PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR REE AND ASSOCIATED MINERALIZATION IN BHIMGODA-SOUTH BLOCK (6.25 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: JULY, 2025

Recommended in – 11th TCC-II (23rd-25th July, 2025)

Approved in 1st PSC- 9th Oct, 2025

OM Letter No. ____________ Dated _____________

Summary of the Block for Preliminary Exploration (G-3 Stage) for REE and associated minerals in Bhimgoda- South Block (6.25sq km), Distt. Balotra, Rajasthan

GENERAL INFORMATION ABOUT THE BLOCK

	Features	Details
	Block ID	Bhimgoda- South Block
	Exploration Agency	Mineral Exploration and Consultancy Limited (MECL)
	Commodity	REE and associated minerals
	Mineral Belt	Siwana Ring Complex, Malani Igneous Suite, Western Rajasthan
	Completion Period with entire Time schedule to complete the project	18 Months
	Objectives	i. To conduct detailed geological mapping on 1:2000 scale to characterize geologically and geochemically, various rock units, acid and basic flows and determine the emplacement of formations with REE mineralization. ii. To systematically collect bedrock/channel samples for IC-PMS analytical studies of 34 elements, including REE, to comprehend the distribution of primary and secondary sources including all Major, minor and Trace elements. iii. To determine the subsurface occurrence of REEs, systematic drilling of boreholes at 400m interval is proposed in compliance with the MEMC rule. iv. To establish the inferred resources (333) for REE mineralization 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, Surface sampling, drilling and chemical analysis will be carried out by the proposed agency.
	Name/ Number of Geoscientists	Two nos. of Geoscientist (1 Field + 1 HQ)
	Expected Field days (Geology) Geological	Geologist Party Days: 150 Days (Field) Geologist Party Days: 60 Days (HQ)

	Party Days	
1	**Location**	
	The coordinates of the corner points of the proposed Bhimgoda- South G-3 Block are as follows:	

Block Boundary Co-ordinates of Bhimgoda-South Block, District - Balotra, Rajasthan, Area 6.25 sq km, (Toposheet No. 45C06)				
Points	DD MM SS.SS		UTM (43N)	
	Lattitude(N)	Longitude (E)	Easting (m)	Northing (m)
A	25° 39' 50.483" N	72° 20' 2.119" E	2841175.39	232369.98
B	25° 40' 36.631" N	72° 19' 49.142" E	2842603.22	232036.64
C	25° 41' 33.869" N	72° 22' 7.641" E	2844287.59	235935.01
D	25° 40' 39.626" N	72° 22' 13.609" E	2842614.61	236068.20

	Villages	Bhimgoda ka Pahar area
	Tehsil/ Taluk	Siwana Tehsil
	District	Balotra
	State	Rajasthan
2.	**Area (hectares/ square kilometers)**	
	Block Area	6.25sq km
	Forest Area	
	Government Land Area	Data Not Available
	Private Land Area	Data Not Available
3.	**Accessibility**	
	Nearest Rail Head	Balotra, 20 km in NW direction from the proposed Block
	Road	The State Highway-325 passes above the northern margin of the block.
	Airport	Jodhpur (94 km) in NE direction from the block
4	**Hydrography**	
	Local Surface Drainage Pattern (Channels)	Only perennial Nalas present inside the block. Flows towards North direction.
	Rivers/ Streams	The drainage system of the proposed area part of Luni River waters shed.
5	**Climate**	
	Mean Annual Rainfall	The average rainfall is 250-300mm.

	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	During summer (March toJune), the maximum temperature generally varies between 46 and 51˚C. Night temperature decreases 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. 45C06.
	Physiography of the Area	The area has a hilly topography with RL varying from 190 mRL to 390mRL. Rhyolitic cliffy hills are located in the central part of the block and aeolian sand is covering the foot hills.
7	**Availability of baseline geosciences data**	
	Geological Map (1:50K/ 25K)	1:12,500 (LSM map, Das et. al, 2015) 1: 50,000 (LSM Map, Bhukosh)
	Geochemical Map	NGCM Data is available in NGDR. Previous geochemical sample analysis data were used to plan G3 level exploration in the area.
	Geophysical Map	NGPM Data is available in NGDR
8.	**Justification for taking up Reconnaissance Survey / Regional Exploration**	1. The proposed block lies in the ENE-WSW trending Neoproterozoic Siwana Ring Complex, a collapsed caldera hosting peralkaline bimodal volcanics, granite ring dykes, and younger intrusives. Located in the central caldera, the block is a promising zone for REE exploration. 2. The proposed block lies in the Siwana Central Region, comprising basalt-rhyolite flows and pyroclastics, favorable for REE hosting. GSI's G-4 exploration (2014–15) over 115 sq.km recommended further assessment for REE potential. 3. GSI (2014–15) conducted G-4 exploration in Siwana Central, collecting 115 bedrock samples. In Bhimgoda ka Pahar, rhyolite and tuff samples showed ΣREE+Y values ranging from 129.92 to 4938.30 ppm. Within the proposed block, 33 samples yielded values between 287.3 and 4938.30 ppm. 4. Chondrite-normalized REE patterns from Bhimgoda ka Pahar show a strong negative Eu anomaly, indicating early plagioclase fractionation

		in the parent magma. 5. Two channels in Siwana Central yielded 13 rhyolite samples from Bhimgoda ka Pahar, with ΣREE+Y ranging from 1813.06 to 7338.68 ppm — confirming strong REE mineralization in the area. 6. Five ΣREE+Y anomalous zones were identified in Siwana Central. Bhimgoda ka Pahar showed peaks >3000 ppm (SE), >1800 ppm (N), and >2200 ppm (W). Dacitic and rhyolitic flows exceed 1500 ppm, while rhyolite dykes surpass 2500 ppm, indicating strong REE enrichment. 7. Hence, the proposed area has been strategically delineated for G-3 stage exploration, targeting REE and associated mineralization for detailed assessment.

PROPOSAL FOR PRELIMINARY EXPLORATION (G-3) FOR REE AND ASSOCIATED MINERALS IN BHIMGODA KA PAHAR BLOCK, SIWANA RING COMPLEX, DISTRICT –BALOTRA, STATE -RAJASTHAN (AREA 9,1SQ.KM.)

1.1.0 INTRODUCTION

1.1.1 The transition to renewable energy infrastructure is accelerating global demand for critical raw materials such as rare earth elements (REEs, including scandium and niobium), driving the expansion and diversification of their supply chains. While alternative sources are under investigation, the majority of global REE and HFSE (high field strength elements) resources are associated with alkaline-silicate rocks and carbonatites—magmatic systems that are also significant sources of fluorine and phosphorus.

1.1.2 Despite their importance, exploration models for critical raw materials remain underdeveloped, especially when compared to those for base and precious metals like iron, copper, and gold, which still dominate the focus of mineral exploration efforts. Additionally, the complex lithological variability and inconsistent nomenclature of many alkaline rock types continue to pose challenges to systematic exploration and evaluation of REE-HFSE deposits. Addressing these barriers is crucial for unlocking new sources of strategic minerals essential for the green energy transition.

1.1.3 Rare Earth Elements (REEs) possess unique physicochemical properties—including high density, high melting points, excellent electrical and thermal conductivity, and distinctive metallurgical, catalytic, nuclear, magnetic, and luminescent characteristics. These properties make REEs indispensable for a wide range of advanced and critical technology applications, especially in areas crucial to India's energy security, such as clean energy, defense, strategic civilian applications, environmental sustainability, and economic development.

1.1.4 With the global shift towards low-carbon technologies, the demand for REEs is projected to grow significantly. This rising demand underscores the urgent need for a focused and coordinated national effort to enhance domestic resource identification, assessment, and development, ensuring India's long-term strategic and economic resilience in the global critical minerals landscape.

1.1.5 Rare Earth Elements (REEs) comprise a group of 17 chemically similar elements in the periodic table, including:

The 15 lanthanides:
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) – corresponding to atomic numbers 57 to 71.

Yttrium (Y, atomic number 39):
Although it has a lower atomic number, Yttrium exhibits chemical and physical properties similar to the heavy lanthanides, and is therefore grouped with REEs.

Scandium (Sc, atomic number 21):
Scandium occurs in a variety of minerals and, while chemically distinct, is often associated with REE deposits and included within the REE group for practical and industrial purposes.

1.1.6 Together, these elements are known for their unique magnetic, luminescent, and electrochemical properties, making them essential for advanced technological applications such as clean energy systems, electronics, defense, and aerospace.

1.1.7 Although rare earth elements (REEs) commonly occur together in nature, the **lanthanides** are typically categorized into two groups based on their atomic number and geochemical behavior:

- **Light Rare Earth Elements (LREEs):**
  These include elements with atomic numbers 57 to 62 — Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pm), and Samarium (Sm).
- **Heavy Rare Earth Elements (HREEs):**
  These comprise elements with atomic numbers 63 to 71 — Europium (Eu), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Thulium (Tm), Ytterbium (Yb), and Lutetium (Lu). In addition, Yttrium (Y) and Scandium (Sc), due to their similar geochemical behavior, are often grouped with the HREEs, despite their lower atomic numbers.

1.1.8 Due to their geochemical affinity, REEs are typically dispersed in the Earth's crust and rarely occur in high concentrations. As a result, economically viable rare earth ore deposits are uncommon, making exploration and extraction of REEs both challenging and strategically important for securing supply chains in advanced technologies.

