Dr. Dhaval Patel, IAS
Commissioner of Geology & Mining
Industries & Mines Department
Government of Gujarat

G20

No: CGM/EXPL/NMET-HME/945/2023-24 /44 to 45

Date: 20 JAN 2024

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

Subject: Submission of detailed placer xenotime prospect Block reports for NMET funding.

Reference: 1) Geo Marine Solution Private Limited letter No. NMET/Dandi-Onjal-Surwada/2022-23/04 dated 27.12.2023.

Respected Sir,

With respect to above mentioned subject and reference, Geo Marine Solution Private Limited, Notified Private Exploration Agencies (NPEA), has submitted detailed project reports for heavy minerals (Ilmenite- Titanomagnetite- Magnetite) for vanadium and titanium vide reference to this office. The same is mentioned below:

1. Proposal for UNFC G3 Level prospecting for vanadium and titanium in Beach & Dune sands of Dandi-Onjal-Surwada Block in Navasari and Valsad Districts, Gujarat State

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,
20/1/24
(Dr. Dhaval Patel, IAS)
Commissioner
Geology and mining,
Gujarat State, Gandhinagar

Enclosed: As above

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

Block 15, Dr. Jivraj Mehta Bhavan, Sector-10 B, Gandhinagar - 382010, Gujarat.
Ph. : +91-79-23254151 | eMail: commissioner-cgm@gujarat.gov.in | www.cgm.gujarat.gov.in

Geo Marine Solutions Private Limited

'Earth-Ocean Science Survey & Consultancy'

4-35/4(10), Sankaigudda, Bejai,
Mangalore-575004, Karnataka, India

Letter No.: NMET/Dandi-Onjal-Surwada /2022-23/04 27.12.2023

To,
The Commissioner of Geology and Mining
Block 15,
Dr. Jivraj Mehta Bhavan,
Sector - 10, Gandhinagar – 382010, Gujarat
Email: commissioner-cgm@gujarat.gov.in

Sub: Submission of Proposal for UNFC G3 Level prospecting for Vanadium and Titanium in Beach & Dune sands of Dandi- Onjal- Survada block in Navsari and Valsad districts of Gujarat State under 'National Mineral Exploration Trust' funding.

Sir,

Our firm is an accredited Private Exploration Agency vide Govt of India Gazette Notification Number: CG-DL-E-29092022-239223, No.4399 dated 29 -09-2022. (copy attached).

With reference to the subject, we hereby submit the UNFC G3 Level mineral prospecting proposal for Titanium and Vanadium in beach and dune sands (critical minerals) in Dandi-Onjal-Surwada Block in Surat and Navsari Districts, Gujarat State, for your kind perusal and in -principle approval. Once approved, kindly forward the proposal to NMET, Ministry of Mines, Govt of India, New Delhi with intimation to us.

Please inform, if any modifications are required in the proposal.

Thanking you

Yours truly

GEO MARINE SOLUTIONS PVT. LTD. MANGALURU 575004

P. Praveen Kumar
Director
for Geo Marine Solutions Pvt Ltd
Bejai, Mangalore
praveen@geomarinesolutions.in

Proposal for UNFC G3 Level prospecting for Vanadium and Titanium in Beach & Dune sands of Dandi- Onjal- Survada Block in Navsari and Valsad districts of Gujarat State

by

Geo Marine Solutions Pvt. Ltd., Mangalore

4-35/4(10), Sankaigudda, Bejai, Mangalore, Karnataka

December 2023

Proposal for UNFC G3 Level prospecting for Vanadium and Titanium in Beach & Dune sands of Dandi- Onjal- Survada Block in Navsari and Valsad districts of Gujarat State.

By

Geo Marine Solutions Pvt. Ltd., Mangalore
4-35/4(10), Sankaigudda, Bejai, Mangalore, Karnataka

Mangalore

27 Dec 2023

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Summary of the Proposal for UNFC G3 Level prospecting for Vanadium and Titanium in Beach & Dune sands of Dandi- Onjal- Survada block in Navsari and Valsad districts of Gujarat State

	Features	**Details**
	Block ID	Guj-HM-1
	Current Exploration Agency	Geo Marine Solutions Pvt. Ltd., Mangalore for Detailed Mineral exploration
	Previous Exploration Agency	MCSD, GSI (G4stage GR Producing Agency)
	G4 stage Geological Report (Previous Stage Geological Report)	Information based on Published literature
	Commodity	Heavy Minerals (ilmenite-titanomagnetite-magnetite) for Titanium and Vanadium
	Mineral Belt	Heavy Mineral sands along Gujarat Coast
	Completion Period with entire Time schedule to complete the project	Mobilization: Thirty days from issue of work order/LOA. Field work: 75 days Analysis and report: 90+30 days
	Objectives	To understand the surficial distribution and downward continuity of economic heavy minerals (magnetite-titanomagnetite-ilmenite) by pit/trench sampling at 400m x 100m interval and scout drilling up to 10m below ground level.
	Whether the work will be carried out by the proposed agency or through outsourcing and details thereof. Components to be out sourced and name of the outsource agency	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
	Expected Field days (Geology)	75

1.	**Location**	Dandi-Onjal-Surwada, Gujarat
	Latitude	Dandi: 20°53’17.82’’ N Onjal: 20° 49’ 23.70’’ N Surwada: 20° 33’ 52.47’’
	Longitude	Dandi: 72°48’14.58’’ E Onjal: 72° 50’ 28.92’’ E Surwada: 72° 54’ 06.01’’ E
	Villages	Dandi, Onjal, Surwada
	Tehsil/Taluk	Jalalpore Taluk, Jalalpore Taluk, Valsad Taluk respectively
	District	Navsari, Navsari and Valsad Districts respectively.
	State	Gujarat
2.	**Area (hectares/square kilometers)**	
	Block Area	2.17sq.km
	Forest Area	NIL
	Government Land Area	2.17 sq.km
	Private Land Area	NIL
3.	**Accessibility**	
	Nearest Rail Head	Navsari- 13 Km
	Road	Dandi, Onjal and Surwada
	Airport	Surat (30km)
4.	**Hydrology**	
	Local Surface Drainage Pattern (Channels)	Dandi and Onjal sectors are situated between Purna River in the north and Kanai Creek in the south. Whereas, Surwada sector is in between Auranga River in the north and Par River in the south.
	Rivers/Streams	Purna River, Kanai Creek, Auranga River and Par River. All rivers are flowing in to the Gulf of Khambhat and Kanai creek is opening to the same gulf.
5.	**Climate**	

	Mean Annual Rainfall	1626mm in Valsad district. 1220 mm in Navsari district.
	Temperatures (December)(Minimum) Temperatures (June)(Maximum)	Navsari: min. temp. is 17°C and max. 42°C Valsad: min. temp. is 27°C and max. 35°C
6.	**Topography**	
	Toposheet Number	Toposheet No. 46D/13&14
	Morphology of the Area	The study area comprises different coastal geomorphic feature like beach, berm, dunes, sand bars etc. of different ages and fluvial geomorphic features like creeks and alluvial planes. Active beaches are very prominent all along the study area and have varying width from 20m to more than 100m. Another prominent geomorphic unit is dune, both older and younger. They have an approximate height of 6.0m extending almost parallel to the beaches. Dunes are having maximum thickness near Kalu Nadi and Par River mouth. In the northern part, mud flat, alluvial plain, valley fill and flood plains are exposed with sediments of Quaternary age and in the south of Udwada village sheeted rocks exposed showing a rugged topography with small narrow sandy beaches. The rivers flowing to the Arabian Sea in the study area are Purna, Ambika, Auranga, Par, Kolak, Damanganga and Kalunadi. Kanai creek is flowing to the Arabian Sea in the northern part of the study area (Dinesh et al., 2013, 2015).

7	**Availability of baseline geoscience data**	
	Geological Map (1:50K/25K)	The proposal is based on the published literatures mentioned in the reference. Geological inputs pertaining to the area falling in 46D/13&14 are available and referred while preparing the write up.
	Geochemical Map	**N.A.**
	Geophysical Map (Aerogeophysical, Ground geophysical, Regional as well as local scale GP maps)	**N.A.**
8.	**Justification for taking up G3 level Mineral Exploration** The preliminary investigation for locating possible ilmenite bearing coastal sand in Navsari, Surat and Valsad district was conducted by Department of Industries and Mines, Gujarat during 2000-2002 (Pandya, 2002). Further, in pursuance of item number 69 of field season programme for the year 2012-13 (FSP Code: 2012-13/ME/IM/WR/Guj/055), a preliminary assessment of heavy minerals was carried out along Gujarat coast between Dumas, Surat District and Tithal, Valsad District, by Op: Gujarat, WR, GSI, Gandhinagar. The objective of the work was to locate and study the heavy mineral potential of the area. Good concentration of ilmenite, titanomagnetite and magnetite were reported in the beach and dune sands in selected areas and vanadium concentrations in titanomagnetite are found to be very encouraging as well (Basheer, 2013). Concurrently, a field investigation was also mounted by MCSD, GSI (FSP item No. 067/2010-12/MGR/SR/2011/67) for a preliminary appraisal of heavy mineral occurrences from Dandi in the north to Daman in the south for a distance of about 55 km along the coast of Gujarat during FS 2010-2012. Total 45 sediment samples were collected from beach and dune. Eighteen samples were from beach and the rest twenty-seven samples from different parts of dune occurring parallel to the shoreline were collected (Plate-1). The total heavy mineral percentage values in the beach sediment samples range from 0.3% to 71.5%. Heavy minerals are mostly concentrated in 120 and 230 ASTM sieve size fractions (0.125mm and 0.063mm size) i.e. in fine and very fine sand fractions.	

Beach sample no. 8B, 14B and 13B collected near to Par River mouth, south and north of Dandi respectively have maximum amount of heavy minerals (>50%) as well as ilmenite content. Seven out of 18 beach samples have high content (>5%) of magnetite. In most of the samples, size fractions 120 and 230 show sympathetic relation with heavy mineral concentrations. Like total HM concentration, the sample Nos. 8B, 13B and 14B have maximum magnetite percentage values. Six out of 18 beach samples are having more than 2% ilmenite concentration. Further, the three samples 8B, 13B and 14B carry maximum ilmenite values ie; 32%, 24% and 37% respectively (Dinesh et al., 2013,2015).

