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DPR for Preliminary exploration for rare earth elements and associated mineralization in NB-15 Block, Balotra District, Rajasthan (UNFC Stage- G3) under NMEDT

Prepared & Proposed by

Ocean Drilling & Exploration Pvt. Ltd.

Shanti Nagar, Jhotwara,
Jaipur- 302012

Proposal for Preliminary exploration for rare earth elements and associated mineralization in NB-15 Block, Balotra District, Rajasthan (UNFC Stage- G3) under NMEDT

<u>Commodity:</u>

Rare earth element and associated mineralization

By:

Ocean Drilling and Exploration Private Limited

Place: Jaipur

Date:23.11.2025

Summary of the Proposed NB-15 block for G3 stage exploration

Sl No	Features	Details
	Block ID	NB-15
	Exploration Agency	Ocean Drilling & Exploration Pvt Ltd.
	Previous Exploration Agency	GSI
	Previous stage Geological Report)	G-3
	Commodity	Rare earth elements
	Mineral Belt	Siwana ring complex
	Completion Period with entire schedule to complete the project	12 months
	Objectives	1. To establish the surface mineralization by systematic mapping and sampling of flows. 2. To establish the subsurface continuity and estimate resource of REE and associated mineralisation.
	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	All the work will be carried out by the proposed agency; some specialised work like GPL, survey chemical analysis, etc may be outsourced
	Name / Number of Geoscientists	1. Sh. T Ravindra Babu 2. Sh. Sanjay Bagora 3. Abhishek Kumar Siddhartha 4. Smt. Sarita Negi
	Expected Field days (Geology, Geophysics, Surveyor)	Geologist party days on field: 230 Geologist party days in HQ: 80
1.	**Location**	
	Latitude & Longitude	
	Villages	Sainji ki Beri, Kerli ki Pahadi, Khera Khindwara
	Tehsil/ Taluk	Siwana
	District	Balotra
	State	Rajasthan
2.	**Area (hectares/ square kilometres)**	
	Block Area	2 sq.km
	Forest Area	As per available kml of Forest boundary 0.41 Sq. Km area of proposed block falls in forest area
	Government Land Area	Data not available
	Private Land Area	Data not available
3.	**Accessibility**	
	Nearest Rail Head	The nearest railway station is Balotra Junction, located approximately 30-40 km from the site, providing rail connectivity to major destinations like Jodhpur, Barmer, and Jaipur.

	Road	The area falls in south-western part of Rajasthan and is well connected by road and rail. The road connectivity to Jaipur is primarily through National Highway NH-25 and NH-62, which further links to NH-48, connecting directly to Jaipur. Metalled roads provide smooth access to the site, while jeepable tracks ensure last-mile connectivity for local travel.
	Nearest Airport	Jodhpur is the nearest airport from the study area which 120 km away.
4.	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	The most of the study area is devoid of any major stream.
	Rivers/ Streams	
5.	Climate	Balotra district, located in the Thar Desert, experiences an arid climate with an average annual rainfall of 350 mm. The highest (1052 mm) and lowest (34 mm) annual rainfall were realized at Siwana. The region is characterized by extreme diurnal and seasonal temperature variations, with summer temperatures ranging from 46–51°C and winter lows occasionally dropping to 0°C. During winters, secondary western disturbances cause light rainfall, increased wind speeds, and a wind-chill effect, while the district's average annual temperature remains around 27.1°C.
	Avg. Annual Rainfall	The average rainfall 350 mm per annum.
	Temperatures Minimum Maximum	 51°C. 0 °C.
6.	**Topography**	
	Toposheet number	45C/06
	Morphology of the Area	The area shows undulatory topography with knobby hills and rest area is sand covered.
7.	**Availability of baseline geoscience data**	
	Geological Map (1:50K/ 25K)	Available 1:50000 scale map
	Geochemical Map Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Available 1:50000 scale map Available 1:50000 scale map
	Justification for taking Preliminary Exploration under G3	**A. Background Information** The present block lies in northern part of Siwana ring complex (SRC). The SRC forms the major geomorphic features in toposheet 45C/6 lying in Barmer district, Rajasthan. The SRC forms a part of the MIS and occupy an area of about 1100km^2. It displays important features namely volcano-plutonic associations, anorogenic setting and holds potentials for rare earths and rare metals (Kochhar, 1992; Jain et al., 1996; Vallinayagam and Kochhar, 1998; Bhushan and Chittora, 1999; Kochhar, 2000; Vallinayagam, 2001; Vallinayagam, 2004; Singh

		and Vallinayagam, 2009). The high hills of Siwana are composed of rhyolitic flows, basaltic flows, granite along with felsic-basic dykes. Previously Geological survey of India (GSI) and Atomic mineral Directorate (AMD) have intensively worked in SRC. Blanford (1877) and Hacket (1881), La Touche (1902), Coulson (1933), Ghosh (1932) carried out initial mapping and survey in these regions. Based on field relationship, mode and type of magmatism, texture and composition, MIS has been divided into three phases of magmatic activity. The first phase commenced with the eruption of basic flows, followed by voluminous outpouring of felsic lava flows and culminating in ash flow deposition. The second phase experienced intrusion of peraluminous, per-alkaline and meta-aluminous granitoids as plutons, ring dyke, bosses and plugs within the extrusive phase. The third phase represents the mafic and felsic dyke swarms and sills within the earlier two phases. The magmatic evolution of Siwana Ring Complex 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 comprises arfvedsonite-reibeckite-aegirine bearing per-alkaline Siwana Granite. The third phase being later intrusives phase includes rhyolite, microgranite, andesite and felsite dykes. The plutonic phase is having intrusive relationship with volcanic phase. All these three phases host anomalous REE+Y concentration and third phase being more enriched (Kumar and Sharma, 2020). Granitoids of different ages (~ 1.8 Ga, ~1.7 Ga, ~1.4 Ga, ~ 1.1Ga and 850-750 Ma) have intruded the belts of basement rocks and overlying supracrustal belts of Aravalli and Delhi Supergroup (Bhushan, 1985). 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). Preliminary sampling of the rhyolites and associated tuffs of Bhimgoda Pahar and Koiliyasar-Ka-Pahar of Siwana Ring Complex, Barmer district, carried out by GSI during 2013-14, indicated anomalous REE values with REE ranging from 1334 to 2692ppm and 1075 to 3319ppm REE respectively (Rastogi & Mukherjee, 2015). Bidwai et al., 2014, reported the presence of high LREE, Zr, Nb, Th and U along with Ag in surface samples in the Siwana Ring Complex. Das et al., 2015, carried G4 investigation in Siwana eastern and central blocks and anomalous value of REE were reported. Barman and Neogi, 2018 caried G-4 stage investigation in northern part of plutonic phase of Siwana

Ring Complex and reported REE+Y ranging from 142.3 ppm to 0.85% in BRS samples. Kumar and Sharma, 2020, carried out G-4 investigation and reported REE+Y ranges in various lithounits are i) Plagioclase rich granite REE+Y = 0.029%-0.70%. ii) K-feldspar rich granite REE+Y= 0.047%-0.66%. iii) Younger Intrusives REE+Y= 0.019%-2.66%. iv) Felsic volcanic REE+Y = 0.015%-0.96% and v) Enclave/Restite/Soil REE+Y = 0.022%-1.27%. Apart from REE, rare metals and some trace elements also indicate very encouraging results, Zr (0.1% to 1.1%), Nb (2.5ppm to 1039ppm), Ba (25ppm to 3948ppm), Zn (120ppm to 1258ppm), U (0.61ppm to 124ppm), Th (2ppm to 481ppm) and Hf (4.52ppm to 828.18ppm). Shankar and Ghosh (2023) carried G4 stage of investigation in Sanji ki Beri-Meli block during FS 2021-22. Based on chemical analysis data of 203 BRS from rhyolite samples of study area yielded ΣREE+Y values ranging from 91.76ppm to 9764.68ppm, with average value of 1844.84ppm. ΣHREE/ΣLREE ratio of the same is 0.15. 22 BRS samples from felsic/rhyolite dykes yielded ΣREE+Y values ranging from 144.77ppm to 7678.75ppm, with average value of 1400.14ppm. ΣHREE/ΣLREE ratio of the same is 0.16. ΣREE+Y value in 109 channel samples ranging from 261.73 to 6224.81ppm, with ΣHREE/ΣLREE ratio of 0.19. Rare earth elements in the study area were associated with peralkaline rhyolite flows.

