

Detailed Project Report

Item ID: **ME/IN/G4/AP/P/26-27/078**

Agency: **M/S MIDWEST LIMITED**

Title: Reconnaissance Survey (G4) for Ionic – Rare Earth Element (I-REE) in Rapur Block, SPSR Nellore & Tirupati Districts, Andhra Pradesh. Area: 25Sq.km

Comment and Modification : TCC-II, NMEDT meeting held on 17th June 2026, the technical evaluation committee made the following Suggestions for modifications to comply with the requirement for In-Principle Approval.

1.Recommendations of TCC-II on 17th June, 2026:

The Committee deferred the proposal and advised the agency to provide detailed information on

1)**Exploration methodology for Ionic Rare Earth Elements (I-REE), including geological aspects, sample media, sample length, sample collection procedures, analytical methods, in-house laboratory processing Methodology (complete workflow)baseline environment studies**

2)**Values observed based on the agency's studies along with map**

The overall Modified Project Proposal after incorporating the details to the abovementioned points was presented: -

Recommendations of 33rd meeting of Technical-Cum-Cost Committee –II (TCC-II) held on 21st and 22nd July,2026:

As a sequel to 1.above, the following suggestions are offered

The TCC-II committee observed that the area proposed was too large for executive test model for Ionic - REE and advised the agency to delineate & target area with fertile lithology e.g. Syenite / alkali granites within PGC-II terrain. Planning of location of Auger BHs & their spacing was only feasible after envisaging regolith thickness. Considering the above, the committee accorded in principle approval to the proposal and asked the agency to submit DPR for a small test area of 20 to 25 sq.km. Accordingly the target area is reduced to 25 Sq.km for which the DPR is submitted.

(Note: In-House and Outsourcing work components are mentioned in item 5; - Nature and Quantum of the work)

DPR PROPOSED FOR
IONIC – RARE EARTH ELEMENT (I-REE)
EXPLORATION IN RAPUR BLOCK
SPSR NELLORE & TIRUPATI DISTRICTS, ANDHRA
PRADESH

(G4 Stage Reconnaissance Survey under NMEDT)

Commodity: Ionic – Rare Earth Elements (I-REE)

Submitted By	M/S Midwest Limited, Hyderabad
Submitted To	National Mineral Exploration Development Trust (NMEDT), Government of India
Block ID	ME/IN/G4/AP/P/26-27/078
Place	Hyderabad
Date	10 th August , 2026

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Summary of the Rapur Block for Reconnaissance Survey (G4 stage)

General Information about the Block

	Features	Details
	Block ID	ME/IN/G4/AP/P/26-27/078
	Exploration Agency	M/S Midwest Limited
	Commodity	Ionic – Rare Earth Elements (I-REE)
	Mineral Belt	Nellore Schist Belt
	Completion Period	10 (Ten) Months
	Objectives	To locate Ionic-REE mineralised zones along the tectonic contact between the Nellore Schist Belt and the Cuddapah Basin : Resource Evaluation .
	Mode of Execution / Outsourcing	M/s Midwest Limited shall carry out the Exploration work in-house. Remote sensing, geophysical survey, drilling and chemical analysis will be outsourced to empanelled / accredited agencies as required.
	Geoscientists Deployed	4 Geoscientists (2 Senior + 2 Junior)
	Total Field Man-Days (Geologists)	~ 60-days
	Geological Party Days	75 (60+15) Party-days
1	Location	
	Latitude (N)	14° 07' 59.73" N to 14° 11' 55.82" N
	Longitude (E)	79° 29' 30.47" E to 79° 31' 40.59" E
	Localities	Rapur, Kaljigudem, Vellampalli, Velikallu, Althurupadu
	Tehsil / Mandal	Rapur Mandal
	District	SPSR Nellore & Tirupati Districts
	State	Andhra Pradesh
2	Area (sq.km)	
	Block Area	25 sq.km
	Forest Area	Nil

	Features	Details
	Government Land Area	To be ascertained during DGPS survey
	Private Land Area	To be ascertained during DGPS survey
3	Accessibility	
	Nearest Rail Head	Gudur (~ 50 km)
	Road	Gudur – Rajampeta Road
	Airport	Tirupati International Airport
4	Hydrography	
	Local Surface Drainage	Sub-dendritic, parallel; local alluvial streams
	River / Stream	Pennar River catchment area
5	Climate	
	Mean Rainfall	~ 929 mm
	Temperature	Min. 28°C (December); Max. 41°C (May)
6	Topography	
	Toposheet Number	57 N/8 and 57 N/12
	Morphology	Pedeplain
7	Availability of baseline Geoscience data (NGDR Portal)	Baseline Geoscience Data Available in NGDR Portal
	Geological Map (1:50K / 1:25K)	Available
	Geochemical Map	Available
	Geophysical Maps (Aeromagnetic / Ground)	Available
8	Justification for Taking up the Block for Mineral Investigation (Ionic – REE)	INTRODUCTION: The present Indian understanding of Ionic Rare Earth Elements (I-REE) is in rudimentary stage, as it is a recently recognised (1969) mineral commodity now coming to limelight. The dominance of China in the global REE market is largely attributed to its early lead in exploiting the ion-adsorption type REE bearing clay deposits. These are also known as Ion Adsorbed clay (IAC) deposits. Definition: “The I-REE is an exogenous sedimentary deposit developed in the regolith soils formed during the Recent period over suitable granitic host rocks in tropical climates under normal weathering conditions, and is

	Features	Details
		amenable for easy extraction at lower cost and metallurgical processing, devoid of Radioactive Signatures." Midwest Initiative: Midwest Limited has been pursuing research on this subject independently for some time. An update on Ionic-REE was published by Lakshminarayana & Raghava Reddy (2026) in the Mining Engineers Journal. Midwest has further set up an in-house chemical laboratory dedicated to the study of Ionic-REEs in soft rocks such as regolith clays (by desorption). GEOLOGICAL SETTING: The tectonic contact between the Nellore Schist Belt (NSB) and the Cuddapah Basin is a well-known domain for the emplacement of a clan of alkali granite intrusives (possible host rocks for REE). Among them, the granite pluton at Rapur is conspicuous, as it has given way to the mica pegmatites of the Nellore Schist Belt which is known for rare minerals, mica, beryl and REE. Detailed petrography, geochemistry and REE abundance data of the Rapur granites are available in GSI unpublished reports, AMD and other records as well as published works. MINERALISATION: Recently, the Midwest Limited has conducted a preliminary survey to re-examine REE abundances in the area and has found values of 0.9 – 1.0 % TREE in the alkali granites — establishing the fact that granite complex at Rapur is a suitable (fertile) host rock for REE mineralisation. It is capped by regolith developed in tropical climates. Furthermore, the Rapur area is characterised by warm climate and significant rainfall, where the regolithic clays developed over the granitic rocks and are found to be ionic in nature whose raw ore values range from 127 ppm to 516 ppm (0.05%) of adsorbed REE. On treatment (by Desorption) with ammonium sulphate @ph. of 5 to 6, the regolith soils have shown encouraging desorption of the magnitudes of 20 to 36 times to the tune of 4800 ppm. The Rapur Regolith soils, on XRD studies are found to be rich in clay minerals such as kaolinite and illite (the carriers of adsorbed REE molecules) — analogous to the South China type IAC deposits and elsewhere. POTENTIAL: Therefore, the study has revealed that the area is likely to contain substantial volumes of Ionic-REE bearing regolithic soil with raw assay of ~ 0.03 % TREE. The current mining grade of regolithic clays in South China and Myanmar is in the range 0.03 – 0.5 %. This forms the basis and justification for taking up the present G4-level reconnaissance exploration to study various facets of regolith development and to undertake a preliminary volumetric estimation of mineable REE-grade

	Features	Details
		regolithic soil — which is expected to strengthen the upstream availability of easily extractable REE-oxide mix in India.

DETAILED DESCRIPTION OF THE PROPOSED BLOCK

1. Block Summary

a.) Physiography

The Physiography of the Rapur block is represented by a pediment formed along the western flank of the Veligonda Range, whose foothills exhibit a gentle slope towards the east. The Veligonda Range forms a 'water divide' in this part of the southern Indian shield and is also a rainy zone with respect to the northeast monsoon. The drainage pattern in the area is sub parallel to trellis.

The Rapur block is located in tropical latitudes around 14° N in the coastal region of Andhra Pradesh. It is flanked by the Bay of Bengal in the east and the Veligonda Range of the Cuddapah Basin in the west. The Veligonda Range is comprised of N–S trending quartzite and phyllite ridges elevated up to ~900 m. The width of the Veligonda Range varies from 6 to 8 km and capped with suitable vegetation cover (Fig-2). On either side, the Veligonda Range is flanked by strike faults — resulting in a sudden fall in elevation that indicates a topographic break. To the east of the Veligonda lies the Nellore Schist belt. The contact between these two terrains is known for the emplacement of younger granitic intrusive. The foothill domain and its slopes coincides with the realm of thick regolith development. Recently, the Rapur railway tunnel and its cuttings for tracks made across the Veligonda range have revealed the geological disposition of intrusive

The general topographic expression is a rubble-laden plain, gently undulating, with localised depressions amidst granite knobs. The soil colour varies from brownish-yellow to light red. **The thickness of the soil regolith ranges up to 8 m along the hill slopes** — as indicated by talus cones and soil prisms coalesced into Pedepain landform and diminishes to ~2 m further east. The depth of Oxidation ranges up to 20 meters in Hard rock which will be elucidated on core drilling of the hard rock. The area experiences a warm and humid climate. Location of the block, block area in Survey of India Toposheet and Google imagery are shown in Figs 1, 2 & 3 respectively.

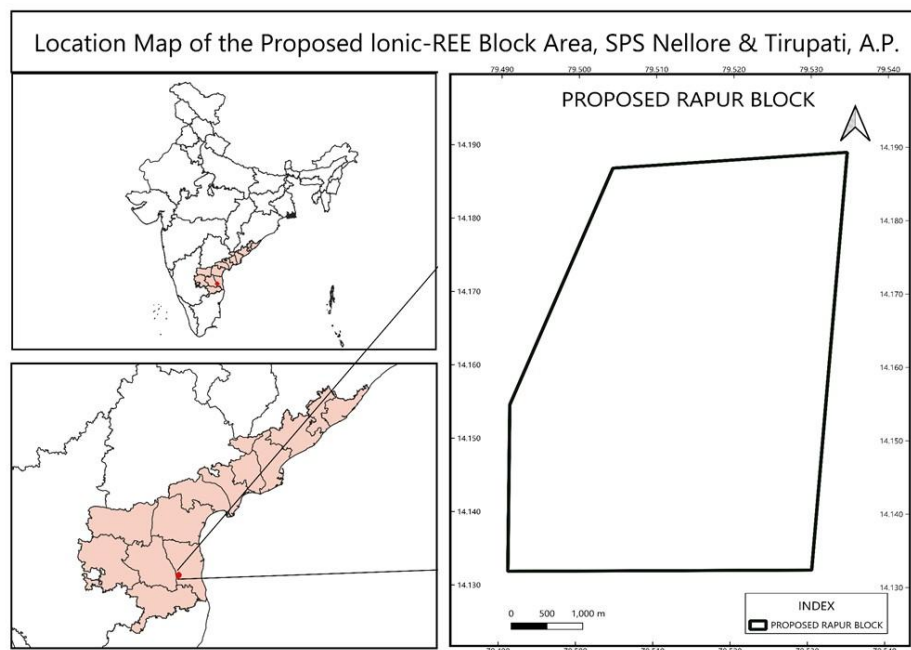


Fig. 1 — Location Map of the Proposed Ionic-REE Block, SPSR Nellore & Tirupati Districts, Andhra Pradesh. original area proposed for the block is 100 Sqkm. However on recommendation of TCC-II the block area is reduced to 25 Sqkm. Fig.1c

