OFFICE OF THE COMMISSIONER OF GEOLOGY & MINING
INDUSTRIES & MINES DEPARTMENT
GUJARAT STATE

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No: CGM/EXPL/NMET-bhuj-clay/882/23-24/1128 Date- 23/08/23

To,
Director,
National Mineral Exploration Trust
Ministry of Mines,
F-114, Shastri Bhawan,
New Delhi-110001

Subject: Submission of detailed proposal for REE exploration in Bhuj Clay prospect Block reports for NMET funding.

Reference: 1) Geovale Services Pvt. Ltd. email dated 13.08.2023.

Respected Sir,

With respect to above mentioned subject and reference, Geovale Services Pvt. Ltd, Notified Private Exploration Agencies (NPEA), has submitted detailed project reports for REE exploration in Bhuj Clay minerals vide reference to this office. The same is mentioned below:

1. Proposal for REE exploration in Bhuj Clay prospect Block, Kachchh district, Gujarat State (G4 Stage).

We would like to submit the same under sub-section 5 of section -9C of the MMDR Act-2021 for NMET funding.

Thank you.

Your Faithfully,

Nodal officer, NMET
Geology and mining,
Gujarat State, Gandhinagar

Enclosed: As above

Copy to: Joint secretory, Industry and mine department, New Sachivalay, Gandhinagar

Proposal for REE Exploration in Bhuj Clay Prospect Block, Kachchh District, Gujarat (G4 Stage Reconnaissance Survey) under NMET

(REE)

By

Geovale Services Private Limited

Place: Kolkata

Date: 14th August 2023

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Summary of the Block for Reconnaissance Survey (G4 Stage)

GENERAL INFORMATION ABOUT THE BLOCK

Sl. No.	Features	Details
1	**Block ID**	**GSPL/NMET/GUJARAT/2023/BLOCK-05**
2	**Exploration Agency**	Geovale Services Private Limited
3	**Block Name**	Bhuj Clay REE Prospect Block
4	**Commodity**	HREE and LREE
5	**Mineral Belt**	Clay horizon near Katrol Fault and median high
6	**Completion Period to complete the project**	14 months
7	**Objectives**	1. To assess the exploration target potential for HREE and LREE in the clay horizons of Kachchh area. 2. To identify the source of the HREE and LREE element in the stratigraphic succession.
8	**Whether the work will be carried out by the proposed agency or through outsourcing and details thereof.**	The exploration will be carried out by the proposed agency. Some elements of the exploration program like drilling, some geophysical and geochemical activities will be outsourced under supervision of Geovale's geoscientists.
9	**Name/ Number of Geoscientists**	Max.9 and Min. 4 geologists in different stages
10	**Expected Field days (Geology) Geological Party Days**	Total man-days: 402 (Geol. Field, HQ, Other and sampler days) Man-days for field work: 270 man-days. No. of field days: approximately 170 days.
11.	**Location**	*Figure 1*
a.	Latitude	Between 23.2325° N to 23.0497° N
b.	Longitude	Between 69.5012° E to 69.7512° E

Sl. No.	Features	Details
c.	Villages	Bhuj, Sukhapur, Kukuma, Naranpar, Surajpur, Kera, Reha Nana, Naranpar, Dahisara etc.
d.	Tehsil/ Taluk	Bhuj
e.	District	Kachchh
f.	State	Gujarat
12.	**Area (hectares/ square kilometers)**	
a.	Block Area	518.2 sq. km.
b.	Forest Area	Around 98.44 sq. km. (~19%) as per the LULC map (*Figure 2*). However, actual status of forest boundaries is not known.
c.	Government Land Area	Information not available in public domain
d.	Private Land Area	Information not available in public domain
13.	**Protected area**	The block does not fall under any Sanctuaries or National Park.
14.	**Accessibility**	
a.	Nearest Rail Head	Bhuj Railway station
b.	Road	SH-42, SH-47, SH-48 (*Figure 3*)
c.	Airport	Bhuj airport
15.	**Hydrography**	*Figure 3*
a.	Local Surface Drainage Pattern (Channels)	Dendritic and Rectangular drainage with localized radial orientations
b.	Rivers/ Streams	Bhubhi or Ganga Nadi, Nagmati, Khari river etc.
16.	**Climate**	
a.	Mean Annual Rainfall	~424 mm
b.	Temperatures (December) (Minimum) Temperatures (June) (Maximum)	Minimum – 2° to 3° C Maximum – 45° to 46° C
17.	**Topography**	
a.	Toposheet Number	41E/12 (*Figure 1*)

Sl. No.	Features	Details
b.	Morphology of the Area	Undulating topography with two east west trending hill ranges separated by low valleys (*Figure 4*).
18.	**Availability of baseline geoscience data**	
a.	Geological Map (1:50K/ 25K)	1:50K map is available (*Figure 5*)
b.	Geochemical Map	KGCMP data are available (*Figure 6, 7*)
c.	Geophysical Map (Aeromagnetic, ground geophysical, Regional as well as local scale GP maps)	Not available

Block Description:

The proposed block and the adjacent area in Bhuj encompass SOI toposheet numbers 41E/7, 41E/11, and 41E/12. According to the KGCMP data, these three toposheets all show high values of both HREE and LREE. However, toposheet no. 41E/12 show the consistently high REE values. Hence, the most prospecting area of SOI toposheet 41E/12 is proposed for REE exploration.

This block is mainly occupied by Mesozoic (Jurassic) sediments in the northern part and younger Deccan basalt in the southern part of the block. There are three major streams (the Nagmati Nadi, the Bhubhi or Ganga Nadi and the Khari river) and their tributaries flowing through the area (*Fig.1, 3*). Study of remote sensing data (SRTM) reveals that 244 sq. km. area out of total 518 sq. km. is crops out as high relief areas whereas the rest of the area is of low relief comprising either bedded sedimentary deposits (Jurassic?) or Quaternary alluvium covers (*Fig.4*).

Boundary Coordinates:

Figure 1

Boundary Corner Points	Latitude	Longitude	Boundary Corner Points	Latitude	Longitude
A	23.2325	69.5012	B	23.2316	69.7511
C	23.0497	69.7502	D	23.0497	69.4985

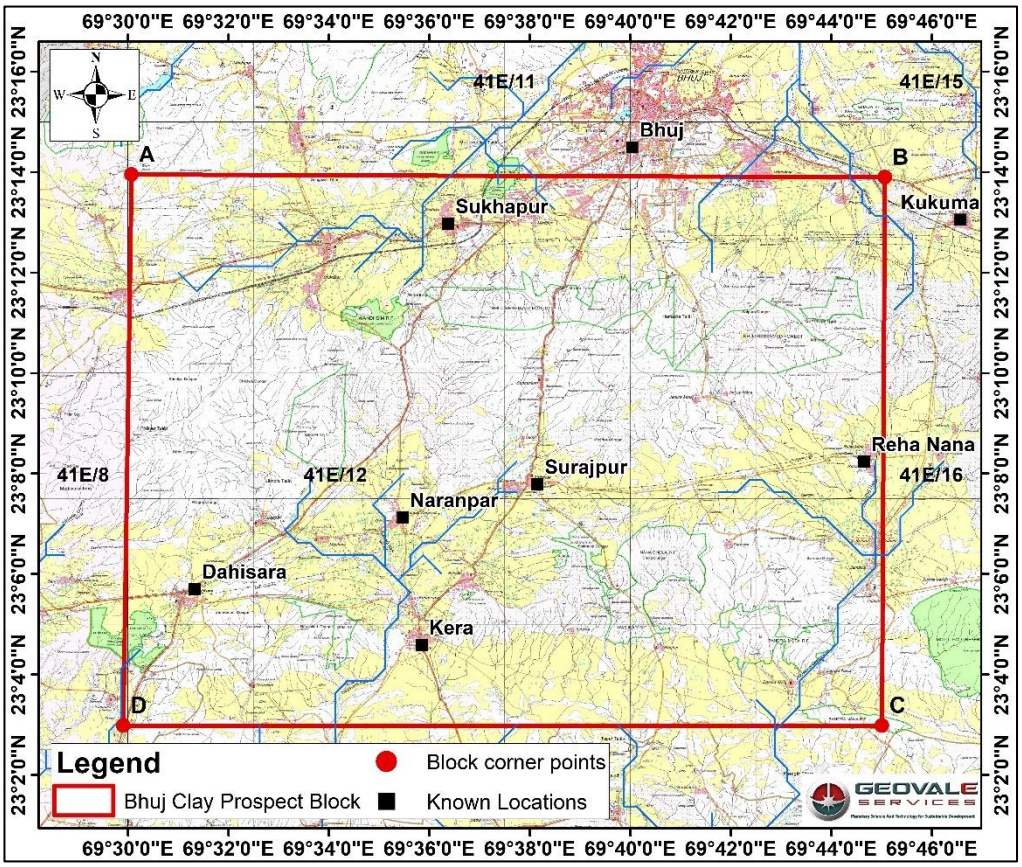


Figure 1 Spatial limit of the Bhuj Clay REE Prospect Blockon SOI toposheet no. 41E/12.

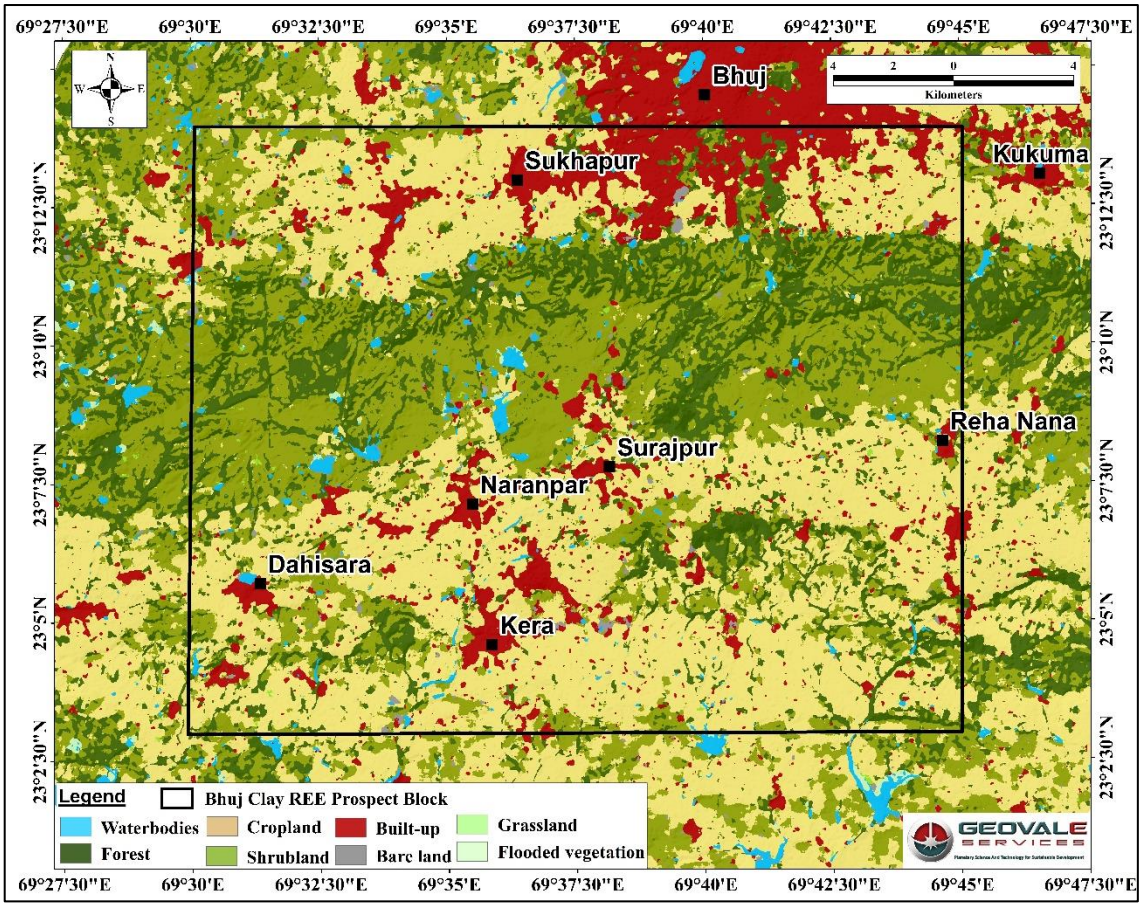


Figure 2 Land-Use Land-Cover (LULC, 2022) map of the Bhuj Clay REE prospect Block.