The total heavy mineral percentage values in dune sediment samples range from 0.03% to 59%. Like that of beach sediments, the heavy minerals are mostly concentrated in fine and very fine sand fractions. About 10 dune samples out of 27 have more than 10% total heavy minerals. Maximum HM concentration (59%) was observed in sample no.10A' collected from dune near Surwada. Samples collected at 1A, 2A, 4A and 20A' have only less than 2% HM and the remaining dune samples carry more than 2% heavy minerals. 11 out of 27 dune samples are enriched with more than 5% magnetite and 4 dune samples show more than 4% ilmenite enrichment (Dinesh et al.,2013, 2015).

The major economic heavy mineral constituents in the beach and dune sediments are found to be ilmenite and magnetite in the area. The source rock of these minerals is attributed to the deccan basalt and related rocks occurring in a vast area in the hinterland. The other heavy minerals like rutile, sillimanite, zircon etc. present in minor quantity. The beach sediments occur along a small stretch west of Dandi and Purna River mouth are found to be highly enriched in ilmenite. The dune sediments occur along a long stretch between Dandi and Kanai creek and a small stretch near Surwada are enriched in ilmenite. GSI has recommended for detailed exploration in the area to know the downward extension of the ilmenite concentration (Dinesh et al., 2013, 2015).

Ilmenite is compositionally $FeTiO_3$. The TiO_2 demand in India grew at a CAGR (Compound Annual Growth Rate) of 8.25% during 2015-2019 and is anticipated to achieve a healthy growth rate during this decade too. TiO_2 pigment is used as a raw material in paints, paper, tooth paste, plastics, inks etc. TiO_2 is an important component in paints holding 25% in its total content. Increasing demands for paints is certain due to expanding construction industry and ongoing infrastructure

development that will boost the demand for TiO2 during the forecast period

2022- 2030 (Chem Analyst, June, 2020). India's Construction Market is expected to register a CAGR greater than 10% during 2022–2027 (Mordor Intelligence, 2023). The infrastructure sector in India is predicted to grow at a CAGR of 8.2% by 2027, signifying the need for robust enhancement of the sector, the Government has also allocated INR 10 Lakh crore in the Union Budget 2022-23 (Kishore Gurumukhi, Jan., 2023).

The installed production capacity of titanium dioxide (TiO2) in India has remained constant at 82,500 metric tons in recent years. In fiscal year 2021, the titanium dioxide production volume in India stood at approximately 51,000 metric tons (Statista Research Department, Feb 9, 2023). Hence, around 70% of the domestic TiO_2 demand is met through imports mainly from China. Increasing investments in promoting domestic production of TiO_2 and curtailing India's reliance on imported volumes from China would propel TiO_2 market prospects in the forecast period (2022-2030) (Chem Analyst, June, 2020).

Vanadiferous titanomagnetite (VTM): The bulk sediments from Gulf of Khambhat contain up to 28.5% of heavy minerals with an average of 12.5%. Within the heavy minerals, more than 50% are opaque in nature represented by titanomagnetite, magnetite and ilmenite. SEM–EDX studies on handpicked opaque grains indicated a higher concentration of vanadium up to 1.1%. The result was confirmed by AAS analysis of magnetic heavy mineral fraction that showed a concentration of vanadium up to 0.36%. Subsequently, XRD analysis of the heavy minerals of randomly selected samples revealed the presence of vanadium-bearing titanomagnetite as well as the vanadium mineral phase, melanovanadate. EPMA studies carried out in titanomagnetite grains revealed V_2O_3 content of 0.36–1.7% with an average of 1.3%. Based on the analytical studies, it is inferred that the vanadiferous titanomagnetites in the Gulf of Khambhat are possibly drained from Deccan basalt mainly through the Rivers of Narmada and Tapti (Gopakumar et al., 2022). High content of vanadium is also reported in Deccan Trap basalts by Sethna and Sethna (1990, 1998).

In India, vanadium is associated with titaniferous magnetite which contains 0.8 to 3% V_2O_5. It also occurs in significant amounts in association with chromite, laterite, bauxite and ferro-magnesian-rich rocks, such as, pyroxenite, base anorthosite and gabbro. As per NMI database, based on UNFC system, the total estimated reserves/resources of vanadium ore as on 1.4.2015 are placed at 24.63 million tonnes with an estimated V_2O_5 content of 64,594 tonnes. The entire resources of vanadium are placed under remaining resources category only. India consumes 4% of about 84,000 metric tonnes of vanadium produced across the globe in 2017. China, which produces 57% of the world's vanadium, consumed 44% of the metal (IBM, 2018).

The worldwide demand for vanadium is directly related to the demand for steel specially with demands of high-strength steel. In vanadium batteries, the consumption may increase in future. On the other hand, with growth of Automobile and Casting Sectors, demand for ferrovanadium is expected to increase and this will have to be met by imports. The accelerated growth in the Forging Industry and increased demand for die steels and tool steel too, have paved way for increased vanadium consumption. Imperatives for utilisation of the huge vanadium-bearing titaniferous ores available in the States viz, Karnataka, Maharashtra and Odisha, through R&D efforts will have to be initiated to meet the domestic demand of vanadium pentoxide and ferrovanadium (IBM, 2018).

Vanadium is much sought after metal now a days for its use in alloys because of its ductile, malleable and non-corrosive nature. Steel Authority of India Limited (SAIL) /Bhilai Steel Plant (BSP) has successfully rolled out vanadium alloyed special grade Rails, R 260 grade, for the Indian Railways and the first rake was flagged off on 30th June, 2020. Indian Railways have initiated replacing the old rails made of carbon steel with vanadium alloyed special R 260 grade rails(SAIL, 2020). Hence, a huge requirement of vanadium is being envisaged in the years to come. Vanadium is also used primarily as an alloying element in the Iron & Steel Industry and to some extent as a stabiliser in titanium and aluminium alloys used in the aerospace Industry.

A recent exploration by Geological Survey of India **(GSI)** has found reserves of vanadium in Arunachal Pradesh. Concentrations of vanadium have been found in the palaeo-proterozoic carbonaceous phyllite rocks in the Depo and Tamang areas of Papum Pare district in Arunachal Pradesh. This is the first report of a primary deposit of vanadium in India with an average grade of 0.76% V_2O_5 (vanadium pentoxide). The metal is recovered as a by-product from the slag of processed vanadiferous-magnetite (iron) ores. The largest deposits of vanadium are in China, followed by Russia and South Africa respectively (The Hindu, Jan., 2021, Drishti, Jan., 2021 & Journals Of India, Jan., 2021).

In nutshell, the opaques present in the sediments are ilmenite-titanomagnetite- magnetite mineral suite that may be considered to be multi-metal (Ti-V) bearing deposit.

This suggests, the entire opaques are economically significant and can be fully utilized.Hence, an area of 2.17 sq.km has been demarcated between Purna

	River and Par River mouths (Plate-2) mainly covering the dunes occurring along the shoreline. The sectors are named Dandi, Onjal and Surwada which constitute Dandi-Onjal-Surwada Block (Plate-3 to 11). Total 73 locations are being proposed for surface sampling by pitting/trenching up to 1m below ground level and drilling up to 10.0m below ground level at 10 locations to understand surface distribution and the downward continuity of ilmenite-titanomagnetite-magnetite mineral suite which altogether form a source for Ti-V-Fe metals. Sixteen pit/trench locations in the Dandi sector (Plate-4), thirty-nine pit/trench locations in the Onjal sector (Plate-6) and eighteen in the Surwada sector (Plate-8) are being planned. The 10 borehole locations are spread across entire block. The sectors were selected as per the data and recommendations of GSI as explained above (Dinesh et al., 2013 and 2015). As per AMD's communiqué to IBM (via letter dt. 26^{th} July, 2018), 2.77 million tons of ilmenite and 0.02 million ton of rutile resources have been estimated between Moti Daman in the south and Ubhrat in the north about 70 km stretch along the coast of Gujarat (IBM, 2020). The proposed areas: Dandi, Onjal and Surwada for prospecting is falling between Moti Daman and Ubhrat.

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; Mainland Gujarat, Saurashtra and Kachchh. The area falls under Mainland Gujarat which is further divisible to two well defined subzones: the Eastern Rocky Highlands and the Western Alluvial Plains. The coastline is a dynamic environment. Gujarat coastline stretches to about 1600 Km facing the Arabian Sea, is quite distinctive from the rest of the west coast of India. The coastal zone of Gujarat is characterized by a variety of geomorphic forms and geological features evolved under different structural controls during the Quaternary period. The present coastline shows much variation in its trend, shoreline features and nearshore and offshore characters. The Coastal tracts has a varying width of about 5 to 80 Km. It covers about 27,000 sq. km stretch sharing about 14% area of the entire state (Rekha & Sarangi, 2000). The area comprises different coastal geomorphic features like beach, berm, dunes, sand bars etc. and fluvial geomorphic features like creeks, alluvial planes etc. are also present. The Dandi and Onjal sectors are situated in between Purna River in the north and Kanai Creek in the south. The Surwada sector is lying between Auranga River in the north and Par River in the south (Plate-2).

Background Information: The Geology of Gujarat comprises a Precambrian basement over which younger rocks commencing with Jurassic, continuing through Cretaceous, Tertiary and Quaternary have given rise to varying sequence in its different parts. The sedimentary sequences are Jurassic, Tertiary and Quaternary in age (S.S. Merh, 1995).

In pursuance of item number 69 of field season programme for the year 2012-13 (FSP Code: 2012-13/ME/IM/WR/Guj/055), a preliminary assessment of heavy minerals was carried out along Gujarat coast between Dumas, Surat District and Tithal, Valsad District. The objective of the work was to locate and study the heavy mineral potentiality of the area. Good concentration of ilmenite, titanomagnetite and magnetite were reported in the beach and dune sands in selected areas and vanadium concentrations in titanomagnetite are found to be very encouraging as well (Basheer, 2013).

This has prompted Marine & Coastal Survey Division of GSI to take up FSP item 067, reconnaissance survey for a preliminary appraisal of heavy mineral occurrence from Dandi in the north to Daman in the south along the coast of Gujarat was taken up through systematic sample collections along beach and dune.

Forty-five sediment samples were collected and subjected to sedimentological studies. Since the samples were collected from two different geomorphological units viz; beach and dune, 18 beach and 27 dune sediment samples were analysed separately to understand the grainsize statistical characters and heavy mineral concentrations. The results of this field season item (067) were published in the Indian Journal of Geosciences (Dinesh et al., 2013, 2015).

