



**PROPOSAL FOR PRELIMINARY EXPLORATION FOR REE
AND ASSOCIATED RARE METALS IN THE NB 18 BLOCK OF
THE NORTHRN PART OF THE SIWANA RING COMPLEX,
BALOTRA DISTRICT, RAJASTHAN**

(REE and Associated Rare Metals)

**By
Natural Resources Division-Tata Steel Limited**

Place: Jamshedpur, Jharkhand



	Features	Details
	Block ID	NB 18
	Exploration Agency	Natural Resources Division- Tata Steel Limited
	Commodity	REE and Associated Rare Metals
	Mineral Belt	Siwana Ring Complex (Malani Igneous Suite)
	Completion Period with entire time schedule to complete the project	12 months
	Objectives	1. To evaluate subsurface potentiality of REE and associate rare metals
	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	Field geological activities including mapping, collection of samples and preparation, chemical analysis, survey, review, interpretations, report writing etc., shall be conducted by inhouse team and facilities. Some of the other jobs such as geophysical survey, mineragraphic study, exploratory drilling shall be conducted thorough outsourced agencies.
	Name/ Number of Geoscientists	4 to 6 geoscientists shall be deployed in the project. <ol style="list-style-type: none"> 1. Sangeeth Gopi 2. Shakil Hassain 3. Sahkti Sourav Das 4. Rajarshi Sarkar 5. Shreenivas Mishra 6. Swastik Prasad Dhar 7. Aditya Sen
	Expected Field days (Geology) Geological Party Days	Geological Mapping, Channel Sampling and trenching = 90 days Drilling = 90 days



1.	Location			
	Coordinates	Label	Latitude	Longitude
		A	25°43'43.214"N	72°19'18.986"E
		B	25°44'6.425"N	72°20'12.350"E
		C	25°43'23.675"N	72°20'14.642"E
		D	25°43'1.403"N	72°19'19.232"E
	Villages	Siwana (nearest town)		
	State	Rajasthan		
2.	Area (hectares/ square kilometers)			
	Block Area	2 sq. km		
	Forest Area	-		
	Government Land Area	-		
	Private Land Area	-		
3.	Accessibility			
	Nearest Railway Head	Mokalsar (about 23 km southeast) and Balotra Junction (around 35 km west)		
	Road	Block is located 15 km northwest of Siwana town, which is connected by metalled and unmetalled roads to Balotra and Barmer		
	Airport	Jodhpur Airport, located roughly 150 km east of Siwana		
4.	Hydrography			
	Local surface drainage pattern (Channels)			
	Rivers/ Streams			
5.	Climate			
	Mean Annual Rainfall			
	Temperatures (December) (Minimum)			
	Temperatures (June) (Maximum)			
6.	Topography			
	Toposheet Number	45 C/06		
	Morphology of the Area			
	Availability of baseline geoscience data			
	Geological Map (1:50K/ 25K) Geochemical Map			
	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)			
	Justification for taking up Preliminary Exploration			

