Preliminary Exploration (G3) for the assessment of Bauxite and Gallium in Naredi Bauxite Block, Kachchh District, Gujarat

by

Geo Marine Solutions Pvt. Ltd., Mangalore

15-17-909/9, Leslie Haven, 5th Cross, Shivabagh

Mangalore-575005, Karnataka

November 2024

Preliminary Exploration (G3) for the assessment of Bauxite and Gallium in Naredi Bauxite Block, Kachchh District, Gujarat

By

Geo Marine Solutions Pvt. Ltd., Mangalore

15-17-909/9, Leslie Haven, 5th Cross, Shivabagh

Mangalore-575005, Karnataka

Mangalore

12 Nov 2024

Summary of the Proposal for UNFC G3 Level prospecting for Bauxite, and Gallium in Naredi Bauxite Block, Kachchh District, Gujarat.

	Features	**Details**
	Block ID	GUJ-Al_2O_3-Ga-1
	Current Exploration Agency	Geo Marine Solutions Pvt. Ltd., Mangalore for Preliminary Mineral exploration G3 level
	Previous Exploration Agency	CGM, Gujarat
	G4 stage Geological Report	Based on the document published by Commissioner of Geology and Mining, Gujarat: "Gujarat's Mineral Wealth: A Responsible Exploration and Development Paradigm"
	Commodity	Bauxite and Gallium
	Mineral Belt	Bauxite and Gallium in weathered zone in Naredi Bauxite Block, Kachchh District, Gujarat
	Completion Period with entire Time schedule to complete the project	**Mobilization:** Two months from issue of work order/LOA. **Field work :** 6 months **Analysis :** 5 months (overlapping with Drilling) **Report :** 3 months
	Objectives	To understand the surficial distribution and downward continuity of Gallium - bearing Bauxite by drilling at 200m x 200m grid over an area of 3.92 sq.km, where there is a thick laterite/ bauxite up to 10.0m below ground level.
	Whether the work will be carriedout by the proposed agency or through outsourcing and details thereof.	The NABET accredited exploration agency (Geo Marine Solutions Pvt Ltd., Mangalore) will be carrying out all the components of the proposed exploration. The chemical analysis will be done at NABL accredited lab.
	Name/Number of Geoscientists	2 Geologists plus 1 Surveyor plus 1 driller
	Expected Field Months (Geology)	6 months including mapping and drilling

1.	**Location**	Naredi, Vanthali, Gujarat.
	Latitude	23°11'33.65"N
	Longitude	69°11'0.92"E
	Villages	Naredi
	Tehsil/Taluk	Vanthali Taluk
	District	Kachchh District
	State	Gujarat.
2.	**Area (hectares/square kilometers)**	
	Block Area	3.92 Sq.km
	Forest Area	NIL
	Government Land Area	NIL
	Private Land Area	3.92 Sq.km
3.	**Accessibility**	
	Nearest Rail Head	Sanosara Railway Station (2.1 Km)
	Road	Naredi-Ratatalav Road
	Airport	Bhuj Airport (48.3 km)
4.	**Hydrology**	
	Local Surface Drainage Pattern (Channels)	Naredi block is situated in the East of Kanakavati river.
	Rivers/Streams	Kanakavati river.
5.	**Climate**	

	Mean Annual Rainfall	1257 mm in Kachchh District.
	Temperatures (December)(Minimum) Temperatures (June)(Maximum)	Min. temp. is 15.2°C and max. 27.7°C
6.	**Topography**	
	Toposheet Number	Toposheet No. 41E/04
	Morphology of the area	The Kachchh district, forming the western most portion of the Indian sub-continent is situated between Gulf of Kachchh in south and Kori creek and vast stretches of Great Rann and Pakistan in North while to the east lies the little Rann and towards west Arabian sea. In Kachchh three district land forms can be readily identified viz. i) plains, ii) undulating landscape and iii) hills. Great and Little Rann, situated in the northern and eastern parts; the coastal plain in the south and south west from prominent plains while the plain of great and little Rann containing salt encrustations forms waste land, coastal plain supports, good vegetation. The area covered between northern and central hilly tracts of mainland presents on undulating landscape. Since the central part of Kachchh forms an up land are it gives rise to many important rivers like Rukmavati, Kankavati, Khari, Kharad, Makhadawali, Chari etc., which are ephemeral in nature and flow towards south or South West and confluence Gulf of Kachchh or Kori creek.