Beach Sediments: Granule sized shells and shell fragments vary from 0 to ~5% whereas sand sized carbonate percentage varies between 3.5 and ~24%. None of the sample is dominated by carbonate granule or carbonate sand while all the samples are dominated by carbonate free sand which ranges from 65 to 96%. The mud content is very low in most of the samples except the samples 1B and 14B (Dinesh et al.,2013, 2015). The former has a mud content of ~7% and was collected near to the muddy Kalu river mouth in the south of the area and the latter sample no. 14B was collected near to Dandi and carries about 5% mud in which majority of the portion constitutes silt sized heavy minerals. The mean size of 18 beach sediments varies between 0.56 and 3.4 phi and sorting from 0.47 to 1.88. More than half (~56%) of the sediments are moderately well sorted and ~22% are poorly sorted (Dinesh et al., 2013 & 2015).

Dune Sediments: Granule sized shells and shell fragments are present in negligible quantity that varies from 0 to ~2% whereas carbonate sand percentage varies in a wider range between 5 and 55%. Sample 11A'', collected from older dune near Tithal has a maximum carbonate sand content (~55%). Carbonate free sand dominates in all the samples except the one collected at 11A''. The carbonate free sand values range from 44 to 94% and mud is negligible in most of the samples except 14A (~8%) in which the major constituents are silt sized heavy minerals like ilmenite, magnetite etc. Carbonate sand contents in dune sediments are relatively more than that of the beach sediments. The mean size varies between 0.003 and 3.2 phi and sorting from 0.43 to 1.3. Most of the sediments are moderately sorted to moderately well sorted. But a few sediment samples are either poorly sorted or well sorted in nature. (Dinesh et al., 2013 & 2015).

Mineralogy: The beach sediments are mostly dominated by iron oxides and opaques with minor presence of shell fragments, quartz, sillimanite, rutile, ortho and clino pyroxenes and rarely zircon. But at sample location 4B, the sediment is dominated by coarse sand sized basaltic rock grains and whereas at 6B, sediment is dominated by shell fragments and clino pyroxene. The dune sediments are mostly dominated by rock grains of basaltic composition, iron oxides and opaques. Some samples are dominated by pyroxenes and iron oxides and opaques.

Heavy Minerals: Heavy minerals especially ilmenite and magnetite are generally enriched in fine sand, very fine sand and silt sized grains of both beach as well as dune sediments. Heavy minerals are not generally observed in the coarser fractions ie; medium to very coarse sand.

The total heavy mineral percentage values of beach sediment samples range from 0.3 to 71.5%. Heavy minerals are mostly concentrated in 120 and 230 fractions. However, sample no. 1B and 14B carry 4 to 6% heavy minerals in -230 fraction. Sample no. 8B, 14B and 13B collected near to Par River mouth, south and north of Dandi respectively have maximum amount of heavy minerals (>50%) as well as ilmenite. Out of 18 beach sediment samples, 14 are having more than 5% heavy mineral concentration after removing magnetite. In most of the samples, size fractions 120 and 230 show sympathetic relation in the heavy mineral concentration. Like total HM concentration, the sample Nos. 8B, 13B and 14B have maximum magnetite percentage values. Six out of 18 beach samples are having more than 2% ilmenite concentration. Further, the three samples 8B, 13B and 14B carry maximum ilmenite values i.e.; 32, 24 and 37% respectively (Dinesh et al., 2013 & 2015).

The total heavy mineral percentage values of dune sediment samples range from 0.03 to 59%. The heavy minerals are mostly concentrated in 120 and 230 fractions. However, sample no. 13A and 14A carry 3 to 6% heavy minerals in -230 fraction. About 10 dune samples out of 27 have more than 10% total heavy minerals. Maximum HM concentration (59%) was observed in sample no.10A' collected from younger dune near Surwada. Samples collected at 1A, 2A, 4A and 20A' have only less than 2% HM and the remaining dune samples carry more than 2% heavy minerals. The HM concentrations in size fractions 120 and 230 do not show any sympathetic relation like that in beach sediments. Out of 27 dune sediment samples analysed, 18 are having more than 5% heavy mineral concentration after removing magnetite. In most of the samples, size fractions 120 and 230 do not show sympathetic relation in the heavy mineral (without magnetite) concentration. Heavy minerals (without magnetite) and magnetite are more concentrated in the size fraction 120 rather than 230 and -230.Ten out of 27 dune samples are having more than 2% ilmenite concentration. The ilmenite concentration in size fractions 120 and 230 does not show sympathetic relation. To the contrary ilmenite is more concentrated in 230 size fractions rather than that of 120. Three samples: 10A', 15A and 17A carry more than 5% ilmenite (Dinesh et al., 2013 & 2015).

Mineral potentiality within the proposed block based on geology

Scope for proposed exploration: The major economic heavy mineral constituents in the beach and dune sediments are found to be ilmenite and magnetite in the area. The beach sediments occur along a small stretch west of Dandi and Purna River mouth are found to be highly enriched in ilmenite and magnetite. Though the occurrence of titano-magnetite within the heavy mineral assemblage has been reported from this area (Basheer, 2013), it has not been looked into in detail. The presence of vanadiferous titano magnetite (VTM) assemblage has also been reported from the immediate offshore in Gulf of Khambhat (Gopakumar et al., 2022). The dune sediments occur along a long stretch between Dandi and Kanai creek and a small stretch near Surwada are also enriched in ilmenite and magnetite. GSI has recommended for detailed exploration in the area to know the downward extension of the ilmenite concentration (Dinesh et al., 2013 & 2015). Since the targeted critical metals (Ti-V) occur in solid solution (ilmenite-titanomagnetite-magnetite), entire opaques will be considered as ore minerals. The ilmenite-magnetite content in the dune sediments of Dandi sector is about 7% where as in the Onjal sector it varies between 9% and 20% and in the Surwada sector it is between 2% and 30%. All these show the proposed sectors are enriched in ilmenite and magnetite and warrants G3 level prospecting.

Recommendations of G4 Stage Mineral Prospecting Report: The available information in the GSI literature and the related published literature suggest to carry out detailed mineral prospecting to understand the downward continuity of heavy mineral placers.

Objectives: The proposed G3 level mineral prospecting is planned for carrying out surface sampling in a grid of 400m along the shoreline and 100m across the shoreline. The surface samples will be collected by pitting/ trenching at each of the location upto a depth of 1.0m below the ground level. Scout drilling is also proposed to be carried out up to a maximum. depth of 10m below ground level at 10 locations within the block. The sub samples at every 1.0m will be collected in each borehole. This would also help to understand the surface distribution and downward continuity of economic heavy mineral (ilmenite- titanomagnetite-magnetite suite).

2. **Previous Work:**

   Attach Complete Previous Geological Report (G4 Stage); G4 and G3 stage reports for G2stage: The GSI Report pertaining to Item No.067 (Dinesh et al., 2013) is the basis for the data dealt here. The scientific paper published based on the Item No.067 of GSI was published in the Indian Journal of Geosciences in 2015 (Dinesh et al., 2015) by incorporating all the relevant data. The paper is attached herewith.

3. **a. Block description (Dandi-Onjal-Surwada Block):** Boundary Coordinates of Dandi- Onjal-Surwada Block are given in the Annexure-2A.

   b. Coordinates of Proposed Pit /Trench and Borehole Locations: Geographical coordinates of the proposed pit/trench and borehole locations are given in the Annexure-2B.

4. **Planned Methodology:**

   a. **Geological and geomorphological Mapping in 1:5000 scale**: Reference points will be established within the mapping area by level transferring of SoI (Survey of India) benchmark point. The total area of 2.17 sq.km in three sectors will be mapped on 1:5,000 scale using DGPS / total station to bring out different geomorphological units like berm, backshore, dune (stabilised/unstablised) etc. present in the area. Geological inputs, streams, rocks and all-important manmade structures if any will be mapped during the course of surveying/mapping.
   b. Detailed analysis of geomorphological units will be carried out in the proposed area.
   c. All the mapped units will be linked (georeferenced) to the toposheets (46D/13&14) pertaining to the area.

d. **Sediment samples:** Surface samples from pits /trenches dug upto a depth of 1.0m below the ground is proposed at 73 locations within entire block. The sampling points are planned in a grid pattern of 400m along the shoreline and 100m across. The shorter grid across the shoreline is intended to capture the different geomorphic units and their control, if any, on mineral content.

e. **Core Drilling for Sub surface mineral content**: the collection of sub-samples at 1.0m interval at 10 borehole locations are proposed upto a depth of 10.0m below ground level (bgl) by means of core drilling. The 10 boreholes up to a depth of 10.0m below surface would generate about one hundred sub-samples. If hard strata not occur within10.0m from ground level, the borehole will be terminated at that point. The sand sediment samples thus collected for every 1.0m depth down the drill hole up to 10.0 m or up to the hard strata whichever occurs earlier will be dried, cone and quartered to segregate into three parts of each sub-sample. One part will be subjected to grain size analysis following the SoP of GSI for grain size analysis and second part will be subjected to separation of opaques by gravity separation and two-level magnetic separation following the SoP of IREL for Heavy Mineral Separation. Third part will be kept in the repository. Further, 5% check samples will be selected and false numbered and sent to IREL Research Centre, Kollam for cross verification of HM data.

5. Feasibility Studies:

a. **Geology:** Geological mapping on 1:5000 scale and seventy-three pit/trench samples at 400mx100m grid size and ten scout bore samples up to 10.0m depth below ground level will bring out the mineral potential of the area. This will help to trace the mineralized beds in space and time.

1. Processing: As mentioned above, an enrichment plant for titano-magnetite is proposed in the vicinity which enables to reconstruct the mined-out dunes using the mine waste and also reduce the amount of transporting material to the V-Ti extraction plant.

The process of beneficiation of titano-magnetite from sands is similar to the process used for the beneficiation of titano-magnetite ore. The main difference is that the titano-magnetite is found in a sand deposit instead of an ore deposit. Here are the basic steps involved in the beneficiation of titano-magnetite from sands:

1. Screening and Crushing: The sand is first screened to remove large particles and then crushed to a fine powder. This process helps to increase the surface area of the sand, which in turn makes it easier to separate the titano-magnetite mineral from the other

minerals present in the sand.