The proposed block is based on the encouraging result of TREE+Y values found in area.

B. Justification:

The Block is being proposed for G-3 level of exploration to establish the subsurface potentiality of mineralization based anomalous value of REE in bed rock samples.

The analytical results of BRS and channel samples in proposed area show TREE+Y values ranging from 114.07ppm to 3230ppm in exposed rhyolitic flow no. 12 to 15 and 25 to 28 and dykes.

Sample no	Latitude	Longitude	TREE	TREE+Y
			(in ppm)	
CH3/SM/5	25.736079	72.358057	1613.9	2075.67
CH3/SM/4	25.736079	72.358057	1562.08	2040.41
CH3/SM/3	25.736079	72.358057	1576.24	2082.63
CH3/SM/2	25.736079	72.358057	1608.62	2098.3
CH3/SM/1	25.736079	72.358057	2046.61	2587.87
BRS/SM/007	25.7219	72.3641	88.84	114.93

BRS/SM/008	25.7219	72.3641	892.61	1132.2
BRS/SM/009	25.7306	72.3571	1249.53	1690.09
BRS/SM/010	25.7316	72.358	1729.62	2166.43
BRS/SM/61	25.7356	72.3524	453.25	583.43
BRS/SM/63	25.732	72.3551	1777.02	2545.95
BRS/SM/66	25.7324	72.3588	1860.31	2639.14
BRS/SM/76	25.7361	72.3596	81.78	114.07
BRS/SM/77	25.7357	72.3587	383.98	478.37
BRS/SM/78	25.7352	72.3588	471.8	599.6
BRS/SM/81	25.7212	72.3643	2464.79	3230.35
BRS/SM/82	25.7217	72.3655	175.71	225.31
BRS/SM/83	25.7222	72.366	168.34	212.21
BRS/SM/84	25.7219	72.3665	484.64	621.99
BRS/SM/85	25.7224	72.3662	476.25	613.25

In the view of the above encouraging result, the proposed block needs to be explored in G-3 stage.

1. BLOCK SUMMARY

1.1 Physiography

The proposed Block is part of the Survey of India toposheet No. 45C/06, Barmer district, Rajasthan. The proposed block marked on toposheet no 45C/06 is attached in Plate I. Total area of the proposed block is 2 sq. km. Siwana area is characterised by arcuate ridges as well as isolated hillocks which are arranged in a semicircular fashion around Siwana. The ridges forming the northern half of the semicircle extend parallel to the strike of the rhyolite flows and show steep escarpments on their northern side and gentle slopes towards south. Sand dunes and sand sheet occur in the area occupying all intervening area among hills and ridges. Proposed area lies in the northern part of hills exposed in Siwana ring complex.

1.2 Background Geology (Regional Geology, Geology of the Block)

1.2.1 Regional Geology: Geologically, the study area is part of Malani igneous suite (MIS) which comes under Trans-Aravalli region. MIS is predominantly composed of volcanic acidic rocks and shows an assemblage of polyphase igneous activities. The term ‘Malani’ is specifically associated with the rocks formed during a significant Neoproterozoic polyphase igneous event, which occurred roughly between 830 million years ago (Ma) and 680 Ma. This period represents a geological gap between the deposition of the Sirohi Group of the Delhi Supergroup (Choudhary et al., 1984) and the overlying Marwar Supergroup (Rathore et al., 1999). The Malani Igneous Suite (MIS) unconformably overlies the Mesoproterozoic rocks of the Delhi Supergroup (Bhushan, 2000), and this contact has been studied extensively near Manihari and Kankani (La

Touche, 1902; Bhushan, 1984; Chittora & Bhushan, 1992; Bhushan, 2000; Nayak & Bhamboo, 2013).

The earliest recorded volcanic activity within the MIS is from the Diri and Gurapratap Singh areas, where the rhyolites have been dated at approximately 779 ± 10 Ma (Rathore et al., 1996). These volcanics likely represent the oldest components of the suite. In contrast, the youngest known phase of the MIS is represented by the ultrapotassic intrusions in the Diri, Gurapratap Singh, and Manihari areas, dated at around 681 ± 20 Ma (Rathore et al., 1999).

Overlying the MIS non-conformably are the sedimentary rocks of the Marwar Supergroup, which were earlier considered equivalents of the Vindhyan Supergroup (Chittora & Bhushan, 1990–94). Earlier studies by Crawford and Compston (1970) suggested that the Malani igneous activities commenced after the emplacement of the Erinpura and Abu Granites. However, Bhushan (1981) observed at Siyana in Jalore district that rhyolites belonging to the MIS overlie the Abu Granite, which was previously dated to around 800 ± 50 Ma (Choudhary et al., 1984). More recent U–Pb dating by Solanki (2011) indicates that the Abu Granite formed between 763 ± 3 Ma and 766 ± 4 Ma, leading to its reclassification as part of the Malani magmatism itself (de Wall et al., 2012).

The igneous activity within the MIS is understood to have begun with felsic volcanism, followed by granite emplacement, and concluding with the intrusion of dyke swarms (Bhushan, 1984; 2000). The origin of the Malani magmas remains a subject of debate. Some geologists suggest they were derived from the melting of the lower crust in a rift-related setting (Bhushan, 2000; Singh & Vallinayagam, 2013), while others propose a mantle plume origin (Eby & Kochhar, 1990). Further models link the MIS to a superplume below South China, associating it with the break-up of the supercontinent Rodinia (Li et al., 1999; Torsvik et al., 2001). An alternate hypothesis suggests a subduction-related origin, involving the Mozambique Ocean between Seychelles–Madagascar and northwestern India (Ashwal et al., 2002; Torsvik et al., 2001; Tucker et al., 2001).

Within the MIS, two important granite emplacements have been recognized. The Jalore Granite has been dated to approximately 727 ± 8 Ma, and the Siwana Granite to 693 ± 8 Ma (Rathore et al., 1999). However, a study by Dhar et al. (1996) proposes that the Siwana Granite is contemporaneous with the Jalore Granite, dating it to around 723 ± 6 Ma, and considers it to be mantle-derived. The Siwana Granite, being peralkaline in nature (Eby & Kochhar, 1990), intrudes the surrounding rhyolites in a distinctive ring-like pattern, leading to the nomenclature Siwana Ring Complex (SRC). This pattern was first observed in early works by Coulson (1933), Murthy (1962), and Mukherjee & Roy (1981). The volcanic flows in the Siwana area also display an elliptical geometry, with a gentle inward slope towards the center, further supporting the ring-complex interpretation.

Based on field relationship, mode and type of magmatism, texture and composition, MIS has been divided into three phases of magmatic activity. The first phase commenced with the eruption of basic flows, followed by voluminous outpouring of felsic lava flows and culminating in ash flow deposition. The second phase experienced intrusion of peraluminous, per-alkaline and meta-aluminous granitoids as plutons, ring dyke, bosses and plugs within the extrusive phase. The third phase represents the mafic and felsic dyke swarms and sills within the earlier two phases. Regional geology of Siwana ring complex is given in Fig 3. A regional stratigraphic succession of Trans-Aravalli region is given in the Table 1.

