PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR REE AND ASSOCIATED MINERALIZATION IN NB-9 & 10 BLOCK (2.85 SQ KM), DISTRICT-BALOTRA, RAJASTHAN

COMMODITY: REE AND ASSOCIATED MINERALS

BY

MINERAL EXPLORATION AND CONSULTANCY LIMITED

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SEMINARY HILLS

PLACE: NAGPUR

DATE: NOVEMBER, 2025

Summary of the Block for Preliminary Exploration (G-3 Stage) for REE and associated minerals in NB9 & 10 Blocks (2.85 sq km), Distt. Balotra, Rajasthan

GENERAL INFORMATION ABOUT THE BLOCK

	Features	**Details**
	Block ID	NB-9 & 10 Blocks
	Exploration Agency	Mineral Exploration and Consultancy Limited (MECL)
	Commodity	REE and associated minerals
	Mineral Belt	Siwana Ring Complex
	Completion Period with entire Time schedule to complete the project	15 Months
	Objectives	i. To conduct detailed geological mapping for determining the emplacement of formations holding REE minerals at a scale of 1:2000. ii. To systematically collect bedrock and channel samples for IC-PMS studies of 34 elements, including REE, in order to comprehend the distribution of primary and secondary sources. iii. To determine the subsurface occurrence of REEs, systematically drilling of boreholes at 400m x 200m grid pattern taking consideration of tabular type of deposit in compliance with the MEMC rule. iv. To establish the inferred resources (333) for REE bearing minerals as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.
	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	Geological mapping and Chemical analysis will be carried out by the proposed agency. Drilling work shall be outsourced.
	Name/ Number of Geoscientists	Two nos. of Geoscientist (1 Field + 1 HQ)

	Expected Field days (Geology) Geological Party Days	Geologist Party Days: 180 Days (Field) Geologist Party Days: 90 Days (HQ)
1	**Location**	
	The coordinates of corner points of proposed NB-9 & 10 blocks are as follows (Toposheet No. 45C/06):	

Points	DD MM SS.SS	
	Latitude(N)	Longitude (E)
A	25° 44' 41.2962" N	72° 27' 43.3956" E
B	25° 44' 41.3225" N	72° 27' 02.3367" E
C	25° 44' 50.4352" N	72° 27' 38.7600" E
D	25° 45' 00.0776" N	72° 27' 36.4874" E
E	25° 45' 00.3073" N	72° 28' 57.8024" E
F	25° 43' 57.3016" N	72° 28' 57.5680" E

	Villages	Meli,Thapan
	Tehsil/ Taluk	Siwana Tehsil
	District	Balotra
	State	Rajasthan
2.	**Area (hectares/ square kilometers)**	
	Block Area	2.85 sq km
	Forest Area	Data not available
	Government Land Area	Data Not Available
	Private Land Area	Data Not Available
3.	**Accessibility**	
	Nearest Rail Head	Mokalsar, 20km from the proposed Block
	Road	The State Highway-66 passing through the southern side of the block.
	Airport	Jodhpur Airport is around 120 km from the Block due North-East direction.
4	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	There are only perennial Nalas present inside block. Flow south direction.
	Rivers/ Streams	The drainage system of the proposed area is manifested by Luni River.

5	**Climate**	
	Mean Annual Rainfall	The average rain fall is 250mm to 300mm.
	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	During summer (March to June), the maximum temperature generally varies between 46 and 51˚C. Night temperatures decrease considerably to 20–29˚C. January is the coldest month. During winter (December to February), minimum temperatures may fall to 2℃ at night.
6	**Topography**	
	Toposheet Number	Part of SoI Topo sheet no. 45C/06.
	Physiography of the Area	The area shows hilly topography with variation of RL from 160 mRL to 190mRL. Granitic and Rhyolitic cliffy hills are lying in the northern part of the block and the Aeolian sand is covering the foot hills. The peak is recorded around 293mRl.
7	**Availability of baseline geosciences data**	
	Geological Map (1:50K/ 25K)	1:50000 in NGDR
	Geochemical Map	NGCM Data is available in NGDR. Previous geochemical sample analysis data has been used for planning the G3 exploration in the area.
	Geophysical Map	NGPM and airborne magnetic survey Data is available in NGDR
8.	**Justification for taking up Reconnaissance Survey / Regional Exploration**	1. The Neoproterozoic Siwana Ring Complex (SRC), which is made up of peralkaline rocks from the Malani Igneous Suite of northern periphery of the Siwana Ring Complex, stretching from Sainji ki Beri to Meli area from which the proposed block has been carved out. These consist of late-phase microgranite and felsite dykes, granite, and rhyolite. Bimodal (acid and basic) volcanics are another feature of the region. 2. Barmer District, Rajasthan explored by GSI in G4 stage. The proposed area mainly consists of Siwana granite which is considered for hosting REEs. During FS 2021-22, GSI carried out G-4 exploration in around Sainji Ki Beri-Meli area, northern part of Siwana Ring Complex over