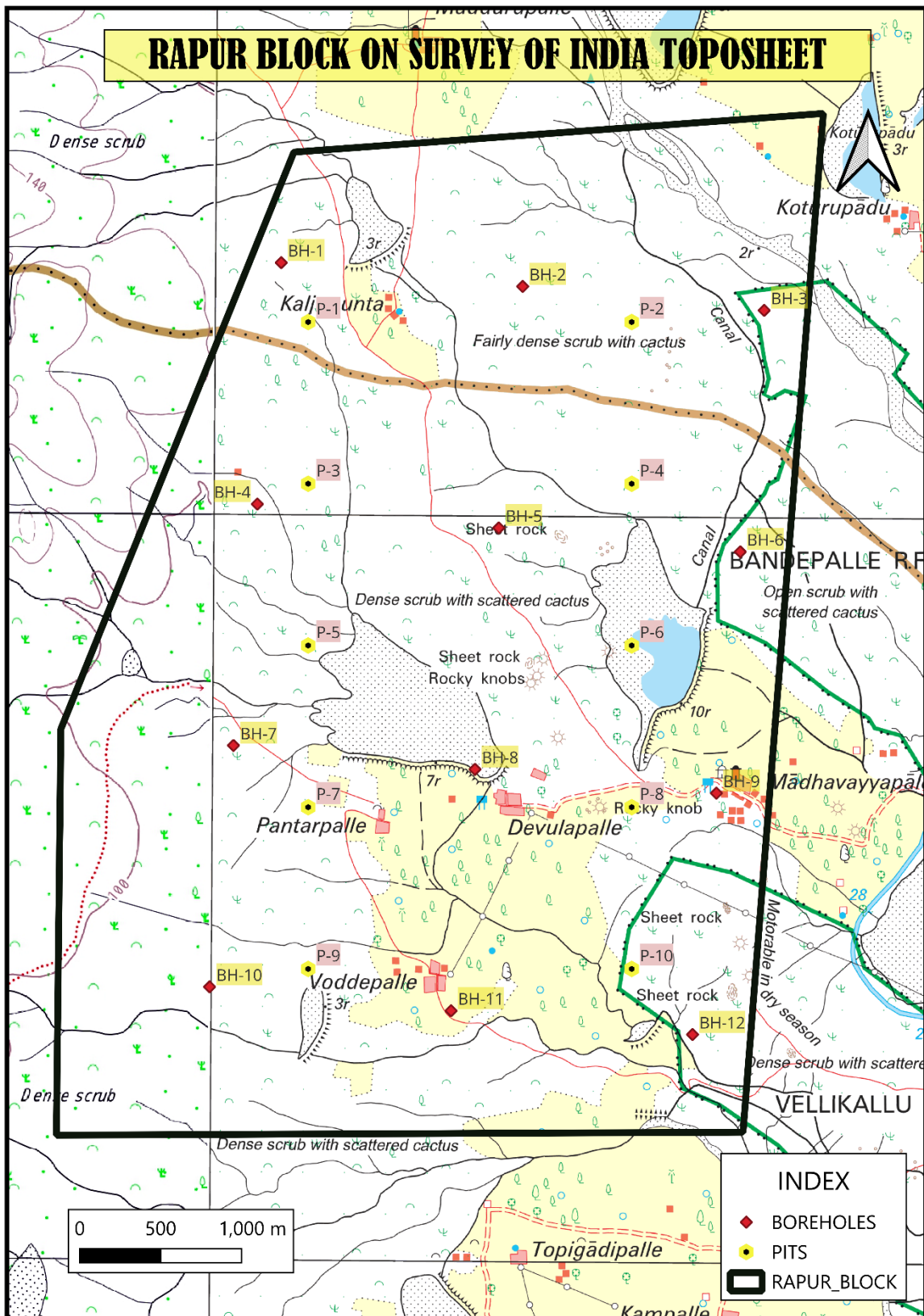


Fig. 2 — Rapur Block with Borehole and Pit Locations demarcated on Survey of India Toposheets (57 N/8 & 57 N/12)

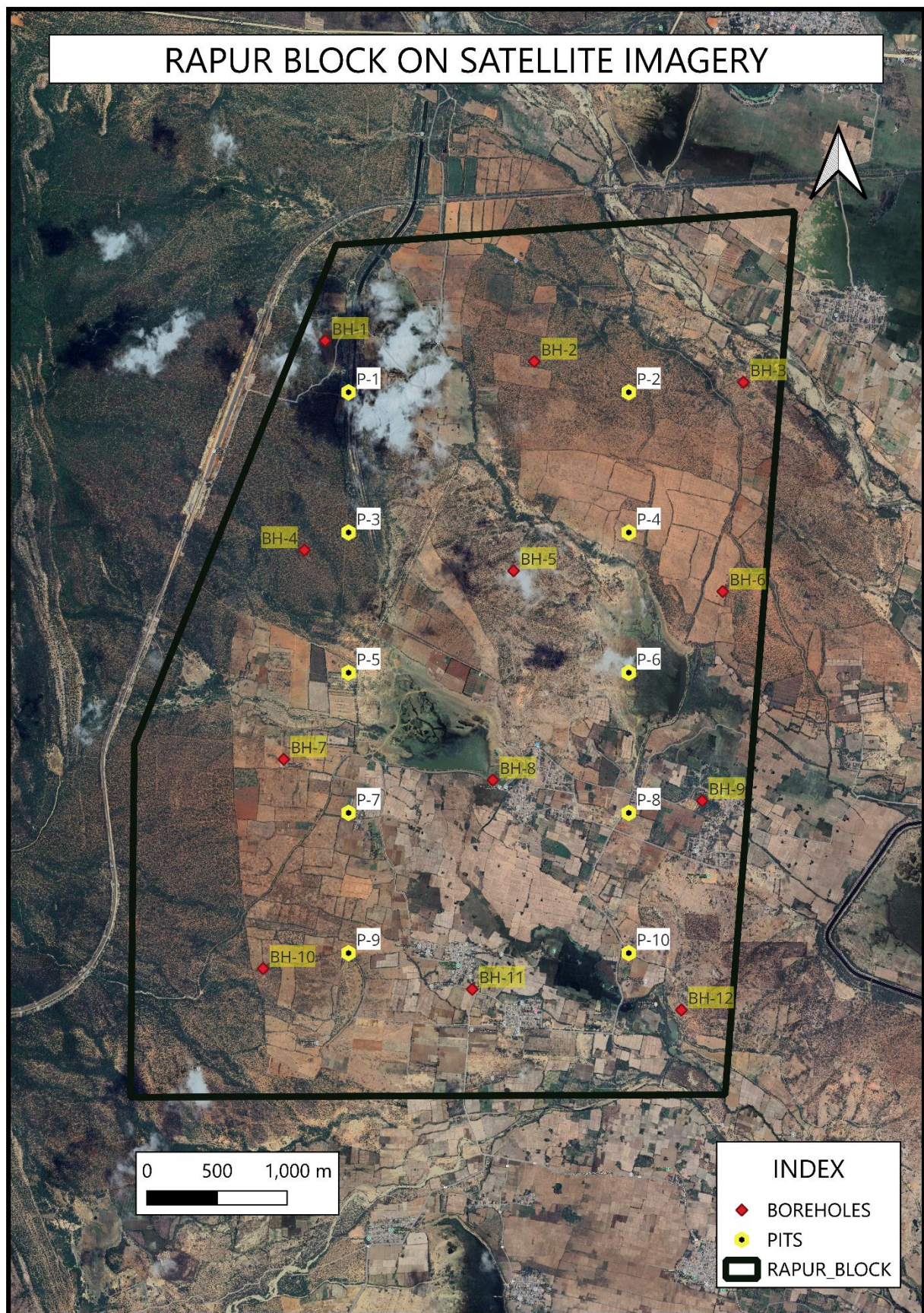


Fig. 3 — Rapur Block outline with Borehole and Pit Locations on Google Satellite imagery

b.) Background Geology

The Rapur block is located in the south-eastern part of the Dharwar Shield, in which the geological terrain known as the Nellore Schist Belt is economically significant for the occurrence of mica, quartz and feldspar and Rare Minerals like Beryl etc. The host rocks for these economic minerals are pegmatites derived from the Rapur Granite that intrude into the phyllitic / schistose rocks and Quartzites of the Nellore Schist Belt. This schist belt is also known for the incidence of copper mineralisation.

The contact zones of the Rapur Granite are marked by the development of metamorphic areoles on the argillaceous rocks leading to their transformation into high-grade schists. The igneous intrusives of the Nellore Schist Belt have been a subject of mineral investigation in India for many years; the GSI has published several write-ups and mineral-belt maps for the Nellore Schist Belt. Baseline geological map is available in NGDR portal. Geophysical and Geochemical maps are to be assessed from data base repository.

c.)Regional Geology & Geology of the Rapur Block

The Nellore Schist Belt (NSB) is believed to be one of the Achaean / Proterozoic schist belts of India, set over the Precambrian crystallines of the Indian Shield. To the west, the NSB is bordered by the Proterozoic Cuddapah Basin, whose eastern half is known as the Veligonda Range of the Nallamalai Fold Belt (NFB). The contact between the NFB and the NSB is a fault zone whose nature has been interpreted as a normal fault by some pioneering workers (William King, 1872) and as a reverse / thrust fault by others (Narayanaswamy, 1976). Setting aside the nature of this contact, the contact between these two domains (Nallamalai Fold Belt – Nellore Schist Belt) forms a prominent physiographic divide and a locale for the emplacement of younger granites that penetrate into the pre-existing country rocks.

The Rapur block is located immediately to the east of this 'divide', and its provisional geological succession is presented below:

Geological Succession in Rapur Block

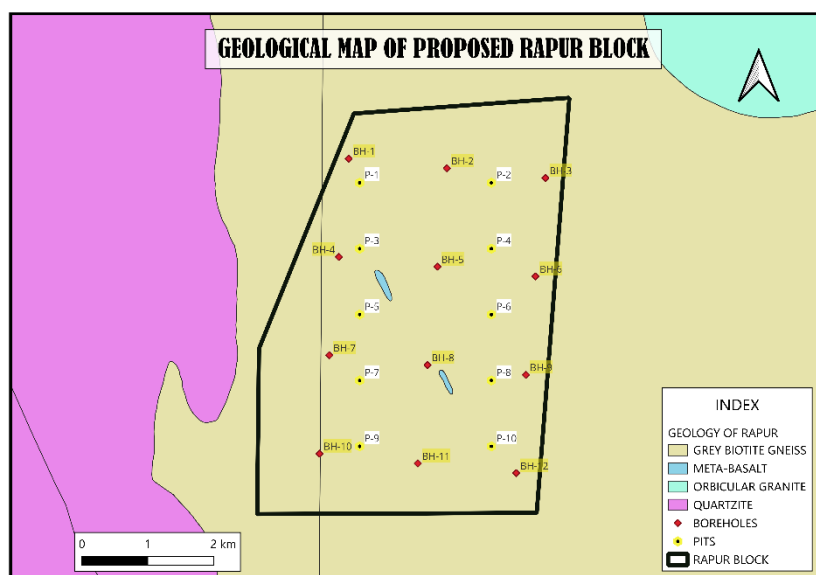
Age	Lithology	Remarks
Quaternary	Regolithic soils	Host of Ionic-REE
— Unconformity —		
Intrusives (Nellore)	Granites, Pegmatites intruding into the high grade schists	Source rocks for REE
Proterozoic (Cuddapah Phyllites / Nellore Schists)	Meta sediments — Phyllites / Schists and Quartzites	Country rock

The NSB Phyllites and Quartzites are considered to be lateral variants of the Cuddapah meta-sediments formed in the intrusive zone.

d.) Mineral Potentiality of the Block

(Based on geology, geophysics, ground geochemistry etc.)