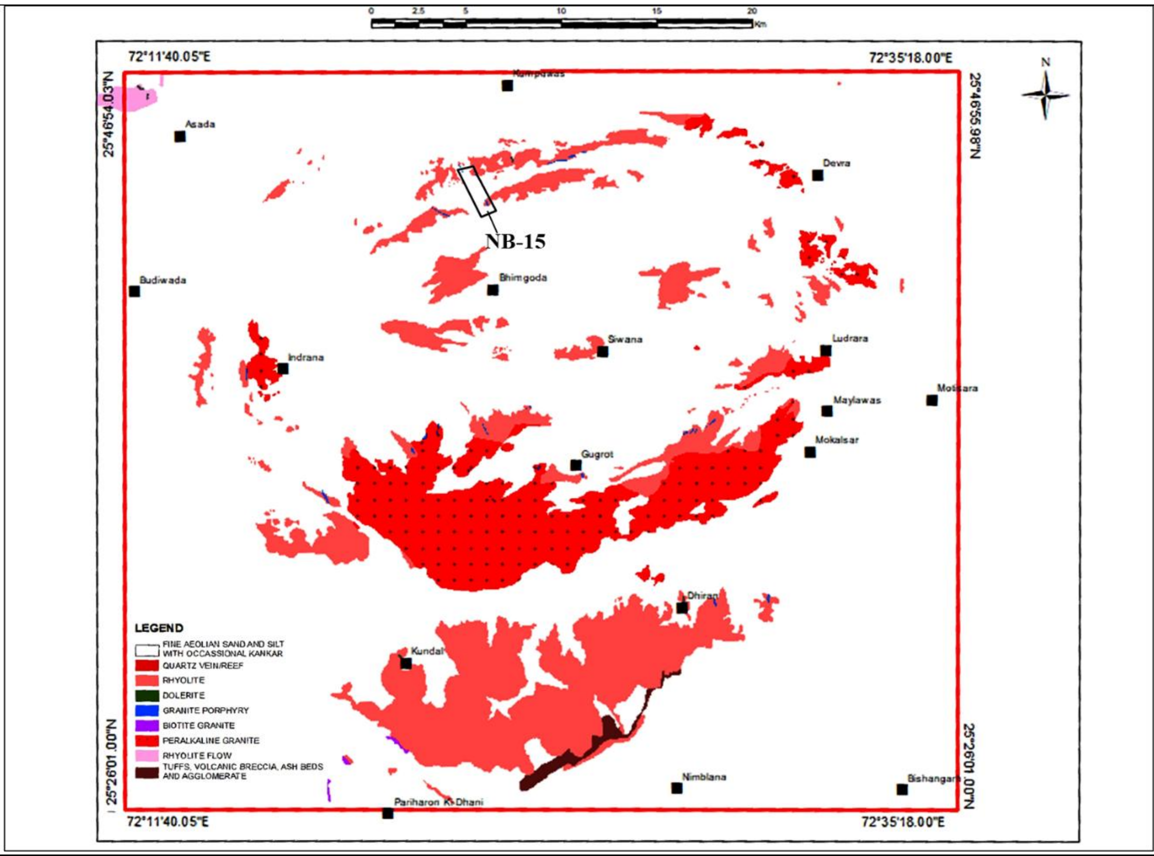

Figure 3: Proposed NB-15 block shown on the Geoloical map of Siwana Ring Complex.

Table 1: Regional lithostratigraphy of Trans-Aravalli region:

Group/Supergroup	Age	Rock type
Marwar Supergroup (Jodhpur group)	Vendian to Lower Cambrian	Maroon and golden sandstone, siltstone and shale
----------------------Unconformity----------------------		
Pokharan Boulder bed	Vendian	Scattered boulders and pebbles of glacial origin
----------------------Unconformity----------------------		
Malani Igneous suite	Neo-Proterozoic	Bimodal volcanics, granites and dyke swarm
----------------------Unconformity----------------------		
Delhi Supergroup (Basement)	Mesoproterozoic to Neoproterozoic	Abu and Erinpura Granite Metasediments of Sirohi and Pali area Unspecified gneisses of Balewa-Harsani area (Archean Supracrustals?)

1.2.2 Geology of the Block:

Major lithologies exposed in proposed block is flows of rhyolite and later felsic dykes along with aeolian sand. During previous G4 exploration, total 8 flows of rhyolite (rhyolitic flow no. 12 to 15 and 25 to 28) with felsic dykes have been mapped in the study area. The general flow trend is NE-SW, with the layers dipping towards the SE at an angle of 25° to 30°. Geological map (1:12500) showing major lithounit in proposed area is attached in Plate-II.

Flow 12 is dark brown flow of rhyolite comprising both laths and tabular shaped phenocrysts of K-feldspar, which are comparatively smaller in size, varying from 0.1cm to 0.5cm with P: G ratio 35:65. (Fig. 2)

Flow 13 is characterised by dark grey rhyolite, consisting of white acicular feldspar in dark grey groundmass.

Flow 14 is porphyritic rhyolite characterised by dark grey and consists of phenocrysts of plagioclase laths. Secondary filling of calcite is also present in vesicles. (Fig. 3).

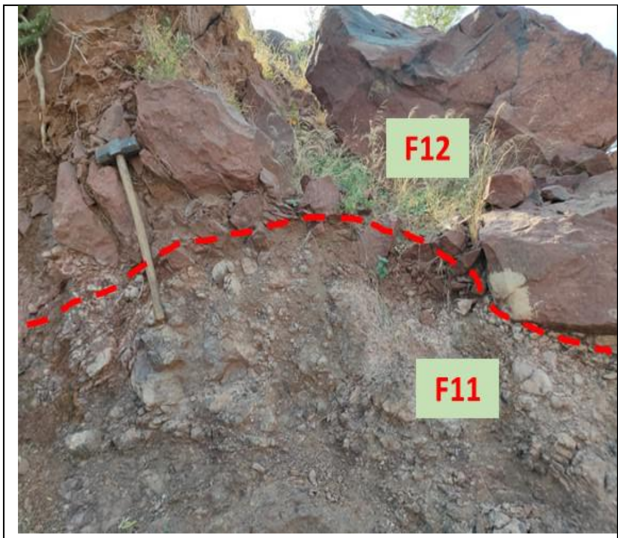

Fig 2: Contact between Flow 11 and Flow 12, N of Thapan (Referred from GSI report)

Fig 3: Porphyritic rhyolite, Flow 14, Sainji Ki Beri. (Referred from GSI report)

Flow 15 is rhyolite, characterised by brown coloured appearance, consisting of tabular shaped phenocrysts of K-feldspar, which varies in size from 0.1cm to 1.0 cm with a P: G ratio 35:65.

Flow 25 is rhyolite with varying colours from reddish brown and often contains ash material at the top part. Both tabular and lath-shaped phenocrysts of K-feldspar are present within fine-grained groundmass. Phenocryst size varies from 1mm to 5mm with phenocryst to groundmass ratio (P:G Ratio) 02:98.

Flow 26 is rhyolite in composition, consisting of tabular and lath-shaped K-feldspars along with few specks of glass within brown-coloured groundmass. Size of the phenocrysts varies from 1mm to 5cm, and approximate P: G ratio is 10:90.

Flow 27 has relatively larger K-feldspar phenocrysts of tabular and lath shaped, varying in size from 5mm to 2cm with fine-grained, brown-coloured groundmass. Phenocryst to groundmass ratio is approximately 15:85.