		an area of 100 sq.km and given recommendation on REE to carry out further assessment. 3. Lal and Ghosh (2021) mapped the northern periphery of the Siwana Ring Complex (Sainji ki Beri–Meli) at 1:12,500 scale and identified 32 rhyolitic flows with multiple felsic dykes, several of which show strong tREE enrichment. Rhyolite samples yielded ΣREE+Y values of **91.76–9764.68 ppm** (avg. **1844.84 ppm**) with an **ΣHREE/ΣLREE ratio of 0.15**. Twenty-two BRS samples from felsic/rhyolite dykes returned **144.77–7678.75 ppm** (avg. **1400.14 ppm**). Channel samples showed **261.73–6224.81 ppm** with an **ΣHREE/ΣLREE ratio of 0.19**. Flows **14 and 15** are the most enriched. In the proposed block, Flow 15 shows **2213.43–8027.71 ppm** (max LREE **5079.52 ppm**, max HREE **992.05 ppm**), while Flow 14 shows **6944.16–7528.11 ppm** (max LREE **4848.19 ppm**, max HREE **941.11 ppm**). 4. RSAS, GSI (FS 2017–18), carried out remote sensing and aeromagnetic surveys (45C/06, 45C/10), which delineate magnetically susceptible lithounits and potassium–thorium anomalies, confirming good REE potential in the area. 5. Hence the proposed area has been carved out for further investigation for REE and associated minerals at G-3 stage .

PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR REE AND ASSOCIATEDMINERALS IN NB-9 & 10 BLOCK, SIWANA RING COMPLEX, DISTRICT –BALOTRA, STATE -RAJASTHAN (AREA 2.85 SQ.KM.)

1.1.0 INTRODUCTION

1.1.1 Development of renewable energy infrastructure requires critical raw materials, such as the rare earth elements (REEs, including scandium) and niobium, and is driving expansion and diversification in their supply chains. Although alternative sources are being explored, the majority of the world's resources of these elements are found in alkaline-silicate rocks and carbonatites. These magmatic systems also represent major sources of fluorine and phosphorus. Exploration models for critical raw materials are relatively less developed than those for major and precious metals, such as iron, copper, and gold, where most of the mineral exploration industry remains focused. The diversity of lithologic relationships and a complex nomenclature for many alkaline rock types represent further barriers to the exploration and exploitation of REE-high field strength element (HFSE) resources that will facilitate the green revolution.

1.1.2 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.

1.1.3 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).

1.1.4 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 atomicnumbers from 63 to 71 (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb and Lu) and Y, Sc. However, because of their geochemicalproperties, rare earth elements are typically dispersed and not often found concentrated as rareearth minerals in economically exploitable ore deposits.

1.1.5 Generally the light rare earth elements (LREE) are more abundant in the earth's crustand 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.

1.1.6 In the other hand, 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.

1.1.7 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)

1.1.8 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.

1.2.0 BACKGROUND

1.2.1 Emphasis has been given by Govt. of India to explore the more numbers of blocks for strategic and critical minerals in the different states of India. Keeping this in view, the present proposal Preliminary Exploration (G-3) for REE and associated elements in proposed NB-9 & 10 Block in Balotra district, Rajasthan is being put up for evaluation under NMET funding and execution.

1.3.0 LOCATION AND ACCESSIBILITY

1.3.1 The proposed exploration block is located north of meli Village, which is a Village in Siwana Tehsil in Balotra District of Rajasthan. It is located 35 Km south-east of District headquarters Balotra. 12 Km from Siwana. 415 Km from State capital Jaipur. Block falls under the parts of Survey of India Toposheet No 45C/06 (Plate No I).

1.3.2 The detailed location of the boundary points are given in Table 1.

Table 1: Coordinates of Corner Points of Proposed NB-9& 10 G-3 block for REE, Balotra District, Rajasthan

Points	DD MM SS.SS	
	Latitude(N)	Longitude (E)
A	25° 44' 41.2962" N	72° 27' 43.3956" E
B	25° 44' 41.3225" N	72° 27' 02.3367" E
C	25° 44' 50.4352" N	72° 27' 38.7600" E
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E	25° 45' 00.3073" N	72° 28' 57.8024" E
F	25° 43' 57.3016" N	72° 28' 57.5680" E

1.3.3 The nearest railhead is Balotra Junction (about 40 km). The nearest airport is Madaram Dhatrwal Airport (about 53 km).

1.4.0 PHYSIOGRAPHY, DRAINAGE AND CLIMATE

1.4.1 The area shows hilly topography with variation of RL from 160 mRL to 190mRL. There is Granitic and Rhyolitic cliffy hills in the north eastern part of the block and majority of the block is covering by aeolian sand. The peak is recorded around 293mRl.

1.4.2 The drainage system of the proposed area is manifested by Luni River.

1.4.3 The climate is characterized by low rainfall with erratic distribution, extremes of diurnal and annual ranges of temperatures, low humidity and high wind velocity. The arid climate has marked variations in diurnal and seasonal ranges of temperature, characteristic of warm-dry continental climates. During summer (March to June), the maximum temperature generally varies between 46 and 51˚C. Night temperatures decrease considerably to 20–29˚ C. January is the coldest month. During winter (December to February), minimum temperatures may fall to 2℃ at night. Occasional secondary western disturbances, which cross mostly western, northern and eastern Rajasthan during the winter months, causing light rainfall and increased wind speeds which result in a wind-chill effect.