2. Magnetic Separation: The crushed sand is then subjected to magnetic separation, where a magnetic field is used to separate the titano-magnetite mineral from the non-magnetic minerals such as quartz, feldspar, pyroxene, mica etc. This step is critical in the beneficiation process as it enables the separation of the valuable mineral from the waste material. Depending on the type of opaques present there may be two levels of magnetic separation.
3. Flotation: In some cases, the titano-magnetite sand may undergo a flotation process to further enrich the mineral content. In this process, chemicals are added to the crushed sand to create a froth that contains the titano-magnetite mineral. The froth is then skimmed off and processed to recover the mineral.
4. Drying and Packaging: Once the titano-magnetite mineral has been separated from the waste material, it is dried and packaged for transport.

The specific process used in a beneficiation plant for titano-magnetite from sands will depend on the characteristics of the sand and the desired end product. Some plants may also include additional steps, such as gravity separation, to further refine the mineral content (Xu and Guo., 2019; Zu et al., 2019; Wang et al., 2020; Chen et al., 2021).

Recent developments in extraction of Ti and V from low-grade ores

Li et al., (2021) explained the hurdles in the extraction of metals from Vanadium–titanium magnetite (VTM) low grade ores. As per Li et al., these low-grade unutilized ores have extremely high and comprehensive utilization value due to abundant associating and valuable elements such as iron, vanadium and titanium. The reserve of the VTM resources attains over 10 billion tons in the Panzhihua and Xichang regions in China, in which the reserve of the TiO_2 reaches 873 million tons and accounts for 90.5% of total national reserves. In the last decades, VTM has been treated by BF (Blast Furnace) ironmaking and a BOF (Basic Oxygen Furnace) vanadium extracting/semi-steel smelting process in China. As a result, a mountain of titanium in VTM enters the BF slag, which is piled along the Jinsha River and was difficult to be utilized. Consequently, this lead to a serious issue of environmental pollution and a large supply of valuable titanium was locked in the slag.

Commercial extraction of titanium and vanadium from titaniferous magnetite usually involves a combination of physical and chemical processes. The following are different procedures for the extraction of these metals from vanadium–titanium magnetite (VTM).

Procedure-1:

A new process of extracting titanium from VTM in the Panxi area in Sichuan, China is introduced by Li et al., (2021). In this work, the process of extracting titanium from VTM through roasting and leaching Ti-bearing slag obtained from metalizing reduction and magnetic separation process with H_2SO_4 was carried out. Then the hydrolyzing experiments of acid leaching liquor were investigated. In this process, the valuable elements of iron and vanadium have been recycled by a pyro-metallurgical process. Thus, the elimination of by-products can be reduced and simultaneously, the energy consumption can be decreased. Meanwhile, the waste problem of titanium in the BF process is solved.

Various experiments, including reduction–magnetic separation, leaching and hydrolyzing experiments, are carried out. The results show that the optimum conditions for leaching experiments are an acid/slag ratio of 4:1, a leaching temperature of 60˚C, a leaching time of 80 min, and a liquid/solid ratio of 3.2:1. The leaching rate of titanium in Ti-bearing slag is 92.41%. The optimum conditions for hydrolyzing experiments are an H+ concentration of 0.75 g_L-1, hydrolyzing temperature of 100 _C, and hydrolyzing time of 180 min, and the hydrolyzing rate of titanium in acid leaching liquor is 96.80%. After the leaching and hydrolyzing experiments, the recovery rate of titanium from the Ti-bearing slag is 89.45% (Li et al., 2021).

Procedure-2:

The following steps were suggested by Gupta, 1990; Han, 2005; Chen et al.,2017 and Zhang et al., 2018 for the extraction of vanadium and titanium.

1. Magnetic separation: Titaniferous magnetite ore is first ground and then subjected to magnetic separation to separate the magnetic iron oxide (magnetite) from the other minerals in the ore.
2. Roasting: The magnetite concentrate is then roasted in the presence of air to convert the magnetite to hematite (Fe2O3) and to oxidize any associated sulfide minerals.
3. Leaching: The roasted ore is then leached with a dilute sulfuric acid solution to dissolve the vanadium and other metals. The resulting solution, known as pregnant leach solution (PLS), is then processed to recover the vanadium and other metals.
4. Precipitation: The PLS is then treated with ammonium sulfate to selectively

precipitate the vanadium as ammonium metavanadate (AMV). The AMV is then calcined to produce vanadium pentoxide (V2O5), which is the commercial product.

5. Solvent extraction: Titanium is usually extracted from the leach solution by solvent extraction using an organic extractant. The extractant selectively extracts the titanium from the leach solution, leaving behind the other metals.
6. Precipitation: The titanium is then precipitated from the extractant using a chemical reagent. The resulting product is titanium dioxide (TiO2), which is the commercial product.
7. Refining: The vanadium pentoxide and titanium dioxide products are then purified and refined to meet the desired specifications and purity levels.

Procedure-3:

The following example is from a low-grade titanium bearing ore from Australia which is fitting to the titano-magnetite deposits of Gujarat coast. The Australian company Atlantic Vanadium Pty Ltd operates the Windimurra Vanadium Project, which is a large-scale vanadium-titanium-iron deposit located in the Mid-West region of Western Australia. The deposit contains low-grade titano-magnetite ore, with a TiO2 content of around 21% (Atlantic vanadium Pty Ltd., 2021; Mining Technology, 2016). The following steps are adapted by the company to extract the metals.

1. The ore is first mined using open pit mining methods and then crushed and ground into a fine powder. The powder is then processed using a magnetic separation technique to separate the magnetite and non-magnetite fractions. The magnetite fraction is then further processed to extract vanadium and titanium oxide.

2. To extract vanadium, the magnetite concentrate is first roasted at high temperatures with a sodium salt additive to convert the vanadium in the magnetite to water- soluble sodium vanadate. The resulting product is then leached with water to dissolve the sodium vanadate, which is then purified and processed to produce vanadium pentoxide.

3. To extract titanium oxide, the magnetite concentrate is first leached with sulfuric acid to dissolve the iron and other impurities, leaving behind a solution of titanium and vanadium. The titanium and vanadium are then precipitated using a chemical reagent, which forms a solid product that is further processed to produce titanium oxide and vanadium pentoxide.

It's important to note that the specific details of the extraction process may vary depending on the composition of the ore and the desired end products. Additionally, the extraction of vanadium and titanium from titaniferous magnetite is a complex process that requires a significant amount of energy and resources. Therefore, the extraction process must be carefully optimized to ensure that it is economically feasible and environmentally sustainable.

6. Nature, Quantum and Target:

a. Mapping in 1:5,000 scale incorporating all geomorphological units, manmade structures, streams etc. falling within and around the area. (total area of 2.17 sq km. Individual sector areas: Dandi-0.44 sq km, Onjal-three sub sectors of 0.13 sq km,0.81 sq km and 0.28 sq km and Surwada- 0.51 sq km)

b. Detailed analysis of land use pattern and geomorphological units in and around the area.

c. Seventy-three pit/trench samples are being proposed in the block (Dandi-Onjal-Surwada) at 400m x 100m grid interval in which 400m is along the shoreline and 100m across to understand the surface distribution of the ore minerals. Ten meter drilling below the ground level is being planned at 10 locations to understand downward continuity of those ore minerals.

d. Collection of sediment samples at 1.0m pit/trench at 73 locations and 100 sub-samples from 10 borehole locations making total 173 samples will be transported with care to the laboratory for processing as per SoP of GSI and IREL for grain size analysis and separation of economic heavy minerals respectively.

e. Grainsize analysis of 173 samples (73 pit /trench and 100 BH samples) at half phi interval.

f. Two level magnetic separation: separation of magnetite by dry magnetic separation and separation of ilmenite-titanomagnetite by high tension separation (HTS). This may produce 346 (173 magnetite and 173 ilmenite-titanomagnetite) enriched samples

g. XRD analysis of 10 selected enriched samples of ilmenite, titanomagnetite, magnetite to understand the mineral phases.

h. Chemical analysis of enriched samples containing magnetite and ilmenite-titanomagnetite for V, Ti, Fe and any other metals. From the enriched pit/trench samples, 25% of total number of samples of magnetite (18 samples) and 25% of the total number of samples of ilmenite-titanomagnetite (18 samples) would be selected.

i. From the enriched core samples, 25% of total number of samples of magnetite (25 samples) and 25% of total number of samples of ilmenite-titanomagnetite (25 samples) would be selected. A Total constituting 86 (18+18+25+25) samples would be thus generated and will be submitted for chemical analysis.

j. Resource estimation at G3 Level based on the surface samples and drill core sample analysis results using SURPAC.

k. Geological Report including the Mineral Resource Assessment at G3 level.

Table 3: Nature, Quantum and Targets

Sl. No.	Description of Work	Quantum (Sq Km/ Number)		Time required
1	Geological & Geomorphological mapping in 1: 5000 scale with DGPS Survey (Total 2.17 sq km)			
	Dandi sector	0.44 sq km		15 days
	Onjal Sub Sector 1	0.13 sq km		
	Sub Sector II	0.81 sq km		
	Sub Sector III	0.28 sq km		
	Surwada sector	0.51 sq km		
2	Total 73 No. of pit/trench samples and 10 BH			
	Sector	No. of Pit/trench samples	No. of BH	30+30 days
	Dandi sector	16 Nos.	3	
	Onjal Sub Sector 1	5 Nos.	1	
	Onjal Sub Sector II	25 Nos.	3	
	Onjal Sub Sector III	9 Nos.	1	
	Surwada sector	18 Nos.	2	
3	Laboratory analysis			
	Grainsize analysis	173 Nos.		90 days
	Mineral Separation and Identification	173 Nos.		
	XRD	10 Nos.		
	Chemical analysis	86 Nos.		
4	Report Writing			30 days

7. Break-up of expenditure:

Attached as separate sheet: Annexure -1

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Plate-1: Map Showing Samples Collected by GSI between Dandi and Kalal During FSP Item No.067

