous sandstone with belemnites. This formation suggests a marine depositional environment, with possible influences from anoxic conditions and biogenic activity, reflecting the paleoenvironmental conditions of that time.

2.1.4 Regional strike of the bedding plane is NW-SE. Rock beds are horizontal to gently dipping (50 to 200) with general dip towards SW and exhibit gradational contact. The tentative stratigraphic sequence of litho units exposed in the Block area (After GSI) is given in below Table.

Table - 2

The generalized stratigraphic succession of the proposed block is as follows (After, GSI)

AGE	SUPER GROUP	GROUP	FORMATION	LITHOLOGY
PLEISTOCENE		PORBANDAR	MILIOLITE	MILIOLITE LIMESTONE
LATE CRETACEOUS-PALAEOCENE	DECCAN TRAP	KACHCHH		DOLERITE
EARLY CRETACEOUS			BHUJ	SANDSTONE
				FERRUGINOUS SANDSTONE AND GRIT
				FELDSPATHIC SANDSTONE AND GRIT

LATE JURASSIC - EARLY CRETACEOUS			KATROL	GYPSEOUS SHALE, CALCAREOUS SST WITH BELEMNITES

3.0.0 PREVIOUS WORK - OBSERVATION AND RECOMMENDATIONS

3.1.0 The area under investigation, including Kachchh, Pavagadh, Chhota-Udepur, and Rajpipla, has been extensively studied since the 18th century due to its diverse rock types, tectonic settings, and depositional environments. Recent studies have focused on the occurrence of mantle xenoliths within basic plugs of Kachchh, which are unique within the Deccan Volcanic Province.

3.2.0 Research on Mesozoic and Tertiary rocks of Kachchh includes studies on the Ir-rich layer related to the K/T boundary, sedimentary horizons, and diverse rock types associated with Deccan Trap volcanic episodes. The region is also significant for the presence of dinosaur remains and complex structural features. Pavagadh, Chhota-Udepur, and Rajpipla expose Deccan Trap flows, dykes of alkalic rocks, carbonatite, and associated alkaline rocks. Studies suggest that the lava flows east of Cambay are primarily tholeiitic, with little alkalinity.

3.3.0 Early geological studies by Blanford (1867, 1869) described the Deccan flows as subaerial and of Late Cretaceous to Early Tertiary age. Bose (1884) recorded trachytic rocks in the Tapti and Narmada valleys. Chatterjee (1961, 1964) studied lava flows in Pavagadh and Kawant, proposing an alkaline olivine-basalt lineage for western India. The Jurassic sediments of Kachchh are intruded by alkali basalt/gabbro plugs, forming domes along fault-bounded lineaments.

3.4.0 Later studies by De (1964) classified Kachchh's basaltic intrusions into less mafic alkali olivine basalt and highly mafic varieties, suggesting that these alkali basalts occur as intrusive plugs within Cretaceous Bhuj sandstone. These were determined to be post-tholeiitic intrusions. Biswas (1989) and Krishnamurthy et al. (1988) also supported the theory of post-Deccan alkali magmatism. Radiometric dating by Pandey et al. (1988) established an age range of 64–67 Ma for these intrusions.

3.5.0 Recent research includes the mapping of alkalic basalt plugs and tholeiitic flows in central Kachchh (Guha, 1998), suggesting that some basalt flows are younger than the intrusive plugs. Field evidence indicates the presence of explosive volcanic activity, as seen in agglomerates and pyroclastic horizons. Studies by Kshirsagar et al. (2011) suggest that the

sub-volcanic intrusions of central Kachchh represent an eroded monogenetic volcanic field, comparable to similar volcanic fields worldwide.

3.6.0 Extensive geological mapping of Mesozoic and associated rocks began with Survey of India projects from 1978-79 onwards. Ghevariya (1984-95) systematically mapped Mesozoic sediments, lava flows, and inter-trappean beds, leading to the discovery of dinosaur fossils near Viri, drawing international interest. His research identified a sequence of nine lava flows, five inter-trappean layers, and pyroclastic rocks. Further studies by Srikarni et al. (1999) mapped 20 volcanic plugs in Nakhatrana, with geochemical analyses indicating positive PGE and gold values in alkalic gabbro plugs.

3.7.0 Continued research by state and geological agencies, including work by Rana (1998) and Guha (2000), has contributed to the understanding of the complex magmatic history of Kachchh, including phreatomagmatic maar volcanic structures and intrusive features. These studies provide a crucial framework for reconstructing the region's magmatic and tectonic evolution..