1.5.0 FLORA AND FAUNA

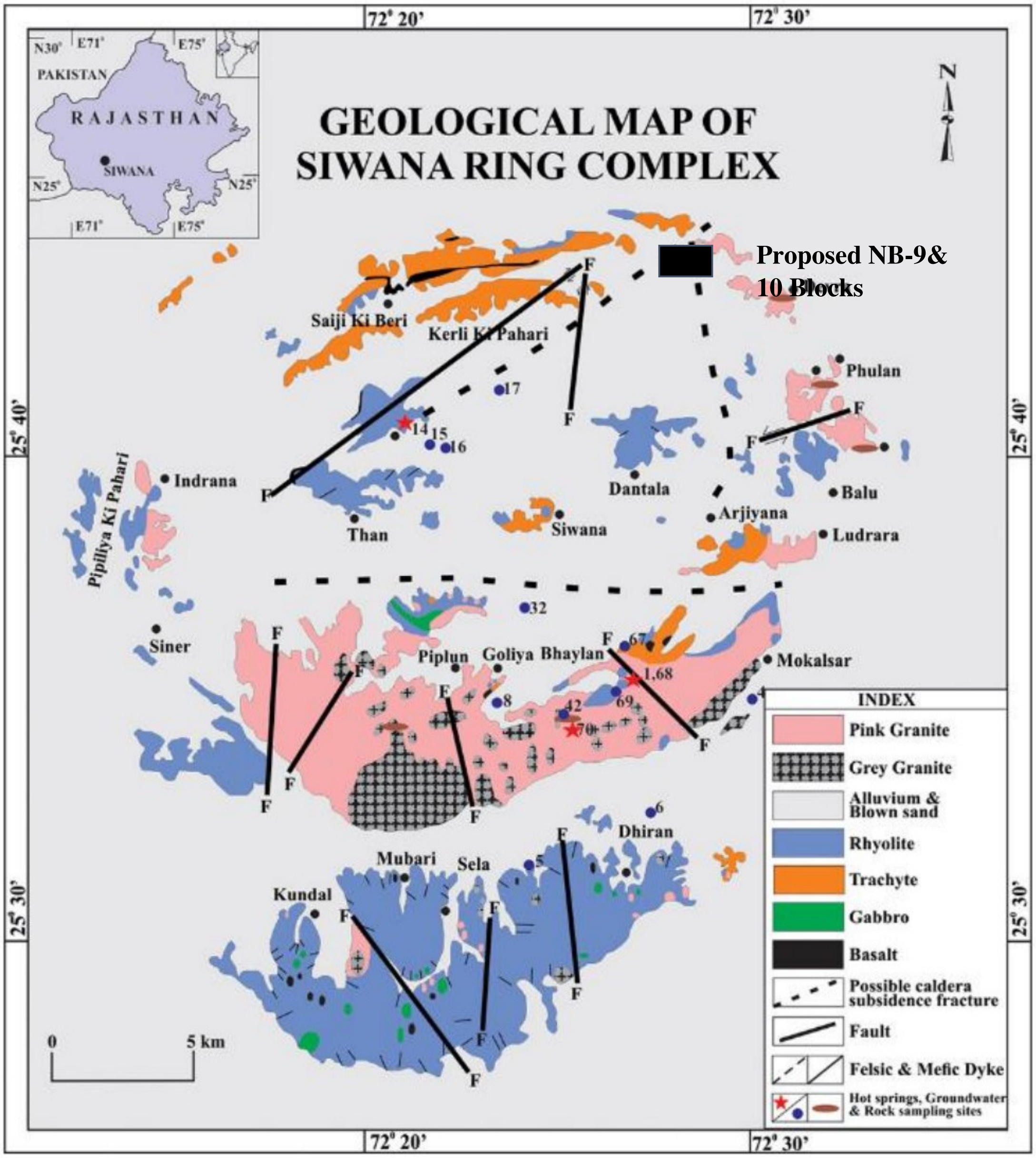
1.5.1 Xerophytic plants can survive in hot arid conditions and can be easily found in the study area. Flora observed in the area is mostly comprises of thorny trees and bushes. Xerophytic plants such as the kumatiyo (*Acacia senegal*), ber (*Zizyphus mauritiana*), and googal (*Commiphoraightii*), kair (*Capparis decidua*), aak (*Caliotropi sprocera*), Thhoris, khejri (*Prosopis cineraria*) are present in the study area. The wild fauna found in the area include foxes, desert cat, desert rat, jackals, chinkaras, deer, snakes, forest rabbits, camels, nilgai (*Boselaphustra gocamelus*) and several varieties of Indian and migratory birds such as sparrow, crow, bulbul, kite, peacock, white-rumped vulture and eagle etc.