- Alkali granites are known, the world over, as the host rocks for REE mineralization. The Rapur granite is an ensemble of alkali granites and monzogranites. Although the previous works of GSI have elaborated Petrography, Geochemistry and Petrogenetic aspects, yet, seldom indicated any notable anomalies of REE mineralization in hard-rock samples, (Mesharam and Dharme, 2014). However, the data published by the scientists of the Bangalore Central University in collaboration with the Geological survey of India have shown a significant incidence of TREE (Total REE) in granitic rock — see Table 1 below. (Jeelani, et. al., 2016) This map does not contain sample locations but the rock type of the samples is specified.
- In course of its Geological studies for granite, the Midwest Limited has collected samples in the Rapur area as part of in-house exploration (See Fig – 5 for sample locations) whose major and trace element data are presented in Tables 2 &3 and REE abundances in Table-4. The latter shows anomalous TREE values (up to ~ 0.9 %) in surface samples (results from a NABL-accredited Laboratory-Lucid, Hyderabad). It has been observed that the Rapur block exposes a substantial amount of alkali granite outcrops and contact-metasomatic zones, capped by a regolithic soil cover whose thickness ranges from 2 m to 8 m. REE values in Regolith are presented in Table-5. It may be remembered that the REE values in regolith are significantly less than the REE values in host rock. Besides the same sample has been studied for clay mineralogy by XRD at Shiva Analytical Laboratory, Bangalore (NABL accredited). The regolith is rich in kaolinite, Halloysite. It is observed that the Rapur block contains substantial volume of weathered regolith in the Rapur block. Regolith Sample locations are shown in Fig.4 and Analytical values are presented in Table -5.
- As a sequel, the Midwest Limited collected soil samples and subjected them to desorption studies using ammonium sulphate in its in-house laboratory (see Table-6. Following the procedure outlined by Chi & Tian (2008). It was found that the regolith contains about ~ 40 % clay minerals — including kaolinite and illite whose platy structure has adsorbed RE oxides and amenable to easy desorption by ammonium sulphate. The desorption levels are 20 to 36 times, qualifying the soil deposit as a 'South China' type ion-adsorption clay (see Table 6 for results of the ionic clay study).



- Fig. 4— Geological outline map showing the location of the Midwest Samples and proposed area. (Modified from NGDR portal)**

- In view of the presence of significant volumes of regolith soil and its inherent ion-adsorbed REE nature, there is a strong indication that significant volumes of easily extractable REE oxides could be identified in the Rapur block. Field photograph of I-REE Sample showing layers in the Regolith of Rapur Area is given in Fig-6. XRD data on I-REE clays of Rapur area are shown in Fig.7. Therefore, in the light of above observations, the present exploration is proposed following the state-of-the-art Ionic-REE exploration methodology.

Previous Analytical results (Analytical Laboratory was not Specified by Jeelani et.al, 2016)

Table 1 — REE DATA OF RAPUR GRANITOIDS (BANGLORE CENTRAL UNIVERSITY & GSI) (Values in ppm)

Element	HBG-1	HBG-2	HBG-3	HBG-4	OG-1	OG-2	AFG-1	AFG-2	MG-1	MG-2
La	48.58	75.91	52.84	91.52	100.3	157.4	81.18	142.8	53.6	82.26
Ce	88.43	119.6	84.02	145.1	145.2	235.7	138.4	222.1	96.9	138
Pr	12.08	16.66	10.38	19.61	21.83	32.85	19.15	30.61	14.54	19.12
Nd	54.69	69.34	40.29	80.18	89.79	129.7	79.47	124.6	65.24	80.72
Sm	13.45	14.36	7.02	18.19	19.36	26.07	18.78	26.9	16.66	19.35
Eu	2.54	1.99	1.51	1.91	1.95	2.23	0.31	2.24	2.1	2.09
Gd	9.1	9.02	3.93	12.21	12.67	16.5	12.46	17.61	11.16	13.07
Tb	1.98	1.77	0.54	2.58	2.65	3.24	2.85	3.62	2.52	2.89
Dy	14.18	11.91	2.78	17.56	18.29	21.18	21.46	23.93	18.05	20.28
Ho	3.1	2.63	0.53	4.04	4.16	4.91	4.87	5.64	4.16	4.67
Er	7.32	6.24	1.12	9.56	9.98	11.72	11.82	13.42	9.94	11.11
Tm	1.45	1.21	0.17	1.8	1.92	2.18	2.37	2.46	1.92	2.12
Yb	9.26	7.79	1.05	11.94	12.56	14.47	14.63	16.71	12.57	13.93
LREE	219.77	297.86	196.06	356.51	378.43	583.95	337.29	549.25	248.04	322.54
HREE	46.39	40.57	10.12	59.69	62.23	74.2	70.46	83.39	60.32	68.07
TREE	266.16	338.43	206.18	416.2	440.66	658.15	407.75	632.64	308.36	390.61

Lithology codes: HBG = Hornblende-Biotite Gneiss, AFG = Alkali Feldspar Granite, MB = Metabasalt, MG = Monzogranite, OG = Orbicular Granite.

Midwest Analytical Data- Tables 2 to 5 (Analysed in NABL Accredited Lucid Laboratory, Hyderabad)

Table 2 MAJOR ELEMENT ANALYSIS OF RAPUR GRANITE AND ASSOCIATED ROCKS

		1	2	3	4	5	6	7	8	9	10	11	12	13
		Phyllitic Quartzite	Feldspathic Quartzite	Mylonitic Quartzite	Mylonitic Quartzite	Metasomatic Granite	Regolith	Alkali Granite	Alkali Granite	Alkali Granite	Alkali Granite	Alkali Granite	Grab Sample	Grab Sample
S.No	Parameters	C-S1	C-S2	C-S3	C-S4	RTG-S5	RTR-S6	KE-S7	KW-S8	KW-S9	KW-S10	KW-S11	CG-S12	CG-S13
1	SiO ₂	79.11	90.93	75.76	80.97	63.7	71.95	67.34	72.42	65.66	70.7	75.53	81.25	66.6
2	Al ₂ O ₃	5.7	3.75	11.14	9.2	10.47	12.16	17.2	15.21	17.46	15.1	14.1	5.05	2.46
3	CaO	0.43	0.42	0.53	0.48	3.38	0.56	2.32	1.83	1.48	2.45	2.02	2.64	4.48
4	MgO	0.27	0.26	0.7	0.53	4.06	0.8	1.4	0.58	1.47	1.45	0.76	1.32	1.3
5	Fe ₂ O ₃	5.03	2.13	5.04	3.32	8.92	6.95	2.61	0.94	2.85	1.58	0.92	5.1	20.95
6	Na ₂ O	0.01	0.01	0.02	0.01	0.87	0.26	3.37	2.83	5.21	3.01	1.65	0.05	<0.01
7	K ₂ O	0.18	0.08	0.78	0.65	2.14	0.72	3.28	5.43	3.3	3.7	3.8	1.6	<0.01
8	TiO ₂	0.18	0.07	0.28	0.22	0.4	0.28	0.27	0.05	0.32	0.24	0.1	0.12	0.07
9	P ₂ O ₅	0.13	0.1	0.05	0.04	0.08	0.06	0.17	0.06	0.17	0.25	0.06	0.06	0.27
10	MnO	0.02	0.01	0.02	0.02	0.06	0.04	0.02	0.01	0.04	0.02	0.04	0.23	0.04

Sample legend: C-S1 to C-S4 — phyllitic / feldspathic / Mylonitic Quartzites; RTG-S5 — metasomatic granite; RTR-S6 — regolith; KE-S7 to KW-S11 — alkali granite; CG-S12 / CG-S13 — grab samples alkali granite; **Samples analysed in NABL-accredited Lucid Laboratories, Hyderabad.**

Table 3 TRACE ELEMENT ANALYSIS OF RAPUR GRANITE AND ASSOCIATED ROCKS (Analysed in NABL Accredited Lucid Laboratory, Hyderabad)

		1	2	3	4	5	6	7	8	9	10	11	12	13
		Phyllitic Quartzite	Feldspathic Quartzite	Mylonitic Quartzite	Mylonitic Quartzite	Metasomatic Granite	Regolith	Alkali Granite	Alkali Granite	Alkali Granite	Alkali Granite	Alkali Granite	Grab Sample	Grab Sample
S.No	Parameters	C-S1	C-S2	C-S3	C-S4	RTG-S5	RTR-S6	KE-S7	KW-S8	KW-S9	KW-S10	KW-S11	CG-S12	CG-S13
1	Ag	0.4	0.35	0.4	0.7	<1.0	0.2	0.7	0.5	0.7	1.4	0.4	0.4	0.1
2	B	57.6	23.8	81.2	90.8	90.6	63.5	36.7	9.1	41.4	15	10.6	176.1	75.6
3	Ba	123	157.3	197.9	126.9	607.2	247.4	548	1060.7	275.4	702.6	713.1	361	34.2
4	Bi	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
5	Cd	0.5	0.02	0.04	0.01	0.4	0.1	0.2	0.2	0.1	0.03	<1.0	<1.0	<1.0
6	Cr	47.1	9.8	83.4	76.5	347	151.3	38.2	40.2	15.8	30.2	6	20.8	30
7	Cu	118.1	54.1	80.4	51.4	177.3	44.6	11	7	10.3	4.5	2	7.4	138
8	Co	0.2	0.4	0.8	0.4	14.9	4.3	0.8	0.04	2.8	1	<1.0	6.1	<1.0
9	Ga	14.5	3.8	20.9	17.2	26.3	23.6	27.1	18.6	27.7	16.3	14.4	10.4	20
10	Pb	7	11.2	13.8	<1.0	<1.0	17.7	28	13	45	5.6	61	3.1	5.8
11	Li	29.9	2.7	18	12.5	7.6	14.6	15.9	0.3	4.6	7.2	1.4	11	<1.0
12	Ni	27.9	16.3	38.6	25.6	133.1	58.2	19.7	4.7	8.1	13.6	1.4	24	28
13	Sr	2.4	7.7	13.88	8.45	125.45	18.5	<1.0	255.7	130	195.7	191.45	9	2.5
14	Zn	75.1	<1.0	26.1	22.5	80	25.7	55.9	10.5	48	20	5.8	61.1	2.5
15	Hf	2.2	2.2	4	4.5	1.7	3.3	6.4	4.8	13.2	10.5	5	1.47	<1.0
16	Nb	21.3	0.3	12.5	9.7	24.7	15.5	6.8	0.4	37.1	2.2	0.1	1.8	<1.0
17	Ta	8.3	0.5	3.3	3.7	9	5.7	1.5	0.5	8.5	0.6	<1.0	2.3	5.4
18	Th	27.8	16.6	441.5	357.5	775.432	607.4	520.4	138.4	1130.1	127.2	209.2	309.4	863.1
19	U	335.1	110.5	230.5	151.4	681.9	454.2	85.3	26.5	71.5	35.1	15.3	357.9	1256.8
20	Zr	58.4	94.1	115.8	152.8	21.8	95.2	222.3	165.6	294	351.8	110.9	49.5	18
21	As	<1.0	41.25	45.35	47.6	112.9	54.45	28.9	8.5	38.2	37.2	28.4	28.4	27.1
22	Be	1	0.4	1.8	1.12	0.4	1.1	1.8	1	4.6	1.2	0.75	0.85	1.75
23	Mo	4.65	5	0.15	0.07	<1.0	1.4	1.75	0.65	<1.0	2.1	<1.0	<1.0	0.15
24	Sb	3.3	1.94	5.85	5.3	14.85	9.8	3.85	4.2	3.2	3.9	2.4	7.1	5.1
25	Se	0.67	<1.0	3.85		<1.0	9.4	<1.0	7.1	<1.0	6.4	7.4	0.63	<1.0
26	Sn	35	<1.0	1.9	1.7	<1.0	<1.0	<1.0	<1.0	3.6	<1.0	<1.0	<1.0	<1.0
27	W	3.1	82.5	7.2	7.2	0.06	5.7	<1.0	0.7	1.7	<1.0	1.4	1.4	<1.0

Table 4 REE CONTENT OF RAPUR GRANITE AND ASSOCIATED ROCKS (Analysed in NABL Accredited Lucid Laboratory, Hyderabad)