1.1.9 In general, Light Rare Earth Elements (LREEs) are more abundant in the Earth's crust and are easier to extract compared to Heavy Rare Earth Elements (HREEs). The term "rare earth" originates not from their scarcity in the crust, but from the rarity of economically viable mineral deposits and the difficulty in separating these chemically similar elements.

1.1.10 The first rare earth mineral discovered was gadolinite, a complex silicate containing cerium, yttrium, iron, silicon, and other elements. It was found in a quarry near the village of Ytterby in Sweden, which played a pivotal role in the history of REE discovery. In fact, several rare earth elements—including Yttrium, Terbium, Erbium, and Ytterbium—are named after Ytterby, commemorating the site of their initial identification.

1.1.11 This early discovery laid the foundation for the identification and classification of the broader group of rare earth elements that are now vital for modern technology and energy applications.

1.1.12 Critical minerals are essential for economic development, technological advancement, and national security. Their significance lies not only in their unique properties but also in their role across a wide array of strategic sectors. However, the limited availability, and the geographic concentration of their extraction and processing, often in a few countries, pose significant supply chain risks and potential disruptions.

1.1.13 The future global economy will increasingly rely on technologies that are mineral-intensive, particularly those involving lithium, graphite, cobalt, titanium, and rare earth elements (REEs). These minerals are fundamental to sectors such as high-tech electronics, telecommunications, transportation, defense, and most critically, to clean energy technologies needed for the global transition to a low-carbon economy.

1.1.14 As more countries commit to achieving Net Zero emissions, the demand for critical minerals is expected to surge. Therefore, it has become imperative to identify, assess, and develop resilient and sustainable value chains for minerals deemed critical to India's economic sovereignty, technological progress, and climate goals.

1.1.15 Taking into account key parameters such as domestic resource and reserve position, production trends, import dependency, strategic importance for future technologies and clean energy, and the role of fertilizer minerals in an agrarian economy, the Ministry of Mines (June 2023) constituted a Committee to identify minerals critical to India's national interest. Based on this comprehensive assessment, the Committee identified a list of 30 critical minerals vital for ensuring economic security, technological advancement, and energy transition:

Antimony, Beryllium, Bismuth, Cobalt, Copper, Gallium, Germanium, Graphite, Hafnium, Indium, Lithium, Molybdenum, Niobium, Nickel, Platinum Group Elements (PGE), Phosphorous, Potash, Rare Earth Elements (REEs), Rhenium, Silicon, Strontium, Tantalum, Tellurium, Tin, Titanium, Tungsten, Vanadium, Zirconium, Selenium, and Cadmium.

1.1.16 This critical mineral list serves as a strategic framework for resource prioritization, exploration planning, supply chain security, and policy formulation in alignment with India's long-term economic and energy goals.

(Source: "Critical Minerals for India", Report of the Committee on Identification of Critical Minerals, Ministry of Mines, June 2023).

1.1.17 The Mines and Minerals (Development and Regulation) Amendment Act, 2023 (dated 9th August 2023) introduced "Part D – Critical and Strategic Minerals" in the First Schedule of the Act. A total of 24 minerals have been officially notified as Critical and Strategic Minerals under this amendment.REE is also included in the list.

Sr. No	Mineral	Sr. No	Mineral	Sr. No	Mineral	Sr. No	Mineral
1	Beryl and other beryllium bearing minerals	7	Indium bearing minerals	13	Platinum group of elements bearing minerals	19	Tellurium bearing minerals
2	Cadmium bearing minerals	8	Lithium bearing minerals	14	Potash	20	Tin bearing minerals
3	Cobalt bearing minerals	9	Molybdenum bearing minerals	15	Minerals of 'rare earths' group	21	Titanium bearing minerals and ores (ilmenite, rutile and leucoxene)
4	Gallium bearing minerals	10	Nickel bearing minerals	16	Rhenium bearing minerals	22	Tungsten bearing minerals
5	Glauconite	11	Niobium bearing minerals	17	Selenium bearing minerals	23	Vanadium bearing minerals
6	Graphite	12	Phosphate (without Uranium)	18	Tantalum bearing minerals	24	Zirconium bearing minerals and ores including zircon

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

1.1.19 The "National Critical Mineral Mission" was announced in July 2024 and approved by the Union Cabinet on 29th January 2025. Timeframe has been kept for this mission is 7 Years (from FY 2024-25 to 2030-31). The National Critical Mineral Mission (NCMM) is a strategic initiative by the Government of India aimed at ensuring a secure, resilient, and self-reliant supply chain for minerals vital to the country's economic growth, clean energy transition, national security, and technological advancement. It focuses on the exploration, development, and processing of identified critical and strategic minerals in Schedule I-D of MMDR Act. It promotes private sector participation, international collaboration, and sustainable mining practices. The mission aligns with key national goals like Atmanirbhar Bharat, Viksit Bharat 2047, and Net Zero emissions by 2070.

1.2.0 BACKGROUND

The Government of India has emphasized the need to explore additional blocks for strategic and critical minerals across various states to strengthen the country's resource security. In line with this objective, a proposal for Preliminary Exploration (G-3 stage) targeting Rare Earth Elements (REEs) and associated elements in the Bhimgoda South Block, located in Balotra district, Rajasthan, is being submitted for evaluation under NMET funding and execution.

1.3.0 LOCATION AND ACCESSIBILITY

1.3.1 The proposed exploration block is located in Bhimgoda ka pahar area. The block falls in the south eastern part of Balotra District of Rajasthan. It is located 20km in south east direction from District headquarters Balotra, 8km in north west direction from Siwana. 372 km in WSW direction 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 coordinates of the boundary points are listed in Table 1.

Table 1: Block Boundary Co-ordinates of Bhimgoda-South REE Block, District - Balotra, Rajasthan (Area 6.25sq km, (Toposheet No. 45C06)

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1.3.3 State Highway 325 connecting Siwana to Thapan passes through the northern margin of the proposed block. The nearest railhead is Balotra Junction (about 20 km) and the nearest railway station is Balotra Railway Station. The nearest airport from the proposed block is Jodhpur (94 km) in NE direction from the block.

1.4.0 PHYSIOGRAPHY, DRAINAGE AND CLIMATE

1.4.1 Topography

The area exhibits a hilly terrain, with elevation (RL) ranging from 190 m to 390 m. The central portion of the block is dominated by rhyolitic cliffy hills, while the foothill zones are covered by aeolian sand deposits, indicating active wind-driven sedimentation.

1.4.2 Drainage

The drainage system of the proposed block is influenced by the Luni River, which flows approximately 10 km north of the area in an east-west direction. This river serves as the principal drainage feature in the broader region.

1.4.3 Climate

The region experiences an arid climate characterized by:

- Low and erratic rainfall
- Extreme diurnal and seasonal temperature variations
- Low humidity and high wind velocity

1.4.4 Summers (March to June) are intensely hot, with daytime temperatures ranging between 46°C and 51°C, while night temperatures fall to 20–29°C. Winters (December to February) are relatively cold, with night-time temperatures dropping to as low as 2°C, particularly in January, the coldest month. Occasional western disturbances during winter may bring light rainfall and increased wind speeds, often causing a wind-chill effect.

1.5.0 FLORA AND FAUNA

1.5.1 The study area lies in a hot arid region, where xerophytic vegetation predominates. These plants are well-adapted to survive in harsh climatic conditions with minimal water availability. The local flora is mainly composed of thorny trees and shrubs, including:

- *Kumatiyo* (*Acacia senegal*)
- *Ber* (*Zizyphus mauritiana*)
- *Guggul* (*Commiphora wightii*)
- *Kair* (*Capparis decidua*)
- *Aak* (*Calotropis procera*)
- *Thor*
- *Khejri* (*Prosopis cineraria*)

1.5.2 The faunal diversity of the region includes a variety of desert-adapted species, such as:

- Mammals: Foxes, desert cats, desert rats, jackals, chinkaras, deer, forest rabbits, camels, and *Nilgai* (*Boselaphus tragocamelus*)
- Reptiles: Various species of snakes
- Birds: A rich avifauna including sparrows, crows, bulbuls, kites, peacocks, white-rumped vultures, and eagles, along with other resident and migratory birds

1.5.3 The ecological setting reflects a resilient desert ecosystem adapted to extreme climatic conditions and limited water resources.