2.0.0 REGIONAL GEOLOGY

2.1.1 The proposed area comes under the Trans-Aravalli region, exposed around west and south west of Aravalli Mountain Range. Malani Igneous Suite (MIS) is the largest acid, predominantly volcanic, magmatic assemblage in India representing rocks of polyphase igneous activity. Throughout the time, the rocks have been referred by various names like 'The Malani Volcanic Suite', 'Malani Volcanic Series', 'Malani Igneous Province', 'Malani Beds', 'Malani Volcanics,' 'Malani Rhyolites' or simply 'Malanis'. But the term 'Malani' is strictly associated to describe the rocks of Neoproterozoic polyphase igneous activity, happened roughly in-between 830Ma and 680Ma, age range representing gap between Sirohi Group of Delhis (Choudhary et al., 1984) and Marwar Supergroup (Rathore et al., 1999) respectively. The MIS unconformably overlies the Mesoproterozoics of Delhis (Bhushan, 2000). The contact between the two has been studied near Manihari and Kankani (La Touche, 1902; Bhushan, 1984; Bhushan, 2000).

2.1.3 The magmatic evolution of Siwana Ring Complex, part of Neoproterozoic Malani Igneous Suite (MIS); ca. 771±2 Ma (Torsvik et al. 2001), 745 Ma (Dhar et al., 1996; Rathore et al., 1999) can be divided into three phases (Kumar and Sharma, 2020). First phase is represented by bimodal volcanism of acid and basic flows (acid flows > basic flows). It is intruded by second, plutonic phase comprising arfvedsonite-reibeckite-aegirine bearing per-alkaline Siwana Granite. The third phase being later intrusive phase includes rhyolite, microgranite, andesite and felsite dykes. All these three phases host anomalous ΣREE+Y concentration and the third phase is more enriched (Kumar and Sharma, 2020). Peralkaline igneous rocks, carbonatites, feldspathoid bearing rocks are the main source of REE minerals (± HFSE, U & Th etc) and therefore are suitable host for targeting REE/RM mineralisation. Peralkaline granites, volcanics and associated zoned pegmatoids are considered to be storehouse of REE and rare metals (Nb–Ta, Zr–Hf, Sn, W, Be) (Pollard, 1995) and in layered intrusions, the mineralisation mostly appears in the more evolved parts of the complexes (Dostal, 2017).

2.1.3 In the Western Indian Craton of Rajasthan, basement rocks and overlying supracrustal belts of Aravalli and Delhi Supergroups have witnessed magmatic events of volcanics and granitoids of Palaeo- to Neo-Proterozoic ages. Granitoids of different ages (~ 1.8 Ga, ~1.7 Ga, ~1.4 Ga, ~ 1.1Ga and 850-750 Ma) have intruded these belts. MIS magmatism occurred during Neoproterozoic age and comprises peralkaline (Siwana), metaluminous to mildly peralkaline (Jalore) and peraluminous (Tusham and Jhunjhunu) granites with cogenetic carapace of acid volcanics (welded tuff, trachyte explosion braccia and perlite) and is characterised by volcano-plutonic ring structure and radial dykes (Singh and Vallinagayam, 2009). Three phases in Siwana magmatic activity is widely observed: i) the basal peralkaline (lower 24 flows), ii) middle meta-aluminous (top 21 flows), and iii) reappearance of peralkaline phase as intrusives (Siwana granite) at the end (Chittora and Bhushan, 1994).



2.1.4 Generalized classification of Malani Igneous suite (after Bhushan and Chandrasekaran, 2002) is given in the Table no 2 below

Table No 2

Generalized classification of Malani Igneous suite (after Bhushan and Chandrasekaran, 2002).

SuperGroup	Group	Formation	Mode ofMagmatism	Lithology
Marwar Supergroup(Vendianto lower Cambrian)				Sandstone, shale,limestoneand evaporates
----------Unconformity----------				
MalaniIgneousSuite (upperProterozoic)	Dykeswarms	Basic dyke;Acid dykesTrachyteporphyryAndesite andPorphyry DykesAplite andDiorite plugs	Intrusivedy kePhase–III	Gabbro, dolerite,basalt, graniterhyolite porphyryTrachyte porphyryandesite porphyryporphyritic/non-porphyritic Dyke &boss andapliteveins.
	Granitoidplutonism	Malani granite, Siwana granite Jalorgranite	Intrusive phase-II	Hornblende graniteriebeckite Aegirinegranite biotite/Hornblende granite
	Bimodalvolcanism	Rhyolite,Trachyte andBasaltflow	Extrusive phase-I	Rhyolite, dacite,trachyte andrhyodacite flows,Basalt andtrachyandesite flows
----------Unconformity----------				
Pre Malanibasement(MiddletoLower Proterozoic		Aravalli andDelhiSupergroup		

2.1.5 Regional Structure and Metamorphism Earlier workers reported no deformational structures except some local faults in the volcanic and plutonic rocks exposed in and around Siwana area. Various primary structures such as flow layers, vesicular and amygdular structures, columnar joints and megaspheruites in volcanic rock. Flow lobes, joints and minor faults are reported in both the volcanic and plutonic phase (Rastogi and Mukerjee, 2015). Murthy, *et al.* (1962) formally established the "Siwana ring structure". Later studies by Mukherji and Roy (1981) also supported this view and they attributed collapse of a caldera to the ring dyke intrusion. No authors reported significant metamorphism in the area.However D F Strong 1982, Baginski et al 2016, J Rong et al 2016. S Mondal et al 2021 have discussed late magmatic and post magmatic metasomatic aspects of Siwana granite and its significance in REE enrichment in detail. Kumar and Sharma 2020 reported various late to post magmatic replacement textures such as coarsening of perthite lamellae due to albitization / Na metasomatism event, formation of chess board perthite, dueteric alteration of alkali feldspar grains, psuedomorphic replacement of alkali feldspar by aegirine, formation of secondary minerals like zircon, apatite within the grains as inclusions as well as intergrowths within the grain boundaries, formation of albite rims etc. The original magmatic inosilicates such as aneagmatite, aegirine - augite, astrophyllite etc were replaced to aegirine and arfvedsonite under the influence of late/post magamatic alkaline fluids (Kumar and Sharma, 2020)