3.4.0 MECL has amalgamated the NGCM data downloaded from Bhukosh website of GSI and previous exploration work carried out by GSI and calculated TREE, HREE & LREE for a total 26 no of stream sediment samples falling in proposed area and seeing the potentiality of the area the present proposed block is submitted to TCC, NMET for approval.

3.5.0 Calculated LREE, HREE and TREE values for 26 no of stream sediments from NGCM data whose range are given in table below, anomaly maps are prepared and submitted as annexures III and IV. The NGCM studies highlighting the anomalous value of Praseodymium maximum upto 20267 ppm, Neodymium 69521 ppm, Gadolinium 1759 ppm, Dysprosium 2734 ppm, Barium 973 ppm and Values of K2O is varying between 1.21% - 3.06%.

Table-3

Data showing NGCM Stream Sediment results for TS No. 73B/01 from Bhukosh of GSI

Item	Sl. No.	Element	RANGE (PPM)		Average crustal abundance values are from Lide (2004, p.17); REE, rare earth element
			MIN	MAX	
LREE	1	Lanthanum(La)	38.4	183.9	39
	2	Cerium(Ce)	77	375.1	66.5
	3	Praseodymium (Pr)	9.8	20267.3	9.2

	4	Neodymium(Nd)	34.9	69521.1	41.5
	5	Promethium (Pm)			
	6	Samarium (Sm)	6	34.1	7.05
	7	Europium(Eu)	0.8	1.9	2
	8	Gadolinium(Gd)	5.8	1759.2	6.2
		LREE	**173**	**91995.1**	
HREE	9	Yttrium (Y)	23	78	33
	10	Terbium(Tb)	0.8	274.5	
	11	Dysprosium(Dy)	4.3	2734.7	5.2
	12	Holmium(Ho)	0.8	6	1.3
	13	Erbium(Er)	2.5	195	3.5
	14	Thulium (Tm)	0.4	1	0.52
	15	Ytterbium(Yb)	2.5	6.8	3.2
	16	Lutetium(Lu)	0.4	1.8	0.8
		HREE	**38.9**	**3260**	
		TREE	**214.6**	**95255.1**	
Rare Elements	17	Hafnium(Hf)	18.5	61.9	
	18	Tantalum (Ta)	3.3	9.7	
	19	Rubidium (Rb)	48	104	
	20	Zirconium (Zr)	675	1741	
	21	Germanium (Ge)	0	510.1	
Radioactive Elements	22	Uranium(U)	3.7	12.3	
Other elements	24	Strontium (Sr)	84	198	
	25	Barium(Ba)	327	973	
	26	Scandium (Sc)	5	17	
	27	K2O	1.21%	3.06%	

4.0.0 SCOPE FOR PROPOSED EXPLORATION.

4.0.1 The Reconnaissance survey at G-4 stage exploration program proposed comprises, Geological mapping (1:12,500 scale), Surface sampling (Bedrock, Soil, Stream Sediments), pitting/trenching, drilling of 5 Nos of scout boreholes involving about 500m with associated survey, chemical analysis, physical analysis and geological report preparation.

4.1.0 JUSTIFICATION

4.1.1 The NGCM data were downloaded from NGDR portal and as per the results of the stream sediment analysis, area is significantly enriched in Light Rare Earth Elements (LREE), particularly Neodymium (Nd) and Praseodymium (Pr), with total LREE concentrations

reaching up to 91,995.1 ppm. Heavy Rare Earth Elements (HREE) are present in lower amounts, with Dysprosium (Dy) being the most abundant, reaching 2,734.7 ppm. The total Rare Earth Elements (TREE) range from 214.6 ppm to 95,255.1 ppm, indicating strong mineralization. Among rare elements, Zirconium (Zr) has the highest concentration (up to 1,741 ppm), while Germanium (Ge) varies widely. Radioactive elements such as Uranium (U) and Strontium (Sr) are found in low concentrations, indicating minimal radioactive content. In the other elements category, Barium (Ba) is the most abundant (up to 973 ppm), suggesting the presence of Ba-rich minerals.

4.1.2 The sample indicates a geological formation with significant rare earth element mineralization, particularly LREE and HREE, along with valuable rare metals like, Zr and Ge and critical mineral potash. Secondary enrichment of REEs in sediments and clays often requires less invasive extraction techniques, reducing ecological damage. Given the economic, strategic, and scientific importance of REEs, conducting geological exploration in the Kutch sedimentary basin is a justified and necessary step. The region's favorable geological conditions, coupled with growing REE demand and sustainable extraction potential, make it a compelling target for future resource development.