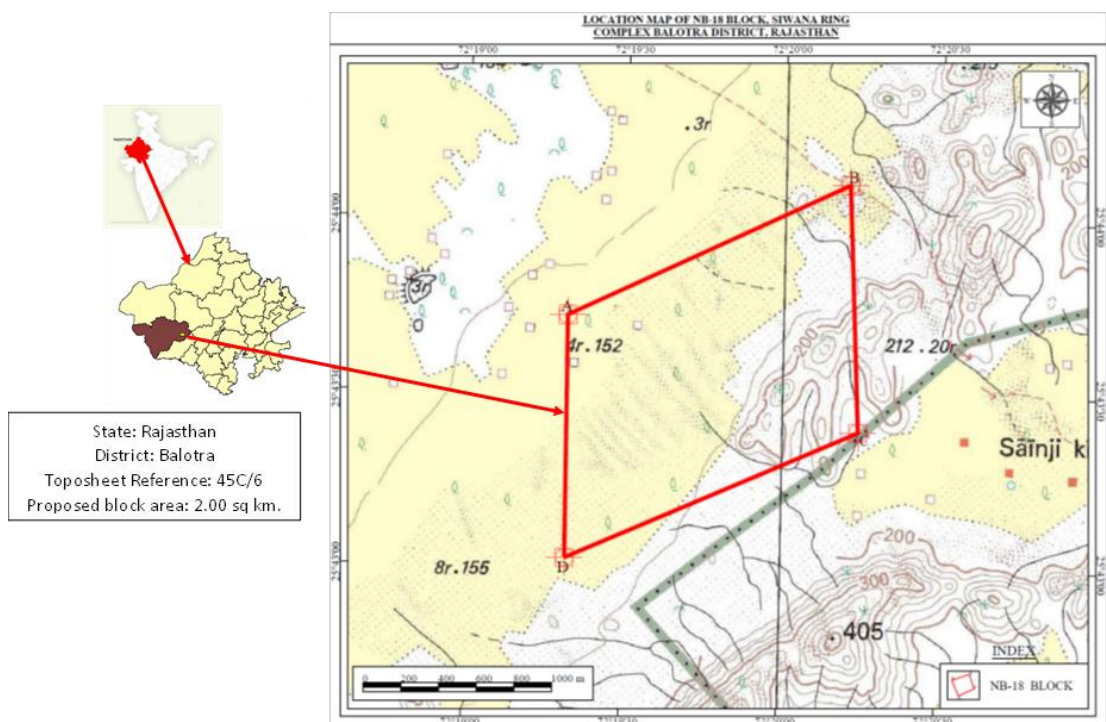
1. Block Summary

1.1 Location and accessibility:

The NB-18 block is located in the northern part of the Siwana Ring Complex within Barmer District, Rajasthan. It falls under Survey of India Toposheet No. 45C/06 and lies approximately 15 km northwest of Siwana town, about 132 km east of Barmer and 35 km southeast of Balotra. The block occupies a segment of the ring-shaped volcanic terrain characterized by rhyolite flows and associated intrusives. Its geographic position places it within an arid region of western Rajasthan, marked by rocky outcrops and low-relief ridges interspersed with soil-covered plains.

The NB-18 block is easily accessible from nearby towns and major transport hubs. It lies approximately 15 km northwest of Siwana town, which is connected by metalled and unmetalled roads to Balotra and Barmer. The nearest railway stations are Mokalsar (about 23 km southeast) and Balotra Junction (around 35 km west), both providing connectivity to Jodhpur and other parts of Rajasthan. The closest airport is Jodhpur Airport, located roughly 150 km east of Siwana. Approach roads from Siwana and Balotra lead to the block, making it convenient for transportation of men and materials. The terrain comprises rocky outcrops and low-relief ridges typical of the Siwana Ring Complex, interspersed with soil-covered plains, which allows vehicular movement with minimal difficulty during dry seasons.

Label	Latitude	Longitude	Easting	Northing
A	25°43'43.214"N	72°19'18.986"E	231311.992	2848363.634
B	25°44'6.425"N	72°20'12.350"E	232814.311	2849047.983
C	25°43'23.675"N	72°20'14.642"E	232851.646	2847730.769
D	25°43'1.403"N	72°19'19.232"E	231292.724	2847076.467



1.2 Physiography:

The NB-18 block forms part of the Siwana Ring Complex and exhibits a rugged physiography typical of volcanic terrains. The area is characterized by low-relief ring-shaped ridges composed mainly of rhyolite flows and associated intrusives, interspersed with shallow valleys and soil-covered plains. Rocky outcrops dominate the central and northern sectors, while the southern and peripheral zones show patches of aeolian sand. Elevation varies from about 180 m near Asotra village to approximately 414 m at Kerli ki Pahari. Drainage is controlled by ephemeral streams forming a dendritic to sub-radial pattern, ultimately joining the Luni River system. Overall, the terrain supports moderate accessibility for field operations during dry seasons.

1.3 Background Geology (Regional Geology, Geology of the Block):

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 $\Sigma\text{REE}+\text{Y}$ 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 (\pm 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).