2.0.0 REGIONAL GEOLOGY

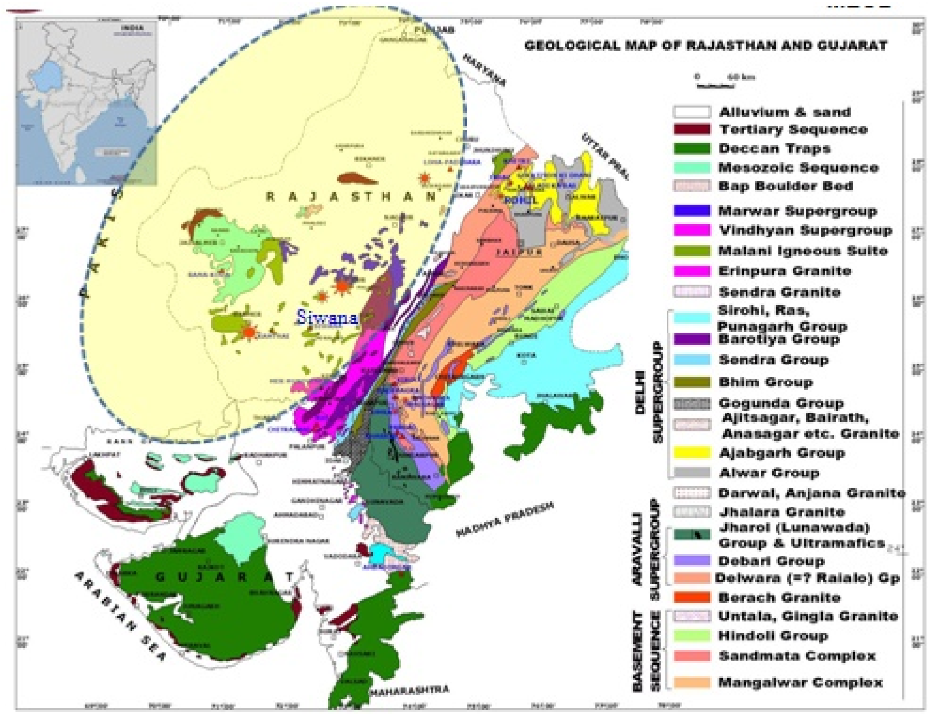

Fig 2.1 Geological map of Gujrat and Rajasthan showing Malani Igneous suit (After GSI)

2.0.1 The proposed exploration area lies within the Trans-Aravalli region, located to the west and southwest of the Aravalli Mountain Range. This region prominently features the Malani Igneous Suite (MIS)—the largest acid-dominated volcanic and magmatic assemblage in India, representing a complex of polyphase igneous activity.Over time, this suite has been referred to by various names, including:

- *Malani Volcanic Suite*
- *Malani Volcanic Series*
- *Malani Igneous Province*
- *Malani Beds*
- *Malani Volcanics*
- *Malani Rhyolites*
- Or simply, *Malanis*

2.0.2 However, the term ‘Malani’ is most accurately used to describe Neoproterozoic igneous rocks formed during a polyphase magmatic episode dated between ~830 Ma and ~680 Ma. This age span represents a tectono-magmatic 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).

2.0.3 The Malani Igneous Suite unconformably overlies the Mesoproterozoic rocks of the Delhi Supergroup (Bhushan, 2000). This contact relationship has been documented and studied notably near Manihari and Kankani by La Touche (1902), Bhushan (1984), and Bhushan (2000).

2.0.4 A vast region of western and southwestern Rajasthan, located to the west of the Aravalli Mountain Range, is geologically characterized by the Malani Igneous Suite (MIS). This suite exposes a remarkable diversity of igneous rocks, including acidic, intermediate, basic, ultrabasic, and alkaline intrusives and extrusives, in addition to associated sedimentary formations. The Malani Igneous Suite spans approximately 51,000 sq. km within the Thar Desert, bounded by: Latitudes: 25° to 27° N and Longitudes: 70°30′ to 73°30′ E

2.0.5 The MIS extends from Pokhran in the north to Sirohi in the south, and from Jodhpur in the east to the India–Pakistan border in the west. The suite is exposed across several districts, including Jodhpur, Pali, Sirohi, Jalor, Barmer, Balotra, and Jaisalmer.

2.0.6 The term ‘Malani’ is historically derived from Mallinath Rawat, a 14th-century ruler of the region encompassing Barmer, Jasol, Nagaur, and Sindhari. The region became the largest pargana of the Jodhpur State in 1891, following its integration into British India in 1836 (Bhushan & Chandrasekaran, 2002).

2.0.7 The name ‘Malani’ was later geologically adopted to describe the volcanic series of porphyritic lavas and ash beds, which are particularly widespread in the Barmer region, as first recognized by Blanford (1877).

2.0.8 The Malani Igneous Suite (MIS) is recognized as the largest acid magmatic complex in India, comprising both plutonic and volcanic phases. It unconformably overlies the rocks of the Delhi Supergroup, with notable contact exposures documented by La Touche (1902) near Manihari and Kankani, and further studied by Bhushan (1984) and Chittora & Bhushan (1992).

2.0.9 At Siyana in Jalore district, rhyolites of the MIS are observed overlying the Abu Granite (Bhushan, 1981), which has been radiometrically dated to approximately 800 ± 50 Ma (Chaudhary et al., 1984). The initiation of Malani volcanism is thought to have occurred after the emplacement of the Erinpura and Abu Granites, which are dated around 745 Ma (Crawford & Compston, 1970).

2.0.10 Stratigraphically, the MIS is non-conformably overlain by sediments of the Marwar Supergroup, considered as lithostratigraphic equivalents of the Vindhyan Supergroup (Late Proterozoic to Cambrian age) (Chittora & Bhushan, 1990–1994).

2.0.11 The polyphase magmatism of the MIS began with an initial phase of felsic volcanic extrusion, often accompanied by basaltic flows, followed by the emplacement of granitic plutons (Bhushan, 1985). The final stage of magmatic activity is marked by rhyolitic dyke swarms that crosscut the granites, signifying the termination of the magmatic cycle.

2.0.12 Geochemical studies have revealed two distinct types of acidic magmatic rocks within the Malani Igneous Suite (MIS) (Eby & Kochhar, 1990):

- Peraluminous type (Jalor-type)
- Peralkaline type (Siwana-type)

2.0.13 According to Bhushan and Chittora (1999), the volcano-plutonic association of the MIS represents three distinct episodes of igneous activity:

- First Episode – Characterized by extensive acid and basic lava flows, covering approximately 31,000 sq km of the Malani Felsic Province.
- Second Episode – Marked by major plutonic activity, resulting in the emplacement of discordant granitic plutons, bosses, and ring dykes.
- Third Episode – Represented by the emplacement of acid and basic dyke swarms, indicating the final phase of magmatism.

2.0.14 The Malani Igneous Suite is not only the largest acidic magmatic province in India but also ranks as the third-largest in the world (Pareek, 1981; Kochhar, 2000; Bhushan, 2000). It predominantly consists of acidic volcano-plutonic rocks, with minor basic intrusives, and is geochemically classified as A-type, an-orogenic granite.

2.0.15 The magmatism is attributed to hotspot tectonics, suggesting an intraplate tectonic setting (Pareek, 1981; Kochhar, 1984; Bhushan & Chandrasekaran, 2002; Vallinayagam, 2004; Singh et al., 2006), which played a significant role in the genesis of these rock types.

2.0.16 The magmatism of the Malani Igneous Suite (MIS) is primarily controlled by NE–SW trending lineaments, which represent zones of crustal extension and high heat flow of a fundamental geotectonic nature (Kochhar, 1984; Eby & Kochhar, 1990; Kochhar, 2000).

These structural trends have played a crucial role in the localization and evolution of MIS magmatism.

2.0.17 According to Jain et al. (1996), the MIS is best described as a hot crust, within-plate, rift-related, bimodal, and volcano-plutonic province, indicative of anorogenic tectonic settings. Further, Singh and Vallinayagam (2009) and Vallinayagam & Singh (2011) proposed a possible linear correlation between surface heat flow and crustal heat generation within the MIS, suggesting an active geothermal influence during magmatic emplacement.

2.0.18 A key subunit of the MIS is the Siwana Ring Complex (SRC), which spans an area of approximately 750 km² (roughly 35 km E–W and 30 km N–S). The SRC exhibits hallmark features such as:

- Volcano-plutonic associations
- Anorogenic magmatic setting
- High potential for rare earth elements (REEs) and rare metals

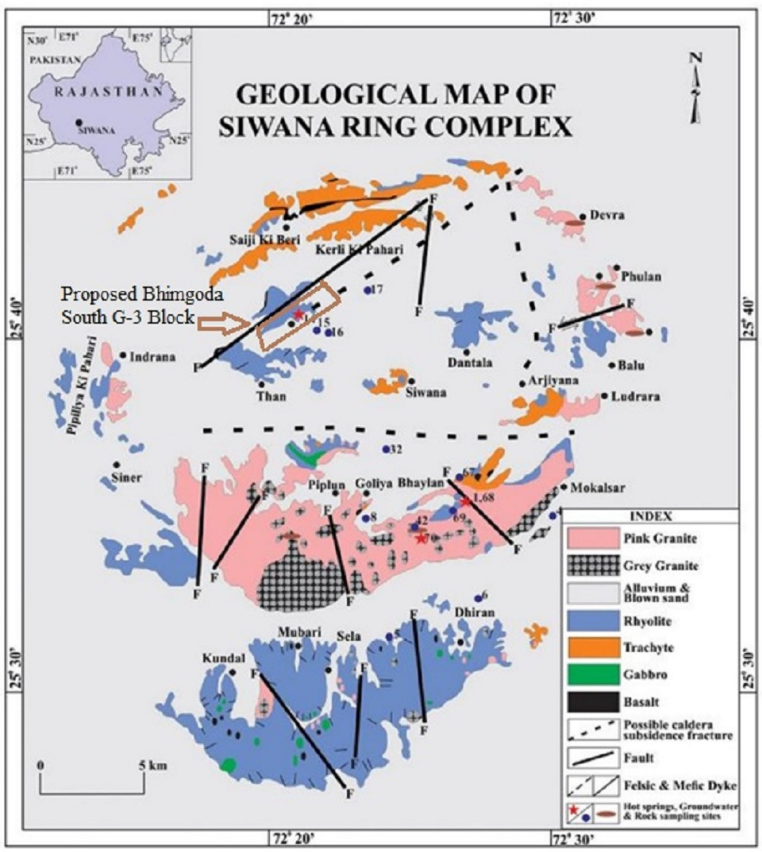

Fig 2.2 Geological map of Siwana Ring Complex showing proposed block (After Yadav, A.K., 2014)

2.0.19 These characteristics make the SRC an important target for exploration of strategic and critical minerals. The significance of the Siwana Ring Complex has been well documented by several researchers (Kochhar, 1992; Jain et al., 1996; Vallinayagam & Kochhar, 1998; Bhushan & Chittora, 1999; Kochhar, 2000; Vallinayagam, 2001; 2004; Singh & Vallinayagam, 2009).

