PROPOSAL FOR RECONNAISSANCE SURVEY (G-4 STAGE) FOR REE, GLAUCONITE AND ASSOCIATED MINERALIZATION IN DEVPUR REE AND GLAUCONITE BLOCK, KACHCHH BASIN, DISTRICT- KACHCHH, GUJARAT

COMMODITY: REE, GLAUCONITE AND ASSOCIATED MINERALS

BY

MINEREAL EXPLORATION AND CONSULTANCY LIMITED

DR. BABASAHAB AMBEDKAR BHAWAN

SEMINARY HILLS

PLACE: NAGPUR

DATE: FEBRUARY, 2025

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

GENERAL INFORMATION ABOUT THE BLOCK

	Features	**Details**
	Block ID	Devpur REE and Glauconite Block
	Exploration Agency	Mineral Exploration and Consultancy Limited (MECL)
	Commodity	REE, Glauconite and associated minerals
	Mineral Belt	Kachchh Basin
	Budget & Time schedule to complete the project	265.26 lakhs, 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 and glauconite bearing formation. 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, 05 nos of orientation pitting will be carried out. 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. Scout boreholes for REE will be carried out after the positive outcome of above exploration activities. 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 for REE bearing minerals as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules-

<table>
<tr><td></td><td></td><td>2015.
ix. To establish the reconnaissance resources glauconite as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.
x. The outcome of this exploration will decide further exploration strategy for upgradation of block to Preliminary (G-3) Exploration.</td></tr>
<tr><td></td><td>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</td><td>Work will be carried out by the proposed agency.</td></tr>
<tr><td></td><td>Name/ Number of Geoscientists</td><td>Three nos. of Geoscientist (3 Field + 1 HQ)</td></tr>
<tr><td></td><td>Expected Field days (Geology)
Geological Party Days</td><td>Geologist Party Days: 270 Days (Field)
Geologist Party Days: 75 Days (HQ)</td></tr>
<tr><td>1</td><td>Location</td><td></td></tr>
<tr><td></td><td colspan="2">The coordinates of corner points of proposed Devpur Block are as follows:
<table>
<tr><th rowspan="2">Sl. No.</th><th rowspan="2">Point</th><th colspan="2">DMS Coordinate (DMS)</th><th colspan="2">UTM Zone: 42N (m)</th></tr>
<tr><th>Latitude</th><th>Longitude</th><th>Northing</th><th>Easting</th></tr>
<tr><td>1</td><td>A</td><td>23° 20' 17.99" N</td><td>69° 16' 20.92" E</td><td>2581000.00</td><td>527854.00</td></tr>
<tr><td>2</td><td>B</td><td>23° 20' 17.1" N</td><td>69° 23' 23.97" E</td><td>2581000.00</td><td>539867.00</td></tr>
<tr><td>3</td><td>C</td><td>23° 13' 35.3" N</td><td>69° 24' 41.02" E</td><td>2568650.00</td><td>542090.00</td></tr>
<tr><td>4</td><td>D</td><td>23° 13' 35.75" N</td><td>69° 21' 36.54" E</td><td>2568650.00</td><td>536847.00</td></tr>
<tr><td>5</td><td>E</td><td>23° 16' 26.27" N</td><td>69° 16' 20.89" E</td><td>2573874.05</td><td>527866.56</td></tr>
</table></td></tr>
<tr><td></td><td>Villages</td><td>Devpur, Morjat, Dhavada, Vithon, Anandsar, Anandpar.</td></tr>
<tr><td></td><td>Tehsil/ Taluk</td><td>Nakhatrana</td></tr>
<tr><td></td><td>District</td><td>Kachchh</td></tr>
<tr><td></td><td>State</td><td>Gujarat</td></tr>
<tr><td>2.</td><td>Area (hectares/ square kilometers)</td><td></td></tr>
<tr><td></td><td>Block Area</td><td>138.52 sq km</td></tr>
<tr><td></td><td>Forest Area</td><td>The proposed block area was checked in PM Gatishakti Portal, where the block was said to be free from Eco sensetive Zone and Wildlife Sanctuary.</td></tr>
<tr><td></td><td>Government Land Area</td><td>Data Not Available</td></tr>
<tr><td></td><td>Private Land Area</td><td>Data Not Available</td></tr>
<tr><td>3.</td><td>Accessibility</td><td></td></tr>
</table>

	Nearest Rail Head	Bhuj (25 km east of the block)
	Road	All the villages in the area are well connected to each other and to the highways by motorable roads and tracks. The State Highway-42 connecting Bhuj to Lakhpat passes through the block through Nakhatrana town.
	Airport	Bhuj (25 km east of the block)
4	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	The northerly flowing rivers remain dry through most of the months except when it rains.
	Rivers/ Streams	Rukmavati and Kherod rivers,
5	**Climate**	
	Mean Annual Rainfall	Maximum Rainfall: 300 mm (July and August)
	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	Maximum Temperature: 45°C (May) Minimum Temperature: 7°C (January) Maximum Rainfall: 300 mm (July and August)
6	**Topography**	
	Toposheet Number	41E/07
	Morphology of the Area	The Katrol range, the hill range south of latitude 23°04' and discontinuous hills lying along latitude 23°27' are the major highlands in the area. To the north of the northern limit of the Kutch mainland lies the monotonous, flat grass-land, the Banni.
7	**Availability of baseline geosciences data**	
	Geological Map (1:50K/ 25K)	1:50000 (Bhukosh)
	Geochemical Map	Stream sediment sample results from NGCM, Bhukosh, GSI for TS 41E/07 have been used to compute LREE, HREE & Total REE geochemical anomaly maps presented as plates in the proposal.
	Geophysical Map	**Not Available**
8.	**Justification for taking up Reconnaissance Survey / Regional Exploration**	i The proposed Devpur block has a maximum total REE value of 5977 followed by 2921 and 2132 ppm. The maximum total HREE value in proposed Devpur block is 369 ppm followed by 203 ppm of which the major contributing

		elements are Dysprosium (maximum 176 ppm) and Gadolinium (maximum 131 ppm). The maximum LREE value in Devpur block is 5607 ppm and the major contributing element is Neodymium (maximum 4158 ppm). ii The Bhuj Formation in the proposed block mainly comprises of Ferruginous Shale, with few intercalated bands of sandy clay, grey-black pyritous shales, siltstone, carbonaceous shale, white kaolinitic clay. REEs can get adsorbed into clay bands. The REE deposits in the clay bands of Southern China particularly in Jiangxi, Guangdong, Fujian, Hunan, Guangxi, and Yunnan have total REE content ranging between 500 ppm to 2000 ppm in oxides with high proportion of HREE like dysprosium, terbium and yttrium. Similar to the ion adsorption clay deposit In Southern china provinces, the proposed blocks has intercalated clay layers within the ferruginous sandstone of Bhuj Formation. The proposed block also has higher concentration of Dysprosium, Gadolinium, Terbium similar to South China REE deposits. Hence the intercalated clay bands within the ferruginous sandstone of Bhuj Formation can be the possible source of secondary REE in the proposed block. iii The Kutch basin is an active tectonic basin with series of E-W trending strike faults in the area. Different phases of magmatic activities have emplaces along the weak planes caused by faulting. Some earlier workers assume that the beds of Bhuj Formation were stained ferruginous where the ferruginous matter might be derived from the weathering of Traps emplaced before the deposition of Bhuj sediments. The diagenetic reactions with Fe-Mn oxides from the volcanic plugs, the hydrothermal activity related to volcanism and later groundwater leaching might release the REE from source rock and redeposit them in the

		ferruginous sandstone of Bhuj Formation. iv The Kachchh Basin has experienced multiple sea-level fluctuations since the Mesozoic era. The Kachchh sedimentary basin contains Mesozoic to Cenozoic sedimentary rocks formed from the weathering of earlier intrusives, Precambrian granites and surrounding rocks. Most of the studied siliciclastic sediments were possibly sourced from Nagar Parkar uplift in the north and Aravalli Highlands to the east (Chaudhari et al, 2018). Nagar Parkar igneous complex comprises of late proterozoic granites, rhyolites, acid and basic dykes (Ahmad and Chaudhary, 2008). Common heavy minerals in the Bhuj sandstone include zircon, rutile, tourmaline, garnet, ilmenite, monazite, apatite, epidiorite, garnet. Chaudhari also inferred that the source of sedimentation was felsic igneous and high grade metabasic rocks. The heavy minerals heavy minerals found in the Bhuj sediments can host REEs. Hence exploration for REE can be carried out in this area. v 23 NGCM Stream Sediment Sample data points fall in the proposed Devpur Block and the maximum K2O value analysed in the stream sediment samples are 3.57 ppm and 3.54 ppm. Hence the proposed block can be taken up for reconnaissance survey of Glauconite.

PROPOSAL FOR RECONNAISSANCE SURVEY (G-4 STAGE) FOR REE AND GLAUCONITE MINERALIZATION IN DEVPUR BLOCK, DISTRICT –KACHCHH, STATE -GUJARAT (AREA 138.52 SQ. KM.)

1.1.0 INTRODUCTION:

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

1.0.2 The Rare earth elements (REE) are a collection of 17elements in the periodic table , namely scandium, yttrium and lanthanides (15 elements in the periodic table with atomic numbers 57 to 71 namely: lanthanum (La), cerium (Ce), praseodymium(Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb) and lutetium (Lu). In spite of its low atomic weight Yttrium (atomic no. 39) has properties more similar to the heavy lanthanides and is included with this group. Scandium (atomic no. 21) is found in a number of minerals although it may also occur with other rare earth elements (REE).

1.0.3 Although these elements tend to occur together, the lanthanide elements are divided into two groups. The light rare earth elements (LREE) are those with atomic numbers 57 through 62(La, Ce, Pr, Nd, Pm, Sm) and the heavy rare earth elements (HREE) are those with atomic numbers from 63 to 71 (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) and Y, Sc. However, because of their geochemical properties, rare earth elements are typically dispersed and not often found concentrated as rare earth minerals in economically exploitable ore deposits.

