Report On
G3 Level Exploration for Vanadium and Titanium in Dandi-Onjal-Surwada Block in Navasari and Valsad Districts, Gujarat.

By

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For

National Mineral Exploration Trust (NMET)

Ministry of Mines

Wing-F, Room No. 325 & 326, Udyog Bhawan,
Rafi Ahmed Kidwai Marg, Rajpath Area, Central Secretariat
New Delhi-110011

Ref. No: 23/451/2024-NMET/606 dated 12th March 2024

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EXECUTIVE SUMMARY

National Mineral Exploration Trust (NMET) approved the proposal for G3 exploration with a main objective to evaluate the critical mineral concentration viz; titanium and vanadium in the beach and dune sands in the Dandi-Onjal-Surwada Block, in Jalalpore and Valsad Mandal, Navsari and Valsad Districts, Gujarat. The approval was accorded vide order No23/451/2024-NMET/606 dt.12/03/2024 after going through the DPR and presentations to TCC and EC. The work components comprise topographic survey and geological mapping, auger drilling and relevant laboratory studies. The field work was started on 19th March 2024.

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 (S.S. Merh,1995). The sedimentary sequences are Jurassic, Tertiary and Quaternary in age. In the northern part of the study area the coastal area is covered with the Quaternary sediments while to the south sheeted rocks are exposed (Dinesh et al., 2013, 2015). The coastal plains of Dandi region of Gujarat are predominantly composed of Holocene to Recent sediments. On the basis of geological disposition, lithological variation and environment of deposition, the sediments have been divided into four Formation; the Katpur Formation, Rann Clay Formation, Akhaj Formation and Mahuva Formation. Deccan basalt is exposed along the beach in the southern part of toposheet number 46D/14 (Rai,1984).

The area under investigation is a coastal tract of 4.16 sqkm comprising Dandi-Onjal and Surwada sector. The Dandi-Onjal sector with a length of 12.5 km and width of 70m to 1200 m is covering an area of 3.21 sq km and lies between the Purna River in the north and Kanai Creek in the south and Surwada sector is extending 2.64 km in length and width varying between 211m and 470m, with an area of 0.95 sq km, situated between the Auranga River in the north and the Par River in the south. The anomalous zone that runs parallel to the NNW-SSE trending coastline is structurally undisturbed and unmetamorphosed. Primary depositional features including current bedding, cross bedding, ripple marks, and signs of active bioturbation are observed in both sectors.

In order to cover the landward extension of the dune, a total of 4.16sq. km, as against TCC, NMET demarcated area of 2.17 sq.km, was mapped and explored. The topographic and geological mapping on 1: 5000 scale was carried out in parts of old toposheet bearing no's 46D/13 and 46D/14. Topographic survey was carried out with Geomate Real Time Kinematic–Global positioning system (RTK-GPS) receiver in UTM coordinate system. The auger drilling at grid spacing 400 x 200m as per MEMC rule for G3 level exploration was planned, executed and accordingly 37 drill-cores were collected up to 5m bgl (below ground level) except some boreholes due to the presence of clay in the bottom layers. The sediment samples at every 1m were collected, packed and labelled in the field.

The heavy mineral and grain analysis of 160 sub-samples was carried out following the SOP of the Geological Survey of India. Other than the grain size analysis, the laboratory work

components include (i) the processing half of the sample while preserving the other half for future reference; (ii) two level magnetic separation using LIRMS (Low Intensity Rotary Magnetic Separator) and REDMS (Rare Earth Drum Magnetic Separator); (iii) the calculation of weight percentage of each magnetic sub-fraction A (LIRMS-magnetics), B (REDMS-magnetics), and C (REDMS-middlings) separately and (iv) Grain size analysis of magnetic fractions separately (v) subjecting the REDMS non-magnetic fraction to gravity separation and (vi) studying the latter and magnetic fractions under polarising microscope. 164 samples were subjected to geochemical analysis using WDXRF spectrometer for determining the concentrations of major oxides such as Al2O3, BaO, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, SO_3 and V_2O_5. 27 samples were subjected to ICPMS studies for trace element and rare earth element analysis.

Based on the mineral separation analysis data, the percentage of A-fraction in the bulk sediment of Dandi-Onjal sector ranges from 12.99-49.83 % with an average of 35.61%, whereas B-fraction ranges between 0.0033 and 5.94% with a low average of 1.25%, C-fraction ranges from 4.76-66.06% with an average of 23.68%, whereas D-fraction (NMHM) which is the non-magnetic heavy minerals ranges between 0.43-13.45% with an average of 5.02% and the nonmagnetic light minerals(NMLM) termed as E fraction ranges from 8.03-45.99% with an average of 29.10%. The wt% of gravel ranges from 0% to a maximum of 28.78% with an average of 0.66% and the clay ranges from 0% to 66.81% with an average of 3.55%.

Similarly, the percentage of A-fraction in the bulk sediment of Surwada sector ranges from 33.31-64.13 % with an average of 47.63%, whereas B-fraction ranges between 0.079 and 14.07% with a low average of 3.43%, C-fraction ranges from 11.41-47.52% with an average of 25.86%, whereas D-fraction (NMHM) which is the non-magnetic heavy minerals ranges between 0.30-4.89% with an average of 1.59% and the nonmagnetic light minerals(NMLM) termed as E fraction ranges from 5.46-28.29% with an average of 11.56%. The wt% of gravel ranges from 0% to a maximum of 22.76% with an average of 6.77% and the clay ranges from 0% to 14.67% with an average of 1.597%.

Among the sieve fractions of LIRMS-magnetics (A), REDMS-magnetics (B) and REDMS-middlings (C) of the Dandi-Onjal block, ABC230-fractions exhibit more or less consistent values of titanium and vanadium. From sieve analysis, it is observed that heavy mineral proportion is mainly concentrated in fine sand (.250mm to.125mm) and very fine sand (.125mm to .063mm). The wt% of heavy minerals concentrated in the A230# sieve size ranges from 2.21% to 11.52% with an average of 6.02%, B fraction ranges between .02 to .87% with an average of .19% and C fraction ranges between 1.73 to 11.29% with an average of 5.98%.

Based on the chemical analysis data of ABC230# fractions, 67 ABC230# -fraction samples out of 69 are having V_2O_5 more than 0.1%, whereas 43 samples are having >14% TiO_2. The concentration (wt%) of Fe_2O_3 is found to be varying between 14.27% to 51.64%, TiO_2 varies between 3.043 to 24.895% and V_2O_5 varies from 0.025% to a maximum of 0.315%. The average value of V_2O_5 is 0.194%, TiO_2 14.83% and 31.35% Fe_2O_3 in this fraction. In view of the concentration of V_2O_5 more than 0.1% in the ore minerals is considered to be potential.

XRD studies for ten representative samples from different sieve fractions (Viz: 60#,120#,230#, -230#) show that the (i) LIRMS-magnetics (A230# and A60#+120# fractions) contain spinel group of minerals (magnetite, titanomagnetite and magnesioferrite) having similar spinel crystal structure, comparable lattice parameters and XRD patterns making distinction between these types of minerals challenging in poly-mineralic samples; the other minerals present in the A-fractions are pyroxenes (Cpx) and plagioclase (pl) (ii) the REDMS-magnetics (B230# fractions) are mostly composed pyroxene, ilmenite, plagioclase, quartz, amphibole, dolomite and clay minerals (iii) REDMS-middlings (C230# and C60#+120#-fractions) are composed of heavy minerals such pyroxenes (mainly cpx), plagioclase and quartz with minor amount of clay minerals, hematite and ilmenite (v) non-magnetic heavy minerals (NMHM) comprise clinopyroxene with hematite. and in the non-magnetic light minerals (NMLM), the identified mineral phases are calcite and quartz with traces of zeolite and (vi)silt fractions are composed of plagioclase, quartz, pyroxenes (mainly cpx), and spinel (mainly magnetite type) with traces of clay minerals, calcite, amphibolite and mica.

Petrographic and EPMA studies of the magnetic fractions revealed that A fractions (60#,120#) are composed of Ilmenite, plagioclase, Cpx, and A230Mt fractions are composed of Ilmenite, Fe-Ti oxide/hydroxide, B fractions (60#,120#) consists of Ilmenite, Cpx, Amphibole and Sphene, C(60#,120#, 230#) Ti-Fe hydroxide, Cpx, Ilmenite, amphibole, plagioclase, fe-hydroxide, ilmenite, clinopyroxene, epidote and albite. The presence of pyroxenes and plagioclase in the magnetic minerals is due to the fact that the TTM was initially masked by rock fragments and was liberated during the sample crushing process. The EPMA analysis of the Fe-TiO2 mineral grains suggests (i) a uniform distribution of FeO and TiO_2 which may reflect a common igneous source and (ii) a wide variation in the elemental concentrations of the titaniferous magnetite grains together with their consistent variation trends with reference to MgO and MnO may reflect inherent variations in mineral compositions during the late-magmatic processes. Five bulk samples representing the exploration area were analysed for radiometric analysis of monazite equivalent at AMD, Hyderabad.

Based on the hand magnet separated data, it is estimated that 7.447 kg of the bulk sample yielded 27.009wt% of hand magnetic fraction (Mt) and 31.77wt% of non-hand magnetic fraction (Nmt) from sieve sizes 35#, 60#, 120#, 230#, -230 and 34.32wt% of non-magnetic fractions (D+E). The analytical data reveal that the +230Mt is having high values of TiO2 and V2O5 which is 17.10% and 0.50%, followed +120Mt and +60Mt which suggests vanadium is mostly concentrated in the titaniferous magnetite (TTM). The TiO_2 and V_2O_5 values of the +120Mt fraction is 8.22% and 0.2% and +60Mt fraction is 3.63% and 0.08% respectively. The estimated tonnage of Fe_2O_3, TiO_2 and V_2O_5 in the Mt fractions in the sand body are 0.2780MMT, 0.0832 MMT and 0.0020 MMT. Thus +120# sieve fraction can also be considered as potential ore fraction.

The famous Dandi museum and historically important Salt Sathyagarh Memorial as well as Smrithi Mantap is situated near to the Dandi coast which is close to the exploration area. Therefore, the tourist places having an area of 5,03,459 sq.m has been kept as buffer zone. So, resource estimation in a total area of 2.719 sq.km in Dandi-Onjal sector and 0.950sq.km in Surwada sector are carried out. The enormous data generated was compiled, synthesized and

interpreted to understand the deposit, generate ore-concentration model and to estimate the resource.

The total tonnage of the sand body in the Dandi-Onjal sector is estimated to be 9.947 MMT, in which 5.008 MMT is the orebody that constitutes about 50.34%. Out of which A fraction (LIRMS-magnetics) represents about 34.647%, B fraction (REDMS-magnetics) 1.207% and C fraction (REDMS-middlings) represents 21.870%. The grade of Fe_2O_3 in the total sand is 3.767%, TiO_2 1.800% and V_2O_5 0.022% The total tonnage of Fe_2O_3 in the sand body is estimated as 0.327 MMT, TiO_2 0.156 MMT and V_2O_5 0.002 MMT in the Dandi-Onjal sector explored.

The total tonnage of the sand body in the block in the Surwada sector is estimated to be 2.870 MMT, in which ABC230 (prime ore) is about 0.315 MMT, that constitutes about 10.98% of the sand body. Out of which A fraction (LIRMS-magnetics) represents about 49.379%, B fraction (REDMS-magnetics) 4.100% and C fraction (REDMS-middlings) represents 22.753%. The grade of Fe_2O_3 in the total sand is 2.707%, TiO_2 0.866% and V_2O_5 0.015%. The total tonnage of Fe_2O_3 in the sand body is estimated as 0.078 MMT, TiO_2 0.025 MMT and V_2O_5 0.0004 MMT in the Surwada Sector explored.

These Vanadium and Titanium bearing minerals are essential for various high-tech industries, including electronics, telecommunications, and renewable energy technologies. The beach and dune sands have been identified as potential sources. The key raw materials for vanadium extraction are titanomagnetite ores (~ 88% of total V production in the world).

The present study shows that the Dandi-Onjal area has promising placer concentrations of Titanium and Vanadium when compared to Vanadiferous titanomagnetite (VTM) deposits hosted mainly within mafic and ultramafic igneous rocks compared to the Surwada sector. The average TiO_2 concentration of about 14% in ABC230-fractions of the explored area is higher than the Windimurra Complex in Western Australia (one of the world's largest titanium-vanadium deposits; has TiO_2 concentrations around 2% and average 0.32% V_2O_5).

The importance of liberated ore minerals in placer deposits is significant because the liberation of ore minerals means that the valuable minerals are already separated from the surrounding rock. This makes the extraction process more efficient and cost-effective compared to deposits where the ore minerals are still locked within the host rock, like the titanomagnetite bands in layered gabbro deposits.

The exploration has been carried out as per Mineral (Evidence of Mineral Contents) Rule-2015, mineral (Evidence of Mineral Contents) Rule-2021 and the Mineral Resources are estimated as per UNFC norms. Since this is preliminary exploration (G3) with no study on 'E' and 'F' axes, the resource has been classified as UNFC G3F3E3.

कार्यकारी सारांश

राष्ट्रीय खनिज खोज न्यास (NMET) ने एक G3 अन्वेषण के प्रस्ताव, जिसका मुख्य उद्देश्य गुजरात के नवसारी और वलसाड जिलों के जलालपुर और वलसाड मंडल में दांडी-ओंजल-सुरवाड़ा ब्लॉक में समुद्र तट और टीलों की रेत में टाइटेनियम और वैनेडियम जैसे महत्वपूर्ण खनिज सांद्रण का मूल्यांकन करना है, को मंजूरी दी । विस्तृत परियोजना रिपोर्ट और टीसीसी तथा ईसी के समक्ष प्रस्तुतीकरण के बाद आदेश संख्या 23/451/2024-NMET/606 दिनांक 12/03/2024 के तहत अनुमोदन प्रदान किया गया। कार्य घटकों में स्थलाकृतिक सर्वेक्षण तथा भूवैज्ञानिक मानचित्रण, ऑगर ड्रिलिंग और प्रासंगिक प्रयोगशाला अध्ययन शामिल हैं। फील्ड वर्क 19 मार्च 2024 को शुरू किया गया।

गुजरात के भूविज्ञान में प्रीकैम्ब्रियन तहखाना शामिल है, जिस के ऊपर जुरासिक से शुरू होकर क्रेटेशियस, तृतीय महाकल्प और चतुर्थ महाकल्प से जारी रहने वाली अभिनव चट्टानों को विभिन्न भागों को अलग-अलग अनुक्रम में दिखाई देता है (एस.एस. मेर, 1995)। अवसादी अनुक्रम जुरासिक, तृतीय महाकल्प और चतुर्थ महाकल्प के हैं। अध्ययन क्षेत्र के उत्तरी भाग के तटीय क्षेत्र चतुर्थ महाकल्प के तलछट से ढका हुआ है, जबकि दक्षिण में चादरदार चट्टानें उजागर हैं (दिनेश et al.,2013, 2015)। गुजरात के दांडी क्षेत्र के तटीय मैदान मुख्य रूप से होलोसीन से लेकर हाल के तलछटों से बने हैं। भूवैज्ञानिक प्रकृति, लिथोलॉजिकल भिन्नता और जमाव के वातावरण के आधार पर तलछट को चार संरचनाओं में विभाजित किया गया है, वो है कटपुर फ़ॉर्मेशन, रन क्ले फ़ॉर्मेशन, अखज फ़ॉर्मेशन और महुआ फ़ॉर्मेशन। टोपोशीट संख्या 46 डी/14 के दक्षिणी भाग के समुद्र के किनारे में डेक्कन बेसाल्ट अनावृत हुआ है (राय,1984) ।

जांच के क्षेत्र 4.16 वर्ग किलोमीटर का तटीय क्षेत्र है जिसमें दांडी-ओंजल और सुरवाड़ा सेक्टर शामिल हैं। दांडी-ओंजल सेक्टर, जो 12.5 किलोमीटर लंबाई और 70 मीटर से 1200 मीटर चौड़ाई वाला है, 3.21 वर्ग किमी क्षेत्र में फैला हुआ है और उत्तर में पूर्णा नदी और दक्षिण में कनाई क्रीक के बीच स्थित है और सुरवाड़ा सेक्टर 2.64 किलोमीटर लंबाई और 211 मीटर से 470 मीटर चौड़ाई के बीच फैला है, जिसका क्षेत्रफल 0.95 वर्ग किलोमीटर है, जो उत्तर में औरंगा नदी और दक्षिण में पार नदी के बीच स्थित है। असंगत क्षेत्र जो उत्तरउत्तरपश्चिम - दक्षिणदक्षिणपूर्वी (NNW-SSE) प्रवृत्त में समुद्र तट के समानांतर चलता है, संरचनात्मक रूप से अप्रभावित और अपरिवर्तित है। दोनों क्षेत्रों में, धारा संस्तरण, क्रॉस संस्तरण, तरंग

निशान और सक्रिय बायोटबेशन के संकेत सहित, प्राथमिक निक्षेपण विशेषताओं को देखा जाता है।

रेत के टीले का स्थलीय विस्तार को कवर करने के हेतु कुल 4.16 वर्ग किलोमीटर का मानचित्रण और छानबीन किया गया, जबकि टीसीसी, एनएमईटी द्वारा सीमांकित क्षेत्र 2.17 वर्ग किलोमीटर था। पुराने टोपोशीट 46डी/13 और 46डी/14 के भागों में 1: 5000 पैमाने पर स्थलाकृतिक और भूवैज्ञानिक मानचित्रण किया गया। यूटीएम निर्देशांक प्रणाली में जियोमेट रियल टाइम काइनेमेटिक-ग्लोबल पोजिशनिंग सिस्टम (आरटीके-जीपीएस) रिसीवर के इस्तमाल करके स्थलाकृतिक सर्वेक्षण किया गया था। G3 स्तर की खोज के लिए एमईएमसी (MEMC) नियम के अनुसार 400 x 200 मीटर के ग्रिड अंतराल पर ऑगर ड्रिलिंग की योजना बनाकर क्रियान्वित करने केलिए, कुछ बोरहोलों, जिसमें नीचे की परतों में मिट्टी की उपस्थिति है, को छोड़कर 5 मीटर जमीनी स्तर के नीचे (बीजीएल) तक 37 ड्रिल-कोरें को एकत्र किया गया । प्रत्येक 1 मीटर ऊर्ध्वाधर अंतराल पर तलछट के नमूने एकत्र करके, फील्ड में ही पैक और लेबल किए गए।

भारतीय भूवैज्ञानिक सर्वेक्षण के एसओपी का पालन करते हुए 160 उप-नमूनों का भारी खनिज और कण विश्लेषण किया गया। कण आकार विश्लेषण के अलावा, प्रयोगशाला कार्य घटकों में शामिल हैं (i) भविष्य के संदर्भ के लिए अन्य आधे को संरक्षित करते हुए आधा नमूने का प्रसंस्करण; (ii) एलआईआरएमएस (लो इन्टेन्सिटी रोटरी मैग्नेटिक सेपरेटर - कम तीव्रता वाले रोटरी चुंबकीय विभाजक) और आरईडीएमएस (रेर एरथ ड्रम मैग्नेटिक सेपरेटर-रेर एर्थ ड्रम चुंबकीय विभाजक) का उपयोग करके दो स्तर के चुंबकीय पृथक्करण; (iii) प्रत्येक चुंबकीय उप-अंश **ए**(एलआईआरएमएस-मैग्नेटिक्स), **बी** (आरईडीएमएस-मैग्नेटिक्स), और **सी** (आरईडीएमएस-मिडलिंग्स) के भार प्रतिशत की अलग-अलग गणना (iv) चुंबकीय अंशों का अलग-अलग कण आकार विश्लेषण (v) आरईडीएमएस गैर-चुंबकीय अंश को गुरुत्वाकर्षण पृथक्करण के अधीन करना और (vi) ध्रुवीकरण माइक्रोस्कोप के सहारे उत्तरार्द्ध और चुंबकीय अंशों का अध्ययन करना। 164 नमूनों को प्रमुख ऑक्साइड जैसे कि Al_2O3, BaO, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, SO_3 and V_2O_5 की सांद्रता निर्धारित करने के लिए डब्ल्यूडीएक्सआरएफ (**WDXRF)** स्पेक्ट्रोमीटर का उपयोग करके भू-रसायनिक विश्लेषण किया गया । ट्रेस तत्व और दुर्लभ पृथ्वी तत्व विश्लेषण के लिए 27 नमूनों के आईसीपीएमएस (ICPMS) अध्ययन किए गए।

खनिज पृथक्करण विश्लेषण के आकड़ों के आधार पर, दांडी-ओंजल क्षेत्र के थोक अवसाद में **ए**-अंश का प्रतिशत 35.61% औसत के साथ 12.99% और 49.83% के बीच में है, जबकि **बी**-अंश सबसे निम्न औसत 1.25% के साथ 0.0033% और 5.94% के बीच में है, **सी**-अंश 4.76% और 66.06% के बीच में है, जिसका औसत 23.68% है, जबकि **डी**-अंश (एनएमएचएम) जो गैर-चुंबकीय भारी खनिज है, 0.43% और 13.45% के बीच में है, जिसका औसत 5.02% है और गैर-चुंबकीय हल्के खनिज (एनएमएलएम) जिसे **ई** अंश नामित किया है, 8.03% और 45.99% के बीच में है, जिसका औसत 29.10% है। बजरी का भार 0% से अधिकतम 28.78% तक है, जिसका औसत 0.66% है, तथा मृत्तिका का भार 3.55% औसत के साथ 0% से अधिकतम 66.81% तक है।

इसी प्रकार, सुरवाड़ा सेक्टर के थोक तलछट में ए-अंश का प्रतिशत 33.31% और 64.13% के बीच में है, जिसका औसत 47.63% है, जबकि बी-अंश 0.079 और 14.07% के बीच में है, जिसका औसत 3.43% है, सी-अंश 11.41 और 47.52% के बीच में है, जिसका औसत 25.86% है, जबकि डी-अंश (एनएमएचएम) जो गैर-चुंबकीय भारी खनिज है, 1.59% औसत के साथ 0.30% से 4.89% तक है, और गैर-चुंबकीय हल्के खनिज (एनएमएलएम-ई अंश) 5.46% से 28.29% के बीच में है, जिसका औसत 11.56% है। बजरी का भार 0% से अधिकतम 22.76% तक है, जिसका औसत 6.77% है, तथा मृत्तिका का भार 1.598% औसत के साथ 0% से अधिकतम 14.67% तक है।

दांडी-ओंजल खंड के एलआईआरएमएस-मैग्नेटिक्स (A), आरईडीएमएस-मैग्नेटिक्स (B) और आरईडीएमएस-मिडलिंग्स (C) के छन्नी अंशों में, ABC230-भिन्नों में टाइटेनियम और वैनाडियम के मान अधिकतर स्थिर हैं। छानने के विश्लेषण से यह देखा गया है कि भारी खनिजों का अनुपात मुख्य रूप से बारीक रेत (0.250 मिमी से 0.125 मिमी) और बहुत बारीक रेत (0.125 मिमी से 0.063 मिमी) में केंद्रित है। A230# छन्नी आकार में भारी खनिजों का वजन प्रतिशत 2.21% से 11.52% के बीच है, जिसका औसत 6.02% है, B भाग में यह् 0.02% से 0.87% के बीच है, जिसका औसत 0.19% है, और C भाग में 1.73% से 11.29% के बीच है, जिसका औसत 5.98% है।

ABC230# अंशों के रासायनिक विश्लेषण आंकड़े के आधार पर, 69 में से 67 ABC230#-अंश नमूने में 0.1% से अधिक V_2O_5 पाया है, जबकि 43 नमूनों में >14% TiO_2 मौजूद है। Fe_2O_3 का सांद्रण (wt%) 14.27% से 51.64% के बीच पाया गया है, TiO_2 3.043% से 24.895% के बीच भिन्न होता है और V_2O_5 0.025% से अधिकतम 0.315% के बीच भिन्न

होता है। इस अंश में V_2O_5 का औसत मान 0.194%, TiO_2 का 14.83% और 31.35% Fe_2O_3 पाया है। खनिजों में V_2O_5 की सांद्रता 0.1% से अधिक होने पर इसे संभावित माना जाता है।

विभिन्न छन्नी अंशों (जैसे: 60#, 120#, 230#, -230#) से दस प्रतिनिधि नमूनों के एक्सआरडी (XRD) अध्ययन से यह स्पष्ट होता है कि (i) एलआईआरएमएस-मैग्नेटिक्स (A230# और A60#+120# अंश) में स्पिनेल ग्रुप के खनिज (मैग्नेटाइट, टाइटनोमैग्नेटाइट और मैग्नेशियोफेराइट) मौजूद हैं जिनकी स्पिनेल क्रिस्टल संरचना समान है, ग्रिड पैरामीटर और XRD तरीका तुलनीय हैं, जिससे इन प्रकार के खनिजों में अंतर करना बहु-खनिज नमूनों में चुनौतीपूर्ण हो जाता है; A-अंशों में पाए जानेवाले अन्य खनिज पाइरॉक्सीन (Cpx) और प्लाजियोक्रेइज (pl) हैं (ii) आरईडीएमएस-मैग्नेटिक्स (B230# अंश) में अधिकांशतः पाइरॉक्सीन, इल्मेनाइट, प्लाजियोक्रेइज, क्वार्ट्ज, एम्फीबल और डोलोमाइट जैसे खनिजों को पाए जाते हैं। (iii) आरईडीएमएस-मिडलिंग (C230# और C60#+120#-अंश) में अल्प मात्रा में मृत्तिका खनिजों, हीमैटाइट और इल्मेनाइट के साथ पाइरॉक्सीन (मुख्यतः cpx) जैसे भारी खनिज, प्लाजियोक्रेइज और क्वार्ट्ज होते हैं, (iv) गैर-चुंबकीय भारी खनिज (एनएमएचएम-NMHM) में क्लिनोपाइरॉक्सीन और हीमैटाइट शामिल हैं और गैर-चुंबकीय हल्के खनिजों (एनएमएलएम-NMLM) में, निर्धारित खनिज चरण हैं कैल्साइट और क्वार्ट्ज जिनमें जिओलाइट के पथरेख हैं और (v) पांशु अंश प्लेजियोक्लेज़, क्वार्ट्ज, पाइरोक्सीन (मुख्य रूप से सीपीएक्स), और स्पिनल (मुख्य रूप से मैग्नेटाइट प्रकार) से बने हैं जिनमें मृतिका खनिजों, कैल्साइट, एम्फीबोलाइट और अभ्रक के पथरेख हैं।

चुंबकीय अंशों के पेट्रोग्राफिक और ईपीएमए(EPMA) अध्ययनों से पता चला है कि A अंश (60#,120#) इल्मेनाइट, प्लेजियोक्लेज़, क्लिनोपाइरॉक्सिन(Cpx) से बने होते हैं, और A230 अंश इल्मेनाइट, Fe-Ti ऑक्साइड/हाइड्रॉक्साइड से बने होते हैं, B अंश (60#,120#) इल्मेनाइट, क्लिनोपाइरॉक्सिन(Cpx), एम्फीबोल और स्फीन से बने होते हैं, C अंश (60#,120#, 230#) टीआई-एफई(Ti-Fe) हाइड्रॉक्साइड, क्लिनोपाइरॉक्सिन(Cpx), इल्मेनाइट, एम्फीबोल, प्लेजियोक्लेज़, एफई-हाइड्रॉक्साइड, इल्मेनाइट, एपिडोट और एल्बाइट से बने होते हैं। चुंबकीय खनिजों में पाइरोक्सीन और प्लेगियोक्लेज़ की उपस्थिति इस तथ्य के कारण है कि TTM को शुरू में चट्टान के टुकड़ों द्वारा आवरण किया गया था और नमूने की पिसाई के दौरान मुक्त किया गया था। Fe-TiO_2 खनिज कणों के ईपीएमए (EPMA) विश्लेषण से पता चलता है कि (i) FeO और TiO_2 का बराबर वितरण है जो एक सामान्य आग्नेय स्रोत को दर्शा

सकता है और (ii) टाइटैनिफेरस मैग्नेटाइट कणों की तत्व सांद्रता में व्यापक भिन्नता के साथ-साथ MgO और MnO के संदर्भ में उनके लगातार भिन्नता की प्रवृत्तियां लेट-मैग्मैटिक प्रक्रियाओं के दौरान खनिज संरचना में अंतर्निहित भिन्नता को दर्शा सकते हैं। अन्वेषण क्षेत्र का प्रतिनिधित्व करने वाले पाँच थोक नमूनों का विश्लेषण हैदराबाद के परमाणु खनिज निदेशालय (AMD) में मोनाज़ाइट समतुल्य केलिए रेडियोमेट्रिक विश्लेषण द्वारा किया गया।

हैंड मैग्नेट द्वारा अलग किए गए डेटा के आधार पर, अनुमान लगाया गया है कि 7.447 किलोग्राम के थोक नमूने ने 27.009wt% हाथ मैग्नेटिक अंश (Mt) और 31.77wt% नॉन-हाथ मैग्नेटिक अंश (Nmt) उत्पन्न किए हैं, जिसमें सीव आकार 35#, 60#, 120#, 230#, -230 शामिल हैं और 34.32wt% नॉन-मैग्नेटिक अंश (D+E) है। विश्लेषणात्मक आकडे से पता चलता है कि +230Mt में TiO_2 और V_2O_5 के उच्च मान हैं जो क्रमशः 17.10% और 0.50% हैं, इसके बाद +120Mt और +60Mt है जो दर्शाता है कि वैनाडियम ज्यादातर टाइटेनिफेरस मैग्नेटाइट (TTM) में जमा है। +120Mt अंश के TiO_2 और V_2O_5 मान क्रमशः 8.22% और 0.2% हैं और +60Mt अंश में ये 3.63% और 0.08% हैं। रेत पिंड के Mt अंशों में Fe_2O_3, TiO_2 और V_2O_5 का अनुमानित टनमान 0.2780MMT, 0.0832 MMT और 0.0020 MMT है। इस प्रकार +120# सीव अंश भी संभावित अयस्क अंश माना जा सकता है।

मशहूर डांडी संग्रहालय और ऐतिहासिक महत्व का साल्ट सत्याग्रह स्मारक तथा स्मृति मंच डांडी तट के निकट स्थित है, जो अन्वेषण क्षेत्र के पास है। इसलिए, 5,03,459 वर्ग मीटर क्षेत्रफल वाले पर्यटन स्थलों को बफर क्षेत्र के रूप में रखा गया है। इस प्रकार, डांडी-ओंजल क्षेत्र में 2.719 वर्ग किलोमीटर और सूरतवाड़ा क्षेत्र में 0.950 वर्ग किलोमीटर के कुल क्षेत्र में संसाधन का आकलन किया गया है। उत्पन्न हुए भारी आकड़ों को संकलित, संश्लेषित और व्याख्यायित किया गया ताकि निक्षेप को समझकर, उसका अयस्क-संघनन मॉडल उत्पन्न किया जा सके और संसाधन का आकलन किया जा सके।

डांडी-ओन्जल क्षेत्र में रेत पिंड की कुल टन भार 9.947 MMT होने का अनुमान है, जिसमें 5.008 MMT अयस्क पिडं है जो लगभग 50.34% है। जिसमें A अंश (एलआईआरएमएस-मैग्नेटिक्स) की मात्रा लगभग 34.647%, B अंश (आरईडीएमएस-मैग्नेटिक्स) 1.207% और C अंश (आरईडीएमएस-मिडलिंग्स) 21.870% निर्धारित किया गया है। कुल रेत में Fe_2O_3 की ग्रेड 3.767%, TiO_2 की 1.800% और V_2O_5 की 0.022% है। डांडी-ओन्जल के जांच

क्षेत्र के रेत पिंड में Fe_2O_3 का कुल टन भार 0.327 MMT, TiO_2 का 0.156 MMT और V_2O_5 का 0.002 MMT होने का अनुमान है।

सुर्वाडा सेक्टर के ब्लॉक में बालू पिंड का कुल टन भार 2.870 MMT होने का अनुमान लगाया है, जिसमें ABC230 (प्रधान अयस्क) लगभग 0.315 MMT है, जो कि बालू पिंड का लगभग 10.98% अंश है। जिसमें A अंश (एलआईआरएमएस -चुंबकीय) लगभग 49.379% का, B अंश (आरईडीएमएस-चुंबकीय) 4.100% का और C अंश (आरईडीएमएस-मिडलिंग्स) 22.753% का प्रतिनिधित्व करता है। कुल रेत में Fe_2O_3 की ग्रेड 2.707%, TiO_2 की 0.866% और V_2O_5 की 0.015% है। जांच किया गया सुर्वाडा क्षेत्र के रेत पिंड में Fe_2O_3 का कुल टन भार 0.078 MMT, TiO_2 का 0.025 MMT और V_2O_5 का 0.0004 MMT होने का अनुमान है।

ये वैनैडियम और टाइटेनियम वाले खनिज, विभिन्न उच्च तकनीकी उद्योगों, जिसमें इलेक्ट्रॉनिक्स, टेलीकम्युनिकेशन और नवीकरणीय ऊर्जा प्रौद्योगिकियां शामिल हैं, के लिए आवश्यक हैं। समुद्र तट और रेत के टीलों को संभावित स्रोतों के रूप में पहचाना गया है। वैनैडियम निष्कर्षण के लिए प्रमुख कच्चे माल टाइटनोमैग्नेटाइट अयस्क हैं (विश्व में कुल V उत्पादन का ~88%)।

वर्तमान अध्ययन दिखाता है कि सुरवाड़ा क्षेत्र की तुलना में, डंडी-ऑन्जल क्षेत्र में टाइटेनियम और वैनाडियम के संभावित प्लेसर सांद्रण हैं, जब इसे मुख्य रूप से मैफिक और अल्ट्रामैफिक ज्वालामुखीय चट्टानों द्वारा होस्ट किए जनवाले वैनडिफेरस टाइटेनोमैग्नेटाइट (VTM) जमा से तुलना की जाती है तो । खोजे गए क्षेत्र में निर्धारित की गए ABC230-फ्रैक्शन के लगभग 14% का औसत TiO_2 सांद्रण, पश्चिमी ऑस्ट्रेलिया के विंडिमुर्ला समुच्चय की तुलना में अधिक है (जो दुनिया के सबसे बड़े टाइटेनियम-वैनाडियम निक्षेप में से एक है; जिसमें TiO_2 सांद्रण लगभग 2% और औसत 0.32% V_2O_5 पाए जाते है)।

प्लेसर जमा में मुक्त अयस्क खनिजों का प्रभाव महत्वपूर्ण है क्योंकि अयस्क खनिजों की मुक्ति का मतलब है कि मूल्यवान खनिज पहले से ही आसपास की चट्टान से अलग हो चुके हैं। यह निष्कर्षण प्रक्रिया को उन जमा के मुकाबले अधिक प्रभावी और लागत-कुशल बनाता है जहाँ अयस्क खनिज अभी भी मेजबान चट्टान के भीतर बंद हैं, जैसे कि परतदार गैब्रॉ में टाइटनोमैग्नेटाइट बैंड।

यह अन्वेषण खनिज (खनिज अंतर्वस्तु का साक्ष्य) नियम-2015, खनिज (खनिज अंतर्वस्तु का साक्ष्य) नियम-2021 के अनुसार किया गया है और खनिज संसाधनों का अनुमान UNFC मानदंडों के अनुसार लगाया गया है। चूंकि यह प्रारंभिक अन्वेषण (G3) है जिसमें 'E' और 'F' धुरों पर कोई अध्ययन नहीं किया गया है, संसाधन को UNFC G3F3E3 के रूप में वर्गीकृत किया गया है।

CHAPTER 1 - INTRODUCTION

1.1 Vanadium and Titanium uses and resources in India:

The critical metals (Ti and V) occur majorly in three minerals namely ilmenite, titanomagnetite, and magnetite found in mafic and ultramafic rocks. Petro-genetically these minerals are formed in a solid solution series represented by ilmenite-titanomagnetite-magnetite series. Thus, primary igneous rocks and the sediments provenanced by the primary igneous sources are targets for the exploration of these critical metals.