2.1.6 **Regional mineralization:** Siwana granites and Malani rhyolites are considered to be important sources of REE in the Siwana area. The peralkaline granite of Siwana Ring Complex (SRC) is enriched with REE potential and the later intrusive dykes intruding the granite and rhyolite at the periphery of Siwana Ring Complex are even more enriched with REE (Das et al. 2015). Barman and Neog, (2019) also reported appreciable occurrences of REE in Siwana Granite. Notable occurrence of REE and RM mineralization in younger intrusive>plag-rich granite> K-rich granite> felsic volcanic were observed by Kumar and Sharma (2020). Majumdar (1976-1978) considered that the Siwana suite is definitely enriched in Nb, La, Y and Zr. At present the granites and rhyolites are being used as building stones and road materials.

3.0.0 GEOLOGY OF THE BLOCK

3.1.0 The proposed block area is the partly covered by Large scale mapping in 1: 12,500 scale by GSI (Item Code No.: M2ASMIF-MEP/NC/WR/SU-RAJ/2021/36824) around Sainji Ki Beri-Meli area, Balotra District, Rajasthan in part of the Toposheet no. 45C/06. The proposed area comprises, plutonic, volcanic and the younger intrusive phases of Malani Igneous Suite.

3.2.0 Felsic volcanic flow phase exposed in and around Siwana town, Indrana, Ludrara, Arjiyana, Devandi, Mawadi, Meli and Mokalsar villages whereas, per-alkaline Siwana granite is exposed in and around Mokalsar, Ludrara, Meli and Indrana villages. Younger dyke phases are intruded in both the volcanic and plutonic phases. However, the proposed blocks in aeolian sand covered area. About 80% area is sand covered out of total proposed area. The stratigraphy of study area is given in table below

Table No 3

Stratigraphic

Group/Supergroup	Rock Types	Igneous Activity
Quaternary	Aeolian sand and silt	---
Malani Igneous Suite	Rhyolite and basic volcanic dykes Siwana Granite	Volcanic phase

3.2.0 DESCRIPTION OF THE ROCK TYPES

3.2.1 **Felsic volcanics:** Felsic volcanics are dominant litho unit observed in the LSM mapped area. The exposures are plenty around Siwana, Mokalsar, Mailawas, Arjiyana, Devandi and Indrana area. Both porphyritic and aphanitic verities of rhyolite are representing the felsic volcanics of the area. The aphanitic variety is the most common volcanic phase exposed in the area. It is well exposed near Siwana town and Arjiyana, Maliavas, Indrana villages. It also occurs as small isolated hillocks parallel to Siwana – Mokalsar road. Occurrences of ferruginous red coloured variety and greenish grey coloured variants are common. They are characterized by the presence of vesicles, cavity fillings and flow bandings at places. Thin veins of iron oxide with a maximum of 1 cm width are ubiquitous along the fracture planes of this variety of rhyolite. The porphyritic variety of rhyolite is well exposed as hill near Mailawas village. It is characterized by the presence of alkali feldspar phenocrysts with varying dimensions. The measured maximum size of the feldspar phenocryst is 2.5 x 1 cm. Ground mass is typically dark colored, signifying the volcanic genesis of the rock.

3.2.2 **Siwana Granite:** Siwana granite is the major intrusive granite exposed in the area. It is exposed as hills around Indrana, Mokalsar, Maliawas, Ludrara area. Mainly two varieties of granites are observed in the area. The pink coloured, porphyritic, alkali feldspar rich variety and grey coloured medium to coarse grained variety; both are found intruding into the volcanic phases with a sharp intrusive contact. These granites are characterized by their alkaline nature, well evident from the presence of alkali amphiboles and pyroxenes. The contact relation between the granite variants of the area appears to be diffusive in nature. The grey coloured medium to coarse grained granite has more plagioclase component in comparison to the other variety. The coarse grained alkali feldspar granite is mostly exposed in the south eastern part of the area with alkali feldspar as a major constituent along with quartz and mafics (alkali amphiboles and alkali pyroxenes). This granite exhibits the presence of rims of feldspar signifying the possibility of deuteric alteration or magmatic re– equilibration process. In this kind of granite, feldspars are observed as inclusions within mafic minerals as well.

3.2.3 **Dykes:** The youngest intrusive phases of the area are dykes intruded along the joint planes with discordant as well as sheet type field relation. Mainly two categories of dykes are observed in the area. The flesh colored, fine grained rhyolitic dykes are observed in various localities. Dark colored mafic dykes mostly observed associated with the granites have a typical discordant field relation. The maximum traceable length of the dyke is up to 400 m with variable width. Sub parallel flesh coloured dykes are exposed near Ludradra and Arjiyana villages. They have a typical anastomosing nature noticed at Ludrara. The dark coloured and relatively coarse grained mafic variety of dykes are commonly found in the granite hills of Mokalsar area.