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

Table No 2

Generalized Lithostratigraphy of Trans-Aravalli region (after Bhushan, 2000)

Group/Supergroup	Age	Rock Types
MarwarSupergroup (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)	Meso- to Neo-proterozoic	Abu and Erinpura Granite; Metasediments of Sirohi and Pali area. Unspecified gneisses of Balewa-Harsani area (ArchaeanSupracrustals?)

2.1.0 REGIONAL STRUCTURE AND METAMORPHISM

2.1.1 The Malani Igneous suite, Siwana area, Barmer district, Rajasthan is characterized by discontinuous, ring-shaped outcrops of Siwana rhyolite and Siwana peralkaline granite with minor outcrops of basalt. The primary features in the area are defined by the flow layers in rhyolite, columnar structure in the rhyolite, vesicles and amygdales

2.1.2 The Malani Igneous Suite (MIS), including the Siwana Ring Complex (SRC), is structurally controlled by a system of NE–SW trending deep-seated lineaments and associated fracture zones, which reflect a within-plate extensional tectonic regime. These structural lineaments are believed to be fundamental lithospheric features, linked to zones of high heat flow and crustal thinning, facilitating magma ascent and emplacement during the Neo-proterozoic (Kochhar, 1984; Jain et al., 1996).

2.1.3 The Siwana Ring Complex itself represents a classic example of ring-dyke intrusion and caldera-related magmatism, forming a semi-circular to elliptical structural pattern. The volcano-plutonic architecture includes:

- Annular outcrops of peralkaline granite and rhyolite
- Radial and ring dyke systems
- Domal uplift and inward-dipping flow structures in rhyolites

2.1.4 These structural features suggest emplacement in an an-orogenic, intraplate rift setting associated with hotspot tectonics.

2.2.0 REGIONAL MINERALIZATION:

2.2.1 The Siwana Ring Complex (SRC) and associated Malani rhyolites form a significant part of the Neoproterozoic magmatic province, known for their enriched peralkaline granitic and felsic volcanic assemblages. These units are considered important sources of rare earth elements (REE) in the region. The peralkaline Siwana Granite, intruded by younger felsic dykes (microgranite, aplite, and felsite) particularly along the periphery, shows substantial REE enrichment (Das et al., 2015). Subsequent studies by Barman and Neog (2019) reaffirmed notable REE concentrations in the Siwana Granite, while Kumar and Sharma (2020) reported a progressive REE and rare metal (RM) mineralization trend from younger intrusives > plagioclase-rich granite > K-rich granite > felsic volcanics. Majumdar (1976–78) earlier noted enrichment in Nb, La, Y, and Zr, further validating the metallogenic significance of the complex. Despite current use of these rocks as building and road materials, their critical mineral potential—particularly for REE—underscores the need for systematic exploration.

3.0.0 GEOLOGY OF THE BLOCK

3.1.0 The proposed block lies within the central part of the Siwana Caldera, which represents a geologically significant zone of polyphase magmatic activity associated with the Malani Igneous Suite. This region showcases a classic example of bimodal volcanism, comprising both mafic and felsic volcanic flows along with diverse pyroclastic deposits, including various types of tuffs.

3.2.0 The magmatic evolution can be categorized into three distinct phases:

- **The first phase** is characterized by extrusive volcanic activity, with flows ranging in composition from basic (basaltic) to acidic (rhyolitic), reflecting the bimodal nature of volcanism.
- **The second phase** involves the emplacement of peralkaline Siwana Granite, enriched with rare minerals and characterized by the presence of riebeckite and aegirine, indicative of an evolved, silica-rich peralkaline melt.
- **The third phase** is marked by the intrusion of younger dykes into both the volcanic and granitic units. These include rhyolite, microgranite, dolerite, and felsite dykes, which further contribute to the petrological and mineralogical complexity of the area.

3.3.0 This sequential magmatic evolution highlights the metallogenic potential of the region, particularly for rare earth element (REE) mineralization associated with peralkaline granitic systems and younger intrusives.

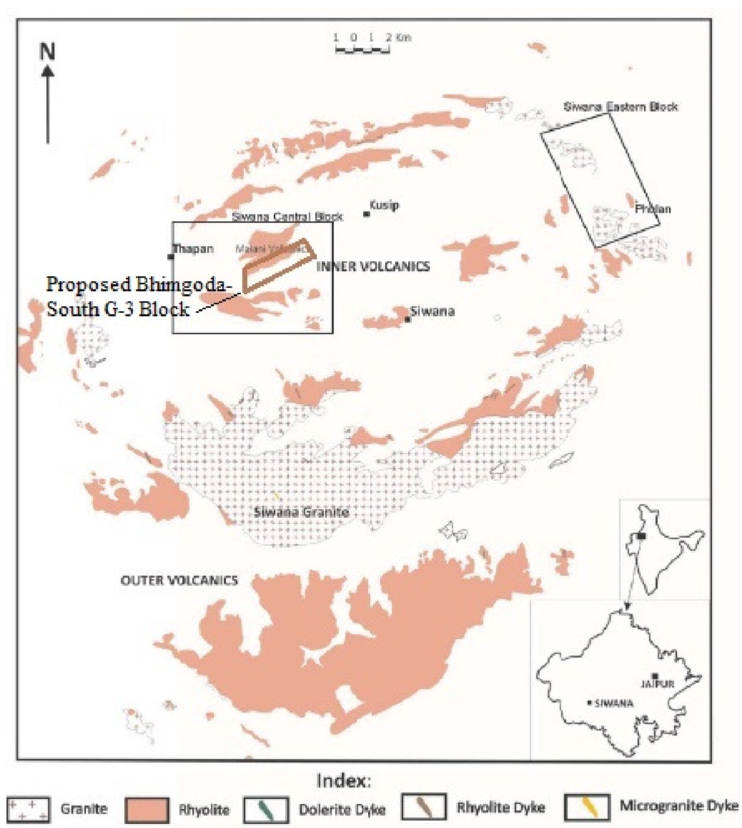

Fig3.1 - Map showing Siwana Central and Siwana Eastern Block along with Proposed Bhimgoda- South G-3 Block - Siwana Ring Complex (After Das et. al , 2015)

3.4.0 The proposed block is situated in the northwestern part of the Siwana Caldera, falling within the geologically significant Malani Igneous Suite. This region is marked by bimodal volcanism, comprising rhyolite, basalt, and pyroclastic rocks, including tuffs and volcanic agglomerates. Rhyolite dykes are also prominently exposed within the block, indicating multiple intrusive events.

3.5.0 Das et al. (2015) mapped five distinct volcanic agglomerate units in the Siwana Central Block—specifically in the areas of Indrana village, Kusip village, the northern spur of Bhimgoda ka Pahar, and two units at Koliyasar ka Pahar. These agglomerates are indicative of explosive volcanic activity, likely associated with successive felsic lava eruptions. One notable agglomerate body, located at the northeastern spur of Bhimgoda ka Pahar, measures approximately 620 meters in length and 250 meters in width. This unit comprises grey to brown, sub-rounded to elliptical blocks and bombs of dacitic composition embedded within a porphyritic rhyolite matrix. These fragments range in size, with their long axis varying from 3 cm to 60 cm, and exhibit a feebly porphyritic texture.

3.6.0 Five rhyolite dykes have been mapped in the Siwana Central Block, each intruding different volcanic or pyroclastic units. Out of these five, three of them falls in Bhimgoda ka pahar area and one of them is present in the proposed Bhimgoda-South block:

1. Dyke 1**:** 80 m long and 10 m wide, trending N60°W–S60°E, intrudes pyroclastic rocks at the northern spur of Bhimgoda ka Pahar.
2. Dyke 2**:** 15 m long and 5 m thick, trending N50°E–S50°W, intrudes rhyolite flow unit 11 in the southwestern part of Bhimgoda ka Pahar.
3. Dyke 3**:** 125 m long and 1.10 m thick, trending N70°E–S70°W, cuts across basaltic flow unit 5 at the northwestern flank of Bhimgoda ka Pahar.
4. Dyke 4**:** 160 m long and 2.30 m wide, trending N30°E–S30°W, intrudes basaltic flow unit 15 at the western part of Koliyasar ka Pahar.
5. Dyke 5**:** 90 m long and 8–10 m wide, trending N45°E–S45°W, intrudes rhyolite flows 15 and 16 at the northwestern margin of Koliyasar ka Pahar.