1.0.4 Generally the light rare earth elements (LREE) are more abundant in the earth's crust and easily extracted than heavy rare earth elements (HREE). It was the very scarcity of these minerals (previously called "earths") that led to the term "rare earth". The first such mineral discovered was gadolinite, a compound of cerium, yttrium, iron, silicon and other elements. This mineral was extracted from a mine in the village of Ytterby in Sweden; several of the rare earth elements bear names derived from this location.

1.0.5 Critical minerals are those minerals that are essential for economic development and national security. The lack of availability of these minerals or concentration of extraction or processing in a few geographical locations may lead to supply chain vulnerabilities and even disruption of supplies. The future global economy will be underpinned by technologies that depend on minerals such as lithium, graphite, cobalt, titanium, and rare earth elements. These are essential for the advancement of many sectors, including high-tech electronics, telecommunications, transport, and defence. They are also vital to power

the global transition to a low carbon emissions economy, and the renewable energy technologies that will be required to meet the 'Net Zero' commitments of an increasing number of countries around the world. Hence, it has become imperative to identify and develop value chains for the minerals which are critical to our country.

1.0.6 Considering important parameters such as resource/ reserve position in the country, production, import dependency, use for future technology/ clean energy, requirement of fertilizer minerals in an agrarian economy, the Committee has identified a set of 30 critical minerals. These are Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, Lithium, Molybdenum, Niobium, Nickel, PGE, Phosphorous, Potash, REE, Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium and Cadmium. *(Critical Minerals for India, Report of the Committee on Identification of Critical Minerals, Ministry of Mines, June 2023)*

1.2.0 BACKGROUND

1.2.1 The Commissioner of Geology and Mining (CGM), Gujarat has identified several blocks for exploration of Critical and Strategic Mineral based on previous work. They published the information of these blocks in Gujarat's Mineral Wealth. CGM, Gujarat (via official email dated 14/11/2024) sent MECL a NOC approval to take up exploration investigation in those blocks. The proposed Devpur REE and Glauconite Block (G-4 stage) is one of them.

1.2.2 The proposed Devpur REE and Glauconite Block is carved from the Nakshatrana Alkaline Plug Block (G-4) allotted to MECL by CGM Gujarat. The maximum total REE NGCM value in the proposed block is 5977 ppm, followed by 2921 ppm and 2132 ppm which is highly anomalous.

1.2.3 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.

1.2.4 Keeping this in view, the present proposal is being put up for Reconnaissance Survey (G-4) for REE and glauconite in Devpur REE and Glauconite Block, Kachchh Basin, Kachchh District, Gujarat for approval in the forthcoming meeting of Technical cum Cost Committee (TCC) of NMET.

2.1.0 LOCATION AND ACCESSIBILITY

2.1.1 The proposed Devpur Block comprises of 138.52 sq km area and lies in Nakhatrana Tehsil of Kachchh District (Toposheet No. 41E/07 and 41E/08), Gujarat. The major villages falling within the proposed block are Devpur, Morjat, Dhavada, Vithon, Anandsar, Anandpar. All the villages in the area are well connected to each other and to the highways by motorable roads and tracks. The State Highway-42 connecting Bhuj to Lakhpat passes through the block. The district headquarter Bhuj is about 25 km east of the block. The nearest railway station and airport is at Bhuj which are at about 25 km east of the proposed block. The proposed Block is bounded by latitudes 23° 13'N to 23° 20' 18"N and longitudes 69° 16'E to 69° 24' 42"E (Plate No- I)

Table 2.1: Coordinates of Corner Points of Proposed Devpur REE and Glauconite Block over an extent of 138.52 sq km, Kachchh District, Gujarat.

Sl. No.	Point	DMS Coordinate (DMS)		UTM Zone: 42N (m)	
		Latitude	Longitude	Northing	Easting
1	**A**	23° 20' 17.99" N	69° 16' 20.92" E	2581000.00	527854.00
2	**B**	23° 20' 17.1" N	69° 23' 23.97" E	2581000.00	539867.00
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5	**E**	23° 16' 26.27" N	69° 16' 20.89" E	2573874.05	527866.56

2.2.0 PHYSIOGRAPHY

2.2.1 Physiographically, the area can be divided into four parts separated by three east-west trending hill ranges, namely (1) the Katrol range which lies approximately parallel to the latitude 23°11', (2) the hill range south of latitude 23°04' and (3) discontinuous hills lying along latitude 23°27'. To the north of the northern limit of the Kutch mainland lies the monotonous, flat grass-land, the Banni. Apart from these ranges, there are many individual conical hills, abruptly rising high from the plains.

2.3.0 DRAINAGE

2.3.1 The Katrol hill range serves as a water divide for the rivers flowing from its northern and southern sides. The southerly coursing Rukmavati, Kherod and Khadkawati rivers flow into the Gulf of Kutch, whereas the Bhoyad and Bukhi rivers drain northwards into the Rann of Kutch. These rivers together with many small *nullahs* cut deep channels. The northerly flowing rivers remain dry through most of the months except when it rains. The Rukmavati and Kherod rivers, however, maintain a meagre discharge throughout the year, owing to the springs in their vicinity near Gangaji and at a place 1 km south-east of Dujapur.

2.4.0 CLIMATE

2.4.1 The area falls under the arid-semi-arid climatic zone receiving annual precipitation between 200-300 mm. The area is quite fertile and sustains a viable population on account of the copious supply of ground water provided by Bhuj Sandstone Formation aquifer. In a region of less rainfall, orchards of mango, sapota and coconuts are found. The temperatures in this region are typically extreme with summer scorching up to 45°C. The oppressive heat conditions persist from April to June. Winters are mild with temperature ranging from 7°C to 10°C.

Maximum Temperature: 45°C (May)
Minimum Temperature: 7°C (January)
Maximum Rainfall: 300 mm (July and August)

2.5.0 FLORA AND FAUNA

2.5.1 Except for the areas which are hilly and bouldery, rest of the area is mostly under extensive and intensive cultivation. The main crops of the area are maize, cotton, groundnut and Aloe vera. Other floras commonly seen in the area are ber, acacia and cactus.

2.5.2 Other flora commonly seen in the area are ber, acacia and cactus. Important fauna present in the area include chinkara, antelope, fox, jackal, rabbit, varanus, etc.

3.1.0 REGIONAL GEOLOGY

3.1.1 Regionally, the area exibits Cretaceous- Jurassic rocks which are the oldest rocks except for some patches of Precambrians. They are fringed by Deccan Traps to the south and the saline marsh of Great Rann of Kachchh to the north. The Cretaceous- Jurassic rocks have an estimated thickness of about 2000 m and in three anticlinal ridges (N to S) trending in E-W direction. Owing to E-W faults, i.e. Kachchh Mainland Fault (KMF), Katrol Hill Fault (KHF), the whole sequence is repeated along N-S. The southernmost chain forms a 65 km long Katrol hill range in the south of Bhuj town. Mesozoic rocks of Kachchh, comprises of four formations i.e. Pachchham, Chari, Katrol and Bhuj in order of superposition.

Pachchham Formation: The Pachchham Formation of Jurassic age comprises 300m thick sequence of intercalated sequence of siltstone / shale, calcareous sandstone and fossiliferous conglomerate with minor coralline and algal limestone bands in the lower part, followed by limestone and sandstone with plant fossils in the middle part and intercalated sequence of gypseous shale /siltstone, fossiliferous calcareous sandstone and grey-khaki coloured gypseous shale, siltstone and limestone in the upper part.

Chari Formation: The Chari Formation of Jurassic age unconformably overlies the Pachchham Formation and comprises of 400m thick sequence of polymicitic conglomerate, fossiliferous gypseous marly shale, fossiliferous calcareous gritty sandstone, shale and oolitic limestone. In Katrol hill range they form half domes cut by Katrol hill fault.

Katrol Formation: The Katrol Formation of Creta-Jurassic age unconformably overlies the Chari Formation and comprises of 400m thick sequence of ammonite bearing marl & shales, calcareous and quartzitic sandstone, brown to dark grey shale and conglomerate bands with belemnites and gastropods and ochreous nodular horizons. The shale and sandstone are glauconitic and carbonaceous.

Bhuj Formation: Bhuj Formation of Cretaceous age forms a vast E-W trending stretch and abut against the Chari and Katrol Formations along the E-W trending Katrol hill fault. It conformably overlies the Katrol Formation and comprises of 1000m thick succession of conglomerate, sandstone, shale, siltstone with cyclically repetitive sequence of ironstone, shale and feldspathic sandstone. The basal part comprises sequence of

gypseous shale, clay, black and carbonaceous shale with coal bands and glauconitic fossiliferous sandstone with plant beds. The upper part contains glauconitic shale, feldspathic and burrowed sandstone and clay. Rhythmic intercalations of ironstone and conglomerates with pebbles of basalt with thick bands of marine and plant fossils are also found.

Deccan Trap: The Deccan Traps of Creta – Eocene age, exposed mainly in the southern parts of Kachchh overlies the Bhuj Formation. The flows are of olivine basalt and alkali olivine basalt affinity in basal part, tholeiitic in middle and andesitic in upper part. Thin intertrappean horizons within the basalts comprises clay, sandstone, shale, limestone and chert. Associated with the basaltic flows are several basaltic / doleritic plugs, sills and dykes.

Tertiary Rocks: The tertiary sediments were deposited over the Mesozoic sedimentary rocks and Deccan Traps along the coastal strip of Kachchh Mainland. The Tertiary rocks are exposed all along the western, southern, southwestern and southeastern part of Kachchh. The Tertiary Formation of Kachchh consists of three distinct facies − the lower one is altered volcanics and is represented by the Matanomadh Formation, the middle is marine transgressional facies i.e. represented by the Fulra, Khari Nadi, Gaj formations and the upper part is fluviatile and is represented by the Manchar Formation. The Matanomadh Formation of Palaeocene age comprises 50m thick sequence of saprolite, ash, bentonite clay, lateritic bauxite, laterite, conglomerate, tuffaceous sandstone, kaolinitic clay, grit and unconformably overlies the lava flows & the older sedimentary rocks. Fulra formation of lower to upper Eocene age conformably overlies the Matanomadh Formation and comprises foraminiferal limestone, glauconitic shale and clay. Khari Nadi Formation of Oligo-Miocene age conformably overlies the Fulra Formation and comprises 60-70m thick sequence of variegated shale, fossiliferous limestone with marl, limestone and shale. Gaj Formation of lower Micoene age comprises variegated shale, clay, fossiliferous marl and limestone. Manchar Formation conformably overlies the Khari Nadi Formation and comprises 50m thick sequence of micaceous sandstone, clay, conglomerate.