		1	2	3	4	5	6	7	8	9	10	11	12	13
		Phyllitic Quartzite	Feldspathic Quartzite	Mylonitic Quartzite	Mylonitic Quartzite	Metaso matic Granite	Regolith	Alkali Granite	Alkali Granite	Alkali Granite	Alkali Granite	Alkali Granite	Grab Sample	Grab Sample
S.No	Param eters	C-S1	C-S2	C-S3	C-S4	RTG-S5	RTR-S6	KE-S7	KW-S8	KW-S9	KW-S10	KW-S11	CG-S12	CG-S13
1	La	84.6	78.8	147.2	4.5	88.6	89	292.4	82.7	2361.3	0	178.4	210.6	973.42
2	Ce	135.3	108.5	353.6	311.4	59.6	1312.6	442.1	93.646	3969.2	217.5	253.3	295.2	125.4
3	Pr	28.5	27.3	84	73.4	12.8	264.2	119.7	23.8	1086.3	55.6	62.5	84.4	28
4	Nd	62.8	49.9	120.3	119.2	355.7	89.87	347.7	103.3	1154.5	245.6	167.1	206.5	1168.5
5	Sm	28.7	10.5	23.6	29.1	26.8	11.7	75.2	11.3	249.6	19.9	36.6	32.9	155.4
6	Eu	2.5	2.4	4.1	3.4	7.1	1.6	5.6	7.2	9.3	6.6	6.9	11.6	36.7
7	Gd	59.1	20.5	80	67.5	126.5	73.2	94.2	20.6	155.7	63.2	23.6	64.8	124.5
8	Tb	10.5	0	13.5	11.3	41.6	16.5	14.8	1.2	20.1	11.6	0	4.6	13.1
9	Dy	25.5	15.8	66	2059.4	296.6	87.2	50.4	8.9	29.1	8.9	2.6	19.4	0.7
10	HO	0	0	0	0	0	0	0	0	212.2	23	16.1	49.5	215.4
11	Er	11.6	4.1	13.1	10.9	28	12.9	11.8	3.8	40.7	10.2	2.4	24.6	28.5
12	Tm	12.4	2.6	16.2	12.5	33.308	17.5	16	2.7	26.1	13.5	4.2	8.5	4.5
13	Yb	9.1	4.2	12.4	11.4	24.7	106	8.6	3.5	49	9.3	2.5	19.1	16
14	Lu	13.1	4.4	12.1	8.7	25.2	89	6.6	2.6	13.9	3.5	1.6	11	30.5
15	Sc	36.1	12.8	87.3	69.9	507.2	132.4	31.8	3.2	50.9	0	2.7	53.2	20.5
16	Y	72.7	28.4	94	81.3	189.5	47.4	121.3	28.1	405.4	87.3	21.5	190.3	136.3
	ΣREE	592.5	370.2	1127.4	2873.9	1823.208	2351.07	1638.2	396.546	9833.3	775.7	782	1286.2	3077.42
	ΣLREE	342.4	277.4	732.8	541	550.6	1768.97	1282.7	321.946	8830.2	545.2	704.8	841.2	2487.42
	ΣHREE	250.1	92.8	394.6	2332.9	1272.608	582.1	355.5	74.6	1003.1	230.5	77.2	445	590

Table 5 **REE content of regolith samples** (Analysed in NABL Accredited Shiva Analytics Laboratory, Bangalore)

Sample No	Sc	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th	U	LREE (ppm)	HREE (ppm)	TREE (PPM)
MP 1	9.5	13.3	28	41	6	24.5	4.2	1.2	4.2	<0.5	2.6	<0.5	1.3	<0.5	1.1	<0.5	10.4	1.6	104.9	22.9	137.3
MP 2	13.8	17.8	29.2	57	6.7	26.6	5.2	1.1	5	0.6	3.8	0.7	2	<0.5	1.9	<0.5	22.7	2.7	126.8	33.5	174.1
MP 3	13.2	7.3	15.7	67	3.4	12.2	2.3	0.5	2.4	<0.5	1.6	<0.5	1	<0.5	0.9	<0.5	17.6	2.7	101.1	12.7	127
MP 4	14	15.9	79.4	163	17.7	64.9	10.4	1.4	9.5	0.7	3.7	0.6	1.7	<0.5	1.4	<0.5	54.6	3.3	336.8	35.5	386.3
VLP 5	15.3	19.2	23.4	56.3	5.5	23	4.7	1.3	4.7	0.5	4.1	0.7	2.1	<0.5	1.7	<0.5	12.3	2	113.2	33	161.5
VLP 6	6.3	8.6	42.6	118	8	28	4.1	1.2	4.1	<0.5	2	<0.5	1.1	<0.5	1	<0.5	25	3.6	201.9	18	226.2
RBB 7	15.9	18.5	92.4	260	20.5	74.6	11.9	1.6	10.8	0.9	4.3	0.7	2.3	<0.5	2	<0.5	69.3	3.8	460	40	515.9

Table 6 — REE Abundance in Regolith and Leached Samples of Rapur Area (M/S Midwest Limited) (Desorption data) (Samples desorbed in Midwest in-house laboratory)

S.No.	Parameter	Units	RR Ore	RR Desorb	CGT1 Ore	CGT1 Desorb	CGT2 Ore	CGT2 Desorb	CGT4 Ore	CGT4 Desorb
1	Ce	ppm	70.4	860.0	2.0	199.5	1.3	5.3	1.5	154.2
2	Dy	ppm	2.1	65.0	0.2	52.7	0.1	1.3	0.1	31.9
3	Er	ppm	3.9	29.1	0.1	29.4	0.1	0.8	0.1	16.6
4	Eu	ppm	1.0	29.1	<0.1	16.0	<0.1	0.5	<0.1	8.4
5	Gd	ppm	22.1	120.5	0.2	70.1	0.1	2.0	0.1	48.8
6	Ho	ppm	<0.5	9.8	<0.1	10.4	<0.1	0.3	<0.1	6.4
7	La	ppm	27.2	1721.3	0.9	367.5	0.9	25.6	0.9	448.9
8	Lu	ppm	1.9	1.4	<0.1	3.6	<0.1	<0.1	<0.1	1.6
9	Nd	ppm	100.3	993.0	1.1	392.1	0.8	11.8	0.8	332.2
10	Pr	ppm	16.2	404.9	0.2	96.9	0.2	2.9	0.2	93.9
11	Sc	ppm	21.2	<1	0.4	0.5	0.3	0.2	0.9	3.0
12	Sm	ppm	6.3	156.3	0.2	77.1	0.2	2.0	0.1	52.5
13	Tb	ppm	<0.5	16.5	<0.1	9.7	<0.1	0.2	<0.1	6.1
14	Tm	ppm	<0.5	2.1	<0.1	4.2	<0.1	0.1	<0.1	2.0
15	Y	ppm	12.4	383.8	0.1	364.6	0.8	11.6	0.7	229.4
16	Yb	ppm	3.1	11.7	1.0	25.7	0.1	0.5	<0.1	11.1
	TREE	ppm	288.1	4804.5	6.4	1720.0	4.9	65.1	5.4	1447.0
	LREE	ppm	214.1	3979.2	4.2	1056.0	3.2	45.6	3.4	1029.2
	MREE	ppm	31.5	387.4	0.6	225.6	0.4	6.0	0.3	147.7
	HREE	ppm	21.3	437.9	1.2	437.9	1.0	13.3	0.8	267.1

Ore = raw clay sample; Desorb = sample desorbed in ammonium sulphate. REE values in ppm. Samples processed in the Midwest Geochemical Lab; desorbed using ammonium sulphate, calcined and subjected to ICP-MS analysis at Lucid (NABL) Laboratories. RR ore = Rapur Regolith Ore; CG samples indicate Ore from the Adjacent Chandragiri Area.



Fig-5: Field Photographs showing Ionic- REE bearing Regolith layers in Rapur block

Figure 6 — XRD Studies of Rapur Clays is shown in the following 6 pages(NABL accredited laboratory,



SHIVA ANALYTICALS INDIA PRIVATE LIMITED

Customer Name: Mid-West Limited. Customer Address: Floor 19, Perstige Skytech, Financial district, Nanakramguda Hyderabad - 500032 Customer Ref: RR CLAY Lab ID : G4380-1 Date of Sample Analysis : 30/03/2026 Date of Reporting : 02/04/2026	INTRODUCTION: X-ray diffraction (XRD) and petrology studies are both valuable techniques used in geology and materials science for analysing minerals and rocks, but they serve different purposes and offer unique advantages. Here's how XRD is superior to petrology studies in certain aspects. XRD excels in identifying crystalline minerals present in a sample. It provides precise information about the crystal structure and lattice parameters of minerals, which can be challenging to ascertain solely through petrological observations. XRD allows for quantitative analysis of mineral phases present in a sample, providing accurate estimates of mineral composition based on peak intensities. Petrology studies, while descriptive, may not always provide quantitative data on mineral abundance. XRD is highly sensitive and can detect trace amounts of minerals present in a sample, even at concentrations as low as a few percent. Powder Diffraction (XRD) Database, contains a comprehensive collection of more than 6000 diffraction patterns for various materials. Researchers use this resource for identifying unknown substances, confirming crystal structures, and conducting material characterization. Shiva Analyticals team has decades of experience on XRD studies. Accurate chemical assay coupled with reliable mineralogy information is vital in resource characterisation.
MINERALOGY TEST REPORT 1.60 KW POWDER X RAY DIFRACTOMETER METHOD	
	

Prepared by: Nagaraj Singh
 Verified by: Satyanarayana



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Bangalore) Cont'd

Figure 6 — XRD Studies of Rapur Clays (NABL accredited laboratory, Bangalore) Cont'd



SHIVA ANALYTICALS INDIA PRIVATE LIMITED

Sample Code: G4380-1 (RR CLAY)

Instruments: WDXRF – Bruker S8 Tiger Series 2 (4 kW); XRD – Bruker D8 Advance (1.6 kW).
2θ Scan Range: 5–80° | Crystallinity: 64.20 % | Amorphous: 35.80 % |

Major Oxide Composition:

Major Oxide	Unit	Results
Silica as SiO ₂	%	50.65
Alumina as Al ₂ O ₃	%	21.15
Iron Oxide as Fe ₂ O ₃	%	12.11
Potassium Oxide as K ₂ O	%	1.41
Magnesium Oxide as MgO	%	0.94
Titanium Dioxide as TiO ₂	%	0.74
Calcium Oxide as CaO	%	0.47
Sodium Oxide as Na ₂ O	%	0.32
Loss on Ignition as LOI	%	11.96

Mineral Phases by XRD:

Sl. No.	Mineral Name	Crystallographic Database No.	Phase Formula	Molecular Weight (g/mol)	XRD Assay (Over all Mineral,%)
1	Quartz	9012600	SiO ₂	60.08	34.25
2	Ulvospinel	9013537	Fe _{2.354} Ti _{0.644} O ₄	226.39	3.28
3	Muscovite	9001054	Al _{2.73} Fe _{0.17} Fe _{0.16} H _{1.83} K _{0.92} Na _{0.07} Si _{2.3} O _{7.83}	401.97	8.32
4	Kaolinite	9009230	Al ₂ H ₄ Si ₂ O ₉	258.15	31.05
5	Goethite	1008766	Fe O (O H)	88.86	9.22
6	Illite	9009665	Al ₄ K Si ₂ O ₁₂	395.19	8.05
7	Chlorite	9000158	H ₄ Mg ₃ Si ₂ O ₉	277.11	5.83
Totals					100

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Figure 6— XRD Studies of Rapur Clays(NABL accredited laboratory, Bangalore) Cont'd



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Elemental Table:

Elements	Element (wt %)	Crystalline Portion (wt %)	Amorphous Portion (wt %)
SiO ₂	50.65	32.52	18.13
Al ₂ O ₃	21.15	13.58	7.57
Fe ₂ O ₃	12.11	7.77	4.34
K ₂ O	1.41	0.91	0.50
MgO	0.94	0.60	0.34
TiO ₂	0.74	0.48	0.26
CaO	0.47	0.30	0.17
Na ₂ O	0.32	0.21	0.11
LOI	11.96	7.68	4.28
Others	0.25	0.16	0.09

Interpretation

Crystalline Fraction (64.20 wt%)

The crystalline portion is dominated by **silicate and oxide/hydroxide minerals**, particularly **Quartz (34.25%)**, **Kaolinite (31.05%)**, and **Muscovite (8.32%)**, which together explain the high **SiO₂ (50.65 wt%)** and **Al₂O₃ (21.15 wt%)** observed in the bulk chemistry.