In India, vanadium is primarily found in titaniferous magnetite (containing 0.8-3% V_2O_5) and in association with chromite, laterite, bauxite, and certain rocks like pyroxenite. India consumed 4% of global vanadium production in 2017, with the global demand driven by steel production, particularly for high-strength alloys, and the emerging use of vanadium in batteries. China, which produces 57% of the world's vanadium, consumed 44% of the metal (IBM, 2021). Imperatives for utilisation of the huge vanadium-bearing titaniferous ores are 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 used essentially in alloy production. Recently the Indian Railways have initiated replacing the old rails made of carbon steel with vanadium alloy (SAIL, 2020). The Geological Survey of India recently discovered vanadium reserves in the Palaeo-proterozoic carbonaceous phyllite in the Depo and Tamang areas of Papum Pare district of Arunachal Pradesh, with an average grade of 0.76% V_2O_5 (vanadium pentoxide). On global scenario, the largest reserves are located in China, Russia, and South Africa (The Hindu, Jan., 2021, Drishti, Jan., 2021 & Journals of India, Jan., 2021).

TiO_2 demand in India grew at a CAGR (Compound Annual Growth Rate) of 8.25% from 2015-2019 and is expected to continue due to the increase in demand in construction and infrastructure sectors. TiO_2 is a key component in paints, which accounts for 25% of its total usage. The Indian construction market is expected to grow at a CAGR of over 10% from 2022-2027 (Mordor Intelligence, 2023), with the infrastructure sector growing at 8.2% by

2027 (Chem Analyst, June, 2020). Despite an installed production capacity of 82,500 metric tons, India relies on imports for about 70% of its TiO_2 demand, mainly from China. Efforts to boost domestic production will enhance market prospects through 2030 (Chem Analyst, June, 2020).

The India's accelerated growth in the mineral-based industries, and ever-growing demand for mineral raw materials for these industries have paved way for increased vanadium and titanium exploration studies across the country. The current project is part of this renewed efforts towards locating these vital mineral commodities.

1.2 Details of the current project

Initiated to unlock the hidden potential of India's coastline, the Vanadium, Titanium Bearing Sand Exploration Project aims to explore and evaluate the vast untapped low-grade resource of beach and dune sand deposits. These deposits scattered along extensive Gujarat and Maharashtra coastline of India hold significant concentrations of vanadium and titanium. A comprehensive geological investigation, involving mapping, sampling, and laboratory analysis was taken up under the G3 level exploration project of NMET at Dandi-Onjal-Surwada block of Gujarat (Fig.1.1.a & 1.1.b). The project aims to identify areas with good concentration of vanadium and titanium deposits. It is hoped that the project may pave the way for their sustainable extraction and industrial utilization.

1.3 Investigating agency

M/s. Geo Marine Solutions Pvt. Ltd (CIN U74900KL2011PTC28241) is a Notified Private Exploration Agency (NPEA), Science and Technology Services Company with a vision to take proactive role in nation building by providing latest scientific know-how in the Earth System Science. The company draws its inspiration and ability to undertake challenging projects from team leaders in different disciplines of Earth Sciences who are former scientists from prestigious organizations like Geological Survey of India, National institute of Oceanography etc. Each of the team leaders of Geo Marine Solutions is the leading scientists in their fields (domain experts) and brings in about more than three decades of experience in Offshore and Onshore Geo Scientific Survey and Exploration.

The entire work components were planned and carried out by the firm, with coordination provided by Praveen Kumar, former Director (Geology) of Geological Survey of India and the Director of Geo Marine Solutions.

Name and address of the NPEA
Geo Marine Solutions Pvt Ltd
15-17-909/9,5th Cross Shivabagh, Kadri,
Mangalore-575005, Karnataka, INDIA
Contact Mobile No: +91-9038534560, +91-8277363919
E-Mail id: mail@geomarinesolutions.in, oed@geomarinesolutions.in

1.4 Objectives of investigation

a) The objective of the investigation is G3 Level Exploration for Vanadium and Titanium in Beach and Dune Sands of Dandi-Onjal-Surwada Block in Navsari and Valsad Districts, Gujarat.

b) To understand the surficial distribution and downward continuity of economic heavy minerals viz; magnetite-titanomagnetite-ilmenite as reported by earlier works, by sampling at 400m x 200m interval and auger drilling up to 5 m below ground level.

c) To estimate the valuable resources of vanadium and titanium within the block and to recommend the feasibility for further level of exploration.

1.5 Basis for taking up investigation

The preliminary investigation for locating heavy mineral potential of coastal sands in the Valsad, Navsari, and Surat districts of Gujarat was initiated by the Department of Industries and Mines, Gujarat during 2000-2002 to locate possible ilmenite-bearing sands (Pandya, 2002). Following this, further assessments were conducted by Geological Survey of India (GSI) of Gandhinagar, as part of the 2012-13 field season programme (FSP Code: 2012-13/ME/IM/WR/Guj/055). The latter study was carried out along the Gujarat coast between Dumas in Surat district to Tithal in Valsad district. The objective was to evaluate the potential heavy mineral deposits in the area, particularly focusing on ilmenite, titano-magnetite, and magnetite in both beach and dune sands. Good concentration of ilmenite, titano-magnetite

and magnetite were reported from the beach and dune sands and vanadium concentrations in titanomagnetite are found to be very encouraging as well (Basheer, 2013).

Concurrently, a field investigation was also taken up 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. The total heavy mineral percentage values in the beach sediment samples range from 0.3% to 71.5%.

The major economic heavy mineral constituents in the beach and dune sediments are found to be ilmenite and magnetite in the area. The other heavy minerals like rutile, sillimanite, zircon etc. present in minor quantity. Beach samples collected near Dandi and the Par River mouth exhibited the highest concentrations, particularly for ilmenite, while dune sediments along a long stretch between Dandi and Kanai creek and a small stretch near Surwada are enriched in ilmenite. 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% (Dinesh et al., 2013).

A study of bulk sediments from the Gulf of Khambhat revealed heavy mineral content up to 28.5%, with notable vanadium concentrations found in titanomagnetite, a by-product that could be further explored for its economic value (Gopakumar et al., 2022). The vanadium is likely sourced from Deccan basalt. High content of vanadium is also reported in Deccan Trap basalts by Sethna and Sethna (1990, 1998). As per the IBM yearbook 2022, the total resource of V_2O_5 is 64,595 tonnes only. Hence, vanadium exploration project is having great significance.

In view of the growing demand for the twin commodities, the Geological Survey of India recommended detailed exploration to assess the downward extension of ilmenite concentrations for these two mineral commodities especially the surficial distribution of heavy mineral placers along the Dandi-Onjal-Surwada block (Gopakumar et al., 2022; Mordor Intelligence, 2023). All these show the proposed sectors are enriched in ilmenite and magnetite and warrants G3 level prospecting.

On the basis of the aforementioned recommendation, the present study is taken up to identify and locate potentially viable zones of titanium and vanadium rich heavy minerals within an area of 4.16 sq.km in the Dandi-Onjal sector (3.21 sq km) which is situated between Purna River in the north and Kanai Creek in the south and the Surwada sector (0.95 sq km) which is lying between Auranga River in the north and Par River in the south (figure 1.1.a and 1.1.b). The sectors are named Dandi-Onjal and Surwada which constitute Dandi-Onjal-Surwada Block. In nutshell, the heavy detritus present in the sediments mainly the ilmenite-titanomagnetite-magnetite mineral suite is considered to be multi-metal (Ti-V) bearing deposit with a high comprehensive utilization value.

A total of 37 locations were proposed for sampling by auger drilling with 1m interval up to 5 m depth below ground level (bgl) to understand surface distribution and the downward continuity of ilmenite-titanomagnetite-magnetite mineral suite which altogether form a source for Ti-V-Fe metals. As per AMD's communiqué to IBM (via letter dt. 26th 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 are falling between Moti Daman and Ubhrat.

1.6 Details and nature and quantum of work proposed vs achievement (Table)

The exploration for vanadium and titanium in Dandi-Onjal-Surwada Block (G3) with quantum of work and targets achieved are given in Table-1.1

Table 1.1: Quantum of Work – Dandi-Onjal-Surwada Block (G3)

Sl. No	Description of Work	Quantum of work proposed (Sq Km/ Number)	Achievement	Remarks
1	Geological, Topographic mapping (1:5000 scale)	2.17 sq km	4.16 sq km	During execution of topographic survey and geological mapping on 1:5000 scale and post data processing in Dandi-Onjal-Surwada block, it is observed that the total area with presence of alluvial sand is 4.16 sq km.
2	Auger drilling of 37 BH up to 5.0m BGL	37 nos (185 m)	37 no's (160 m)	The total samples up to 5m were not fully recovered from some boreholes by auger due to the presence of clay.
3	Grain size analysis	185 no's	160 no's	All recovered samples were subjected to Grain size analysis.
4	Mineral Separation and Identification of sediment samples of 2mm size through two-level magnetic and gravity separation	185 no's	160 no's	All recovered samples were subjected to Mineral separation.
5	Geochemical analysis (i) Major oxides including Ti, V, Fe, and other oxides using XRF (25 % of sub samples)	139 no's	164 no's	All the sub-samples were subjected to WDXRF
	(ii) For niobium, tantalum, scandium and REE by ICP-MS (5% of samples)	27 no's	27 no's	-
6	EPMA	3 hours	3 hours	3 hours

Sl. No	Description of Work	Quantum of work proposed (Sq Km/ Number)	Achievement	Remarks
7	XRD analysis	10 no's	10 no's	-
8	Mineralogical study under microscope	-----	9 no's	-
9	10 % Check samples-XRF	14 no's	14 no's	-
10	Resource estimation and report writing	1	1	-
11	Radiometric analysis of Monazite equivalent (AMD)	5 no's	5 no's	-
12	Specific gravity of rock samples (Bulk density)	10 no's	10 no's	-
13	Grain size of magnetic fractions	-----	480 no. s (160*3)	LIRMS magnetics (A), REDMS magnetics (B) and REDMS middlings (C) were subjected to Grain size analysis

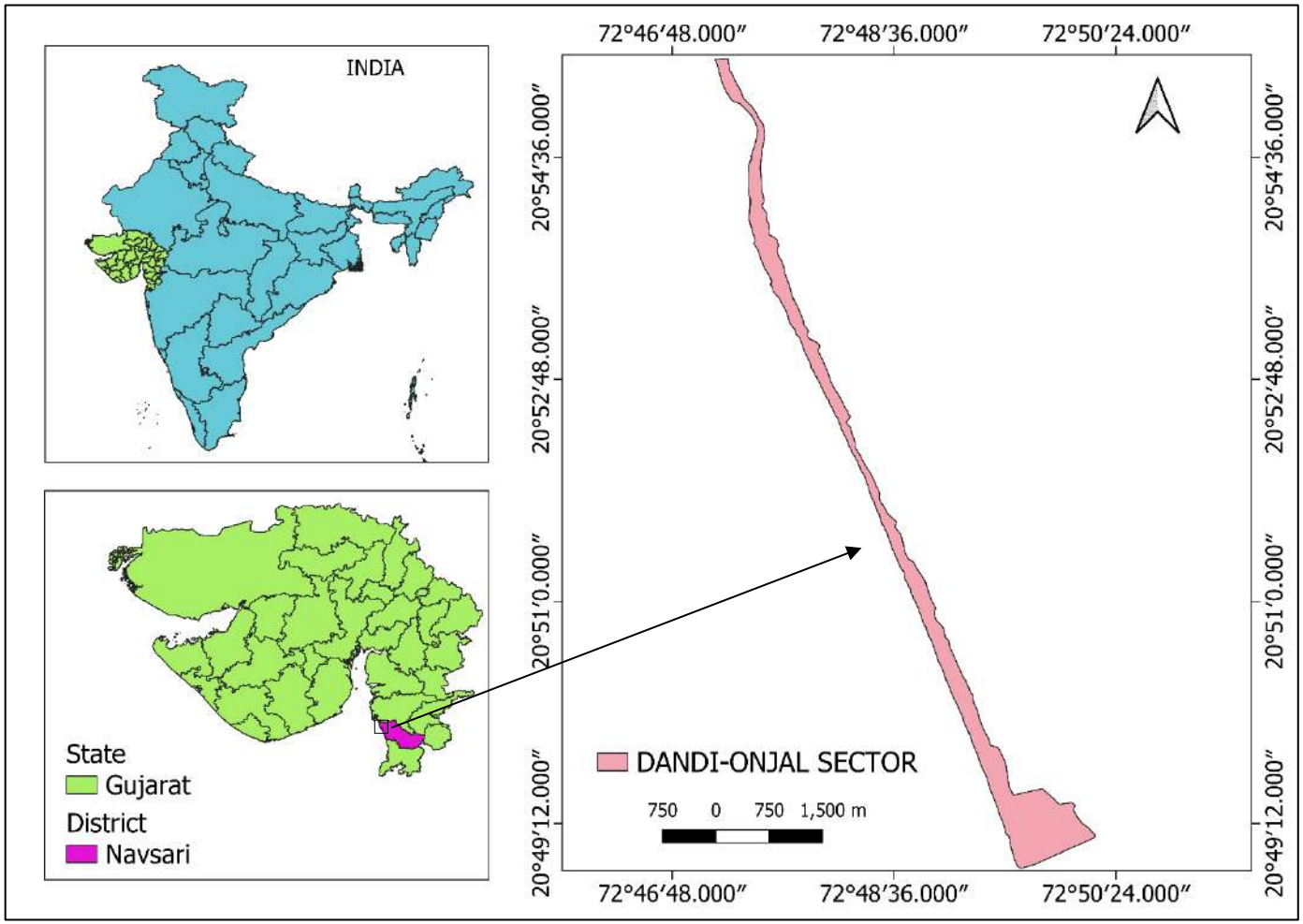


Fig.1.1. a: Index map of the G3 Exploration area (Dandi-Onjal sector).

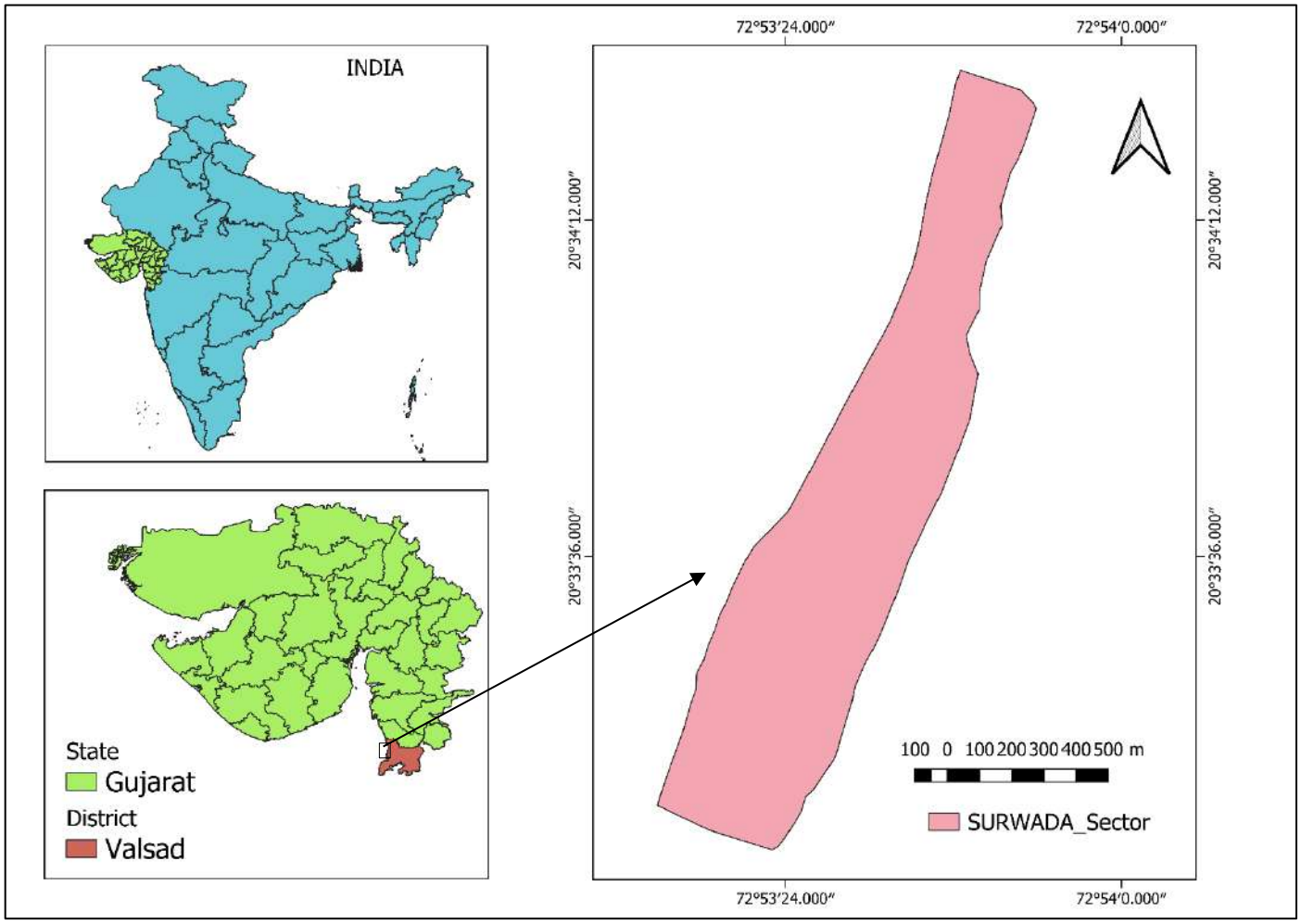


Fig.1.1. b.: Index map of the G3 Exploration area (Surwada sector).

1.7 Technical Personal involved in the project.

The Table- 1.2 shows the technical experts deployed in the exploration with their qualification, designation and major contributions in the investigation.

Table 1.2: Technical persons engaged in exploration				
Sl no	**Name**	**Qualification**	**Designation**	**Main contributions**
1	Dr. Fareeduddin	PhD in Geology with 41 years of experience in Mineral Exploration and Geological mapping	Former director in GSI, Principal Consultant- Geo Marine Solutions Pvt Ltd. and NABET approved Project coordinator	Guidance throughout the field season, sample processing, analysis and report writing
2	P. Praveen Kumar	M.Sc. (Tech.) Applied Geology, with 30 years of experience in Mineral Exploration and Geological mapping	Former Director, GSI, Nodal Officer, Geo Marine Solutions Pvt Ltd and NABET accredited Technical Area Expert (Geology) for Mineral Exploration.	Supervision and guidance in geological mapping, topographic survey, auger sampling, mineral separation in the lab, selection of samples for chemical analysis, synthesis and interpretation of data, map preparation, ore modelling analysis and report writing.
3	A.C Dinesh	M.Sc. Marine Geology, with 36 years of experience in Mineral Exploration and Geological mapping	Former Director, GSI and Chief Technology Officer, Geo Marine Solutions Pvt. Ltd.	Field planning, co-ordination of mineral separation in the lab, interpretation of data, resource estimation and writing of report.

4	Vidya Vincent	M.Sc. Marine Geology with 3 years of experience.	Geologist, M/s. Geo Marine Solutions Pvt. Ltd.	Geological mapping, Supervision of sub sampling and separation of heavy mineral of samples.
5	Aswathy P S	M.Sc. Marine Geology with 3 years of experience.	Geologist, M/s. Geo Marine Solutions Pvt. Ltd.	Geological mapping, Separation of heavy mineral of beach samples, Grain size analysis, synthesis and interpretation of data and writing of report.
6	Guruprasad S.	M.Sc. Geology with 6 years of experience.	Sr. Geologist, M/s. Geo Marine Solutions Pvt. Ltd.	Sampling, synthesis and interpretation of data, map preparation, ore modelling. Resource estimation, writing of report.
7	Aparna C V	M.Sc. Marine Geophysics with 4 years of experience.	Geophysicist, M/s. Geo Marine Solutions Pvt. Ltd.	Map preparation, preparation of pre-feasibility report, supervision of sample processing and assisting in data interpretation.
8	Jithesh	Diploma in Civil Engineering with 8 years of experience.	Surveyor, M/s. Geo Marine Solutions Pvt. Ltd.	Topographic Survey, borehole fixing
9	Abhay Krishna S U	Diploma in Surveying with 5 years of experience.	Surveyor, M/s. Geo Marine Solutions Pvt. Ltd.	Topographic Survey, borehole fixing
10	M.P. Prathep Kumar	Chief Mate Phase I&II, LBS college Mumbai.	Former Chief Nautical Officer, Shipping Corporation of India	Logistics and field Manager

1.8 Mode of operation of different work components and associated agency

During this investigation, the work was executed in three different stages, namely pre-field studies, field studies and post-field studies. The different components and procedures followed in each stage are discussed below.

A. Pre-field studies: It includes preliminary research (published papers) and feasibility studies on concerned toposheets (46D/13&14), geological maps, OSM sheets and previous reports to identify potential area of exploration and preparation of in-principal proposal. The pre-field studies were undertaken from the first week of January 2024.

B. Field studies: The field studies were undertaken between the period from third week of April 2024 to third week of May 2024 and second week of September 2024 to second week of November 2024. Reconnaissance survey was conducted initially to assess the actual conditions of roads, accessibility in different parts of area, communication links therein, hydrography (drainage pattern and nearby streams) and climatic conditions. Topographic survey in the study area was carried out with three sets of Geomate Real Time Kinematic–Global positioning system (RTK-GPS) receivers. A total of 4.16 sq.km area was covered by systemic Geological mapping on 1:5000 scale with collection of beach and dune sand samples from representative boreholes within 400*200 m grid pattern as per MEMC rule (Fig. 1.2.a & 1.2.b). A total of 160 nos. of beach sediment samples were collected by hand auger drilling from 37 boreholes at 1.0m interval up to a maximum depth of 5.0m below ground level. The samples were dried and subjected to coning and quartering in the riffle splitter and they are packed and labelled separately. One part of the sample is kept as repository and other was used for laboratory studies.

C. Post field studies: The post field study includes (i) data compilation, (ii) grain size analysis, (iii) magnetic and gravity separation, (iv) sample preparation for XRF, XRD, EPMA, ICPMS, bulk density and radiometric analysis (v) processing and interpretation of the laboratory data, (vi) summarizing analytical results, (vii) finalization of maps and (viii) writing of report.

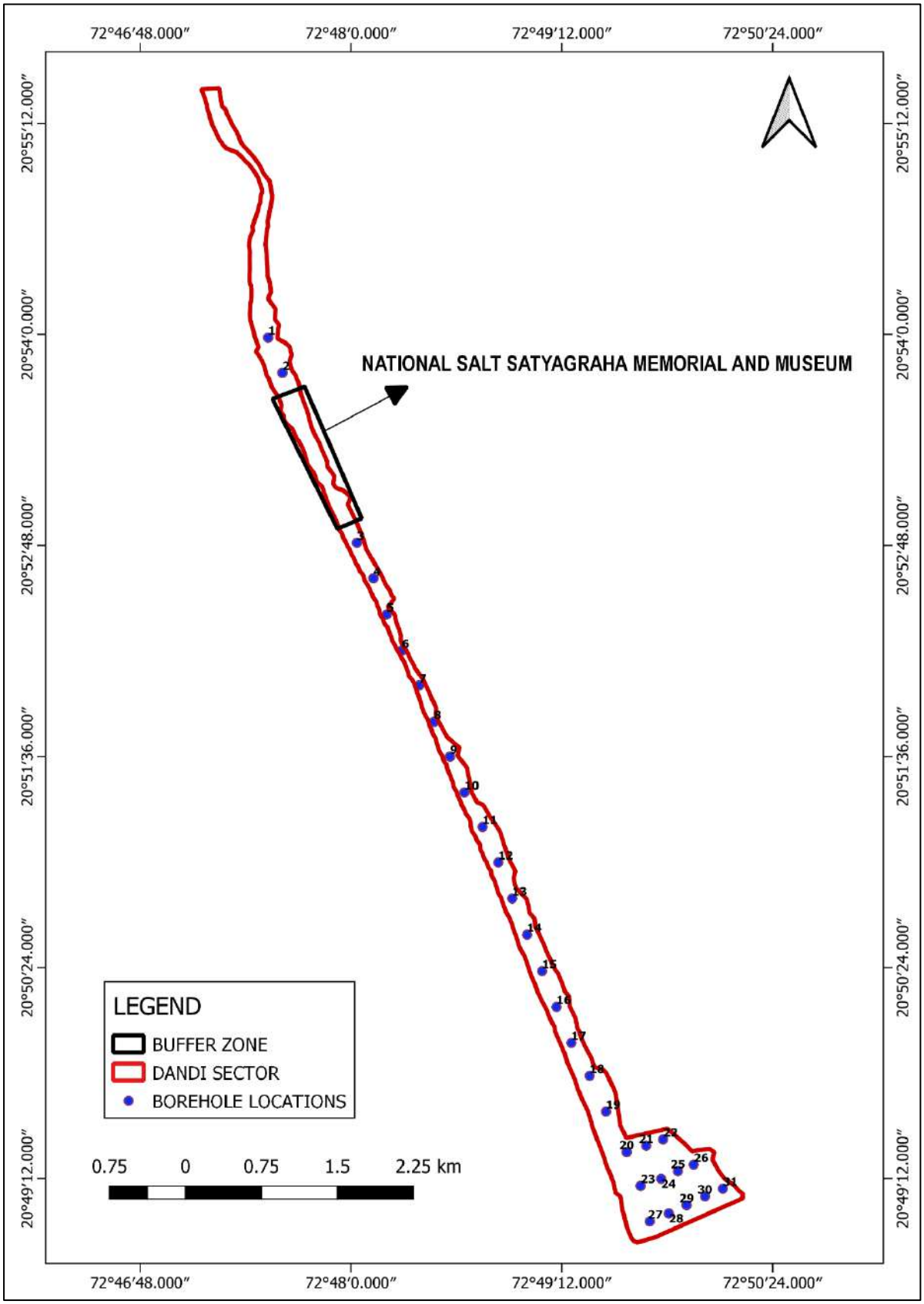


Figure 1.2.a: Borehole locations in Dandi-Onjal Sector

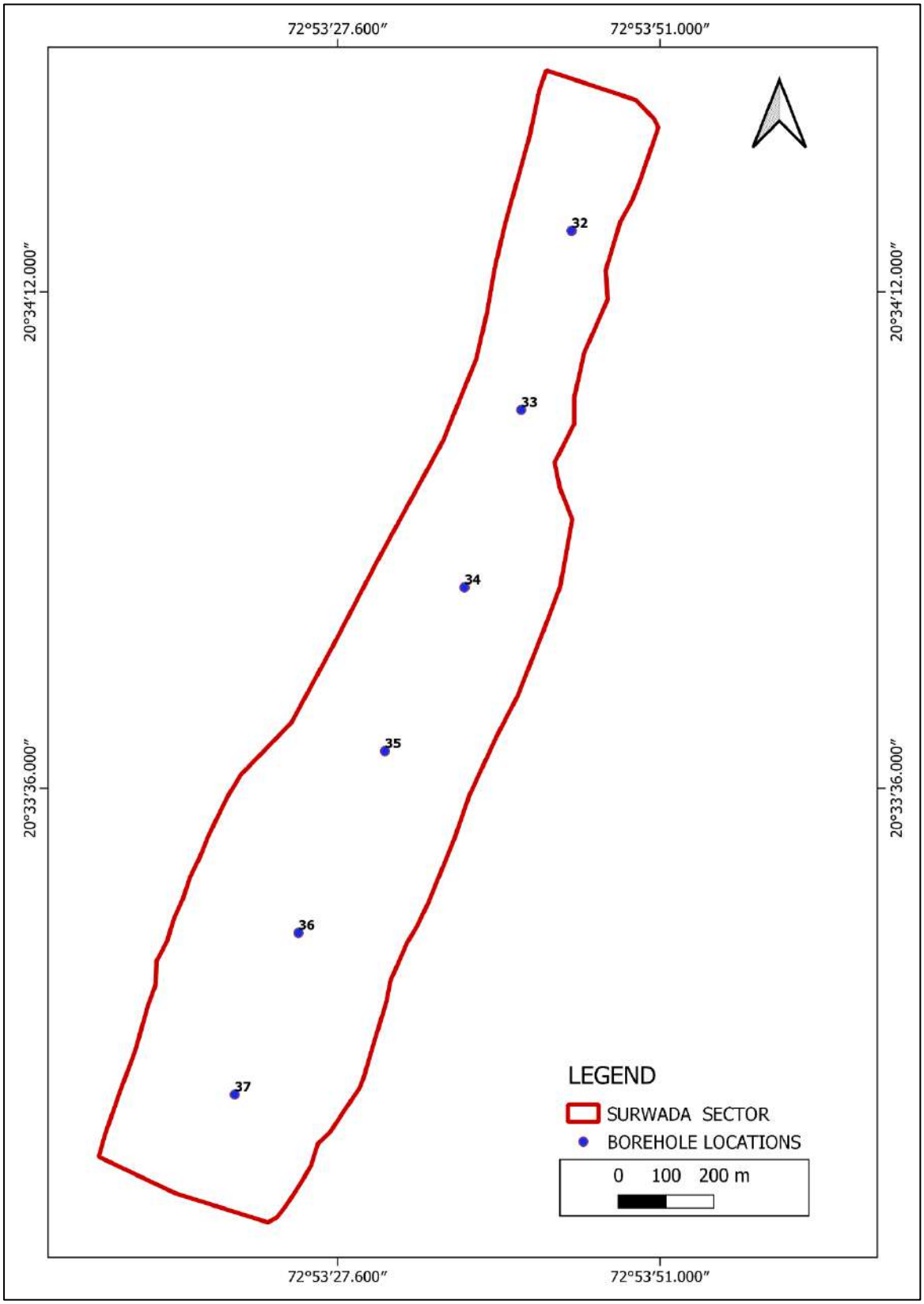


Figure 1.2.b: Borehole locations in Surwada Sector.

Other agencies involved with this project are;

All field components like, geological mapping, topographic survey, auger drilling, sample collection as well as post field components like, grain size analysis, two level magnetic separation using LIRMS & REDMS, gravity separation and mineralogical studies were done in-house at Geo Marine Solutions Pvt Ltd. The associated agencies in the laboratory analysis such as XRD, EPMA, WDXRF, ICP-MS etc. are mentioned below.

I. Shiva Analyticals (India) Private Ltd., Hoskote, Bangalore- 562 114

(NABL accredited Company)

Founded in 1997, Shiva Analyticals is NABL accredited company and is a leading analytical testing laboratory in India, based in Bangalore. Specializing in diverse sectors such as pharmaceuticals, food & agriculture, ores & minerals, petroleum, environmental, and materials testing, Shiva Analyticals offers comprehensive solutions using advanced instrumentation and expert analysis. With a focus on regulatory compliance, quality control, and innovative testing methods, the lab supports clients in ensuring product safety and efficacy, while also contributing valuable insights to the mining industry and addressing environmental and industrial hygiene concerns. As part of the Cotecna Group (Switzerland), Shiva Analyticals is committed to enhancing service delivery and customer satisfaction in a dynamic market.

Chemical analysis of 164 samples for major oxide using WDXRF followed by lithium-borate fusion bead, and 27 samples for niobium, tantalum, scandium, REE and other trace element analysis by ICP-MS were carried out at Shiva Analyticals.

II. AMD

Atomic Minerals Directorate (AMD) for Exploration and Research is the oldest unit of the Department of Atomic Energy (DAE). The Directorate is presently employing latest technology viz. Time Domain EM system along with gamma-ray spectrometer and magnetometer for airborne geophysical surveys, and multi-disciplinary field operations viz. geological, geophysical, Geo-chemical surveys on regional as well as detailed scale and drilling activities by induction of state-of-the-art hydrostatic rigs. The Directorate also has Beach-sands & Offshore, Rare metal and rare earth Investigations Groups and very well-equipped Physics and

Instrumentation Groups. The prime mandate of Atomic Minerals Directorate for Exploration and Research is to identify and evaluate uranium resources required for the successful implementation of Atomic Energy programme of the country. The Beach Sand and Offshore Investigations (BSOI) is entrusted with the exploration and evaluation of BSMs associated with shoreline placer deposits confined to East and West coasts of India in general as well as inland sand bodies (palaeo-beach ridges), inland alluvium and red sediments/teri sands along East coast in particular.

5 bulk samples were examined for radiometric analysis equivalent to monazite to verify radioactive substance in the samples.

III. M/s. Bureau of Veritas, Inspectorate Griffith India Pvt. Ltd., Plot No 73, Sector 11, GIDC Gandhidham-370201, Kutch, Gujarat., an NABL accredited analytical laboratory, offers biological, chemical and mechanical testing services along with validations, research and failure investigations. Bureau Veritas is a world leading inspection and testing organization for the growing commodities industry. Inspectorate Griffith India is the core of the Bureau Veritas Commodities Division in India.

All the 14 check samples were analyzed by Bureau of Veritas, Inspectorate Griffith India Pvt. Ltd.

IV. Matter Material Testing & Research Laboratory (P) Ltd. Mini Bypass Road, Thiruvannur Nada (PO), Thiruvannur, Kozhikode Kerala, 673029

Matter Laboratory is exceptionally well equipped with a group of Engineers and Technical Professionals committed to provide best in class Engineering & Technical solutions across the region for construction and other industries through material testing, inspection and consultancy services.

Activities of Matter Laboratory include wide range of construction materials testing, chemical analysis & microbiological examination of water, food & food products, environmental testing, metallurgical (steel) testing, non-destructive concrete testing and forensic investigation of concrete structures.

Dry bulk density of 10 bulk sand samples was carried out by Matter Material Testing and Research laboratory.

V. Geological Survey of India (GSI)

The Geological Survey of India (GSI) was set up in 1851 primarily to find coal deposits for the Railways. The arrival of Sir Thomas Oldham, Professor of Geology at Trinity College Dublin and the Chief of Irish Geological Survey at Calcutta on 4th March 1851, marked the beginning of the continuous period of the Geological Survey of India. Over the years, it has not only grown into a repository of geo-science information required in various fields in the country, but has also attained the status of a geo-scientific organization of international repute. The main functions of GSI relate to creation and updation of national geoscientific information and mineral resource assessment. These objectives are achieved through ground surveys, air-borne and marine surveys, mineral prospecting and investigations, multi-disciplinary geoscientific, geo-technical, geo-environmental and natural hazards studies, glaciology, seismotectonic study, and carrying out fundamental research. Outcome of work of GSI has immense societal value. Functioning and annual programmes of GSI assume significance in the national perspective.

GSI, headquartered at Kolkata, has six regional offices located at Lucknow, Jaipur, Nagpur, Hyderabad, Shillong and Kolkata and State Unit offices in almost all States of the country. Presently, Geological Survey of India is an attached office to the Ministry of Mines.

The XRD analysis of 10 samples for the identification of mineral phases and the EPMA studies of 9 samples per 3 hours were carried out at GSI, Kolkata.

CHAPTER 2 - PROPERTY DESCRIPTION

2.1 Details of the area (Village name, District, State)

Block name	**:**	**Dandi-Onjal-Surwada Block**
Villages	**:**	**Dandi, Onjal, Surwada**
Mandal / Taluk	**:**	**Jalalpore Taluk, Valsad Taluk**
District	**:**	**Navsari and Valsad**
State	**:**	**Gujarat**

The area under investigation is a coastal tract of 4.16 sq.km comprising Dandi-Onjal and Surwada sector. The Dandi-Onjal sector with a length of 12.5 km and width of 70m to 1.2 km covers an area of 3.21 sq km and lies between the Purna River in the north and Kanai Creek in the south. The Surwada sector is extending 2.64 km in length and width varying between 211m and 470m, with an area of 0.95 sq.km, situated between the Auranga River in the north and the Par River in the south. Key location map of the study area is given in (Figure 1.1.a & 1.1.b).

2.2 Survey of India Toposheet No

The Dandi-Onjal-Surwada block of G3 Level exploration is in the toposheet no 46D/13 & 14 (Fig. 2.1.a and 2.1.b).

2.3 Geo-coordinates of the area of all corner points

Boundary Coordinates of block (4.16 sq.km) considered for topographic survey and geological mapping is given in the Annexure 1.