4.1.3 NGCM raw data was downloaded from Bhukosh portal of GSI and a total 26 no of stream sediment sample (SSS) were collected by GSI out of 26 samples 6 stream samples shows Total REE (TREE) of more than 1000 ppm. These 26 no of sample were calculated for LREE, HREE & Total REE, upon preparation of geochemical anomaly map the area is promising for REE mineralization was identified and presented to TCC of NMET for approval, Geochemical anomaly map are enclosed as plate IV, V, VI.

4.1.4 With above study, the current proposed block may be studied for REE & RM, Glauconite and Phosphorite mineralization at G4 level of exploration.

4.2.0 BLOCK DESCRIPTION

4.2.1 The proposed Devisar Block lies in in Bhuj tehsil of Kachchh District, Gujarat and falls in the Survey of India Toposheet No 41E/07 covers 112.81 sq.km in around villages of Bhimsar, Aral Moti, Nani Aral, Devisar and Lkhiyavira etc. The block location in topo sheet is given in **PLATE-I.** The Co-ordinates of the corner points of the block area both geodetic and UTM are given in **Table No.- 4**.

Table- 4

Co-ordinates of the Corner points of the Devisar Block

Corner Points	Latitude	Longitude	Area
A	23° 28' 52.798" N	69° 15' 50.517" E	
B	23° 28' 57.961" N	69° 18' 10.831" E	
C	23° 26' 47.486" N	69° 18' 15.049" E	
D	23° 26' 51.379" N	69° 20' 1.661" E	
E	23° 27' 57.092" N	69° 19' 58.848" E	
F	23° 28' 3.459" N	69° 22' 54.243" E	
G	23° 26' 57.740" N	69° 22' 57.032" E	
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I	23° 28' 5.990" N	69° 24' 4.406" E	
J	23° 28' 9.771" N	69° 25' 49.655" E	112.81
K	23° 26' 0.313" N	69° 25' 55.100" E	sq.km
L	23° 25' 48.932" N	69° 20' 39.455" E	
M	23° 23' 7.134" N	69° 20' 46.351" E	
N	23° 23' 8.404" N	69° 21' 21.409" E	
O	23° 21' 31.323" N	69° 21' 25.531" E	
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Q	23° 23' 33.106" N	69° 17' 49.686" E	
R	23° 23' 30.535" N	69° 16' 39.576" E	
S	23° 27' 49.381" N	69° 16' 28.396" E	
T	23° 27' 48.088" N	69° 15' 53.324" E	

5.0.0 PLANNED METHODOLOGY

5.0.1 The exploration program is proposed in accordance to the objective set for reconnaissance survey (G-4) of the block. The Exploration shall be carried out as per Minerals (Evidence of Mineral Contents) Amendment Rules, 2021. Accordingly, the following scheme of exploration is formulated in order to achieve the objectives. The details of different activities to be carried out are presented in subsequent paragraphs.

I. To carry out Geological & Structural mapping on 1:12500 scale for identification of REE and glauconite bearing formations to identify the surface manifestation and lateral disposition of the mineralized zones.

II. To collect bedrock, stream sediment samples (from positive catchment area) for analysis of REEs and only bedrock samples for glauconite to decide further course of exploration program.

III. To identify the REE enriched soil horizon, 10 nos of orientation pitting will be carried out. Soil samples will be collected from A, B, C horizon and bedrock separately by panning for heavy mineral separation.

IV. To further determine the REE mineralised zone in the proposed block, auger drilling will be carried out and samples will be collected from targeted soil horizon established by orientation survey.

V. To establish the reconnaissance resources for REE bearing minerals as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.

VI. Trenching/ pitting will be carried out in the glauconite mineralized zone covered by soil identified during mapping and bedrock sampling.

VII. Scout drilling will be carried out for glauconite, after positive outcome of above exploration activities.

VIII. To establish the reconnaissance resources glauconite as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.

IX. The outcome of this exploration will decide further exploration strategy for upgradation of block to Preliminary (G-3) Exploration.

5.1.0 GEOLOGICAL MAPPING

5.1.1 Geological mapping will be done in the entire 112.81 sq.km area on 1:12,500 scale. Rock types, their contact, structural features will be mapped. Surface manifestations of the mineralisation available along with their surface disposition will be marked on map. 10 nos. of surface samples and borehole samples of various lithounits for petrological studies and 10 nos. of surface samples and borehole samples of various lithounits for mineragraphic studies.

5.2.0 GEOCHEMICAL SAMPLING

5.2.1 **Stream, Bed Rock and Soil Sampling for REE & RM:**

5.2.1.1 Initially around 60 Nos of follow up stream sediments samples shall be collected from 1st order and 2nd order stream around the samples with high anomalous value reported by GSI during the NGCM work to identify the provenance of the mineralisation. The collected stream subjected to heavy mineral reparation.