7	**Availability of baseline geoscience data**	
	Geological Map (1:50K/25K)	The proposal is based on the published literature mentioned in the reference. Geological inputs pertaining to the area falling in 41E/04 are available and referred while preparing the write up.
	Geochemical Map	Geochemical inputs in soil regolith pertaining to the area falling in 41E/04 are available and referred while preparing the write up.
	Geophysical Map (Aero-geophysical, Ground geophysical, Regional as well as local scale GP maps)	**N.A.**

8. Justification for taking up G3 level Mineral Exploration

Based on the Document released by Commissioner of Geology and Mining: "Gujarat's Mineral Wealth: A Responsible Exploration and Development Paradigm", published on 17 August 2024.

NOC issued by CGM, Gujarat to Geo Marine Solutions Pvt Ltd, to undertake exploration in the block

Based on the paper titled "Chowdhury, A.N., Chakraborty, S.C., and Bose, B.B., 1965, Geochemistry of gallium in bauxite from India: Economic Geology, v. 60, p. 1052–1058".

Based on the paper titled "Hui Qi, Neng Gong, ShengQiang Zhang, Jun Li, Guo-Li Yuan, Xue-Fei Liu (2023) Research progress on the enrichment of Gallium in Bauxite. Ore Geology reviews, ELSEVIER,Vol 160,Sept 2023, 105609".

Based on the paper titled "Hua, Y., Zhang, Ta., Wang, L. (2024). A Review of the Extraction of Gallium from Bauxite Ores. In: Iloeje, C., et al. Energy Technology 2024. TMS 2024. The Minerals, Metals & Materials Series. Springer, Cham".

A reconnaissance field work was conducted in Naredi Block by Geo Marine Solutions Pvt Ltd in 30-31 October 2024. The entire area is soil covered with agricultural and a few bushy land. It can be seen from the map that the Laterite-bearing Matanomadh Formation is exposed only on the northeastern fringe of the Block. To the west and southwestwards, the Argilaceous Limestone of Fulra Formation and Fossiliferous Marl / Limestone of Gaj Formation occurs. The latter two formations have scanty or no outcrops within the block area. The aluminous laterites of

	Matanomadh Formation is expected to continue below the Gaj and Fulra Formations within the block area. Two grab samples were collected– one of the sample is from an active Bauxite quarry of GMDC which is situated at about 1.0 km from the southern margin of the block. The other sample was collected within the block from Fulra Formation. The aluminous Laterite sample from the GMDC quarry analysed 35.5% Al2O3; **Gallium was 47ppm. The values of Gallium (Critical Mineral) is above the industry cut-off.** It is also worth noting that the NGCM (GSI) data for Soil Regolith near Naredi (TS 41 E/04) shows Al2 O3 value of 22.48 % and Gallium value of 29 ppm. The other sample from Fulra formation may qualify as a low grade Limestone for cement with CaO 45.39% and SiO2 10.94%. So the proposed exploration might bring out the low grade limestone potential for use in cement industry in addition to the Alumina and Ga bearing laterite potential.

Detailed description on the following titles to be made in the proposal.

1. Block Summary:

Physiography: Physiography of the state of Gujarat comprises three distinct zones; Alluvial plains, Coastal plain and Desert areas. This area is part of the Rann of Kutch, a salt marsh known for its distinctive landscape and seasonal salt flats. The region is primarily flat, with some elevated areas, and it experiences a semi-arid climate. The nearby Kutch desert contributes to its arid conditions, while the surrounding hills provide a contrast to the flat terrain.

Background Information:

The geology of the area includes Matanomadh formation which is reported to be bauxite bearing. CGM studied the area by means of pitting, trenching and drilling with an estimated resource of 27.85 MT. Chemical analysis of the bauxite from the proposed area shows Al2O3 (average 49.77%) and low SiO2 percentage (average 2.49 %). In the vicinity of the proposed block leases of bauxite exists which shows the potentiality of the block. Hence, G3 level of exploration is recommended by CGM, Gujarat.

A reconnaissance field work was conducted in Naredi Block by Geo Marine Solutions Pvt Ltd in October 2024. It can be seen from the map that the Laterite-bearing Matanomadh Formation is exposed only on the northeastern fringe of the Block. To the west and southwestwards, the Argilaceous Limestone of Fulra Formation and Fossiliferous Marl / Limestone of Gaj Formation. The latter two formations have scanty or no outcrops within the block area. The aluminous laterites of Matanomadh Formation is expected to continue below the Gaj and Fulra Formations within the block area. Two grab samples were collected from the area – one of the sample is from an active quarry which is situated at about 1.5km from the southern margin of the block. The other sample was collected from Fulra Formation. The aluminous Laterite sample from the GMDC quarry analysed 35.5% Al2O3; Gallium was 47ppm. The values of Gallium (Critical Minerals) is above the industry cut-off. It is also worth mentioning that the NGCM (GSI) data for Soil Regolith near Naredi (TS 41 E/04) shows Al2 O3 value of 22.48 % and Gallium value of 29 ppm.