2.4 Location and accessibility

The Dandi-Onjal sector is bounded by latitudes 20°48'50.34"N to 20°55'23.63"N and longitudes 72°47'8.89"E to 72°50'13.75"E and Surwada sector is bounded by latitudes 20°33'4.55"N to 20°34'28.05"N and longitudes 72°53'10.28"E to 72°53'50.85"E.

Navsari and Valsad are the nearby township near Dandi-Onjal sector and Surwada sector respectively. The city is well connected by NH-228 also known as Sabarmati-Dandi Highway that reaches to historic place Dandi. The study area can be approached by state highway and

smaller localities in the area are well connected by a network of district level roads as well as village roads. The nearest national highway is NH 64. The nearest railway station is Navsari at a distance of 13km. Nearest airport is Surat International Airport located at a distance of 30km.

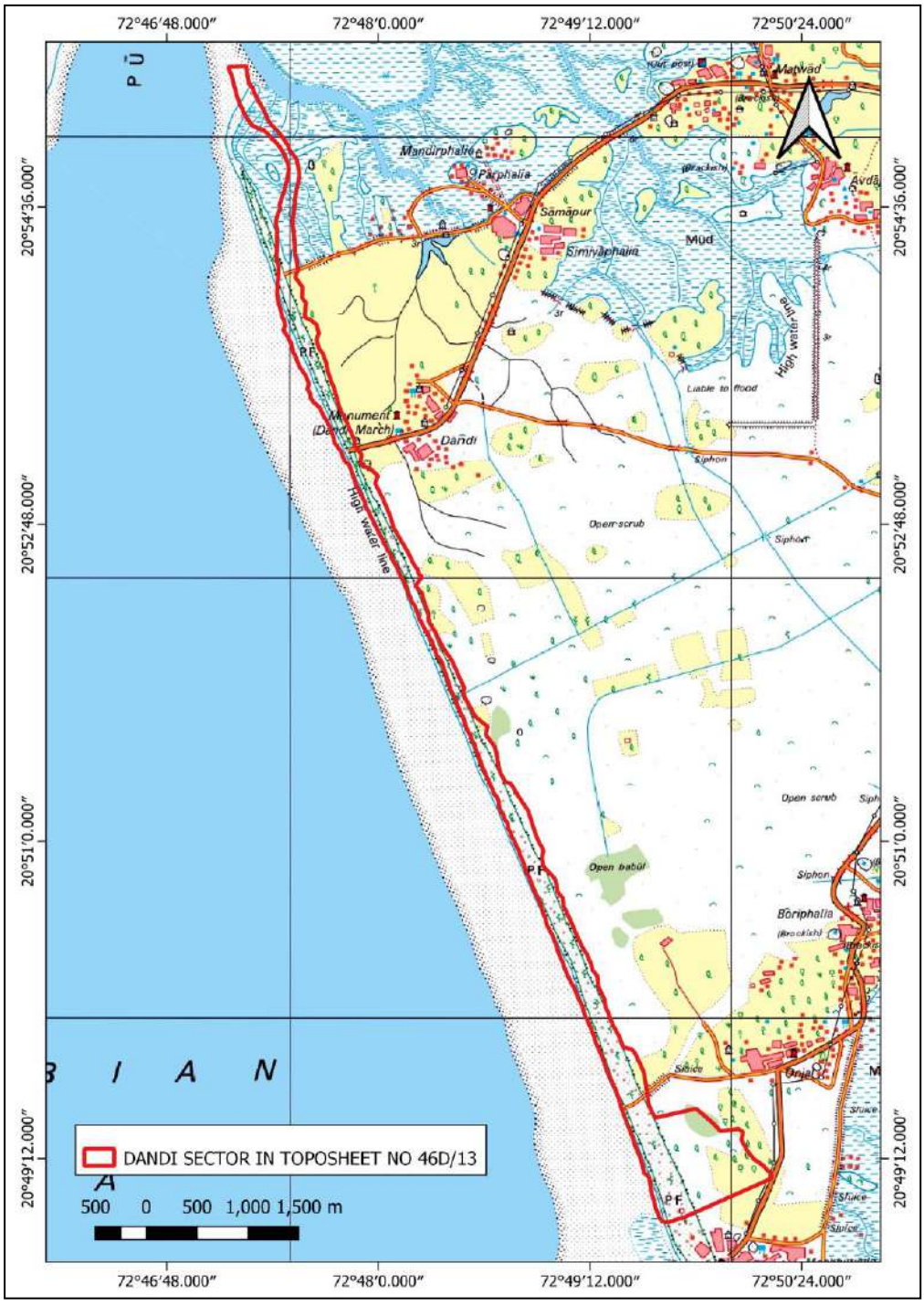


Figure 2.1.a: Dandi-Onjal sector in Toposheet no. 46D/13

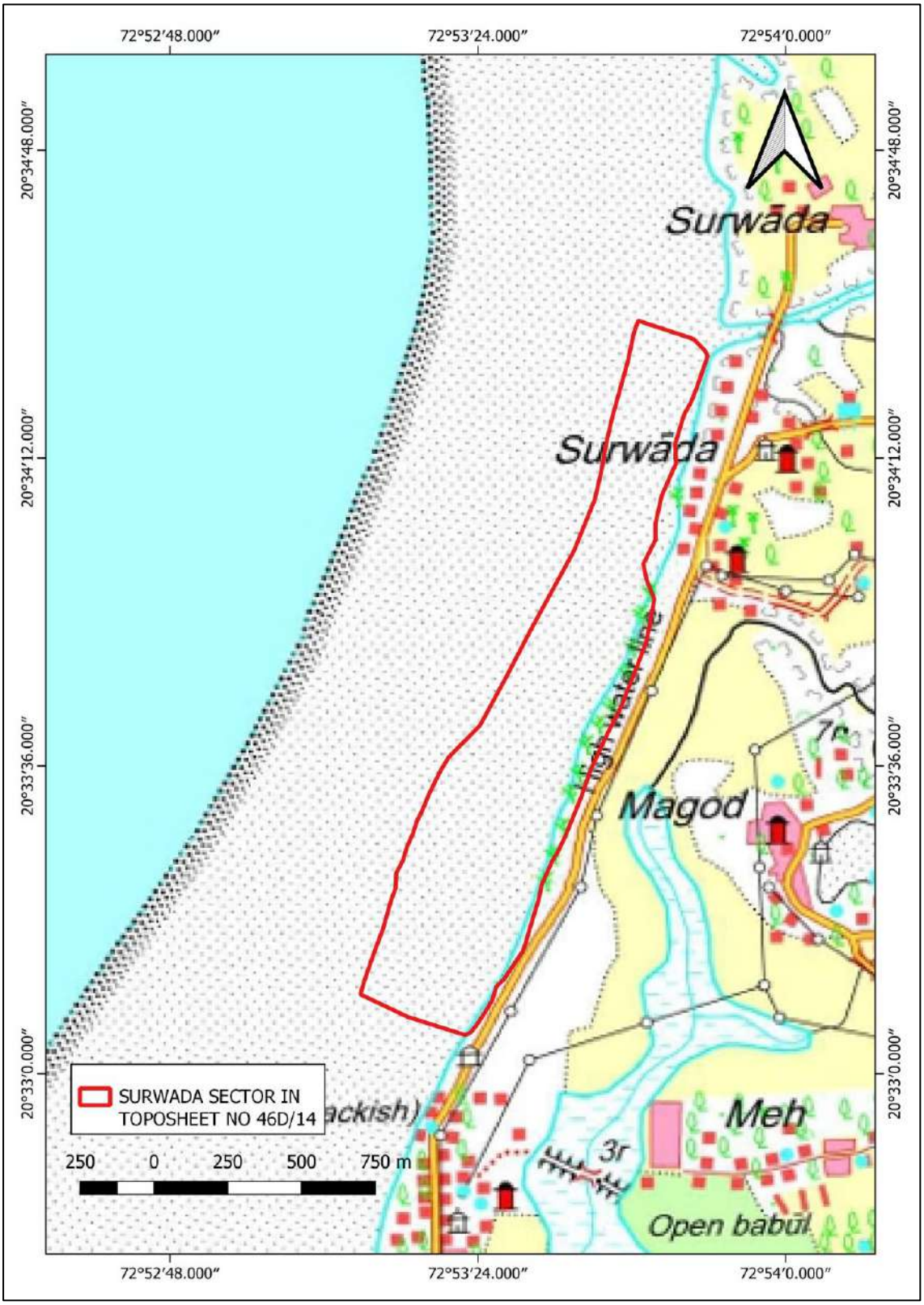


Figure 2.1.b: Surwada sector in Toposheet no. 46D/14

2.5 Cadastral details, land use/cover, forest with type of forest, free hold/lease hold details

Major portion of the study area is under government land. There is no record of leasehold area.

2.6 Climate

Navsari and Valsad districts comes under heavy rainfall areas of South Gujarat, having sub-tropical climate with moderately high humidity. The main seasons prevailing in the district are (a) monsoon - mid of June to October, (b) winter - November to February, and (c) summer – March to June (Gupte., P, CGWB, 2013).

General climate of the district is sub-tropical and is characterized by three well defined seasons, i.e. summer - from April to June, monsoon - from July to September, and winter - from October to March. Mean maximum daily temperatures range from 30° to 37°C and mean minimum daily temperatures from 14 to 26 °C. April and May are the hottest months where the temperatures may exceed 44°C. The winters are generally pleasant with minimum temperatures around 9°C. In the monsoon season the humidity is high reaching up to 84%, during winters it may drop down to 47%. Mean wind speed ranges from 108 km/d during winters to more than 220 km/d during summer and monsoon. The Potential Evapo-transpiration (PET) is maximum during summer months. It ranges from 3.9 mm/d during December to 6.9 mm/d during May. The average monthly PET is about 4.8 mm/d (K. Ashok, CGWB, 2013)

2.7 Flora/Fauna

The coastline of Gujarat hosts several minor areas of mangrove trees and shrub forests at the mouths of various rivers and creeks. The coastal wetland ecosystem includes mudflats, floodplains, tidal flats, coral reefs, and beaches. Riverbank mudflats primarily support Avicenna shrubs, while Avicennia trees grow further inland, interspersed with Sonneratia, Salvadora, and Acanthus species along the landward side. The dominant mangroves in these areas are Avicennia species and Acanthus illicifolius (Das A & Desai, 2019).

'Nani Kakrad' in the Valsad district has been identified as a wetland of national importance under the National Wetland Conservation Program (NWCP). The diverse range of bird species recorded are Charadriiformes, Accipitriformes, Anseriformes, and Pelecaniformes. Among the 72 recorded families, Anatidae, followed by Accipitridae and Scolopacidae, dominate the avian population in the Navsari outskirts area. Of the recorded species, the majority are resident birds, with minor winter migrants. Notable species observed in the area include the Common Shelduck,

Black-necked Stork, Long-billed Vulture, Red-headed Vulture, Egyptian Vulture, Black-Capped Kingfisher, and Great White Pelicans (Patel, M. et al, 2022).

2.8 Geomorphology

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 have 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 study area comprises different coastal geomorphic features 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).

2.9 Local infrastructure

The important places in the area are well connected through NH 64, Navsari Railway, state highways and local roads. The National Satyagraha Memorial and Dandi Museum are situated to the north of the Dandi-Onjal sector. Samarpan Ashram and Gurugram are located 0.3 km from Dandi Beach. The Canai Creek Lighthouse is approximately 0.36 km from the southern boundary of the Dandi-Onjal sector. Vinay Mandir School, the nearest educational institution, is 0.5 km from Dandi Beach. The Government Polytechnic College is located 4.2 km from the northern boundary of the Dandi-Onjal block. The nearest hospital in the Surwada is Valsad District Hospital, and Dandi-Onjal is GMERS Medical College situated 3.43 km and 5.3 km respectively.

2.10 Population

According to the 2011 census the total population of Valsad district is 17,03,068 persons. Out of this nearly 73 % population is spread in 434 villages while 27 % of population is spread in 28 towns. The density of population in rural area is 365 souls per sq.km while in urban area it is around 3049 souls per sq.km. The decadal growth rate 2001-2011 is 21 %. The 2011 census recorded the population of Navsari district as 1,329,672 with 678,165 people were male and 651,507 people were female. The population growth rate between 2001 and 2011 was 8.24% (District Census Handbook, Navsari, 2011).

2.11 Archaeological & Historical sites

The National Satyagraha Memorial and Dandi Museum are the most important historical sites in the Dandi-Onjal-Surwada block.

2.12 National parks and Environmental settings of the area

There are no national parks in the vicinity of the study area, but Vansda National Park, located in the Navsari district is at a distance of 65 km from the study area.

CHAPTER 3 - PREVIOUS WORK

3.1 Details of previous exploration/investigation carried out by other agencies/parties.

The Atomic Minerals Directorate (AMD) has been conducting exploration of mineral deposits along India's coastal regions, covering a total coastline of 5,921 km across West Bengal, Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Maharashtra, Goa and Gujarat. Detailed exploration has been completed over 451 km, while 1,873 km has been covered by general exploration and 112 km by preliminary exploration. The average grade of heavy minerals in these deposits' ranges from 10% to 25%, with 30% to 40% of it being ilmenite. The production of Ilmenite at 391 thousand tonnes in 2021- 22 increased by 11% as compared to that in the preceding year (IBM., 2021).

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% V2O5 (vanadium pentoxide). The metal is recovered as a by-product from the slag of processed vanadiferous-magnetite (iron) ores (The Hindu, Jan., 2021, Drishti, Jan., 2021 & Journals of India, Jan., 2021). 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. 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 (Dinesh et al., 2013,2015).

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 i.e.; 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. GSI has recommended for detailed exploration in the area to know the downward extension of the ilmenite concentration (Dinesh et al., 2013, 2015).

3.2 A very brief note on previous work on geology, geophysics (aero geophysical, ground geophysical), geochemistry

Dinesh et al., (2013, 2015), reported that the major economic heavy mineral constituents in the beach and dune sediments are found to be ilmenite and magnetite between Dandi to Daman. The primary 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. The heavy mineral content in beach sediments varies in a wide-range from 0.3 to 71.5wt%. The total heavy mineral content in dune sediments ranges from 0.03 to 59 %. Similar to beach sediments, heavy minerals are mostly concentrated in 120 and 230 size 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. Maximum heavy minerals (HM) concentration (59%) was observed in the sample collected from younger dune near Surwada. The granulometric studies reveals that the sediment types dominated in the area is sand (fine sand (~32%), very fine sand (~26%), medium sand (~23%) and coarse sand (~12%)) followed by very slightly gravelly sand and very slightly muddy sand with minor presence of slightly muddy sand and gravelly sand.

Gopakumar et al., (2022), reported that 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. High content of vanadium is also reported in Deccan Trap basalts by Sethna and Sethna (1990, 1998).

3.3 In case the area forms part of the area covered earlier by exploration then same should be shown in the map with proper scale and a brief description

The proposed block boundary is falling within the area explored by the GSI (G-4) pertaining to Item No.067 (Dinesh et al., 2013) and the scientific paper published based on the Item No.067 of GSI, published in the Indian Journal of Geosciences in 2015 (Dinesh et al., 2015). The sample locations of previous studies over lapping with the present block boundary is shown in the figure 3.1 and 3.2.

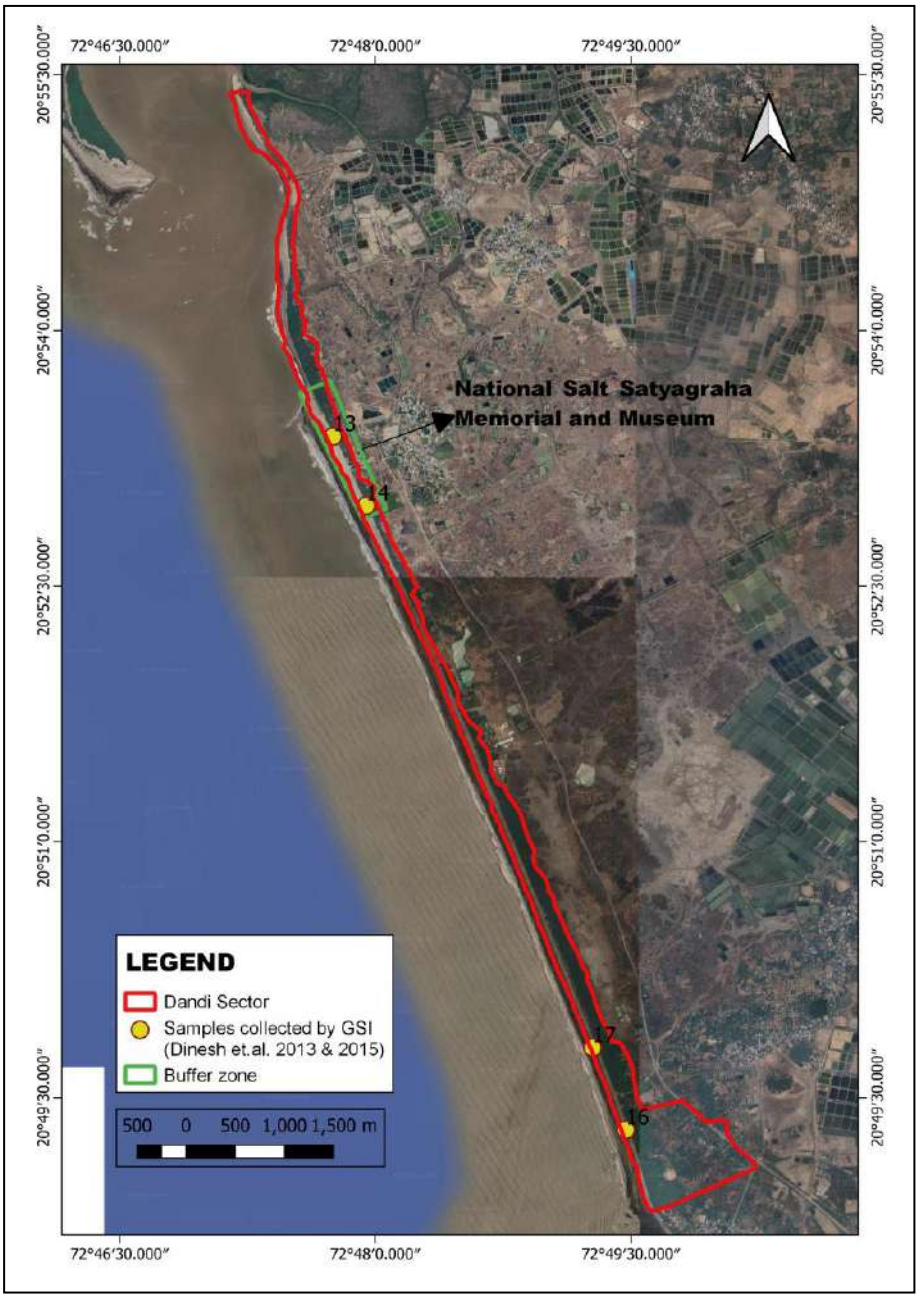


Figure 3.1: Map showing the Borehole locations of previous study with in the Dandi-Onjal Sector.

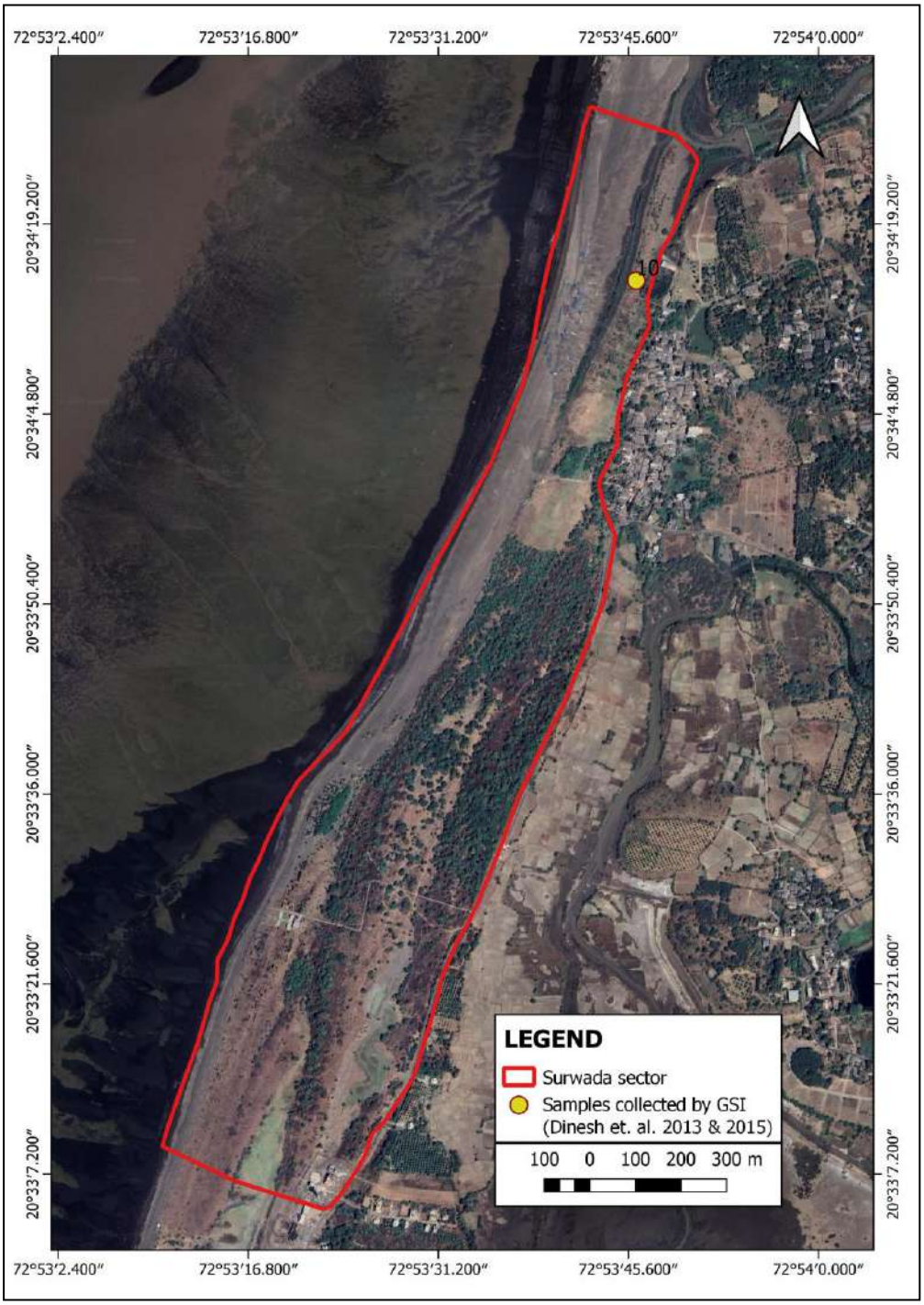


Figure 3.2: Map showing the Borehole location of previous study with in the Surwada Sector.

Samples collected from boreholes 13 (72.79586111E, 20.88963889N), 14 (72.79908333E, 20.8828611116 N), 16 (72.8245E, 20.82186111N) and 17 (72.82125E, 20.82988889N) of GSI falls within the Dandi-Onjal sector and sample from borehole 10 (72.89616667E, 20.57080556N) falls within the Surwada sector explored by Geo Marine Solutions Pvt. Ltd.

CHAPTER 4 - GEOLOGY OF THE AREA

4.1 Aerial reconnaissance

Aerial reconnaissance surveys were not carried out during G3 level exploration, since the area of 4.16 Sq.km is very well accessible and the work scope does not demand the same.

4.2 Regional geological set up of the area with stratigraphy

The geology of Gujarat comprises a Precambrian basement overlain by the younger rocks commencing with Jurassic, continuing through Cretaceous, Tertiary and Quaternary. Different parts of Gujarat expose varying lithostratigraphic sequences (Merh., 1995). The sedimentary sequences are Jurassic, Tertiary and Quarternary in age. In the northern part of the study area the coastal area is covered with the Quaternary sediments while towards the south, sheeted rocks are exposed (Dinesh et al., 2013, 2015).

The coastal plains of Dandi region of Gujarat are predominantly composed of Holocene to Recent sediments. On the basis of geological disposition, lithological variation and environment of deposition, the sediments have been divided into four formations; the Katpur Formation, Rann Clay Formation, Akhaj Formation and Mahuva Formation. The Quaternary sediments of the area are divided into fluvial and marine deposits. Deccan basalt is exposed along the beach in the southern part of toposheet number 46D/14 (Rai., V, 1984). A brief description of the litho-units in the study area obtained from the compiled geological map is given below.

The Katpur Formation comprise of flood plain deposit consisting of sand, silt and clay. The Rann Clay Formation represents older tidal flats consisting of sediments of marine environment. These are black silty clay forming mud flats and mangrove swamps. Stabilized sand and silt in the area are categorized as Akhaj Formation. These are believed to be of marine origin and denoted as older tidal flats. The Mahuva Formation is exposed in the area in the form of younger tidal flat, shoal and spit. During the high tides they are submerged under water and comprise black, fine silt and clay. On drying, polygonal mud cracks appear at the surface (Dinesh et al., 2013, 2015).

The Deccan volcanics exposed in the eastern and south eastern part of the area consists predominantly of basaltic flows intruded by basic dyke at places. The basic lava flows of the area belong to Deccan volcanics of Upper Cretaceous to Eocene age. South of Auranga River,

around Tithal and Surwada, basalt flows are exposed along the beach. The Deccan volcanics under the present area of study is covered under thick pile of fluvio marine quaternary sediments. Towards the west they lose the elevation and merge with the alluvium. South of the Valsad town the traps extend even up to the coast. Megascopically traps can be differentiated into the two types. One is the dark grey to bluish black, hard, compact and massive type and the other is light green to light brown to pink in color. The vesicles and amygdales are filled with secondary calcite, quartz zeolite, vary from rounded to cylindrical in shape. The distribution of joints and fracture in traps is not uniform. The major joint system trend in NE-SW direction. The weathered portion of the Deccan trap is locally known as Murrum. It is very soft and friable, brownish red granular soil (Rai., 1984).

Nearly the whole western part of the area is covered with alluvium, which consists of sand, clay, silt, kankars & gravels. Along the coast 3 to 6 m high sand dunes are present roughly parallel to the coast which shows false bedding (aeolian activity). The Quaternary formations of the deltaic and coastal planes comprise clay, silt, sand, grit, & their admixtures. Geologically, the sediments can be classified into following litho units Older Alluvium, Recent Alluvium, Tidal flat deposits and Barrier-Bar-dune-beach deposits (Rai., 1984).

Table No 4.1: Lithostratigraphy of the area (Source; Compiled from reports of GSI and CGWB)

Geological Age	Formation	Group	Lithology
Holocene	Mahuva Formation		Younger tidal formation, spit/bar and shoal deposit
	Akhaj Formation		Coastal dune deposit
	Rann Clay Formation		Older tidal flat deposit
	Katpur Formation		Flood plain deposit
Upper Cretaceous to Eocene	Intrusive	Deccan Volcanic	Granophyre and other basic dykes, sills and plugs
	Extrusive		Basalt and dacite

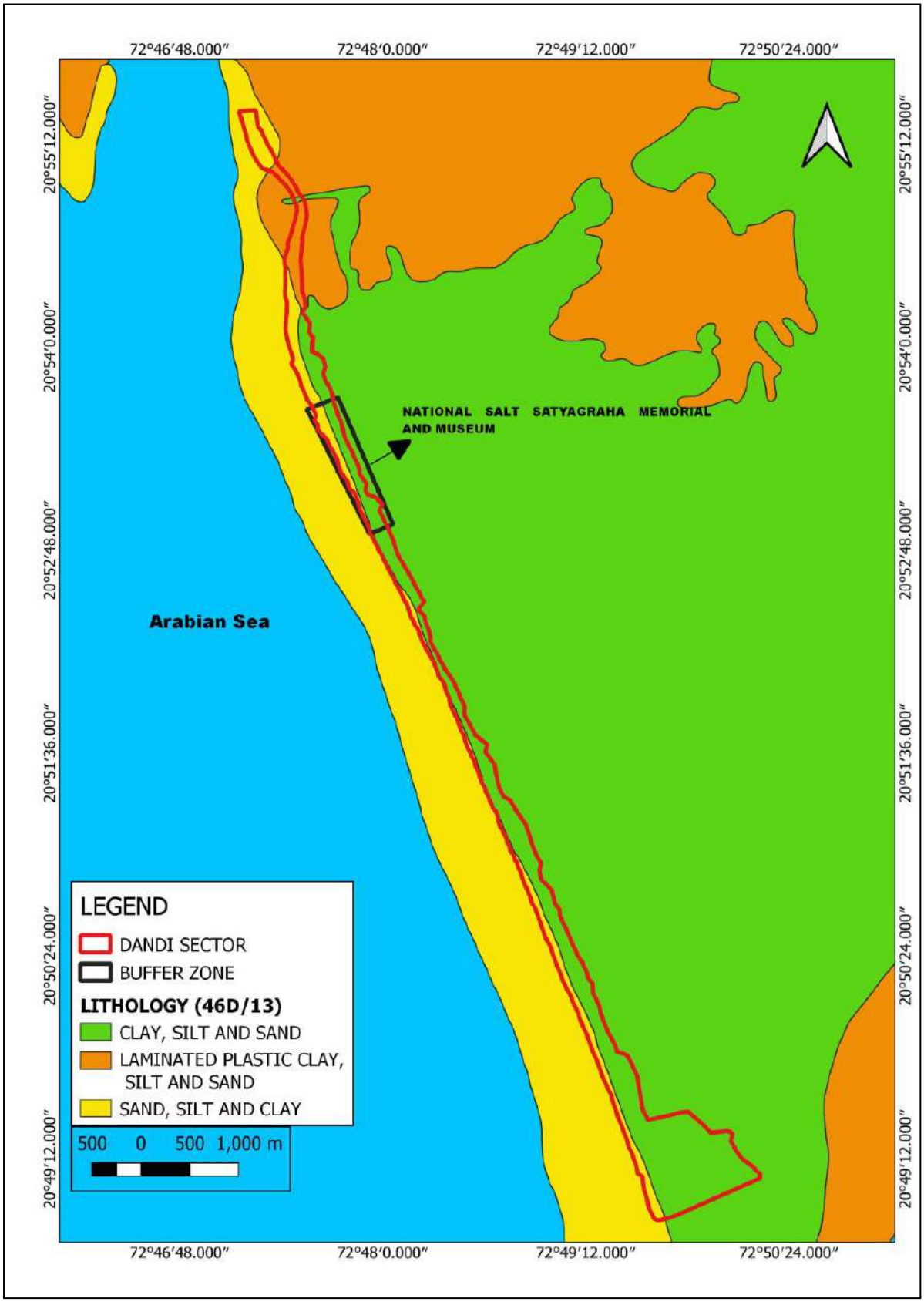


Figure 4.1: Geological map of Dandi-Onjal sector (1:50000; Source: NGDR)

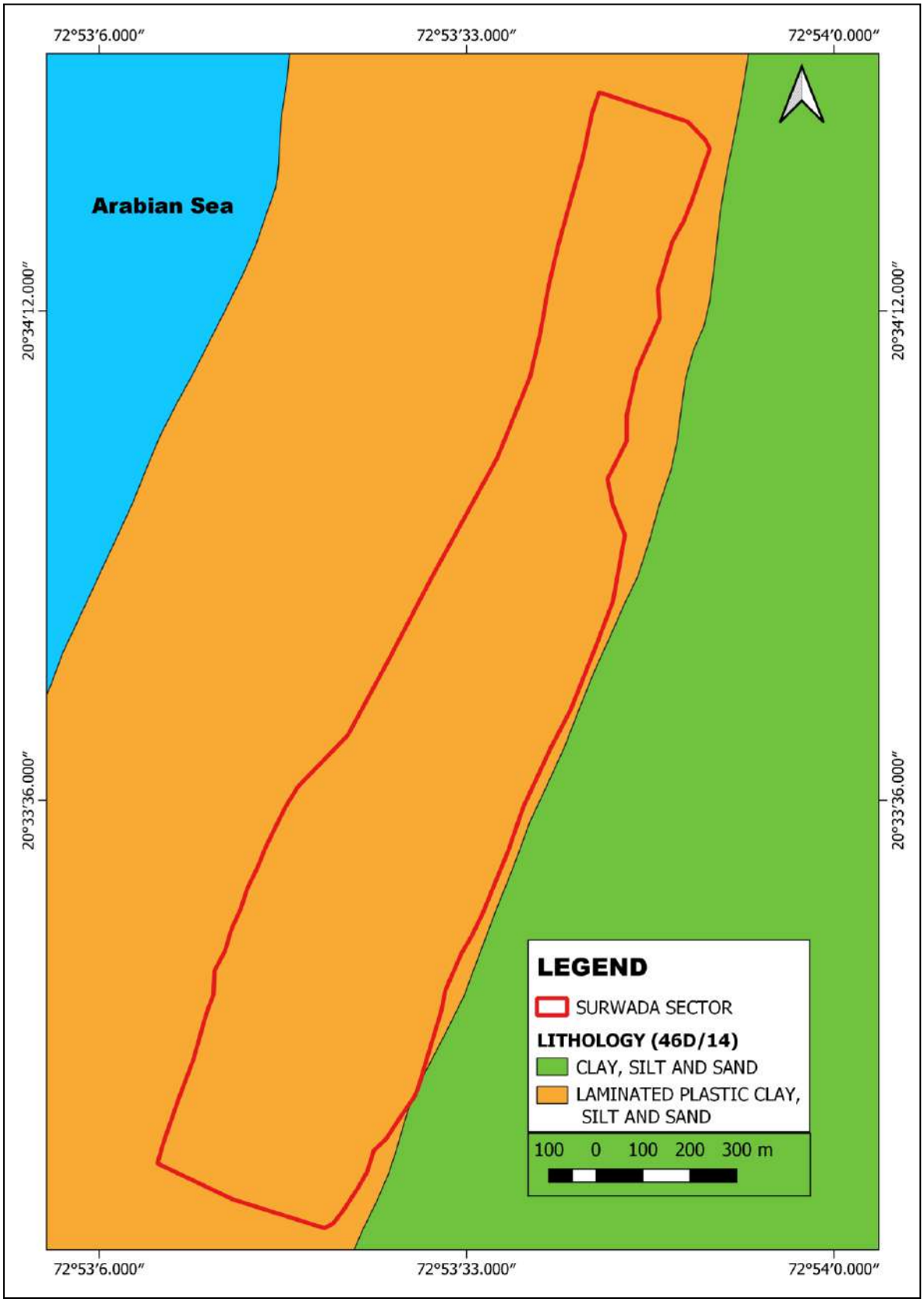


Figure 4.2: Geological map of Surwada sector (1:50000; Source: NGDR)

4.3 Structure and metamorphism

The area studied is largely covered by a thick layer of sand of Holocene to Recent age. The general trend of the coastline is NNW-SSE and the anomalous zone run parallel to the coastline. The area is structurally undisturbed and unmetamorphosed.

The Quaternary Sediments in the area have suffered neotectonic activity and it was indicated by the sudden bend of the Ambica River near Sonwadi which is indicative of the neotectonic activity. Large number of small-scale faulting's is present in the Quaternary Sediments along the right bank, south of Kambada. The meandering nature of the Purna and the Ambica coupled with a large number of oxbow lakes is also indicative of neotectonism. The high parts of tidal/mud flats along the coast that now stand at higher level, not affected by tides, but submerged during the rainy season indicate recent emergence (Rai., 1984).

4.4 Surface indication of mineralization

Beach and dune sands are primarily composed of recent alluvial deposits with the presence of clay. Alternating layers of black sand within dunes and beach is dominant in the area. Common heavy minerals such as magnetite/titanomagnetite, ilmenite, hematite, pyroxene (mainly clinopyroxene) are typically associated with these placer deposits. The major heavy mineral constituents found are magnetite/titanomagnetite and ilmenite.

The field evidences indicate the presence of primary depositional features such as current bedding, cross bedding, ripple marks, and signs of active bioturbation. Cross bedding, observed in the sand dunes of the study area, indicate that it might have been formed as a result of avalanching of sand during migration of dune and subsequent deposition of sand over the avalanched sand. Elliptical shaped balls of clay/mud were observed in the Surwada sector. These are composed of fine clay and the surface is armored by shell fragments and gravels. This might have been formed from the fine mud during low tide zone in the shore. Wave cut platform is also a prominent feature identified in the coastal domain.