Flow 28 is greyish brown coloured rhyolite consisting of sparsely distributed small laths of K-feldspars which vary in size from 0.1cm to 0.5cm, where P: G ratio is approximately 02:98.

Felsic dykes are showing coarse grained texture, primarily composed of K-feldspar, Na-feldspar and quartz. Often K-feldspars are rimmed by Na-feldspar.

1.2.3 Structure and Framework of the Block

Exposed lithounits don't show any remarkable deformation event. Primary igneous layering and joints are common. Secondary vesicles and amygdules are also visible in the lithounits. Joints are major secondary structures in the area. Three sets of prominent joints are usually seen, which are near vertical. Based on the crosscutting relationship, the older joint (J1) trends in NS to NE-SW with near vertical dip, the second phase of joint (J2) trends in NW-SE direction with moderate dip and the youngest joint (J3) trends in E-W, ENE to WNW with moderate to low angle. Another set of crudely developed joint planes are sub-horizontal parallel to flow direction.

1.3 Mineral Potentiality Based on Geology and Geochemistry

The Siwana Ring Complex is a prominent component of the Malani Igneous Suite and occupies an area of approximately 1100 square kilometers, extending 30 km east–west and 25 km north–south. It exhibits classic features of volcano-plutonic association in an anorogenic setting and is recognized for its potential to host rare earth elements (REEs) and rare metals (Kochhar, 1992; Jain et al., 1996; Vallinayagam & Kochhar, 1998; Bhushan & Chittora, 1999; Kochhar, 2000; Vallinayagam, 2001, 2004; Singh & Vallinayagam, 2009). The analytical results of BRS and channel samples in proposed block show TREE+Y values ranging from 114ppm to 3230ppm in exposed rhyolitic flow no. 12 to 15 and 25 to 28 and later felsic dykes. Y, Ce, Sm, Nd and Hf are comparatively more enriched.

Aeromagnetic map (fig 4) shows very high magnetic anomaly in the soil covered area. A magnetic gradient traversing in EW direction of the block maybe interpreted as fault running parallel to the flow direction. Low magnetic anomaly is present in the southern part of the block. These magnetic anomalies corroborate well with enrichment of REE in this locality.

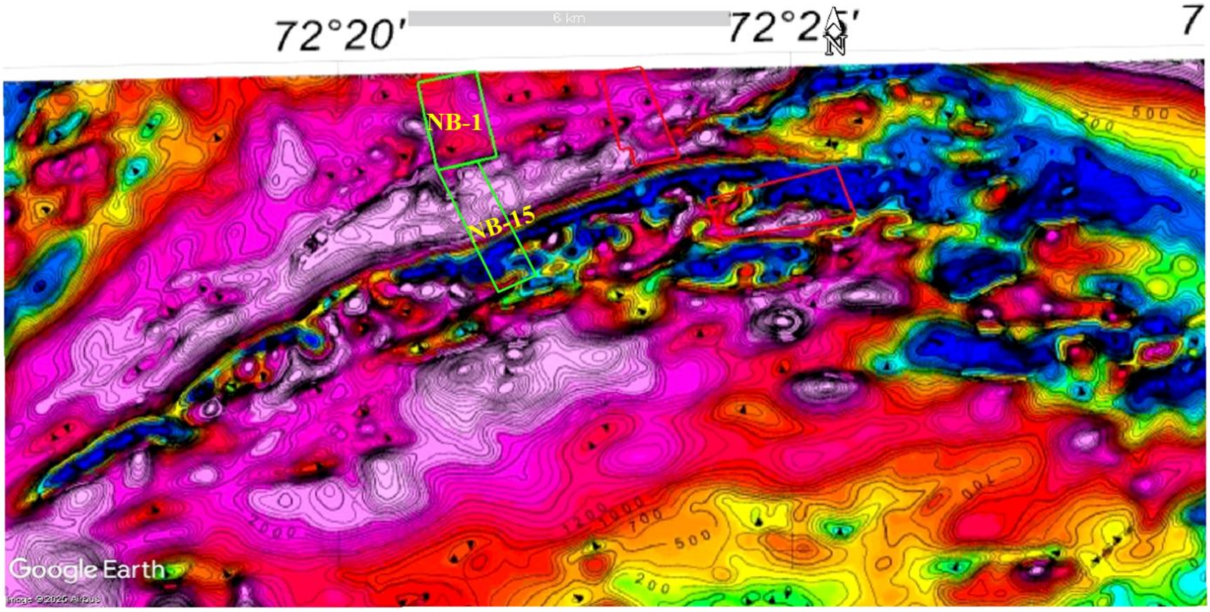

Figure 4: Proposed block NB-15 shown on aeromagnetic anomaly map.

1.4. Scope for Proposed Exploration

This project proposes a preliminary exploration at the G-3 stage consisting of detailed geological and topographical mapping on 1:2,000 in block of 2 sq. km area to establish the surface mineralization by systematic mapping and sampling of flows and to establish the subsurface continuity and estimate resource of REE and associated mineralisation. Total 3000m of drilling is proposed with 24 vertical boreholes of nearly 125m depth is planned on 400m x 200m grid, along with chemical analysis of the core samples, estimation of resources under G3 category and report preparation.

1.5 Recommendations of previous exploration work

1. Lal, S., Ghosh, I. (2023) carried G4 stage of investigation in Sanji ki Beri-Meli block during FS 2021-22. The proposed block is based on the recommendation and encouraging result of TREE+Y values found in North of ra area of G4 stage exploration done during FS 2021-22.
2. Systematic deep drilling activities to know the extent of REE enriched flows showing remarkable values of TREE+Y.
3. Rare earth elements in the study area are associated with peralkaline rhyolite flows.

Based on these facts the proposed area is being proposed for further exploration with closed spacing boreholes.

1.6 Objectives of Exploration

1. To establish the surface mineralization by systematic mapping and sampling of flows.

2. To drill 24 nos. of vertical boreholes at 400m x 200m grid pattern to establish depth and strike persistence of REE and associated mineralisation in rhyolitic flows.

3. Estimate resources for REE along with any accessory elements (if any) as per UNFC norms and minerals (evidence of mineral contents) rules - 2015 at the G-3 level.

2.0 PREVIOUS WORK

Previous Exploration details in the proposed block area:

1. **Blanford (1877)** was among the earliest geologists to study the Malani rocks. He introduced the term ‘Malani beds’ to describe these volcanic rocks, which included porphyritic lavas and ash beds.
2. **Hacket (1881)** recorded the occurrence of schist at the contact zone of Malani rhyolites to the south of Jodhpur. He also described the nature of the volcanics in the Jodhpur region and examined their relationship with overlying sandstones.
3. **La Touche (1902)** conducted detailed work on the Malani volcanics, providing insights into their eruptive nature, physical characteristics, and petrography. He interpreted Siwana granite as an intrusive phase into the Malani rhyolite and reported rhyolite occurrences near Rajpura in the Kankani area.
4. **Ghosh (1932)** studied borehole data around Jodhpur and discovered basic lava flows beneath felsic flows, suggesting a basic magma as the source for both lava types.
5. **Coulson (1933)** included these rocks in the ‘Malani system’ and described Siwana granite as a hornblende granite occurring in a nearly continuous ring within the volcanic terrain.
6. **Mukherjee (1958)** identified Siwana granite as a coarse, porphyritic, hornblende granite lacking mica and proposed that the erupted rocks form a doubly plunging syncline.
7. **Murthy et al. (1961)** referred to the rhyolites and granites as the Malani Suite of igneous rocks, a term later used by **Venkataraman et al. (1968)** and modified as Malani Igneous Suite by **Ray (1998)**.