Gallium has high strategic significance today, due to its requirement in semi-conductor chips used in electronic industry. Currently, Gallium is produced as a byproduct from Bauxite ore processing.

It is pertinent that the entire global supply chain of Gallium monopolized by China, which

controls 96% of the global supply chain of Gallium. Due to its immense application in Semiconductors, LEDs, Photo-voltaics and medical imaging technologies, the projected global annual growth rate of Gallium market from 2024 to 2030 is pegged at 24.8%. Given this scenario, presently, 30 ppm and above content of Gallium in bauxite is considered as a recoverable quantity in laterite/ bauxite.

Background Geology (regional and geology of the block):

The Geology of the area comprises of Fulra Formation (Clay and marl), Gaj Formation (Limestone and Shale), Matanomadh (Laterite /Bauxite) and Anjar volcanics (Basalt). The latter basalt occurs outside the block area. The topography of the area where laterite occurs is characterized by series NW-SE trending ridges. The laterite follows the slopes of the basalt ridges & mounds and reflects the highly irregular nature of the ground. Bauxite mineralization is bounded by Deccan Traps to east and north and Gaj beds to the west and south. It is suggested that in-situ lateralization and bauxitization of Deccan Traps and associated pyroclastic materials have resulted in the formation of bauxite (Kulkarni & Thothatiri, 1965).

Mineral potentiality within the proposed block based on geology:

In GSI report titled "G*eology of parts of Abdasa, Nakhatrana and Mandvi Taluks, Kutchchh District, Gujarat state" by Kulkarni et al. (1964-65)* reported that the bauxite occurs in the form of pockets, capping the laterites of Supra-Trappean group. In situ lateritization and bauxitzation of Deccan Traps and associated pyroclastic materials have resulted in the formation of bauxite. Also, there are reworked bauxites which cap the in-situ bauxites. In the field, bauxite forms shinning fawn grey boulders which can be recognised very easily. Near Balachod, Naredi and Nandra, extensive areas are strewn over with bauxite boulders. Shri Y.S. Sahasrabudhe has dealt with Kutch bauxites in some detail and conclude that Balachod Nana, Naredi, Nangrecha, Nandra and Kotad-Jarjok deposits will give 97,000,9,00,000,3,70,000,77,500 and 3,20,000 metric tons respectively of bauxite.

CGM, Gujarat studied the area by means of pitting, trenching and estimated a resource quantity of 27.85 MT. Chemical analysis of the bauxite from the proposed area shows Al2O3 (average 49.77%) and low SiO2 percentage (average 2.49 %). In the vicinity of the proposed block leases of bauxite exists which shows the potentiality of the block.

Scope for proposed exploration:

The proposed work for G3 Exploration comprises detailed topographic and geologic mapping in 1: 4000 scale and drilling in 200m grid within the Naredi Bauxite Block (about 10 m depth for

each borehole) over an area of 3.92 sq km at 200 by 200m grid as per the MEMC guidelines for G3 level for bodies of irregular habit.

Recommendations of G4 Stage Mineral Prospecting Report: The available information provided by CGM Gujarat, and recommendation of CGM Gujarat for carrying out G3 level exploration as well as the information in the GSI literature suggests to carry out exploratory mining and drilling to prove the quality and quantity in these area .

Objectives: The proposed G3 level mineral prospecting is planned for carrying out exploration of Aluminous Laterite / Bauxite with significant values of Ga extending below the Eocene carbonate rock formations.

2. Previous Work:

The document released by the Commissioner of Geology and Mining, titled "Gujarat's Mineral Wealth: A Responsible Exploration and Development Paradigm," on August 17, 2024, highlights the geological features of the region comprises of Fulra Formation (Clay and marl), Gaj Formation (Limestone and Shale), Anjar volcanics (Basalt) and Matanomadh formation, which is known to contain bauxite deposits.

The Commissioner of Geology and Mining conducted a prospecting study of the area through methods such as pitting, trenching, resulting in an estimated resource of 27.85 million tons of bauxite. Chemical analysis of the bauxite revealed an average aluminum oxide (Al2O3) content of 49.77%, accompanied by a low silicon dioxide (SiO2) percentage of 2.49%.