Table No. 3.1
Regional stratigraphy of the area (After GSI)

Age	Group	Formation	Lithology
Holocene/ Recent		**Recent**	Sand, Silt
		Mahuva	Younger tidal flat and Marsh deposit
		Rann Clay	Older tidal flat and Marsh deposit
		Rann	Rann Clay and mud deposit
		Varahi	Younger Flood Plain, Channel fill and Deltaic Deposit
		Katpur	Older Flood Plain, Channel fill and Deltaic Deposit
		Jantral	Unstabilised sand sheet and sand dune deposit
Lower Pleistocene	**Porbandar**	**Miliolite**	Miliolite limestone, shell limestone, calcareous sandstone, pebbly limestone, conglomerate.

Age	Group	Formation	Lithology
Lower Pleistocene		**Kothara**	Pebbly sandstone, Conglomerate, gravel and sand
Pliocene		**Sandhan**	Micaceous sandstone, mottled clay, siltstone, conglomerate, calcareous clay with marl
Lower to Middle Miocene		**Gaj**	Shale interbedded with fossiliferous marl
Early Miocene		**Khari Nadi**	Varigated Siltstone, Gypseous claystone
Middle to Upper Oligocene		**Maniyara Fort**	Calcareous and Gypseous claystone/ siltstone, clay, coral limestone, sandstone
Eocene		**Fulra**	Fossiliferous marl and limestone, Glauconitic Shale and Clay
Lower Eocene		**Kakdi Nadi**	Gypseous, lignite bearing shale, fossiliferous nodular limestone and clay, ferruginous shale and clay with intercalated marl.
Early Palaeocene		**Matanomadh**	Laterite, Sandstone, Conglomerate, Bentonitic and Kaolinitic Clay
Unconformity			
Upper Cretaceous to Eocene	**Deccan Trap Super Group**	**Anjar Volcanics**	Basalt, amygdular basalt and basic intrusive dykes
		Dayapar Volcanics	Basalt
		Khambhaliya Volcanics	Basalt
Intrusive Contact			
Lower Cretaceous		**Bhuj**	Feldspathic sandstone, ferruginous sandstone, gritty sandstone, ferruginous gritty sandstone, quartzite and shale – siltstone in alternation
Conformable			
Upper Jurassic to Lower Cretaceous		**Katrol**	Calcareous sandstone, gritty sandstone, khakhi shale – siltstone, gypseous shale, ash coloured shale, pink sandstone, pink siltstone, dark shale, fossiliferous limestone, ferruginous sandstone, quartzite
Unconformity			
Middle to Upper Jurassic		**Chari**	Fossiliferous oolitic marl, calc arenite / calc quartzite, fossiliferous conglomerate, pink sandstone, gypseous shale – siltstone, ash colour shale – brown colour siltstone, arenite, bouldery sandstone, fossiliferous sandstone, ferruginous sandstone, gritty sandstone
Middle Jurassic		**Pachchham**	Gypseous Shale, Siltstone, Limestone, Sandstone, Conglomerate
Basement not exposed			

3.2.0 GEOLOGY OF THE BLOCK

3.2.1 The proposed block area represents the southern part of the Kachchh Basin which is an east-west oriented pericratonic rift basin. Geologically the block comprises of sediments belonging belonging to the Lower Cretaceous Bhuj Formation, minor volcanics of Upper Cretaceous to Eocene Deccan Trap and Lower Pleistocene Miliolite Formation. The Bhuj Formation almost entirely covers the proposed block represented by lower feldspathic sandstone and grit, which commonly shows current bedding and upper ferruginous sandstone which are gritty and quartzitic. Patches of shale within the feldspathic sandstone were observed were observed by earlier workers. The Deccan Traps have intruded the Bhuj Formation at places, which are represented by litholigies like basalt, olivine basalt and dolerite. The tertiary sediments i.e. Miliolite Limestone has deposited at the fringes of Deccan Traps. One East- West trending fault about 12 km long with the fault plane dipping towards south west is observed in the block along with other minor faults.

Table- 3.2
The generalized stratigraphic succession of the proposed block. (After GSI)

Age	Super Group	Formation	Lithology
Lower Pleistocene	Porbandar Group	Miliolite	Miliolite limestone, shell limestone,
Upper Creataceous	Deccan Trap Supergroup	Anjar Volcanics	Basalt, Olivine basalt, Dolerite
Lower Cretaceous		Bhuj	Ferruginous gritty sandstone, quartzite and shale – siltstone in alternation Feldspathic sandstone

3.3.0 PREVIOUS WORK - OBSERVATION AND RECOMMENDATIONS

3.3.1 Kulkarni G.R. and Thothathiri G., during the field season 1964-65, carried out systematic geological mapping and preliminary and investigation, in topo-sheet No. 41 E/4 and parts of 41E/7. They had observed that the Bhuj Series consist of of felspathic, gritty sandstones, intercalated with clays and carbonaceous shales comprising of estuarine to deltaic sediments. It was also observed that the beds were stained ferruginous where the ferruginous matter might be derived from the weathering of Traps. Jointing in sandstone resulting in pentagonal and hexagonal columns perhaps due to the thermal effects of adjoining lava on the argillaceous cement and from the subsequent cooling were also noticed. This has resulted in formation of buchite rock, where melted edges of quartz grain and formation of cristobalite were noticed. The sansstone units were also noticed to be intercalated with sandy clays and dark shales. Around Nakhatrana, the Bhuj sandstones showed a general E-W strike and dip at 3° to 5° towards south. Detailed investigation for bentonite clay was recommended.

3.3.2 Desikan N., Kulkarni G.R. and Thothathiri G., during the field season 1965-66, carried out systematic geological mapping on 1: 63,360 scale in an area of 1,355 sq km covered by the Toposheet Nos. 41 E/7 and 41 E/8. They have observed that the oldest rock unit in the area is Chari Formation of Jurassic Period. There are three major strike faults trending WNW-ESE or E-W, which affect the northen limb of three anticlines called Banni, Bhadli and Katrol. The upthrown side is always south, thus exposures of Katrol and Chari are repeated. Owing to the transverse undulations of the anticlines, domal inliers had formed. The faults observed in the area were assumed to be post-Bhuj and per-Deccan trap, for they have not affected the Deccan traps. It was recommended that systematic geological mapping of adjacent toposheet No. 41/E/11 and 41 E/12 can be taken up as the major folds and faults in the area continue there.

3.3.3 Ghevariya Z. G., Srikarni C., during field season1989-90 carried out systematic geological mapping of Mesozoic Rocks in 1130 sq km area in parts of Toposheet No. 41 E/7, 13, & 14, 41 I/1, 6 & 7. It was observed that Bhuj Formation unconformably lies over Katrol formation and comprises of two members lower and upper. The lower member comprises of burrowed ferruginous sandstone, grey and black pyritous shales, siltstone, carbonaceous shale with thin coal seams at places. The upper part of Bhuj Formation comprises of thick sequence of friable, cross bedded feldspathic white, grey siltstone clays, white kaolinitic clay profusely burrowed and lateritised sandstone sequences. Bhuj Formation was deposited in shallow fluvial conditions with a constantly changing basin floor with intermittent sub-aerial exposure.

They have also opined that the Mesozoic rocks have been intruded by many intrusive bodies such as plugs, dykes, sills, laecoliths, phacoliths of various dimensions. The mesozoic rocks are affected by many faults and some of the intrusives have found their way along these faults. Three common sets of faults are (1) N - S to NW - SE (2) NE-SW and (3) E -W. These intrusives were grouped into two types based on composition and relation with the host rocks.

I. Ultrabasic and alkaline set of intrusives which show hypabyssal characters represented by alkaline gabbro, essexite, ankaramite, trachite, granophyre, camptonite with explosive phase and are mainly confined to Pachham Formation. These plugs are rich in olivine, pyroxene. These intrusives were emplaced at the end of Pachchham times and pre-Chari age.

II. Younger dykes of doleritic basaltic and olivine gabbroic nature which are intrusive into the first type and also into the Katrol and Bhuj Formation. These bodies are surrounded by rim of thick pyroclastic surge slope deposits which contain boulders of varied composition including the host rocks. These rocks show abundant growth of crystatites within the interstitial space and in the olivine and augite cystals. These dykes have produced a set of hybrid rocks including banding in which the mafics, cystallites and microliter are concentrated within the bands. The quartz-grains of the host rocks show

exsolution and corroded crystal boundary due to mixing of magmatic matter in the vicinity of the intrusive. The development of hexagonal columnar joints within the sandstone is probably related to this textural change. The younger dykes and plugs have intruded rocks of lower Bhuj and evidences show that the plugs are Pre-Deccan Trap before the closing of Bhuj sedimentation. Dykes younger than plugs intruding the upper members of Bhuj were also observed.

It was recommended that geochemical work for search of nickle, cromium and platinum group of metals in alkaline gabbroic bodies and essexite can be carried out in detail. Geochronological work was proposed for the alkaline plugs and the younger pre-Deccan traps intrusives in order to date the magmatic events and correlate them with the tectonic events.

3.3.4 Kathiara R. S. during the field season 1978-79 carried out investigation for phosphorite in 220 sq km area falling in toposheet no 41, E/4 7, 8, &12 in 1:63,360 scale. The bands of Phosphatic Cherty Limestone of Chari series were tested and sampled for determinations of P2O5 content. The maximum cumulative thickness of limestone is 2.3 m out of which the upper two bands of limestone having a total thickness of about 1.5 m show the presence of P2O5 by Shapiro's method. The analytical data of 275 samples indicated that the P2O5 content in all the samples is between 1.0 and 5.00% only 04 samples showed 7 to 8% P2O5. The estimated reserve for phosphorite was given as 9. 00 million tones but cannot be exploited economically due to low P2O5 content.