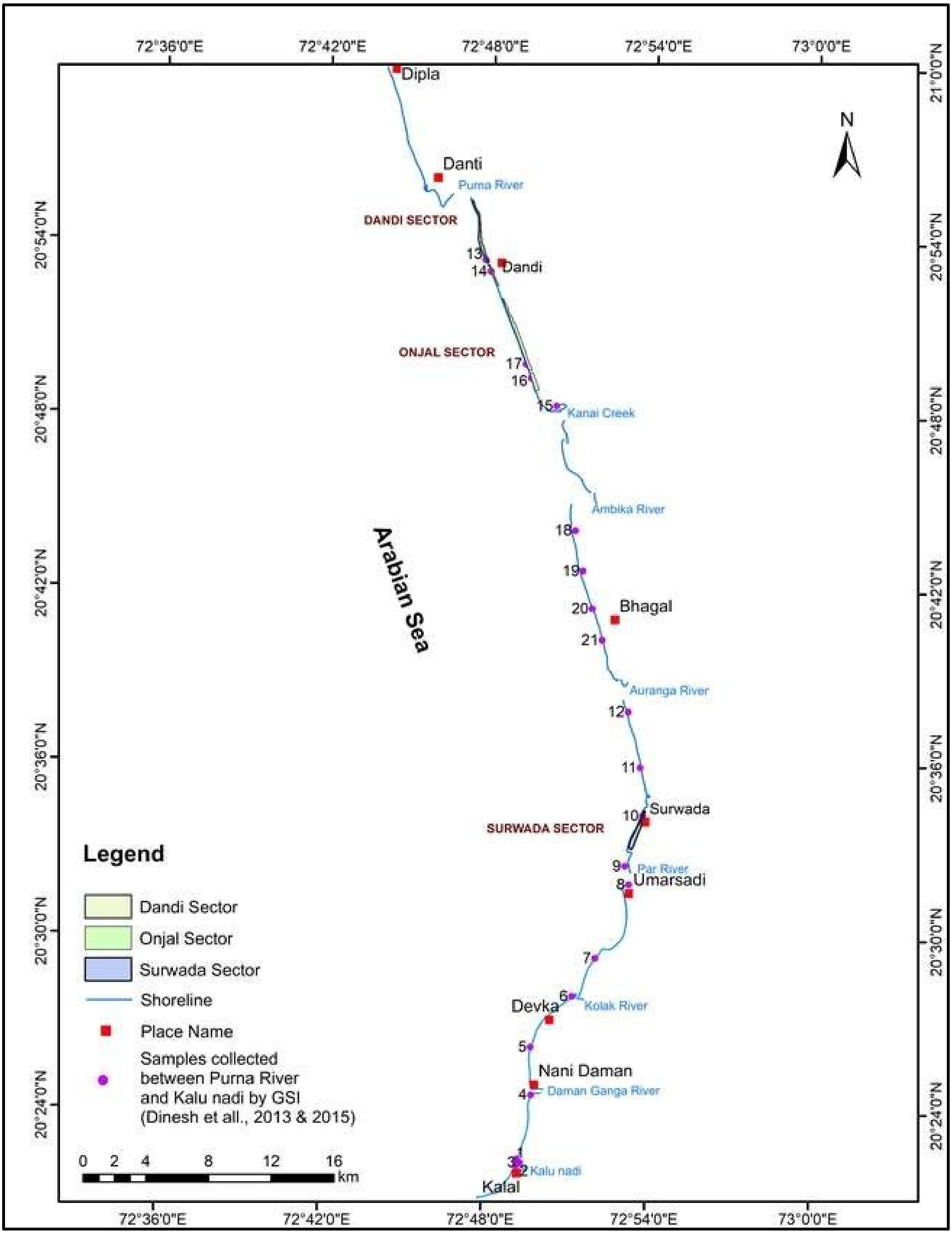


Plate-2: Map Showing Dandi-Onjal-Surwada Sectors with Samples Collected by GSI between Purna and Par Rivers during FSP Item No.067

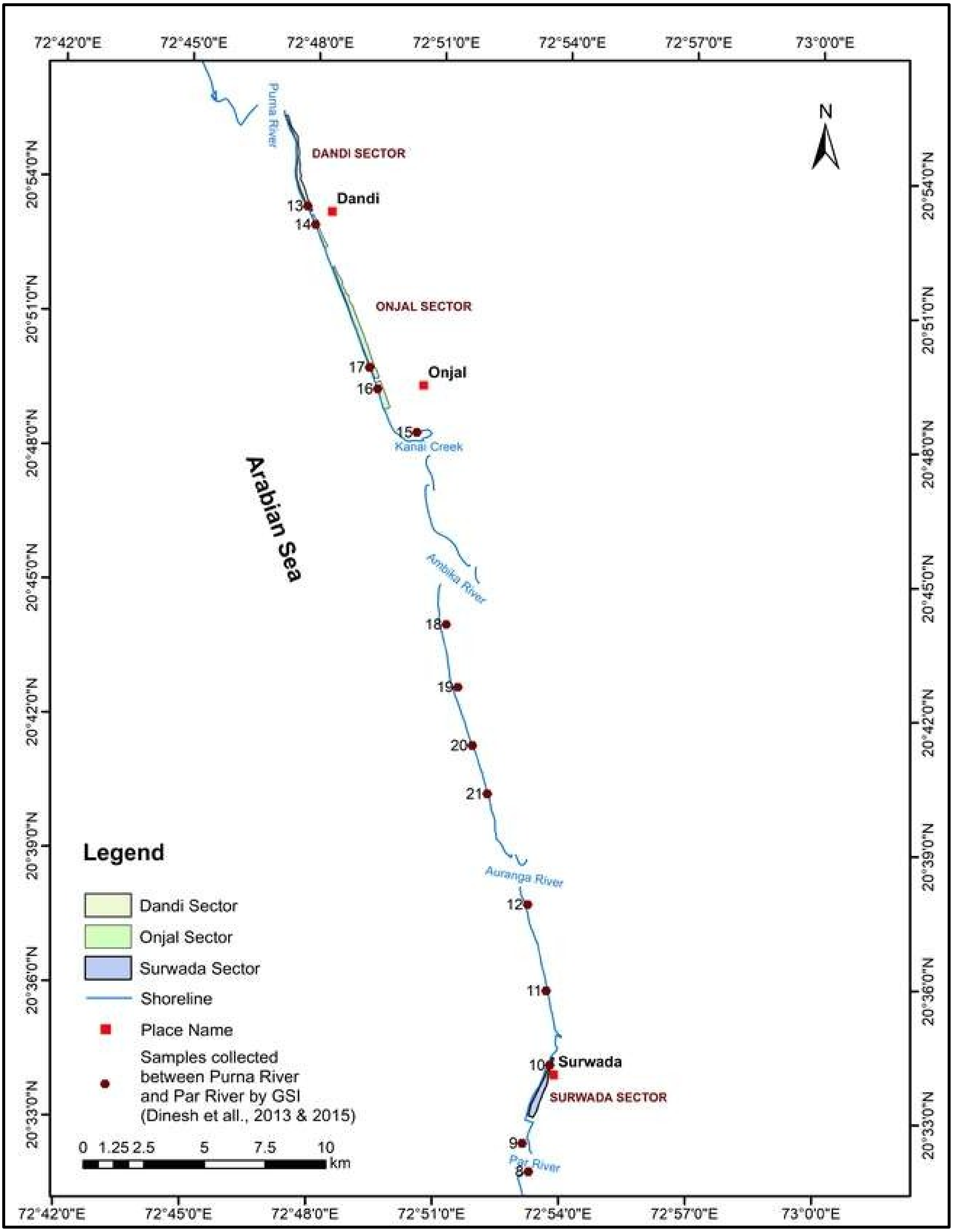


Plate-3: Map Showing Dandi Sector with Samples Collected by GSI in the Vicinity

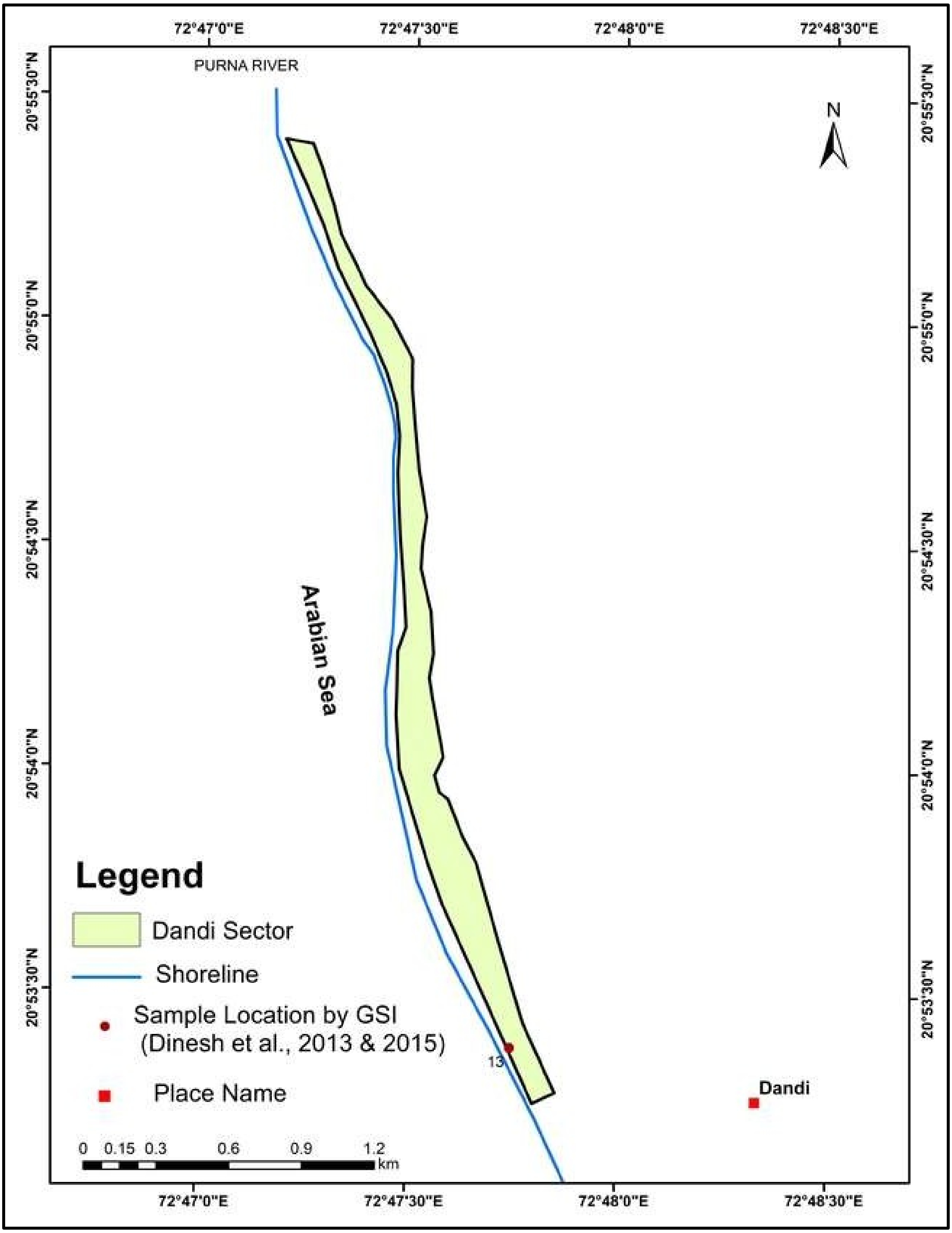


Plate-4: Map Showing Dandi Sector with Proposed Pit/trench and Borehole Locations