Quartz represents the primary silica framework, forming a stable and inert matrix. Kaolinite (Al₂Si₂O₅(OH)₄) is the dominant clay mineral, indicating intense weathering or hydrothermal alteration. Muscovite and Illite together represent K-bearing aluminosilicate phases, accounting for **K₂O (1.41 wt%)**. Chlorite contributes minor Mg-bearing silicate content, consistent with **MgO (0.94 wt%)**.

Goethite (9.22%) is the principal Fe-bearing phase, explaining the presence of **Fe₂O₃ (12.11 wt%)**, and indicates oxidized iron conditions. Ulvospinel is a minor Fe–Ti oxide phase, contributing to both Fe and **TiO₂ (0.74 wt%)**.

This mineral assemblage clearly indicates a **silica–alumina rich clay-dominated system with iron oxide enrichment**, typical of weathered or lateritic environments.

Silicate / Clay Mineral Phases

- Quartz (34.25%) → Major contributor to SiO₂ (50.65 wt%), forming the siliceous framework
- Kaolinite (31.05%) → Dominant clay mineral, indicating strong weathering/alteration
- Muscovite (8.32%) + Illite (8.05%) → K-bearing aluminosilicates explaining K₂O
- Chlorite (5.83%) → Mg–Al silicate contributing to MgO

These phases confirm a **clay-rich aluminosilicate system**, typical of altered feldspathic or metamorphic precursors.

Iron-bearing Phases

- Goethite (9.22%) → Fe-oxyhydroxide phase explaining Fe₂O₃
- Ulvospinel (3.28%) → Minor Fe–Ti oxide phase contributing Fe and Ti

This indicates an **oxidizing environment**, where iron is stabilized as oxyhydroxides rather than sulfides.

Accessory / Minor Contributions

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Figure 6 — XRD Studies of Rapur Clays(NABL accredited laboratory, Bangalore) Cont'd



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- Ti is hosted in Ulvospinel
- Na (Na_2O 0.32 wt%) is partly accommodated in Illite/Muscovite
- CaO (0.47 wt%) is very low, indicating negligible carbonate phases

These confirm a **low-calcium, non-carbonate system** with minor accessory oxides.

Secondary / Amorphous Fraction (35.80 wt%)

The amorphous portion is relatively high and consists of poorly crystalline or non-crystalline materials such as:

- Amorphous silica / silica gel
- Clay precursors and disordered aluminosilicates
- Fe-oxyhydroxide gels (weathering products of iron phases)
- Bound water contributing to high **LOI (11.96 wt%)**

This reflects **intense chemical weathering and alteration**, leading to partial breakdown of crystalline minerals and formation of amorphous phases.

Potential Commercial Uses

Major Application	Industry
Quartz (Silica)	Glass, Ceramics, Foundry
Kaolinite (Clay)	Ceramics, Refractories, Paper coating
Iron oxides (Goethite)	Pigments, Cement
Aluminosilicates	Bricks, Tiles, Fillers

Probable Origin Assessment

The mineral assemblage indicates a **weathered aluminosilicate (clay-rich) system**, dominated by Quartz and Kaolinite with significant iron oxidation.

- Presence of Kaolinite → Strong chemical weathering (kaolinization)
- Goethite → Oxidizing, near-surface conditions
- Absence of sulfides → No primary sulfide mineralization
- High amorphous content → Advanced alteration and leaching

This suggests formation in a **lateritic or highly weathered residual environment**, possibly derived from feldspar-rich parent rocks such as granite or gneiss.

Final Results

- **Crystallinity:** 64.20%
- **Amorphous Content:** 35.80%

Major Mineral Phases:

Quartz, Kaolinite

Secondary Phases:

Muscovite, Illite, Goethite

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Figure 6 — XRD Studies of Rapur Clays(NABL accredited laboratory, Bangalore) Cont'd

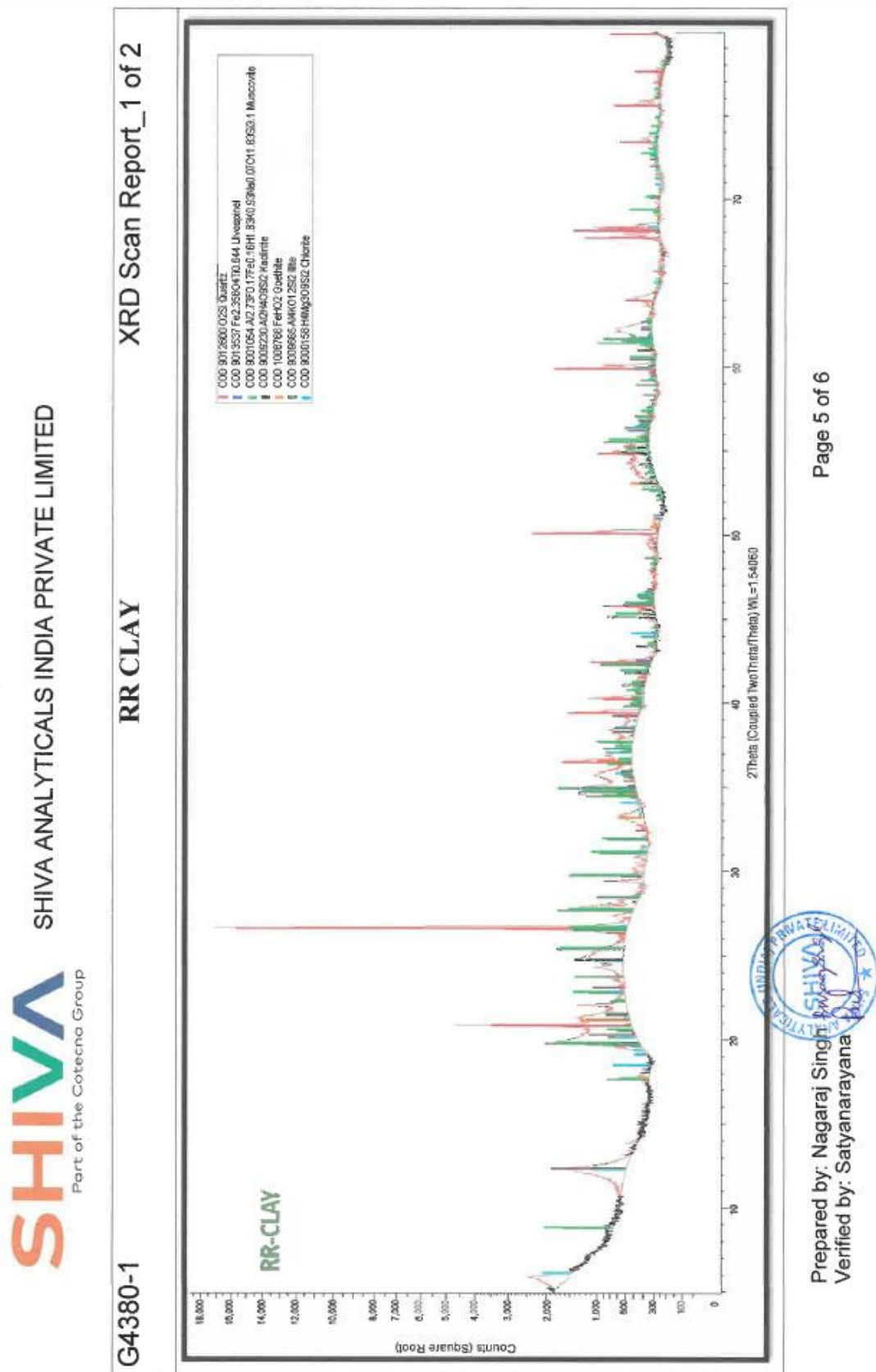
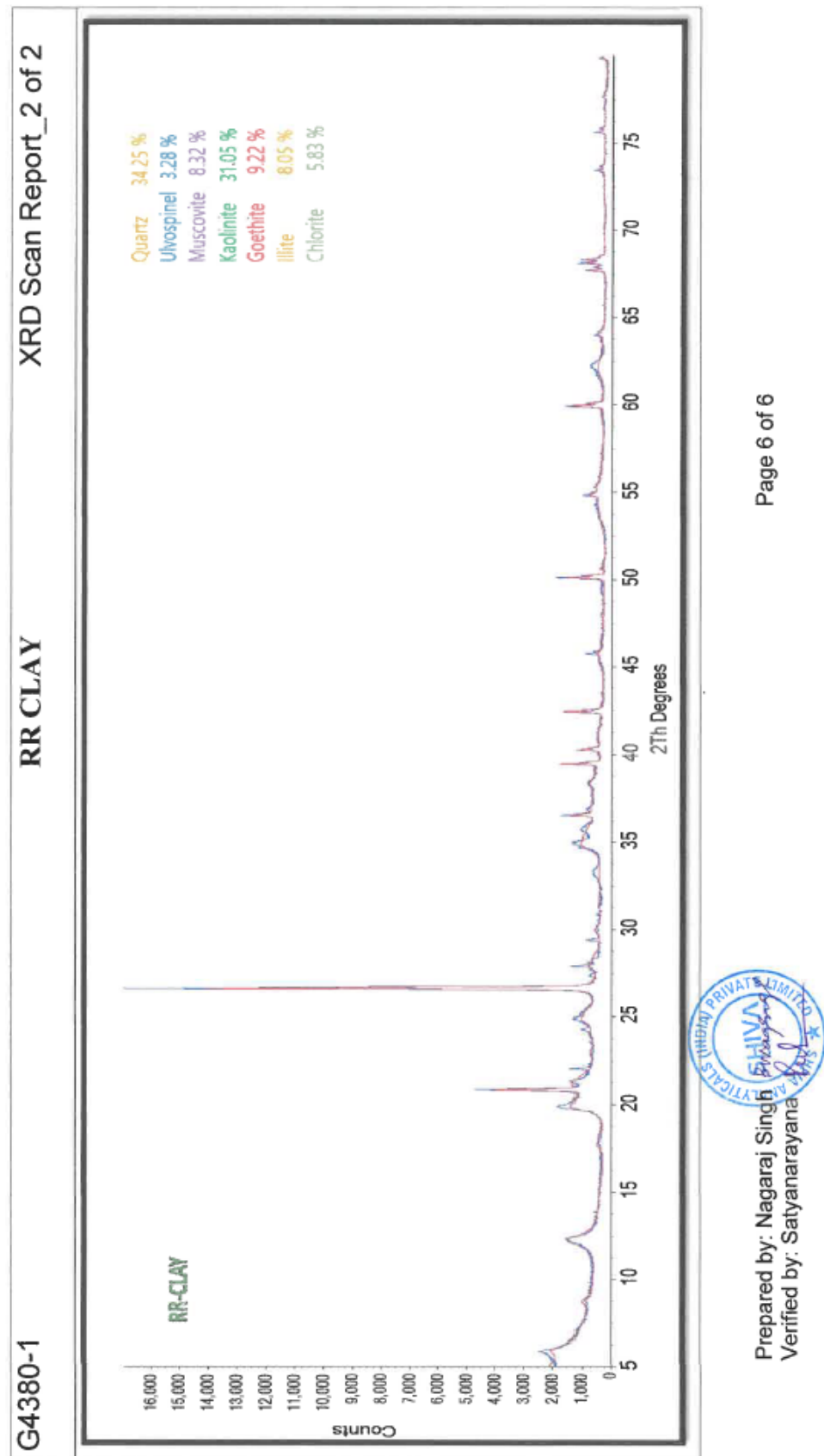