4.0.0 PREVIOUS WORK

4.1.1 Preliminary work by GSI (2013–14) on rhyolites and associated tuffs of the Siwana Ring Complex (Balotra district) revealed **anomalous ΣREE values of 1334–3319 ppm**, indicating strong REE enrichment in the volcanic suite (Rastogi & Mukherjee, 2015). Bidwai et al. (2014) further confirmed enrichment of **LREE along with high Zr, Nb, Th, U and Ag**, signifying a fertile peralkaline magmatic system capable of concentrating multiple critical metals.

4.1.2 Subsequent **G-4 investigations** by Das et al. (2015) and Kumar & Sharma (2020) provided a detailed geochemical framework across major lithounits of the complex. Their ∑REE+Y ranges highlight significant compositional variability:

- **Plagioclase-rich granite (n=79):** 0.029–0.70%
- **K-feldspar granite (n=116):** 0.047–0.66%
- **Younger intrusives (n=146):** 0.019–2.66%
- **Felsic volcanic (n=43):** 0.015–0.96%
- **Enclaves/Restite (n=19):** 0.022–1.27%

The **LREE:HREE ratio (~4:1)** demonstrates a distinct dominance of LREE. LREE values range from **86.45 ppm to 1.93%**, whereas HREE range from **23.94 ppm to 0.26%**, consistent with the fractionated, peralkaline character of Siwana magmatism. Associated trace metals also show favourable enrichment: **Zr (0.1–1.1%), Nb (2.5–1039 ppm), Ba (25–3948 ppm), Zn (120–1258 ppm), U (0.61–124 ppm), Th (2–481 ppm), and Hf (4.52–828 ppm)**—all supporting the exploration relevance of the region.

4.1.3 Barman & Neog (2018) carried out extensive mapping of A-type peralkaline–peraluminous granites from Mokalsar to Siner. They identified key REE-bearing minerals such as **perisite (carbonate) and monazite (phosphate)**, along with accessory **haematite, ilmenite and zircon** in both plutonic and volcanic phases. Granite samples yielded **182.77–8611.11 ppm** REE (avg. 2006.95 ppm), while volcanic rocks recorded **142.3–8502.50 ppm** (avg. 2008.03 ppm). In the nearby **Sukleswar Ka Mandir (G-3) block**, microgranite dykes, alkali feldspar granite and andesite yielded tREE values up to **2901 ppm**, **2121 ppm** and **2996 ppm** respectively, further demonstrating widespread mineralization.

4.1.4 Lal & Ghosh (2021) conducted detailed 1:12,500-scale geological mapping along the northern periphery of the complex (Sainji ki Beri to Meli), delineating **32 rhyolitic flows** and several felsic dykes. Multiple flows exhibit strong tREE enrichment. Rhyolite samples show ∑REE+Y values of **91.76–9764.68 ppm** (avg. 1844.84 ppm; ∑HREE/∑LREE = 0.15). Felsic/rhyolite dykes show **144.77–7678.75 ppm** (avg. 1400.14 ppm), while channel samples returned **261.73–6224.81 ppm** (ratio 0.19).

Flows 14 and 15 are the most significant:

- **Flow 15:** 2213.43–8027.71 ppm; max LREE **5079.52 ppm**, max HREE **992.05 ppm**
- **Flow 14:** 6944.16–7528.11 ppm; max LREE **4848.19 ppm**, max HREE **941.11 ppm**

Although the block presently contains only one bedrock sample from granite exposures, reporting approximately 1794.70ppm total REE, analytical results from the western extension of the same lithological unit are showing encouraging and favourable REE values.

4.1.5 Remote Sensing and Aerial Surveys (RSAS Division, GSI; FS 2017–18) across toposheets **45C/06 and 45C/10** reveal regional continuity of magnetically susceptible lithounits beneath soil cover. Complementary **potassium and thorium spectrometric anomalies** further corroborate the presence of REE-fertile peralkaline lithologies in the proposed block.

4.1.6 Overall, the combined geological, geophysical and geochemical datasets consistently confirm that the Siwana Ring Complex hosts widespread, multi-lithounit REE mineralization with particularly strong LREE enrichment, high trace-metal fertility, and clear exploration potential in both exposed and covered zones. Based on the anomalous values of REE analyzed for samples in the area and supported by previous Investigations, the proposed NB-9 & 10 block having area of 2.85 sq. km has been curved for further G3 stage of investigation of REE and associated minerals.

5.0.0 PLANNED METHODOLOGY

Based on the evaluation of geological data available, the present exploration program has been formulated to fulfill the following objectives:

i. To conduct detailed geological mapping for determining the emplacement of formations holding REE minerals at a scale of 1:2000.

ii. To systematically collect bedrock and channel samples for IC-PMS studies of 34 elements, including REE, in order to comprehend the distribution of primary and secondary sources.

iii. To determine the subsurface occurrence of REEs, systematically drilling of boreholes at 400m x 200m grid pattern in compliance with the MEMC rule.

iv. To establish the inferred resources (333) for REE bearing minerals as per UNFC norms & Minerals (Evidence of Mineral Contents) Rules- 2015.