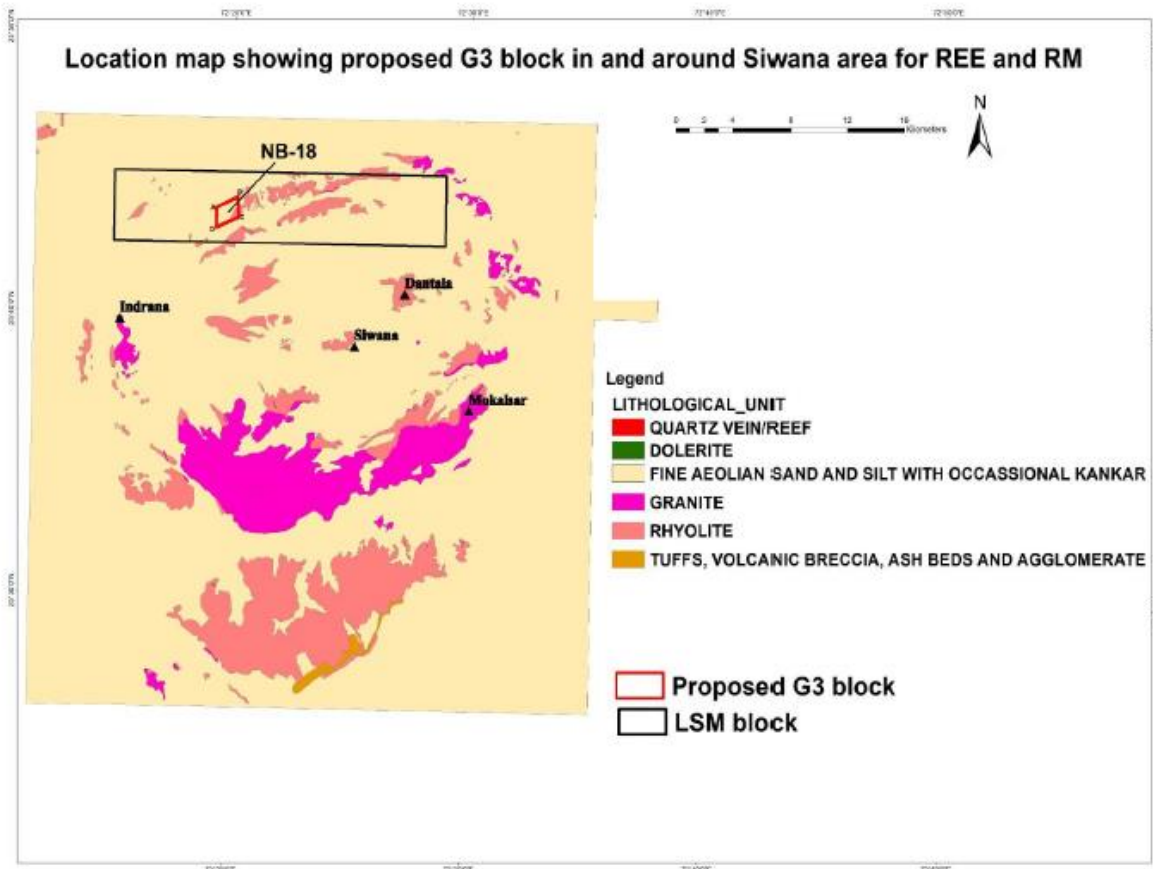
In the Western Indian Craton of Rajasthan, basement rocks and overlying supracrustal belts of Aravalli and Delhi Supergroups have witnessed magmatic events of volcanics and granitoids of Palaeo- to Neo-Proterozoic ages. Granitoids of different ages (~ 1.8 Ga, ~1.7 Ga, ~1.4 Ga, ~ 1.1Ga and 850-750 Ma) 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).

1.4 Regional Stratigraphy:

The Delhi Supergroup rocks form the foundational basement for the Malani Igneous Suite. Near Kankani, a volcanoclastic conglomerate marks a clear angular unconformity between the granites, phyllites, and quartzites of the Delhi Supergroup and the overlying pyroclastic deposits of the Malani Igneous Suite, located about 30 km south of Jodhpur. The rhyolite of the Malani Igneous Suite rests above the Mt. Abu granitoid (Choudhury et al., 1984). This volcano-plutonic assemblage is subsequently overlain either by the glacial Pokhran Boulder Bed or by sediments of the Marwar Supergroup. The magmatism of the Malani Igneous Suite occurred after the emplacement of Mt. Abu granitoids and before the Vendian glaciation.