Figure 6 — XRD Studies of Rapur Clays (NABL accredited laboratory, Bangalore)



Conclusions from the Desorption Study

- Strong ion-adsorbed REE fraction is established for the regolithic clays of the Rapur area.
- High recovery potential — 30 to 70 % of REE are readily desorbable, typical of the Chinese IAC (ion-adsorption clay) type.
- Element behaviour: LREE — strong extraction; HREE — good response, recoverable and economically interesting.
- Ore grade is low-grade but leachable, with an Nd-rich IAC (Ion adsorbed clay) system and very low radioactive concerns.
- **Geological interpretation: the deposit qualifies as a true ion-adsorption clay (IAC) deposit and Warrants detailed Exploration.**

Scope for proposed exploration

The scope for proposed exploration extends but not limited to –

- Deciphering the detailed geological mapping of the Rapur granites and the inter relationship
- Delineation of the regolith and its vertical zonation
- Zone wise sampling and assay determination
- Geochemical Characterization and ionic mobility of various REE ions
- Ore body determination and resources estimation

2. Previous Work

Previous work in the environs of the Rapur block dates back to the pioneering studies of King (1880, 1881) and Foote (1879). Later, Roy (1956) mapped the geology of the Nellore Schist Belt and elucidated its economic potential. Kaila et al. (1979) carried out a geophysical survey and proposed a tectonic model. Several workers from the GSI have undertaken mineral-commodity explorations in different parts of the Nellore Schist Belt (for details of the classical works, please refer to Ramakrishnan & Vaidyanathan, 2010). Geospatial scrutiny of the proposed block has been completed. The Toposheet does not indicate any RF/PF/ Sanctuary/National Reserve Forest; but PM Ghatisakti portal could not be accessed. Geochemical map available from NGDR portal does not indicate any significant geochemical anomaly relevant to ionic REE in stream sediment samples; however, the database shall be evaluated during the present work progress. Ground geophysical map on magnetic, gravity5M, bouguer anomalies available from NGDR portal shall be assessed in due course and taken cognisance during the stage of GP data augmentation of the present G4 exploration. Airborne geophysical data relevant to the Rapur block and its environs (block-11) shall be reviewed as necessary. Geophysical legacy data is awaited heliborne data of the Atomic Mineral Directorate are not available.

A detailed thematic study of the Rapurgranitoids was undertaken by Meshram and Dharme (2014). Geochemical analysis including REE abundance was reported by Jeelani et al. (2016) of the Central University of Karnataka in collaboration with the GSI — and forms the basis of the present study in the Rapur Block. Previous mineral exploration data in Rapur block and adjoining areas are not available from the study of the NGDR portal. However, some information is available on Barytes, mica, copper, phosphorite, Dimension stone from the fringes of Rapur block (Ref no. GSI, SRO/06456-1975/ 00614-1962/ 16375-2022/ 10967-1982/ 12360-1993;

Observation and Recommendation of Previous Work

- It has been established that the Rapur area contains granitoids and Dioritic rocks (Srinivasan and Roopkumar, 1995) & (Meshram and Dharme, 2014).
- Anomalous REE values are reported from granitoids rocks of Rapur area (Jeelani et al 2016).
- The Atomic Minerals Directorate for Exploration and Research (AMD) has investigated the Rapur granites in the Nellore District, Andhra Pradesh, as part of its mandate to identify Rare Earth Elements (REE) and rare metal (RM) resources. The Rapurgranitoids are characterized by high concentrations of Light Rare Earth Elements (LREE). They typically display pronounced negative Europium (Eu) anomalies and carry LREE-rich accessory minerals, including allanite, monazite, and fluorapatite.
- The MEC database does not indicate any overlapping work
- The APMG has indicated no overlapping work and indicated that the addition of new information is welcome in the state of Andhra Pradesh.

S.N.	Agency	Comment
1	GSI	There is no ongoing exploration project for REE within the proposed NPEA area. The proposed NPEA block was covered by STM work during FS 2012-14. Exploration activity has not been done. The area may be feasible for further exploration.
2	AMD	AMD has carried out reconnaissance exploration (G-4 stage) in and around the proposed block for uranium in different phases. Significant surface radioactive zones were delineated along Nagayarpalle Venkataramarajupeta. AMD does not have baseline / exploration data on the commodity mentioned. In view of known potentiality for uranium in the area, analysis of uranium may be included in the list of elements to be analyzed.
3	MECL	No overlapping with the ongoing or completed blocks of MECL.
4	DGM	No active projects in the proposed area. Geological and geochemical evidence supports REE exploration. No leases or licenses exist in the proposed block.
5	NMEDT	Overlapping with Eco Sensitive Zone (PM Gatishakti). No NMEDT funded block in and around the proposed area as per NGDR Portal.

3. Block description Boundary Coordinates

Latitude (Northern)	14° 07' 59.73" N to 14° 11' 55.82" N
Longitude (Eastern)	79° 29' 30.47" E to 79° 31' 40.59" E
Localities	Rapur, Kaljigudem, Vellampalli, Velikallu, Tirupati, Althurupadu
Tehsil / Mandal	Rapur Mandal
Districts	SPSR Nellore & Tirupati Districts
State	Andhra Pradesh

Block Corner points / Cardinal points

ID	Latitude (N)	Longitude (E)
1	14°11'12.93"N	79°30'15.94"E
2	14°11'21.38"N	79°32'5.04"E
3	14° 7'56.31"N	79°31'49.81"E
4	14° 7'54.82"N	79°29'28.28"E
5	14° 9'16.57"N	79°29'28.67"E

4. Planned Methodology.

(Exploration Methodology for I-REE deposits, RAPUR BLOCK by Midwest Limited :)

Mode of occurrence: Exploration for **ionic rare earth element (REE) deposits** (also called **ion-adsorption clay deposits**) differs from exploration for hard-rock REE deposits because the valuable rare earth elements are weakly adsorbed onto clay minerals rather than occurring mainly in discrete minerals. The proposed exploration Methodology includes

a. Regional Geological Studies (Geological aspects)

Its objectives include identifying area with favourable geology. These include 1) deeply weathered granitic rocks in Warm, humid tropical to subtropical climates. 2) Thick weathering profiles 3) Low-relief hills and uplands. 4) Presence of kaolinite, Halloysite, and illite-rich clays

b. Remote sensing and regional geological maps are often used to identify favourable weathered terrains. It includes a) Landsat program b) Sentinel-2 c) Hyperspectral imagery d) Digital elevation models (DEMs) to identify i) Weathering intensity, ii) Clay-rich zones, iii) Drainage patterns iv) Vegetation anomalies v) Surface alteration

c. Geophysical Studies (Resistivity Profiling)

The data base available in GPDR Profile will be studied, then Resistivity profiling will be undertaken to estimate the Weathered zone thickness and it's Vertical / Lateral variations.

d. Weathering profile Logging

Each drill hole will be logged carefully to determine the typical profile and its REE content. With focus on 1) Topsoil 2) Laterite 3) Clay Horizon 4) Saprolite 5) Weathered Granite 6) Fresh Granite

e. Geochemical Sampling (Sample Media, Sample length & Sample collection)

This is the most important exploration method.

Previous data available on NGDR portal will be assessed. The present study includes: -

Sample Media:

1) Soil samples 2) Saprolite samples obtained from soft rock drilling, manual pits, & Stream sediment sampling.

Sample length and collection: In Borehole the sample interval is based on Regolith Profile. Else it should be at an interval of 1m. Sample collection is for the entire core length; core splitting will be done as required; one half will be preserved for future reference. In case of Grab sample, it is Regolith zonal specification.

f. Drilling

Drilling defines the deposit. It is done through the Diamond core drilling in shallow boreholes. The proposed drill spacing at G4 level Exploration is 1.5 km. Method of Drilling will be by coring method or as appropriate based on the above mentioned studies and Reconnaissance field visits. **The authors have recently (3rd - 6th August 2026) conducted regolith thickness evaluation which indicates the core drilling of soft rock is appropriate method.**

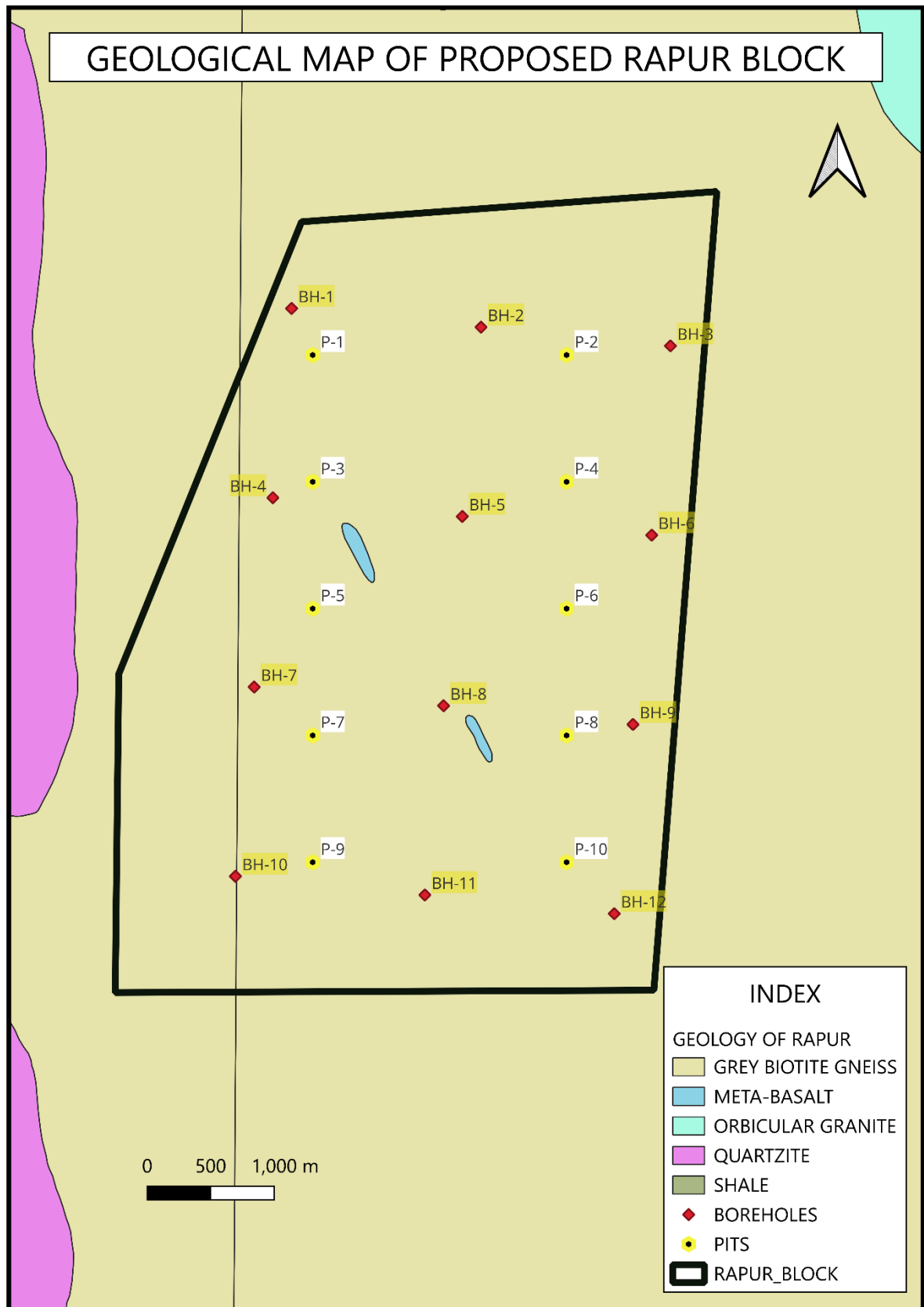


Fig 7- Geological map of Rapur block (NGDR Portal) with Borehole and Pit Locations

g. Pitting: A total number of 10 pits of 5-meter depth each will be executed. Pits will be backfilled after collecting the sample. The location of the pits will be on in-fill mode. An outline map showing the location of pits is shown in Fig- 7.

h. Analytical Studies: The samples collected in field will be processed and treated in the In-House laboratory set up by the Midwest Limited (Fig-9). Sample treatment is aimed at the estimation of desorption process on the guidelines of South Chinese deposits.