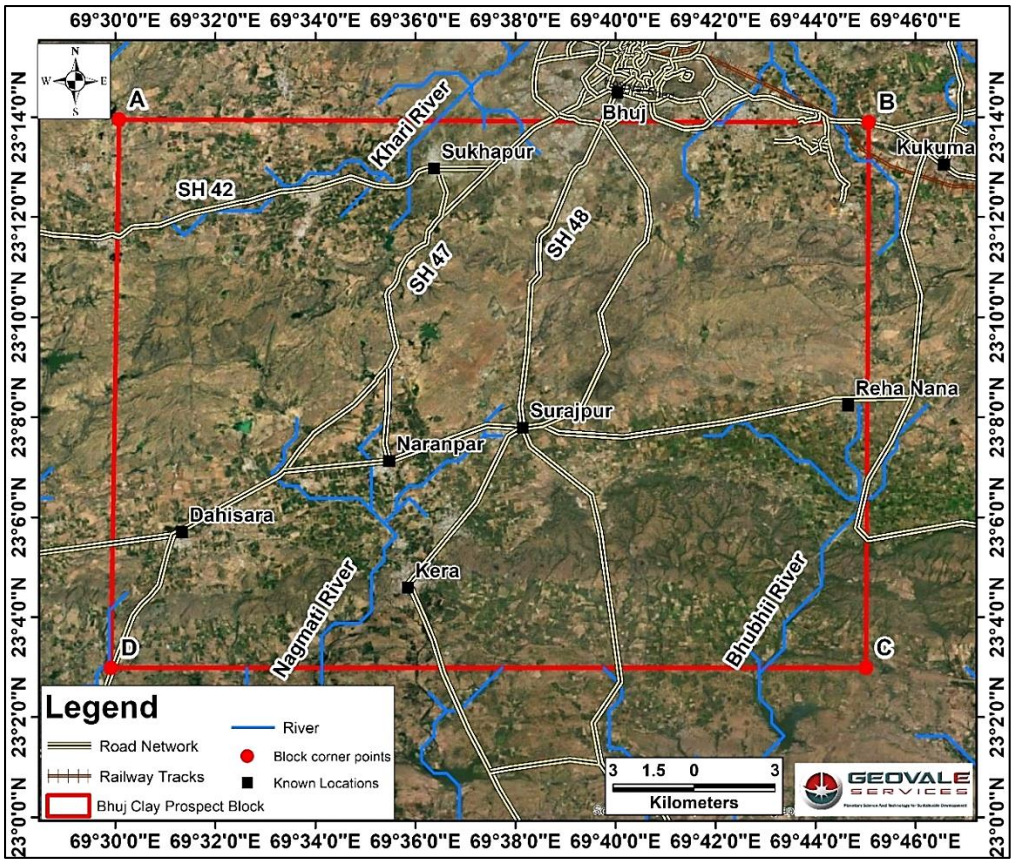


Figure 3 Accessibility map including the road and river network of the Bhuj Clay REE prospect Block.

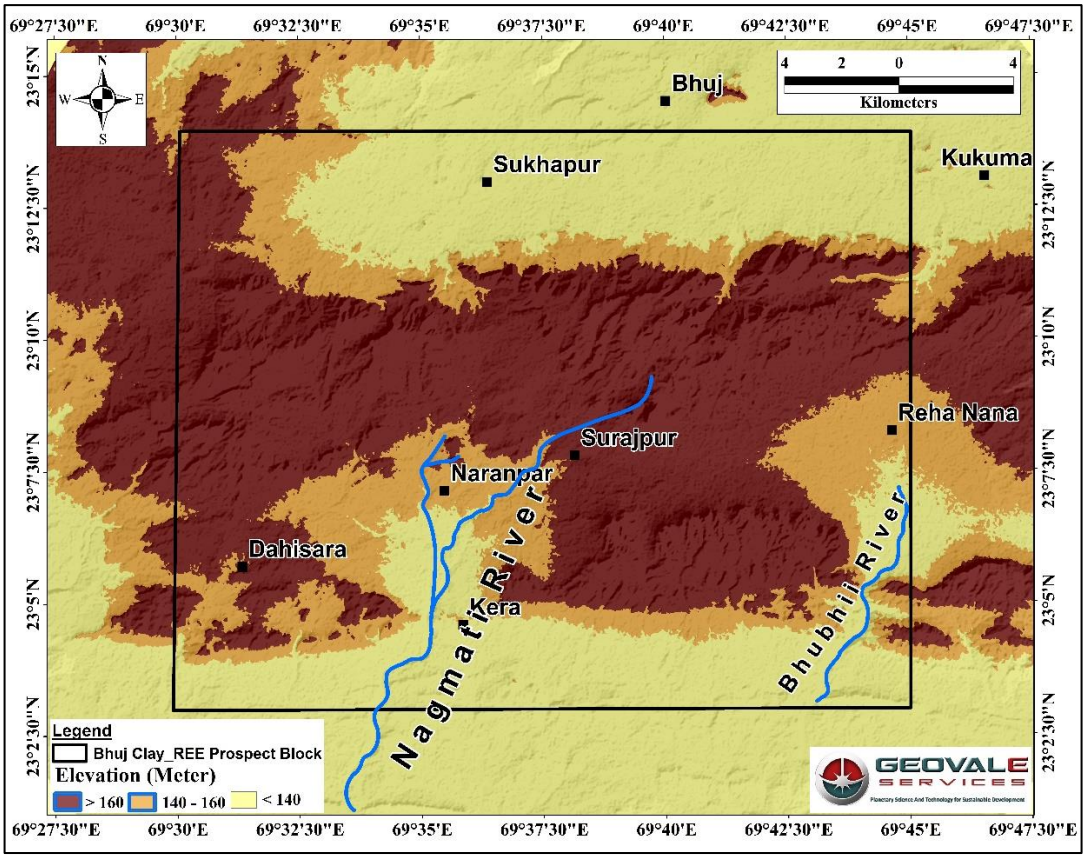


Figure 4 Relief map of the Bhuj Clay REE Prospect Block.

DETAILED DESCRIPTION OF THE BHUJ CLAY REE PROSPECT BLOCK

1. Physiography

Physio-graphically the targeted study area belongs to the central part of the Kachchh Mainland and topographically it can be distinguished by gently sloping plains with two major hill ranges, running primarily in an east-west direction (*Fig. 2, 4*). Both the ranges are characterized by very steep northern, free and gently sloping southern flanks with general elevation ranging between 160 to 200 mt. above MSL of the northern range, whereas the southern range varies between 180 to 270 mts above MSL. The low-lying plain between the two mountains has a general gentle easterly slope with height varying between 140 and 160 meters above the MSL. Both the northern hill ranges and central northern plains are occupied by sandstones and shales and other rock types belonging to Mesozoics whereas the southern hills and slopes of southern hills are covered by Deccan Trap lava flows.

There are three main rivers in the study area, viz. the Nagmati Nadi, the Bhubhi or Ganga Nadi and the Khari river flowing southward (*Fig. 3*). The major drainage system in the region is directed either towards north or south and is dominantly characterized by rectangular and dendritic drainage with very localized radial drainage pattern. (*Fig. 3*).

2. Background Geology (Regional Geology, Geology of the Block)

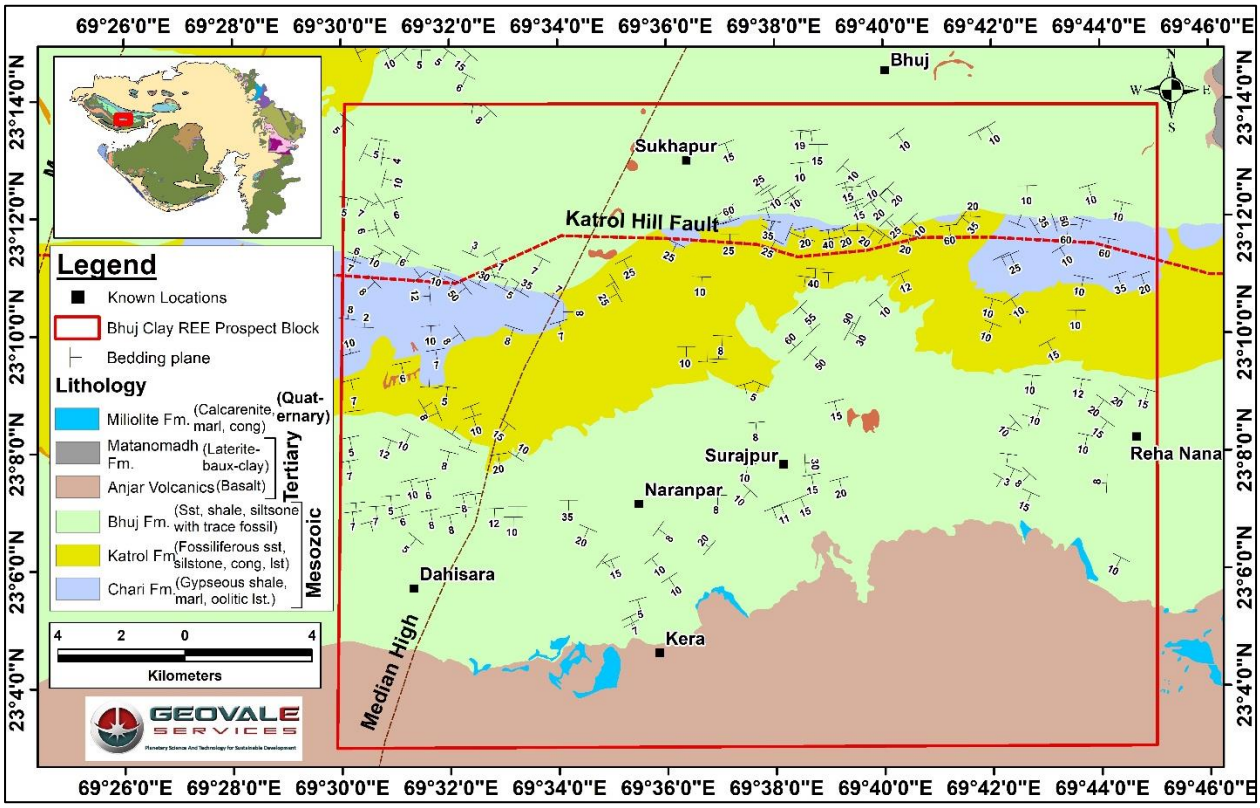


Figure 5 Map showing the geology of the Bhuj Clay REE Prospect Block.