5.2.1.2 Further around 120 Nos Bed Rock samples by means of chip sampling shall be collected from suitable litho units from the potential provinance to identify the primary source of mineralisation and to identify its distribution pattern.

5.2.1.3 Soil samples shall be collected from a 1 km x 1 km grid in the positive catchment area by means of pitting. Approximately 100 pits may be dug, resulting in a cumulative excavation of 200 cubic meters. Initially, 10 pits will be dug across the block as orientation pits. All soil horizons will be sampled, generating around 20 orientation samples. The REE-bearing soil horizon will be identified from these orientation samples. Based on the results, the enriched soil horizon will be sampled from the remaining 90 pits, yielding approximately 90 soil samples.

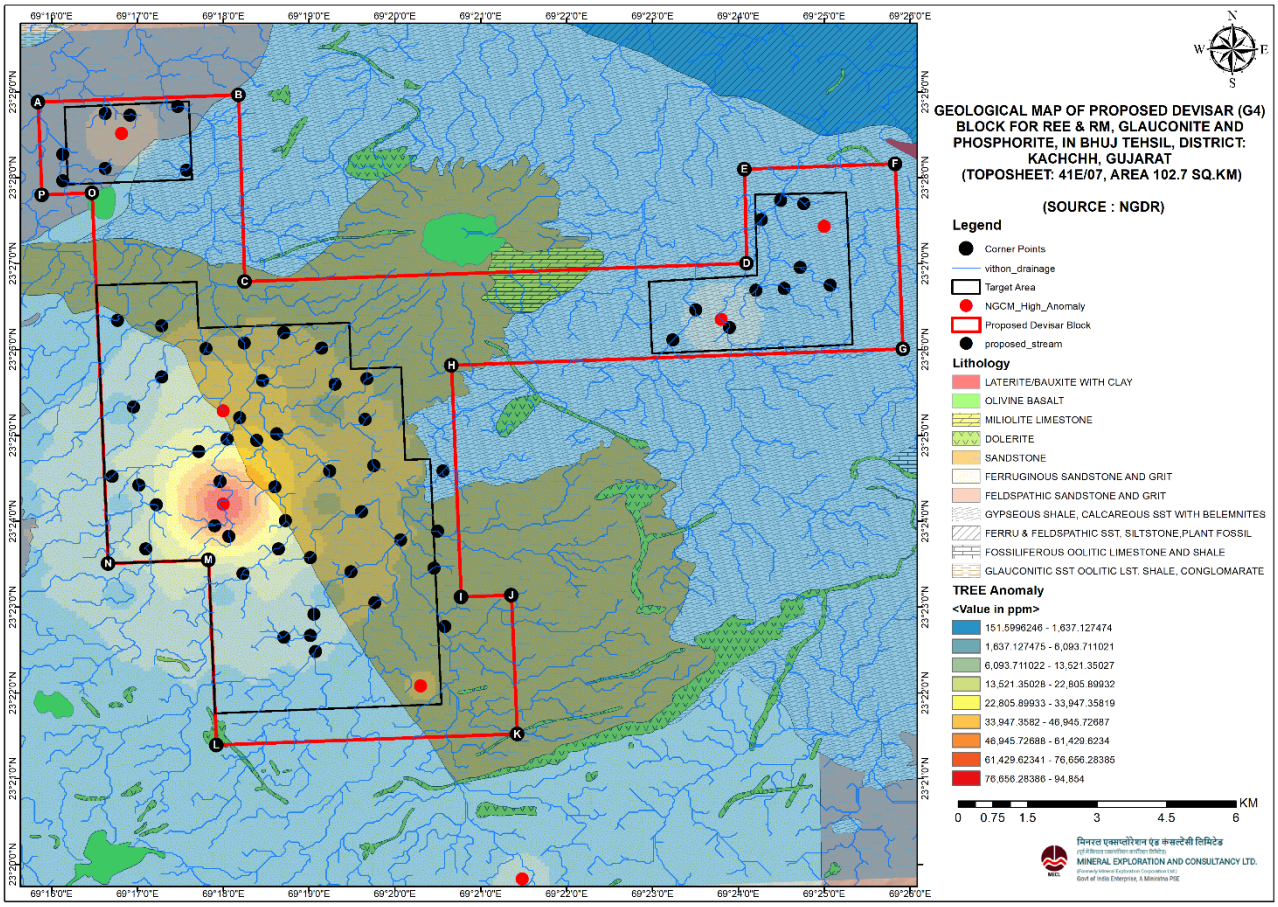

Fig. 6 Scheme of Follow-up of Stream Sediment Sampling

5.2.2 **Surface Geochemical sampling (Bed Rock/Channel/Chip Sample): for Glauconite and Phosphorite:** During the course of Geochemical Sampling, around 100 nos. of bed rock /Channel/Chip samples shall be collected from the suitable surface locale. A total of 100 nos. of primary and 10 nos. of external check surface samples will be analysed for 8 radicals (K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3). 10% of Primary samples (5 Nos) will be sent to NABL External Labs as External Check Sample