4.5 if so nature of host rock for mineralization

Placer deposits of recent origin are mostly exposed and easy to identify. The identified mineral assemblages viz; titaniferous magnetite, ilmenite, pyroxene (mainly Cpx), hematite etc. by XRD, ICP-MS, EPMA and microscopic studies indicate the possibility of their derivation from basic igneous rock. Trace amount of metamorphic minerals like amphibole, dolomite, calcite and talc are also identified in the XRD studies. The composition of the heavy minerals indicate that the hinterland rocks include predominantly Deccan basalt and metamorphic sources and are drained by the Purna River, Kanai River, Auranga river and Par River, which is further sorted and deposited along the beach by the effect of to and fro motion of the sea waves.

CHAPTER 5 - GEOSCIENCE INVESTIGATION

5.1 Geological mapping and Topographic survey

Topographic survey of the study area was carried out in 1:5000 scale. The work was carried out in the UTM coordinate system, and the MSL value was transferred to the survey area from Atul railway station. Contour map was prepared with a 1.0 m contour interval. This can be used as the base map for future reference.

Geological mapping is also carried out in 1:5000 scale incorporating all geomorphological units. It provides the detailed account of regional geological setup present in the study area. Detailed topographic map and geological map is attached as Annexure 2 & Annexure 3 respectively.

Plate 5.1: Field photos during topographic survey and geological mapping

5.2 Description of rock types

The area under investigation is a coastal plain with prominent active beaches which is about 12.5 km in length and ranging in width from 70 m to 1.2 km, with an average width of 350 m in the Dandi-Onjal sector and the Surwada sector is 2.64 km in length and width varying between 211 m and 470 m, with an average width of 320 m. The Geological formations in the area are beach sand and dune sand of Holocene to Recent age (Annexure 3) with clayey material. The dune height varies from 2m to 8m above msl and extending almost parallel to the shoreline. Coarser sediments (+5 ASTM) such as pebbles and gravels were identified from the Dandi-Onjal-Surwada block with larger being observed from the Surwada area. Amygdaloidal basalt of varying size was also identified with in the sand sediments. The sorting pattern, heavy mineral assemblage and the size of sediments indicates the immature nature of beach and dune sand. Elliptical shaped balls of clay/mud were observed in the Surwada sector and this might be formed from fine mud during the low tide zone of the shore.

The dunes exhibit maximum thickness near Kalu Nadi and Par River mouths. The beach sediments are found to be highly enriched in ilmenite. The dune sediments along the stretch between Dandi and Onjal and a small stretch near Surwada are enriched in ilmenite (Dinesh et al., 2013, 2015).

The likely provenance for the heavy mineral concentration in the proposed coastal zones is located due east, exposed lava flows of Deccan Trap. Therefore, it is likely that heavy mineral concentrations in the coastal zone are magnetite, titanomagnetite, ilmenite, magnesioferrite, hematite, pyroxene, amphibole etc. The rivers and/or streams draining the area are acting as feeders of inland sediments to coastal zone and concentrate as beach and dune sediments due to the continuous wave action. Based on the analytical studies, it is inferred that the vanadiferous titanomagnetites (VTM) in the study area are possibly drained from Deccan basalt mainly through the Purna River in the north and Kanai Creek in the south of Dandi-Onjal and the Auranga River in the north and Par River in the south of Surwada sector. After sands accumulate on the beach, particularly in the backshore, winds may rework these sands and form sand dunes.

5.3 Petrological, petrochemical studies (SEM-EDX, EPMA), whole rock and trace element analysis.

Petrological studies of heavy minerals of different size fractions of LIRMS magnetics (A), REDMS magnetics (B) and REDMS middlings (C) under microscope were carried out to decipher the heavy mineral assemblage in the study area. The entire area under investigation chiefly consists of titanomagnetite, ilmenite with minor heavies like pyroxene (Cpx), amphibole. The photomicrographs of different size fractions of magnetic minerals are given below. Petrochemical studies (EPMA) and trace element analysis (ICP-MS) with their interpretation is discussed detail in the chapter 9.

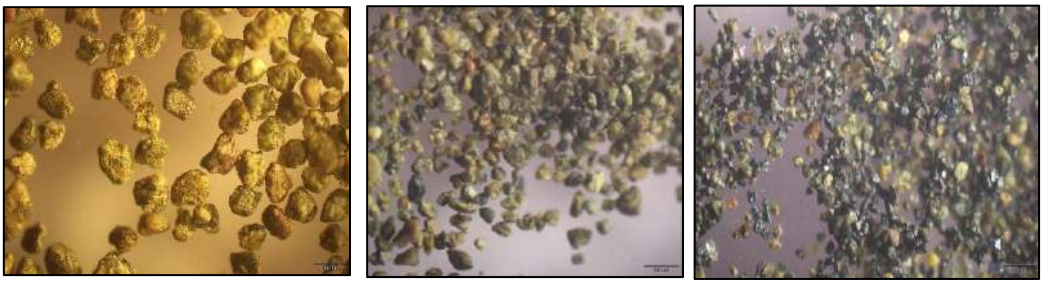


Plate 5.2a: +60, +120 and +230 ASTM sieve fraction from LIRMS magnetics (A) with sub-rounded rock grains under microscope (Major minerals are titano-magnetite and minor ilmenite, with no magnetic minerals in +60# fraction, fewer in +120# fraction and larger in +230# fraction)

Plate 5.2b: +60, +120 and +230 ASTM sieve fraction from REDMS magnetics (B) with sub-rounded rock grains under microscope (Major minerals are titano-magnetite and minor ilmenite, with no magnetic minerals in +60# fraction, larger in +120# fraction and more in +230# fraction)

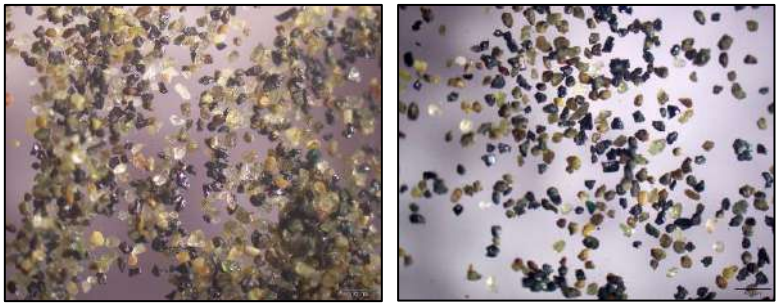


Plate 5.2c: +120 and +230 ASTM sieve fraction from REDMS middlings (C) with sub-rounded rock grains under microscope (Major minerals are titano-magnetite and minor ilmenite)

5.4 Structure and Metamorphism

The explored area consists of alluvium (sand) deposits.

5.5 Mineralogy of the ore zones and ore textures

Heavy minerals are characterized by high density (>2.89g/cm^3), durability and resistance to weathering. Unlike any other ore deposits, heavy mineral sands do not exhibit prominent geochemical or mineralogical zonation. Variations in mineral chemistry across a deposit are generally result of the presence or absence of heavy minerals rather than the geochemical gradients typically seen in hypogene, hydrothermal, or supergene processes found in other types of ore deposits. These variations are more reflective of the sorting mechanisms involved in the deposition of the sediments. Hydrothermal alteration and other types of geochemical diffusion typically found in ore deposits are not associated with heavy mineral sands. Additionally, there are no specific textures or structures characteristic of the igneous, metamorphic, or sedimentary source rocks for these deposits (Basha, S. N. H., & Pal, T., 2020).

The heavy mineral in the area predominantly consists of ilmenite, magnetite, titano-magnetite, magnesioferrite and hematite. Other non-magnetic heavy minerals (NMHM) such as amphibole and pyroxene indicate that the sediments originated from mafic sources such as basaltic lava flows and associated mafic intrusive rocks. Some other non- magnetic light minerals (NMLM) such as quartz, plagioclase and k-feldspar etc. indicate contributions from sialic sources as well. The shapes of the mineral grains range from rounded to sub-rounded and angular, indicating varied distances that the detritus has travelled before getting deposited.

5.6 Pitting and trenching

No pitting and trenching carried out in the area.

5.7 Sampling

The unconsolidated sand samples were collected from different domains of beach and dune along the transect perpendicular to the coast in the study area. The sampling method employed was auger drilling, as the terrain was highly undulating and inaccessible to carry large instruments. All drill holes were oriented vertically. Beach and dune sand samples were collected using hand auger at one-meter intervals up to a depth of 5 meters except some boreholes where clay was encountered. Samples were assessed visually for recoveries and labeled in the following format: location & borehole number - depth range (e.g., DD01-0.m to 1.0m).

Plate 5.3: Auger sampling

5.8 Discussion

Detailed interpretation of qualitative and quantitative analysis is explained in the Chapter 10.

5.9 Ore Zones

Mineralized zone in the surface was primarily identified on the basis of black sand concentration and presence of magnetic minerals and opaque grains, which can be identified by field magnet and pocket lens. As per the magnetic separation data, the weight percentage of Valuable heavy minerals (VHM) containing iron, titanium and vanadium ranges from 19.147% to 91.147%.

Based on gravity separation of heavy minerals, petrography and chemical analyses data, 3D modelling and resource estimation, the valuable heavy minerals (VHM) are varying from 1.756 wt% to 33.950 wt% with an average of 10.880 wt% in the Dandi-Onjal sector, whereas it is ranging

from 3.702 wt% to 38.477 wt% with an average of 11.641 wt%% in Surwada sector (Table 10.2). The Fe_2O_3 value in total sand body is ranging between 0.584% and 8.962% with an average of 3.761%, whereas 0.935 % to 9.735% with an average of 2.852% in Surwada sector. Minimum and maximum value of TiO_2 is 0.299 % and 4.592% respectively with average of 1.792% in Dandi-Onjal sector while 0.297% and 3.614% respectively with average of 0.911% in Surwada sector. The V_2O_5 values show minimum of 0.001%, Maximum of 0.058% and average 0.022% in Dandi-Onjal sector. The Surwada sector having minimum, maximum and average value of V_2O5 is 0.005, 0.061 and 0.016 respectively. The Tonnage of total sand body is calculated as **12.817 MMT**. The total tonnages of THM and VHM are **7.687MMT** and **7.197 MMT respectively The Prime ore constitutes 10.942% of total sand i.e., 1.261 MMT.** Apart from that, the tonnage of Fe_2O_3, TiO_2 and V_2O_5 in +120# fraction separated by hand magnet in the bulk sample of 7.447kg is 0.2780MMT, 0.0832MMT and 0.0020MMT respectively.

5.10 Geophysical exploration

Aerial or ground geophysical surveys were not carried out during G3 level exploration since the area of 4.16 Sq.km is very well accessible, ground data of entire area can be collected by direct observation. Similarly geochemical surveys and geophysical surveys were not carried out in the area as the work scope does not demand the same.

5.11 Geochemical exploration

Although chemical analyses of sediment samples were carried out, the item cannot be categorized into the domain of geochemical exploration. Bed rock/ pedogeochemical sampling was not part of the Quantum of work. Chemical Analysis results are discussed in the Chapter 9.

CHAPTER 6 - INTEGRATION OF GEOLOGY, GEOPHYSICS (WITH AVAILABLE AERO GEOPHYSICAL DATA) AND GEOCHEMICAL EXPLORATION DATA AND THE INTERPRETATION

Since the study is G-3 level exploration of beach and dune sands (bedded deposit), this is not part of the work scope.

CHAPTER 7 - MINERAL PROSPECT

7.1 Surface indication

Surface indications of mineralization are observed as black sand containing opaque grains of ilmenite and magnetite, identifiable with a pocket lens. In this area, the heavy mineral sands consist of unconsolidated to weakly consolidated sediment layers with sandy beaches and dune ridges. Deposits exhibit current bedding, cross bedding, ripple marks, and evidence of active bioturbation due to variation in mineral content and changes in environmental settings such as tidal shifts, current patterns, wind shifts and sediment supply. The area consists of laminated or lens-shaped sediments that are rich in heavy minerals, with thicknesses extending to several meters.

The beach and dune sediments in the Dandi-Onjal-Surwada area is composed predominantly of recent alluvium, exhibit varying grain size and sorting patterns at 0–1 m depth, indicating potential surface mineralization. The mean grain size (ϕ) of sediments in 0-1 m depth varies from 0.08 ϕ or 3.617mm in DD28 to 0.87 ϕ or 0.261 mm in DD26, with an average of 0.20 ϕ or 2.495 mm (Figure 7.1). The sediments in the dune area are finer compared to the beach face. On the basis of magnetic separation data, the THM values varies from 30.06 wt% (DD28) to 91.62 wt% (DD32) in the surface.

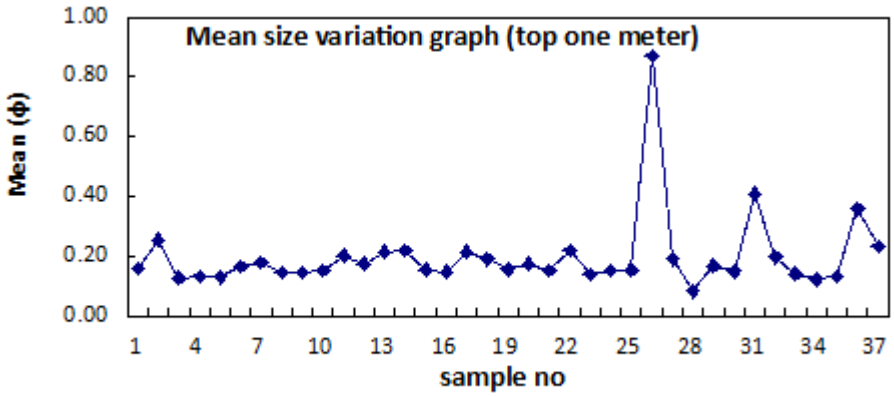


Figure 7.1: Mean grain size variation (ϕ) graph in 0-1 m depth

Sorting values (standard deviation, SD) range between 1.37 ϕ and 2.49 ϕ, averaging 1.62 ϕ, in the top one-meter depth indicating moderately sorted to poorly sorted sediments (Figure 7.2). This confirms that the particles are not uniformly distributed in size, where it contains a mix of both coarser and finer particles. This immature nature of sediments is the typical characteristic

of depositional environments such as riverbeds or beach areas, where a wide range of particles are deposited due to the fluctuations in the wave energy.

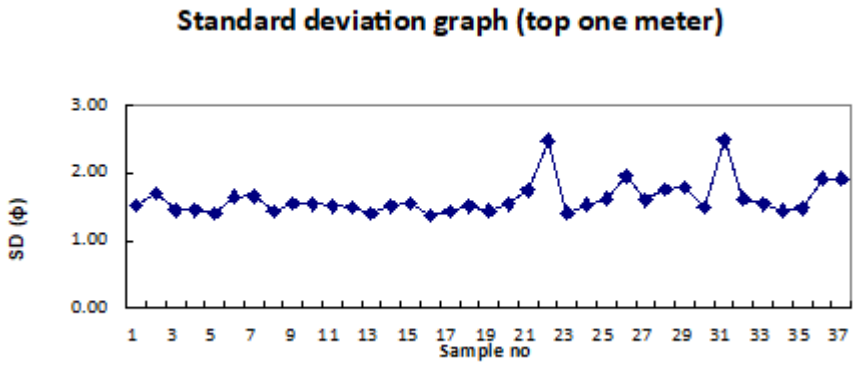


Figure 7.2: Standard deviation variation graph in 0-1 m depth

7.2 Mode of occurrence

Heavy mineral sands are widely distributed in coastal settings. In plan view, these occurrences are elongated and generally aligned parallel to the strike of shoreline. These deposits are formed through selective sorting in the intertidal zone due to waves and currents. The deposits are in the form of lens-shaped bodies rich in heavy minerals, stacked along the length of the strandlines (Basha, S. N. H., & Chatterjee, S., 2019).

Near Dandi, beach is composed mainly of fine sand followed by very fine sand and medium sand with streaks of black heavy minerals on it. Coastal dunes develop where there is a supply of sand from the beach coupled with frequent strong onshore wind. The scale and character of the coastal dunes are dependent on the combination of a variety of factors such as wind and wave regime, sand supply and obstacles for accumulation of sand and plant growth along the coast. Continuous dunes along the coast near Dandi are the storehouses of black magnetic sand. Alternating bands of black sand were observed at many places near Dandi beach (Basheer, 2013).

The heavy minerals are enriched in the +230 (very fine sand) sieve fraction followed by +120 (fine sand), +60 (medium fine sand), with more magnetic fractions particularly being in the A fraction (LIRMS magnetics) and less magnetic in the B fraction (REDMS magnetics) respectively.

7.3 Strike length and width of anomalies identified on the basis of geology, geochemical, geophysical exploration

Based on the geological, geochemical, petrochemical and mineralogical evidences, the entire sand body is trending along NNW to SSE direction and is anomalous.

7.4 Alteration zones

Not applicable in beach and dune sand.

7.5 Genesis of mineralization

The deposits in the beach and dune sediments of Dandi-Onjal-Surwada block consist of heavy mineral sands, with Titaniferous magnetite (TTM) and ilmenite in the area. The beach sediments occur along a small stretch west of Dandi and Purna River mouth are found to be enriched in ilmenite and magnetite (Dinesh.et al., 2013,2015).

The boundaries of the Dandi-Onjal sector are defined by two rivers: Purna River in the north and Kanai Creek in the south and Surwada sector is defined by Auranga River in the north and Par River in the south. These rivers drain through the Deccan provenance and discharge into the Arabian Sea. The South of Purna river mouth, beach is wide and sandy with medium size sand. Slope of the beach is comparatively gentle in this coastal stretch (Dinesh.et al., 2013,2015).

The mineralization of beach placers originates inland and extends to the coastline, involving the weathering of source rock, contributing detritus composed of sand, silt, clay, and heavy minerals to streams/rivers. Rivers transport the detrital minerals along their course and deposit in a variety of coastal environments, such as, the beach face (foreshore), the nearshore, barrier islands or dunes, and tidal lagoons, as well as the channels and floodplains of streams and rivers in the coastal plain, depending up on the energy of the transporting media. This material is then reworked by wave action, tides, longshore currents, and wind, which sorts the mineral grains according to their size and density. The finest-grained, most dense heavy minerals are the most effectively sorted (Hou, 2017).

Dinesh et al., (2013 & 2015) reported that the sediment types in the area falls in sand (S), very slightly gravelly sand ((vg)S), very slightly muddy sand ((vm)S), slightly muddy sand ((m)S) and gravelly sand (gS) in which sand dominates and followed by very slightly gravelly sand and

very slightly muddy sand with minor presence of slightly muddy sand and gravelly sand. Among the sand fractions, fine sand (~32%) dominates followed by very fine sand (~26%), medium sand (~23%) and coarse sand (~12%).

The sediment analysis reveals that the dune sands of Dandi-Onjal sector exhibit a trend of very fine, fine to medium fine sand whereas Surwada sector is characterized by fine to medium gravelly sand. The sediments are moderately well sorted to poorly sorted. Generally, the degree of sorting decreases towards the depth in both sectors. As per Folk classification (Folk et al., 1972) the sediment type in the Dandi-Onjal-Surwada block area falls in sand (s), gravelly sand (gS), slightly gravelly sand ((g)S), silty sand (siS), sandy silt (sSI) and sandy gravel (sG).

The exploration is mainly focused on dune sands rather than the beach which is dynamic. Heavy minerals especially TTM (Titaniferous Magnetite) and ilmenite are generally enriched in fine sand (+120#), very fine sand (+230#) and silt sized grains (-230#) of dune sediments. Heavy minerals are not generally observed in the coarser fractions i.e.; medium to very coarse sand.

CHAPTER 8 - EXPLORATION SYSTEMATIC DRILLING

8.1 Spacing of boreholes should be as per MEMC, 2015

The spacing of boreholes and data acquired from the core boreholes in the Dandi-Onjal-Surwada block, using a 400m x 200m grid for auger drilling, is in accordance with the guidelines provided in Parts II and III of the Schedule MEMC Rules 2015. This data is sufficient to establish the degree of geological and grade continuity appropriate for the mineral resource estimation procedures and classifications applied. This approach enables full coverage across an area of 4.16 square kilometers explored, allowing for an effective assessment of spatial and temporal variability in iron, vanadium and titanium concentrations.

8.2 Methodology of drilling with details of type of drilling

In the Dandi-Onjal-Surwada block, unconsolidated beach/dune sand samples are extracted using a hand auger drill that employs a 2-inch sediment sampler made up of GI pipe and a 6-inch diameter auger. A core catcher will be fitted to the sample tip to avoid sample loss whenever the samples are very loose and unconsolidated. Maximum depth of sampling is 5.0m below ground level (bgl). All the drill holes are oriented vertically by eye during the sampling. For the G-3 level exploration in the Dandi-Onjal-Surwada block, a total of thirty-seven sampling locations by auger drilling are achieved, with grid intervals of 400 meters along the shoreline and 200 meters across, covering an area of 4.16 square kilometers.

Initially the 2-inch sampler pipe will drive into the ground by hammering till 1.0m depth and first sample pertaining to 0.00m to 1.00m will be collected. Then the hand auger is rotated manually by a handle attached with 3.0m drill rods which can be extended for deeper sampling. The augers are rotated into the ground until it is filled, then lifted out and emptied. The recovered samples were packed in a polythene cover and labeled with proper sample number format that includes borehole name, sample number, depth of sample and date of collection. The cycle of steps will be repeated starting with driving the sampler GI pipe to get second sample pertaining to 1.00-2.00m from ground level. Samples are collected at one-meter intervals up to a depth of 5.0 meters except some boreholes.

Each sample is carefully labeled and stored to maintain integrity for accurate geochemical analysis, ensuring efficiency and precision in evaluating beach/dune sand characteristics.

8.3 Borehole planning (spacing of boreholes, level of intersection), co-ordinates, RL of collar, borehole logging, core recovery percentage

Boreholes are fixed in a grid pattern of 400 m * 200 m interval (The borehole plan was approved by TCC-2) covering the entire area (Figure 8.1). All the borehole points, coordinates and collar height (Figure 8.1a & 8.1b & Table 8.1) were fixed using high end DGPS system - Geomate RTK-GPS to an accuracy of 10 mm.

Topographic survey in the study area was carried out with three sets of Geomate Real Time Kinematic–Global positioning system (RTK-GPS) receivers along with a set of GeoMate GNSS SG7. The work was carried out in the UTM coordinate system, and the MSL value was transferred to the survey area from Atul railway station, accepted as MSL +13.69 m. Traverses were planned at 50 m intervals, covering the entire block, and a contour plan was prepared at a 1:5000 scale with 1.0 m contour interval. Levels were tied to the benchmark of +13.69 m at Atul railway station, and a few temporary benchmarks were established within the survey area. Cultural features including roads, houses, and buildings, were mapped and represented on the topographic map. 37 bore hole locations and geological details were also included on the geological map, prepared on 1:5000 scale. The topographic map of the Dandi-Onjal-Surwada block area is prepared on 1:5000 scale (ANNEXURE-2).

Geophysical logging is not carried out as the work does not demand it. Since the sand sediments are loose and unconsolidated, the core recovery method is not applicable. To ensure comprehensive sampling, samples were collected at one-meter interval, and it is assumed that the entire sample has been recovered.

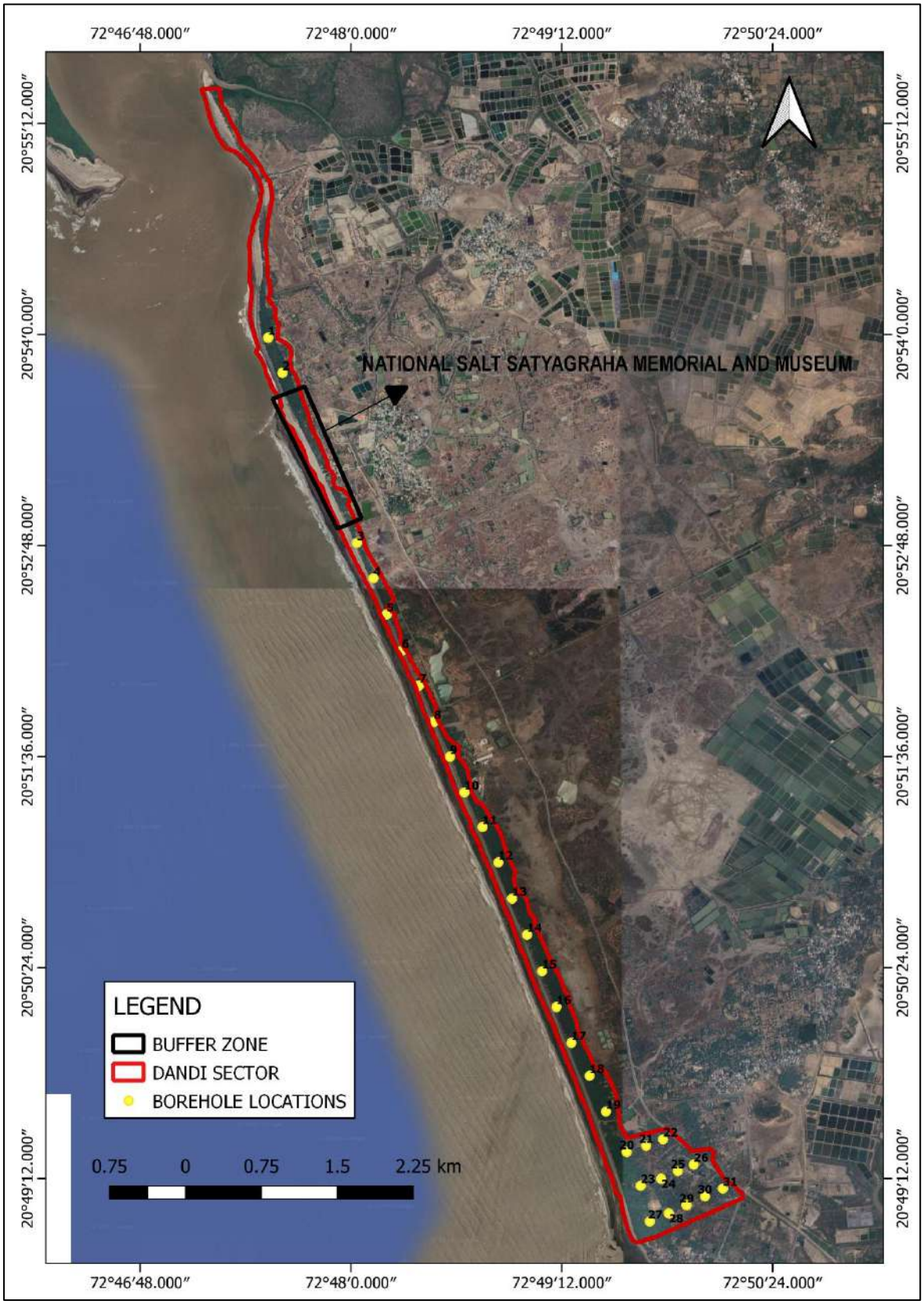


Figure: 8.1.a: Borehole location map of Dandi-Onjal sector

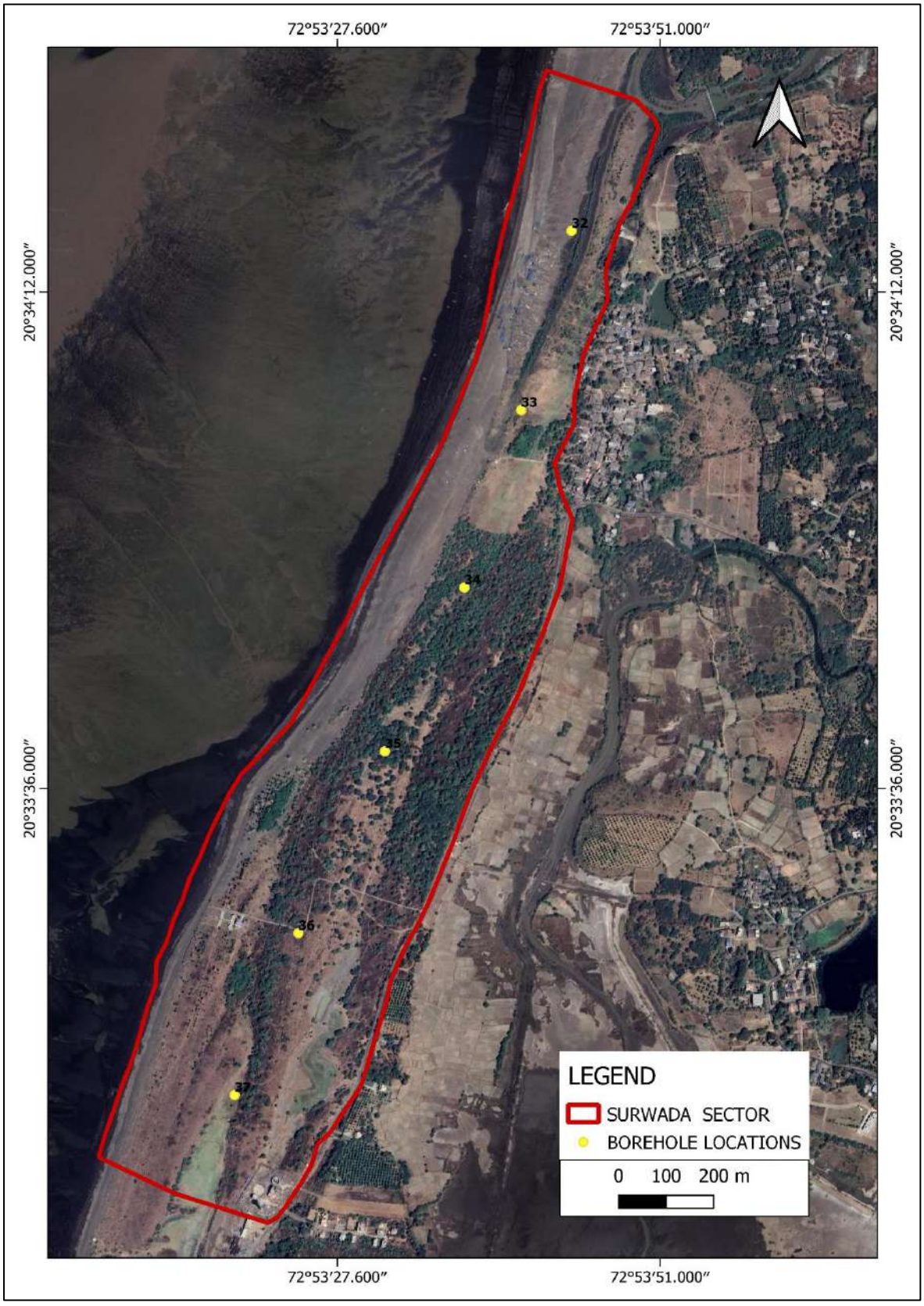


Figure: 8.1.b: Borehole location map Surwada sector.

Table 8.1: Details of borehole

Sl no.	Borehole No	Longitude (m)	Latitude (m)	RL (m in MSL)	Total depth (m)
1	DD 01	2312581.927	270379.009	3.217	4
2	DD 02	2312249.864	270506.068	3.035	4
3	DD 03	2310467.973	271178.537	6.656	5
4	DD 04	2310059.349	271354.91	5.434	5
5	DD 05	2309713.685	271481.676	6.681	5
6	DD 06	2309331.561	271642.506	5.549	5
7	DD 07	2308972.605	271795.436	5.797	5
8	DD 08	2308558.037	271944.1	3.718	5
9	DD 09	2308181.399	272112.388	4.205	5
10	DD 10	2307834.342	272249.399	6.17	5
11	DD 11	2307467.925	272394.81	4.954	5
12	DD 12	2307072.163	272514.998	5.072	5
13	DD 13	2306722.174	272673.359	5.085	5
14	DD 14	2306313.321	272822.396	4.6	5
15	DD 15	2305906.02	272941.412	5.788	5
16	DD 16	2305545.473	273084.084	6.144	5
17	DD 17	2305152.066	273261.054	5.43	5
18	DD 18	2304792.477	273380.363	6.199	5
19	DD 19	2304450.275	273530.067	5.555	5
20	DD 20	2303998.444	273694.465	4.882	5
21	DD 21	2304124.464	273785.449	1.202	2
22	DD 22	2304131.509	274181.968	1.717	2
23	DD 23	2303704.591	273758.982	7.556	5
24	DD 24	2303721.508	274085.338	1.745	3
25	DD 25	2303836.545	274270.571	0.956	2
26	DD 26	2303898.554	274435.548	2.865	2
27	DD 27	2303312.95	273965.808	7.085	5
28	DD 28	2303381.5	274162.849	1.775	1
29	DD 29	2303451.097	274318.071	0.704	2
30	DD 30	2303623.61	274567.375	1.499	4
31	DD 31	2303611.517	274725.603	2.593	4
32	DD 32	2276130.01	280612	2.497	5
33	DD 33	2275748.384	280502.441	2.248	5
34	DD 34	2275289.642	280334.98	3.494	5
35	DD 35	2274996.75	280175.547	3.013	5
36	DD 36	2274581.629	280069.847	3.235	5
37	DD 37	2274234.619	279847.617	2.699	5

8.4 Mineralogy of ore zone

Mineralized zone in the surface was primarily identified on the basis of black sand concentration and presence of opaque grains visually estimated by pocket lens. XRD, EPMA, XRF, ICP-MS, petrochemical and petrological studies reveal diverse range of minerals, magnetite/ titanomagnetite, hematite, ilmenite, clinopyroxenes, amphibole, plagioclase, quartz, clay minerals feldspars, rock grains etc.

Mineralogical composition of heavy mineral concentrates indicates that titaniferous magnetite (TTM) is the dominant mineral component followed by pyroxene (Cpx) and ilmenite in heavy mineral composite. The opaque minerals mainly magnetite and ilmenite have been derived from the igneous rocks of basic composition.

8.5 Borehole deviation test and methodology

Borehole deviation test is not carried out in the given area, since the maximum depth of borehole drilling is in shallow depths up to 5m bgl and in soft sediments.

8.6 Methodology of ore zone sampling and sample preparation

The thirty-seven drill locations of the Dandi-Onjal-Surwada block yielded a maximum of 160 sub-samples by means of 1.0 m sub-sampling down the core by auger drilling, up to a maximum depth of 5.0 m. Sediment sub-samples were subjected to two level magnetic separation and gravity separation using bromoform and the procedures are detailed below.

After collection, samples weighing approximately 1.5 to 2 kg were dried and subjected to coning and quartering. The samples containing silt and clay portion (if any) were eliminated by wet sieving and were dried and weighed before feeding in the riffle splitter. The weighed aliquot of the sediment is treated with 10% hydrogen peroxide to remove organic matter. The samples were then washed thrice with distilled water for the complete removal of salts. Then the silt and clay fraction were separated by washing the sediment through a +230 ASTM mesh (63 microns) sieve. The quantity of the mud (-230 mesh) is dried and weighed separately and the sediments retained on +230 mesh is used for grain size analysis and magnetic separation after coning and quartering (SoP of GSI).

During coning and quartering by riffle splitter, a homogeneous, dry, and free-flowing sample is evenly poured into the hopper. The material then flows through the alternating passages in the riffle bank into two collecting pans positioned beneath the dividing head outlets. With each

operation, the feed sample is divided into two representative halves. One part is being stored as a repository for future reference.

An approximately 100g sample was prepared for grain size analysis from the half portion of the bulk sample through multiple coning and quartering procedures. Remaining sample is used for two level magnetic separation.

Similarly, the 160 sub-samples (@1m interval) generated were subjected to for grain size analysis following the SoP of Geological Survey of India.

(a) **(b)** **(c)**

Plate 8.1: Sample processing procedures (a&b) Sun-drying (c) Coning and Quartering

8.7 Chemical analysis and laboratory procedures

8.7.1 Grain Size Analysis

Sieve analysis involves the shaking of loose or unconsolidated sediments through a set of standard sieves. Larger vegetal matters (if any) were hand-picked and removed before sieving. Here, sieves at one phi interval (ASTM sieve no's 5#, 10#, 18#, 35#, 60#, 120#, 230# and pan) were stacked in such a manner that larger sieves lie over the smaller ones. The representative fractions of dried samples collected for grain size analysis were exactly weighed using an electronic balance and the weights were recorded against each sample.