Regionally major part of the proposed block belongs to the Jurassic and Cretaceous sedimentary rocks belonging to the Chari, Katrol and Bhuj formations (*Table 1*). Cenozoic Deccan Traps and Miliolitie Limestone cover the remaining part of the proposed block.

Structurally, the area includes two very prominent Quaternary structures, the E-W trending Katrol Hill Fault and the NNE-SSW trending Median High of Kachchh Mesozoic basin (*Fig. 4*). SOI toposheet 41E/12 includes intersection of these two structures.

Stratigraphically the proposed block comprises of Chari Formation, overlain by the Katrol Formation and the Umia Formation (rechristened to 'Bhuj Formation') subsequently. The Chari Formation is exposed as small lenses at the southern part of the Katrol Fault within the targeted area (*Fig. 4*). It comprises gypseous shales, fossiliferous limestone, calcareous and ferruginous gritty sandstone, conglomerate, and greenish grey shales. The ~750m thick Katrol Formation (*138 + 22 M.Y, Srivastava et. al., 1994*) is represented by dark grey to black shale interbedded with calcareous/ferruginous sandstone, and siltstone/clays. Bhuj Formation consists of sandstone, shales, grits, and conglomerates. The Deccan Traps at the southern part of the proposed block comprise lava flows and intrusive dykes of different ages and composition, primarily containing black, olive green colored amygdule basalt with isolated occurrences of silica and zeolite. The Quaternary Miliolite Limestone is observed as thin capping above these traps.

Table 1 Stratigraphic table of the proposed Bhuj Clay REE Prospect Block.

Stratigraphic unit		Age	Lithology
Rajnath, 1932	Biswas, 1977		
Miliolite Formation		Quaternary	
Matanomadh Formation		Paleocene	Laterite, bauxite, clay
Deccan Trap		~67-65 Ma Uppermost Cretaceous	Basalt, tholeiitic, minor alkalic basalt
Umia Series	**Bhuj Formation**	Jurassic Cretaceous boundary 149-145 Ma	Sandstone-shale in the lower part, succeeded by glauconitic sandstone, sandstone-claystone
Katrol Series	**Jhuran Formation**	Late Jurassic	Predominantly dark grey to black shale in the lower part, interbedded with ferruginous sandstone and micaceous siltstone and shale
Chari Series	**Jhumara Formation**	Middle part of Upper Jurassic ~155 Ma -~149 Ma	Olive green shale, succeeded by sandstone, limestone with golden oolites, and shale

3. Mineral potentiality based on geology, geophysics, ground geochemistry etc.

The central part of the Kachchh Mainland covering SOI toposheet 41E/12, shows an unusually high concentration of both LREE and HREE values, reported in fine (<80 mesh) fractions of stream sediment samples, under the KGCMP survey with a grid spacing of 2

km x 2 km (*data provided by the CGM office of Gujarat, Table 1*). A total number of 182 samples analyzed in toposheet numbers 41E/12.

The highest concentration of the values for both the ΣLREE and ΣHREE are reported to occur along the Katrol hill fault (*Fig.6, 7*).

NGCMP BHUKOSH data is not available for the proposed block. However, GSI's NGCM data is available for 41A/15 toposheet that also show abnormally high HREE concentration with highest value of 749ppm.

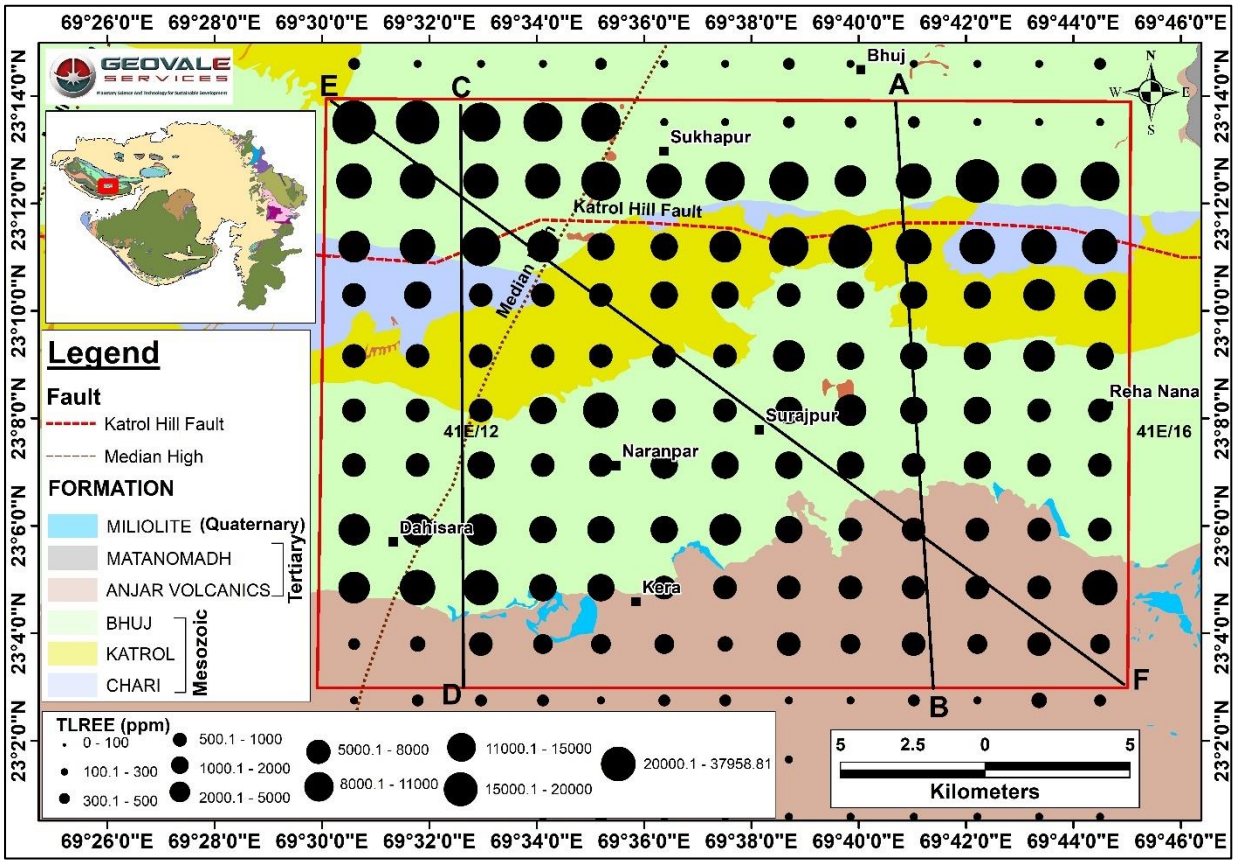


Figure 6 ΣLREE distribution of the KGCMP samples of the Bhuj Clay REE Prospect Block. Note that the very high values of ΣLREE are concentrated in the northern part of the proposed block. AB, CD, EF are topographic cross section lines (Fig.8).

Table 2 Topo-Sheet wise unusual high concentration of both ΣLREE and ΣHREE: Figures in each concentration range indicate percent of analyzed samples.

Concentration in %	Range	Percent data
ΣLREE	0-0.05%	32.42
	0.05-0.5%	28.57
	0.5-1.0%	21.43
	1.0%-10%	17.58
	Median value	3719 ppm
	Highest value	379591 ppm

Concentration in %	Range	Percent data
ΣHREE	0-0.01%	33.52
	0.01-0.05%	35.71
	0.05-0.1%	19.78
	0.1-0.2%	10.99
	0.2-0.5%	-
	>0.5%	-
	Median value	331.37 ppm
	Highest value	1964.7 ppm

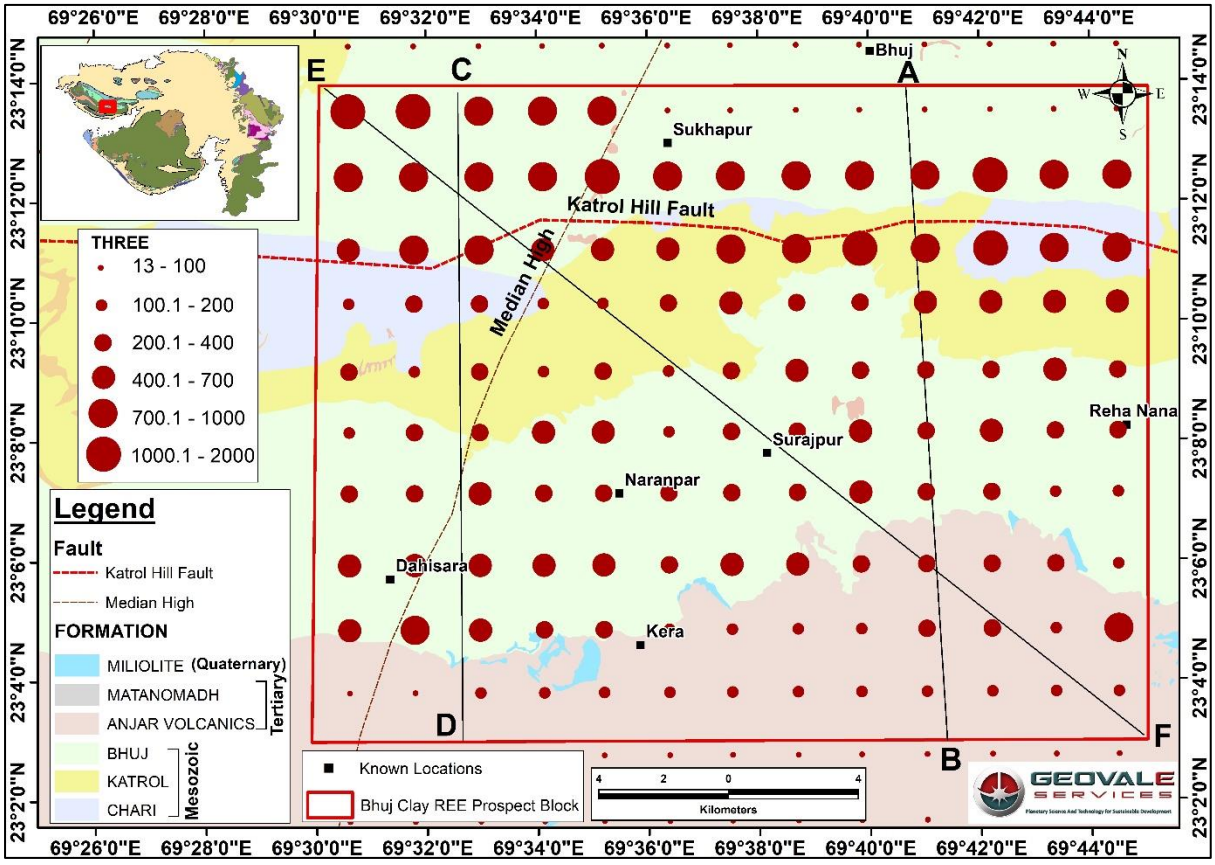


Figure 7 ΣHREE distribution of the KGCMP samples of the Bhuj Clay REE Prospect Block. Note that the very high values of ΣHREE are concentrated in the northern part of the proposed block. AB, CD, EF are topographic cross section lines (Fig.8).