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

6.1.0 GEOLOGICAL MAPPING

6.1.1 Geological mapping will be carried out in the entire 2.85 sq.km area on 1:2000 scale. Rock types, their contact, structural features will be mapped. Surface manifestations of the mineralization (REE) available along with their surface disposition will be marked on map.

6.2.0 GEOCHEMICAL SAMPLING

6.2.1 **Channel Sampling:** 50 nos. of channel samples will be collected systematically during mapping and drilling from the various lithounits viz Rhyolites, felsic dykes present in the area, to understand the distribution of REE.

6.3.0 EXPLORATORY DRILLING

6.3.1 Exploratory drilling has been planned in systematic manner in 400m x 200 m interval as specified in MEMC rule. The vertical boreholes have been planned from the north to south. The depth continuity, grade and thickness of these zones will be checked by drilling about 27 vertical boreholes of 125m depth on a grid of 400m x 200m. Initially 5 boreholes i.e. PBH- 6, 9 12, 16 and 19 will be drilled and respective core samples will be tested for REE and associated RM concentrations. If encouraging results are received the remaining drilling and core sampling will be done simultaneously. Hence a total 3500 m drilling quantum is proposed for 27 nos. of vertical boreholes. Out of these, one vertical stratigraphic borehole (PBH -10) shall also be drilled upto depth of 250 m depth to prove the stratigraphic succession below the aeolian sand.

6.3.2 Borehole Geophysical Logging: Each of the drilled borehole will be logged by Dual Density, Spectral gamma, SP and Resistivity method to identify the potential REE mineralized zones which will lead to precise sampling.

6.3.3 **Borehole Samples:** Core sampling will be carried out for each borehole. Since the REE & RM mineralization cannot distinguished easily by naked eye or petrographic studies, sampling can be done on the basis of the mineralized zone established on surface by channel sampling, the geophysical inferred zones delineated during geophysical borehole logging. The sample interval will be kept at 1m. However, to avoid mixing of samples of different lithologies, variable lengths samples may be collected near to the litho-contacts. Hence a provision of 1000 Nos of borehole core samples have been kept in the quantum.

6.3.4 Pitting and trenching: Pitting of 50 cu.m to be carried out along the borehole section for REE and RM mineralization. Hence a provision of 50 Nos of pit samples have been kept in the quantum.

6.4.0 Chemical Analysis

6.4.1 All the 1100 nos of samples including channel samples (50 Nos), pit samples (50 Nos) and borehole core samples (1000 Nos) will be subjected to chemical analysis of Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, Rb, Zr, Ge, Sr, Sn, W, V, Be, Ga, Nb, Mo, Nb, Li, Cs, U & Th through ICPMS at MECL's chemical laboratory facility Nagpur.

6.4.2 10% of primary samples, i.e., 110 nos will be analysed at NABL accredited laboratory as external check sample and will be analysed for Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, Rb, Zr, Ge, Sr, Sn, W, V, Be, Ga, Nb, Mo, Nb, Li, Cs, U & Th through ICPMS.

6.4.3 20nos. of samples for PCS (petrochemical studies) has been kept for major, minor, trace and REE (SiO2, Al2O3, Fe2O3, MnO, MgO, CaO, Na2O, K2O, TiO2, P2O5, Ba, Ga, Sc, V, Th, Pb, Ni, Co, Rb, Cr, Sr, Zr, Nb, Cu, Zn, Au, Cu, Zn, Ag, Cd, Be, Ge, Y, Mo, Sn, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W and U.).

6.5.0 PETROLOGICAL STUDIES:

6.5.1 During the course of Geological mapping, drilling and sampling 25 nos. of samples from borehole core samples of various lithounits will be collected for Petrographic Studies.

6.6.0 XRD STUDY

6.6.1 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 higher values of REE in core samples

6.7.0 EPMA Study

6.7.1 EPMA study on different REE and silicate phases will be carried out and a provision of 15 hrs. has been kept.

Details of the particular, Quantum and the targets are tabulated in **Table No.-5**

Table No-5

Envisaged Quantum of proposed work

Sl. No.	Item of Work	Unit	Target
1	**Detail Geological Mapping** (on 1:2,000 Scale)	Sq km	2.85
2	**Topographic Survey** (on 1:2,000 Scale)	Sq km	2.85
3	**Geochemical Sampling**		
i	Channel samples	Nos	50
4	**Core Drilling**		
i	Systematic Drilling in 400m x 200 m interval	m	3500
ii	Borehole Geophysical logging	m	3500
iii	Borehole Core Sampling	Nos	1000
5	**Laboratory Studies** (34 elemental analysis by ICPMS Sc, Y, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, Rb, Zr, Ge, Sr, Sn, W, V, Be, Ga, Nb, Mo, Nb, Li, Cs, U & Th		
	i)Primary Samples	Nos	1100
	ii) External Check Samples	Nos	110
6	**Petrological Samples**	Nos	25
7	**PCS**	Nos	20
8	**XRD Mineral phase analysis**	Nos	20
9	**EPMA studies**	Hrs	15
10	**Report Preparation (5 Hard copies with a soft copy)**	Nos.	1
11	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	Nos.	1

7.0.0 BREAK-UP OF EXPENDITURE

7.0.1 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. 747.98 Lakhs.** The summary of cost estimates for preliminary exploration (G-3) is given in **Table No. - 6.** The detailed cost sheet is given as Annexure-I.