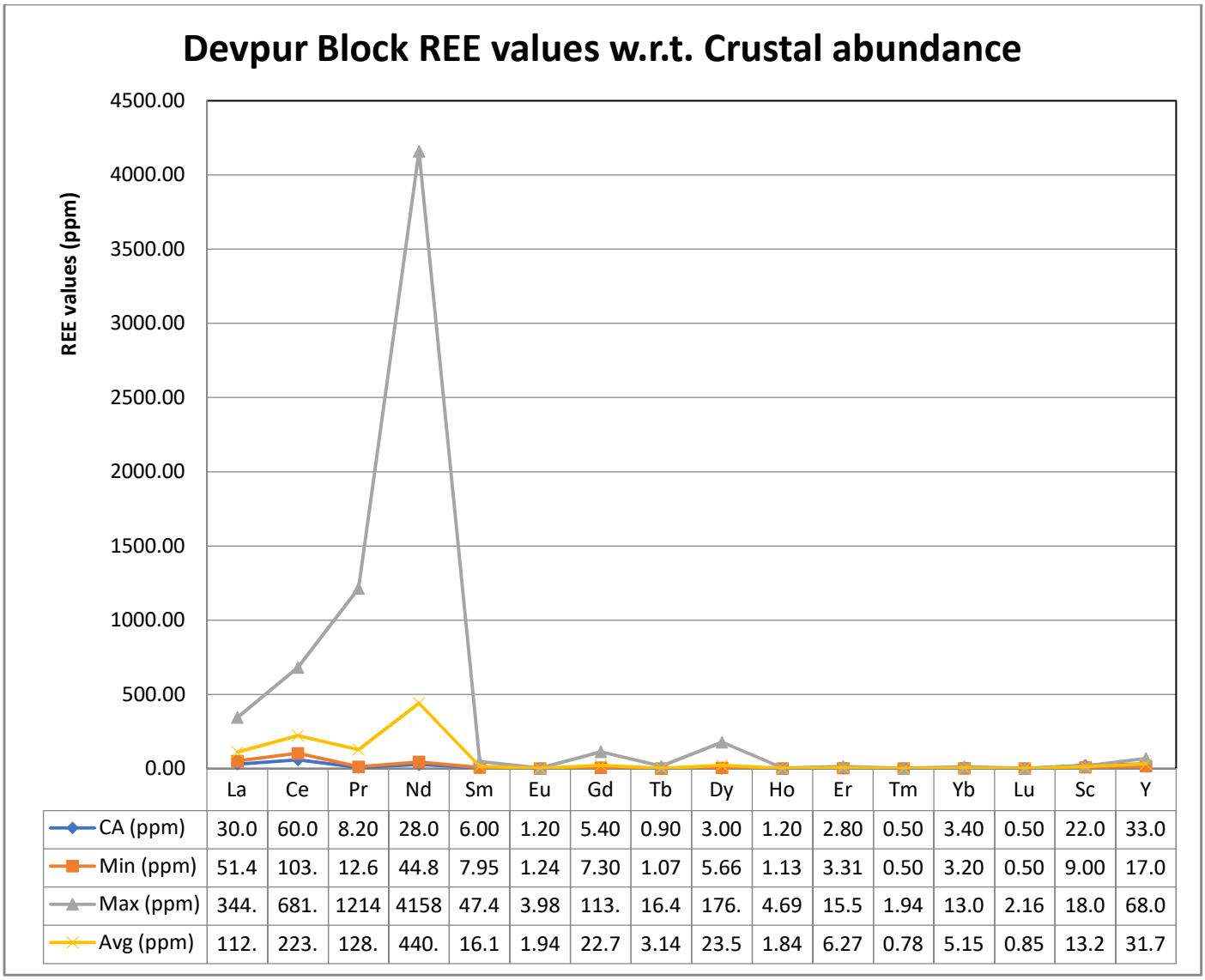
3.3.5 MECL has downloaded NGCM data from NGDR portal, GSI of Toposheet No. 41E/07. The total REE, LREE, HREE values in stream sediments falling in the proposed block was calculated and it was observed that the maximum total REE value in the proposed block was 5977 ppm followed by 2921 ppm and 2132 ppm. The maximum and minimum range for each element is given in below table.

Table-3.1

Data showing NGCM Stream Sediment results for Proposed Devpur Block (23 numbers of samples) (Source: NGDR portal GSI)

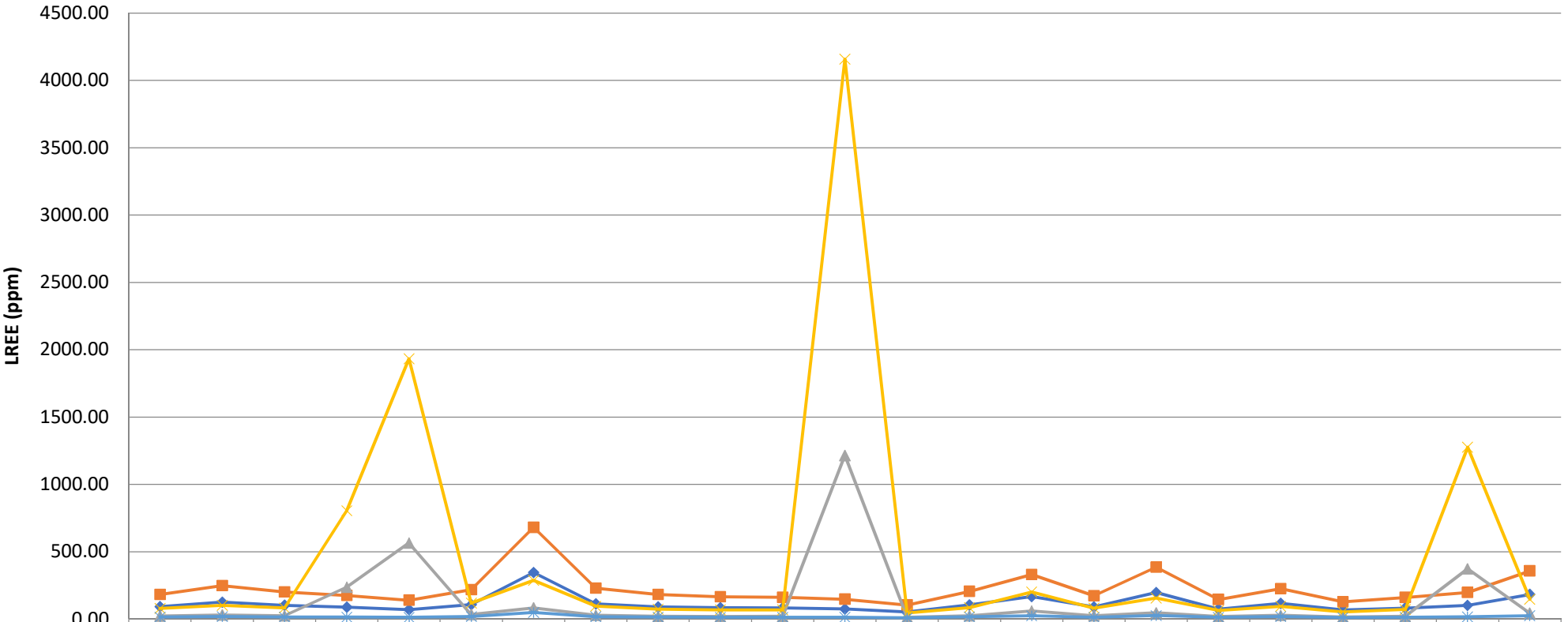
Crustal abundance (ppm) of rare earth elements (After Mason and Moore 1982)			**Summary of Stream sediment sample data falling in Proposed Block**		
Group	**Element**	**Crustal abundance (ppm)**	**Minimum (ppm)**	**Maximum (ppm)**	**Average (ppm)**
LREE	Lanthanum (La)	30	51.48	344.25	112.26
	Cerium (Ce)	60	103.28	681.35	223.15
	Praseodymium (Pr)	8.2	12.61	1214.61	128.35
	Neodymium (Nd)	28	44.87	4158.36	440.79
	Samarium (Sm)	06	7.95	47.41	16.18
	Europium (Eu)	1.2	1.24	3.98	1.94
	Gadolinium (Gd)	5.4	7.30	113.05	22.75
	Terbium (Tb)	0.9	1.07	16.44	3.14
	Dysprosium (Dy)	03	5.66	176.92	23.58

Crustal abundance (ppm) of rare earth elements (After Mason and Moore 1982)			Summary of Stream sediment sample data falling in Proposed Block		
Group	**Element**	**Crustal abundance (ppm)**	**Minimum (ppm)**	**Maximum (ppm)**	**Average (ppm)**
HREE	Holmium (Ho)	1.2	1.13	4.69	1.84
	Erbium (Er)	2.8	3.31	15.57	6.27
	Thulium (Tm)	0.5	0.5	1.94	0.78
	Ytterbium (Yb)	3.4	3.20	13.00	5.15
	Lutetium (Lu)	0.5	0.50	2.16	0.85
	Scandium (Sc)	22	9	18	13.26
	Ytrium (Y)	33	17.00	68.00	31.70
LREE			**221.68**	**5607.48**	**922.67**
HREE			**51.67**	**369.35**	**109.33**
TREE			**273.35**	**5976.83**	**1032.00**