4. Mineral System Analyses (prospectivity analyses) and rationale for block selection:

REE is the one of the strategic commodities of India. KGCMP data shows some striking high anomalous values of ΣLREE and ΣHREE in the proposed block. The following points are noticed.

I. Nearly whole of the proposed block show high ΣLREE and ΣHREE values (*Fig.6, 7*). Highest ΣLREE concentration being 37959 ppm with a median value of 3719

ppm. The highest ΣHREE concentration being 1965 ppm with a median value of 331 ppm. Among these exceedingly high ΣLREE and ΣHREE values there is little bias of high concentration along the E-W trending Katrol Hill Fault and along the NNE-SSW trending Median Fault (*Fig. 6, 7*).

II. The analyzed samples are from bulk low-energy stream. Samples were sieved to -80 mesh (~180µm) and then milled without further size or density separation. The samples thus might include both clay fractions and silt sized grains.

III. High concentration of REE in stream sediments does not show any bias for underlying litho-stratigraphic units.

Possible sources of REE in the stream sediments:

Absence of any bias of high REE concentration with underlying geological units suggest that any of the rocks present in the catchment areas of each sample could represent possible source for REE. Thus, Jurassic formations represented by Chari Formation or Katrol Formation or the Cretaceous Bhuj Formation could be the source. Again, the Deccan Trap that is exposed in the southern part might also be the source as the Deccan Trap occupies higher topographic heights.

If the sedimentary units are the source, then REE minerals could be present as placer deposits. Such placer enrichment from existing REE mineral enriched terrigenous sediments (may include paleoplacers) might include both LREE-enriched minerals (monazite, florencites) and HREE-enriched minerals (xenotime, zircon) that gets concentrated in stream sediments because of their relative heaviness compared to other minerals. Prominent subvertical and steep Quaternary structures in the area (Katrol Hill Fault and the 'Median High') might have provided the right environment for placer enrichment on the downside of these prominent Quaternary faults (*Fig.4, 5, 8*). Hence a proper investigation is needed in the studied area.

5. Previous Work

This area has not been previously explored for REE prospectivity and there is also no previous report of mineralization from the proposed block. However, the proposed block was covered by Kachchh Geochemical Mapping Program (KGCMP). High concentration of both LREE and HREE is reported in fine (<80 mesh) fractions of stream sediment samples, under the KGCMP survey. The samples were collected with a grid spacing of 2 km x 2 km (*data provided by the CGM office of Gujarat*).

6. Observation and Recommendations of previous work

Remarkably high concentration of both ΣLREE and ΣHREE in the proposed block warrants a closer follow-up survey to locate the source(s) and vectors (stratigraphic, structural) of such high concentration of both ΣLREE and ΣHREE in stream sediment samples for defining a prospecting target for a REE deposit.

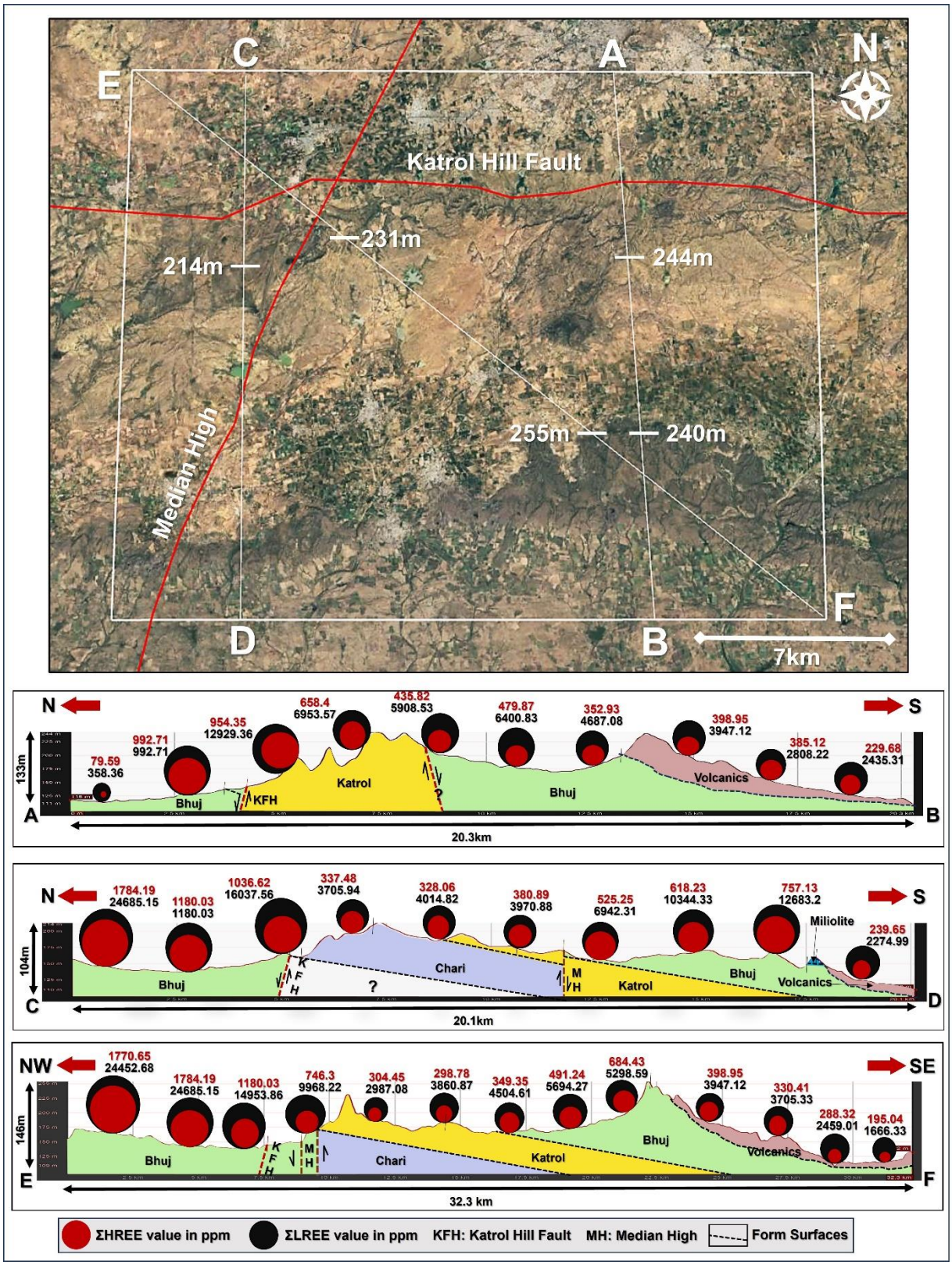
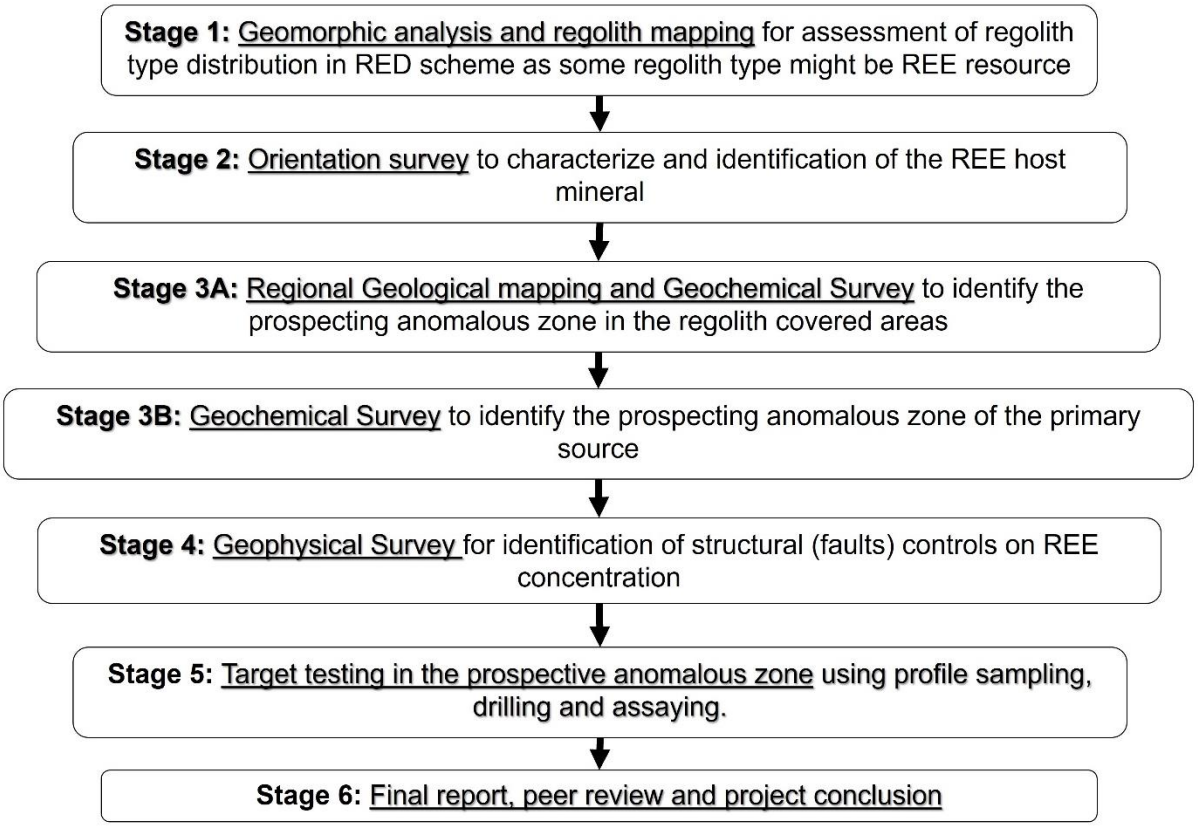


Figure 8 Schematic diagram of the cross-sectional profile across the Katrol hill fault and the Median High. Note that the high REE values have concentrated in the low elevation areas on both sides of the Katrol hill Fault which may have provided the right environment for REE enrichment. Also note that the vertical scale of the sections are over 20 times exaggerated than the horizontal scale to highlight distribution of high REE assays in valleys. However, this exaggeration also gives an erroneous impression of high relief and steepness of lithological formations.