5.2.2.1 Exploratory Mining (trenching/pitting): Pitting (Excavation) shall be carried out in the potential zones identified based on the results of geological mapping and geochemical sampling. A provision of trenching/pitting of 200 cubic meter has been planned. trenching/pitting work will be carried out by excavating trenches of 1m width and up to 2m depth in the area to expose the source rock and mineralization. Locations of pits/trenches on ground will be decided by field geologist based on field observations. Trenches will be geologically mapped thoroughly by the field geologist. Around 50 nos. of trench/pit samples shall be collected. A total of 100 no of primary and 15 no of external check trench samples will be analysed for 8 radicals (K_2O, SiO_2, MgO, CaO, Na_2O, P_2O_5, Al_2O_3 & Fe_2O_3). 10% of Primary samples will be sent to NABL External Labs as External Check Samples.

5.3.0 Heavy Mineral Separation

5.3.1 The 120 soil samples collected from the pit, 60 stream samples and 300m Auger drilling samples may be subjected to panning to collect pan concentrate samples for analysis of REEs.

5.4.0 DRILLING:

5.4.1 Based on Geological mapping and pitting, the extension of the enriched zones will be marked. 300m Auger drilling for REE and RM mineralisation area and 480 m for Glauconite potential area will be drilled. A total 300 Auger drilling samples will be analysed for REE associated Trace Elements (34 Element) by ICPMS and 200 core sample will be analysed for for K_2O, SiO_2, MgO, CaO, Na_2O, P_2O_5, Al_2O_3 & Fe_2O_3.

5.5.0 DRILL CORE LOGGING:

5.5.1 The drill core will be logged for rock types, structural features, textures, intersection of mineralization/ore zones, types of mineralization and occurrence of various ore minerals. Rock quality designation (RQD) will also be undertaken.

5.6.0 CHEMICAL ANALYSIS

A total around 990 Nos of samples (590 for REE and RM, 400 for Glauconite) shall be generated. (Surface samples for REE -290 (60 Stream Sediment, 120 BRS), Pit sample-110 (Initial 20 Orientation Sample + Rest 90 nos enriched soil horizon samples (For Soil Profile Sampling)), Auger Sample: 300) for REE and shall be analysed for 34 elements, i.e., REE and associated trace elements (Sn, Hf, Nb, Ta, U, Th, Be, Ba, Ge,

As, Rb, Sr, W, Mo, Ti, Zr, Cs, Y, Sc, Pb, Zn) through ICPMS. 10% of the primary samples, i.e., Nos samples shall be subjected as external check samples and analysed for the same elements by ICPMS.

Surface samples for glauconite – 350 (100 BRS, 100 pit and 200 core sample) shale be analysed for 8 radicals (K_2O, SiO_2, MgO, CaO, Na_2O, P_2O5, Al_2O_3 & Fe_2O_3).

5.7.0 PETROLOGICAL & MINERAGRAPHIC STUDIES:

During the course of Geological mapping and core logging, 15 samples from various litho units from surface and intersected in boreholes will be subjected to petrographic study and 15 nos of samples from suspected mineralized zones shall be subjected for mineragraphic study.

5.8.0 XRD & EPMA Study:

15 nos. of samples from mineralized zones shall be subjected for XRD studies. Moreover, few samples shall also be subjected to EPMA study.