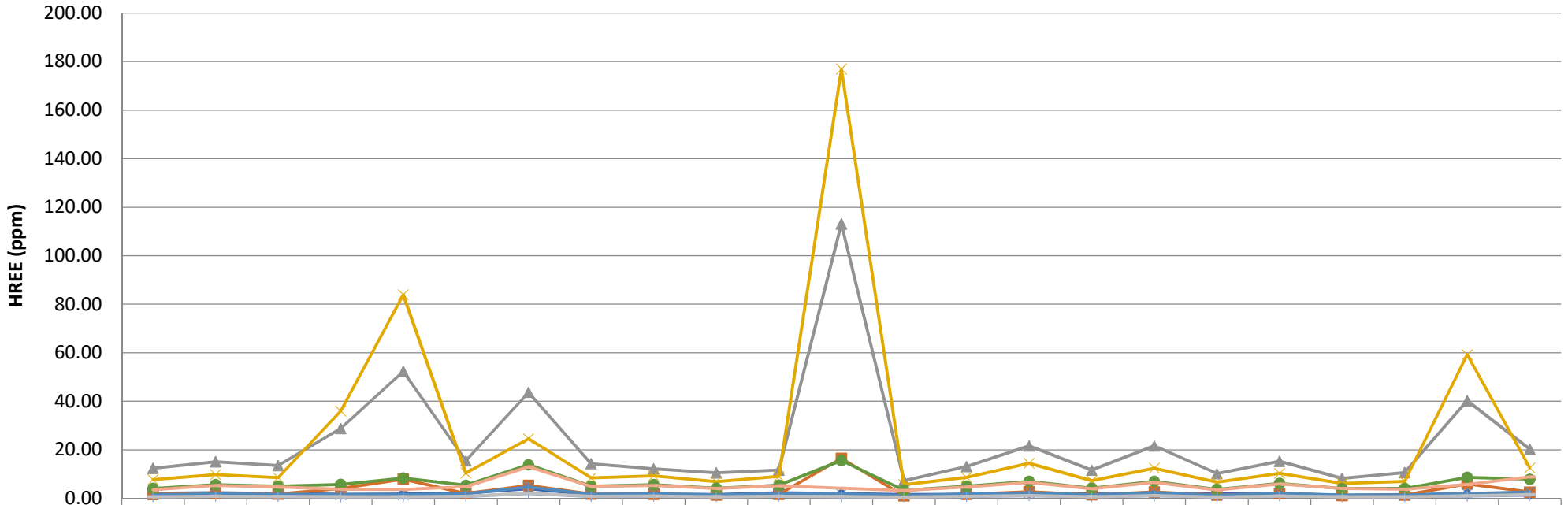
	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Sc	Y
CA (ppm)	30.0	60.0	8.20	28.0	6.00	1.20	5.40	0.90	3.00	1.20	2.80	0.50	3.40	0.50	22.0	33.0
Min (ppm)	51.4	103.	12.6	44.8	7.95	1.24	7.30	1.07	5.66	1.13	3.31	0.50	3.20	0.50	9.00	17.0
Max (ppm)	344.	681.	1214	4158	47.4	3.98	113.	16.4	176.	4.69	15.5	1.94	13.0	2.16	18.0	68.0
Avg (ppm)	112.	223.	128.	440.	16.1	1.94	22.7	3.14	23.5	1.84	6.27	0.78	5.15	0.85	13.2	31.7

Fig 3.1: Line Diagram for total LREE (ppm)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
la	90.9	123.	101.	86.9	68.9	106.	344.	112.	88.6	82.9	80.9	73.2	51.4	103.	166.	88.5	196.	72.7	115.	65.8	80.2	100.	181.
ce	182.	247.	200.	174.	138.	217.	681.	228.	181.	165.	160.	146.	103.	204.	330.	172.	385.	145.	224.	126.	160.	196.	357.
pr	21.9	29.6	23.5	235.	564.	33.7	82.0	27.1	20.9	19.0	19.2	1214	12.6	24.2	59.1	24.0	45.5	17.4	26.8	15.0	19.8	372.	42.9
nd	78.5	101.	81.6	804.	1933	118.	286.	94.6	73.5	67.7	67.4	4158	44.8	84.5	201.	81.3	156.	63.0	94.3	52.3	70.7	1276	146.
sm	14.1	17.7	14.1	13.0	11.0	16.5	47.4	16.2	13.1	11.9	12.1	12.4	7.95	14.6	23.2	12.2	25.4	11.8	17.0	9.35	11.8	14.8	23.7

Fig 3.2: Line Diagram for total HREE (ppm)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
eu	2.13	2.26	2.02	1.68	1.73	2.22	3.98	1.60	1.77	1.59	2.24	1.95	1.50	1.66	2.31	1.87	1.88	2.03	1.96	1.24	1.56	1.84	1.67
tb	1.66	2.05	1.76	4.10	7.96	2.04	5.32	1.79	1.74	1.42	1.70	16.4	1.07	1.74	2.79	1.47	2.68	1.39	2.05	1.17	1.41	6.00	2.60
gd	12.3	15.1	13.5	28.7	52.3	15.4	43.7	14.3	12.2	10.5	11.6	113.	7.30	13.0	21.6	11.6	21.6	10.1	15.3	8.26	10.6	40.1	20.2
dy	7.75	9.81	8.58	35.9	83.9	10.4	24.6	8.47	9.32	6.89	9.06	176.	5.66	8.71	14.4	7.28	12.4	6.68	10.3	6.17	7.05	59.2	12.5
ho	1.39	1.86	1.69	1.48	1.46	1.83	4.69	1.64	1.89	1.40	1.85	1.82	1.13	1.71	2.25	1.40	2.37	1.28	2.03	1.29	1.37	1.99	2.60
er	4.03	5.61	4.98	5.74	8.27	5.34	13.8	4.97	5.57	4.17	5.43	15.5	3.31	5.00	6.95	4.14	6.97	3.62	6.16	3.99	4.06	8.58	7.85
tm	0.55	0.81	0.73	0.57	0.56	0.73	1.94	0.74	0.82	0.62	0.78	0.65	0.50	0.72	1.00	0.60	0.97	0.51	0.89	0.60	0.59	0.86	1.23
yb	3.55	5.26	4.64	3.70	3.61	4.77	13.0	4.87	5.24	4.07	5.19	4.17	3.20	4.62	6.58	3.89	6.57	3.44	5.88	4.03	3.74	5.67	8.83
lu	0.59	0.86	0.74	0.61	0.60	0.78	2.16	0.84	0.89	0.64	0.86	0.72	0.50	0.76	1.09	0.65	1.08	0.55	0.94	0.65	0.63	0.97	1.51

4.1.0 PLANNED METHODOLOGY

4.1.1 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.

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, 05 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. After the positive outcome of the above activities 300 m of scout drilling will be carried out for REE.

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

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

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

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

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

4.1.2 The details of different activities to be carried out are presented in subsequent paragraphs.

5.1.0 GEOLOGICAL MAPPING

5.1.1 Geological mapping will be carried out in the entire 138.52 sq.km area on 1:12,500 scale. Rock types, their contact, structural features will be mapped. Surface manifestations of the mineralization (REE and glauconite) available along with their surface disposition will be marked on map.

5.1.2 50 nos. of bedrock samples will be collected from the various lithounits present in the area, to identify the host REE bearing formation. The Bhuj Formation which in the

proposed block mainly comprises of Ferruginous Shale, but few intercalated bands of sandy clay, grey-black pyritous shales, siltstone, carbonaceous shale, white kaolinitic clay were also reported by earlier workers. REEs can get adsorbed into clay bands, thus these lithounits will be sampled and analysed for REE bearing minerals. Few samples will be collected from alkaline plugs present in the area, which will be analysed for REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti. 34 element ICPMS studies will be carried out for the 50 bedrock samples collected from various lithounits, 10% of primary samples i.e. 05 external check samples will be sent to NABL External Labs for analysis.

5.1.3 For identification of glauconite bearing mineral horizon, a provision of 50 bedrock samples have been proposed. The samples collected for glauconite will be analysed for major oxides K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3 by XRF method. Around 10% of Primary samples i.e. 05 samples for glauconite will be sent to NABL External Labs for analysis of major oxide studies (K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3) by XRF method

5.1.4 15 nos. of surface samples from various lithounits will be studied for petrology and minerography.

5.2.0 GEOCHEMICAL SAMPLING (Stream Sediment Sampling)

5.2.1 During the course of Geological mapping stream sediment samples will be collected from 1st order and 2nd order streams to identify the positive catchment area for REE mineralization. The stream sediment sample will be commenced from the positive catchment area identified by NGCM samples having total REE value greater than 1000 ppm.

5.2.2 Total 40 stream sediment samples will be collected from the proposed block which will be subjected to heavy mineral separation. The heavy mineral separation will help to give an idea about the amount of heavies which can be extracted from stream sediments. The final heavies collected by both methods will be powdered and sent to laboratory for 34 element ICPMS analysis of REE. 04 external check samples will be analyzed for assay of 34 elemental analysis includes REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti

5.3.0 EXPLORATORY MINING (PITTING & TRENCHING):

5.3.1 Orientation pitting will be carried out in positive catchment area identified on the basis of total REE NGCM values of GSI and analysis of stream sediment samples collected during proposed exploration. A provision of 05 nos of pits on the identified anomalous zone (2 m wide X 2 m deep) with 20 cubic meters is kept. Pitting will be carried from surface up to a depth of 2 m. Locations of pits will be decided by field geologist based on field observations.

5.3.2 20 orientation soil samples will be collected from 05 pits (soil and bedrock if exposed). The collected soil samples will be subjected to heavy mineral separation. The orientation soil samples would help to decide the target soil horizon best suitable for REE mineralization. All heavies generated would be powdered and analysed for 34 elemental analysis including REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti by ICPMS method. Total 2 nos. of check samples will be analyzed for 34 element ICPMS analysis includes REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti.