7. Scope for proposed exploration

Geovale would carry out the proposed exploration program for finding targets for REE resource for high ΣLREE and ΣHREE through a well-defined. The broad schema for exploration is given as below:



Stage: 1. Geomorphic analysis of the regional area and regolith mapping (*Fig. 9*):

The existing KGCMP data show extremely anomalous ΣREE, especially ΣHREE assay. NGCM data in nearly toposheet carried out by the GSI also yielded very high ΣREE, especially ΣHREE assay. It is important to get assessment of different regolith types as the recent sediments could itself be the source of the REE concentration due to terrain control (*Fig. 8*).

The whole area would be mapped for its regolith types in the RED scheme (R, Residual; E, Erosional; and D, Depositional) subsequently followed by field verification. The regolith type map would be useful for finding correlation among regolith types and ΣLREE and ΣHREE assay.

Stage: 2. Orientation survey (*Fig. 9*):

For an ΣREE exploration it is important to understand REE host phases so that target geological formation is identified.

Possible REE phases might include:

I. REE occurring as adsorbed phases in clay minerals.

II. REE occurring in amorphous Fe-Mn oxyhydroxides that might occur as separate grains or as coating on other mineral grains.
III. REE occurring as detrital mineral phases (heavy minerals like zircon, monazite, xenotime etc.).
IV. REE occurring in caliche or carbonate phases.

These possible REE phases might be present in following types of geological formations:

1. REE host is the Recent and Quaternary sediments in the low-lying valley north of the Katrol Hill Fault.
2. Ferricrete of laterite developed primarily over Deccan Traps or other geological formations.
3. Lithomerge of laterite developed over Deccan Trap.
4. Paleoplacers in coarse detrital sedimentary units of Mesozoic age.
5. Clay-rich strata in the Mesozoic sedimentary units of the area.

An orientation survey is designed such that target REE host phase and the target geological formation would be identified such that next phase of exploration is directed to identify the geological formation that hosts the REE mineralization (*Fig. 10*). The orientation survey would make the exploration much more focused and exploration cost would also be optimized.

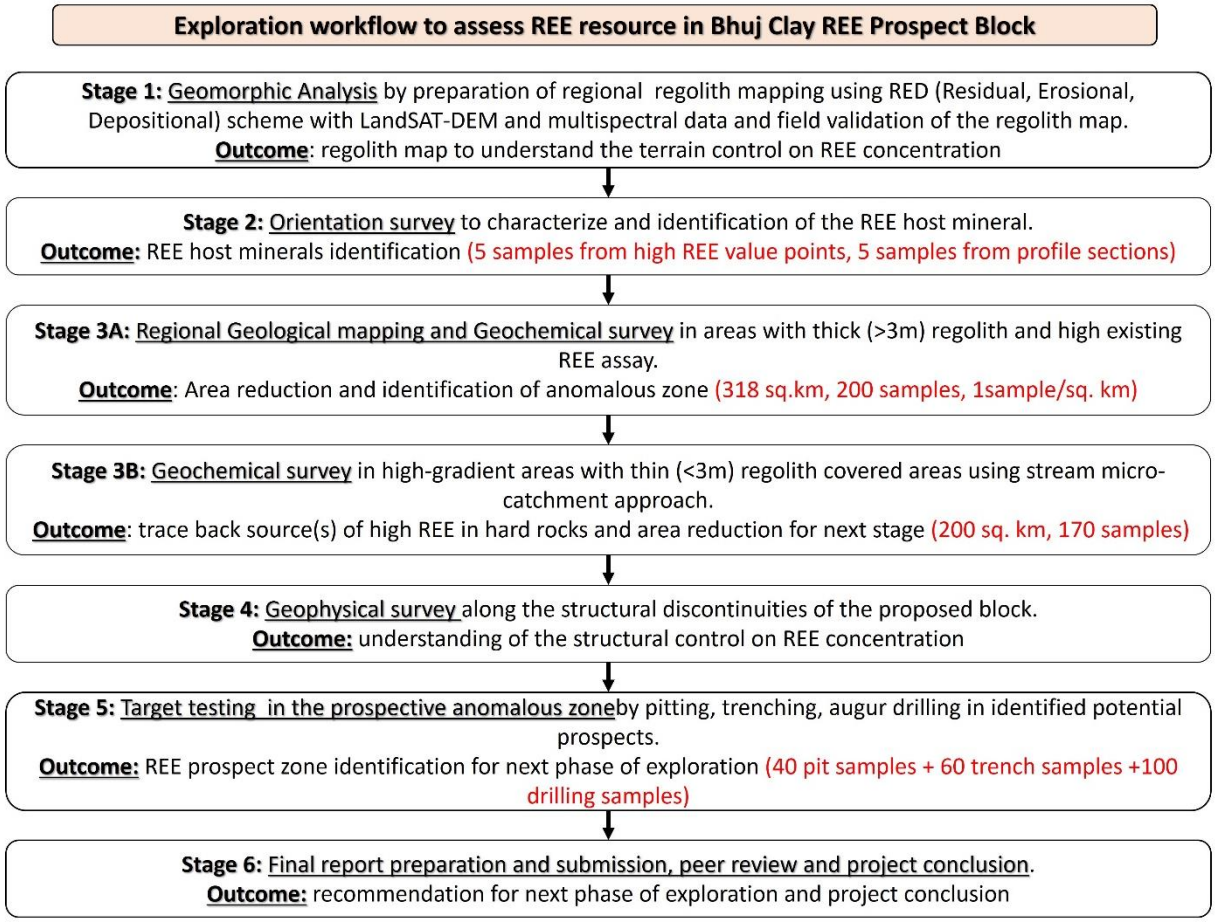


Figure 9 Workflow of planned exploration activities in the Bhuj Clay REE Prospect Block.

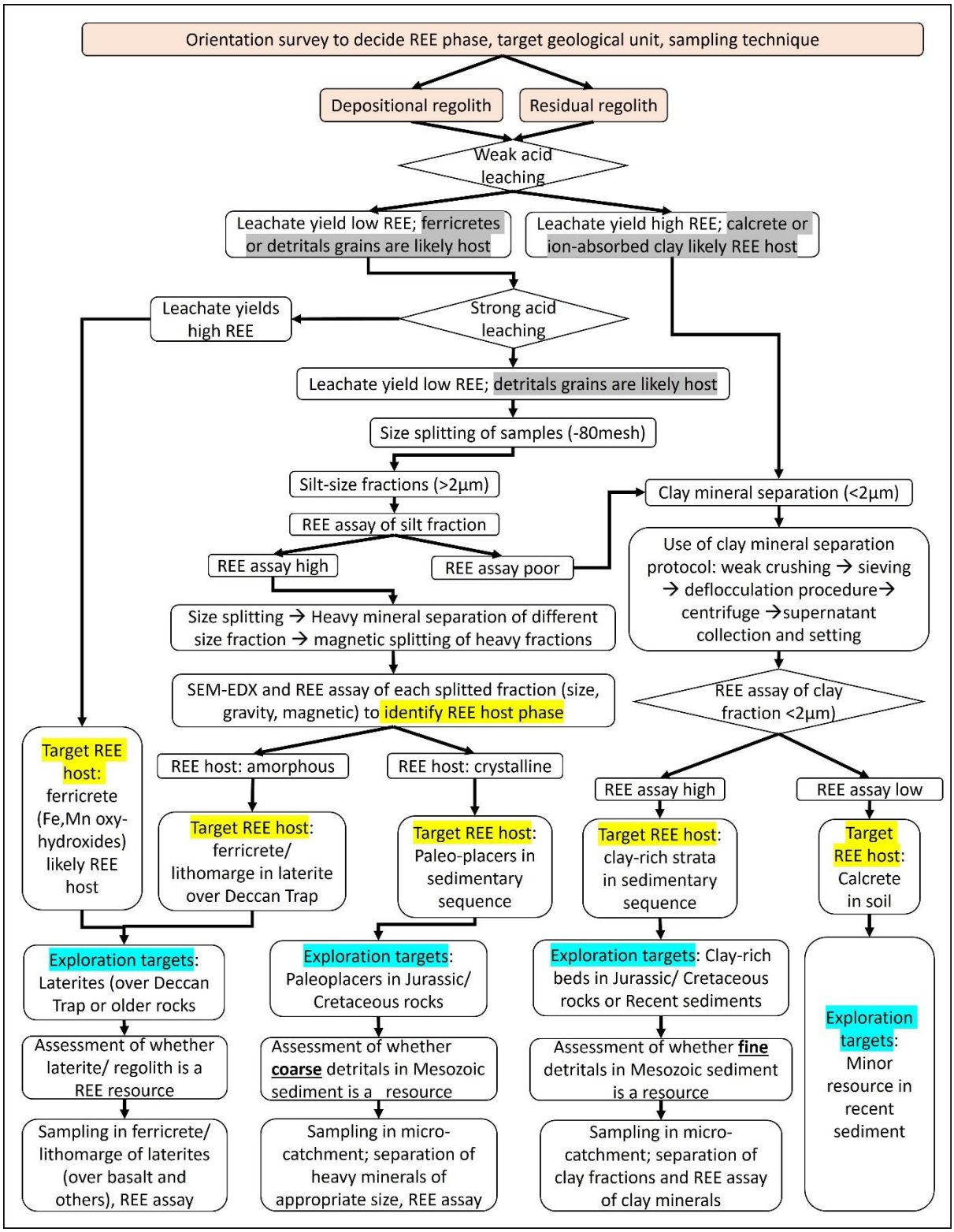


Figure 10 Planned workflow of Orientation Survey at stage 2 to characterize and identification of the REE host mineral.

Stage: 3. Geological mapping and Geochemical Survey (Fig. 9):

Once an orientation survey has identified the REE host phases a geological mapping and sampling, and geochemical survey would be undertaken in two stages.

Stage 3A: Regional Geological mapping and Geochemical survey: Since extremely anomalous REE assays are reported from loose Recent sediments, it would be prudent to assess the possibility of these Recent and Quaternary sediments as a REE resource. Samples will be collected in one square kilometer grid pattern in the thick (>3m) covered areas. Two profile sections in the areas having very thick (>4m) loose sediments would be collected in either pit sections or drilled using hand augur drilling and the profile section samples would be systematically assayed for REE concentration. A total of 200 numbers of sample would be collected from 297 sample point locations (*Fig. 11*). Such data would be used for an assessment of REE resource in loose sediments.

Stage 3B: Geochemical survey: In high gradient areas with low or no regolith cover (<3m), the sampling strategy would follow micro-catchment discharge zones. A total of 170 samples will be collected (Fig. 12). Sampling following micro-catchment discharge zones would give vectors to REE host formation and area. Detailed sampling survey would identify target REE zones.