8. **Chittora and Bhushan (1994)** observed three distinct phases of magmatism in Siwana: a basal peralkaline volcanic phase, a middle metaluminous phase, and a reappearance of the peralkaline phase as intrusive Siwana granite.
9. **Dhar et al. (1996)** dated the Siwana granite at ~745 Ma and described it as peralkaline in nature with high REE enrichment.
10. **Singh and Vallinayagam (2009)** characterized the MIS as comprising peralkaline, metaluminous to mildly peralkaline, and peraluminous granites with associated acid volcanics, ring structures, and radial dykes.
11. **Rastogi and Mukherjee (2015)** carried out preliminary sampling of rhyolites and associated tuffs from Bhimgoda Pahar and Koiliyasar-ka-Pahar in the Siwana Ring Complex and reported anomalous ∑REE values ranging from 1334 to 3319 ppm.
12. **Bidwai et al. (2014)** reported high surface concentrations of LREE, Zr, Nb, Th, U, and Ag in the Siwana Ring Complex.
13. **Barman and Neog (2018)** conducted G-4 stage investigations in the northern plutonic phase of the Siwana Ring Complex and observed ∑REE+Y ranging from 142.3 ppm to 0.85%.
14. **Kumar and Sharma (2020)** proposed a three-phase magmatic evolution model for the Siwana Ring Complex—comprising bimodal volcanism, a plutonic phase with arfvedsonite–riebeckite–aegirine-bearing peralkaline granite, and a final phase of younger felsic intrusives. They reported enriched ∑REE+Y concentrations across various lithounits (ranging from 0.015% to 2.66%) and significant trace element values for Zr, Nb, Ba, Zn, U, Th, and Hf.
15. **Lal and Ghosh (2023)** carried out G-4 stage investigations in the Sanji ki Beri–Meli block during FS 2021–22 and reported ∑REE+Y values ranging from 91.76 ppm to 10130 ppm in 203 BRS rhyolite samples, with an average value of 1844.84 ppm.

3.0 BLOCK DESCRIPTION

Proposed G3 investigation area

The area falls under Survey of India Toposheet no. 45C/06 and covers about 2 sq. km. Localities present in the vicinity is Sainji ki Beri, Kerli ki Pahadi, Khera Khindwara village. The coordinates of the proposed NB-15 Block's corner points are given in table below.

Proposed area - NB-15 (2 sq.km)		
CARDINAL POINTS	**LATITUDE (DD)**	**LONGITUDE (DD)**
A	25.73623°	72.35163°
B	25.73791°	72.35903°
C	25.7169°	72.36984°
D	25.7138°	72.36279°

4.0 PLANNED METHODOLOGY

4.1 Methodology of exploration: A 2 sq. km area within the Siwana Igneous Complex of western Rajasthan has been proposed as the NB-15 block for the exploration of Rare Earth Elements (REE) and associated critical minerals such as Yttrium, Niobium, Zirconium, and Thorium. The objective of the exploration is aligned with the requirements of the Preliminary Exploration (G-3) stage as defined by the Minerals (Evidence of Mineral Contents) Rules, 2015 and subsequent amendments in 2021. The primary aim of this exploration is to assess the lateral and vertical continuity of REE-enriched zones hosted in rhyolitic flows exposed in proposed block. Accordingly, the following scheme of exploration has been formulated:

Geological Mapping (1:2,000 Scale): Detailed geological mapping will be carried out on the entire proposed block at 1:2,000 scale. The area is dominantly covered by rhyolitic flow, few dyke in N-S direction and lower lying with aeolian sand of Thar formation. Structural elements such as joints, flow bands, faults (if any), and lithological contacts will be mapped and interpreted to delineate REE-bearing lithounits.

a) **Surveying:** The block boundary will be demarcated using DGPS and Total Station instruments in WGS-84 datum. Contouring at 3m intervals will be done. Borehole locations will be fixed with accurate RL and coordinates prior to drilling. During the detailed mapping rock types along with their contact and structural features, if any will be demarcated by the using DGPS/Total Station. Further, during the drilling programme, the survey party will carry out borehole fixation and determination of the reduced levels and coordinates of the proposed 24 nos. of vertical boreholes.

b) **Pitting/ Trenching:** A total 50 cubic meter pitting/ trenching will be carried out to expose the mineralized body. Composite sample of 1 meter will be collected from these pit/trench.

c) **Core Drilling:** A total of 24 vertical boreholes are proposed at a grid pattern of 400m × 200m to probe the continuity of mineralized rhyolite flows, location maybe shifted based on the local terrain condition/local issues. Proposed depth of boreholes is 125m. All boreholes will be fully cored (NQ). Drilling will aim to intersect REE-enriched flow units (e.g., 12 to 15 and 25 to 28) and felsic intrusions, if any. Total 3000m of drilling is proposed. Location with tentative planning of the proposed boreholes is given in Plate-III and IV.

   The locations of these boreholes are tentative and may be changed due to local issue/terrain condition.

d) **Geophysical logging:** Spectral Gamma, natural gamma, single point resistance, short normal resistivity, long normal resistivity, Neutron, magnetic susceptibility and density logs will be performed, as per the availability with empanelled agency for all boreholes to support lithological and mineralogical correlation. Spectral gamma in particular will aid in identification of Thorium, Uranium, and Potassium anomalies commonly associated with REE-host rocks. The interpretation of the geophysical logging may help to identify the potential zone and further in sampling of the core samples.

e) **Drill Core Logging:** All cores will be systematically logged for lithology, grain size, texture, color, mineralogy, alteration, structures (flow banding, joints, etc.), and visual REE indicators (e.g., zircon, monazite, fluorite, bastnaesite). Rock Quality Designation (RQD) will also be recorded for geotechnical understanding.

f) **Surface and drill Core Sampling:** Systematic surface sampling will be carried out while mapping. All the rhyolitic flows will be sampled to understand the strike wise variation in REE enrichment in flow. Core samples will be marked based on visual mineralization, geophysical indication of mineralization, alteration, and lithotype. Length of the core samples will be kept at 100cm. A total of 800 primary core samples, and 80 check samples (10%) will be analysed for trace elements (Y, Hf, Zr, Nb, Ta) and REEs (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu).

4.2 Laboratory studies:

a) **Channel/Pit sample and core sample:** A total 100 nos. of channel samples with 10 nos. of check samples (10%) and a total 50 nos. of Pit samples, with 5 nos. of check samples (10%) will be analysed for REE and associated trace elements.
b) **Petrochemical samples (PCS):** A total 15 nos. of samples will be collected for whole rock analysis for classification of rocks and understand the associated mineralization with different litho-unit present in proposed block.
c) **Petrological sample preparation and study:** A total 15 nos. of thin polished section/ore microscopy samples will be prepared from surface and drill core. These samples will be studied to understand mineralogical, textural relationship with ore mineralization.
d) **Geotechnical study:** Specific Gravity along with porosity will be determined for 20 nos. samples from the mineralised zones intersected in the boreholes for the resource estimation.
e) **XRD studies:** A total of 5 nos. samples shall be subjected to XRD studies for the determination of mineral phase.
f) **EPMA studies:** A total of 5 nos. samples shall be subjected to EPMA studies for the determination of mineralized phase.

4.3 Estimation of resources

Estimation of resources will be done according to UNFC norms and the Minerals Evidence & Mineral Contents (MEMC) Rule—2015 at the G-3 level and to meet the NMEDT objectives.

4.4 Report preparation

Submission of reports will be done as per the recommendations of NMEDT in compliance with G3 level as per MEMC 2015 and suggestions for follow-up work to upgrade the project, if deemed necessary.