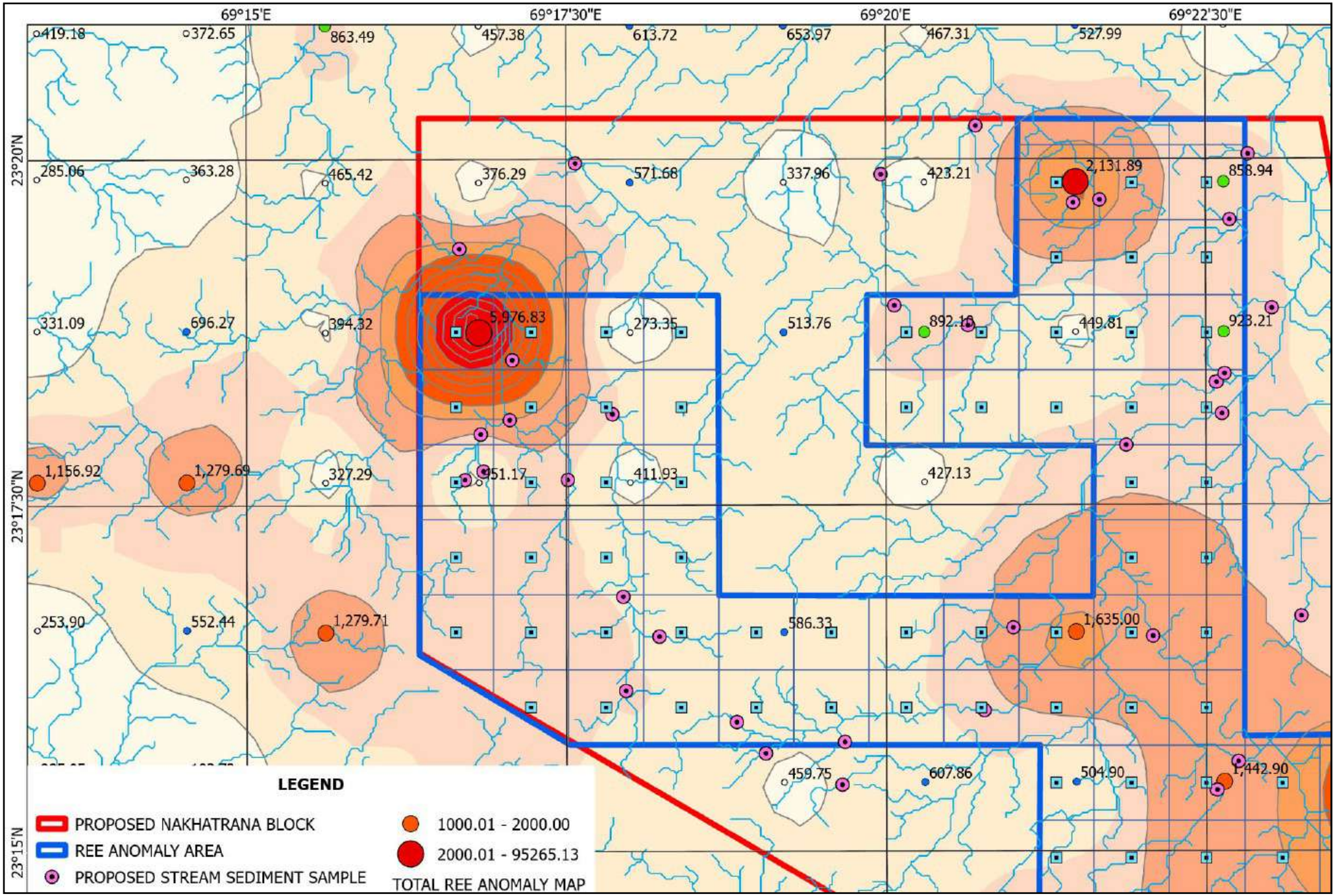
5.3.3 Trenches/ pits (200 cubic m) have been proposed in the area to ascertain the continuity of galuconite mineralization identified by bedrock sampling and geological mapping. Trenches will be carried out in the strike extension of mineralization concealed by soil cover. Trenching work will be carried out by excavating trenches of 1 m width, 2 m depth and average 10 m length to expose the bedrock. Trench walls and bottom will be mapped by field geologist in 1:100 scale. 50 nos of trench samples for glauconite will be analysed for major oxides K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3 by XRF method. Around 10% of Primary samples i.e. 10 samples for glauconite will be sent to NABL External Labs for analysis of major oxide studies (K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3) by XRF method.

5.4.0 EXPLORATORY DRILLING

5.4.1 Auger Drilling will be carried out in the REE anomaly area marked in the proposed block on the basis of total REE NGCM values of GSI and drainage map. The REE anomaly area will be redefined on the basis of geological mapping, bedrock sampling and stream sediment sampling carried out by MECL. Auger drilling will be carried out in a grid pattern of 1 km X 1 km.

5.4.2 Total 70 numbers of auger drilling boreholes have been proposed in the block each having a depth of 7 m. The total auger drilling carried out in the block will be 490 m. Based on the result of orientation pitting samples from auger drilling will be collected from targeted soil horizon and bedrock. 10% of the soil samples generated during auger drilling will be subjected to heavy mineral separation and the remaining samples will be processed by natural faction by sieving in 120 mesh after sun drying. Total 350 nos of primary samples will be analysed for REE by 34 element ICPMS method. 10% of Primary Samples i.e. 35 samples will be sent for external check in NABL External Labs by ICPMS method.

5.4.3 300 m scout drilling will be carried out in the REE bearing formation only after the positive outcome of above exploration activities. 10 boreholes wil be drilled upto a depth of 30 m. 10 m of mineralized zone from each borehole will be analysed for REE. Total 100 core samples will be analysed for REE by 34 element ICPMS analysis (REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti). 10% of the primary samples will be sent to NABL External Labs for analysis for 34 element ICPMS analysis including REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti.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23°15'N
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863.49
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459.75
607.86
504.90
1,442.90
LEGEND
PROPOSED NAKHATRANA BLOCK
REE ANOMALY AREA
PROPOSED STREAM SEDIMENT SAMPLE
1000.01 - 2000.00
2000.01 - 95265.13
TOTAL REE ANOMALY MAP

5.4.3 500 m of scout drilling will be planned only after positive results indicated by geological mapping, bedrock sampling and trenching. Boreholes will be planned after the completion of the above proposed exploration work.

5.4.4 For preparation of samples, the borehole core will be splitted into two equal halves by using core splitter. One half will be powdered to 100 mesh size and the other half will be kept for future studies. The powdered material will be mixed thoroughly and about 100 gram of samples will be taken for chemical analysis by successive coning and quartering as primary samples and rest of the material (-100 mesh size) will be kept as duplicate half for future reference. The core samples for glauconite will generate 50 nos of primary samples and 5 nos of samples will be sent for external check in NABL External Labs for analysis of major oxides (K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3) by XRF method.

5.4.5 Geological core logging will be carried out systematically by recording carefully the minute details like physical/ lithological characters of the rock formations including colour, core recovery, grain size, weathered zone, texture, banding, mineralogical composition, micro-structural/structural details. As per the requirement the rock quality designation (RQD) shall also be carried out, while logging drill cores.

5.5.0 PETROLOGICAL & MINERAGRAPHIC STUDIES:

5.5.1 During the course of Geological mapping and sampling 15 nos. of samples from outcrops of various lithounits will be collected to carry out Petrography and Minerography. These samples would be drawn from ore zones and host rocks.

5.6.0 XRD STUDY

5.6.1 To know the different mineral phases which can possibly host REE, 20 samples will be studied by XRD method. The samples for XRD will be selected from the samples which will analyze anomalous values of REE in bedrock, stream sediment and auger drilling.

5.7.0 EPMA STUDY

5.7.1 A selected few heavy mineral grains will be analysed by EPMA.

6.1.0 PROPOSED QUANTUM OF WORK

6.1.1 Details of the particular, Quantum and the targets are tabulated in **Table No.-6.1.**

Table No- 6.1

Quantum of proposed work in proposed Devpur REE and Glauconite Block

Sl. No.	Item of Work	Unit	Target
1	**Geological Mapping** (on 1:12,500 Scale)	Sq km	138.52
2	**Geochemical Sampling**		
i	Bedrock samples for REE (34 elemental analysis BY ICPMS includes REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti	Nos	50
ii	Stream Sediment samples for REE (34 elemental analysis by ICPMS includes REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti	Nos	40
iii	Bedrock samples for Glauconite (Major Oxide analysis by XRF Method: K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3)	Nos	50
3	**Exploratory Mining**		
i	Orientation Pitting	Cu.m	20
ii	Pit samples for 34 elemental analysis includes Nb, Sr, Ta, W, Mo, Sn, Rb, Be, Cs, LI & REE	Nos	20
iii	Trenching for Glauconite (1m x 2m x10m) x 10 trenches	Cu.m	200
iv	Trench Samples for Glauconite (Major Oxide analysis by XRF Method: K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3)	Nos	50
4	**Drilling for REE**		
i	Auger Drilling in 70 boreholes	m	490
ii	Auger Drilling samples for 34 elemental analysis includes REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti	Nos	350
iii	Scout Drilling in 10 boreholes	m	300
iii	Core Samples for REE for elemental analysis includes REE, Ni, Co, Cr, Zn, V, Rb, Sr, Zr, Nb, Cu, Pb, Zn, Ba, Ti	Nos	100
5	**Scout Drilling for REE & Glauconite**		
i	Scout Drilling in (10 boreholes)	m	500
ii	Core samples for glauconite (Major Oxide analysis by XRF Method: K2O, SiO2, MgO, CaO, Na2O, P2O5, Al2O3 & Fe2O3)	Nos	100
4	**Laboratory Studies**		
i	Heavy Mineral Seperation (40 Stream Sediment Samples + 20 Orientation Pit Samples + 35 Auger Drilling Samples)	Nos	95
ii	Bedrock samples for REE (50 Primary samples + 5 External Check Samples)	Nos	55
iii	Stream sediment samples for REE (40Primary samples + 4 External Chec Samples)	Nos	44
iv	Orientation Pit samples for REE (20 Primary samples + 2 External Check Samples samples) extracted by heavy mineral seperation	Nos	22
v	Orientation Pit samples for REE (20 Primary samples + 2 External Check Samples samples) extracted by natural seperation	Nos	22
v	Auger Drilling Samples for REE (350 Primary samples + 35 External Check Samples samples)	Nos	385

Sl. No.	Item of Work	Unit	Target
vi	Bedrock Samples for Glauconite (50 Primary samples + 5 External Check Samples)	Nos	55
vii	Trench samples for Glauconite (50 Primary samples + 5 External Check Samples samples)	Nos	55
viii	Scout Drilling samples for Glauconite (100 Primary samples + 10	Nos	110
7	**Petrographic Samples**	Nos	15
8	**Mineragraphic Studies**	Nos	15
9	**XRD Mineral phase analysis**	Nos	20
10	**EPMA Studies**	Hrs.	20
11	**Report Preparation (5 Hard copies with a soft copy)**	Nos.	1
12	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	Nos.	1

6.2.0 BREAK-UP OF EXPENDITURE

6.2.1 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. 266.89 Lakhs.** The summary of cost estimates for Reconnaissance Survey (G-4 Level) is given in **Table No. - 6.2** and details of cost estimates is given in **Annexure -1**

Table No. 6.2
Summary of cost estimates for Reconnaissance survey (G-4) in Proposed Devpur REE and Glauconite Block, District- Kachchh, Gujarat.