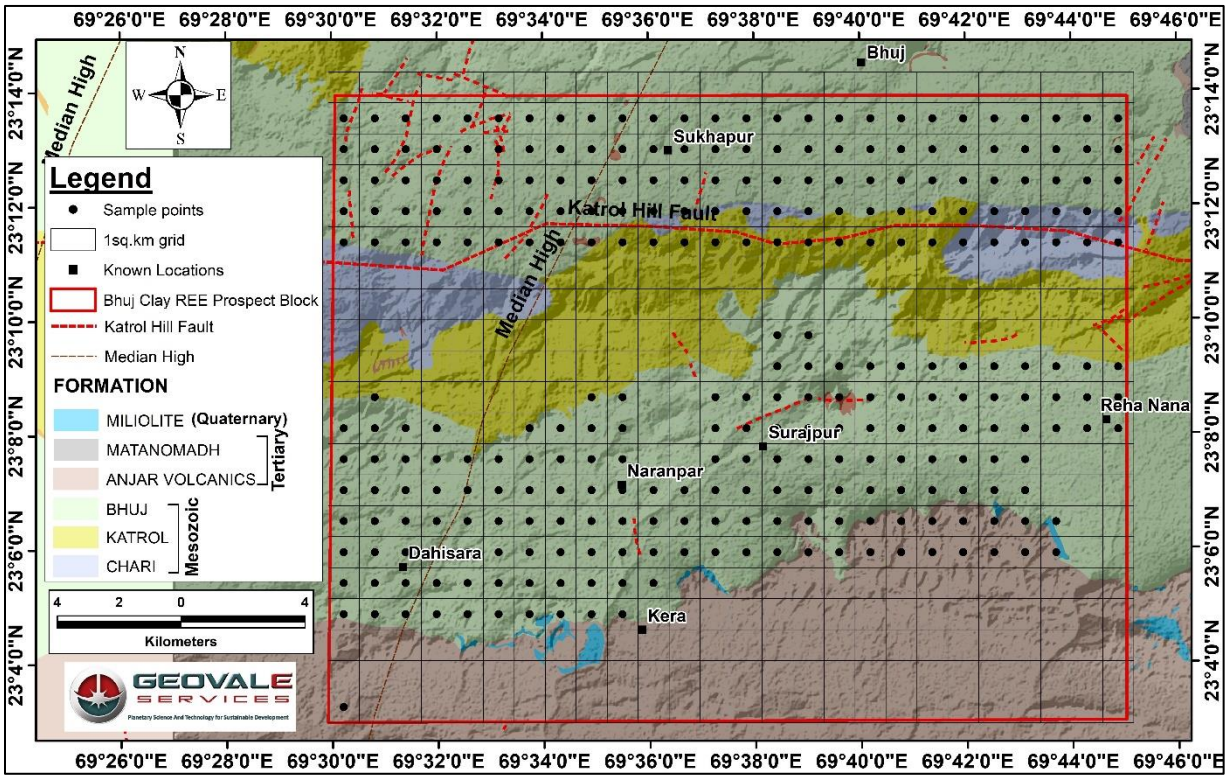


Figure 11 Sample location points of stage 3A in the high regolith covered areas (>3m) in the Bhuj Clay REE Prospect Block.

Stage: 4. Geophysical Survey (*Fig. 9*):

The Existing KGCMP data show high ΣREE and ΣHREE assay along the E-W trending Katrol Hill Fault and the NNE-SSW trending Median Fault of the proposed block (*Fig. 8*). Hence it is also important to get assessment of the depth and strike continuation of the regional faults existing in the area. It is possible that movement on these faults might have controlled distribution of ΣLREE and ΣHREE.

Thickness distribution of the Recent and Quaternary sediments and depth continuation of the existing structural discontinuities would be assessed using electrical resistivity and image profiling survey. Regolith thickness map would help in assessing whether particular type of regolith would represent the REE resource.

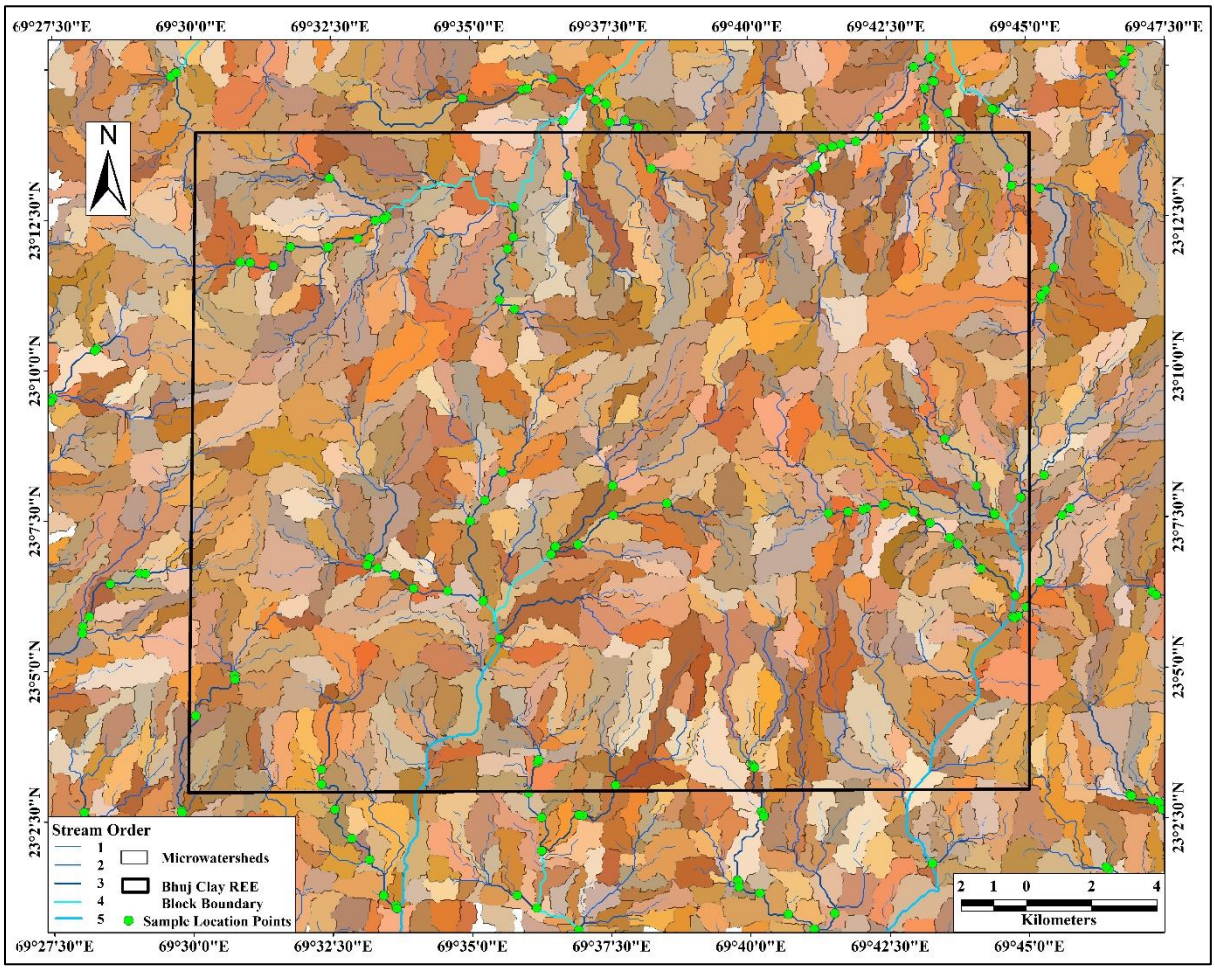


Figure 12 Micro watershed map of the Bhuj Clay REE Prospect Block with the sample location points of stage 3B. The proposed sampling points are kept at the outlets of a micro-catchment area such that primary source of REE can be traced back.

Detailed morphotectonic analyses and regolith thickness mapping along with high REE values obtained from geochemical analyses would lead to understanding of the morphotectonic control on the high REE values. Two possible sources, either some Quaternary sediments or the Mesozoic sediments could be the possible source of the REE mineralization.

Stage 3 and 4 would together help to identify the potential anomalous target zone or stratigraphy and/or area for target testing based on the mineralization vectors like stratigraphic controls, structural controls, and mineral geochemistry.

Stage: 5. Target testing in the prospective anomalous zone (*Fig. 9*):

The proof of exploration modelling would be to test a few prospective targets. Some selected targets would be tested using standard techniques of pitting, trenching and augur

drilling. Additionally, this exercise would also yield some idea of the resources of the target area.

Stage: 6. Report preparation, Peer Review and Project Conclusion (*Fig. 9*):

Finally at stage 6 all data of mapping, sampling, and REE assay values would be collated with geological, tectonic and lineament control of tectonics on REE enrichment zones. Such correlation will produce the final report with recommendation for next phase of exploration.

Summary:

The detailed exploration plan has 6 stages and 85 tasks. The total duration of the work plan is 14 months with an interim review after the 7th month.

8. Nature Quantum and Target

Stages	Milestones	Activities	Nature	Quantum	Timeline (in weeks)
Stage 1	Geomorphic analysis of the regional area, regolith mapping to identify the terrain control on mineralization and sample collection for orientation survey	Multispectral and DEM data analysis	Desktop (518 sq. km), Geol. (other)	30 Man-days	6
		Field validation of regolith map and sample collection for orientation survey	Fieldwork, 518 sq. km (1:50,000)	60 Man-days	4
			Pitting	2 pits (24 cub.m, 5 samples)	
Stage 2	Orientation survey to characterize and identification of the REE host mineral	Detailed mineralogical characterization of the high REE value samples	XRF	10 samples	8
			Gravity Separation	10 samples	
			Heavy Liquid Separation	20 samples	
			Magnetic Separation	20 samples	
			ICPMS	80 samples	
			XRD	10 samples	
			Petrography	5 samples	
			SEM-EDX	10 samples	
			EPMA	5 samples	
			Sampler	1 Man-days	
			Desktop (Geol. HQ)	15 man-days	
Stage 3A	Regional geological mapping and geochemical survey in 1 sq. km grid pattern to identify the prospecting anomalous zone or stratigraphic horizon through mapping, sampling in thick regolith covered areas	Regional Geological and Geochemical Survey: Mapping and Sampling	Fieldwork, 318 sq. km (1:25,000), 200 samples	120 Man-days	10
		Regional Geological and Geochemical Survey: Geochemical Analysis	XRF	100 samples	11
			ICPMS	200 samples	
			Sampler	25 Man-days	

Stages	Milestones	Activities	Nature	Quantum	Timeline (in weeks)
Stage 3B	**Geological mapping and geochemical survey following micro catchment approach to identify the prospecting anomalous zone in high gradient areas with thin or no regolith cover**	Geological and Geochemical Survey: Mapping and Sampling (1:50000)	Fieldwork, 200 sq. km (1:25,000), 170 samples	80 Man-days	7
		Detailed Geological and Geochemical Survey: Geochemical Analysis	XRF	30 samples	8
			ICPMS	170 samples	
			Sampler	21 Man-days	
Stage 4	**Geophysical Survey for identification of structural (faults) controls on mineralization**	Regional Geophysical survey along the structural discontinuities	Electrical Resistivity (AB/2=1km))	80 stations	8
			Resistivity Profiling (Station interval 200m.)	50 line km	
			Expert Geophysicist (Field)	10 Man-days	
		Interpretation of geophysical data	Desktop (518 sq. km), Geol. (HQ)	15 Man-days	
Stage 5	**Target Testing in the prospective anomalous zone for identification of the prospecting anomalous zone or stratigraphic horizon for next phase of exploration**	Target testing through pitting, trenching and augur drilling	Pitting	10 pits (120 cub.m, 40 samples)	6
			Trenching	5 trenches (450 cub.m, 60 samples)	
			Auger Drilling	5 BHs (100m, 100 samples)	
		Geochemical Analysis of the collected samples	XRF	100 samples	8
			ICPMS	200 samples	
			Sampler	25	
Stage 6	**Report Preparation, peer review and project conclusion**	Final report preparation, submission, recommendation for next level of exploration, peer review and project conclusion	Desktop	-	10

Borehole spacing (As per MEMC, 2015)

Type of deposit	Bedded Stratiform and tabular deposit of regular habit minerals to be identified	Bedded stratiform and tabular deposits of irregular habit (Minerals to be identified)	Lenticular bodies occurring En-echelon Lenses, pockets. (Different minerals)
G4 Stage	Not Applicable	Approximately 5 boreholes (Auger drilling), each approximately 20m depth planned in geochemically positive profiles (Total drilling = approximately 100 m)	Not Applicable
Remarks		Decision on the number of boreholes and depth of drilling may vary depending on the nature and disposition of the ore minerals in the area.	
(Vertical depth of intersection of mineralized zone should be specified (first level), number of boreholes, approximate borehole spacing, approximate length of boreholes may be specified)			

9. Geophysical Studies

Electrical Resistivity and resistivity profiling will be used to determine the thickness of the regolith and alluvium. In phase stage 4, electrical resistivity for 80 stations for 60% of the total area (considering regolith covered according to SRTM data); are incorporated to determine the depth and extension of the alluvium. This would help to plan for the detailed exploration in the next phase.