Furthermore, the presence of existing bauxite leases and mines owned by GMDC in the vicinity shows the potential of this proposed block for bauxite mining and development. This combination of resource estimation and favorable chemical composition indicates significant opportunities for sustainable mineral exploration in Gujarat.

The NGCM (GSI) data for Soil Regolith near Naredi (TS 41 E/04) shows Al2 O3 value of 22.48 % and Gallium value of 29 ppm.

3. a. Block description (Naredi Block): Boundary Coordinates of Naredi Block are given below.

Table-1. Boundary coordinates of Naredi block, Karnataka

Sl no.	Longitude	Latitude
1	69°10'49.81"E	23°10'50.69"N
2	69°10'8.48"E	23°11'46.48"N
3	69°11'26.98"E	23°12'9.32"N
4	69°11'56.68"E	23°11'22.75"N
5	69°10'58.24"E	23°11'8.18"N

b. Coordinates of Proposed Borehole Locations: Geographical coordinates of the proposed borehole locations are given in the Annexure-1.

4. Planned Methodology:

a. **Geological and geomorphological Mapping in 1:4000 scale**: Reference points will be established within the mapping area by level transferring of SoI (Survey of India) benchmark point. The total area of 3.92 sq km will be mapped on 1:4000 scale using DGPS survey method to bring out different geological and geomorphological units

b. All the mapped units will be linked (geo-referenced) to the toposheet (41 E/04) pertaining to the area.

c. **Core drilling for Sub surface mineral content**: the collection of sub-samples at 1.0 m interval in 91 borehole drilled upto 10m or upto bedrock whichever is occurring earlier ,at 200 by 200m grid pattern covering the entire block.

5. Feasibility Studies:

a. **Geology:** Geological mapping on 1:4000 scale and 9 1 borehole locations up to 10.0m depth at 200m x 200m grid size will bring out the mineral potential of the block.

6. Nature, Quantum, and Target:

a. Mapping in 1:4,000 scale incorporating all geomorphological units, manmade structures, streams etc. falling within and around the area. (Total area of 3.92 sq km.)

Table 3: Nature, Quantum, and Targets

Sl. No.	Description of Work	Quantum (SqKm/ Number)	Time required
1	Geological & Geomorphological mapping in 1: 4000 scale with DGPS Survey (Total 3.92 sq km)	3.92 sq km	75 days
2	Bore hole up to 10.0m depth	91 BH	120 days
3	XRF, ICP AES and ICP-MS, fire assay analysis and Bulk density determination,	303 nos.	180 days
4	Report Writing		90 days

7. Break-up of expenditure and Time schedule:

Attached as separate sheet: Attached as Excel

References:

1. *G.R. Kulkarni and G. Thothathiri, geology of parts of Abdasa, Nakhatrana and Mandvi Taluks, Kutchchh District, Gujarat state.*
2. *Document released by Commissioner of Geology and Mining: Gujarat's Mineral Wealth: A Responsible Exploration and Development Paradigm, published on 17 August 2024.*
3. *Chowdhury, A.N., Chakraborty, S.C., and Bose, B.B., 1965, Geochemistry of gallium in bauxite from India: Economic Geology, v. 60, p. 1052–1058.*
4. *Hui Qi, Neng Gong, ShengQiang Zhang, Jun Li, Guo-Li Yuan, Xue-Fei Liu(2023) Research progress on the enrichment of Gallium in Bauxite. Ore Geology reviews, ELSEVIER,Vol 160,Sept 2023, 105609.*
5. *Hua, Y., Zhang, Ta., Wang, L. (2024). A Review of the Extraction of Gallium from Bauxite Ores. In: Iloeje, C., et al. Energy Technology 2024. TMS 2024.*