5.0 NATURE, QUANTUM AND TARGET

The nature and quantum of work proposed are given in Table:

Preliminary exploration for rare earth elements and associated mineralization in NB-15 Block, Balotra District, Rajasthan			
Sl. No.	**Item of work**	**Unit**	**Qty.**
1.	Geological mapping (1:2,000)	Sq.km	**2**
2.	i) DGPS Survey of 24 nos. boreholes and 04 boundary points	Days	**28 days**
	ii) Total Station survey for detailed mapping and contouring	Days	**60 days**
3.	**Drilling 24 nos. of vertical boreholes**	meters	**3000m**
4.	**Geophysical studies of borehole**	m	**1000m**
5.	**Laboratory studies**		
	i) Channel sample (Primary for REE and associated trace elements)	Nos.	**100**
	ii) Check Channel Sample (10%)	Nos.	**10**
	iii) Pit/Trench Samples (Primary for REE and associated trace elements)		**50**
	iv) Check Pit/Trench Sample (10%)		**5**

	i) Drill core samples (Primary for REE and associated trace elements)	Nos.	**800**
	ii) Check core samples (10%)	Nos.	**80**
	Whole rock analysis (Surface and sub-surface)	Nos.	**15**
	Petrological samples preparation (For mineralogical, textural and ore study)	Nos.	**15**
	X-ray diffraction studies	Nos.	**5**
	EPMA	Nos.	**5**
	Report preparation (5 Hard copies with a soft copy)	Nos.	**1**
	Preparation of exploration proposal (5 Hard copies with a soft copy)	Nos.	**1**

6.0 TIMELINE

Proposed Timeline for carrying out work in NB-15 Block, Siwana (G3) *																
S. No.	**Activity**	**Unit**	**Months**													
			1	**2**	**3**	**4**	**5**	**6**		**7**	**8**	**9**	**10**	**11**	**12**	
1	Camp Setting	Months/Days							**Review**							
2	Geological Mapping & Sampling	days														
3	Topographic Survey	days														
4	Surface Drilling (3 rigs)	m														
5	Core logging and sampling															
6	Geophyscist party days (HQ) for data interpretation & Report	Days														
7	Geologist Man days (Field)	days														
8	Geologist Man days (HQ)	days														
9	Sampler Man days	days														
10	Laboratory Studies	Nos.														
11	Report Writing with Peer Review	months														
12	Camp Winding	months														
Note:																
1. Time loss on account of monsoon/agricultural activity/forest clearance/local law and order issue/lockdown etc. will be additional to above timeline																
2. Commencement of project may be reckoned from the day; the exploration acreage is available along with all statutory clearances.																

7.0 MAN POWER DEPLOYMENT

Manpower deployment plan is summarized below.

Activity	Type of Job	Geologist/Geophysicist (HQ manday)	Geologist/ Geophysicist (Field manday)	Labour (Manday)	Sampler (Manday)
Geological mapping, sampling	Field	10	100	150	40
Laboratory studies	Desk + Field	10	-	-	-
Petrographic studies	Desk		-	-	-
Geophysical survey	Field	20	20	-	-
Core drilling, logging, sampling	Field	-	130	910	110
Report preparation	Desk	60	-	-	-

8.0 BREAK-UP OF EXPENDITURE:

S. No.	Item of Work *	Unit *	Rates as per NMET SoC 2020-21		Estimated Cost of the Proposal	Total Amount (Rs) (a*b)
			SoC-Item No. *	Rates as per SoC * (a)	Qty. (b)	
A	**Geological Mapping Other Geological Work & Surveying**					
i)	a. Charges for Geologist per day (Field) Geological mapping, drilling work, core logging, sampling, supervision of drilling, etc(1:2,000 scale)	day	1.3, 1.5.1a	11,000	230	25,30,000
	b. Labours Charges; Base rate	day	5.7	541	460	2,48,860
ii)	a. Charges for Geologist per day (HQ)	day	1.2	9,000	80	7,20,000
iii)	a. Charges for one Sampler per day (1 Party)	one sampler per day	1.5.2	5,100	150	7,65,000
	b. Labours (4 Nos)	day	5.7	541	600	3,24,600
	Sub Total- A					**45,88,460**
B	**Survey work**					
a	DGPS Survey for BH fixation & RL determination along with the demarcation of block boundary	Per Point of observation	1.6.2	19,200	28	537600

b	a. Charges of Surveyor (1 party) for Detail mapping and contouring by total station (outsource)	one surveyor per day	1.6.1b	8,300	60	498000
c	b. Labour Charges for survey work (4 Nos)	day	5.7	541	240	129840
	Sub-Total B					**11,65,440**
C	**DRILLING**					
i)	Drilling up to 300m (Hard Rock), NQ	m	2.2.1.4a	11500	3000	3,45,00,000
ii)	Land / Crop Compansation (in case the BH falls in agricultural Land)	per BH	5.6	20,000	24	4,80,000
iii)	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2000	24	48,000
iv)	Borehole plugging by cement	m	2.2.7b	150	3000	450000
v)	Transportation of Drill Rig & Truck associated per drill (3 rigs) (36*3=108)	Km	2.2.8	108	600	64,800
vi)	Monthly Accommodation Charges for drilling Camp (For 2 Rigs 50000+ (for 1 rig (50000 X 50%) X 1) = 75,000	month	2.2.9	75,000	7	5,25,000
vii)	Drilling Camp Setting Cost	Nos	2.2.9a	2,50,000	3	7,50,000
viii)	Drilling Camp Winding up Cost	Nos	2.2.9b	2,50,000	3	7,50,000
ix)	Road Making (Rugged-hilly Terrain)	Km	2.2.10a	32,200	10	3,22,000
x)	Drill Core Preservation	per m	5.3	1,590	1,000	15,90,000
	Sub Total C					**3,94,79,800**
D	**Borehole Geophysical Logging**					
i)	Borehole Geoophysical logging(5 BH of 350m each)	m	3.12	1088941	1	10,88,941
ii)	Expert charges for Geophysicist in HQ	day	3.18	9,000.00	20	1,80,000
iii)	Expert charges for Geophysicist in Field	day	3.18	11,000.00	20	2,20,000
	Sub Total D					**14,88,941**
E	**LABORATORY STUDIES**					
1	**Channel Samples+ Pitting & Trenching samples + Drill Core Samples**					
a)	Analysis of one rock sample (Channel/ pitting & Trenching/core samples) of a pakage for 34 elements by ICP-MS	Nos	4.1.14	7,731	950	73,44,450
b)	Check samples (10%)	Nos	4.1.14	7,731	95	7,34,445
2	**Petrochemical samples**					
a)	Petrochemical samples major oxides by XRF	Nos	4.1.15a	4,200	15	63,000
b)	b. Check samples (10%)	Nos	4.1.15a	4,200	2	8,400
3	**XRD analysis for identification of minerals (Random)**	Nos.	4.5.1	4,000	10	40,000
4	**Physical & Petrological Studies**					
i	Preparation of thin section	Nos	4.3.1	2,353	5	11,765
ii	Study of thin section	Nos	4.3.4	4,232	5	21,160

iii	Digital photomicrograph of thin polished section	Nos.	4.3.7	280	5	1400
iv	EPMA	per hour	4.4.1	8,540	10	85,400
	Sub Total E					**82,90,020**
F	**Total A to E**					**5,50,12,661**
G	**Geological Report Preparation**	**5 Hard copies with a soft copy**	**5.2**	For the projects having cost more than Rs. 300 lakhs - A minimum of Rs. 9 lakhs or 3% of the value of work whichever is more subject to a max. amount of Rs. 20 lakhs		**16,50,380**
H	**Peer review Charges**		**As per EC decision**			**30000**
I	**Preparation of Exploration Proposal (5 Hard copies with a soft copy)**	**5 Hard copies with a soft copy**	**5.1**	2% of the Cost or Rs. 5.0 Lakhs whichever is less		**500,000**
J	**Total Estimated Cost without GST**					**5,71,93,041**
K	**Provision for GST (18% of J)**					**1,02,94,747**
L	**Total Estimated Cost with GST**					**6,74,87,788**
				Rs. In Lakhs		**674.88**