Electrical Resistivity Profiling survey will be used for defining the morphotectonics related to the structural features of the proposed block. 50 line-km profiling for Katrol fault and Median high have also been proposed in Stage 4.

Other geophysical tools may also be introduced at the later stage based on the reconnoitory studies and outcome of different stages of work.

10. Manpower deployment (includes both field and non-field deployment)

Attached in Appendix I.

11. Breakup of expenditure

The total cost of the project is ₹2,81,66,438.34. The breakup of the expenditure is attached in *Appendix II.*

12. Timeline

The project is planned to be completed in 14months of time with interim review at the end of the 7th month.

Stages	Activities	Timeline														
		M 1	M 2	M 3	M 4	M 5	M 6	M 7		M 8	M 9	M 10	M 11	M 12	M 13	M 14
Stage 1	Geomorphic analysis of the regional area and regolith mapping															
	Field validation of regolith map and sample collection for orientation survey															
Milestone I: Morphometric analysis of the proposed block and identify the terrain control on mineralization and sample collection for orientation survey																
Stage 2	Orientation Survey through detailed mineralogical characterization of the high REE value samples															
Milestone II: Orientation survey to characterize and identification of the REE host mineral and the probable source stratigraphic horizon (whether the Quaternary or Mesozoic is the source)																
Stage 3A	Regional geological mapping and geochemical survey in 1 sq. km grid pattern to identify the prospecting anomalous zone or stratigraphic horizon through mapping, sampling in thick regolith covered areas															
Stage 3B	Geological mapping and geochemical survey following micro catchment approach to identify the prospecting anomalous zone in high gradient areas with thin or no regolith cover															
Milestone III: Identification of the anomalous zone and area reduction for target testing																
Stage 4	Geophysical survey along the structural discontinuities															
Milestone IV: Regional Geophysics for identification of structural (faults) controls on mineralization																
Stage 5	Target testing in the prospective anomalous zone through pitting, trenching and augur drilling															
	Geochemical Analysis of the collected samples and Data Interpretation															
Milestone V: Identify the prospecting anomalous zone or stratigraphic horizon for next phase of exploration																
Stage 6	Final report preparation, submission, recommendation for next level of exploration															
	Peer review and project conclusion															
Milestone VI: Report Preparation, peer review and project conclusion																

REVIEW

13. Lease area

The proposed block includes 36 minor mineral leases of different commodities viz. calcareous sand, ochre and perlite (*Fig. 10*). The details of the minor mineral leases within the proposed block are listed below (*Table 3*).

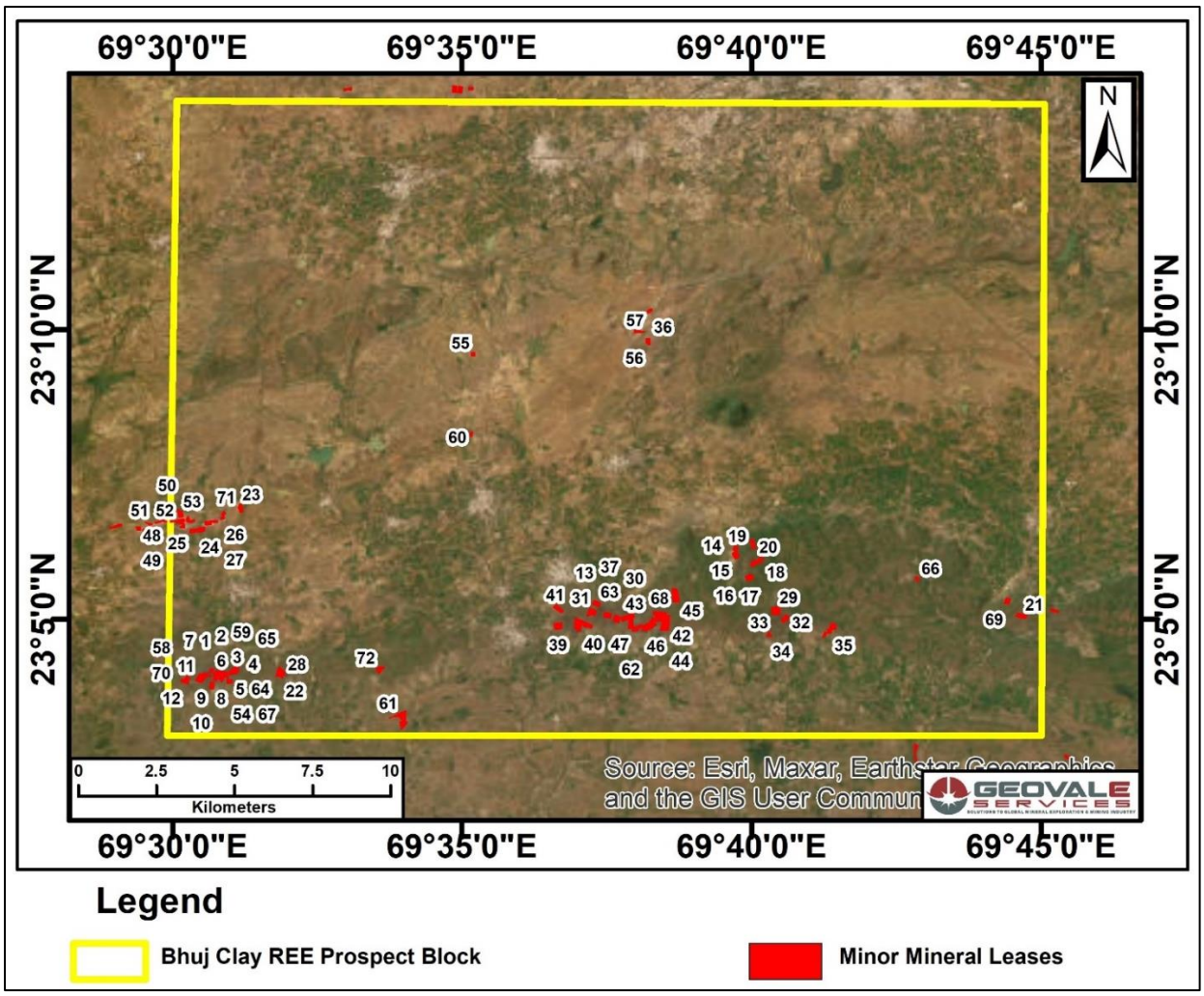


Figure 13 Map showing existing minor mineral leases in the proposed block boundary of the Bhuj Clay REE Prospect Block.

Table 3 Existing leases of minor minerals in the proposed study area.

Sl.No	Mine Name	Village	Taluka	District	Commodity	Area (sq. km)
1	Manshukhlal Manilal Amrutiya	Dhunai	Bhuj	Kachchh	Perlite	0.0116844
2	Harilal Pachan Patel	Dhunai	Mandvi	Kachchh	Perlite	0.00946882
3	Lalaji Mavaji Rabadiya Tr to Kesara Lalaji Halai	Dhunai	Mandvi	Kachchh	Perlite	0.0195136
4	Dhanji Govind Pachani	Dhunai	Mandvi	Kachchh	Perlite	0.0117989
5	Manilal Bhanji Amrutiya	Dhunai	Mandvi	Kachchh	Perlite	0.015669901
6	M/S Gangji Ramji	Dhunai	Mandvi	Kachchh	Perlite	0.030137001

Sl.No	Mine Name	Village	Taluka	District	Commodity	Area (sq. km)
7	Transfer To Shamji Velji Pindoriya (Hiralal Pachan*	Dhunai	Bhuj	Kachchh	Perlite	0.0113529
8	Himat Parsotam Keshrani	Dhunai	Mandvi	Kachchh	Perlite	0.023184501
9	Mrs.R.N.Vagela Tr To Daud Ladha Rayama -		Mandvi	Kachchh	Perlite	0.019890901
10	Samaji Sivaji Gorasiya Tr Kerai Karasan Jadva	Dhunai	Mandvi	Kachchh	Perlite	0.0116772
11	Shahjanand Krashmetal Indusryz	Dhunai	Mandvi	Kachchh	Perlite	0.033822902
12	Dhajibha Zilubha Sodha	Sherdi	Mandvi	Kachchh	Chalk	0.0199196
13	Vishram Dhanji Hirani	Baladiya	Bhuj	Kachchh	Perlite	0.025541101
14	Kishorchandra Pravinchandra Chandarana	Bharapar	Bhuj	Kachchh	Calcareous Sand	0.0148989
15	Ranjitbhai Jivabhai Vishana	Bharapar	Bhuj	Kachchh	Calcareous Sand	0.030861299
16	Laxmi Cras Metal Indstrij Pro Bhimji Ravji Hirani		Bhuj	Kachchh	Perlite	0.0100832
17	Lakshmi Mines		Bhuj	Kachchh	Perlite	0.020354001
18	Shamji Shivaji Gorshiya	Bharapar	Bhuj	Kachchh	Perlite	0.021641901
19	Mavji Dhanji Rabdiya	Bharapar	Bhuj	Kachchh	Perlite	0.0196811
20	Harun Husain Meman	Bharapar	Bhuj	Kachchh	Perlite	0.026533701
21	Prakash Hirji Vagadiya	Chakar	Bhuj	Kachchh	Perlite	0.0314909
22	Shamji Devshi Pindoriya	Chunadi	Bhuj	Kachchh	Perlite	0.0106287
23	Sarbanu Abdaraheman Khalifa	Dahisara	Bhuj	Kachchh	Ochre	0.017432399
24	Khalifa Abdreman Fakirmamad	Dahisara	Bhuj	Kachchh	Ochre	0.0462908
25	Dhirubhai Sudabhai Rabari	Dahisara	Bhuj	Kachchh	Ochre	0.018713299
26	Bhaybhai Bhojabhai Parmar	Dahisara	Bhuj	Kachchh	Ochre	0.017451501
27	Rukshana Abdreman Khalifa	Dahisara	Bhuj	Kachchh	Ochre	0.0116835
28	Premsangji Laluji Jadeja	Chanadi	Bhuj	Kachchh	Perlite	0.0381217
29	Siddhrajsinh Hanubha Chudasma	Vadzar	Bhuj	Kachchh	Perlite	0.052399501
30	Ratilal Kesra Patel	Rampar	Bhuj	Kachchh	Perlite	0.0302513
31	Ratilal Kesra Patel	Rampar	Bhuj	Kachchh	Perlite	0.032573599
32	Jyoti Stone Crusher	Vadzar	Bhuj	Kachchh	Perlite	0.01437
33	Jyoti Ston Crasar Pro Vijaysinh L Jadeja	Vadajar	Bhuj	Kachchh	Perlite	0.0103632
34	Surendrasinh Godji Jala Tr. To Hanubha Natubha Ch	Vadazar	Bhuj	Kachchh	Perlite	0.0108188
35	Aanandabhai Bhachubhai Mata	Vadazar	Bhuj	Kachchh	Perlite	0.049784601
36	Haji Jusab Rathod	Sedata	Bhuj	Kachchh	Ochre	0.00965188