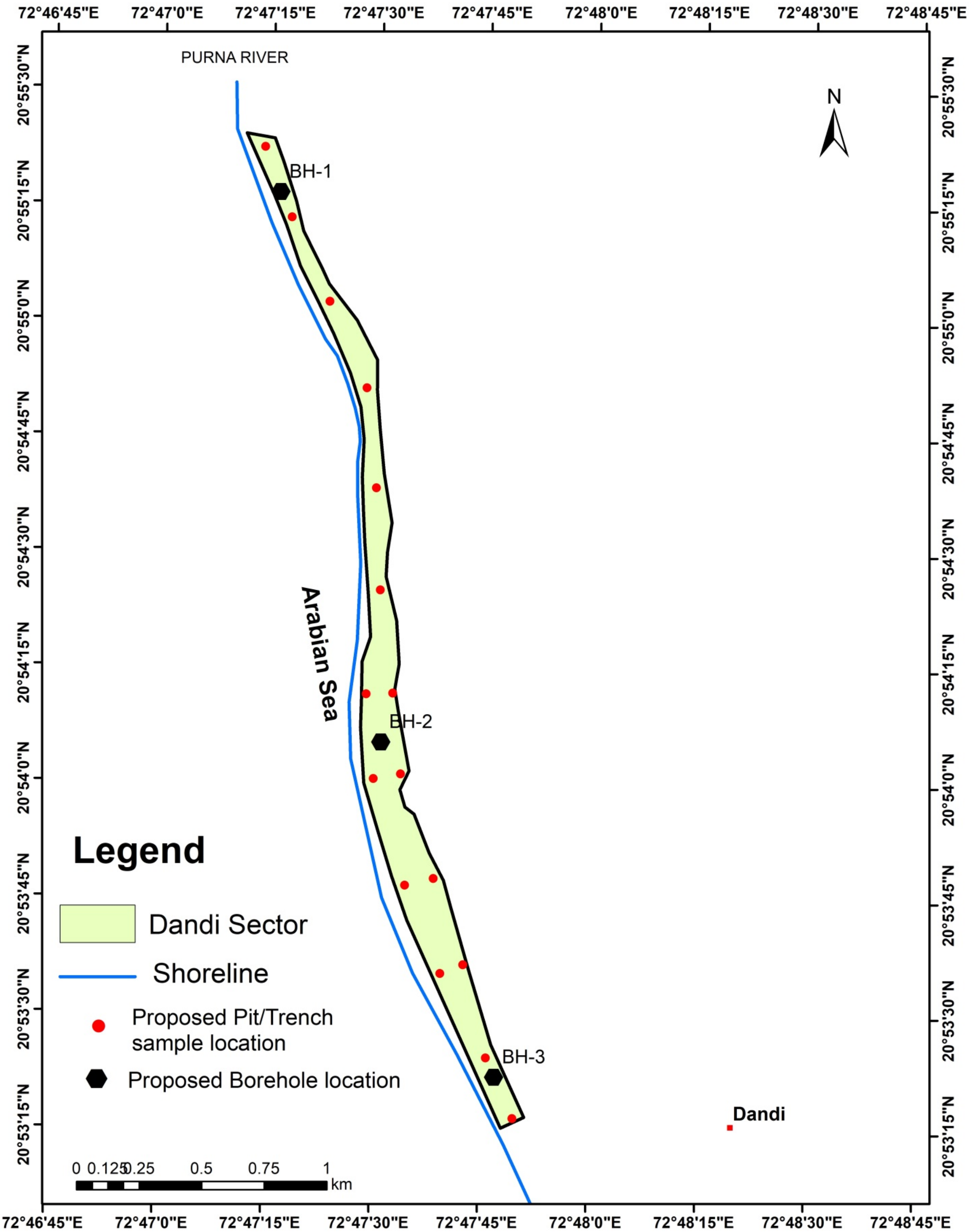


Plate-5: Map Showing Onjal Sector with Samples Collected by GSI in the Vicinity

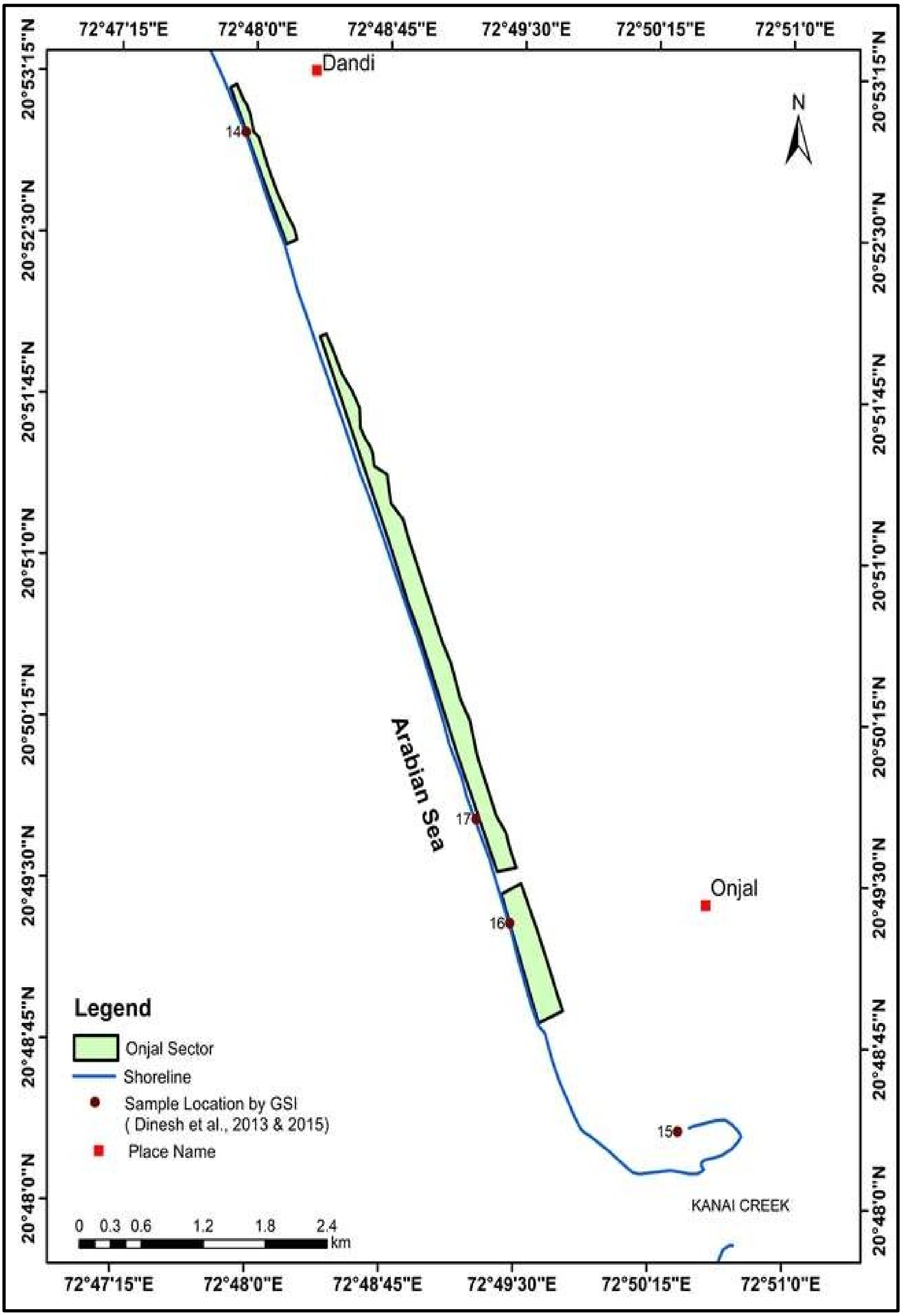


Plate-6: Map Showing Proposed Pit/trench and Borehole Locations in Onjal Sector

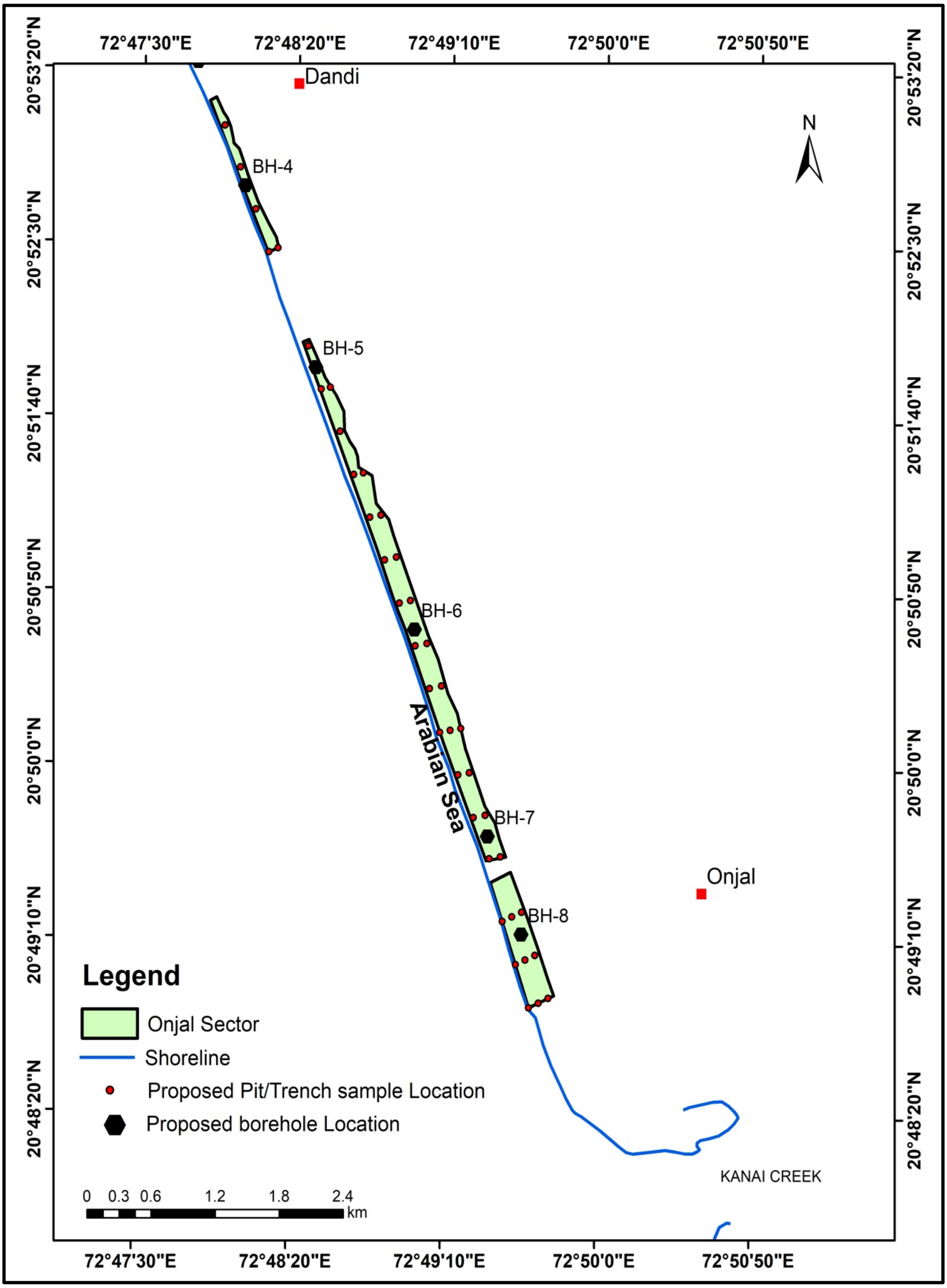


Plate-7: Map Showing Surwada Sector with Samples Collected by GSI in the Vicinity

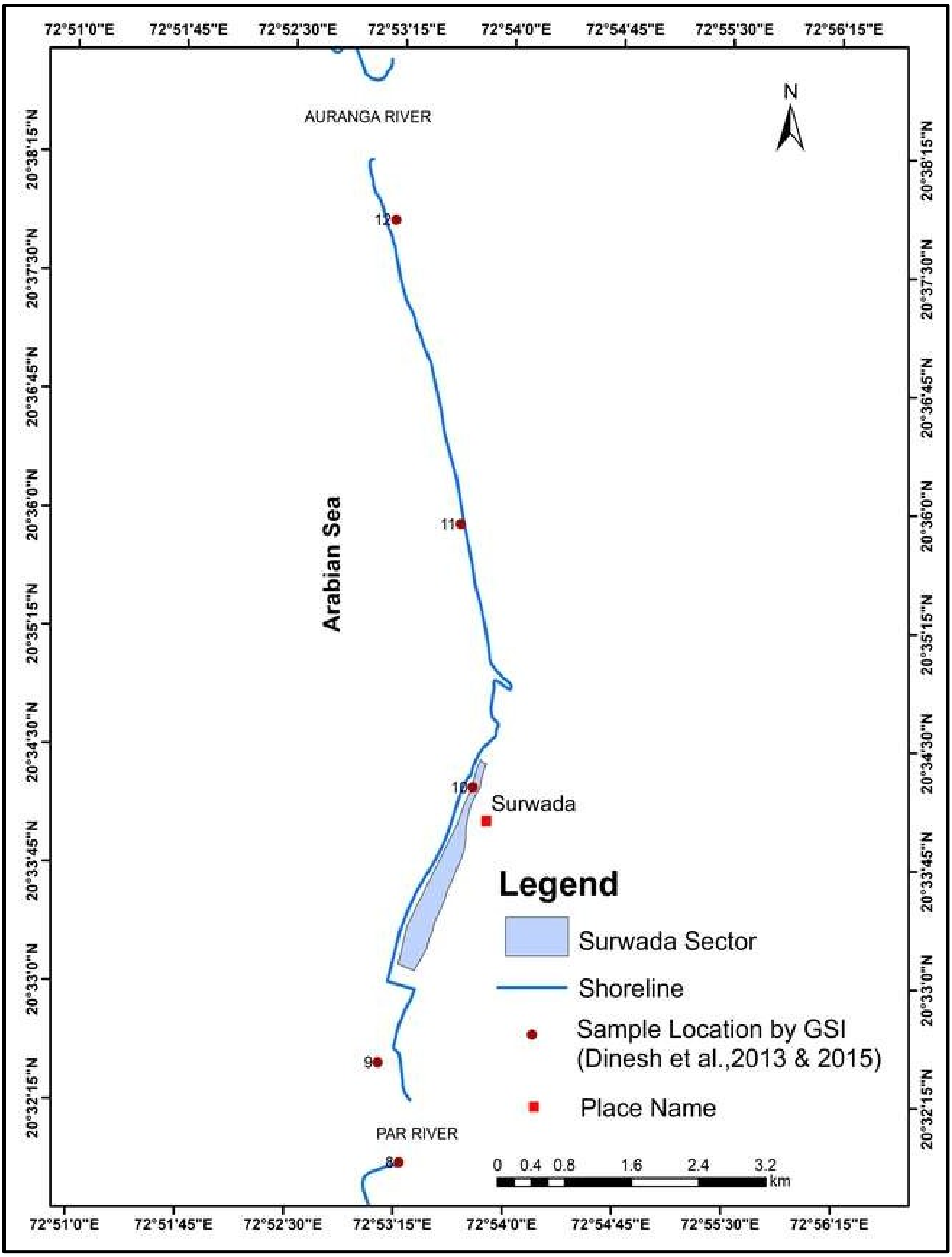
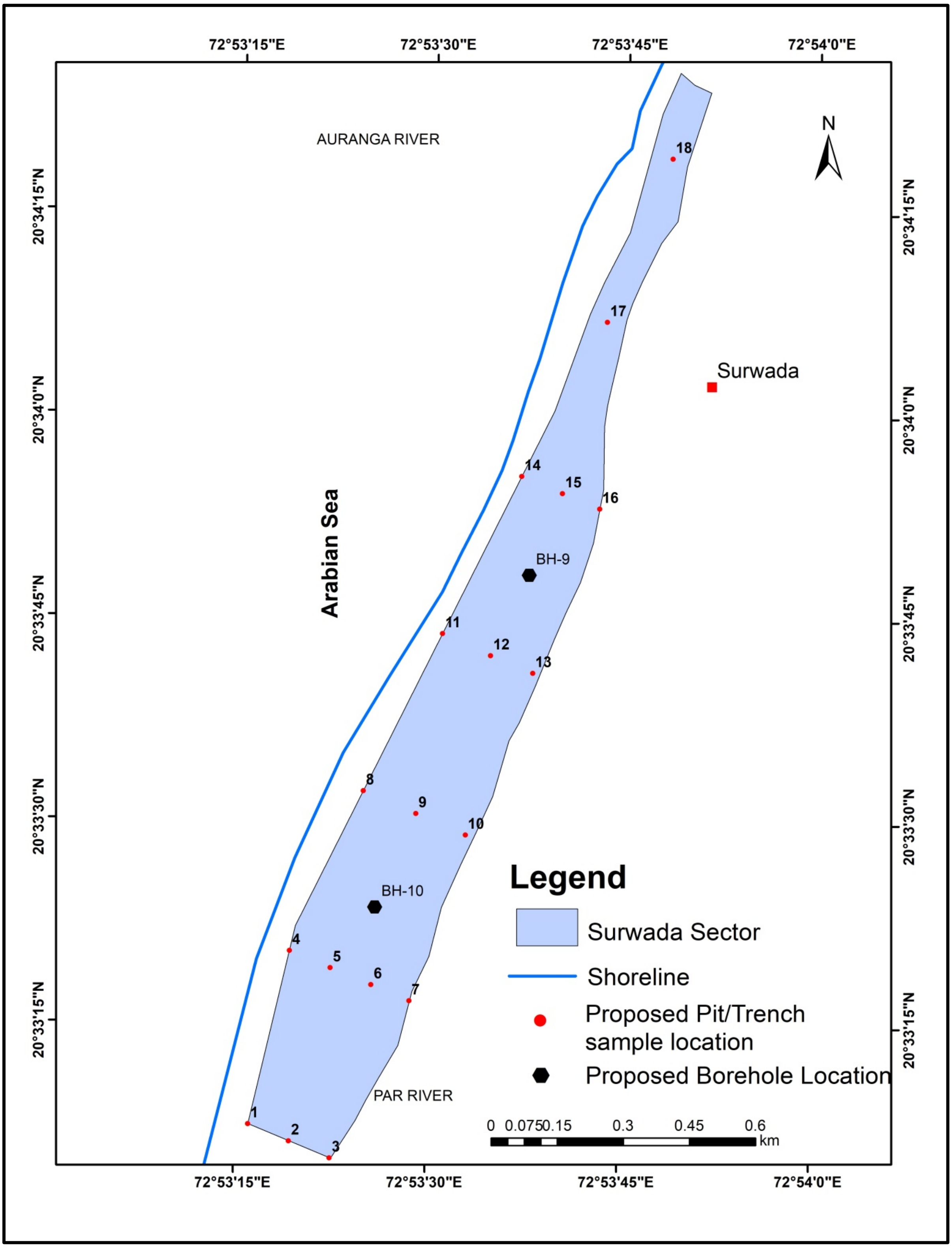


Plate-8: Map Showing Surwada Sector with Proposed Pit/trench and Borehole Locations



PHOTOGRAPHS TAKEN DURING THE FIELD DAYS OF ITEM NO.067 OF GSI

Plate-9: Long View of Dandi Beach

Plate-10: Sampling at Dandi beach

Plate-11: Younger Dune at Surwada

Plate-12: Older Dune near Onjal

Annexure-I: Table Showing Expenditure Break up for G3 Level Prospecting for Vanadium and Titanium in Beach & Dune sands of Dandi -Onjal -Surwada Block in Navsari and Valsad Districts, Gujarat State