Sieves were assembled in the ascending order of sieve numbers such that the sieve with the smallest opening is at the base and the largest is at the top. Placed the pan below ASTM sieve no.230. The sample was introduced into the topmost sieve and covered it. Set the shaker timing for 10 minutes and put the switch on. When the vibration stops, remove the stack and sieves from

the shaker. Spread a clean sheet of paper that is larger than the diameter of the sieve and dump contents on a paper from each sieve one by one. The weight of the sand retained in each sieve was weighed accurately. The portion collected on each sieve was collected separately in a dry pre-weighed beaker and weight of each sample was recorded (SoP of GSI).

Plate 8.2: Grain Size Analysis

8.7.2 Heavy Mineral Separation

The mineral separation was carried out inhouse, at the laboratory of Geo Marine Solutions Pvt. Ltd. Mangalore. The dried bulk sample was weighed first and then sieved using 10# mesh to remove the pebbles (gravels) and the weight is noted separately and the sand samples were subjected to two-level magnetic separation using LIRMS (Low Induced Rotary Magnetic Separator) and REDMS (Rare Earth Drum Magnetic Separator).

8.7.2.a Separation of Magnetite/ Titanomagnetite/ magnesioferrite by LIRMS

The samples were processed on the Low Intensity Roll Magnetic Separator (LIRMS) to separate the strongly magnetic heavy minerals such as magnetite/titano-magnetite/magnesioferrite etc. which is termed as 'A' fraction and the low magnetic fraction (B) comprising of minerals like ilmenite, hematite, pyroxene etc. and paramagnetic fraction (weakly magnetic) (C) minerals such as amphibole, pyroxene etc., and the remaining tailings are non-magnetic fractions containing quartz, plagioclase, calcite, zeolite etc. The test conditions for the Low Intensity Roll Magnetic Separator (LIRMS) are given below.

Test Conditions:

The feed fraction obtained after separation of the magnetic fraction were further processed 3-4 times in the LIRMS until all the strongly magnetic minerals (magnetite/ titano-magnetite/magnesioferrite) are separated.

Equipment –Swenco Model for ferrite lab roll separator
LIRMS of 4" dia* 5" wide lab roll
Configuration- 3 Roll, Magnetite repass
Roll Speed – 1st 2nd & 3rd roll - 110rpm.
Vibratory Feeder rate- 160 V for 3 rolls

8.7.2.b Separation of low magnetic (B), Middlings (C) and Non-mag Fraction

The non-magnetic fractions of LIRMS were further processed using Rare Earth Drum Magnetic Separator (REDMS) to obtain three sub fractions; low magnetic minerals (B), feebly magnetic minerals (C) and non-magnetic minerals.

The REDMS efficiently separates minerals with low/weak magnetic properties. Based on the content of low magnetic (B), feebly magnetic (C), and non-magnetic fractions, the separation process on the REDMS was repeated to obtain a pure low magnetic fraction (B) enriched in ilmenite and hematite, which were collected separately. The non-magnetic fraction from REDMS contains plagioclase, quartz, calcite, feldspar and shells. The test condition on REDMS is given below.

Test Conditions:

Feed: Fraction obtained after separation of magnetite/ titano-magnetite

Equipment –Swenco Model REDMS of 15" dia* 12" wide lab drum
Configuration- 2 Roll, Mids. repass
Roll Speed – 1st & 2nd Roll - 30rpm.
Vibratory Feeder rate- 140 V for both roll

Similarly, the bulk samples (7.447kg) representing the entire study area was also separated by two-level magnetic separation and the data is shown in table 8.2 below.

Table 8.2: magnetic separation data of Bulk sample

Bulk sample (7.447 kg)				
LIRMS		**REDMS**		
Mag (LIRMS) (A)	**Non-mag (LIRMS)**	**Mag (REDMS) (B)**	**Mid.Mag (REDMS) (C)**	**Non-mag (REDMS)**
(g)	(g)	(g)	(g)	(g)
2538	4864	131	2274	2312

8.7.2.c Gravity Separation

The REDMS non-magnetic fraction containing quartz, feldspar, shells, non-magnetic amphiboles, pyroxenes etc. were subjected to Gravity separation to separate lights from the heavies. The non-magnetic fraction thus obtained from REDMS is coned and quartered and about 100g fraction is taken for gravity separation. The separation medium used is Bromoform ($CHBr_3$), which is a dense liquid with density of 2.89g/cm^3. It is most commonly used medium in density separation to separate minerals based on their density. When a mixture of minerals is combined with bromoform and allowed to settle, the minerals having specific gravity less than 2.89 (bromoform density) will float, while heavier minerals will sink to the bottom of the wide-mouthed separating funnel containing bromoform. The heavy mineral fraction settled at the bottom is collected on to a funnel with filter paper kept below the conical flask by draining out only the heavies. The heavy mineral fraction thus separated will be retained in the filter paper is washed using acetone to remove bromoform from the minerals.

After gravity separation, the lighter fractions (NMLM) such as quartz, calcite are collected separately by draining out the bromoform and washing in acetone, and the heavier fractions (NMHM) like amphibole and clinopyroxene are subjected to mineralogical studies. The magnetic separation data and gravity separation data are quantified in terms of weight percentage and is attached as Annexure 4.

Plate 8.3: Mineral separation methods: LIRMS (b) REDMS (c) Gravity Separation using Bromoform

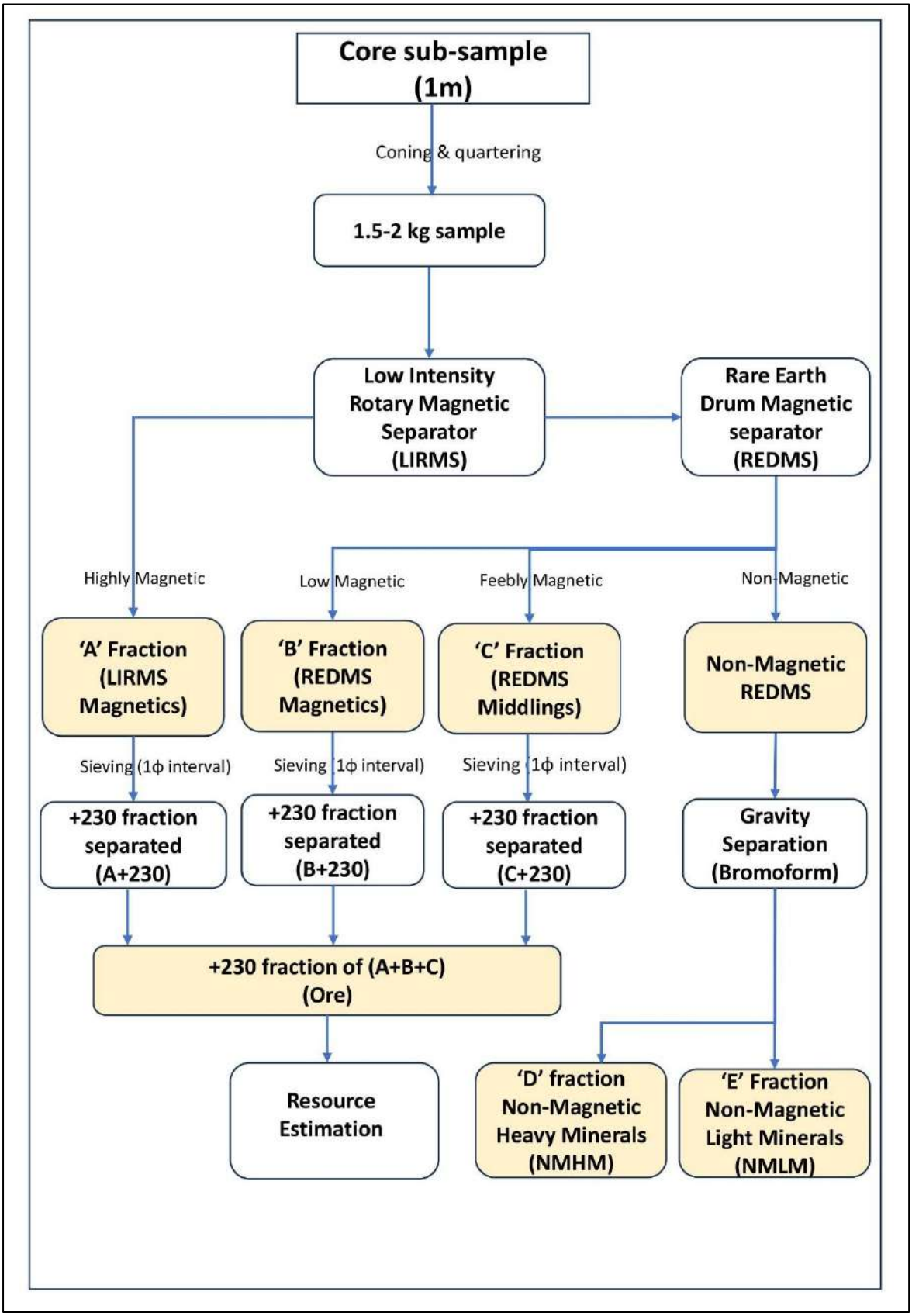


Figure 8.2: Flow chart of Test methodology for Ore generation

8.7.3 Grain Size analysis of strongly magnetic (A), low magnetic (B) and Middlings (C)

The LIRMS magnetics (A), REDMS magnetics (B), REDMS middlings (C) were further sieved in different size fractions: viz: +18 (1000 micron), +35 mesh (500 micron), +60 mesh (250 micron), +120 mesh (125 micron), and +230 mesh (63 micron) to assess the distribution of magnetics in each fraction. The heavy mineral concentration in different size fractions were quantified in terms of weight percentage (wt%) and is attached as Annexure 5.

The chemical analysis data confirms that majority of the magnetic minerals are concentrated in +230 sieve size followed by +120# and +60# fractions. Some selected samples were further separated by hand magnet from the +230# fraction.

In order to assess the concentration of heavy minerals in the entire area, composite bulk samples were made and processed in two-level magnetic separator. Then the A, B and C fractions were mixed together and subjected to grainsize analysis at one phi intervals. Similarly, the non-magnetic fractions (D+E) were also sieved. The 35#, 60#, 120#, 230#, and -230# size fractions of ABC were then separated using a hand magnet. XRF and ICP-MS analyses were then performed on the separated samples (both Mt and Nmt). The procedure followed is outlined as flowchart below (Figure 8.3) and the sieve data is attached in table 8.3.

Table 8.3: Sieve data of Bulk sample

Sieve data of Bulk Sample (7.447kg) (one phi interval)								
Sample	**5#**	**10#**	**18#**	**35#**	**60#**	**120#**	**230#**	**-230#**
	(wt%)							
A+B+C (4943 g)	0.81	0.87	5.22	4.87	18.48	24.39	10.04	1.50
D+E (2312 g)	0.18	0.26	2.49	1.89	14.24	11.04	0.80	0.03

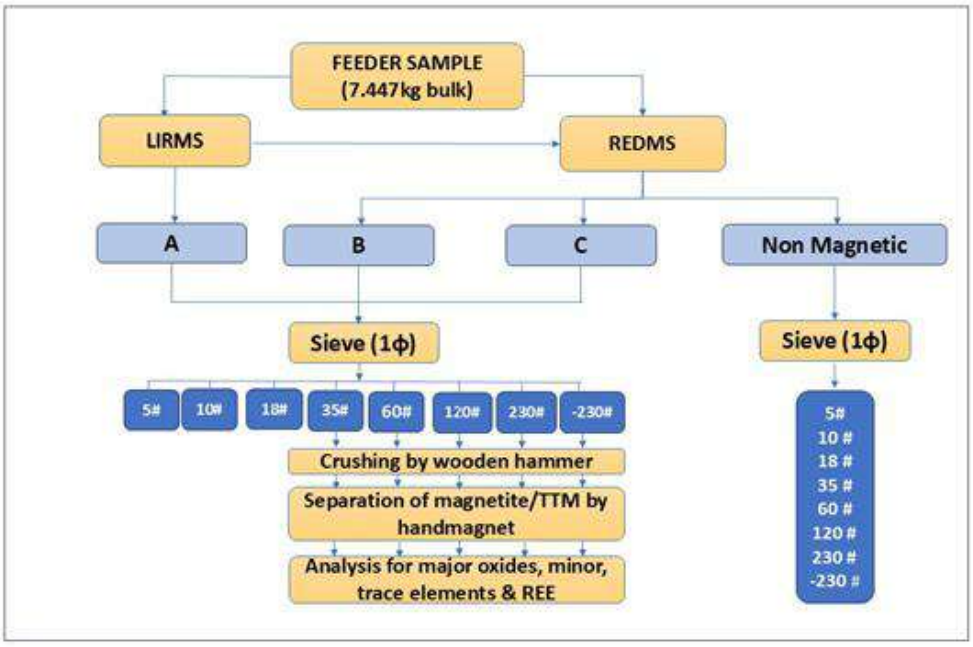


Figure 8.3: Flow chart of Test methodology for hand magnet separation of Bulk Sample

8.7.4 Chemical analysis by XRF

The two-level magnetic separation yielded a total of 480 sub-samples (160*3) (A, B and C sub-fractions), apart from non-magnetic heavies (D) and non-magnetic lights (E). From the 480 sub-samples obtained, 139 samples (~25% of the total sub-samples) were proposed for XRF analysis, but a total of 164 samples were subjected to geochemical analysis for determining the concentrations of major oxides such as Fe_2O_3, TiO_2, V_2O_5, MnO, SiO_2 etc. The location of samples was considered in such a way that, it should represent horizontal as well as vertical distribution of entire sand body explored (Figure 8.4.a & 8.4.b).

A total of 72 samples of A, B, C fractions from all depths of the boreholes DD02, DD03, DD15, DD33, DD36, 12 samples from different sieve sizes of A,B, C fractions viz; 60#,120#, 230# and -230# from DD03 and DD15, 69 composite samples (A230+B230+C230) from boreholes DD01, DD03, DD05, DD07, DD09, DD11, DD13, DD15, DD17, DD19, DD23, DD33, DD35 and DD37, 10 composite samples (A+B+C) from sieve sizes 35#, 60#, 120#, 230#, -230 # from the bulk sediment were separated manually by using hand magnet and one silt fraction mixed from the boreholes DD01, DD06, DD07, DD08, DD11, DD12, DD13, DD14, DD16, DD18, DD19, DD21, DD22, DD25, DD26, DD27, DD28, DD29, DD30 were chemically analyzed for major

oxides. The procedure followed for the chemical analysis at Shiva analytical lab is mentioned below.

Preparation of Fusion bead for the Analysis of Majors by using flux mixture containing Lithium Tetra borate, Lithium Meta borate, Lithium Bromide in a fusion bead machine in Geological samples by WDXRF spectrometer

The estimation of major elements in sand samples is by making a fusion bead followed by WDXRF analysis for oxides, - Al_2O_3, BaO, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, SO_3, V_2O_5 and LOI.

All samples were prepared and ensured the sample pulp is 90% passing 200# (75micron) as per SOP/OM/083 before taking for fusion bead. This method describes the fusion and analytical procedure used for the preparation of all types of geological exploration, mining and ore grade rock chips, soils, stream sediment samples for the subsequent analysis by WDXRF. The preparation of fusion bead of the samples by this procedure is 0.55 g sample ~~is~~ taken for bead preparation.

Fusion flux is weighed in glass bottle of 9.45g and sample of 0.55g on the top of the flux. The glass bottle is capped and mixed thoroughly with shaking to get a homogenized mixture. Samples are weighed by the operator/chemist depending upon the availability of 30ml Pt-Au crucibles.

Prior to using 30ml Pt-Au crucibles - Molds are visually inspected for cleanliness without any residues of previous fusions. If residues are seen they are returned for cleaning in 5% citric acid immersed in a glass beaker and in an ultra-sonic bath. Fusion beads are labelled as per the sequence given in the worksheet.

Instrumentation

The WDXRF procedure is based on X-ray fluorescence spectroscopy and is used for the sequential element determination of elements in a variety of sample matrices. The instrument has a vacuum chamber for sample, goniometer for changing the angle of detectors (both Scintillation and gas detector). Also, Crystals for focusing the secondary x-rays from the samples towards the detector. The XRF instrument is connected with a PC which controls the operations, analysis and results. The X-ray tube is protected by circulating water from a chiller unit which helps to keep the tube at 25°C.

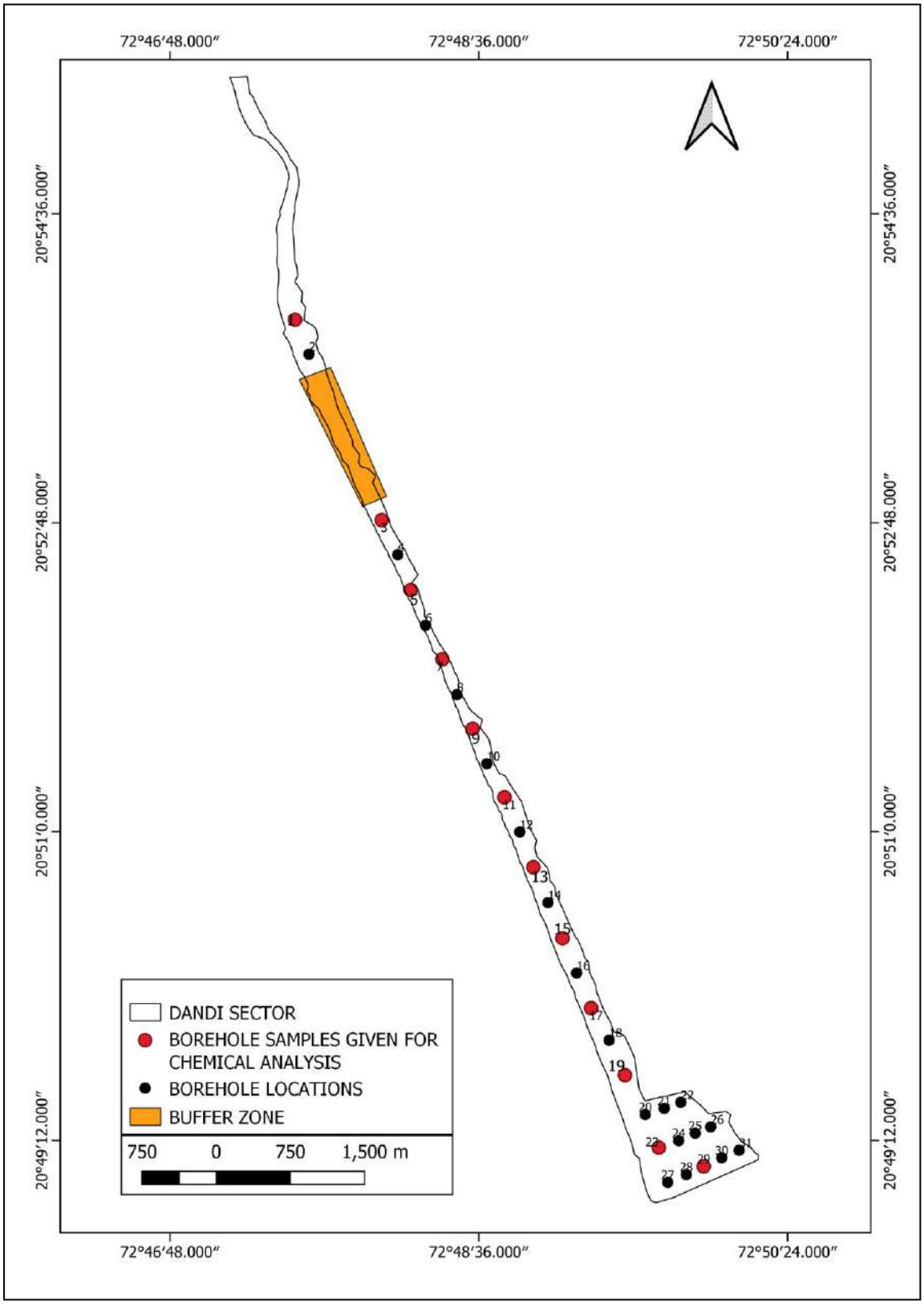


Figure 8.4.a: Map showing the boreholes selected for chemical analysis in Dandi-Onjal sector.

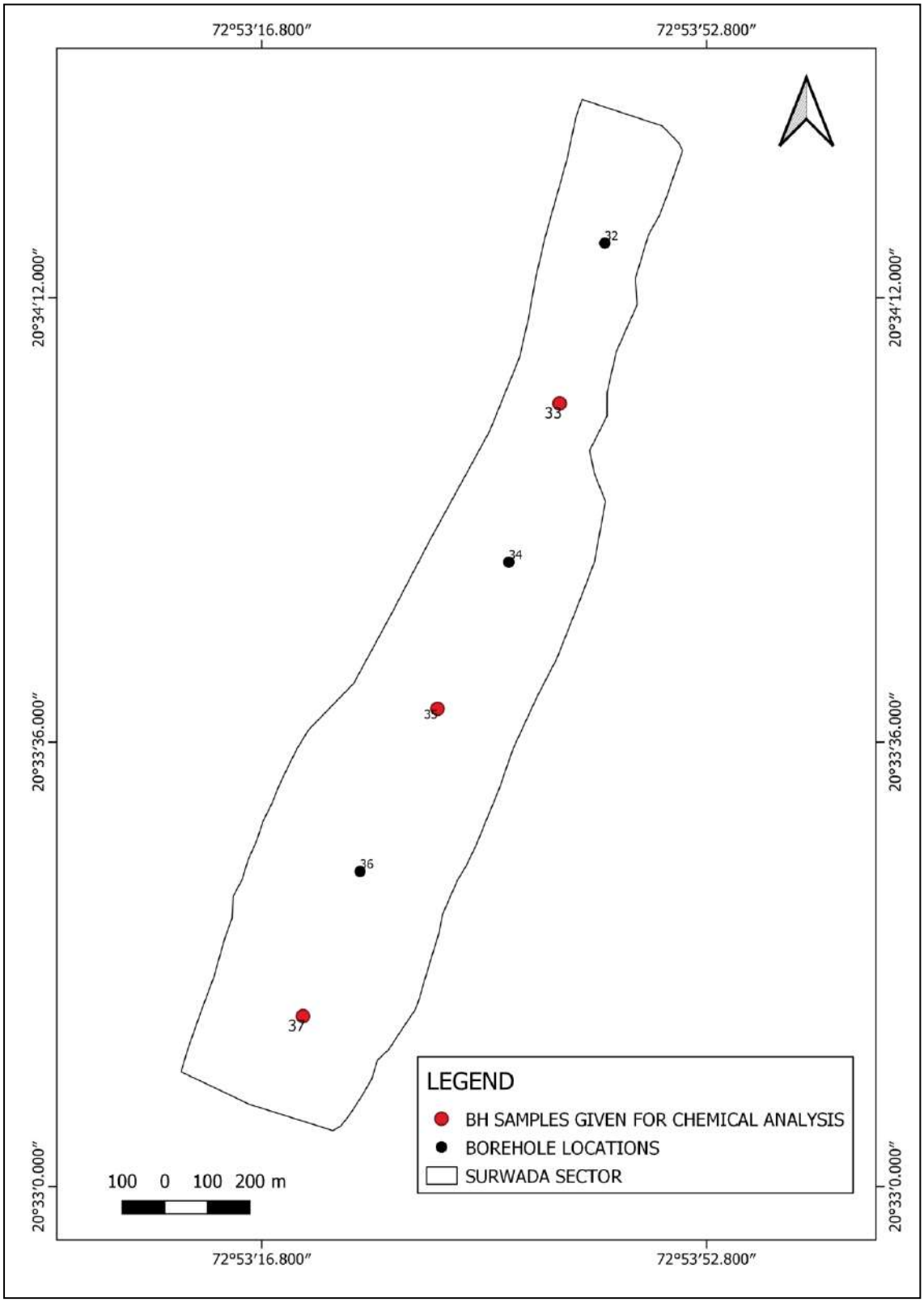


Figure 8.4.b: Map showing the boreholes selected for chemical analysis in Surwada sector.

8.7.5 Inductively Coupled plasma Mass Spectrometry (ICP-MS)

This analytical technique is used for determining trace elemental concentrations, particularly niobium (Nb), tantalum (Ta) and scandium (Sc) in the beach and dune sediments. A total of 27 samples had undergone ICP-MS studies at Shiva analytical laboratory, Bangalore. Out of 27 samples, 18 composite samples were made from the top and bottom of boreholes DD01, DD03, DD07, DD11, DD15, DD19, DD23, DD33 and DD37. The remaining 9 samples were the hand magnet separated fractions of A+B+C viz, +35, +60, +120, +230, -230 sieve size of the bulk sample. The procedure for ICP-MS is mentioned below.

Multi-element Analysis of Majors, Minors and trace metals in sand samples by ICPMS

The major, minor and trace elements viz; Li, Be, B, Sc, Co, Ga, Ge, Rb, Y, Nb, Mo, Cd, In, Sn, Sb, Te, Cs, Cu, Ni, Pb, Sr, Zn, Zr, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Tl, Bi, Th and U were analyzed using four acid near total digestion beginning with mixture of Hydrofluoric, Nitric, per chloric acid, Hydrochloric acid.

The sample is weighed in a Teflon beaker, wetted with Milli-q water followed by adding Hydrofluoric acid, Nitric acid, Perchloric acid, Hydrochloric acid fumed on a preheated hot plate at 180°C to obtain a viscous mass. The viscous mass is further digested twice with Hydrochloric acid on a preheated hot plate at 180°C to obtain a viscous mass. Finally, the viscous mass is dissolved in Nitric and Hydrochloric acid by warming on a hotplate and diluted to 50.0gms with Milli-q water and mixed well. The sample solutions are aspirated directly without diluting, directly on ICPMS-Agilent-7700x with the calibration standards.

8.7.6 XRD Analysis

XRD analyses of 10 sub-fractions were carried out to understand the mineral phases at Mineral Physics Lab of Geological survey of India, Kolkata. All the samples for XRD analysis were prepared from boreholes DD01, DD05, DD09, DD15, DD23, DD33, D35 and DD37 from the depths of 1m, 3m, 5m respectively, except DD01 in which depth of 4m was taken instead of 5m. Two composite samples of +230# fraction of A, each from Dandi and Surwada sector, one composite sample of +230 sieve fraction of B, one composite sample of +230 sieve fraction of C, two composite samples of D fractions each from Dandi and Surwada sector, one composite

sample of E, two composite sample of +60 sieve fraction mixed with 120 mesh size fraction of A and C separately from Dandi and Surwada and the one composite fraction of silt from boreholes DD01, DD06, DD07, DD08, DD11, DD12, DD13, DD14, DD16, DD18,DD19, D20, DD22, DD25, DD26, DD27, DD28, DD29 and DD30 of the Dandi-Onjal-Surwada block were analyzed using X-ray diffraction (XRD).

Samples were analyzed in PANalytical X'pert PRO powder diffractometer having an X-ray tube with copper target. Analyzing iron-rich samples using XRD with copper radiation results in a high background level due to fluorescence, which affects the quality of the diffractogram. Also, the samples analyzed were fractions separated by magnetic separator/bromoform.

Spinel minerals such as magnetite, titanomagnetite and magnesioferrite etc. having similar spinel crystal structure and comparable lattice parameters are identified and their X-ray diffraction (XRD) patterns are quite similar making distinction between these types of minerals challenging in polymineralic samples. A fraction chiefly constitutes spinel minerals with pyroxene and plagioclase, suggesting that the rock fragments are masking the heavy minerals in the area. Similarly, B fractions are composed of Clinopyroxene (CPx), spinel type minerals, quartz, plagioclase, with trace amount of ilmenite and hematite and C fractions are composed of feebly magnetic heavy minerals such as pyroxenes etc. Non-magnetic heavies comprise of CPx and the non-magnetic light minerals identified are calcite, quartz, plagioclase with minor amount of zeolite in which the secondary minerals such as calcite and zeolite may be the filled within the vesicles of the amygdaloidal basalt.

Measurement Conditions:

Instrument: PANalytical *X'Pert PRO*™ powder diffractometer

Software used for analysis of spectra: PANalytical *HighScore Plus*™

Raw Data Origin	XRD measurement (*. XRDML)
Scan Axis	Gonio
Start Position [°2Th.]	4.0054
End Position [°2Th.]	79.9784
Step Size [°2Th.]	0.0170
Scan Step Time [s]	50.8000
Scan Type	Continuous
PSD Mode	Scanning
PSD Length [°2Th.]	2.12
Offset [°2Th.]	0.0000

Divergence Slit Type	Fixed
Divergence Slit Size [°]	0.4354
Specimen Length [mm]	10.00
Measurement Temperature [°C]	25.00
Anode Material	Cu
K-Alpha1 [Å]	1.54060
Generator Settings	30 mA, 40 kV

8.7.7 Petrographic Study

The grain mount sections were prepared by spraying the heavy detritus on an araldite base spread all over a 2-inch x 1-inch size thin glass slide. The grains were spread uniformly all over the slide. Care was taken to spread the grains in such a way that individual grains do not overlap one on another. The fixed grain mounts were then subjected to a low-speed polishing in order to bring all the grain mounts on a level-plane surface.

The grains were studied under transmitted light (plane polarized and crossed nicol conditions) and reflected light (plane-polarized and cross nicol conditions) of a Polarizing Microscope. Due to smaller sizes, the silicate grains exhibit many of their inherent optical properties and therefore could be identified. On the other hand, the identification of oxide facies minerals is constrained by un-even surfaces and therefore their identification under reflected light is based on limited properties. Digital photomicrographs under different magnifications are obtained and reported in the form of plates for each sample.

8.7.8 Bulk Density

The concentration of heavy minerals in the beach and dune sands varies along the coastal stretch and samples were selected to represent the entire mineralized body both horizontally and vertically. Subsequently, the dry bulk density was determined for the representative samples, which were selected based on the cumulative weight percentage of magnetic fractions A, B, and C. These fractions were isolated through a two-stage magnetic separation process.

To determine representative samples for calculating bulk density, the total weight percentage of magnetic fractions, non-magnetic heavies and gravels (A+B+C+D+G) across 160 samples was analyzed. The values ranged from 36.82% to 93.52%. To categorize these samples, 10 intervals were created: 30%-50%, 50%-55%, 55%-60%, 60%-65%, 65%-70%, 70%-75%, 75%-80%,

80%-85%, 85%-90%, and 90%-95%. One sample from each interval was selected as a representative, resulting in a total of ten representative samples. The samples selected from each category are mentioned in the table 8.4 below. The dry bulk density of the representative samples was determined by following the standard procedure as per IS:1124-1074 by water displacement method at Matter Material Testing and Research Laboratory Pvt. Ltd, Calicut.

Table 8.4: Samples selected for dry bulk density calculation

Sl no.	Sample No	Wt.% range (A+B+C+D+G)
1	DD01/3-4	30%-50%
2	DD13/1-2	50%-55%
3	DD14/2-3	55%-60%
4	DD07/4-5	60%-65%
5	DD18/1-2	65%-70%
6	DD18/0-1	70%-75%
7	DD08/2-3	75%-80%
8	DD35/3-4	80%-85%
9	DD34/0-1	85%-90%
10	DD34/1-2	90%-95%

8.7.9 Radiometric analysis at Atomic Mineral Division

Five bulk samples that are covering entire explored area are submitted for radiometric equivalent of monazite at AMD, Hyderabad. The result is attached as Annexure 20.

8.8 Check samples (at least 10%) analysed from third party NABL accredited lab

Out of 160 original samples (representing 37 boreholes), 10% samples were taken as check samples (14 samples) were given for Lithium Borate fusion bead followed by WDXRF analysis for the major oxides as per the standard procedure IGI/GDM/TPM-48 from the NABL accredited lab at Inspectorate Griffith India Pvt. Ltd., Gandhidham, Gujarat. Chemical values of check samples vis-à-vis original samples are compared. Detailed comparison of chemical values of check samples with that of corresponding original samples is given in Chapter 9.

8.9 Details of intersected ore zones of the boreholes drilled and their correlation

Since the exploration is restricted to beach and dune sands and the heavy minerals are disseminated in the sands, demarcation of ore zones and their correlation is not possible.

8.10 Depth of the ground water condition should be ascertained and reported.

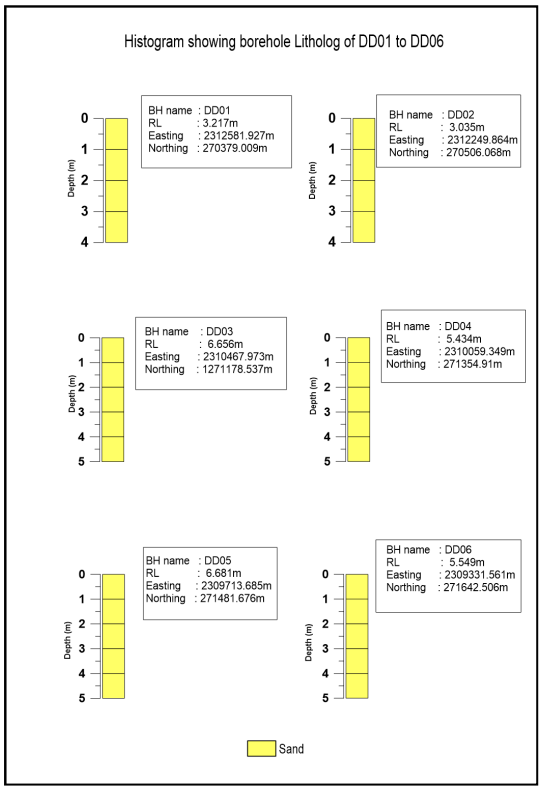
The ground water occurs mainly under unconfined conditions but at places semi-confined conditions are also observed. The occurrence and movement of ground water in alluvium is controlled by primary porosity (interstitial pore spaces) of the alluvial material. The ground water exploration carried out in the Navsari district revealed that the yield of wells drilled in alluvial area ranges between 78 lpm to 2744 lpm whereas the Co-efficient of transmissivity ranges between 300 m^2 /day to 2261 m^2 /day. The ground water condition along the coastal areas of Valsad district is low as 20 m above msl (CGWB, 2013).

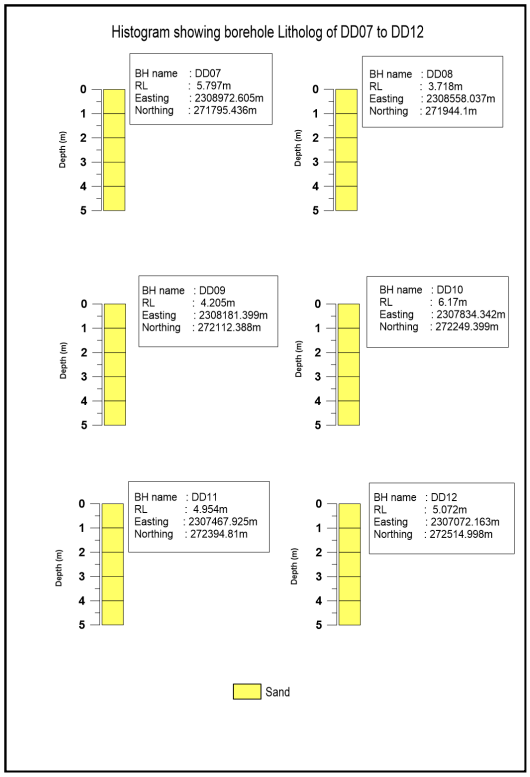
CHAPTER 9 - ANALYTICAL RESULTS AND INTERPRETATION

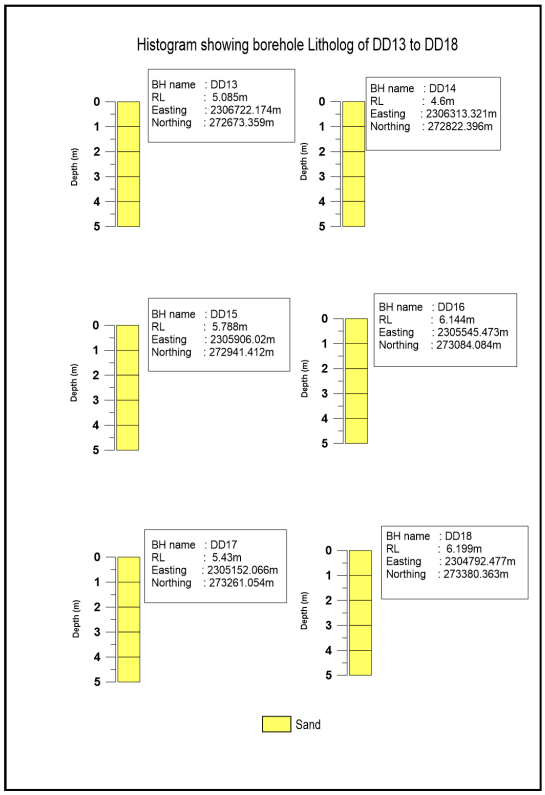
The mineral separation using two level magnetic separators (LIRMS and REDMS) was carried out for the entire 160 sub-samples from 37 boreholes and 480 (160*3) magnetic fractions were generated and they were subject to grain size analysis. A total of 164 samples were subjected to chemical analysis by XRF and 27 samples were subjected to ICPMS studies. The representative magnetic samples of +60#, +120# and +230# sieve fractions and nonmagnetic heavy minerals were undergone EPMA followed by thin section studies. Ten representative samples of different sieve sizes from magnetic fractions and a composite of silt fractions were subjected to XRD analysis at Mineral Physics lab of GSI, Kolkata to identify the mineral phases and their semi-quantitative presence. Granulometric studies of all the 160 sub-samples are conducted and the results are analyzed. A total of 14 numbers of XRF samples (10%) considered as check sample were analysed at a different NABL accredited lab. All the quantitative and qualitative analyses and their results are discussed below.