14. References

Srivastava, A.P., Krishna, J., Rajagopalan, G., Pathak, D.B. and Ojha, J.R., 1994. The first ever absolute agedetermination from the Jurassic of Kachchh, Western India. Geobios, 27, pp.529-533.

Appendix I: Manpower deployment

Stages	Activities	No. of geologists involved	Total Geologist (Field) Man-days	Total Geologist (HQ) Man-days	Total Geologist (Other) Man-days	Total Sampler (Other) Man-days	Timeline														
							M 1	M 2	M 3	M 4	M 5	M 6	M 7	REVIEW	M 8	M 9	M 10	M 11	M 12	M 13	M 14
Stage 1	Geomorphic analysis of the regional area and regolith mapping	7	-	-	30	-															
	Field validation of regolith map and sample collection for orientation survey	4	60	-	-	-															
Milestone I: Morphometric analysis of the proposed block and identify the terrain control on mineralization and sample collection for orientation survey.																					
Stage 2	Orientation Survey through detailed mineralogical characterization of the high REE value samples	6	-	15	-	1															
Milestone II: Orientation survey to characterize and identification of the REE host mineral and the probable source stratigraphic horizon (whether the Quaternary or Mesozoic is the source).																					
Stage 3A	Regional geological mapping and geochemical survey in 1 sq. km grid pattern to identify the prospecting anomalous zone or stratigraphic horizon through mapping, sampling in thick regolith covered areas	6	120	-	-	25															
Stage 3B	Geological mapping and geochemical survey following micro catchment approach to identify the prospecting anomalous zone in high gradient areas with thin or no regolith cover	6	80	-	-	21															
Milestone III: Identification of the anomalous zone and area reduction for target testing.																					
Stage 4	Geophysical survey along the structural discontinuities	8	10	15	-	-															
Milestone IV: Regional Geophysics for identification of structural (faults) controls on mineralization.																					
Stage 5	Target testing in the prospective anomalous zone through pitting, trenching and augur drilling	6	-	-	-	-															
	Geochemical Analysis of the collected samples and Data Interpretation	7	-	-	-	25															
Milestone V: Identify the prospecting anomalous zone or stratigraphic horizon for next phase of exploration.																					
Stage 6	Final report preparation, submission, recommendation for next level of exploration	9	-	-	-	-															
	Peer review and project conclusion																				
Milestone VI: Report Preparation, peer review and project conclusion.																					
Total Man-days			**270**	**30**	**30**	**72**															

Appendix II: Breakup of expenditure

Cost Sheet of Bhuj Clay REE Prospect Block

Stage	Item of work	Rate as per SOC (2020-21) Item no.	Unit	Rate as per SOC	Quantum	Total Cost	Remarks
	Preparation of Exploration Proposal	5.1	Lumpsum	3,80,000.00	1	3,80,000.00	
Stage 1	**Geological Mapping [Large scale mapping (LSM)/Detailed Mapping (DM)], Other Geological Work and Surveying**						
	Multispectral and DEM data analysis (Cost of interpretation in terms of Geologist man days)	1.1	per day	9,000.00	30	2,70,000.00	Geomorphic analysis of the regional area and regolith mapping
	Geologist man-days for large scale mapping	1.2	per day	11,000.00	60	6,60,000.00	Field validation of regolith map, 10 sample collection for orientation survey
	Labor (Field days) (2 workers per geologist)	As per CLC or State Govt. whichever is higher	per day	497.00	120	59,640.00	
	Mineral Investigation						
	Pitting (2 no.s) (5 samples)	2.13	per cu.m	5,330.00	24	1,27,920.00	
Stage 2	**Geochemical Investigation**						
	XRF (major oxides)	4.1.15a	per sample	4,200.00	10	42,000.00	Geochemical Assay for Orientation Survey
	Check samples for XRF		per sample	4,200.00	1	4,200.00	
	Gravity Separation	4.3.6b	per sample	13,820.00	10	1,38,200.00	
	Heavy Liquid Separation	4.3.6a	per sample	2,380.00	20	47,600.00	
	Magnetic Separation	4.3.6b	per sample	13,820.00	20	2,76,400.00	
	ICPMS (34 elements)	4.1.14	per sample	7,731.00	80	6,18,480.00	
	Check samples for ICPMS		per sample	7,731.00	8	61,848.00	
	XRD	4.5.1	per sample	4,000.00	20	80,000.00	
	Check samples for XRD		per sample	4,000.00	2	8,000.00	
	Petrological studies						
	i) thin section preparation	4.3.1	per sample	2,353.00	5	11,765.00	
	ii)Microscopic study	4.3.4	per sample	4,232.00	5	21,160.00	
	SEM-EDX (40 samples)	4.4.2	per hour	2,940.00	10	29,400.00	
	EPMA (5 samples)	4.4.1	per hour	8,540.00	5	42,700.00	
	Sampler man-days	1.5.2	per day	5,100.00	1	6,375.00	
	Labor (Field days) (4 workers per sampler)	As per CLC or State Govt. whichever is higher	per day	494.00	5	2,470.00	
	Geologists (HQ)	1.2	per day	9,000.00	15	1,35,000.00	Data Analysis

Cost Sheet of Bhuj Clay REE Prospect Block

Stage	Item of work	Rate as per SOC (2020-21) Item no.	Unit	Rate as per SOC	Quantum	Total Cost	Remarks
Stage 3A	**Geological Mapping [Large scale mapping (LSM)/Detailed Mapping (DM)], Other Geological Work and Surveying**						
	Geologist man-days for large scale mapping (318 sq.km, 200 samples)	1.2	per day	11,000.00	120	13,20,000.00	Regional geological mapping and geochemical survey in 1 sq. km grid pattern in thick regolith covered areas (200 samples)
	Labor (Field days) (2 workers per geologist)	As per CLC or State Govt. whichever is higher	per day	497.00	240	1,19,280.00	
	Geochemical Investigation						
	XRF (major oxides)	4.1.15a	per sample	4,200.00	100	4,20,000.00	
	Check samples for XRF		per sample	4,200.00	10	42,000.00	
	ICPMS (34 elements)	4.1.14	per sample	7,731.00	200	15,46,200.00	
	Check samples for ICPMS		per sample	7,731.00	20	1,54,620.00	
	Sampler man-days	1.5.2	per day	5,100.00	25	1,27,500.00	
	Labor (Field days) (4 workers per sampler)	As per CLC or State Govt. whichever is higher	per day	494.00	100	49,400.00	
Stage 3B	**Geological Mapping [Large scale mapping (LSM)/Detailed Mapping (DM)], Other Geological Work and Surveying**						
	Geologist man-days for large scale mapping (200 sq.km, 100 samples)	1.2	per day	11,000.00	80	8,80,000.00	Geological mapping and geochemical survey following micro catchment approach in high gradient areas with thin or no regolith cover (170 samples)
	Labor (Field days) (2 workers per geologist)	As per CLC or State Govt. whichever is higher	per day	497.00	160	79,520.00	
	Geochemical Investigation						
	XRF (major oxides)	4.1.15a	per sample	4,200.00	30	1,26,000.00	
	Check samples for XRF		per sample	4,200.00	3	12,600.00	
	ICPMS (34 elements)	4.1.14	per sample	7,731.00	170	13,14,270.00	
	Check samples for ICPMS		per sample	7,731.00	17	1,31,427.00	
	Sampler man-days	1.5.2	per day	5,100.00	21	1,08,375.00	
	Labor (Field days) (4 workers per sampler)	As per CLC or State Govt. whichever is higher	per day	494.00	85	41,990.00	

Cost Sheet of Bhuj Clay REE Prospect Block

Stage	Item of work	Rate as per SOC (2020-21) Item no.	Unit	Rate as per SOC	Quantum	Total Cost	Remarks
Stage 4	**Geophysics**						
	Electrical Resistivity (AB/2=1km))	3.5a	per station	70,650.00	80	56,52,000.00	Geophysical survey along the structural discontinuities
	Resistivity Profiling (Station interval 200m.)	3.6a	per line km	58,880.00	50	29,44,000.00	
	Expert Charges for Geophysicist (Field)	3.18	per day	11,000.00	10	1,10,000.00	
	Geologists (HQ)	1.2	per day	9,000.00	15	1,35,000.00	Data Analysis
Stage 5	**Mineral Investigation**						Target testing in the prospective anomalous zones through pitting, trenching, augur drilling and geochemical assay
	Pitting (10 no.s) (40 samples)	2.13	per cu.m	5,330.00	120	6,39,600.00	
	Trench (5 nos) (60 samples)		per cu.m	3,330.00	450	14,98,500.00	
	Auger drilling (5 BH) (100 samples)	2.2.2	per meter	4,760.00	100	4,76,000.00	
	Geochemical Investigation						
	XRF (major oxides)	4.1.15a	per sample	4,200.00	100	4,20,000.00	
	Check samples for XRF		per sample	4,200.00	10	42,000.00	
	ICPMS (34 elements)	4.1.14	per sample	7,731.00	200	15,46,200.00	
	Check samples for ICPMS		per sample	7,731.00	20	1,54,620.00	
	Sampler man-days	1.5.2	per day	5,100.00	25	1,27,500.00	
	Labor (Field days) (4 workers per sampler)	As per CLC or State Govt. whichever is higher	per day	494.00	100	49,400.00	
Stage 6							
	Final report preparation	5.2	3% of project cost or 7.5 lakh whichever is higher	7,50,000.00	1	7,50,000.00	Final report submission, peer review and project conclusion
	Report Peer Review	As per EC	Lump sum	30,000.00	1	30,000.00	
					Project Cost	**2,40,71,160.00**	
					18% GST	**43,32,808.80**	
					Total Project Cost	**2,84,03,968.80**	