Based on field relationships, magmatic style, texture, and composition, the Malani Igneous Suite is divided into three distinct phases of magmatic activity. The first phase began with the eruption of basic lava flows, followed by extensive outpouring of felsic lavas and deposition of ash flows. The second phase involved the intrusion of peraluminous, peralkaline, and meta-aluminous granites as plutons, ring dykes, bosses, and plugs within the earlier volcanic phase. The third phase is represented by swarms of mafic and felsic dykes and sills cutting across the earlier two phases. A detailed regional stratigraphic succession is presented in Table below:

Group/Supergroup	Age	Rock Type
Marwar Supergroup (Jodhpur Group)	Vendian to Lower Cambrian	Maroon and golden sandstone, siltstone and shale
-----Unconformity-----		
Pokharan Boulder Beds	Vendian	Scattered boulders and pebbles of glacial origin
-----Unconformity-----		
Malani Igneous Suite	Neo-Proterozoic	Bimodal volcanics, granites and dyke swarms
-----Unconformity-----		
Delhi Supergroup (Basement)	Meso to Neo- Proterozoic	Abu and Erinpura Garnite Metasediments of Sirohi and Pali area Unspecified gneisses of Balewa-Harsani area (Archean supracrustals?)



Proposed NB-18 block shown on the Geological map of Siwana Ring Complex

1.5 Selection of the block for exploration:

The proposed NB-18 block lies within the northern part of the Siwana Ring Complex, which is part of the Malani Igneous Suite in Barmer District, Rajasthan. This area has been identified as highly prospective for Rare Earth Elements (REE) and associated rare metals based on previous reconnaissance surveys and thematic mapping by GSI and subsequent field validation.

The block covers approximately **2.0 sq. km** and includes peralkaline rhyolite flows, felsic dykes, and associated intrusive phases that have shown anomalous $\Sigma\text{REE}+\text{Y}$ concentrations in earlier investigations. Geochemical analysis of bedrock and channel samples from adjacent areas indicates enrichment of Light Rare Earth Elements (LREE) and High Field Strength Elements (HFSE) within rhyolitic flows and felsic dykes.

Based on these findings, the exploration strategy focuses on delineating mineralized zones through detailed geological mapping, geochemical sampling, and exploratory drilling. The section selected for exploration represents the most promising part of the ring structure, where rhyolite flows exhibit continuity and structural features favorable for mineralization.



1.6 Geology of the Block

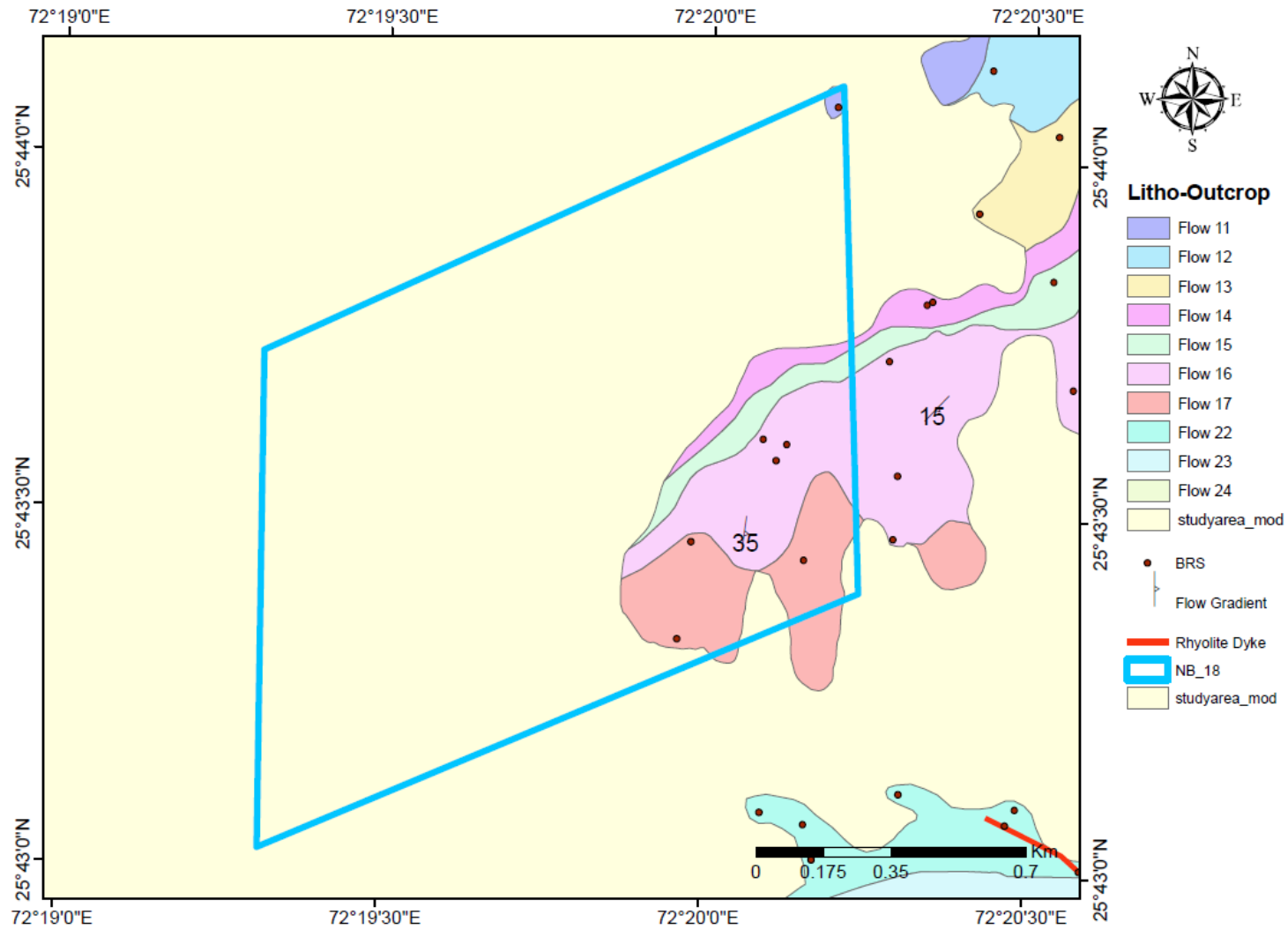
Most of the block is agricultural land which is covered in the alluvium soil. In the northern part of the block there are multiple flows of rhyolite. Description of the different flows is given below:

Flow 14: Porphyritic rhyolite characterised by dark grey and consists of phenocrysts of plagioclase laths. Secondary filling of calcite is also present in vesicles.

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 16: is brownish red coloured rhyolite consisting of tabular shaped phenocrysts of K-feldspar, which varies in size from 0.1cm to 0.5cm with P: G ratio of 20:80.

Flow 17: is light, brown-coloured rhyolite consisting of glass with phenocrysts of K-feldspar, which varies in size from 0.1cm to 0.5 cm with P: G ratio of 10:90. Flow banding is visible in this flow. Part of this flow is marked as brecciated rhyolite with large angular breccias embedded within rhyolitic mass.



LSM map of NB-18 block (Lal and Ghosh, GSI 2023)

2. Previous Work

Preliminary sampling of the rhyolites and associated tuffs of Siwana Ring Complex, Balotra district, carried out by GSI during 2013-14, indicated anomalous REE values with Σ REE ranging from 1334 to 3319ppm Σ REE (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 block. Kumar and Sharma, 2020, carried out G-4 investigation and reported Σ REE+Y ranges in various lithounits are i) Plagioclase rich granite (n=79) Σ REE+Y = 0.029%-0.70%. ii) K-feldspar rich granite (n=116) Σ REE+Y= 0.047%-0.66%. iii) Younger Intrusives (n=146) Σ REE+Y= 0.019%-2.66%. iv) Felsic volcanic (n=43) Σ REE+Y = 0.015%-0.96% and v) Enclave/Restite (n=19) Σ REE+Y = 0.022%-1.27%. LREE/HREE ratio indicates that LREE>>HREE in the area and LREE values ranges between 86.45ppm to 1.93%, however, HREE values ranges between 23.94ppm to 0.26%. LREE:HREE ratio in Siwana area is 4:1 approximately. 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).

Barman and Neog, 2018 mapped the peralkaline – peraluminous granite (A type) and in the Siwana area extending from Mokalsar in the east to Siner in the west through Mawri, Gugrot, Piplun, Goliyan Bhairan and Kalur Ka Danta area. REE bearing carbonates (perisite) and phosphates (monazite) were identified in both plutonic and volcanic rock types. In addition to REE bearing mineral phases, haematite, ilmenite and zircon are also identified from both plutonic and volcanic phases. The granite recorded values ranging from 182.77 ppm to 8611.11 ppm and the average being 2006.95 ppm (count=84). The volcanic recorded values ranging from 142.3 ppm to 8502.50 ppm, average value being 2008.03 ppm (count=116). Sukleswar Ka Mandir (G3) block yields tREE upto 2901ppm in microgranite dyke, 2121 ppm in alkali feldspar granite and 2996ppm in andesite.