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geological Mapping (LSM), Other Geological Work	3864188
2	Trenching	812,000
3	Drilling	8,762,300
4	Laboratory Studies	7,835,868
	Sub Total (1 to 4)	**21,274,356**
5	Exploration Report Preparation	750,000
6	Proposal Preparation	428,187
7	Peer review charges	30,000
8	**Sub Total (1 to 7)**	**22,479843**
9	GST 18%	4,046,372
10	**Total:**	**26526215**
	Say Rs. In Lakh	**265.26**

6.3.0 TIMELINE

6.3.1 The entire project is planned tentatively for 10 months. Initially, geological mapping and surface bedrock sampling along with stream sediment sampling and pitting shall be carried out. Based on the positive results obtained in the first phase of sampling auger drilling and scout drilling will be carried out for respective commodities.

Table No. 6.4

Tentative Time schedule / Action plan of G-4 Survey in Devpur REE and Glauconite Block, District- Kachchh, Gujarat, Total block area- 138.52 sq km; Completion Time- 10 Months

Sl. No.	Activities	Months										
		1	2	3	4	5	6		7	8	9	10
1	Camp setting											
2	Geological mapping & Sampling (3 party)											
3	Exploratory Trenching & Sampling											
4	Sample preparation											
5	Analytical work											
6	Auger Drilling for REE											
7	Scout Drilling for REE											
8	Scout Driiling for Glauconite											
10	Camp winding											
12	Geologist at HQ											
13	Geological report											
14	Peer Review											

REVIEW

7.0.0 JUSTIFICATION

7.1.0 23 NGCM Stream Sediment Sample data points fall in the proposed Devpur Block. The total REE, LREE and HREE values have been calculated and the geochemical anomaly map for the same has been prepared. The proposed Devpur block has a maximum total REE value of 5977 followed by 2921 and 2132 ppm. The maximum total HREE value in proposed Devpur block is 369 ppm followed by 203 ppm of which the major contributing elements are Dysprosium (maximum 176 ppm) and Gadolinium (maximum 131 ppm). The maximum LREE value in Devpur block is 5607 ppm and the major contributing element is Neodymium (maximum 4158 ppm). The NGCM stram sediment samples carried out by GSI show highly anomalous values for REE, therefore the proposed Devpur Block can be taken up for reconnaissance survey for REE.

7.2.0 The Bhuj Formation in the proposed block mainly comprises of Ferruginous Shale, but few intercalated bands of sandy clay, grey-black pyritous shales, siltstone, carbonaceous shale, white kaolinitic clay were also reported by earlier workers. REEs can get adsorbed into clay bands. The REE deposits in the clay bands of Southern China particularly in Jiangxi, Guangdong, Fujian, Hunan, Guangxi, and Yunnan have total REE content ranging between 500 ppm to 2000 ppm in oxides with high proportion of HREE like dysprosium, terbium and yttrium. Similar to the ion adsorption clay deposit In Southern china provinces, the proposed blocks has intercalated clay layers within the ferruginous sandstone of Bhuj Formation. From the line diagram of HREE concentration, it can be observed that the proposed block has higher concentration of Dysprosium, Gadolinium and Terbium, similar to South China REE deposits. Hence the intercalated clay bands within the ferruginous sandstone of Bhuj Formation can be the possible source of REE in the proposed block.

7.3.0 The Kutch basin is an active tectonic basin with series of E-W trending strike faults in the area. Different phases of magmatic activities have taken place in the Kachchh Basin, which have emplaced along the weak planes caused by faulting. Ultrabasic and alkaline set of intrusives represented by alkaline gabbro, essexite, ankaramite, trachite, granophyre, camptonite have intruded lower Mesozoic sediments i.e. Patchcham and Chari. Whereas, the doleritic, basaltic and olivine gabbro plugs have the Katrol and Bhuj Formation. Some earlier workers assumed that the beds of Bhuj Formation were stained ferruginous where the ferruginous matter might be derived from the weathering of Traps emplaced before the deposition of Bhuj sediments. It was inferred by previous workers that the undifferentiated olivine gabbro plugs might be emplaced from upper mantle. The diagenetic reactions with Fe-Mn oxides from the volcanic plugs, the hydrothermal activity related to volcanism and later groundwater leaching might release the REE from source rock and redeposit them in the ferruginous sandstone of Bhuj Formation.

7.4.0 The Kachchh Basin has experienced multiple sea-level fluctuations since the Mesozoic era. The Kachchh sedimentary basin contains Mesozoic to Cenozoic sedimentary rocks formed from the weathering of earlier intrusives, Precambrian granites and surrounding rocks. Most of the studied siliciclastic sediments were possibly sourced from Nagar Parkar uplift in the north and Aravalli Highlands to the east (Chaudhari et al, 2018). The Nagar Parkar igneous complex comprises of late proterozoic granites, rhyolites, acid and basic dykes (Ahmad and Chaudhary, 2008). Common heavy minerals in the Bhuj sandstone include zircon, rutile, tourmaline, garnet, ilmenite, monazite, apatite, epidiorite. Chaudhari also inferred that the source of sedimentation was felsic igneous and high grade metabasic rocks. The heavy minerals found in the Bhuj sediments can host REEs. Thus exploration for REE in this area can be taken up.

7.5.0 23 NGCM Stream Sediment Sample data points fall in the proposed Devpur Block and the maximum K2O value analysed in the stream sediment samples are 3.57 ppm and 3.54 ppm. Hence the proposed block can be taken up for reconnaissance survey of Glauconite.

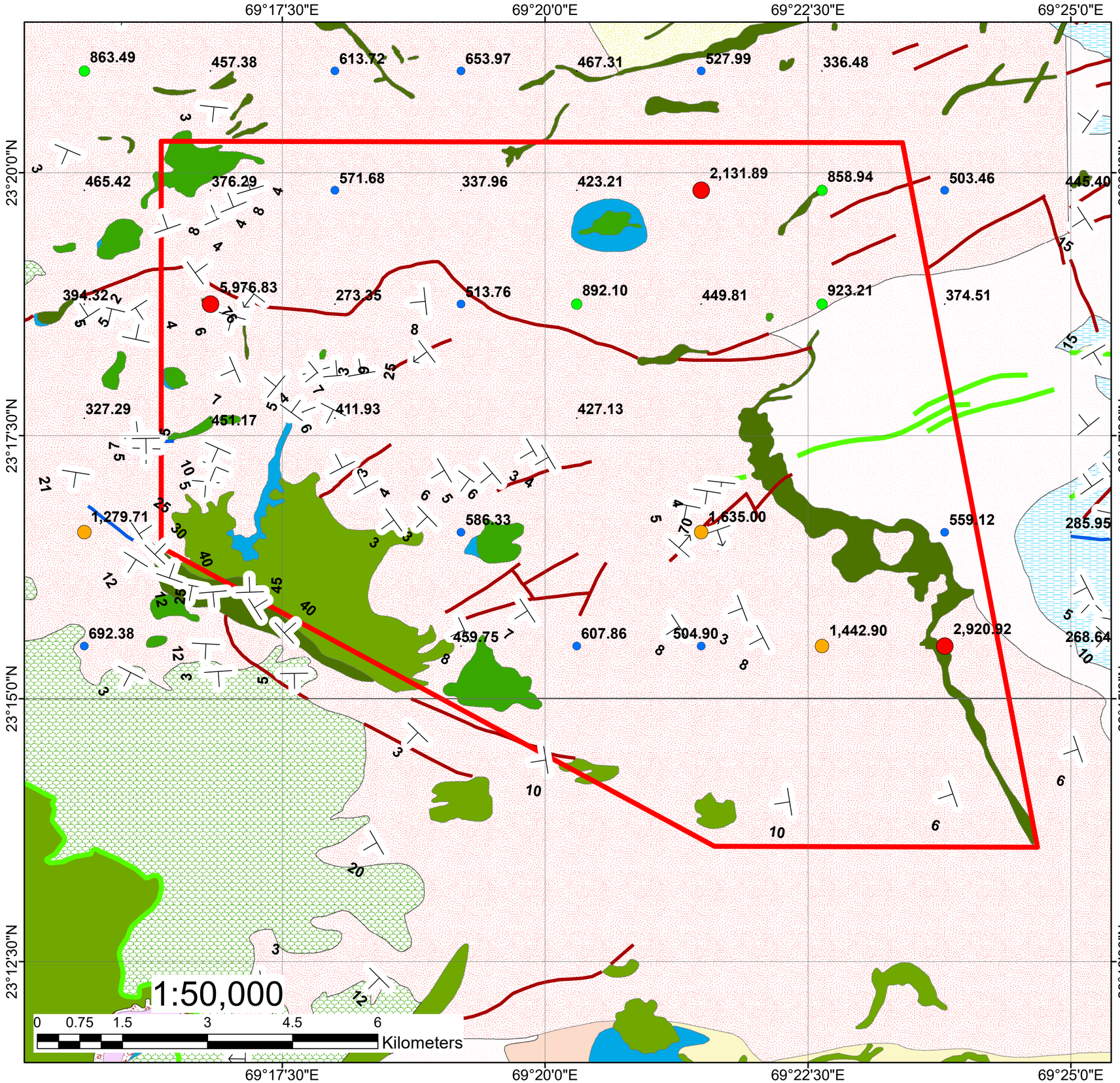
With above justifications, the current proposed block may be studied for REE and Glauconite and associated mineralization at G-4 level of exploration.