6.0.0 PROPOSED QUANTUM OF WORK

6.0.1 Details of the particular, Quantum and the targets are tabulated in **Table No.-V.A.**

Table No-V. A Envisaged Quantum of proposed work in Devisar Block

Sl. No.	Item of Work	Unit	Target
1	**Geological Mapping** (on 1:12,500 Scale)	sq.km	112.81
2	**Geochemical Sampling**		
	Primary samples for K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3	Nos	400
	Analysis of samples of REE for determination of a package by 34 elements by ICP-AES / ICPMS (sequential technique)	Nos	590
3	**Pitting**		
	a) For REE	Cu.m	100
	b) For Glauconite	Cu.m	200
	c) Collection of different horizon soil sample for REE	Nos	110
	d) Collection of different horizon soil sample for Glauconite	Nos	100
4	**Heavy Mineral Separation (60 Pit sample, 110 stream sample and 300 auger drilling sample)**	Nos	470
5	**Drilling* (Phase II After Review)**		
	A) Drilling (core) Scout drilling for Glauconite	m	480 m
	i) Geological Logging	m	480

	ii) Borehole core samples	Nos	200
	B) Auger Drilling for REE	m	300m
	i) Auger Drilling samples	Nos	300
6	**Laboratory Studies**		
	a) REE associated Trace Elements (34 Element)by ICPMS (590 Nos.)	Nos	990
	BRS 120, Stream 60, Pit samples 110		
	Auger Drilling samples 300		
	Orientation Sample-20 (10 Pit X 2 samples from B and C Horizon),		
	b) samples for K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3 (350 Nos.)		
	BRS 100, Pit samples 100 and core drilling-200		
	b) External Check Samples	Nos	149
	d) Major Oxide study	Nos	47
7	**Physical Study**		
	a) Petrological Study	Nos	15
	b) Mineragraphic Study	Nos	15
	c) XRD Study	Nos	15
	d) EPMA Study	Hours	15
8	**Report Preparation (5 Hard copies with a soft copy)**	Nos.	1

‘

6.1.0 BREAK-UP OF EXPENDITURE

6.1.1 Tentative Cost has been estimated based on Schedule of Charges (SoC) of projects funded by National Mineral Exploration Trust (NMET) w.e.f. 01/04/2020 The total estimated cost is **Rs. 328.13 Lakhs.** The summary of cost estimates for Reconnaissance Survey (G-4 Level) is given in **Table No.-VI** and 6.0.1 Details of the particular, Quantum is given in **Table No. –V.A.,** Summary of Cost Estimates for Reconnaissance Survey (G-4 Level) Exploration given in table no. V.B and **Detail** cost sheet for proposed Reconnaissance Survey (G-4) for REE and RM as Annexure No.**I**

Table No-V. B

Summary of Cost Estimates for Reconnaissance Survey (G-4 Level) Exploration

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geological Work	30,33,540.00
2	Pitting	10,40,000.00
3	Drilling	71,69,140.00
4	Heavy Mineral Separation	76,14,000.00
5	**Sub total**	**1,88,56,680.00**

6	Laboratory Studies	76,40,673.50
7	**Sub total**	**2,64,97,353.50**
8	Report	7,50,000.00
9	Peer Review	30,000.00
10	Proposal Preparation	5,29,947.07
11	**Total**	**2,78,07,300.57**
12	GST (18%)	50,05,314.10
Total cost including 18% GST		**3,28,12,614.67**
SAY, in Lakhs		**328.13**

6.2.0 TIME SCHEDULE

6.2.1 The proposed exploration programme envisages surveying, updating of geological mapping, geochemical sampling, exploratory mining, sample preparation and laboratory studies, which will be completed within 6 months by geological report preparation will consume 4 more months with one month overlapping. Therefore, a total of 10 months is planned for completion of the entire programme.

Time Schedule for Reconnaissance Survey (G-4 Stage Exploration) For REE & associated minerals in and around REE & RM, Glauconite and Phosphorite, in Devissar (G4) Block, Bhuj Tehsil , District: Kachchh, Gujarat

		1	2	3	4	6		7	8	9	10
1	Camp Setting										
2	Geological Party Days										
3	Pitting & Sampling										
4	Heavy Mineral Separation/ Sample Preparation										
5	Laboratory Studies										
6	Dilling										
7	Camp Winding										
8	Geologist Party days, HQ										
9	Geological Report Writing										
10	Peer Review										

*** Commencement of project will be reckoned from the day the exploration acreage is available along with all**

*** Time loss on account of monsoon/agricultural activity/forest clearance/local law and order problems will be**

List of Plates

1. Plate-I: Location Map of Devisar (G4) Block in Bhuj Tehsil of Kachchh District, Gujarat.
2. Plate-II: Regional Geological Map Devisar (G4) Block in Bhuj Tehsil of Kachchh District, Gujarat (Source: NGDR).
3. Plate-III: Geological Map of Devisar (G4) Block in Bhuj Tehsil of Kachchh District, Gujarat (Source: NGDR).
4. Plate – IV: Devisar (G4) Block -NCGM anomaly map for TREE (Source: Source: NGDR).
5. Plate – V: Devisar (G4) Block -NCGM anomaly map for LREE (Source: Source: NGDR).
6. Plate – VI: Devisar (G4) Block -NCGM anomaly map for Total HREE (Source: Source: NGDR).
7. Plate-VII: Drainage map with proposed stream sample location of Devisar (G4) Block in Bhuj Tehsil of Kachchh District, Gujarat