Lal and Ghosh, 2021 carried out large scale geological mapping (1:12500 scale) at the northern periphery of the Siwana Ring Complex, stretching from Sainji ki Beri to Meli area. They marked 32 nos. of rhyolitic flows along with several felsic dykes in the area. Several flows are found to be highly enriched in tREE concentration. Chemical analysis data from rhyolite samples of study area yielded Σ REE+Y values ranging from 91.76ppm to 9764.68ppm, with average value of 1844.84ppm. Σ HREE/ Σ LREE ratio of the same is 0.15. 22 BRS samples from felsic/rhyolite dykes yielded Σ REE+Y values ranging from 144.77ppm to 7678.75ppm, with average value of 1400.14ppm. Σ REE+Y value in channel samples ranging from 261.73 to 6224.81ppm, with Σ HREE/ Σ LREE ratio of 0.19. Flow no. 14 and 15 are highly enriched REE flow of rhyolite in the area. In the proposed block Σ REE+Y in flow no. 15 ranges between 2213.43ppm to 8027.71ppm with maximum value of LREE 5079.52ppm and maximum value of HREE 992.05ppm. In flow no. 14, Σ REE+Y ranges between 6944.16ppm to 7528.11ppm with maximum LREE 4848.19ppm and maximum HREE 941.11ppm. Remote Sensing and Aerial Survey for toposheet no. 45C/06 and 45C/10 were carried out by RSAS Division, GSI, Bangalore, during FS. 2017-



18. Aeromagnetic maps help in delineating the regional continuity of magnetically susceptible lithounits of Siwana Ring Complex even under soil-covered terrain. Spectrometric maps of potassium and thorium further suggest that the proposed area possesses good potential for rare earth element (REE) mineralization in exposed area.

3. Planned Methodology

Detailed mapping of 2.0 sq km area (on 1:2,000) is to be carried out for the item along with collection of surface samples to delineate REE & RM mineralised zones. The depth continuity, grade and thickness of these zones will be checked by drilling about 24 vertical boreholes of 125m depth on a grid of 400m x 200m.

As most of the REE minerals are not identified by study of thin sections, 05 samples for EPMA and 05 samples for XRD studies are also proposed to identify the REE mineral phases.

Initially 4 to 5 boreholes 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.

4. Nature, Quantum, and Target

4.1 Detailed mapping

Detailed mapping of 2.0 sq km area (on 1:2,000) is to be carried out for the block along with collection of surface samples and channel samples to delineate REE & RM mineralised zones.

4.2 Trenching at Selected locations

Based on the initial understanding there is soil cover up to substantial depth. Pitting and trenching shall be done using long arm excavators up to a depth of 3 meter and samples shall be collected from the bottom of the pit. Pitting and trenching are proposed for 50 Cum. of excavation for sample collection.

4.3 Drilling and borehole geophysical survey.

The depth continuity, grade and thickness of these zones will be checked by drilling vertical boreholes on a grid of 400m x 200m. A total boreholes of 3000m are proposed to be drilled across the block area summing up to 3000m of core drilling.

4.4 Petrochemical samles (PCS)

Petrochemical samles (PCS) will be used for geochemical characterisation of important lithological unit of the study area. 15 petro-chemical samples and 15 perto mineragrapic samples study.

4.5 X-Ray Diffraction and EPMA

X- Ray Diffraction (XRD) and EPMA studies are proposed to identify the REE mineral phases. 05 samples for EPMA and 05 samples for XRD studies proposed to identify the REE mineral phases.



Sl. No.	Item of Work	UoM	Proposed Quantum
1	Detailed Geological Mapping (1:2000 scale)	Sq. Km.	2.0
2	Topographic survey using drone	Sq. Km.	2.0
3	Pitting and Trenching	Cum	50
4	Channel Sampling	Nos.	100
5	Pit and Trench Samples	Nos.	50
6	Core Drilling (24 nos of Boreholes)	m	3000
7	Chemical Analyses (number)- *REEs, Y, Hf, Zr, Nb, Ta (ICP-MS for 34 elements)	Nos.	1250
8	PCS (Major, Minor, Trace, REEs)	Nos.	10
9	Complete mineragraphic studies	Nos.	10
10	XRD	Nos.	100
11	EPMA (Avg. 6 hours/sample)	Nos.	25
12	Beneficiation Study	Nos.	1
13	Geological Report	Qty.	1

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