Plate-1: **Map showing Naredi block on Toposheet no. 41E/04**

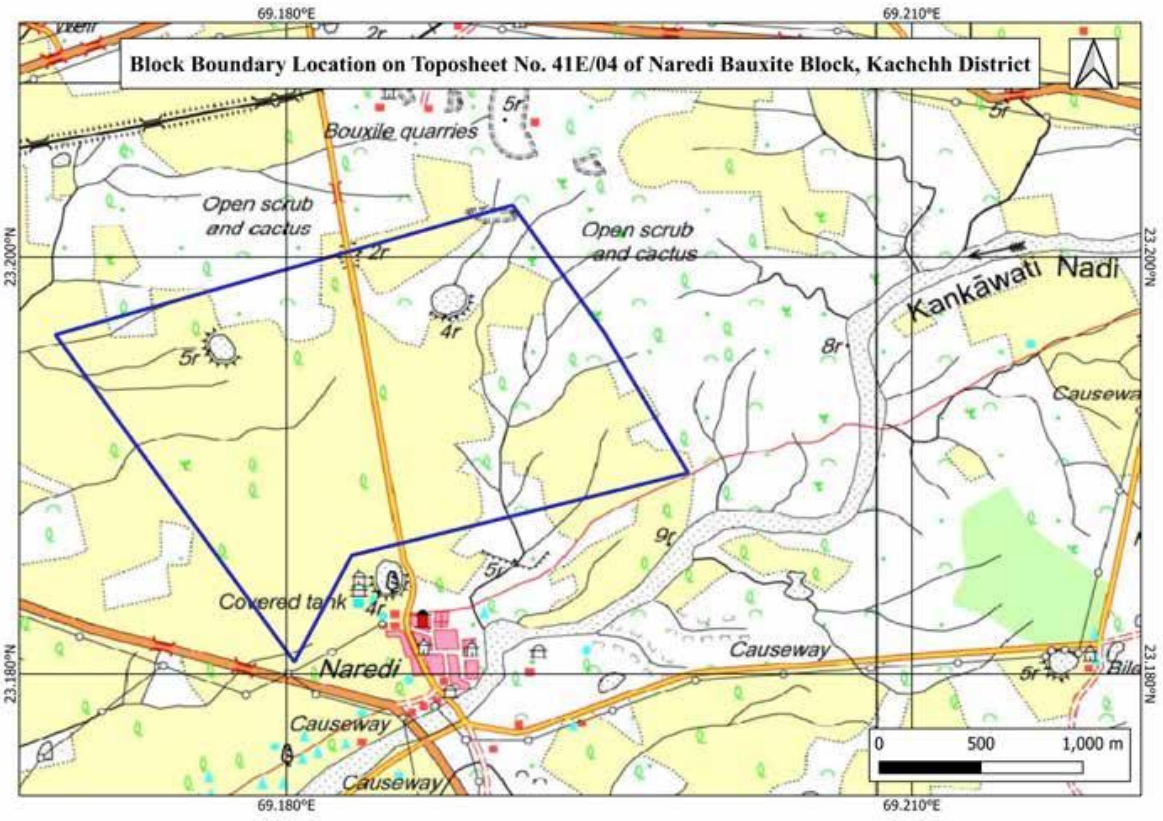


Plate-2: Block Boundary in 1:50K Map (source: GSI)