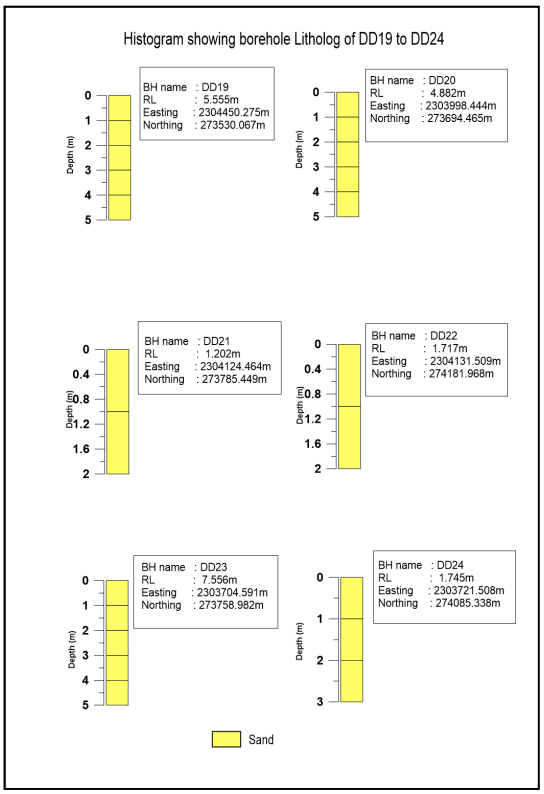
9.1 Borehole Log

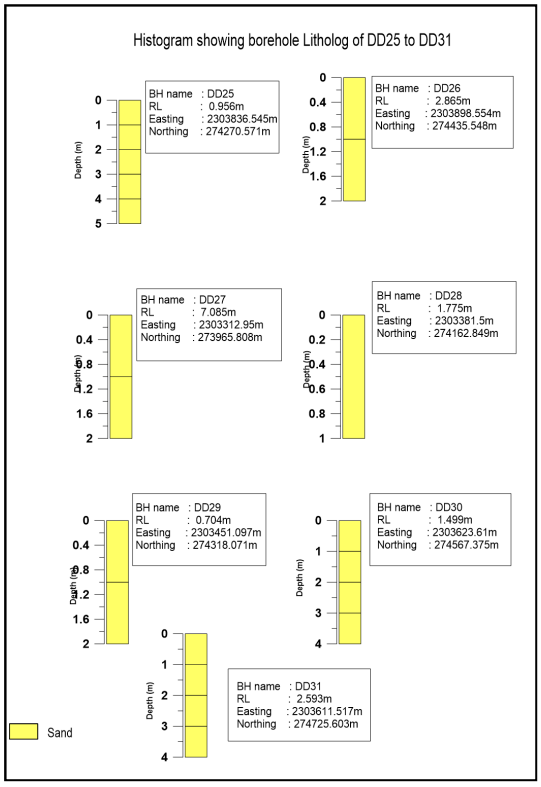
The Litholog of 37 boreholes (Fig.9.1) indicates that the sediments fall in category of Sand.











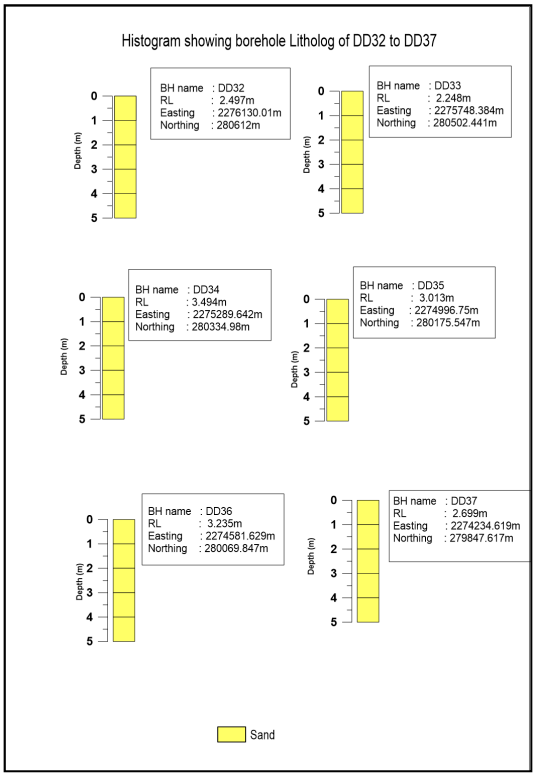


Figure 9.1: Litholog of boreholes from DD01 to DD37

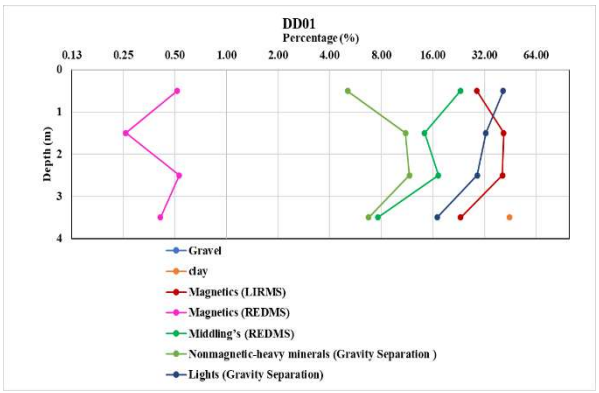
9.2 Two-Level Magnetic Separation of Bulk samples

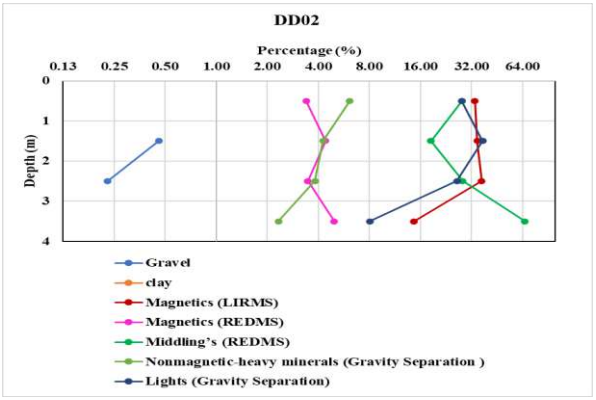
The thirty-seven drill locations of the Dandi-Onjal-Surwada block yielded a maximum of 160 sub-samples by means of 1.0 m sub-sampling down the core up to a maximum depth of 5 m. The samples are processed by two level magnetic and gravity separation.

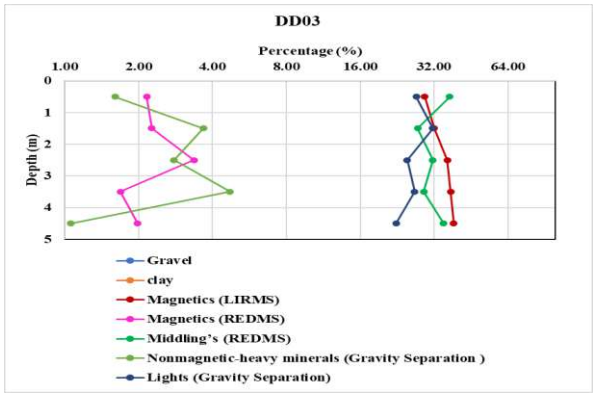
The wt% of gravels (G), clay, A (LIRMS magnetics), B (REDMS magnetics), C (REDMS middlings), D (NMHM) and E (NMLM) represents the composition of bulk sample (Annexure 4).

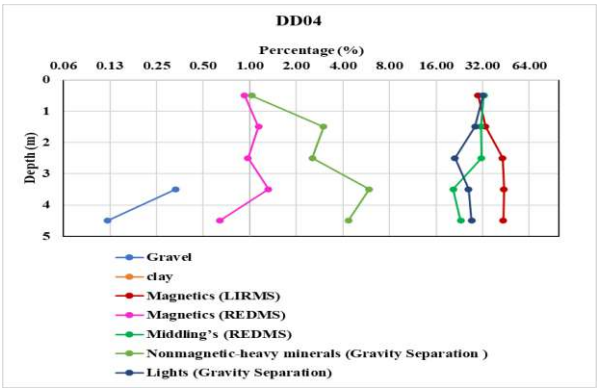
Based on the analysis, the percentage of heavy minerals in A fraction of the Dandi-Onjal sector (DD01- DD31) ranges from 12.99% in DD30/3-4 to 49.83 % in DD17/3-4 with an average of 35.61%, B fraction ranges between 0.033% in DD24/0-1 to 5.94 % in DD05/3-4 with an average of 1.25%, C fraction ranges from 4.76% in DD22/1-2 to 66.06% in DD02/3-4 with an average of 23.68%, whereas D fraction ranges from 0.43% in DD15/4-5 to 13.45% in DD11/2-3 with an average of 5.02% and E fraction ranges from 8.03% to 45.99% with an average of 29.10%.The weight percentage of VHM varies from 19.15% to 86.99% with an average of 60.53%. The wt% of gravel ranges from 0% to a maximum of 28.78% in DD22/1-2 with an average of 0.66% and the clay ranges from 0% to 66.81% in DD21/1-2 with an average of 3.55%. The THM varies ranges from 51.392% (DD21/1-2) to 92.88% (DD17/3-4) with an average of 78.51%.

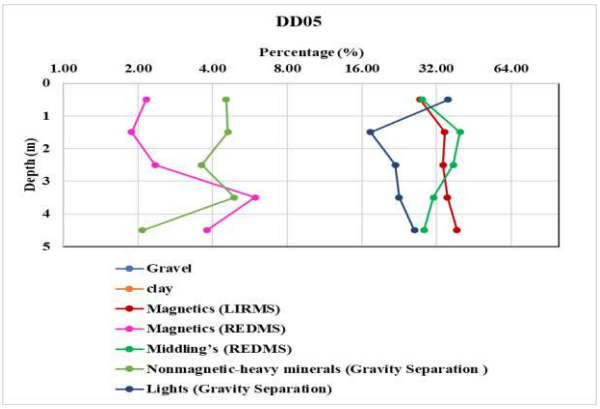
The A, B, C fractions show increasing trend towards greater depths, indicating enrichment of magnetic minerals at greater depths (3-4m). In areas where clay layers are encountered (DD21, DD22, DD26, DD29,.DD29etc.), the A, B and C values are considerably decreased. The boreholes along the southern extremity of the Dandi-Onjal block have lower values of magnetic minerals. This may be due to (i) the presence of immature sediments such as clay and (ii) presence of fine-size mafic rock fragments in the fractions, where heavy minerals have not been fully segregated from the source rock.

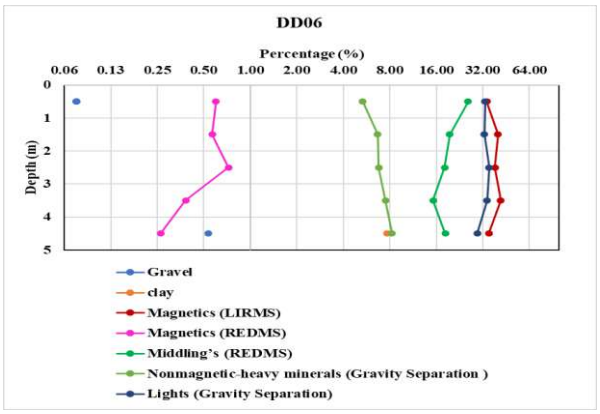

DD01
Percentage (%)
0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

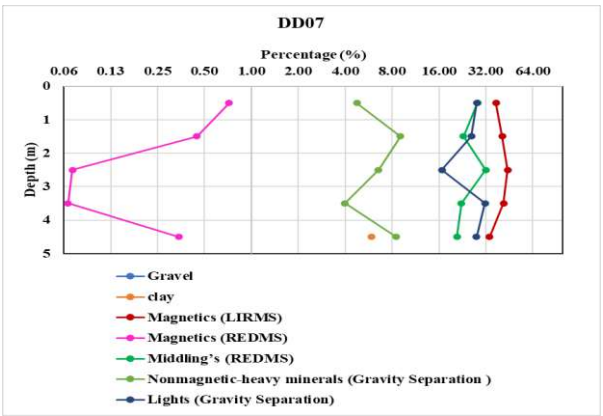

DD02
Percentage (%)
0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

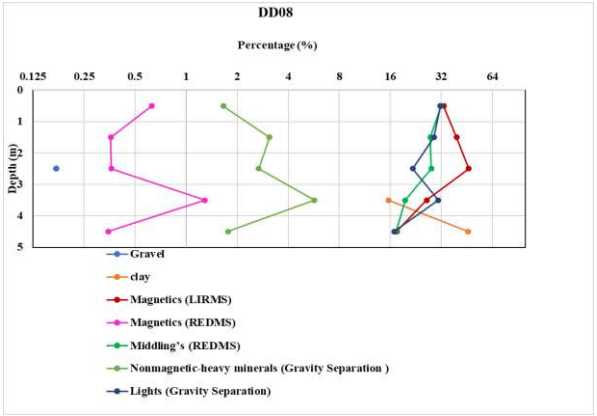

DD03
Percentage (%)
1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

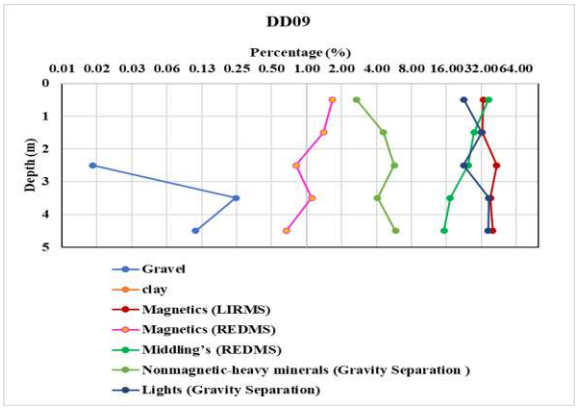

DD04
Percentage (%)
0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

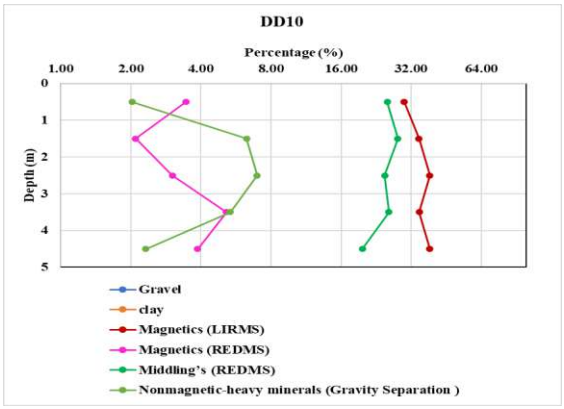

DD05
Percentage (%)
1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

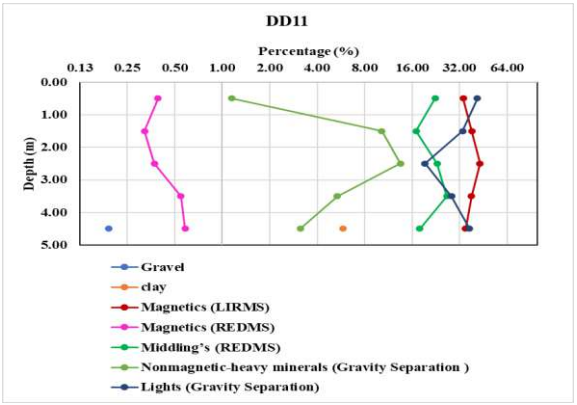

DD06
Percentage (%)
0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

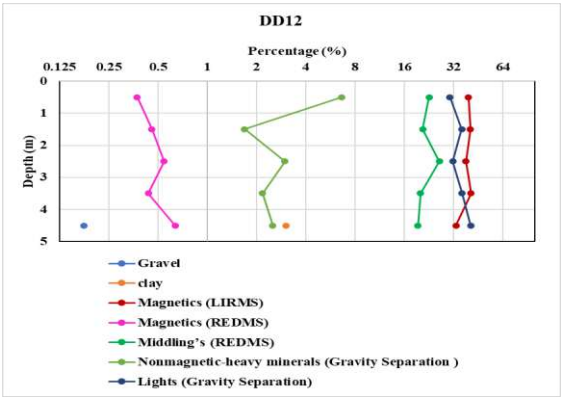

DD07
Percentage (%)
0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

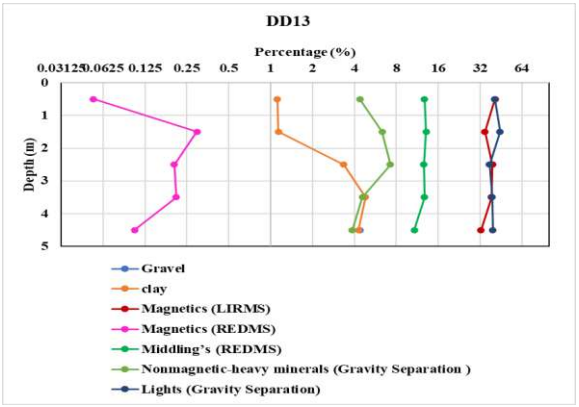

DD08
Percentage (%)
0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

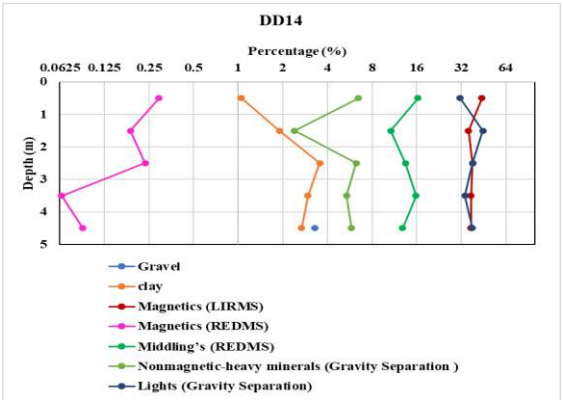

DD09
Percentage (%)
0.01 0.02 0.03 0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

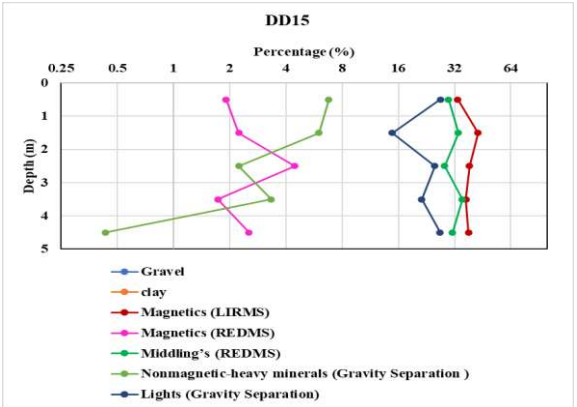

DD10
Percentage (%)
1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)


DD11
Percentage (%)
0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0.00 1.00 2.00 3.00 4.00 5.00
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD12
Percentage (%)
0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD13
Percentage (%)
0.03125 0.0625 0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD14
Percentage (%)
0.0625 0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)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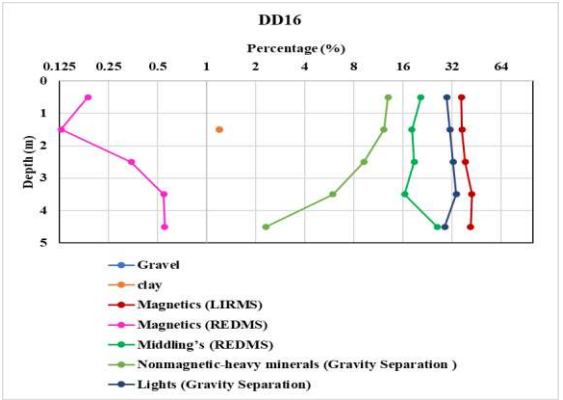
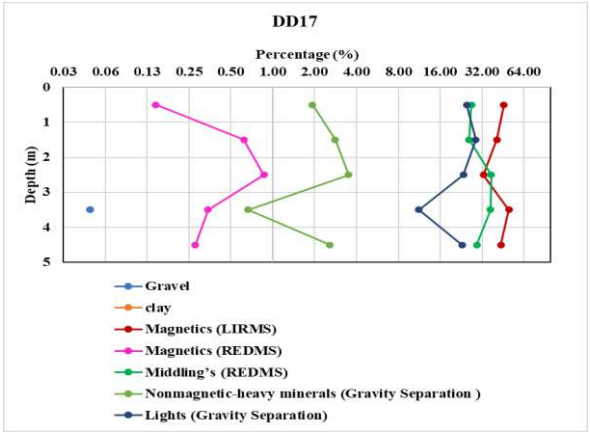
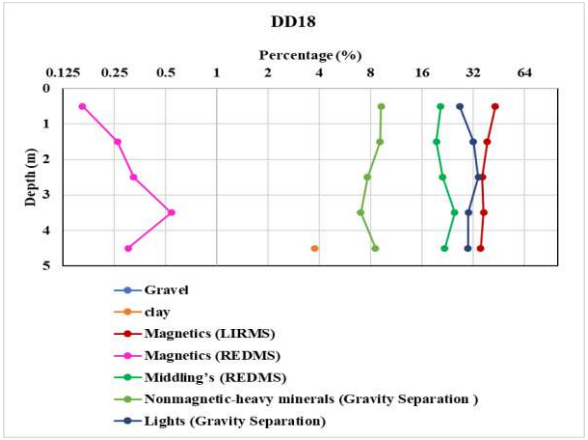
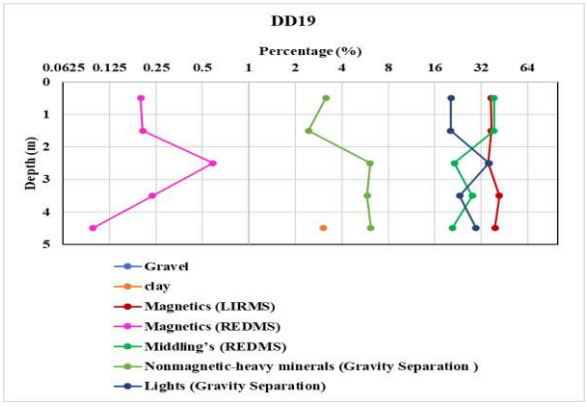
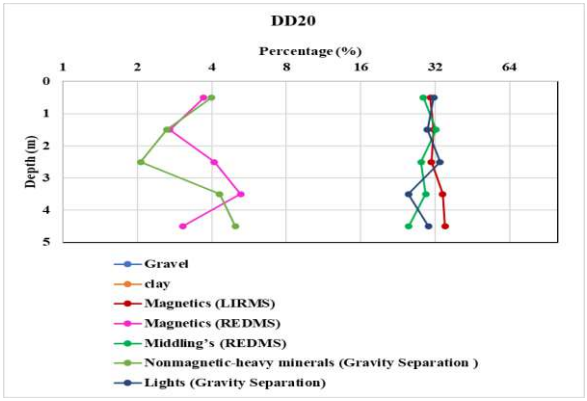
Percentage (%)
0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

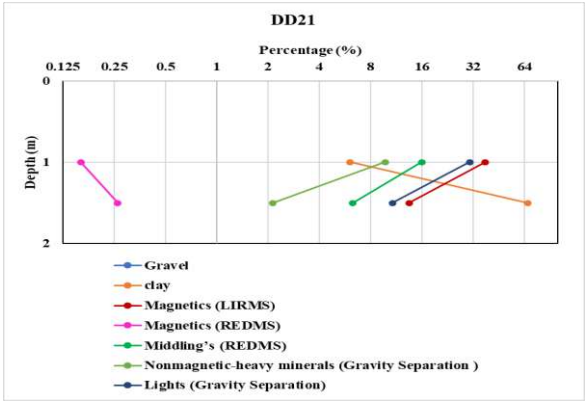

DD16
Percentage (%)
0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

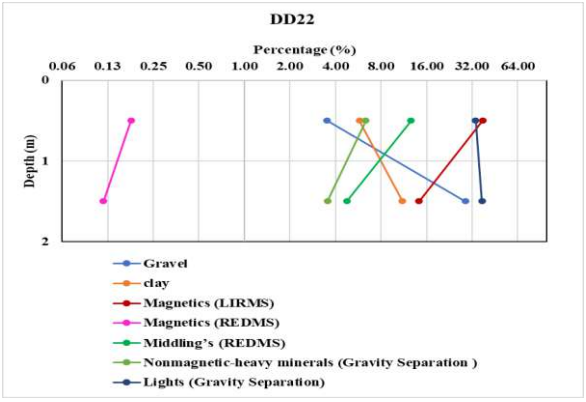

DD17
Percentage (%)
0.03 0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

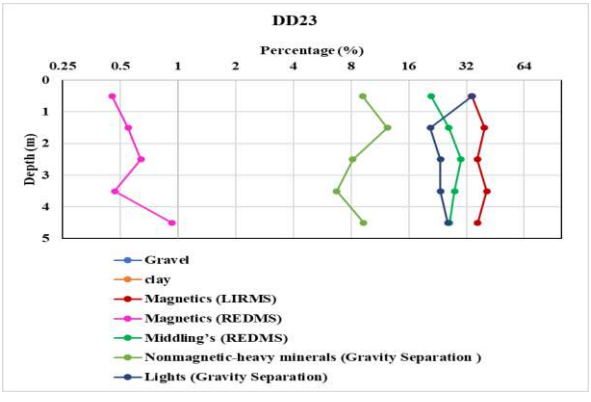

DD18
Percentage (%)
0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

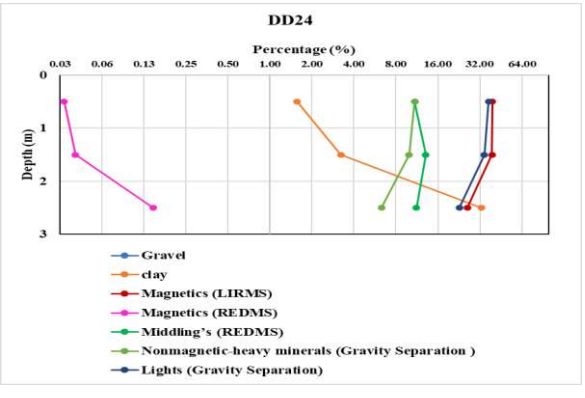

DD19
Percentage (%)
0.0625 0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD20
Percentage (%)
1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD21
Percentage (%)
0.125 0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD22
Percentage (%)
0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD23
Percentage (%)
0.25 0.5 1 2 4 8 16 32 64
Depth (m)
0 1 2 3 4 5
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)


DD24
Percentage (%)
0.03 0.06 0.13 0.25 0.50 1.00 2.00 4.00 8.00 16.00 32.00 64.00
Depth (m)
0 1 2 3
Gravel
clay
Magnetics (LIRMS)
Magnetics (REDMS)
Middling's (REDMS)
Nonmagnetic-heavy minerals (Gravity Separation)
Lights (Gravity Separation)

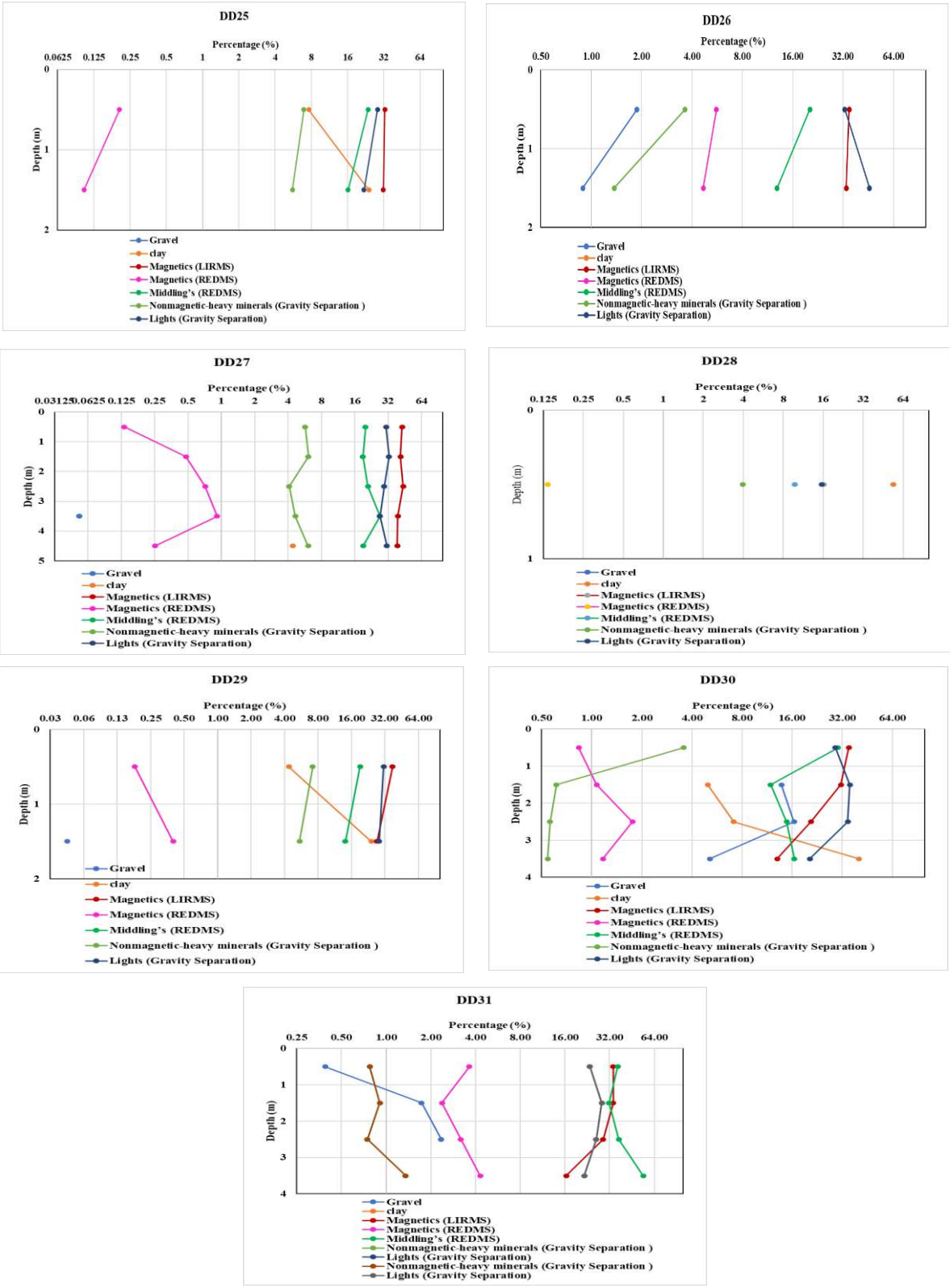


Figure 9.2: Magnetic separation graphs of Dandi-Onjal sector

The percentage of heavy minerals in A fraction of the Surwada sector (DD32-DD37) ranges from 33.31% in DD37/4-5 to 64.13% in DD34/2-3 with an average of 47.63%, B fraction ranges between 0.079% in DD37/0-1 to 14.07 % in DD36/3-4 with an average of 3.43%, C fraction ranges from 11.41% in DD36/3-4 to 47.52% in DD33/4-5 with an average of 25.86%, whereas D fraction ranges from 0.30% in DD33/1-2 to 4.89% in DD37/4-5 with an average of 1.59% and E fraction ranges from 5.46% to 28.29% with an average of 11.56%. The weight percentage of VHM varies from 46.51% to 91.15% with an average of 76.92%. The wt% of gravel ranges from 0% to a maximum of 22.76% in DD36/4-5 with an average of 6.77% and the clay ranges from 0% to 14.67% in DD37/4-5 with an average of 1.597%. The THM values ranges from 22.13% (DD37/4-5) to 88.01% (DD36/1-2) with an average of 72.51%. The percentage of gravel and clay is very high in Surwada sector compared to that of Dandi-Onjal. Based on the analysis, the percentage of VHM in Surwada (DD32-DD37) block varies from 19.15% to a maximum of 91.15% with an average of 63.61% and THM varies from 22.13% to 92.89% with an average of 67.98%.

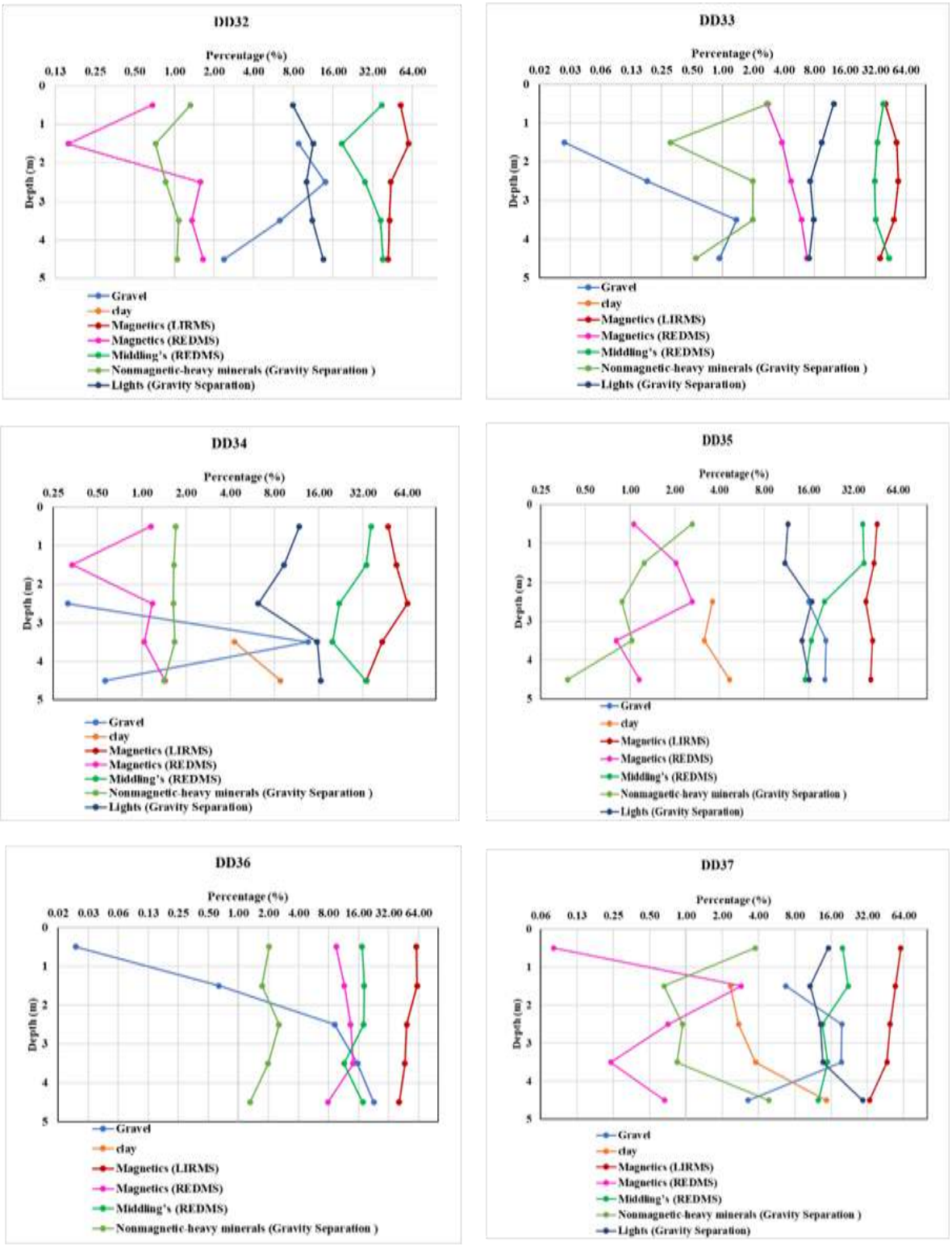


Figure 9.3: Magnetic separation graphs of Surwada sector

In general, the concentration of THM is higher in the Dandi-Onjal sector in comparison with the Surwada sector. The chemical analysis values of TiO_2 and V_2O_5 of Surwada sector is having much lower value than the Dandi-Onjal sector, this discrepancy can be attributed to the nature of gravelly sand present in the area, where the sediments are immature and have not yet undergone significant weathering or sorting processes.