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Plate-I: Proposed NB-15 block on toposheet no 45C/06

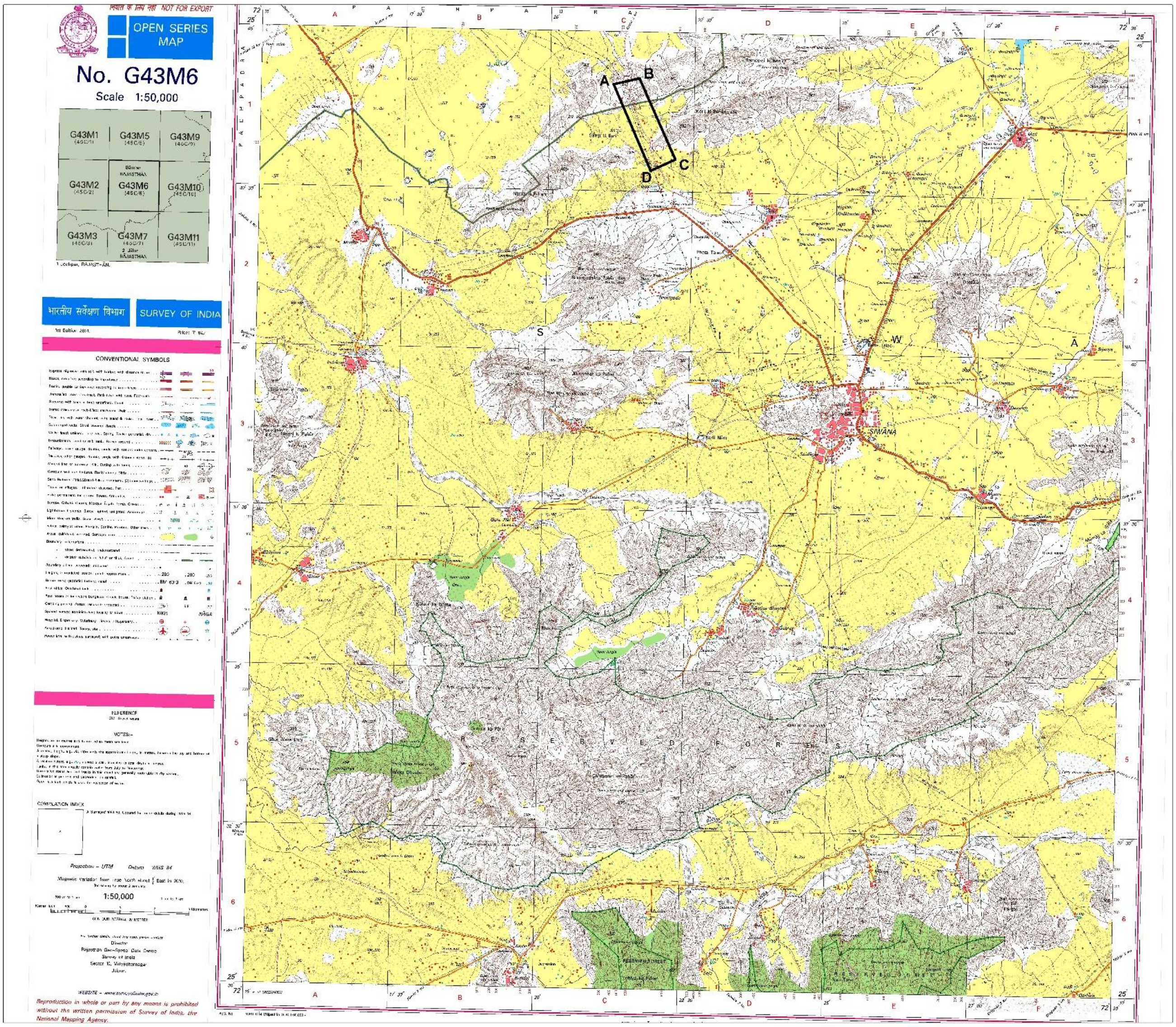


Plate-II: Proposed NB-15 block marked on large scale geological map (1:12500) showing TREE values in bed rock samples collected during FS 2021-22 by Geological Survey of India (After Lal and Ghosh, 2023)