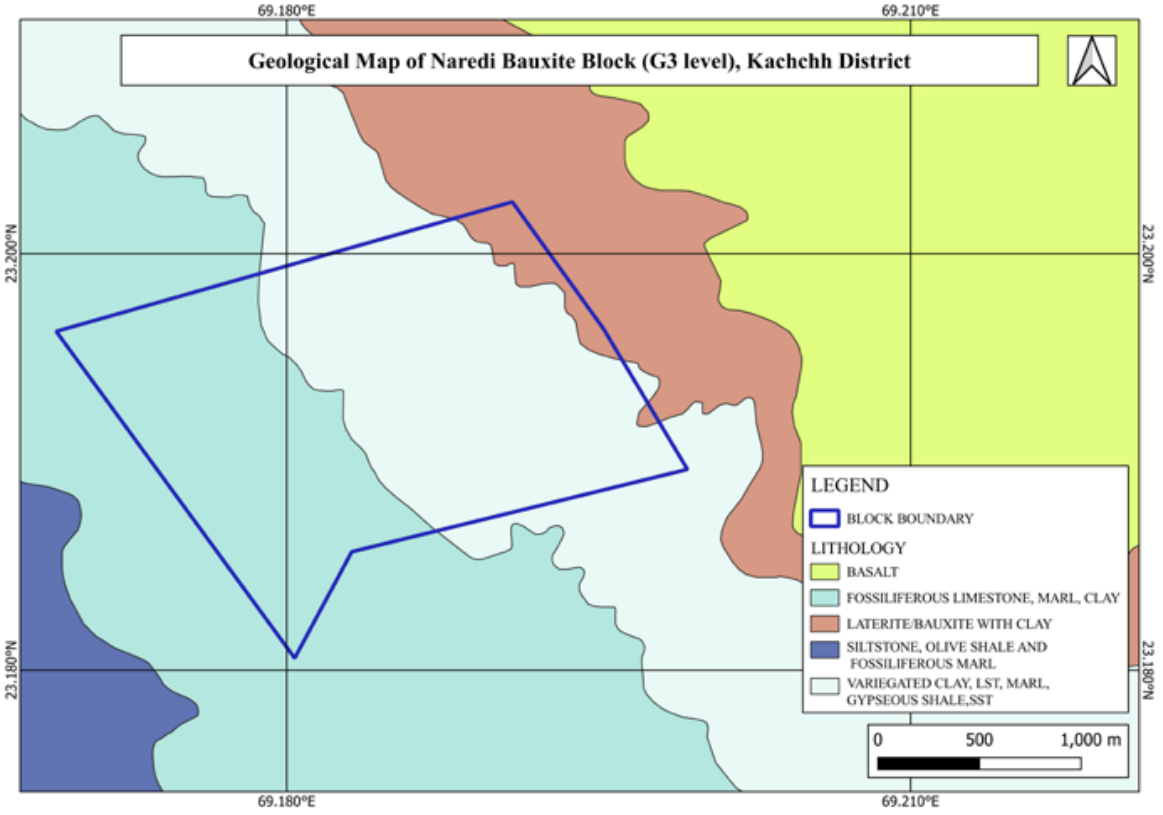


Plate-3: NGCM (GSI) data for Soil Regolith in Toposheet. No. 41 E/04

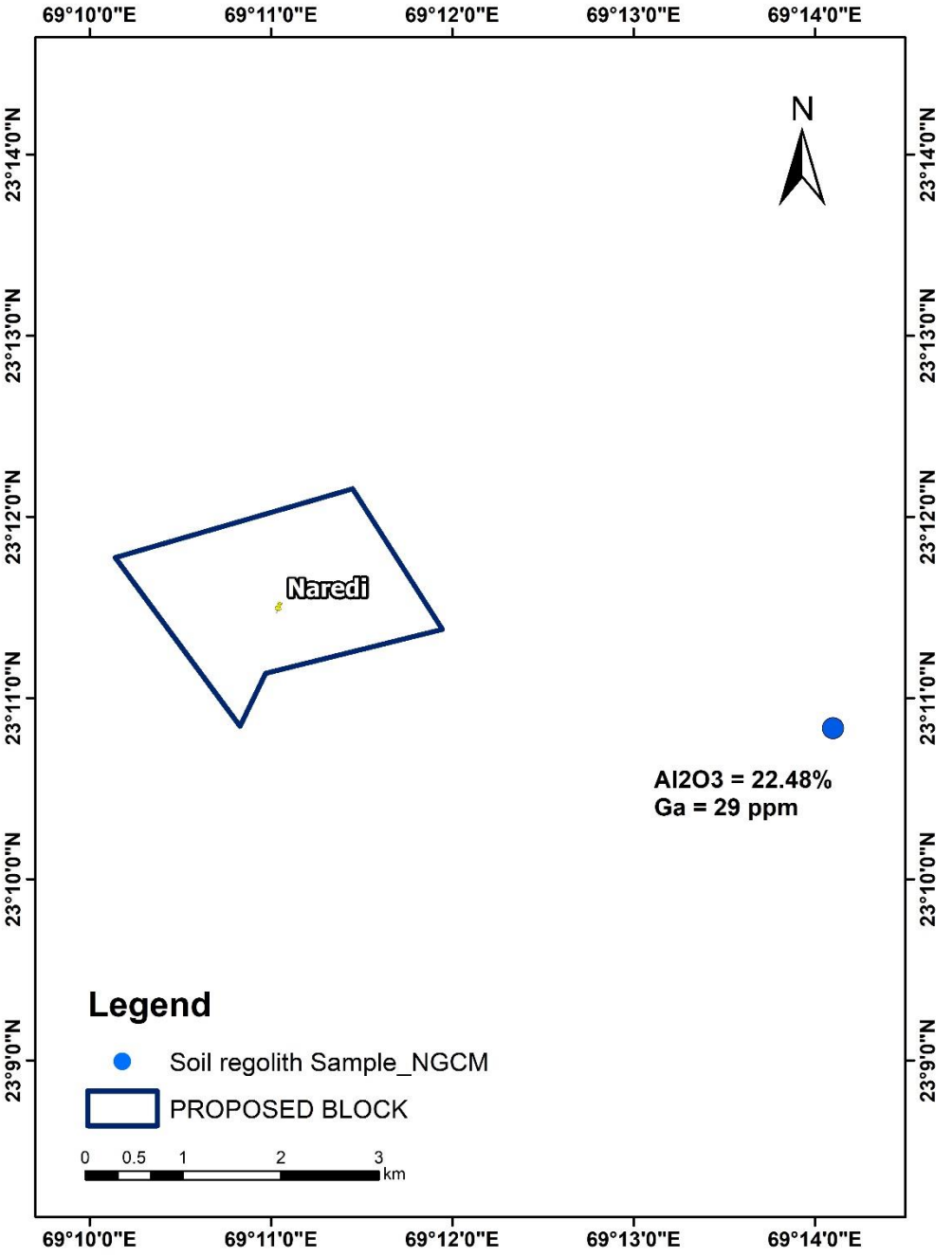


Plate-4: Map showing Sample locations (200x200m grid) in Naredi block in 3.92 sq.km.