GEOLOGICAL MAP OF PROPOSED DEVISAR (G4) BLOCK FOR REE & RM, GLAUCONITE AND PHOSPHORITE, IN BHUJ TEHSIL, DISTRICT: KACHCHH, GUJARAT
(TOPOSHEET: 41E/07, AREA 112.81 SQ.KM)

(SOURCE : NGDR)

N
W E
S

69°16'0"E 69°17'0"E 69°18'0"E 69°19'0"E 69°20'0"E 69°21'0"E 69°22'0"E 69°23'0"E 69°24'0"E 69°25'0"E 69°26'0"E 69°27'0"E

23°30'0"N 23°29'0"N 23°28'0"N 23°27'0"N 23°26'0"N 23°25'0"N 23°24'0"N 23°23'0"N 23°22'0"N 23°21'0"N 23°20'0"N 23°19'0"N

A B C D E F G H I J K L M N O P Q R S T

Legend

- Corner Points
- Proposed Devisar G4 Block

Lithology

- AEOLIAN SAND, CLAY, MARL
- LATERITE/BAUXITE WITH CLAY
- OLIVINE BASALT
- MILIOLITE LIMESTONE
- DOLERITE
- SANDSTONE
- FERRUGINOUS SANDSTONE AND GRIT
- FELDSPATHIC SANDSTONE AND GRIT
- GYPSEOUS SHALE, CALCAREOUS SST WITH BELEMNITES
- FERRU & FELDSPATHIC SST, SILTSTONE,PLANT FOSSIL
- FOSSILIFEROUS OOLITIC LIMESTONE AND SHALE
- GLAUCONITIC SST OOLITIC LST. SHALE, CONGLOMARATE

0 0.75 1.5 3 4.5 6 KM

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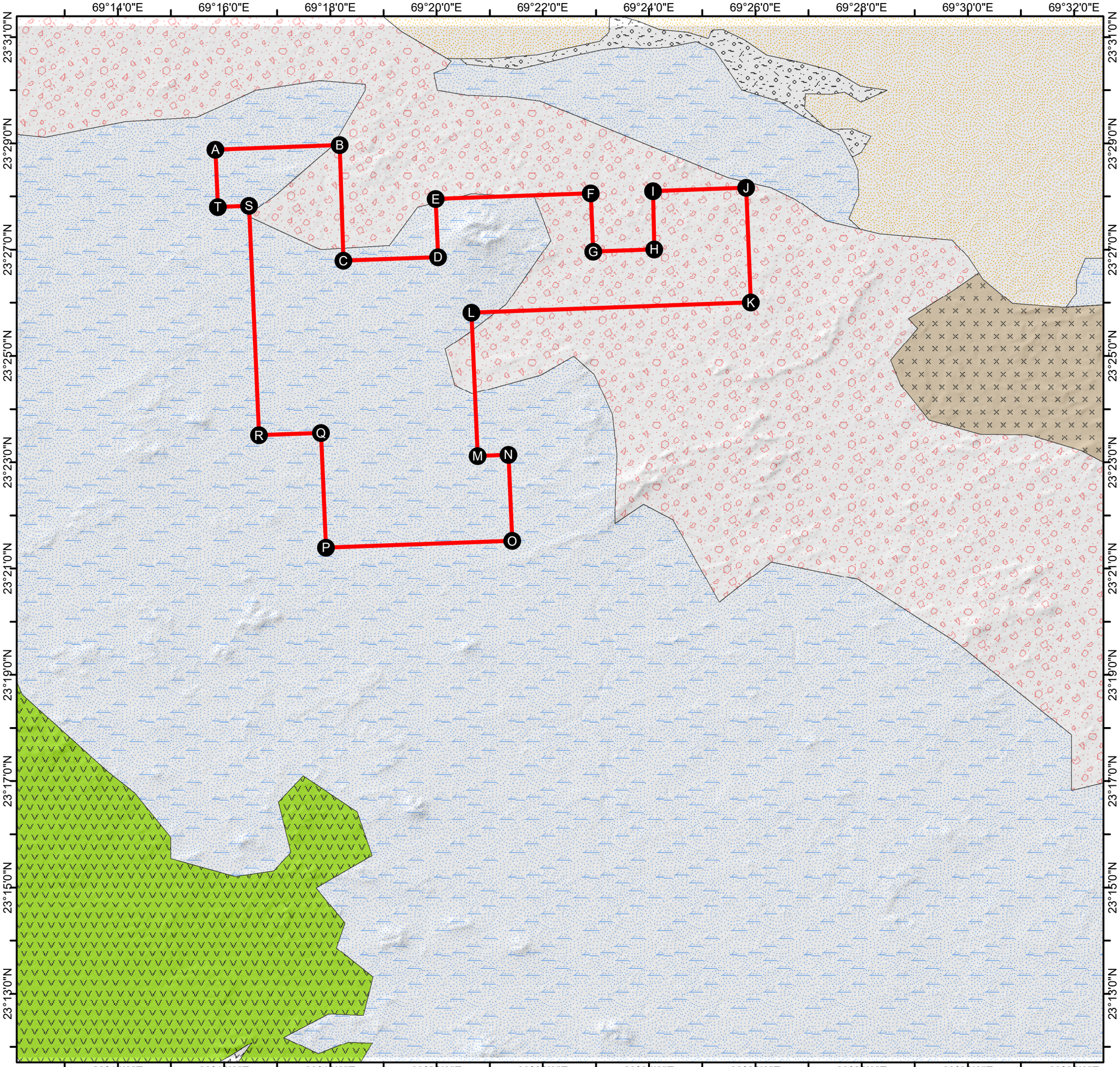
Govt of India Enterprise, A Miniratna PSE
MECL