Fig-8: A glimpse at the Facilities Available for Sample Preparation in In-House Laboratory, Hyderabad (Laboratory Work Flow by arrows).

Advanced Laboratory studies for REE determination will be conducted in the **Midwest Limited** itself for the determination of Total rare earth elements (TREE); Individual REEs (La–Lu); Yttrium; Scandium; Major oxides; pH; Clay mineralogy. The Equipment for Analytical techniques includes.

- Inductively Coupled Plasma Mass Spectrometry (ICP-MS) or
- Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES)
- X-ray Fluorescence and also conventional methods as ap.

- Scanning Electron Microscope
- X-Ray Diffraction

Analytical Results for reproducibility and Repeatability will be tested in the Third Party Analytical Laboratory (NABL Accredited)

Portable XRF will be used for rapid field identification but scope is limited on sensitivity concerns.

i. Mineralogical Investigations

Understanding the host clay minerals is essential in the exploration of I-REE.

Common investigation methods include:

- X-ray Diffraction
- Scanning Electron Microscopy
- Electron Probe Micro-Analyser

To determine 1) Clay mineral types 2) Degree of weathering 3) Distribution of REEs 4) Presence of unwanted minerals/ elements

j. Sequential Extraction Tests

This is a defining feature of exploration for ionic REE deposits. The goal is to distinguish:

- Ion-exchangeable REEs (economically recoverable)
- Mineral-bound REEs
- Residual REEs

Common leaching reagents include:

- Ammonium sulphate
- Magnesium sulphate
- Ammonium chloride

These tests estimate the proportion of REEs that can be recovered by simple ion-exchange leaching.

k. Metallurgical Testing

Bulk samples are tested to determine:

- Leaching efficiency
- Acid consumption
- Ammonium salt consumption

- Impurity dissolution
- Recovery of heavy versus light REEs

Typical recoveries vary depending on deposit characteristics and the proportion of exchangeable REEs.

I. Environmental Baseline Studies

Because ionic REE mining commonly uses in-situ or heap leaching, environmental studies begin early.

Baseline investigations include:

1)Surface water quality2)Groundwater quality3) Soil chemistry 4)Biodiversity 5) Acid-base characteristics 6) Natural background concentrations of trace elements.

5. Nature, Quantum and Target

S.NO	Description and Nature of Work	Quantum / Target
•	Aerial Survey : Remote-Sensing & Imagery Studies (out sourcing work)	25 km ²
•	Geological Survey: 1:12,500 scale Assessment of lithology, structure, surface mineralization and analysis of the old history of mining, if any. (In-House)	25 km ²
•	Geochemical Survey : Regional Grab/ Chip/ Stream sediments/ Soil sampling Broad Geomorphology, Drainage (In-House)	25 km ²
•	Geophysical Survey : Resistivity Survey (Out sourcing)	17 L.km
•	Pitting: (Dimension 1 × 2 × 2 m). Spacing will be planned in a representative way. (In-House)	100 Cu.m in 10 nos. of pits
•	Soft rock Drilling (in metres) 240 m (Out sourcing)	Total 240m
•	Grab and chip sample (In-House)	Total 50 No's
•	Core sample (In-House)	240 no's
•	Petrographic and Mineragraphic studies (Out sourcing)	5 no's Principal rock types, mineral assemblage, identification of minerals of interest.
•	Synthesis of all available data (In-House)	• Integration of regional geophysical, geological and geochemical data. • Synthesis of all available data and Report writing

Borehole spacing (as per MEMC 2015)

Total Number of Boreholes	12 Nos.
Borehole Depth	20 m each
Borehole Interval	1.5 km × 1.5 km grid
Total / Cumulative Metrage	240 m
Type of Drilling	Soft rock Drilling by coring
Source	In-house / Outsourcing

Geophysical Studies

- REE & RM (Regolith based) – Resistivity method

6. Manpower Deployment

- Two Senior Geologists.
- Two Junior Geologists.
- Two Chemists.
- Two labourers per team (4 labourers in total).
- One Sampler with two labourers for sample collection and preparation.

7. SUMMARY OF EXPENDITURE

Cost Estimate for Reconnaissance Survey (G4) of Rapur Block, SPSR Nellore & Tirupati Districts, Andhra Pradesh

S.No.	Item	Cost Estimate (₹)
A	Geological Work	31,28,964
B	Survey Work	2,88,000
C	Soft rock Drilling by coring (12 boreholes ; 20m each)	18,13,200
D	Laboratory Studies & Petrological Studies	39,32,760
E	Preparation of Project Proposal	1,83,258
F	Preparation of Final Geological Report	2,50,000
	Sub-Total (without GST)	96,26,182
	Add: 18 % GST	17,32,713
	TOTAL PROJECT COST	1,13,58,895

8. BREAK-UP OF EXPENDITURE

Estimated cost for Reconnaissance survey (G4) for Ionic – Rare Earth Element (i-REE) in Rapur Block, SPSR Nellore & Tirupati Districts, Andhra Pradesh						
S.No.	Item	Unit	SOC S.No.	Rate (₹)	Quantum	Total Amount (₹)
A. Geological Work						
1	Geological Mapping (1:12,500)	per sq. km	1.1	18,300	25	4,57,500
2	Geologist (HQ) days	day	1.2.1a(a)	10,500	30	3,15,000
3	Satellite imagery/Aerial photo interpretation studies – Charges for procurement of imageries.		5.5.1a	0	0	0
4	Charges for Geologist per day (Field) for geological mapping & trenching work, drilling work	day	1.2.1a(b)	14,500	90	13,05,000
5	Excavation of Pit up to 2.0 m depth with back filling	per cu.m	2.1.2	4,725	40	1,89,000
6	Excavation of Pit between 2.0 m to 5.0 m depth with back filling	per cu.m	2.1.3	6,662	60	3,99,720
7	Sample processing work including marking of samples, core splitting, crushing and powdering of samples, coning and quartering, packing & labeling of samples, preparation of beneficiation samples etc.	per day	1.2.1.b	7,850	36	2,82,600
8	Labour for sampler	day	5.8	556	144	80,064
9	Labour for Geologist field work	day	5.8	556	180	1,00,080
	Sub-Total — A					31,28,964

B. Survey Work

1	Demarcation of lease boundary; fixation, coordinates & RL of boreholes by DGPS (incl. labour)	Per point of observation	1.3.2	24,000	12	2,88,000
	Sub-Total — B					2,88,000

C. Core Drilling (Outsource)

1	Drilling in Soft Rock	per m	2.2.1.1c	5,500	240	13,20,000
2	Tendering process cost		5.9	26,400		26,400
3	Technical Supervision cost		6			1,32,000
4	Drill-core preservation	per m	5.3	1,590	120	1,90,800
5	Construction of concrete Pillar (12"x12"x30")	per borehole	2.2.7	2,000	12	24,000
6	Borehole plugging by cement	per borehole	2.2.8	10,000	12	1,20,000
	Sub-Total — C					18,13,200

D. Laboratory Studies

1	Analysis of one rock/soil sample for quantitative analysis of 14 REE elements + 9 trace element by ICP-MS (sequential technique)	per sample	4.1.15	7,400	250	18,50,000
2	Analysis of one rock/soil sample for quantitative analysis of 14 REE elements + 9 trace element by ICP-MS (sequential technique) – Check sample 10%	per sample	4.1.15	7,400	25	1,85,000
3	Major oxides (WD XRF) – (oxides + traces – 24 elements)	per sample	4.1.17a	4,200	20	84,000
4	Major oxides (WD XRF) – (oxides + traces – 24 elements) (check	per sample	4.1.17a	4,200	2	8,400

	samples)					
5	Preparation of standard thin sections — 10 sections per sample	per sample	4.3.1	500	10	5,000
6	Complete petrographic / ore-microscopic / Mineragraphic studies	per sample	4.3.4	2,800	5	14,000
7	XRD analysis	per sample	4.5.2	4,000	10	40,000
8	Complete Laboratory Scale Mineral Processing investigation involving studies for recovery of ore mineral by various physical beneficiation methods	per sample	4.7.5	4,36,590	4	17,46,360
	Sub-Total — D					39,32,760
	TOTAL (A + B + C + D)					91,62,924
E	Preparation of Exploration Proposal — soft copy		5.1	1,83,258		1,83,258
F	Geological Report — soft copy		5.2 ii			2,50,000
G	Peer review Charges		As per EC decision	30,000		30,000
H	Project Cost (without GST)					96,26,182
	Add: 18 % GST					17,32,713
	TOTAL PROJECT COST (in ₹)					1,13,58,895
	Total Cost in Lakhs (₹)					113.59

9. TIMELINE

The proposed exploration programme will be executed over a 10-month period as per the schedule below. The number of days against each activity will be adjusted on a pro-rata basis against the days indicated, as per the convenience and suitability of field operations.

Note: Shaded cells indicate the months in which the activity is planned. Total man-days are indicated in the rightmost column.

Timeline for Reconnaissance survey (G4) for Ionic – Rare Earth Element (i-REE) in Rapur Block, SPSR Nellore & Tirupati Districts, Andhra Pradesh															
S.No.	Particulars	Months/ Days	1	2	3	4	Review	5	6	7	8	Review	9	10	
1	Camp Setting														
2	Geological Mapping, Pitting and trenching														
3	Topographic Survey														
4	Core Drilling														
5	BH core Sampling														
6	Camp winding														
7	Laboratory Studies														
8	Report Compilation & Submission														