The Dandi-Onjal-Surwada block exhibits varying mineralization patterns across regions, influenced by surface and subsurface processes such as erosion and deposition. Although high values of Total Heavy Minerals (THM) and Valuable Heavy Minerals (VHM) are observed in the study area, the X-ray Diffraction (XRD), petrographic studies, EPMA and chemical analysis results suggest that a significant portion of the magnetic fractions is occupied within rock fragments.

9.3 Sieve data of Magnetic fractions of boreholes

The magnetic fractions such as A, B and C are sieved at +18#, +35#, +60#, +120#, +230# mesh sizes in order to assess the concentration of heavy minerals in different sieve fractions. Sieving is done as per the standard operating procedure of GSI. The data of each sieve fractions in a borehole is averaged for understanding the borehole wise mineral resource evaluation (Annexure 7). From sieve analysis, it is observed that heavy mineral proportion is mainly concentrated in fine sand (0.250mm to 0.125mm) and very fine sand (0.125mm to 0.063mm).

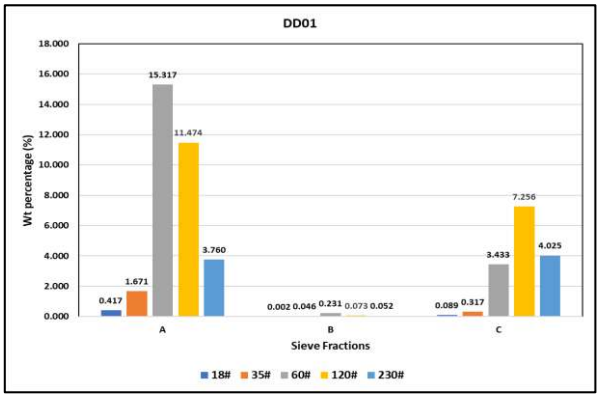
On the basis of analysis, the weight percentage of A18# varies from 0 to 15.29% with an average of 1.92%, A35# varies from 0.05% to 4.89% with an average of 2.55%, A60# varies from 1.26% to 19.19% with an average of 11.68%. The maximum magnetic samples are retained in the 120# sieve fraction and the weight percentage ranges between 4.04% to 20.51% with an average of 13.05%. As per the chemical analysis, EPMA, ICP-MS and petrographic studies, the heavy minerals are concentrated in the +230# sieve size and the wt% ranges from 2.21% to 11.52% with an average of 6.02%. the TTM fractions are enriched in +230#, 120# and 60# and hence they together constitute heavy mineral dominant sieve fractions of the orebody.

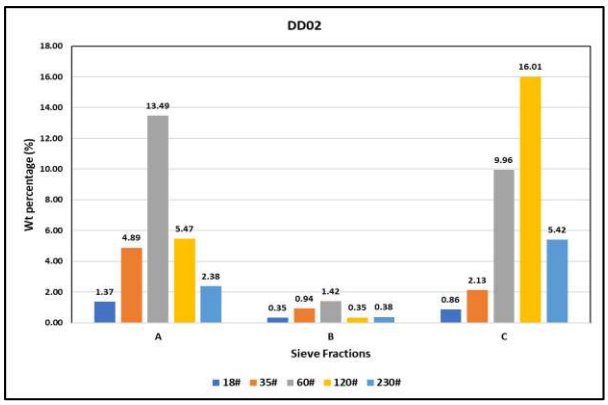
The weight percentage of B18# ranges from 0% to 5.02% with an average of 0.25%, B35# ranges between 0 to 2.93% with an average of 0.28%, B60# varies from 0% to 2.02%, with an average of 0.48%, B120# varies from 0.01% to 1.54% with an average of 0.26% and B230# ranges

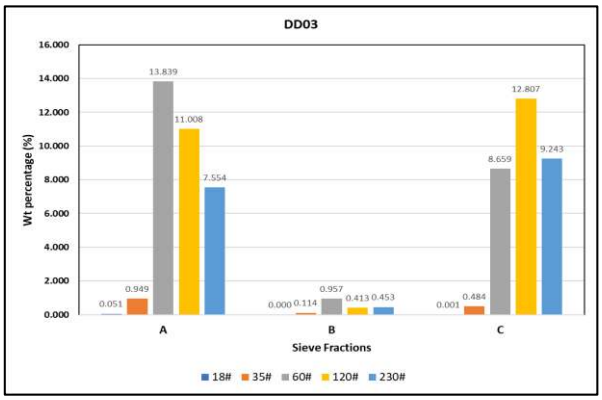
between 0.02 to 0.87% with an average of 0.19%. The ilmenite fractions are enriched in the +230# followed by +120# sieve size.

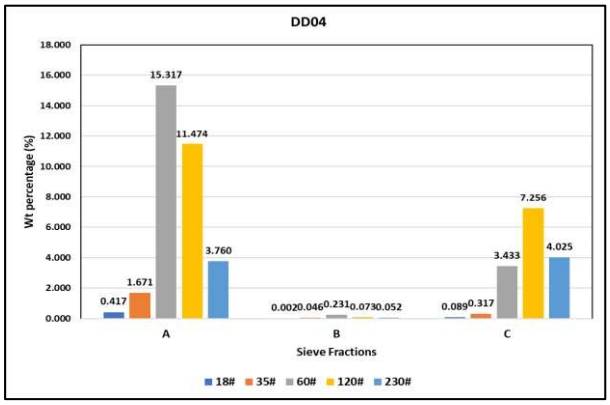
The weight percentage of C18# ranges from 0% to 4.11% with an average of .75%, C35# between 0 to 4.02% with an average of .79%, C60# varies from 0.44% to 9.96%, with an average of 4.11%, C120# varies from 2.64% to 8.31% with an average of 10.66% and C230# ranges between 1.73 to 11.29% with an average of 5.98%.

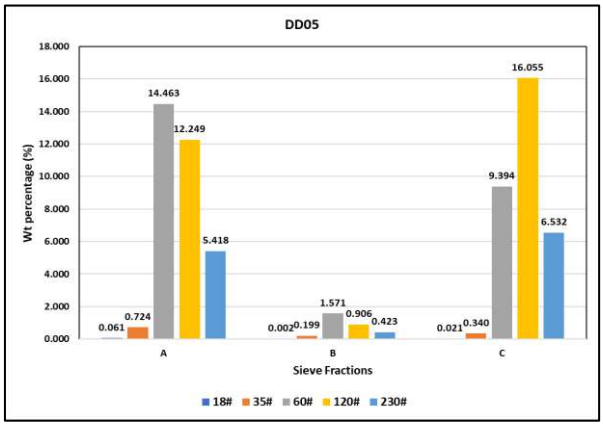
The mineral distribution in the sieves shows that the heavy minerals are primarily distributed in the +230# and +120# sieve fractions, particularly in the finer fractions (fine to very fine sand).

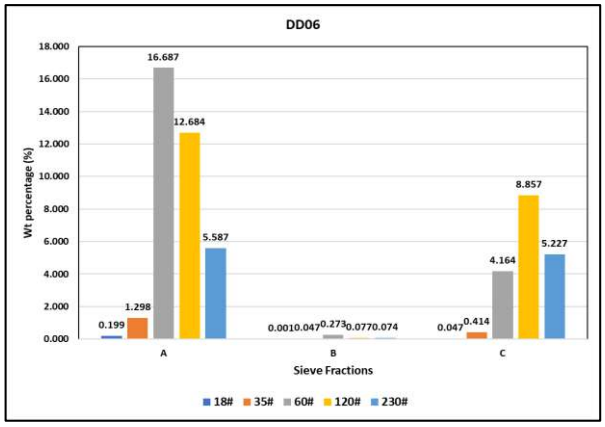


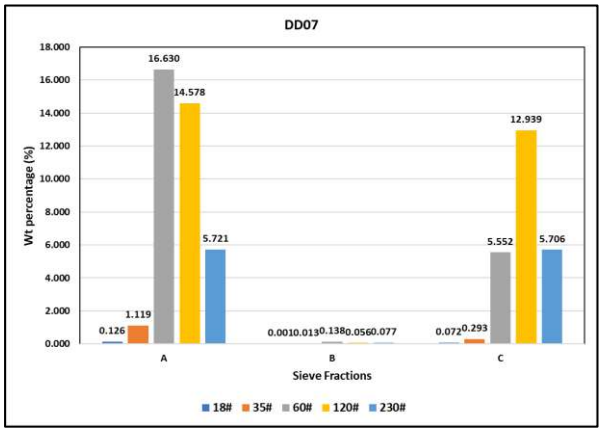


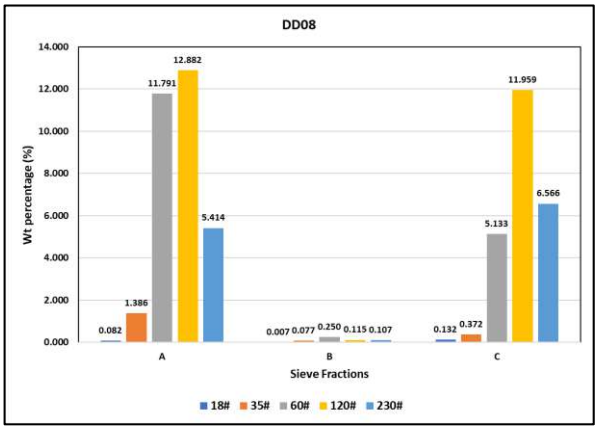


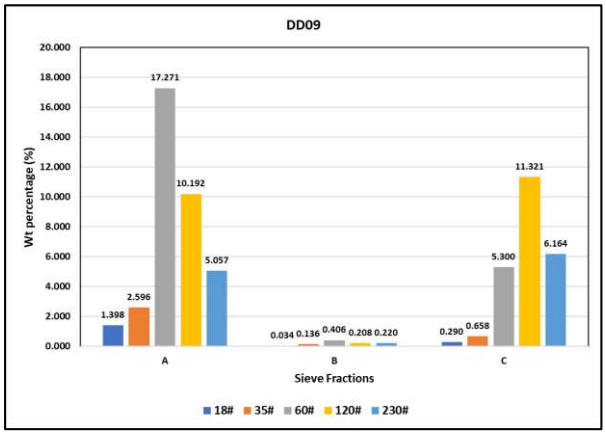


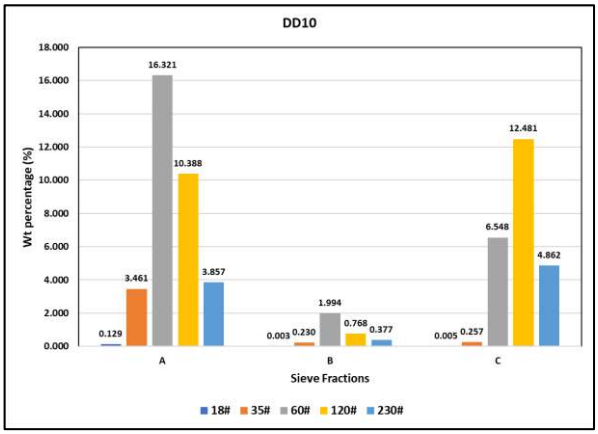


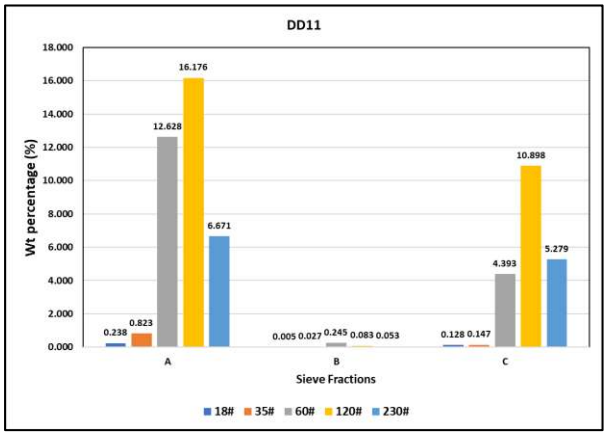


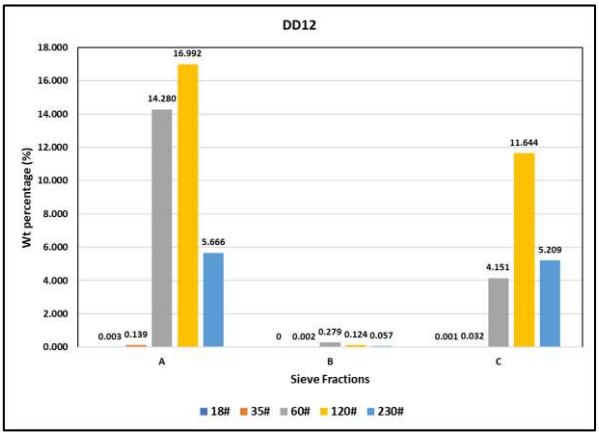

DD07
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.126
1.119
16.630
14.578
5.721
0.001
0.013
0.138
0.056
0.077
0.072
0.293
5.552
12.939
5.706

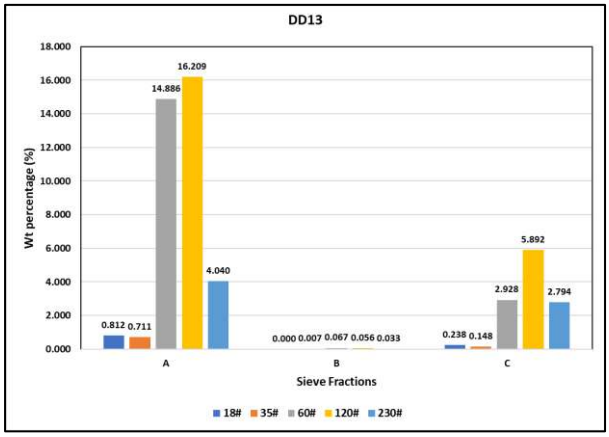

DD08
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.082
1.386
11.791
12.882
5.414
0.007
0.077
0.250
0.115
0.107
0.132
0.372
5.133
11.959
6.566

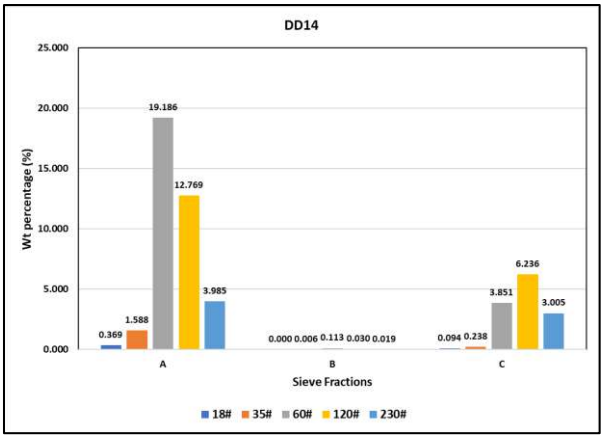

DD09
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
1.398
2.596
17.271
10.192
5.057
0.034
0.136
0.406
0.208
0.220
0.290
0.658
5.300
11.321
6.164

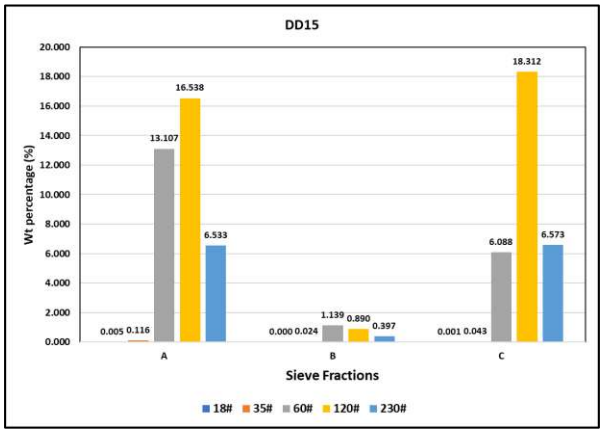

DD10
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.129
3.461
16.321
10.388
3.857
0.003
0.230
1.994
0.768
0.377
0.005
0.257
6.548
12.481
4.862

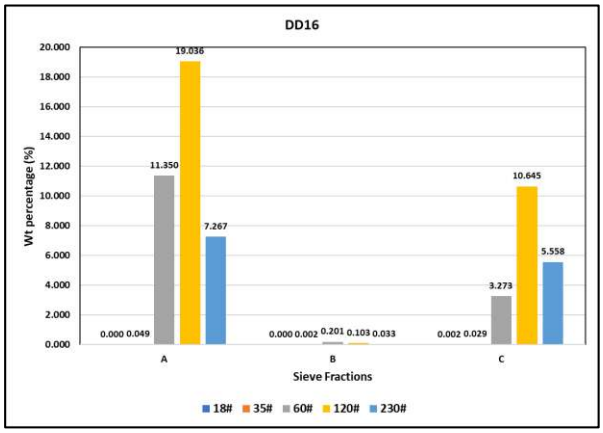

DD11
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.238
0.823
12.628
16.176
6.671
0.005
0.027
0.245
0.083
0.053
0.128
0.147
4.393
10.898
5.279

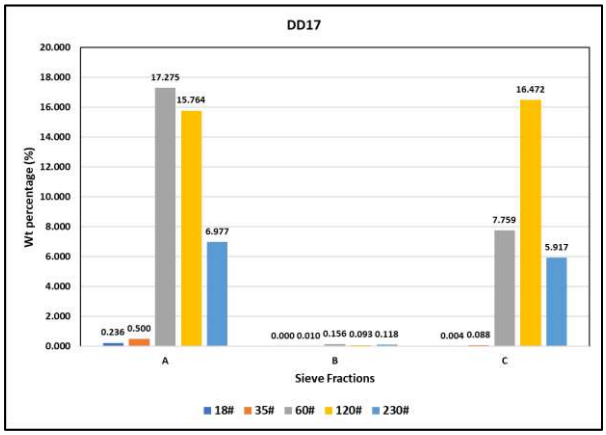

DD12
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.003
0.139
14.280
16.992
5.666
0
0.002
0.279
0.124
0.057
0.001
0.032
4.151
11.644
5.209

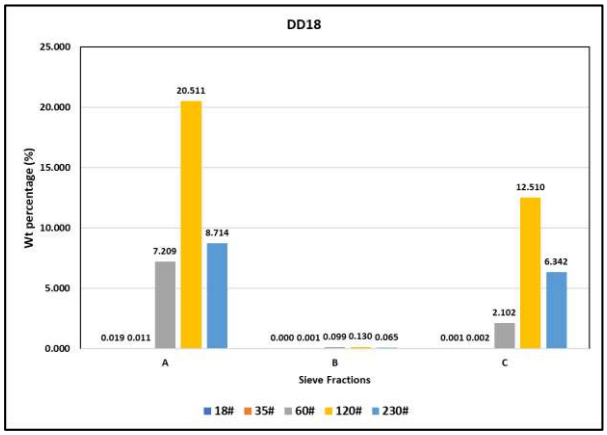

DD13
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.812
0.711
14.886
16.209
4.040
0.000
0.007
0.067
0.056
0.033
0.238
0.148
2.928
5.892
2.794

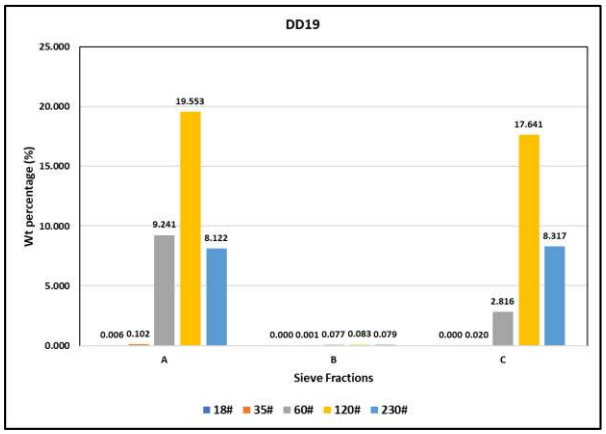

DD14
Wt percentage (%)
Sieve Fractions
A
B
C
18#
35#
60#
120#
230#
0.369
1.588
19.186
12.769
3.985
0.000
0.006
0.113
0.030
0.019
0.094
0.238
3.851
6.236
3.005

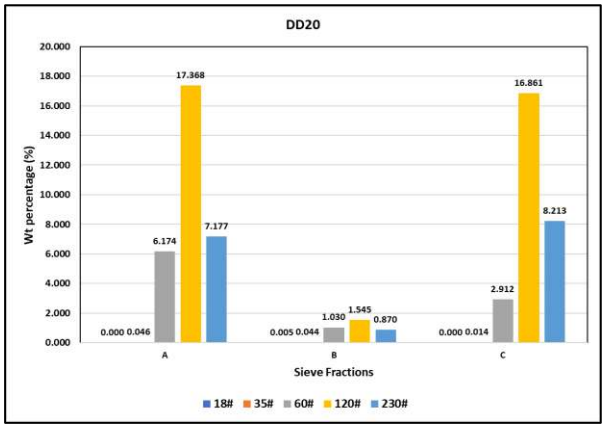

DD15
Wt percentage (%)
Sieve Fractions
A
B
C
0.005 0.116
13.107
16.538
6.533
0.000 0.024
1.139
0.890
0.397
0.001 0.043
6.088
18.312
6.573
18# 35# 60# 120# 230#

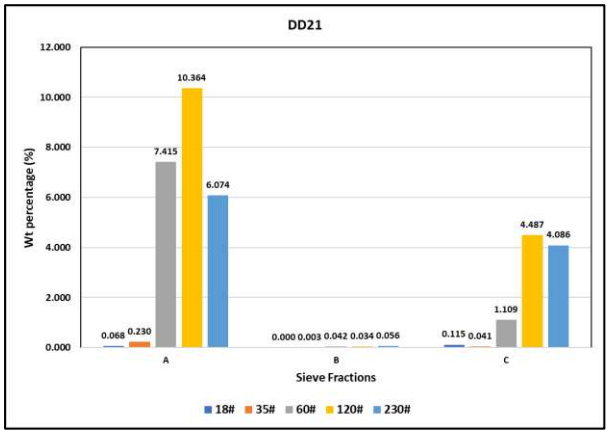

DD16
Wt percentage (%)
Sieve Fractions
A
B
C
0.000 0.049
11.350
19.036
7.267
0.000 0.002
0.201
0.103
0.033
0.002 0.029
3.273
10.645
5.558
18# 35# 60# 120# 230#

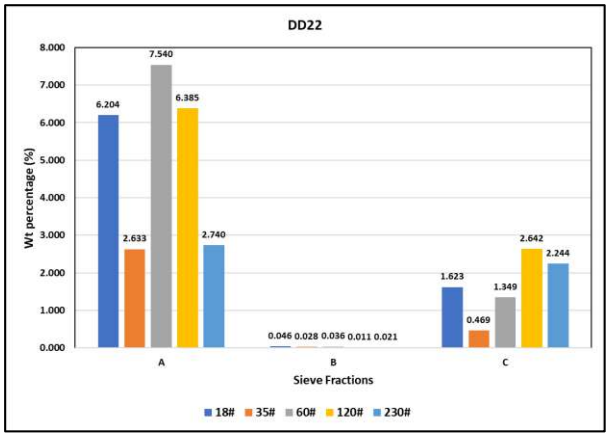

DD17
Wt percentage (%)
Sieve Fractions
A
B
C
0.236 0.500
17.275
15.764
6.977
0.000 0.010
0.156
0.093
0.118
0.004 0.088
7.759
16.472
5.917
18# 35# 60# 120# 230#

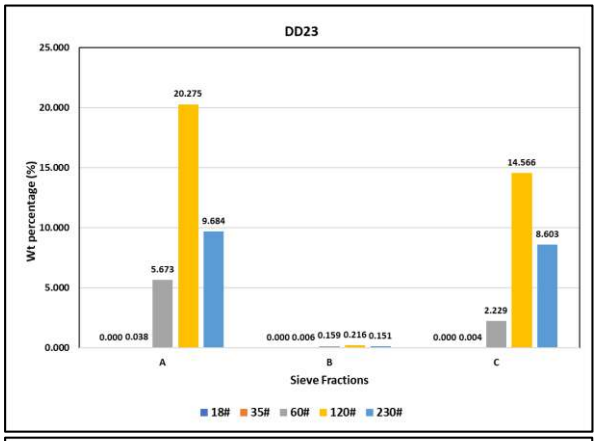

DD18
Wt percentage (%)
Sieve Fractions
A
B
C
0.019 0.011
7.209
20.511
8.714
0.000 0.001
0.099
0.130
0.065
0.001 0.002
2.102
12.510
6.342
18# 35# 60# 120# 230#

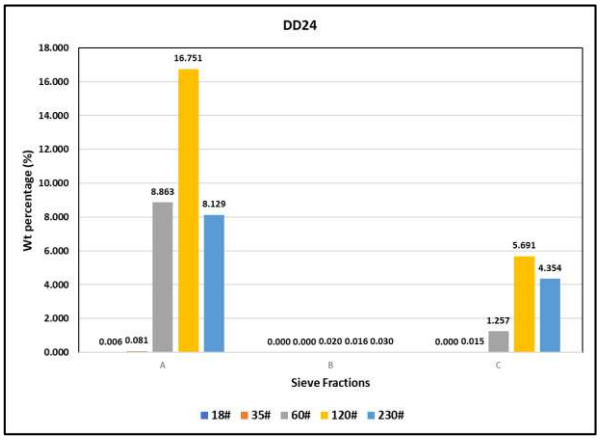

DD19
Wt percentage (%)
Sieve Fractions
A
B
C
0.006 0.102
9.241
19.553
8.122
0.000 0.001
0.077
0.083
0.079
0.000 0.020
2.816
17.641
8.317
18# 35# 60# 120# 230#

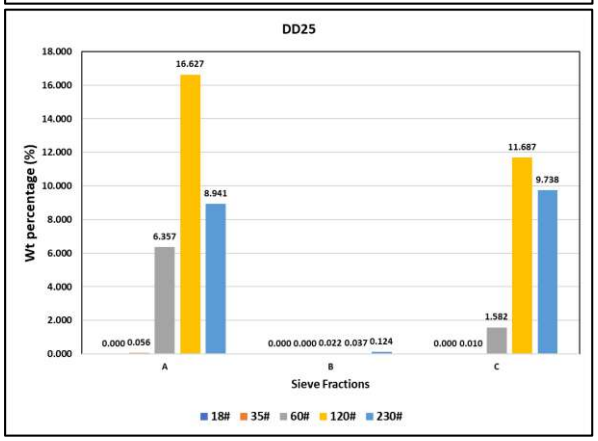

DD20
Wt percentage (%)
Sieve Fractions
A
B
C
0.000 0.046
6.174
17.368
7.177
0.005 0.044
1.030
1.545
0.870
0.000 0.014
2.912
16.861
8.213
18# 35# 60# 120# 230#

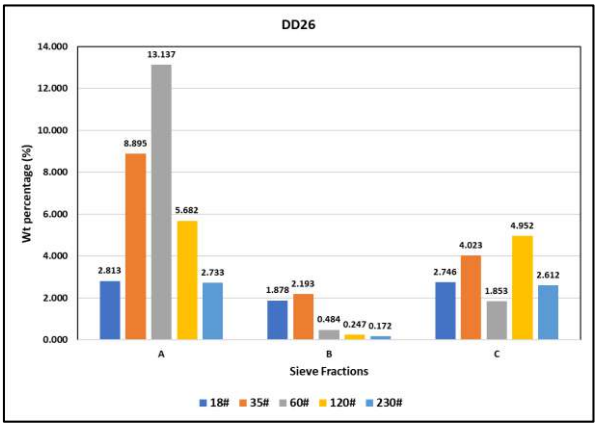

DD21
Wt percentage (%)
Sieve Fractions
A
B
C
0.068 0.230
7.415
10.364
6.074
0.000 0.003
0.042
0.034
0.056
0.115 0.041
1.109
4.487
4.086
18# 35# 60# 120# 230#

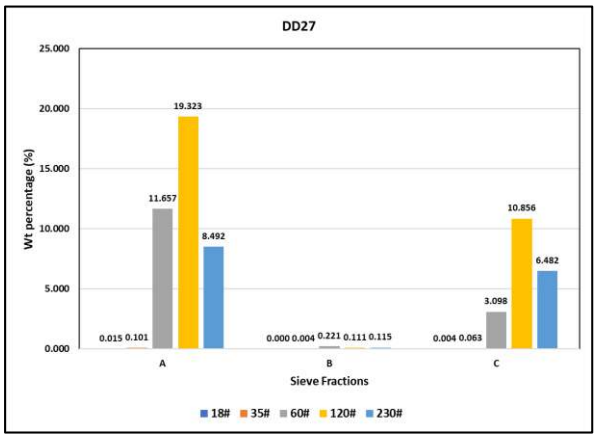

DD22
Wt percentage (%)
Sieve Fractions
A
B
C
6.204
2.633
7.540
6.385
2.740
0.046 0.028 0.036 0.011 0.021
1.623
0.469
1.349
2.642
2.244
18# 35# 60# 120# 230#

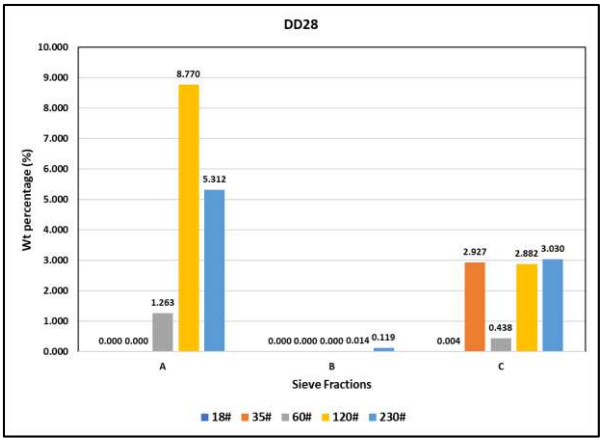

DD23
Wt percentage (%)
25.000
20.000
15.000
10.000
5.000
0.000
0.000 0.038
5.673
20.275
9.684
0.000 0.006 0.159 0.216 0.151
0.000 0.004
2.229
14.566
8.603
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#

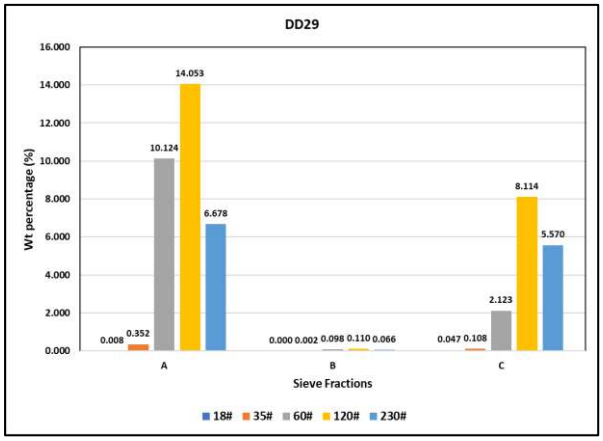

DD24
Wt percentage (%)
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
0.006 0.081
8.863
16.751
8.129
0.000 0.000 0.020 0.016 0.030
0.000 0.015
1.257
5.691
4.354
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#

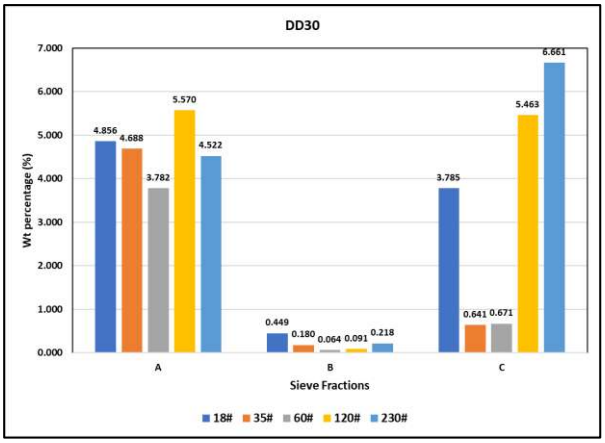

DD25
Wt percentage (%)
18.000
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
0.000 0.056
6.357
16.627
8.941
0.000 0.000 0.022 0.037 0.124
0.000 0.010
1.582
11.687
9.738
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#


DD26
Wt percentage (%)
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
2.813
8.895
13.137
5.682
2.733
1.878
2.193
0.484
0.247
0.172
2.746
4.023
1.853
4.952
2.612
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#


DD27
Wt percentage (%)
25.000
20.000
15.000
10.000
5.000
0.000
0.015 0.101
11.657
19.323
8.492
0.000 0.004 0.221 0.111 0.115
0.004 0.063
3.098
10.856
6.482
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#


DD28
Wt percentage (%)
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
0.000 0.000
1.263
8.770
5.312
0.000 0.000 0.000 0.014 0.119
0.004
2.927
0.438
2.882
3.030
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#


DD29
Wt percentage (%)
16.000
14.000
12.000
10.000
8.000
6.000
4.000
2.000
0.000
0.008
0.352
10.124
14.053
6.678
0.000 0.002 0.098 0.110 0.066
0.047 0.108
2.123
8.114
5.570
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#


DD30
Wt percentage (%)
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
4.856
4.688
3.782
5.570
4.522
0.449
0.180
0.064
0.091
0.218
3.785
0.641
0.671
5.463
6.661
A
B
C
Sieve Fractions
18# 35# 60# 120# 230#

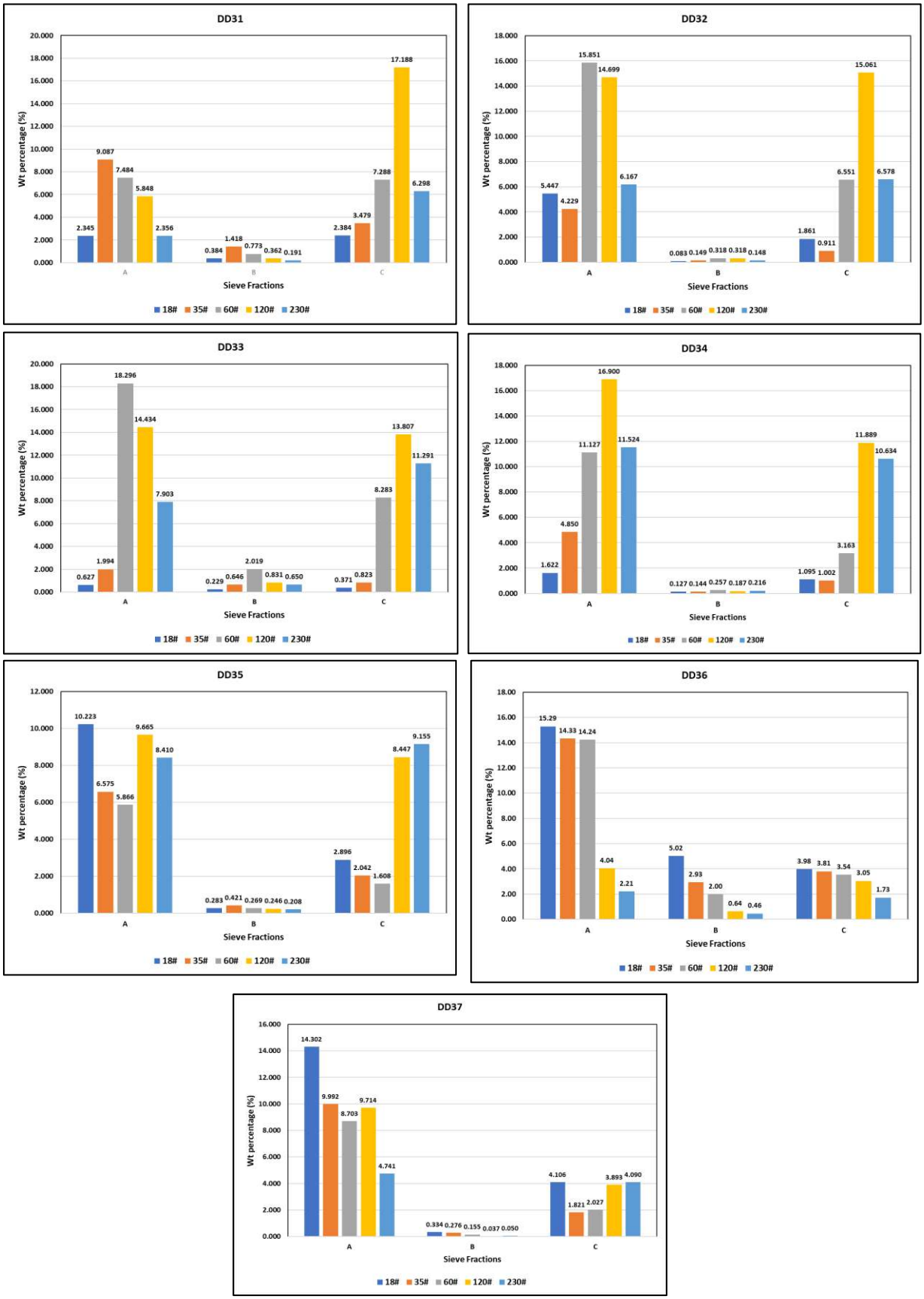


Figure 9.4: Average sieve data of magnetic fractions borehole wise

9.4 Sieve data of Magnetic fractions & Downcore variation of A230, B230 and C230 fractions (Ore).

Based on the sieving of the magnetic minerals; viz, A, B, C fractions, the weight percentages of sieve fractions are calculated to identify the heavy mineral concentration within the sieve sizes. The weight percentage of total ore body (A230+B230+C230) ranges between .89% (DD22/1-2) to 38.96% (DD33/4-5) with an average of 12.47% (Annexure 6).