List of Plates

1. Plate –I: Location Map of Proposed Devpur REE and Glauconite Block (138.52 sq km), District: Kachchh, State: Gujarat.
2. Plate–II: Regional Geological Map showing Proposed Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat. (Source: NGDR Portal, GSI).
3. Plate–III: Geological Map showing Proposed Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat. (Source: NGDR Portal, GSI).

4. Plate–IV: Total REE anomaly map with total REE values in Proposed Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat (Source: NGDR Portal, GSI).
5. Plate–V: HREE anomaly map with HREE values in Proposed Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat (Source: NGDR Portal, GSI).
6. Plate–VI: LREE anomaly map with LREE values in Proposed Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat (Source: NGDR Portal, GSI).
7. Plate–VII: Proposed stream sediment sample location with drainage map in Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat (Source: NGDR Portal, GSI).
8. Plate–VIII: Proposed stream sediment sample location and auger drilling location with drainage map in Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat (Source: NGDR Portal, GSI).
9. Plate–IX: K2O anomaly map for proposed Devpur REE and Glauconite Block, District: Kachchh, State: Gujarat (Source: NGDR Portal, GSI).

Geology Map with total REE value in Proposed Devpur REE and Glauconite Block, Kachchh District, Gujarat



Legend

PROPOSED DEVPUR REE AND GALUCONITE BLOCK

LITHOLOGY

- MILIOLITE LIMESTONE
- AMYGDULAR BASALT
- BASALT
- OLIVINE BASALT
- DOLERITE
- FERRUGINOUS SANDSTONE AND GRIT
- FELDSPATHIC SANDSTONE AND GRIT
- FOSSILIFEROUS CALC SST.LIMESTONE, SILTSTONE&CONG
- LATERITE/BAUXITE WITH CLAY
- SANDSTONE
- GYPSEOUS SHALE, CALCAREOUS SST WITH BELEMNITES
- SST,SHALE,SILTSTONE WITH ABUNDANT TRACE FOSSIL
- VARIEGATED CLAY, LST, MARL, GYPSEOUS SHALE,SST
- BASIC DYKE
- DOLERITE
- INTERTRAPPEAN
- OLIVINE GABBRO

STRUCTURAL DATA

- BEDDING
- FAULT
- JOINT
- FAULT
- F1 FOLD

Total REE in Stream sediment

- 27.323000 - 500.000000
- 500.000001 - 750.000000
- 750.000001 - 1000.000000
- 1000.000001 - 2000.000000
- 2000.000001 - 95265.132170

Source: NGDR Portal, GSI

Regional Geology Map showing Proposed Devpur REE and Glauconite Block over an extent of 138.52 sq km, Kachchh District, Gujarat

68°45'0"E 69°0'0"E 69°15'0"E 69°30'0"E 69°45'0"E 70°0'0"E 70°15'0"E

23°45'0"N 23°30'0"N 23°15'0"N 23°0'0"N 22°45'0"N

N

Vigodi Fault

Kachchh Mainland Fault

Katrol Hill Fault

Legend

PROPOSED DEVPUR REE AND GLAUCONITE BLOCK

STRUCTURAL DATA

- BEDDING
- FAULT
- JOINT
- KACHCHH FAULTS
- ANTICLINE (F1)
- F1 FOLD
- SYNCLINE (F1)

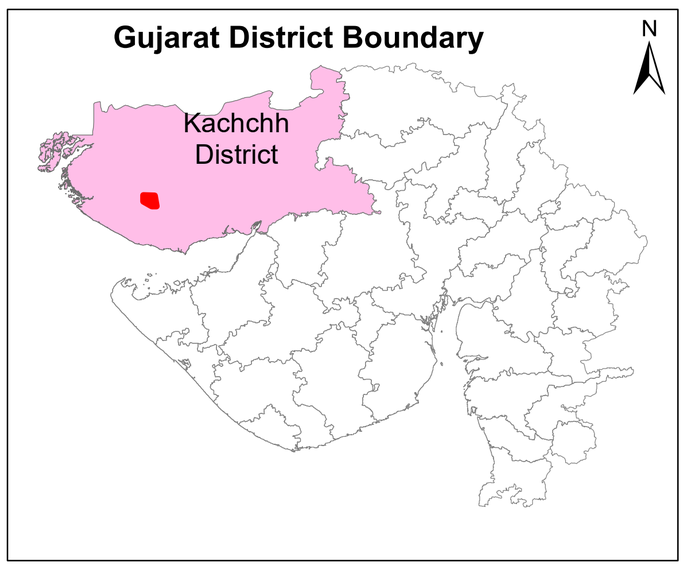
FORMATION NAME

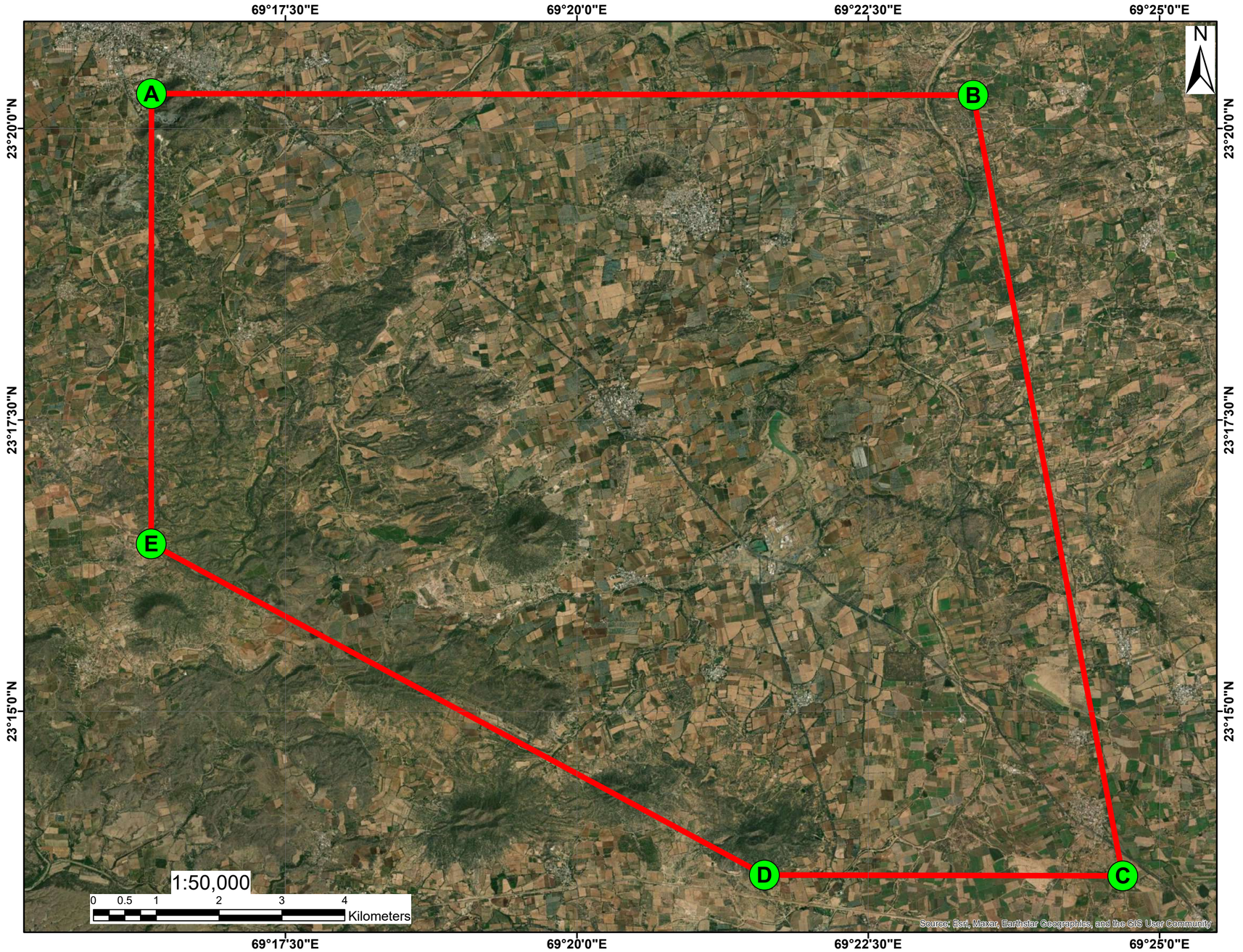
- AKHAJ
- FULAI
- MAHUVA
- RANN
- VARAHI
- MILIOLITE
- KOTHARA
- DWARKA
- SANDHAN
- GAJ
- KHARI NADI
- MANIYARA FORT
- FULRA
- KAKDI NADI
- MATANOMADH
- ANJAR VOLCANICS
- DAYAPAR VOLCANICS
- BHUJ
- KATROL
- CHARI
- PACHCHHAM

Source: NGDR Portal, GSI

0 5 10 20 30 40 Kilometers

Location Map showing Proposed Devpur REE and Glauconite Block over an extent of 138.52 sq km, Nakhatrana Tehsil, Kachchh District, Gujarat





Coordinates of Corner Points of Proposed Devpur Block (138.52 sq km)

Sl. No.	Point	DMS Coordinate (DMS)		UTM Zone: 42N (m)	
		Latitude	Longitude	Northing	Easting
1	A	23° 20' 17.99" N	69° 16' 20.92" E	2581000.00	527854.00
2	B	23° 20' 17.1" N	69° 23' 23.97" E	2581000.00	539867.00
3	C	23° 13' 35.3" N	69° 24' 41.02" E	2568650.00	542090.00
4	D	23° 13' 35.75" N	69° 21' 36.54" E	2568650.00	536847.00
5	E	23° 16' 26.27" N	69° 16' 20.89" E	2573874.05	527866.56

Part of Survey of India Toposheet No.: 41E/07, 08

Legend

- Corner Points of Proposed Devpur Block
- Proposed Devpur REE nad Glauconite Bock