REGIONAL GEOLOGICAL MAP OF PROPOSED DEVISAR (G4) BLOCK FOR REE & RM, GLAUCONITE AND PHOSPHORITE, IN BHUJ TEHSIL, DISTRICT: KACHCHH, GUJARAT (TOPOSHEET: 41E/07, AREA 112.81 SQ.KM)

(SOURCE : NGDR)



N
W E
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Legend

- Corner Points
- Proposed Devisar G4 Block

STRATIGRAP

- 289,UNDIFF.FLUVIAL / AEOLIAN / COASTA & GLACIAL SEDIMENTS,QUATERNARY
- 386,FULRA Fm,EOCENE
- 387,KAKDI NADI Fm.,EOCENE
- 469,DECCAN TRAP,LATE CRETACEOUS - PALAEOCENE
- 516,BHUJ Fm.,EARLY CRETACEOUS
- 538,KATROL Fm.,LATE JURASSIC - EARLY CRETACEOUS
- 558,CHARI Fm.,MIDDLE - LATE JURASSIC

KM
0 1.25 2.5 5 7.5 10

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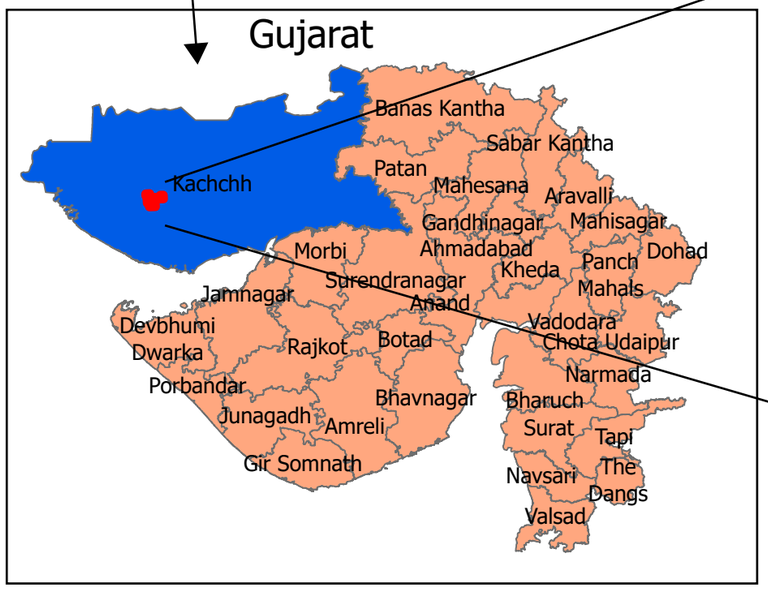
LOCATION MAP OF PROPOSED DEVISAR (G4) BLOCK FOR REE & RM, GLAUCONITE AND PHOSPHORITE, IN BHUJ TEHSIL, DISTRICT: KACHCHH, GUJARAT (TOPOSHEET: 41E/07, AREA 112.81 SQ.KM)



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S	23° 27' 49.381" N	69° 16' 28.396" E	
T	23° 27' 48.088" N	69° 15' 53.324" E	

Legend

Devisar_updated_block

Devisar_updated_corner

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