3.7.0 The spatial distribution and intrusive nature of these rhyolite dykes, along with associated pyroclastic features, reflect a dynamic and multi-phase volcanic history in the region—favorable for hosting rare earth element (REE) mineralization.

3.8.0 GSI conducted a G-4 level reconnaissance survey in F.S. 2015, during which parts of the volcanic sequence were mapped. The volcanic flows generally show a curvilinear pattern with moderate dips toward the center of the Siwana Ring Complex, likely due to subsidence along ring dyke fractures. A total of 21 flows were identified, with the possibility of more buried under alluvium. In the Bhimgoda ka Pahar area alone, 14 flows were mapped—8 in the northern sector and 6 in the southern—separated by a broad zone of tuffaceous material in the central part.

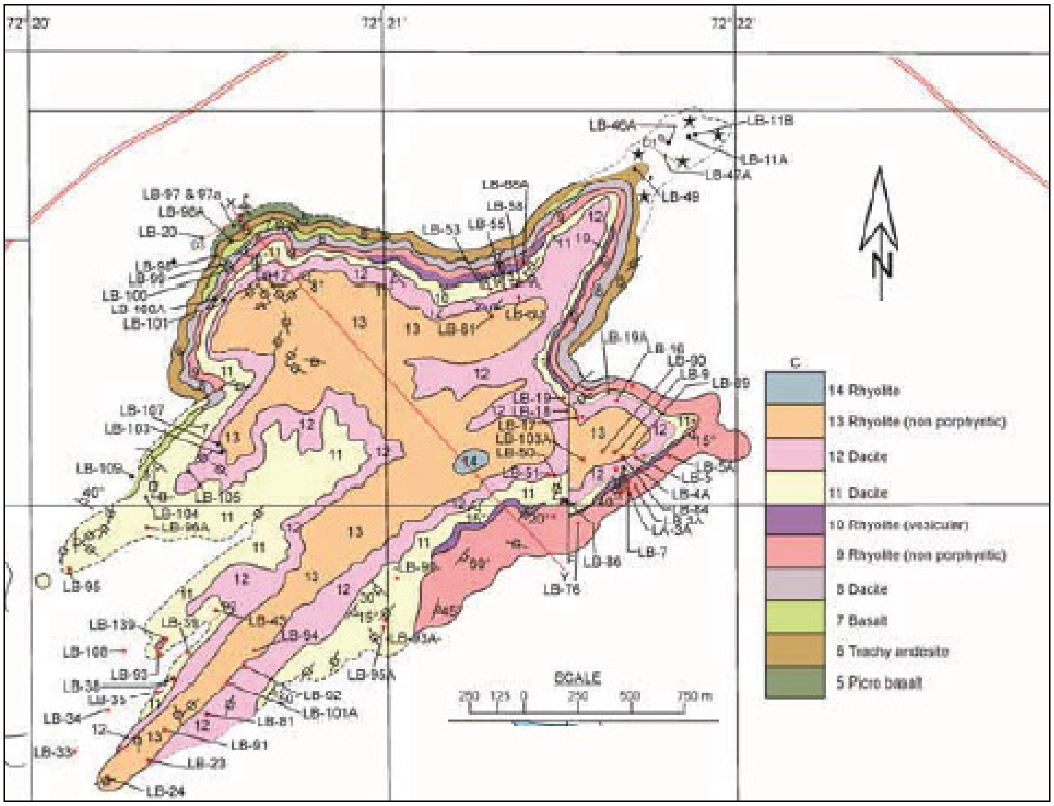

Fig 3.2: Large scale Map of Bhimgoda ka Pahar area (1:12500 scale, After Das Et. Al, 2015)

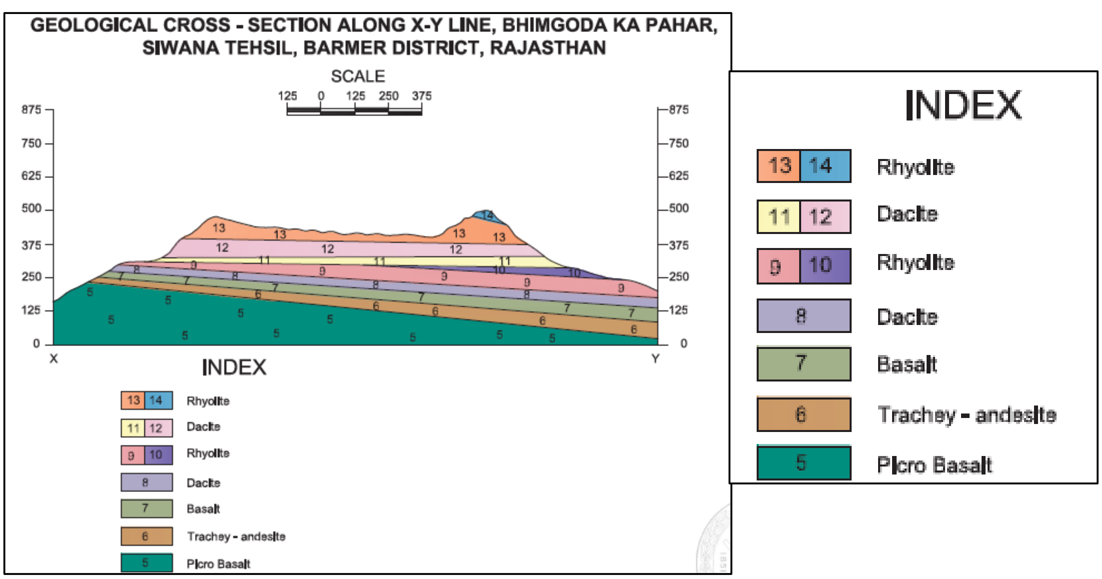

Fig 3.3: Geological Cross-Section showing different flows in Bhimgoda Area (After Das et.al, 2015)

3.9.0 The proposed G-3 exploration block exhibits a diverse lithological assemblage, reflective of complex magmatic and volcanic processes associated with the Siwana Ring Complex. The major lithounits present in the area include:

- **Aeolian sand and silt**: Representing the youngest surficial cover, these deposits obscure parts of the underlying geology and are indicative of ongoing desertic processes.
- **Tuffaceous beds**: These pyroclastic deposits, interbedded with the volcanic flows, point to explosive volcanic activity and serve as important stratigraphic markers.
- **Microgranite, felsite, and dolerite dykes**: These intrusives crosscut the older lithologies and suggest multiple phases of magmatic intrusion postdating the main volcanic episodes.
- **Siwana Granite**: A peralkaline granite phase enriched in rare earth elements, forming a major component of the ring complex.
- **Rhyolite flows**: Representing the felsic phase of the bimodal volcanic suite, these are extensive and structurally significant within the block.

3.10.0 This lithological sequence captures the evolution of the region from explosive volcanism and caldera formation to later intrusive activity, all of which contribute to the area's metallogenic significance, particularly for REE exploration. The generalized stratigraphy of study area is given in table below

Table No 3
Generalized Stratigraphic succession in and around the proposed Bhimgoda block, After GSI

<table>
<tr><td>Group/Supergroup</td><td>Rock Types</td><td>Igneous Activity</td></tr>
<tr><td>Quaternary</td><td>Aeolian sand and silt</td><td>---</td></tr>
<tr><td rowspan="3">Malani Igneous Suite

(Neo Proterozoic) 750Ma</td><td>Tuff, Micro granites, felsites and dolerite dykes</td><td rowspan="3">Volcanic phase</td></tr>
<tr><td>Siwana Granite</td></tr>
<tr><td>Rhyolites and basic volcanic dykes,</td></tr>
</table>

4.0.0 PREVIOUS WORK

4.1.1 Blanford (1877) first introduced the term *'Malani'* for porphyritic lavas and ash beds. Hacket (1881) and La Touche (1902) further described these rocks as predominantly acidic rhyolites, with Siwana granite intruding them. Coulson (1933) termed the suite the *'Malani System'*, noting the ring-shaped distribution of Siwana hornblende granite.

4.1.2 Mukherjee (1958) identified the Siwana granite as porphyritic, coarse-grained, and hornblende-bearing. Murthy et al. (1961) reported riebeckite and aegirine in the suite, and Murthy (1962) later established the 'Siwana ring structure'. Majumdar (1976–78) highlighted enrichment of Nb, Y, La, and Zr in Siwana rocks.

4.1.3 Mukherji and Pyne (1977–78) suggested two igneous phases in rhyolites and three in Siwana granite. Mukherji and Roy (1981) affirmed the ring structure, attributing it to caldera collapse, later modified by NE–SW folding. Kochhar (1984) linked Malani magmatism to hotspot activity post-Delhi orogeny.

4.1.4 Bhushan (1985) associated local structures with collapse features and flow dynamics. Bhushan and Mohanty (1988) reported bimodal volcanism (basaltic–rhyolitic). Srivastava (1988) found the Malani rhyolites contemporaneous with Erinpura granite.

4.1.5 Chittora and Bhushan (1991–92) mapped 45 volcanic flows in Siwana, ranging from dacite/rhyodacite to trachyte and rhyolite. They proposed three magmatic phases: basal peralkaline, middle metaluminous, and late-stage intrusive granites (1990–94).