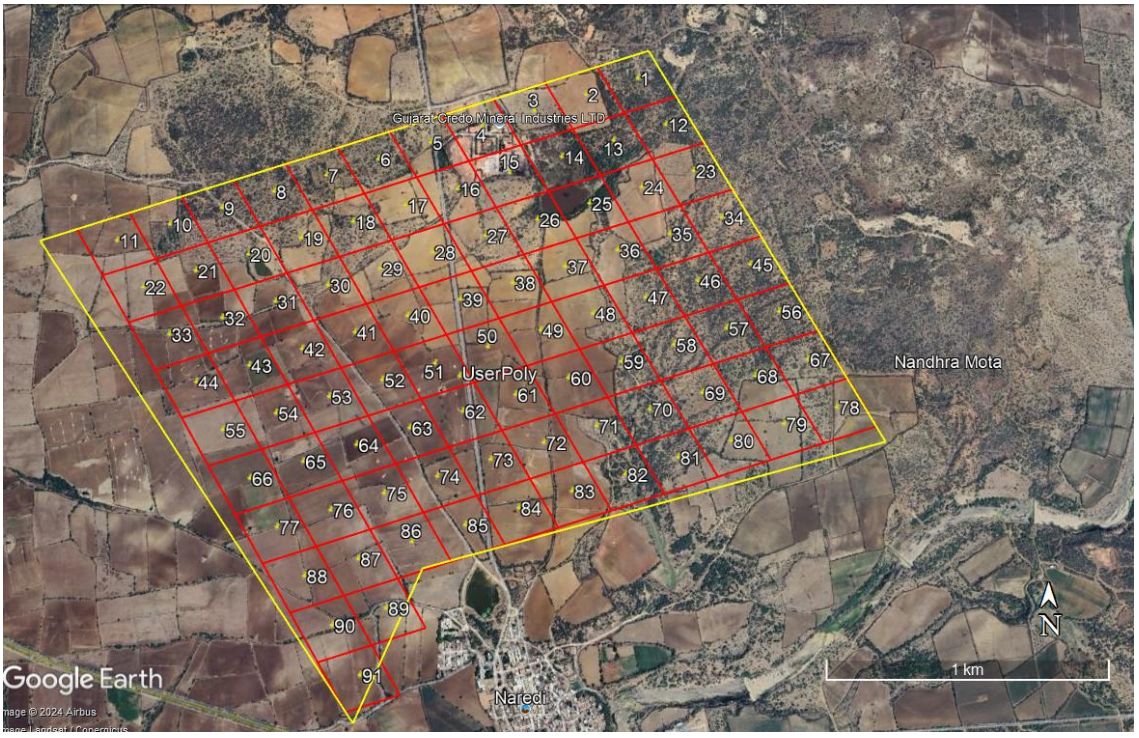
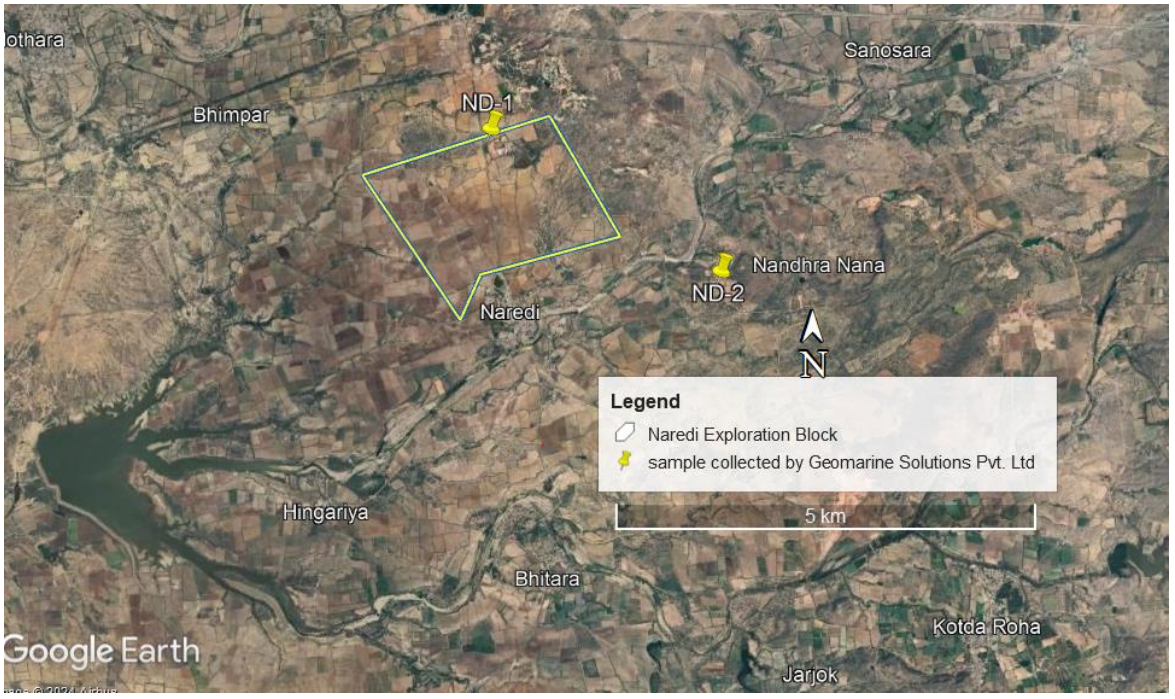