Table No. 6

Summary of cost estimates for Preliminary Exploration (G-3) in NB-9 & 10 Block, District-Balotra, Rajasthan

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geological Mapping (LSM), Other Geological Work and Survey	5,494,000
2	Drilling	45,315,382
3	Laboratory Studies	10,048,635
4	**Sub Total (1 to 4)**	**60,858,017**
5	Exploration Report Preparation	2,000,000
6	Proposal Preparation	500,000
7	Peer review charges	30,000
8	**Sub Total (1 to 7)**	**63,388,017**
9	GST 18%	11,409,843
10	**Total:**	**74,797,860**
	Say Rs. In Lakh	**747.98**

8.0.0 TIMELINE

8.0.1 The entire project is planned tentatively for 15 months.

Table No. 7

Tentative Time schedule / Action plan

Estimated timeline for Preliminary Exploration (G-3) for REE and associated minerals in NB-9 & 10 Block, Districts: Balotra, State: Rajasthan [Block area- 2.85 sq. km; Schedule timeline- 15 months]

S. No.	Particulars	Months/ Days	1	2	3	4	5	REVIEW	6	7	8	9	10	11	12	13	14	15
1	Camp Setting	months	■															
2	Geological Mapping & BR sampling	months	■	■	■													
3	Channel Sampling	cu.m			■	■	■											
4	Topographic Survey	months			■	■												
5	Out Source Tendering Process	months					■		■									
6	Core Drilling	m								■	■	■	■	■	■			
7	BH Geophysical Logging	m								■	■	■	■	■	■			
8	BH Core Sampling	Nos					■				■	■	■	■	■	■		
9	Camp winding	months														■		
10	Laboratory Studies	months					■							■	■	■	■	
11	Report Writing with Peer Review	months														■	■	■

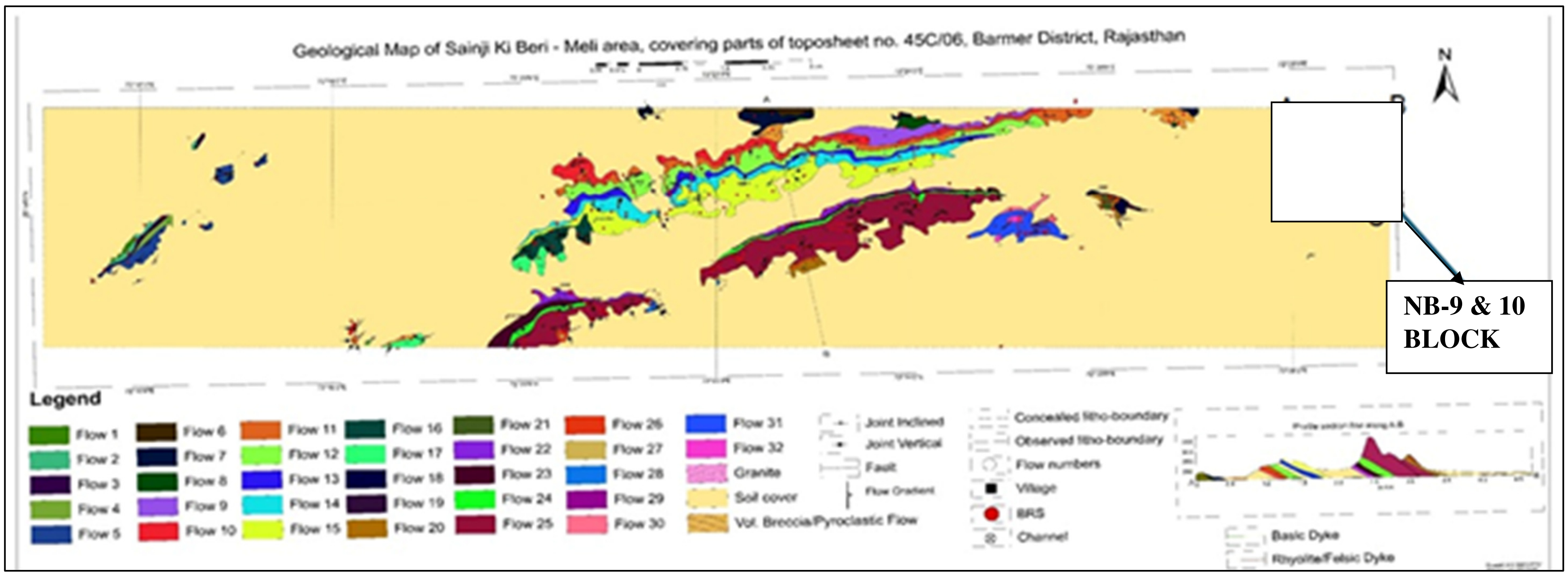


Figure 1: Proposed NB- 9 & 10 block shown in black on the LSM (Sainji ki beri-Meli G-4 block, FS 2021-22).