4.1.6 Recent works (Singh & Vallinayagam, 2013; Bhushan et al., 2013; Bidwai et al., 2014; Rastogi & Mukherjee, 2015) have further refined the geological understanding of the Siwana–Malani region.

4.1.7 **G4 Investigation for REE and Rare Metals in Siwana Area (Das et al., 2015, GSI) -** GSI conducted a G4-stage investigation in the Siwana area, Barmer district, Rajasthan to assess REE and rare metal potential. The study included large-scale mapping over 115 km² at 1:12,500 scale, along with 148 bedrock samples, 53 channel samples, and 50 m³ of pitting.Detailed mapping and geochemical sampling were carried out in two blocks:

- **Siwana Eastern Block (30 km²)** – Hosts peralkaline Siwana granite with riebeckite/aegirine, rhyolite, rhyolite dykes, dolerite dykes, microgranite, and felsite.
- **Siwana Central Block (85 km²)** – Exhibits bimodal volcanism with rhyolite and basalt, along with later-stage rhyolite dykes

4.1.8 **During this investigation, Volcanic Flow Mapping in Siwana Central Block** was carried out. The volcanic flows generally exhibit a curvilinear pattern with moderate dips directed toward the center of the ring structure (Siwana). In the Siwana Central Block, **21 distinct volcanic flows** were identified, though additional flows may be obscured beneath alluvial cover.

Fig- : Panoramic view of rhyolite dyke intruding the pyroclastic unit at northern spur of Bhimgoda ka pahar.

Fig- : Rhyolite dyke intruding the basaltic flow at north western part of Bhimgoda ka pahar.

4.1.9 The volcanic flows of Guranal, Indrana, Koiliyasar ka Pahar, and Bhimgoda ka Pahar lack continuity and marker horizons, and thus were not correlated—each was placed at separate stratigraphic levels.

4.1.10 Five volcanic agglomerate units were mapped in the Siwana Central Block—at Indrana village, Kusip village, northern spur of Bhimgoda ka Pahar, and two at Koiliyasar ka Pahar. These agglomerates, containing pyroclastic bombs of varying sizes, indicate episodes of explosive volcanic activity triggered by felsic lava eruptions.

Fig- : Grey coloured bombs embedded in rhyolite at north eastern spur of Bhimgoda ka pahar.

Fig- : Grey coloured elliptical shaped bombs showing neocrysts of feldspar, embedded in rhyolite at north eastern spur of Bhimgoda ka pahar.

Fig- : Basaltic flow showing spheroidal weathering, north-western slope of Bhimgoda ka Pahar.

Fig- : Sharp contact between lower basaltic flow and above trachy-andesite flow at north-western slope of Bhimgoda ka Pahar.

All the photographs Source: G4 report of Das Uttpal. et.al 2014)

4.1.11 Electron Probe Microanalysis (EPMA) of felsite dyke samples, conducted at GSI's EPMA Laboratory, Faridabad, identified the major REE-bearing minerals as monazite, bastnaesite, parisite, eudialyte, perrierite, allanite, and tritomite (in decreasing order of abundance). Accessory minerals include zircon, zektzerite, galena, and baryte.

4.1.12 REE minerals are typically euhedral to anhedral, ranging from 25 µm to 250 µm in size. They occur as discrete grains along alkali feldspar–aegirine and quartz–aegirine grain boundaries, and also as inclusions within quartz, alkali feldspar, and aegirine.

4.1.13 33 nos. bedrock grab samples, collected from various lithotypes in Siwana Eastern block, analysed 1366 ppm to 7532 ppm of ΣREE+Y in 17 granite samples, 935 ppm to 4660 ppm of REE+Y in 05 rhyolite samples and 5939 ppm to 21937 ppm of ΣREE+Y in 08 felsite samples. Analytical results of 30 nos channel samples of felsite dykes indicated ΣREE+Y from 0.17% to 3.49% with an average of 1.38%. The felsite samples have analyzed U upto 169.25 ppm, Th upto761 ppm, Nb upto 1468 ppm, Zr upto 9957 ppm, Hf upto 428.8 ppm, W upto 30 ppm and the Pb+Zn upto 0.18%.

4.1.14 A total of 33 bedrock grab samples from various lithologies in the Siwana Eastern Block yielded the following ΣREE+Y values:

- Granite (17 samples): 1,366 to 7,532 ppm
- Rhyolite (5 samples): 935 to 4,660 ppm
- Felsite (8 samples): 5,939 to 21,937 ppm

Channel sampling (30 samples) of felsite dykes revealed ΣREE+Y values ranging from 0.17% to 3.49%, with an average of 1.38%.

4.1.15 A total of 115 bedrock grab samples were collected from various lithotypes in the Siwana Central Block:

- **Bhimgoda ka Pahar:**
    - *Rhyolite (55 samples):* ΣREE+Y ranges from **215.86 to 4,938.30 ppm**
    - *Tuff (22 samples):* ΣREE+Y ranges from **129.92 to 3,793.72 ppm**
- Koiliyasar ka Pahar:
    - *Rhyolite (30 samples):* ΣREE+Y ranges from 231.24 to 4,295.33 ppm
    - *Tuff (2 samples):* ΣREE+Y ranges from 309.66 to 9,103.41 ppm
- Near Indrana and Guranal villages (6 rhyolite samples):
  ΣREE+Y ranges from 1,076.69 to 3,908.11 ppm

4.1.16 Systematic channel sampling was conducted in felsite dykes near Phulan (Siwana Eastern Block), and in rhyolite and trachy-dacite flows at Bhimgoda ka Pahar and Koiliyasar ka Pahar (Siwana Central Block). A total of 30 samples were collected from 13 channels

(PCH-1 to 7) across felsite dykes 1 to 7 at 10–50 cm intervals, corresponding to dyke widths ranging from 10 cm to 2.5 m. In the Central Block, two channels were sampled: one 13 m channel across Rhyolite Flow 9 at Bhimgoda ka Pahar (13 samples; 1 m intervals) with ΣREE+Y ranging from 1,813.06 to 7,338.68 ppm, and a 10 m channel (10 samples) across Flows 18 and 20 near Bhilon ki Dhani at Koiliyasar ka Pahar.

4.1.17 In the Siwana Central Block, five ΣREE+Y anomalous zones were delineated through geochemical anomaly mapping. In the Bhimgoda ka Pahar area, significant ΣREE+Y peaks were recorded—over 3000 ppm southeast and 1800 ppm north of Bhimgoda temple, with another >2200 ppm anomaly on the western periphery. Dacitic flows (Flows 11 & 12) and rhyolitic flow (Flow 13) show concentrations exceeding 1500 ppm, while rhyolite dykes register values above 2500 ppm, indicating strong rare earth element (REE) enrichment.

4.1.18 The chondrite-normalized REE patterns of bedrock grab samples from the Bhimgoda ka Pahar area, Siwana Central Block, exhibit a pronounced negative Eu anomaly, indicative of early plagioclase fractionation from the parent magma. The patterns also show a moderate enrichment trend in LREEs, a relatively flat HREE profile, and consistent negative Eu anomalies, except in a few samples.

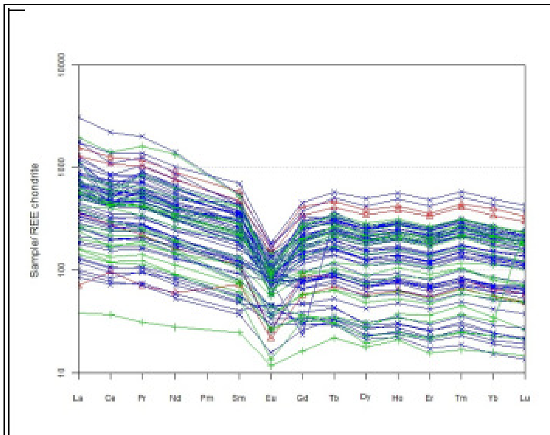

Figure- Chondrite normalized pattern of REE of samples collected from Bhimgoda ka pahar, Siwana central block (after Nakamura, 1974).

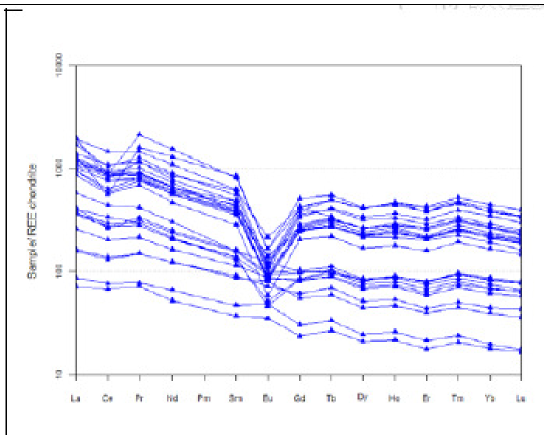

Figure- : Chondrite normalized pattern of REE of samples collected from Koiliyasar ka pahar, Siwana central block (after Nakamura, 1974).

4.1.19 Multiple studies (Das et al., 2015; Barman & Neog, 2019; Kumar & Sharma, 2020) have reported preferential enrichment of ΣREE+Y in a variety of litho-units including: 1. Alkali granites 2. Microgranites 3. Intrusive dyke systems 4. Rhyolites and 5. Felsites.