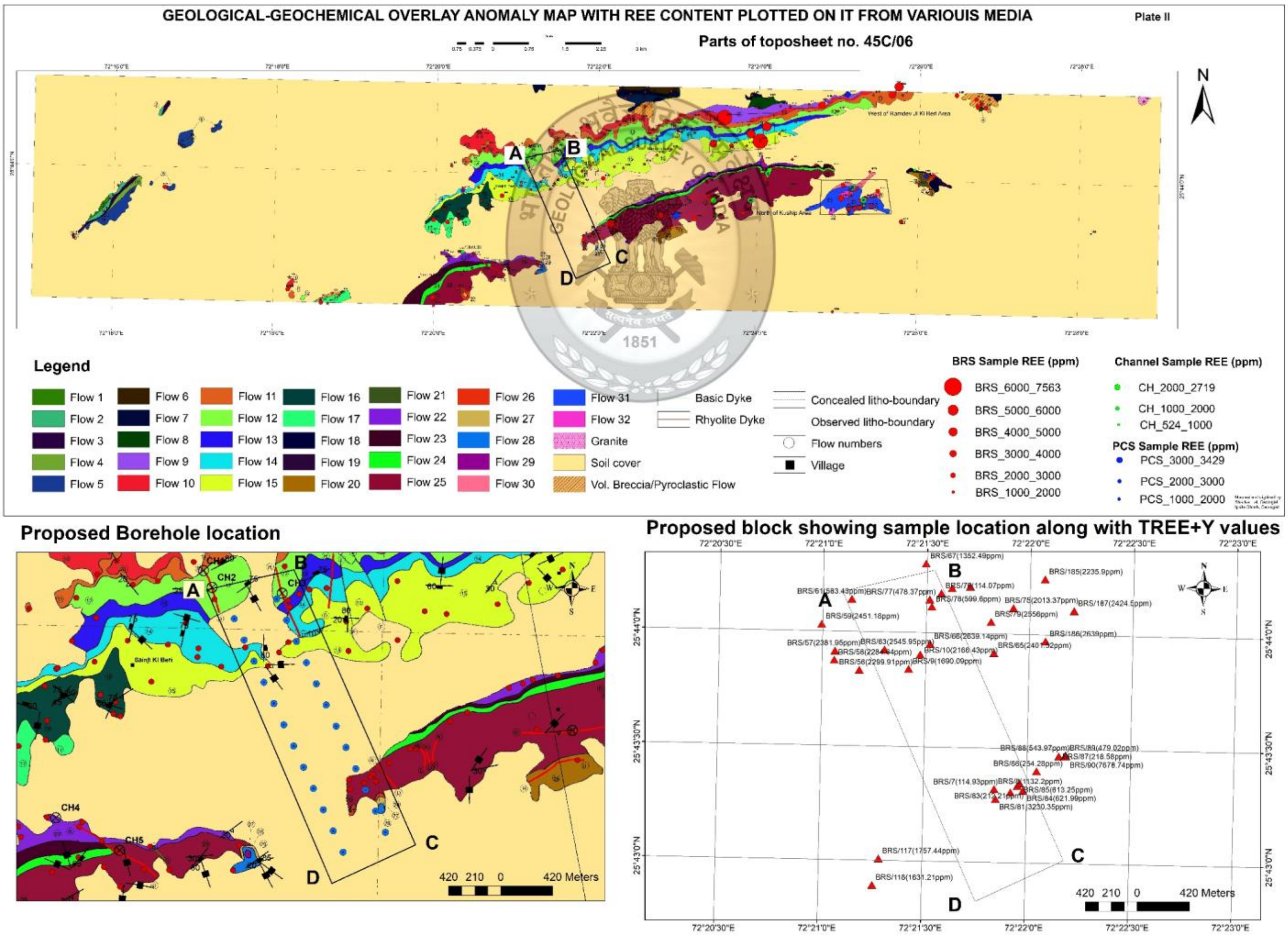
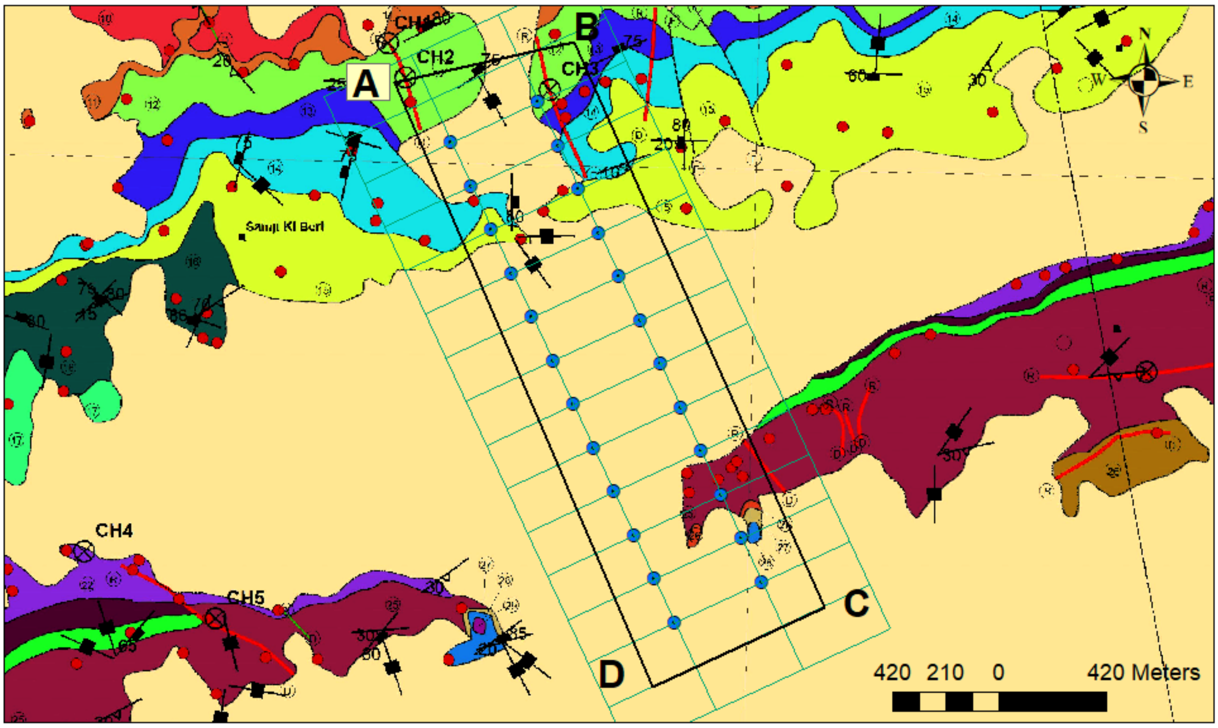
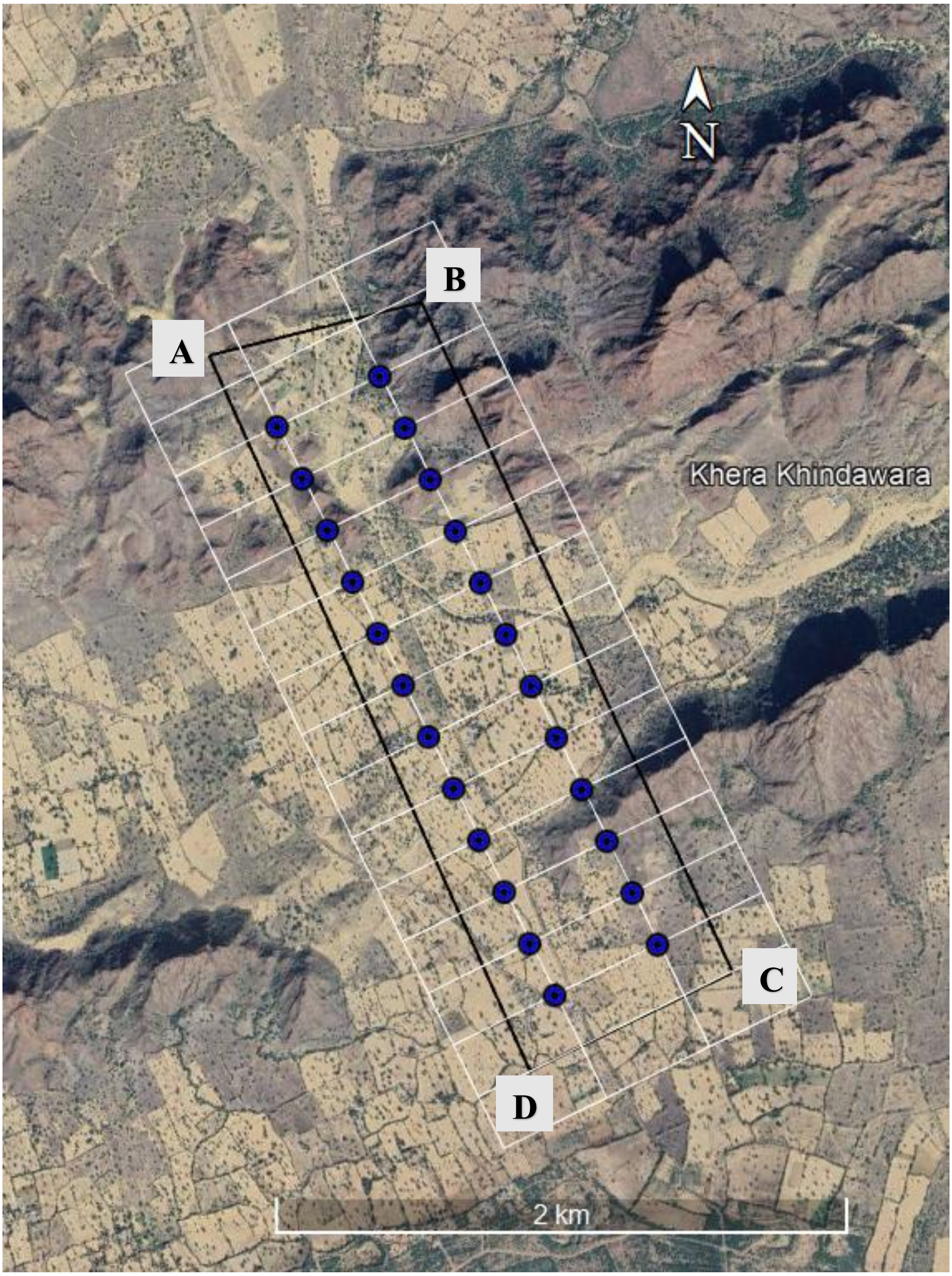


Plate-III: Proposed NB-15 block marked on large scale geological map (1:12500) showing planning of borehole



Proposed BH

Plate IV: Proposed NB-15 block marked on google earth showing planning of borehole



 Proposed BH