Sl. No	Description	UNIT	Expected number	Unit rate	Total Amount
1	Accommodation charges for drilling team	months	1	50000	50,000
2	Camp setting and winding up cost	L.S	LS	2*250000	5,00,000
3	Mobilisation/ Demob of drill rig from HQ (Mangalore to Dandi)	km by road	1204	36	43,344
4	Auger Drilling:, (0-10 m in sediment)	meter	10 nos.*10m	4760	4,76,000
5	Geologists- on field (mapping) -2	days	15*2	11000	3,30,000
6	Geologists- on field (drill site)- 2	days	30*2	11000	6,60,000
7	Geologists- on field (pit /trench) -2		30*2	11000	6,60,000
8	Geologist -office work -1	days	90*1	9000	8,10,000
9	Surveyor mapping	days	15 *1	8300	1,24,500
10	Surveyor -for drilling point fixing-1	days	10*1	8300	83,000
11	Labourers -mapping	days	15*2	473	14,190
12	Labourers -for drilling point fixing	days	10*2	473	9,460
13	Pit/trench	Nos./cu m	73	3,300	2,40,900
14	Sample processing charges (one sampler-173 samples)	days	25	5100	1,27,500
15	Sub sample preparation-removal of salt &organic content removal, drying, sieve & hydrometer analysis	number	173	2000	3,46,000
16	Core sample preservation- core box	number	100	1590	1,59,000
17	Heavy Mineral separation by gravity and 2 level magnetic separation (magnetite, Ilmenite, Titanomagnetite) and quantification	number	100+73	13820	23,90,860
18	Chemical analysis of enriched samples (at NABL lab) ICP OES with MS finish	number	86 (18+18+25+25)	4181	3,59,566
19	XRD analysis of enriched samples	number	10	4000	40,000
	Subtotal 1				**74,24,320**
20	Preparation of Mineral Exploration Report (3% of subtotal 1)	L.S			2,22,730
	Subtotal 2 (including report charges)				**76,47,050**
21	Preparation of exploration proposal (2% of subtotal 2)	L.S			1,52,941
	TOTAL				**77,99,991**
	Total with GST @ 18%				92,03,989

The escalation formula for inflation adjusted rates given in NMET SoC is not reflected in the above table.

Annexure-2A

Table 1A: Boundary Coordinates of Dandi Sector						
Sl. No.	Longitude	Latitude		Sl. No.	Longitude	Latitude
1	72.79686	20.8876		27	72.78847	20.92092
2	72.79767	20.88799		28	72.78796	20.92236
3	72.79637	20.89059		29	72.78755	20.92338
4	72.79546	20.89333		30	72.78654	20.92335
5	72.79478	20.89547		31	72.78748	20.9212
6	72.79446	20.8965		32	72.78791	20.92002
7	72.7939	20.89748		33	72.78867	20.91865
8	72.7933	20.89887		34	72.78947	20.91729
9	72.79295	20.89912		35	72.79029	20.91629
10	72.79275	20.89975		36	72.79115	20.91522
11	72.79299	20.90041		37	72.79156	20.91431
12	72.79263	20.90263		38	72.7917	20.91242
13	72.7925	20.90338		39	72.79137	20.91102
14	72.79265	20.90428		40	72.7912	20.90977
15	72.79253	20.90584		41	72.79124	20.90864
16	72.79211	20.90743		42	72.79143	20.9068
17	72.79215	20.90831		43	72.79154	20.90525
18	72.79231	20.90937		44	72.79123	20.90436
19	72.79211	20.91115		45	72.79122	20.90297
20	72.79218	20.91277		46	72.7912	20.90198
21	72.79203	20.91409		47	72.7914	20.90005
22	72.79167	20.91523		48	72.7919	20.89833
23	72.79086	20.91666		49	72.7926	20.89667
24	72.78977	20.91796		50	72.79324	20.89505
25	72.7895	20.9185		51	72.79686	20.8876
26	72.78876	20.91985				

Table 1 B: Boundary Coordinates of Onjal Sector-1		
Sl. No.	Longitude	Latitude
1	72.80019	20.88036
2	72.80298	20.87423
3	72.80392	20.87461
4	72.80368	20.87543
5	72.80296	20.87658
6	72.80201	20.87826
7	72.80106	20.88041
8	72.80066	20.88146
9	72.80025	20.88248
10	72.79975	20.88293
11	72.79971	20.88322
12	72.79945	20.88422
13	72.79914	20.88492
14	72.7988	20.88535
15	72.79816	20.88657
16	72.79759	20.8863
17	72.80019	20.88036

Annexure-2A

Table 1 C: Boundary Coordinates of Onjal Sector-2		
Sl. No.	**Longitude**	**Latitude**
1	72.81294	20.85055
2	72.81471	20.84648
3	72.81577	20.84414
4	72.81936	20.83506
5	72.82327	20.82585
6	72.82504	20.82617
7	72.82445	20.82759
8	72.82403	20.82889
9	72.8231	20.8302
10	72.82251	20.8317
11	72.82148	20.83554
12	72.82079	20.83761
13	72.81994	20.83924
14	72.81847	20.84186
15	72.81768	20.84359
16	72.81429	20.85165
17	72.81372	20.85313
18	72.81221	20.85507
19	72.81156	20.85599
20	72.81125	20.85716
21	72.81108	20.85796
22	72.811	20.85861
23	72.81052	20.85921
24	72.81005	20.86007
25	72.81001	20.86074
26	72.80996	20.8616
27	72.80926	20.86288
28	72.80824	20.86427
29	72.80744	20.86599
30	72.80676	20.86731
31	72.80604	20.86697
32	72.81294	20.85055

Table 1 D: Boundary Coordinates of Onjal Sector-3		
Sl. No.	**Longitude**	**Latitude**
1	72.82726	20.81416
2	72.82951	20.81514
3	72.82895	20.8165
4	72.82803	20.8189
5	72.82704	20.82136
6	72.82549	20.82496
7	72.82368	20.82411
8	72.82726	20.81416

Annexure-2A

Table 1 E: Boundary Coordinates of Surwada Sector						
Sl. No.	**Longitude**	**Latitude**		**Sl. No.**	**Longitude**	**Latitude**
1	72.89593	20.57044		22	72.89438	20.56207
2	72.89538	20.56941		23	72.89463	20.56263
3	72.89508	20.56876		24	72.89494	20.56326
4	72.89434	20.56677		25	72.89521	20.56406
5	72.88884	20.55616		26	72.89542	20.56517
6	72.88786	20.55209		27	72.89542	20.56646
7	72.88967	20.5514		28	72.89548	20.56689
8	72.88997	20.55185		29	72.89558	20.56732
9	72.89019	20.55218		30	72.89571	20.56788
10	72.89042	20.5526		31	72.89588	20.56865
11	72.89069	20.55306		32	72.896	20.56899
12	72.8911	20.55373		33	72.89621	20.56945
13	72.89139	20.55484		34	72.89661	20.57023
14	72.89175	20.55556		35	72.89696	20.57068
15	72.89201	20.55657		36	72.89715	20.5718
16	72.89242	20.55746		37	72.89766	20.57332
17	72.89273	20.55809		38	72.89729	20.57348
18	72.89309	20.55885		39	72.89699	20.57372
19	72.89343	20.56		40	72.89661	20.57288
20	72.89365	20.56037		41	72.89593	20.57044
21	72.89399	20.56113				

Annexure-2B

Table 2A: Proposed Pit /Trench sample Locations in Dandi Sector		
Sample Points	**Longitude**	**Latitude**
1	72.78831	20.92035
2	72.78981	20.91732
3	72.79128	20.91422
4	72.79169	20.91062
5	72.79189	20.90694
6	72.79242	20.90322
7	72.79276	20.90031
8	72.79172	20.90013
9	72.79408	20.89655
10	72.79298	20.8963
11	72.79525	20.89346
12	72.79438	20.89313
13	72.79617	20.89011
14	72.79722	20.88793
15	72.78726	20.92288
16	72.7914	20.90318

Table 2B: Proposed Pit /Trench sample Locations in Onjal Sector						
Sample No.	**Longitude**	**Latitude**		**Sample No.**	**Longitude**	**Latitude**
1	72.80305	20.87426		21	72.8138	20.84977
2	72.80386	20.87459		22	72.81485	20.85
3	72.80182	20.87766		23	72.81243	20.85317
4	72.80039	20.881		24	72.81342	20.85335
5	72.79895	20.88433		25	72.81062	20.85631
6	72.82355	20.82602		26	72.81136	20.8565
7	72.82455	20.82618		27	72.80956	20.86
8	72.82209	20.82929		28	72.80791	20.86336
9	72.82313	20.82948		29	72.80873	20.86351
10	72.82064	20.83268		30	72.80671	20.86679
11	72.82166	20.83286		31	72.82726	20.81416
12	72.81896	20.83606		32	72.82813	20.81454
13	72.82008	20.83624		33	72.829	20.81492
14	72.82097	20.83646		34	72.82603	20.81759
15	72.81799	20.83955		35	72.8269	20.81797
16	72.81907	20.83976		36	72.82777	20.81835
17	72.81666	20.84295		37	72.82479	20.82102
18	72.8177	20.84315		38	72.82566	20.8214
19	72.81518	20.84634		39	72.82653	20.82178
20	72.81617	20.84656				

Annexure-2B

Table 2C: Proposed Pit /Trench sample Locations in Surwada Sector		
Sample Points	**Longitude**	**Latitude**
1	72.88786	20.55209
2	72.88875	20.55175
3	72.88964	20.55141
4	72.88872	20.55565
5	72.88961	20.55531
6	72.8905	20.55497
7	72.89133	20.55465
8	72.89028	20.55894
9	72.89143	20.55849
10	72.89251	20.55806
11	72.89196	20.56218
12	72.89301	20.56174
13	72.89393	20.56139
14	72.89364	20.56542
15	72.89453	20.56508
16	72.89534	20.56477
17	72.89546	20.5686
18	72.89684	20.57196

Table 2D: Proposed Borehole Locations in the Dandi-Onjal-Surwada Block		
Borehole No.	**Longitude**	**Latitude**
BH-1	72.78787	20.92126
BH-2	72.79199	20.90146
BH-3	72.7965	20.88942
BH-4	72.80088	20.87954
BH-5	72.80741	20.8651
BH-6	72.81657	20.84424
BH-7	72.82337	20.82779
BH-8	72.82652	20.81999
BH-9	72.893831	20.563396
BH-10	72.89056	20.55656