Das et al. (2015) analysed ΣREE+Y	Barman & Neog (2019) analysed ΣREE+Y	Kumar & Sharma (2020) analysed ΣREE+Y
granite: 1400ppm–7500ppm rhyolite: 940ppm-4700ppm felsite: 5900–21900ppm	granite: 180ppm-8600ppm volcanics: 140ppm-8500ppm	Granite: 290ppm–7000ppm Alkali feldspar granite: 470ppm–6600ppm Younger intrusives: 190ppm–26,600ppm Felsic volcanic: 150ppm-9600ppm Enclave/restite/soil: 220ppm–12,700ppm

4.1.20 Exploration for atomic minerals and REEs by AMD began in 2010 across various geocentres of the Siwana Ring Complex, including the Bhimgoda ka Pahar area. Bidwai et al. (2014) reported high concentrations of LREE, Zr, Nb, and Ag, along with notable occurrences of Th and U within the complex.

4.1.21 Based on the results of the previous G-4 investigation in the Siwana Central Block, which revealed anomalous REE values and indicated strong mineralization potential, the Bhimgoda South Block (6.25 sq. km) has been delineated for G-3 stage exploration. This aims to evaluate the deeper-level extension of REE-bearing felsite dykes through drilling.

5.0.0 PLANNED METHODOLOGY

5.1.0 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 on 1:2000 scale to characterize geologically and geochemically, various rock units, acid and basic flows and determine the emplacement of formations with REE mineralization.

II. To systematically collect bedrock/channel samples for ICPMS analytical studies of 34 elements, including REE, to comprehend the distribution of primary and secondary sources including all Major, minor and Trace elements.

III. To determine the subsurface occurrence of REEs, systematic drilling of boreholes at 400m interval is proposed.

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

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

5.2.0 GEOLOGICAL MAPPING

Detailed geological mapping will be undertaken over an area of 6.25 sq. km on a 1:2000 scale to establish the lithological, structural, and mineralization framework of the Bhimgoda South Block. The mapping will focus on identifying and delineating various rock types**,** their lithological contacts, and structural features such as faults, joints, folds, and fractures. Special emphasis will be given to documenting surface manifestations of REE mineralization, including the distribution, orientation, and geometry of felsite dykes and associated alteration zones. All observed mineralized zones, including visible mineral concentrations or geochemical anomalies, will be precisely plotted on the map to aid in planning subsurface exploration activities such as trenching and drilling.

5.3.0 SURVEY WORK

Topographical survey will be conducted over the proposed 6.25 sq. km area at a 2-m contour interval on a 1:2000 scale to generate an accurate and detailed terrain model. This survey will provide essential information on the surface relief, slope variation, drainage patterns, and accessibility, which are critical for planning exploration logistics and drilling operations. All drilled borehole locations, including collar points and depths, as well as the exploration block boundary, will be precisely surveyed using Differential Global Positioning System (DGPS) to ensure high positional accuracy. The DGPS data will aid in integrating geological, geochemical, and geophysical datasets with topography, and will form the base for generating various thematic maps and for future resource estimation work.

5.4.0 GEOCHEMICAL SAMPLING

5.4.1 Bed Rock Sampling: 100 nos. of bedrock samples will be collected systematically during mapping from the various lithounits viz Rhyolites, Granites, tuffs, micro granites present in the area, to understand the distribution of REE.

5.5.0 EXPLORATORY DRILLING

5.5.1 Vertical exploratory drilling has been planned in systematic manner in 400m x 400m interval. Drilling will be carried for intersection of mineralization upto the vertical depth of 120m. Since higher elevation area in the block may be unapproachable for drilling, A total 33 no of BHs has been planned with depth of 120 m each, avoiding the higher elevation area. Additionally, one vertical stratigraphic borehole of 150m and 2 boreholes of 250m depth shall also be drilled to prove the stratigraphic succession below the aeolian sand.

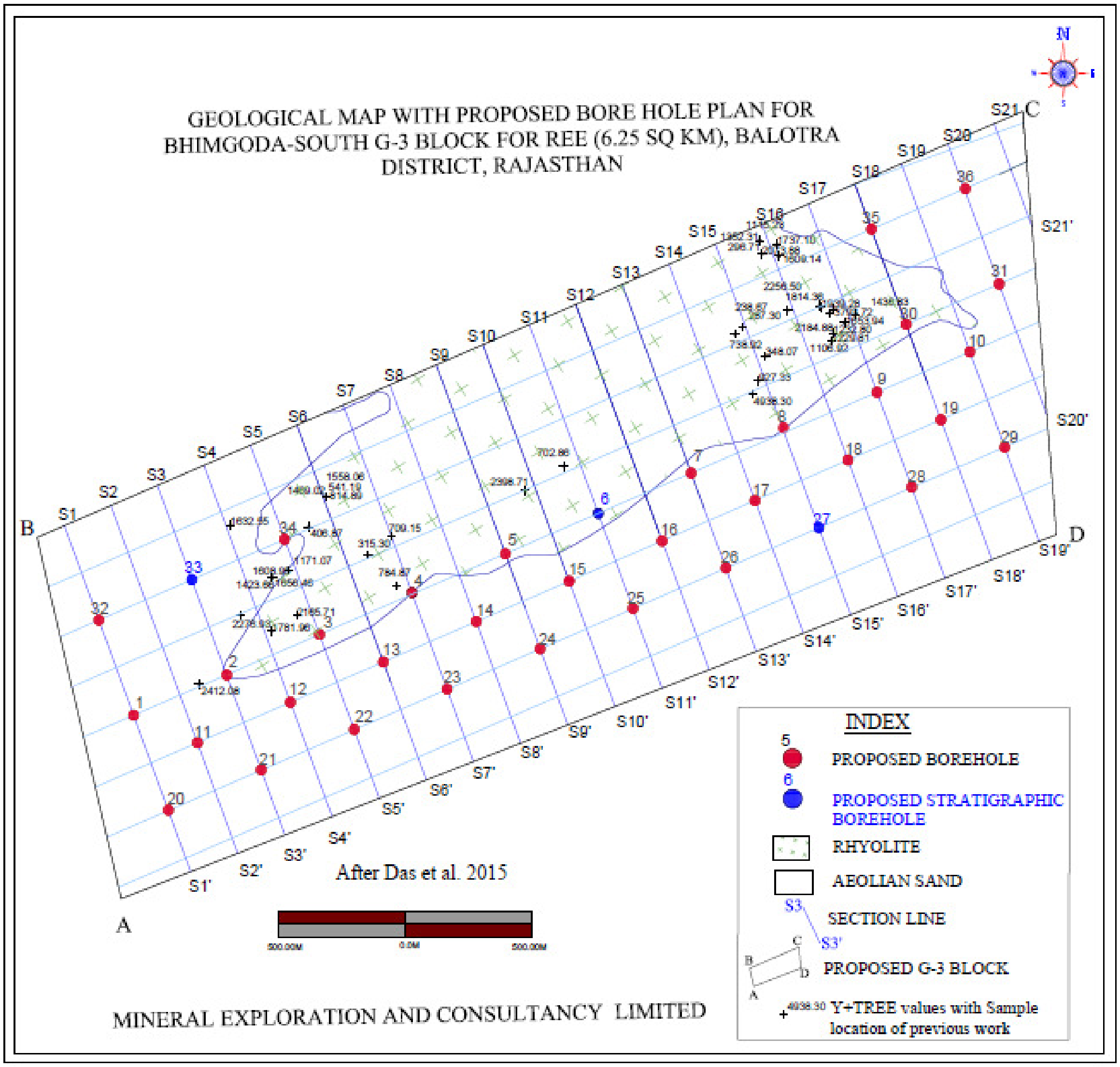

Fig 5.1- Borehole plan Map- Bhimgoda-South G-3 Block

5.5.2 Drilling of total 4610m in thirty-six (36) boreholes including three (03) stratigraphic boreholes with average depth of 120m in 33 BH; 250m in 2 stratigraphic BH & 150m in 1 stratigraphic BH were agreed by the TCC-II. Initially twelve (12) boreholes including three (03) stratigraphic boreholes will be drilled to target the REE rich flows. Subsequent drilling will be after review. Only three stratigraphic borehole cores will be preserved initially. Also, the quantum of sampling may vary based on the results of initial 3 to 4 boreholes.

5.5.3 **Borehole Geophysical Logging:** As per the suggestion of 11th TCC-II, a total of 2300m 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.

5.5.4 **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. Taking into account of the G3 stage exploration carried out in the adjacent areas, nearly 50% of the drilling length sampling (2305 samples) was planned. However, TCC-II has recommended initially for only 1000nos.of BH samples and quantum of sampling will be further decided based on the results of initial 3-4 BH.

5.6.0 CHEMICAL ANALYSIS

5.6.1 All the samples including bedrock samples/channel samples and borehole core samples 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, Pb, Li, Cs, U & Th through ICPMS at MECL's chemical laboratory facility Nagpur.

5.6.2 20 Nos of samples will be subjected to whole rock analysis through XRF.

5.6.3 10% of primary samples, 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, Pb, Li, Cs, U & Th through ICPMS.

5.7.0 PETROLOGICAL STUDIES:

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

5.8.0 XRD STUDY

5.8.1 To know the different mineral phases which possibly host REE, 30 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 bedrock, channel and core samples.