Plate-5: Block Boundary and location of sample collected in Google earth imagery



Annexure -1. Coordinates of Borehole points

PointName	Longitude	Latitude
1	69.19039	23.20154
2	69.18853	23.201
3	69.18667	23.20046
4	69.1848	23.19992
5	69.18294	23.19938
6	69.18108	23.19884
7	69.17921	23.1983
8	69.17735	23.19776
9	69.17548	23.19722
10	69.17361	23.19667
11	69.17175	23.19613
12	69.19138	23.19999
13	69.18952	23.19945
14	69.18766	23.19891
15	69.18579	23.19837
16	69.18393	23.19783
17	69.18206	23.19729
18	69.1802	23.19675
19	69.17834	23.19621
20	69.17647	23.19567
21	69.17461	23.19513
22	69.17274	23.19459
23	69.19238	23.19843
24	69.19051	23.19789
25	69.18865	23.19735
26	69.18678	23.19681
27	69.18492	23.19627
28	69.18305	23.19573
29	69.18119	23.19519
30	69.17933	23.19465
31	69.17746	23.19411
32	69.1756	23.19357
33	69.17373	23.19303
34	69.19337	23.19687
35	69.19151	23.19633
36	69.18964	23.1958
37	69.18777	23.19526
38	69.18591	23.19472
39	69.18404	23.19418
40	69.18218	23.19364
41	69.18032	23.1931
42	69.17845	23.19256
43	69.17659	23.19202

PointName	Longitude	Latitude
44	69.17472	23.19147
45	69.19436	23.19532
46	69.1925	23.19478
47	69.19064	23.19424
48	69.18877	23.1937
49	69.1869	23.19316
50	69.18504	23.19262
51	69.18317	23.19208
52	69.18131	23.19154
53	69.17944	23.191
54	69.17758	23.19046
55	69.17571	23.18992
56	69.19535	23.19376
57	69.19349	23.19322
58	69.19163	23.19268
59	69.18976	23.19214
60	69.1879	23.1916
61	69.18603	23.19106
62	69.18417	23.19053
63	69.1823	23.18998
64	69.18044	23.18944
65	69.17857	23.1889
66	69.17671	23.18836
67	69.19634	23.19221
68	69.19448	23.19167
69	69.19262	23.19113
70	69.19075	23.19059
71	69.18889	23.19005
72	69.18702	23.18951
73	69.18516	23.18897
74	69.1833	23.18843
75	69.18143	23.18789
76	69.17957	23.18735
77	69.1777	23.18681
78	69.19733	23.19065
79	69.19547	23.19011
80	69.19361	23.18957
81	69.19174	23.18903
82	69.18988	23.18849
83	69.18801	23.18795
84	69.18615	23.18741
85	69.18429	23.18687
86	69.18242	23.18633

87	69.18056	23.18579
88	69.1787	23.18525
89	69.18155	23.18424

90	69.17969	23.1837
91	69.18068	23.18214

Field Photos by Geo Marine Solutions Pvt Ltd from the vicinity of Naredi Bauxite Block