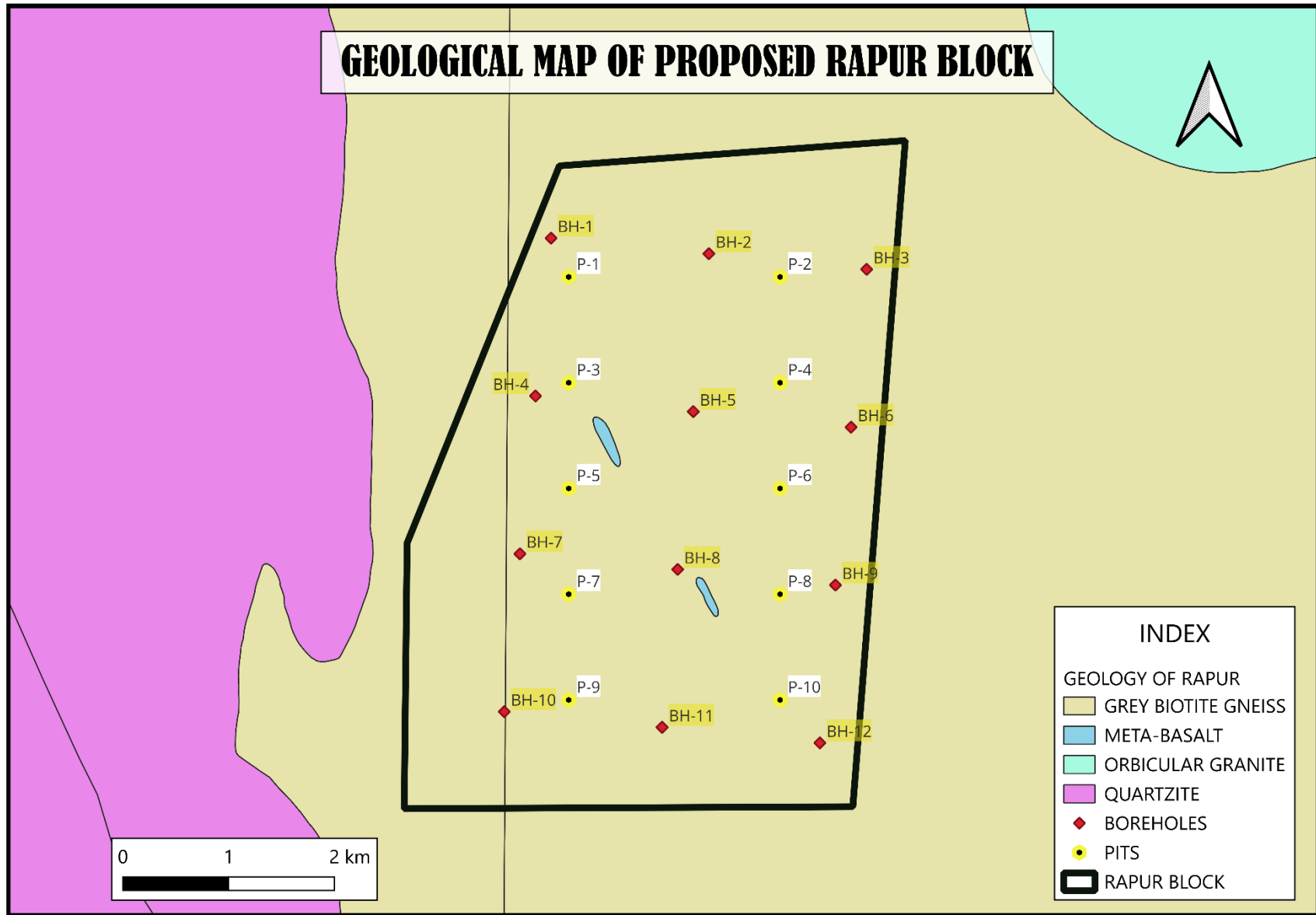
10. SELECTED REFERENCES

- Chen, Z., Zhang, Z. and Chi, R. (2020). Leaching process of weathered crust elution-deposited rare-earth ore with formate salts. *Frontiers in Chemistry*, 8, 598752.
- Jeelani, S.H., Lingadevuru, M., and Mitra, S.K. (2016). Petrology and Geochemistry of the Granitoids occurring within the Nellore Schist Belt, Rapur area, Nellore District, Andhra Pradesh. *Journal of Applied Geochemistry*, V. 18 (2), pp. 170–180.
- Lakshminarayana, G. and Raghava Reddy, K. (2026). I-Rare Earths: A New Facet in the Exploration and Exploitation of REE Minerals — A Way Forward in India. *Mining Engineers Journal*, Vol. 27, No. 6, pp. 25–29.
- Meshram, T. and Dharme, R.G. (2014). Systematic thematic mapping of granitoids in the southern part of the Nellore Schist Belt, Rapur area, Nellore and Cuddapah districts — Final Report for Field Seasons 2012-13 & 2013-14. Geological Survey of India (Unpublished), 107 p. (available on the GSI portal).
- Mitra, S. J., Meshram, t. AND Rajani, G. Uraninite associated with Thorite and REE minerals in the younger granites of Rapur area, Nellore district, Andhra Pradesh. *National Conference on Earth Sciences in India Challenges and Emerging Trends (ESICET- 2013.)* pp. 58-60.
- Ramakrishnan, M. and Vaidyanathan, R. (2010). *Geology of India, Vol. I — A publication of the Geological Survey of India.*
- Ruan Chi and Jun Tian (2008). *Weathered Crust Elution-Deposited Rare-Earth Ores.* Nova Publishers, 298 p.
- Srinivasan, K.N. and Roopkumar, D. (1995). Orbicular structures from a diorite within the granitoid complex of the Nellore Schist Belt. *Journal of the Geological Society of India*. DOI: 10.17411/jigs/1995/450304.
- Wang, D-H., Zhao, Z., Yu, Y., Dai, J-J., Zhao, T., and Liu, L-J. (2018). Exploration and Research Progress on Ion-Adsorption Type REE Deposits in South China. *China Geology*, V. 3, pp. 415–424.

List of Plates

- Plate 1: Geological Map on 1:50000 with sample location index.
- Plate 2 Proposed Rapur block and its Environs Google satellite imagery
- Plate 3: Proposed Rapur block boundary over topographic Map

Plate 1: Geological Map on 1:50000 with Sample location index studied by the Midwest.



Plates 2: Proposed Rapur block and its Environs from the Google Satellite Imagery

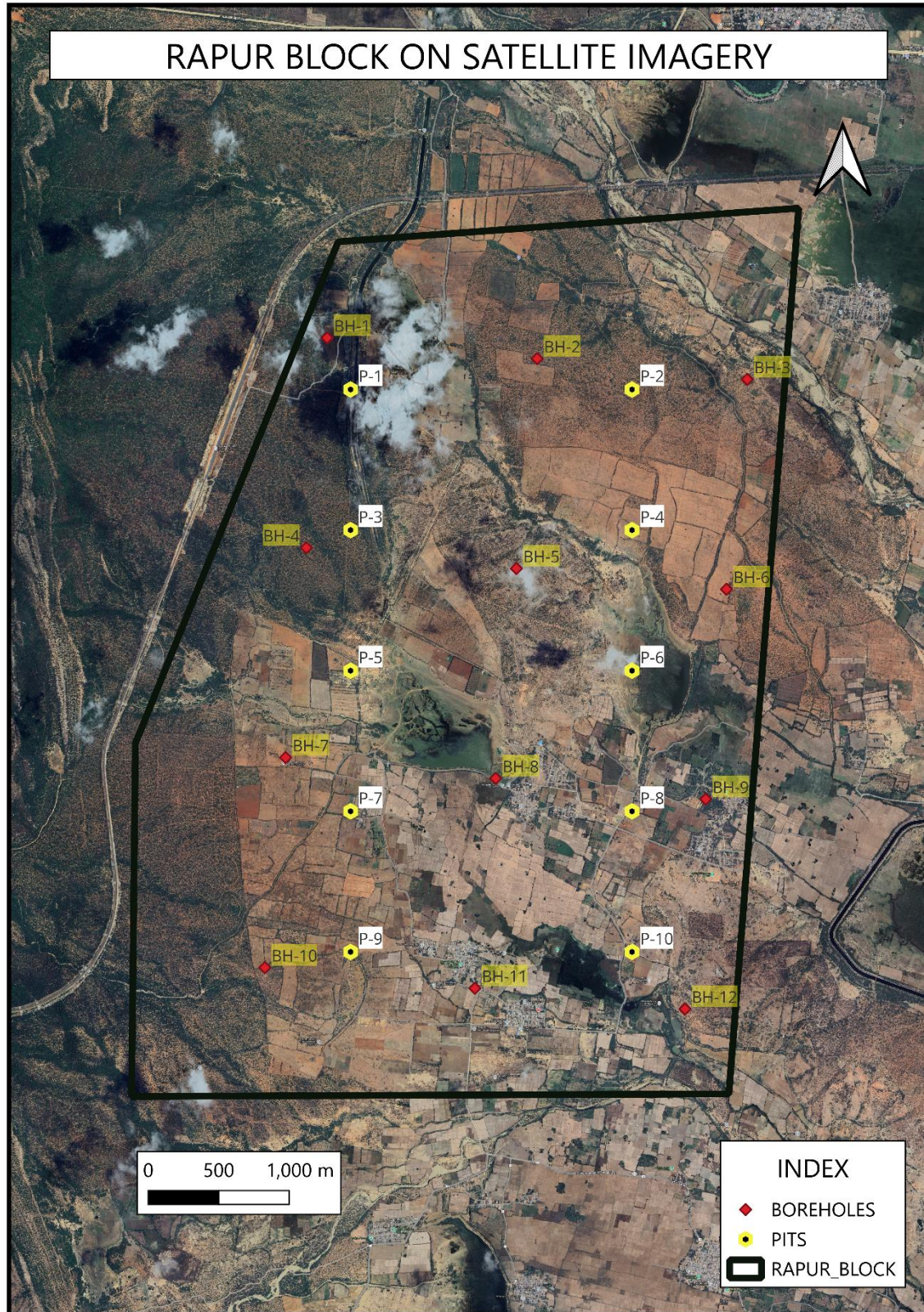
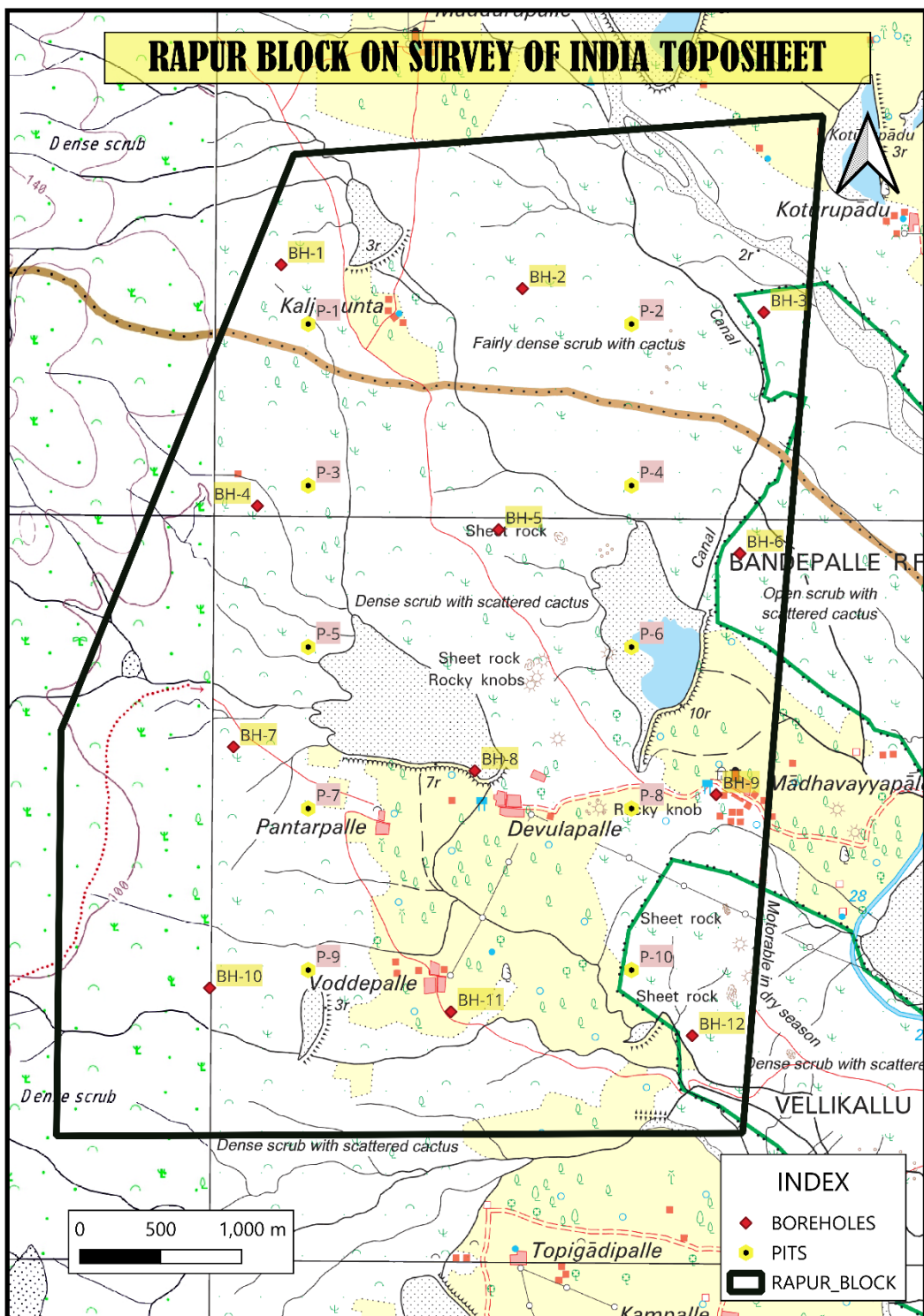


Plate 3: Proposed Rapur block boundary over topographic Map



***** END OF PROPOSAL *****