5.9.0 EPMA Study

5.9.1 EPMA study on different REE and silicate phases will be carried out in few silicate samples. A provision of 10 hours of study has been kept.

6.0.0 Details of Nature and Quantum of work (NQT)and the targets are listed in **Table No.-5**

Table No-5
Envisaged Nature and Quantum of work (NQT) in Bhimgoda-South G-3 block, Distt. Balotra, Rajasthan

Sl. No.	Item of Work	Unit	Target
1	**Detail Geological Mapping** (on 1:2,000 Scale)	Sq km	6.25
2	**Topographic Survey** (on 1:2,000 Scale)	Sq km	6.25
3	**Geochemical Sampling**		
i	Bedrock/Surface samples	Nos	100
4	**Core Drilling**		
i	Systematic Drilling in 400 m interval with 3 stratigraphic BH	m	4610
ii	Borehole Geophysical logging	m	2300
iii	Borehole Core Sampling	Nos	1000
6	**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, Pb, Li, Cs, U & Th		
	i)Primary Samples	Nos	1100
	ii) External Check Samples	Nos	110
	iii) Bedrock samples for Major oxides by XRF	Nos	20
7	**Petrological Samples**	Nos	25
8	**XRD Mineral phase analysis**	Nos	30
9	**EPMA studies**	Hrs	10
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. 897.45 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 Bhimgoda-South Block, District- Balotra, Rajasthan

Sl. No.	Item	Total Estimated Cost (Rs.)
1	Geological Mapping (LSM), Other Geological Work and Survey	5,127,560
2	Geophysical Survey	0
2	Drilling	59,394,402
3	Laboratory Studies	9,003,485
4	**Sub Total (1 to 4)**	**73,525,447**
5	Exploration Report Preparation	2,000,000
6	Proposal Preparation	500,000
7	Peer review charges	30,000
8	**Sub Total (1 to 7)**	**76,055,447**
9	GST 18%	13,689,980
10	**Total:**	**89,745,428**
	Say Rs. In Lakh	**897.45**

7.0.2 TIMELINE

7.0.3 The entire project is planned tentatively for 18 months.

Table No. 7
Tentative Time schedule / Action plan

Estimated timeline for Preliminary Exploration (G-3) for REE and associated minerals in Bhimgoda-South Block, Districts: Balotra, State: Rajasthan [Block area- 6.25 sq. km; Schedule timeline- 18 months]

S. No.	Particulars	Months/ Days	1	2	3	4	5		6	7	8	9	10		11	12	13	14	15	16	17	18
1	Camp Setting	months	■																			
2	Geological Mapping & BR sampling	months	■	■	■																	
3	Geophysical Survey	Months		■	■	■	■															
4	Topographic Survey	months			■	■																
5	Out Source Tendering Process	months					■		■													
6	Core Drilling	m						REVIEW		■	■	■	■	REVIEW	■	■	■					
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																		■	■	■

Annexure-I

Preliminary Exploration (G-3) for REE and associated minerals in Bhimgoda-South Block, District: Balotra, State: Rajasthan Block area- 6.25 sq. km; No of BH:33 + Stratigraphic BH:3 = Total 36 Boreholes, Average Depth of BH: 120 m, Total Drilling : 4610 m Schedule timeline- 18 months, Review: after 05 months and 10 months							
Sl. No.	**Item of Work**	**Unit**	**Rates as per NMET SoC 2020-21**		**Estimated Cost of the Proposal**		**Remarks**
			SoC- Item- S. No.	**Rates as per SoC**	**Qty.**	**Total Amount (Rs)**	
A	**GEOLOGICAL WORK**						
1	**Geological Mapping (1:2000)**						
	Geologist man days (1 No.) for Geological map & Report (HQ)	days	1.1b	9,000	60	540,000	
	a) Geologist man days for Detailed Geological mapping/Channel Sampling/ Drilling	days	1.2	11,000	180	1,980,000	
	b) Labour (field)	per worker	5.7	541	360	194,760	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
	c) Sampler for Suface Samples/ Core Samples Labour charge not included (1 sampler)	day	1.5.2	5100	140	714,000	
	d) 4 labours/ party (As per rates of Central Labour Commissioner)	day	5.7	541	560	302,960	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
2	**Survey**						
i	Bore Hole Fixation and determination of co-ordinates & Reduced Level of the boreholes by DGPS	Per Point of observation	1.6.2	19,200	40	768,000	36 Boreholes + 4 Boundary Points = 40
ii	Charges of one qualified surveyor with Total Station for carrying out topographical survey in different RF and surface contouring at different interval	days	1.6.1a	8,300	60	498,000	Contouring at 2 m interval for preparation of base map on 1:2000 scale
iii	4 labours/ party (As per rates of Central Labour Commissioner)	days	5.7	541	240	129,840	Amount will be reimbursed as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
					Sub-Total A	**5,127,560**	
B	**SURFACE GEOPHYSICAL SURVEY**						
i	Gravity - Magnetic Method	Per Station	3.1b	4,500	0	-	
ii	Geophysicist Man days for interpretation in HQ	days	3.2	9,000	0	-	
					Sub-Total B	**-**	
C	**DRILLING**						
i	Core Drilling upto 300m Hard Rock	per m	2.2.1.4a	11,500	4,610	53,015,000	33 Nos of BH with 120 m Depth =3960 m Straticgraphic BH 02 No. x 250 m + 01 No. x 150 =Total 4610 m Drilling (Initially, 12 Boreholes including 3 stratigraphic boreholes)
ii	Land / Crop Compensation (in case the BH falls in agricultural Land)	per BH	5.6	20,000	36	720,000	Amount will be reimbursed as per actuals or max. Rs. 20000 per BH with certification from local authorities
iii	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7a	2,000	36	72,000	
iv	Borehole plugging by cement	m	2.2.7b	150	4,610	691,500	
v	Transportation of Drill Rig & Truck associated per drill	Km	2.2.8	36	4,400	158,400	2 Rig Transport, 1100 Km from Nagpur to Bhimgoda
vi	Monthly Accommodation Charges for drilling Camp (Rs 50000/- per Month upto 3 rigs, 50% Additional Charge for additional rigs)	month	2.2.9	50,000	12	600,000	2 Rig Operation* for 6 months
vii	Drilling Camp Setting Cost	Nos	2.2.9a	250,000	2	500,000	
viii	Drilling Camp Winding up Cost	Nos	2.2.9b	250,000	2	500,000	
ix	Road Making (Flat Terrain)	Km	2.2.10a	22,020	5	110,100	Amount will be recalculated after Completion of Tender Process
x	Drill Core Preservation	per m	5.3	1,590	1,000	1,590,000	Including complete meterage of straitigraphic boreholes
xi	Borehole Geophysical logging (5 BHs of 350m each) (In House)	5 BHs of 350m each	3.12	1,088,941	1.32	1,437,402	
					Sub Total- C	**59,394,402**	
D	**LABORATORY STUDIES**						
1	**Chemical Analysis**						
	i) Primary Samples for 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, Pb, Li, Cs, U & Th	per sample	4.1.14	7,731	1000	7,731,000	The quantum of sampling will be deicided based on the results of initial 3-4 BH
	ii)External Check Samples for 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, Pb, Li, Cs, U & Th	per sample	4.1.14	7,731	100	773,100	10% of primary samples
	iii) Major Oxides by XRF Method: CaO, MgO, K2O, SiO2, Na2O, P2O5, Al2O3, Fe2O3, SO3 & LOI	per sample	4.1.15a	4200	20	84,000	
	iv) 10% percent external check sample	per sample	4.1.15a	4200	2	8,400	
2.0	**Petrological / Mineralographic studies**						
	a) Preparation of thin section	per sample	4.3.1	2,353	25	58,825	
	b) Study of thin section for petrography	per sample	4.3.4	4,232	25	105,800	
	c) Digital photomicrograph of thin polished section	per sample	4.3.7	280	20	5,600	
	XRD Mineral Phase Analysis	per sample	4.5.1	4,000	30	120,000	
	EPMA Studies	per hour	4.4.1	8,540	10	85,400	
	Density	per sample	4.8.3	1,568	20	31,360	
					Sub-Total D	**9,003,485**	
					Total (A TO D)	**73,525,447**	
E	**Geological Report Preparation**	**Nos**	**5.2**	For the projects having cost exceeding Rs. 300 Lakhs: A minimum of ₹ 9 lakh or 3% of the value of work whichever is more subject to a maximum amount of ₹ 20 lakh and ₹ 10,000/- per each additional copy.	**1**	**2,000,000**	
F	**Preparation of Exploration Proposal**	**Nos**	**5.1**	2% or Rs. 500000 whichever is less	**1**	**500,000**	EA has to submit the Hard Copies and the soft copy of the final proposal along with Maps and Plan as suggested by the TCC- NMET in its meeting while clearing the proposal.
G	**Report Peer Review Charges**	**lumpsum**	**As per EC decision**	**30000**	**1**	**30,000**	
H	**Total Estimated Cost without GST**					**76,055,447**	
I	**Provision for GST (18%)**					**13,689,980**	GST will be reimburse as per actual and as per notified prescribed rate
J	**Total Estimated Cost with GST**					**89,745,428**	
					Say, in Lakhs	**897.45**	

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