A18# varies from 0% to 29.11%, A35# ranges between 0 to 24.59%, A60# varies from 0.26% to 33.88%, A120# varies from 0.44% to 25.22%, A230# varies from 0.30% to 18.77% with an average of 6.10 % and A (-230) varies from 0.04% to 5.6%.

B18# varies from 0% to 7.61%, B35# ranges between 0 to 5.53%, B60# varies from 0% to 5.21%, B120# varies from 0.001% to 1.94%, B230# varies from 0.002% to 1.83% with an average of 2.10% and B (-230#) varies from 0% to 2.14%.

C18# varies from 0% to 9.23%, C35# ranges between 0 to 6.01%, C60# varies from 0.076% to 16.06%, C120# varies from 0.29% to 35.73%, C230# varies from 0.24% to 27.76% with an average of 6.16% and C (-230#) varies from 0.063% to 8.59%.

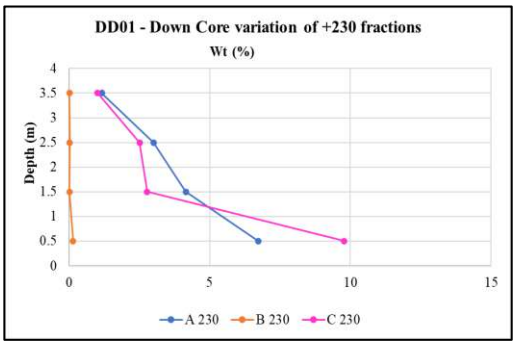
In Dandi-Onjal sector, wt% of A230# varies between .3% in DD22/1-2 to 16.31% in DD03/1-2, wt% of B230# varies between 0.002% (DD18/0-1) to 1.83% (DD20/3-4) and C230# varies between 0.59% (DD22/1-2) to 20.56% (DD03/0-1).

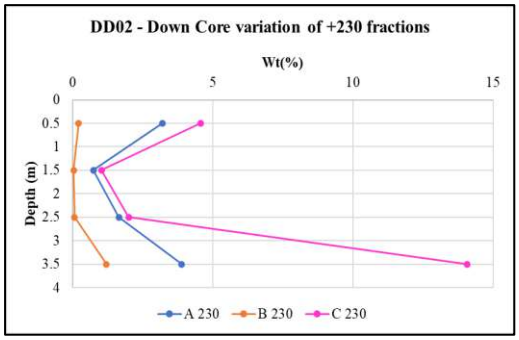
In Surwada sector, wt% of A230 varies between 1.10% in to 18.77% in DD35/0-1, wt% of B230 varies between 0.01% (DD32/1-2) to 1.67% (DD33/4-5), C230% varies between .24% (DD36/3-4) to 27.76% (DD33/4-5).

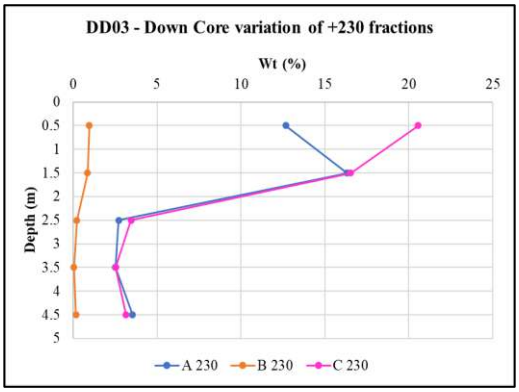
A230# and C230# is having a similar trend, whenever the A230 is increased, a similar trend is generally observed in C230. Along downcore, no profound trend is observed in the concentration of heavy mineral, at any depth highest or lowest heavy mineral concentration can be expected.

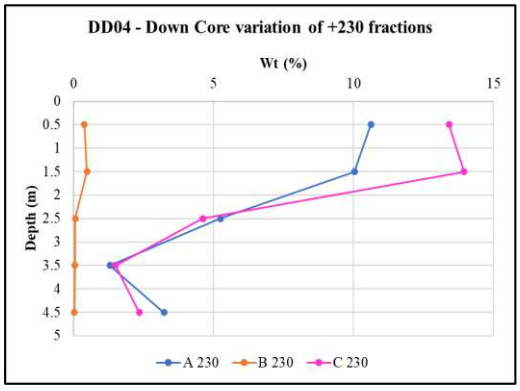
The sieving and chemical analysis of magnetic minerals (A, B, and C fractions) reveal that heavy mineral concentrations without minor presence of rock grains, particularly in the +230# sieve fraction, vary significantly across different samples. The weight percentages of A230#, B230#, and C230# range from minimal values (as low as 0.002%) to high concentrations (up to 27.76%), with the combined total ore body averaging 12.47%. In the Dandi-Onjal sector, A230# is peaking at 16.31% and C230# at 20.56% where as in the

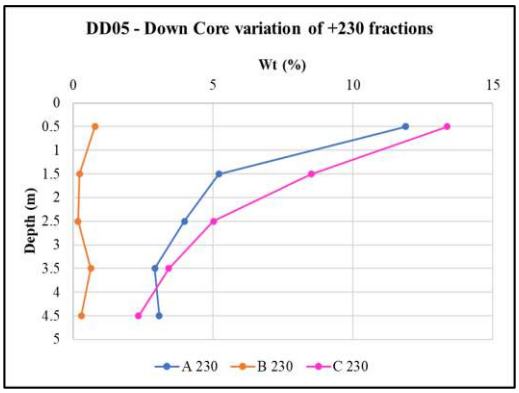
Surwada sector C230#, is reaching up to 27.76%. A consistent trend is observed in A230# and C 230# whereas there is an incline or decline in any of the component, it is often mirrored by similar rise or depression in another component. However, no depth-related downcore patterns are observed.

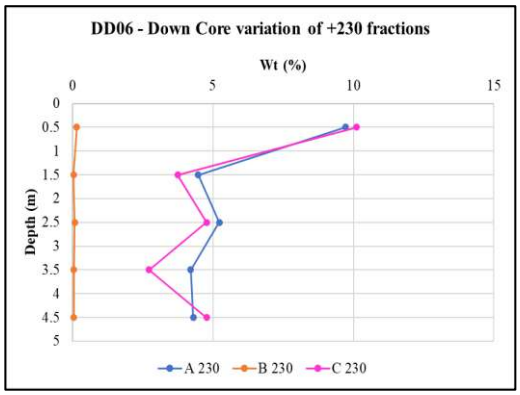


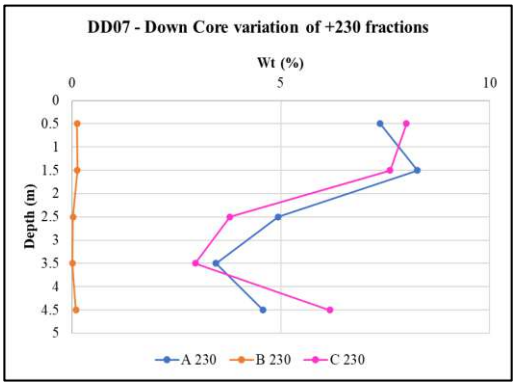


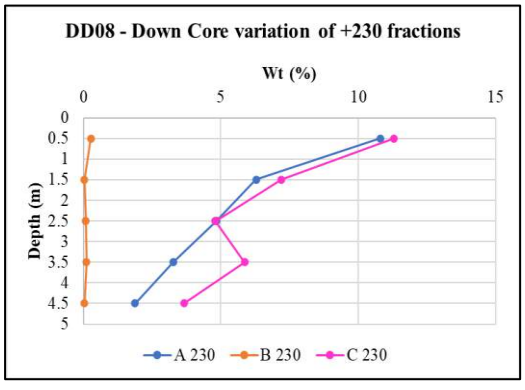


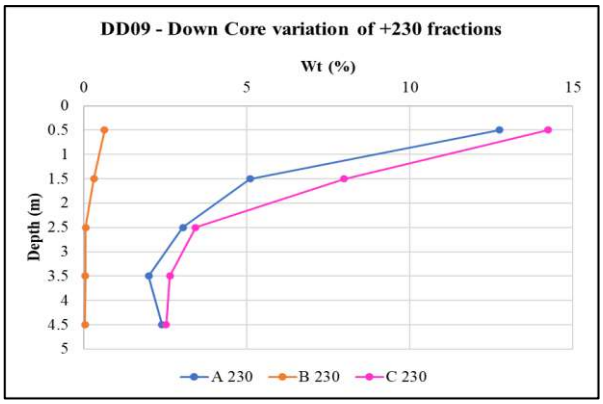


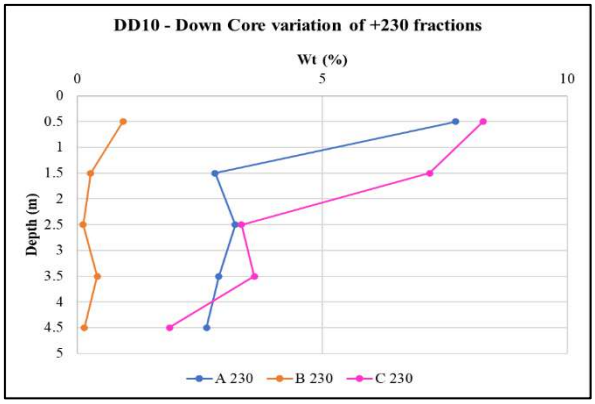


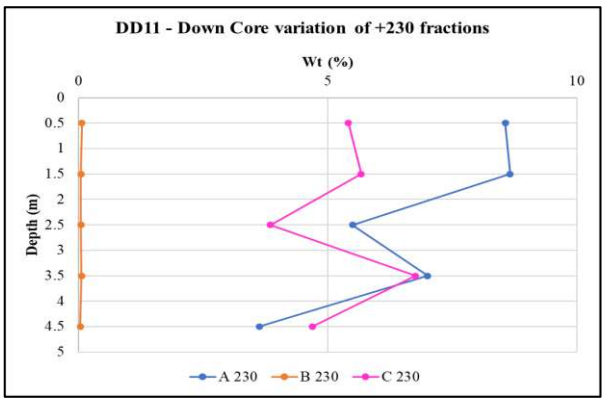


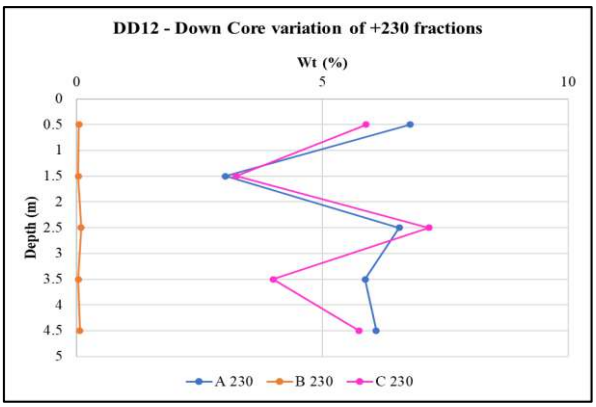


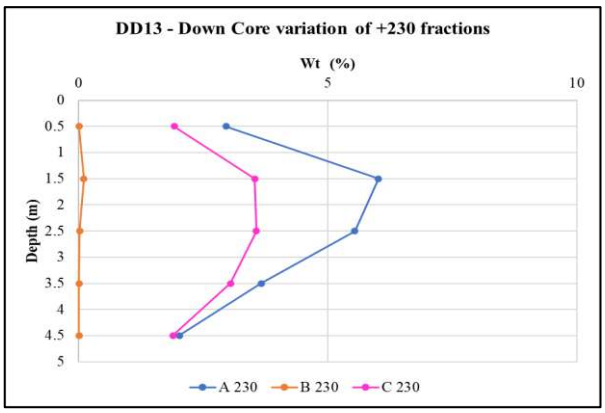


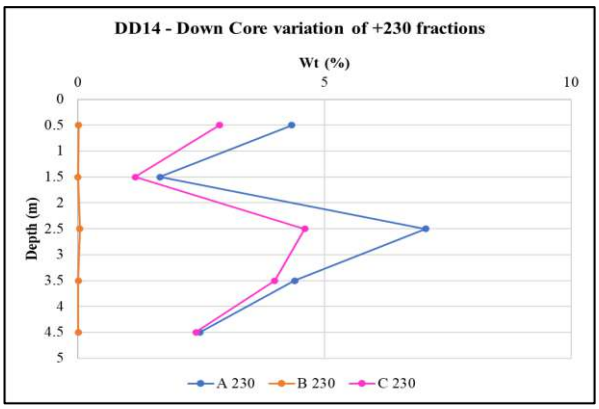

DD09 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

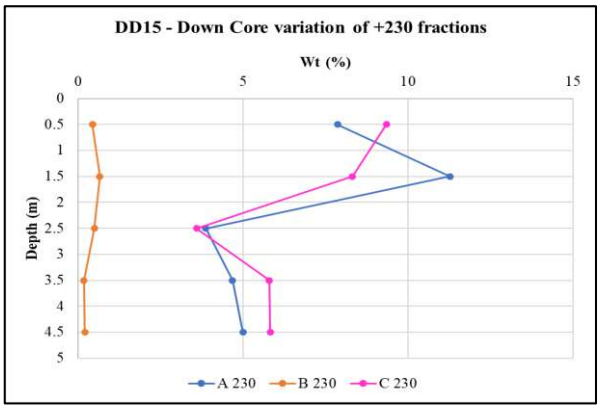

DD10 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

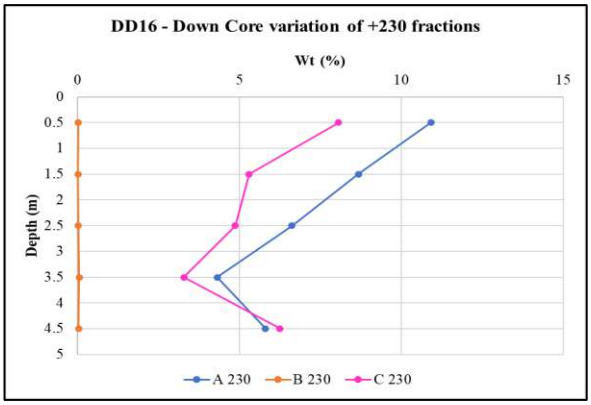

DD11 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

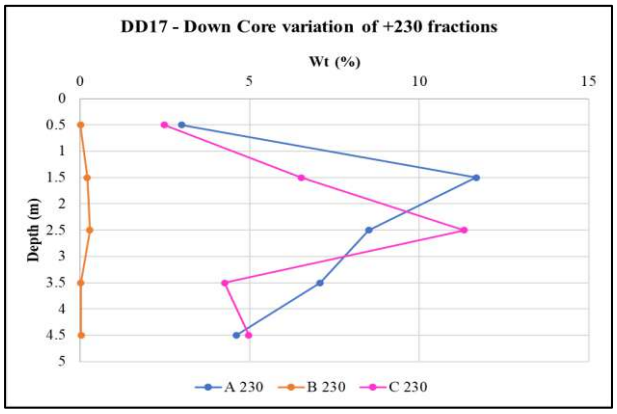

DD12 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

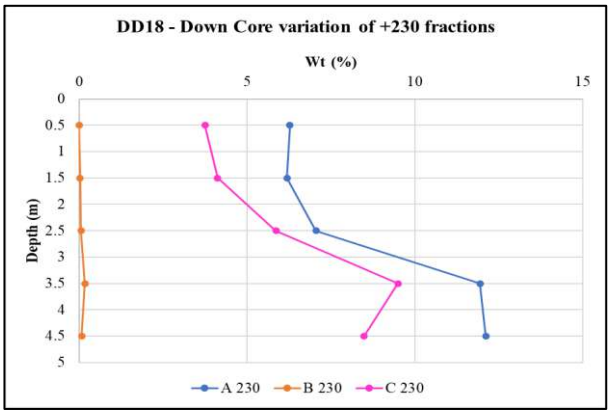

DD13 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

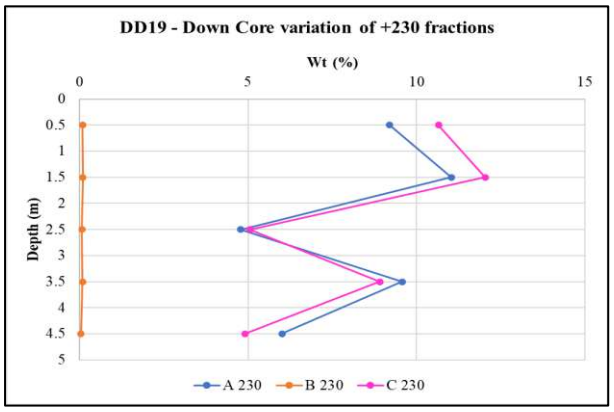

DD14 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

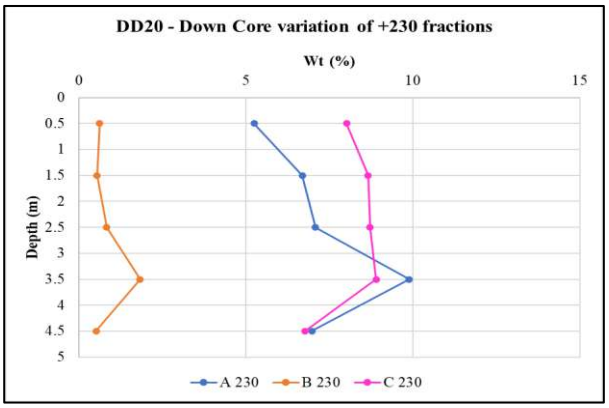

DD15 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

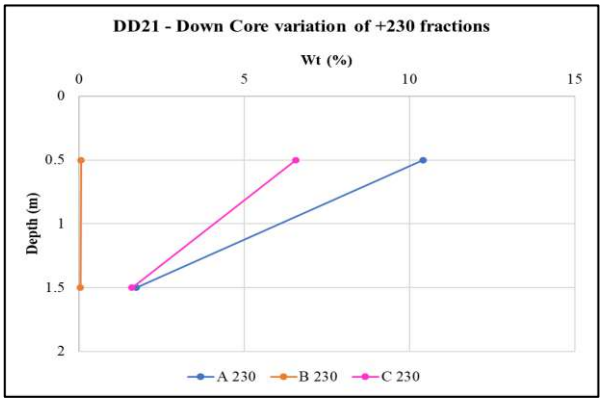

DD16 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

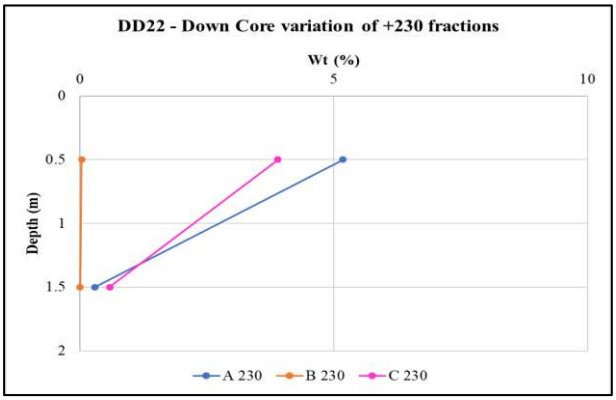

DD17 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

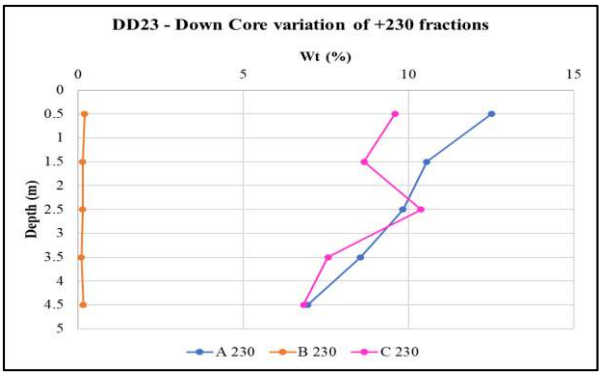

DD18 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

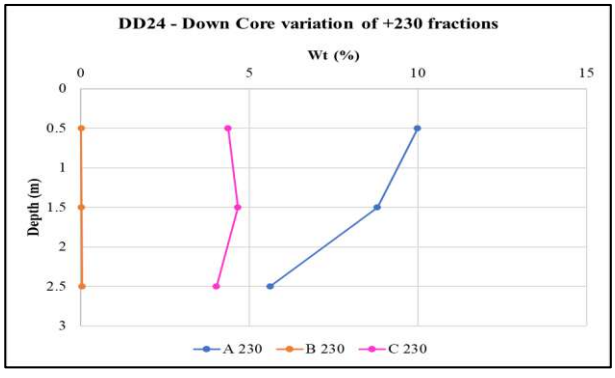

DD19 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

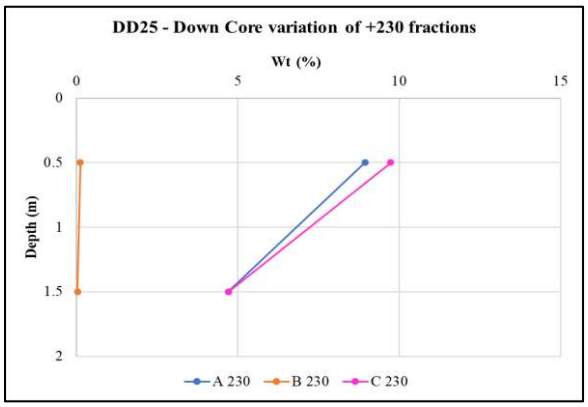

DD20 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

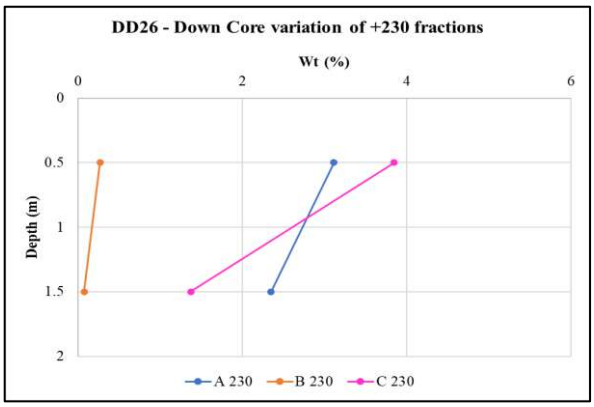

DD21 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

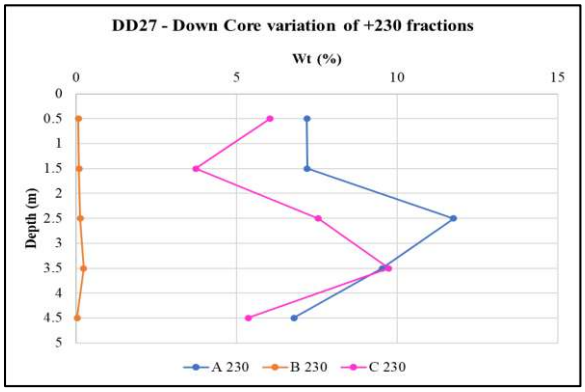

DD22 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

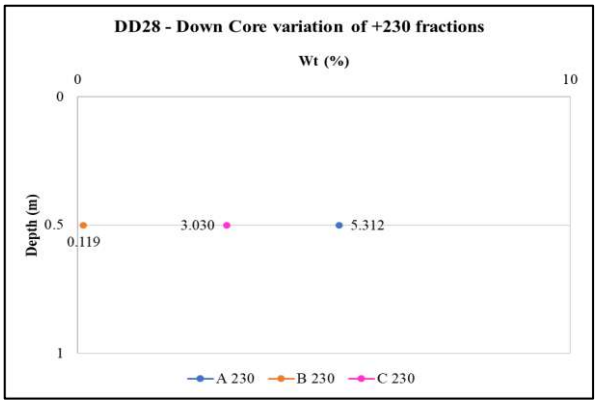

DD23 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

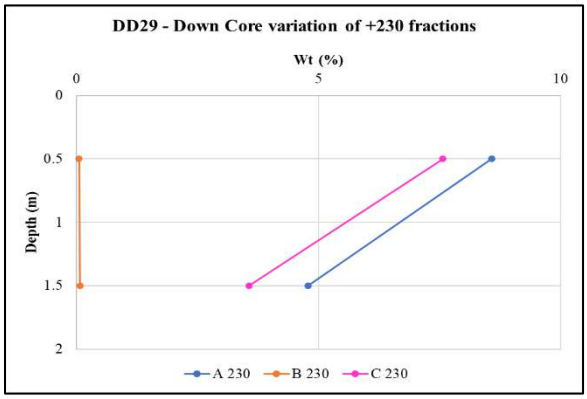

DD24 - Down Core variation of +230 fractions
Wt (%)
Depth (m)
A 230
B 230
C 230

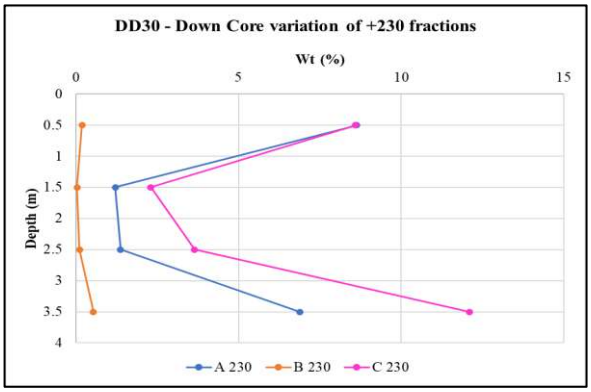

DD25 - Down Core variation of +230 fractions
Wt (%)
0
5
10
15
Depth (m)
0
0.5
1
1.5
2
A 230
B 230
C 230

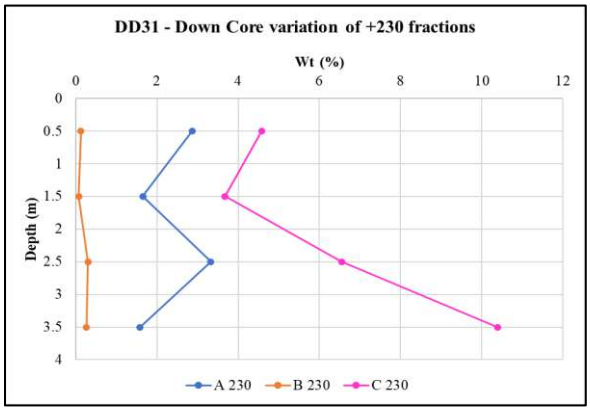

DD26 - Down Core variation of +230 fractions
Wt (%)
0
2
4
6
Depth (m)
0
0.5
1
1.5
2
A 230
B 230
C 230

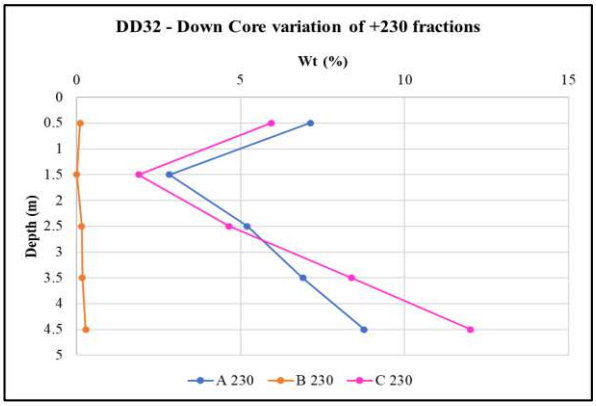

DD27 - Down Core variation of +230 fractions
Wt (%)
0
5
10
15
Depth (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
A 230
B 230
C 230

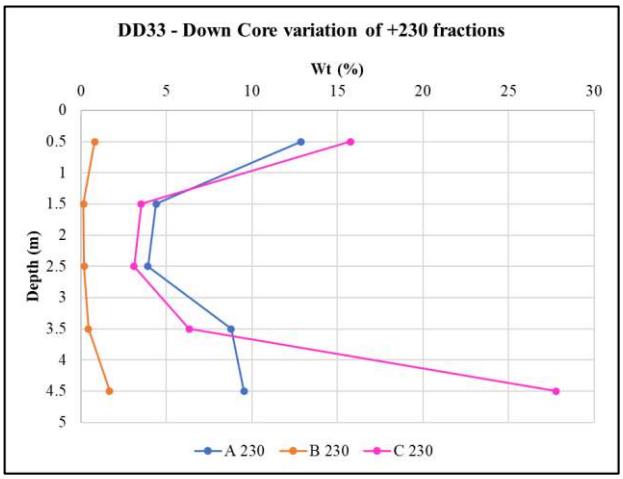

DD28 - Down Core variation of +230 fractions
Wt (%)
0
10
Depth (m)
0
0.5
1
0.119
3.030
5.312
A 230
B 230
C 230

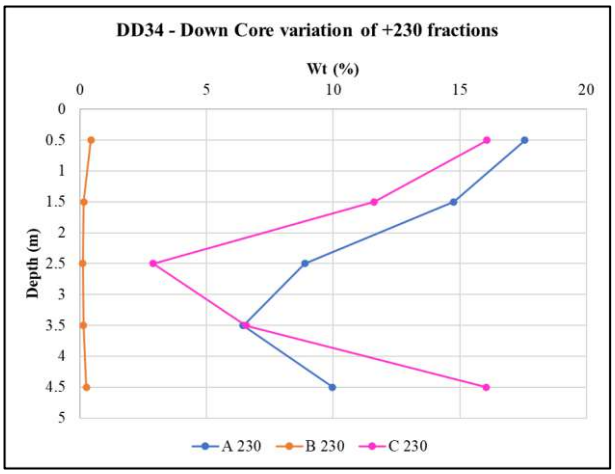

DD29 - Down Core variation of +230 fractions
Wt (%)
0
5
10
Depth (m)
0
0.5
1
1.5
2
A 230
B 230
C 230

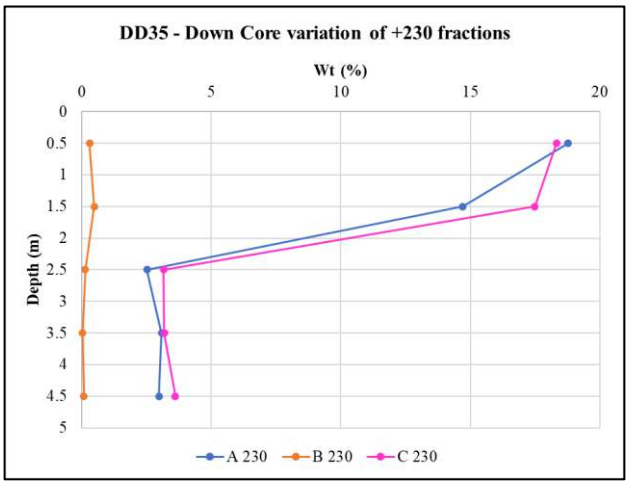

DD30 - Down Core variation of +230 fractions
Wt (%)
0
5
10
15
Depth (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
A 230
B 230
C 230

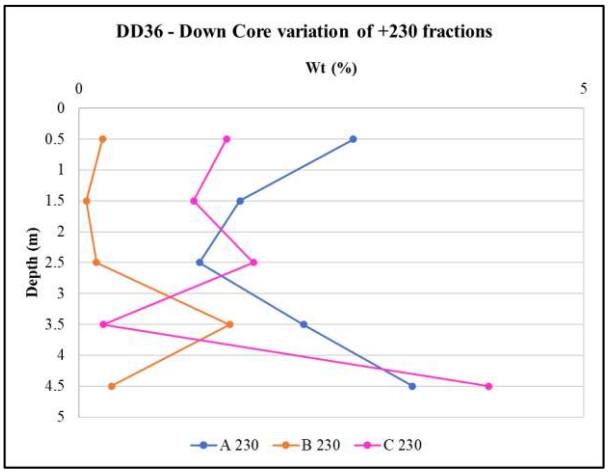

DD31 - Down Core variation of +230 fractions
Wt (%)
0
2
4
6
8
10
12
Depth (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
A 230
B 230
C 230


DD32 - Down Core variation of +230 fractions
Wt (%)
0
5
10
15
Depth (m)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
A 230
B 230
C 230









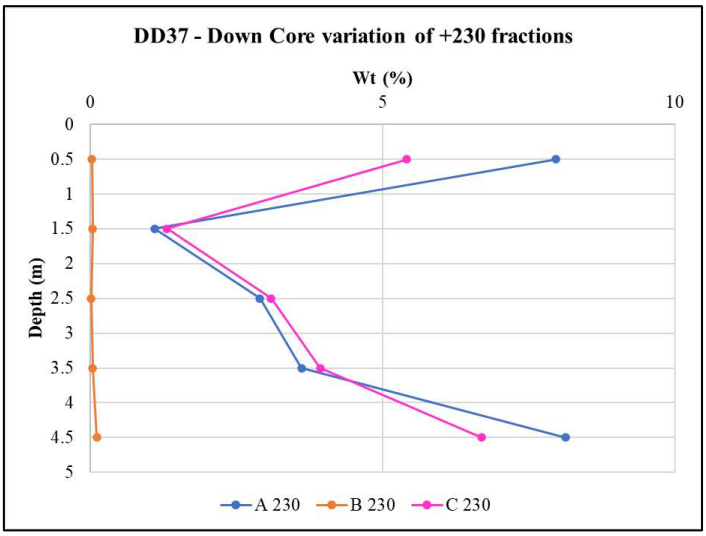


Figure 9.5: Downcore variation of A230#, B230# and C230# fractions

9.5 Granulometric studies

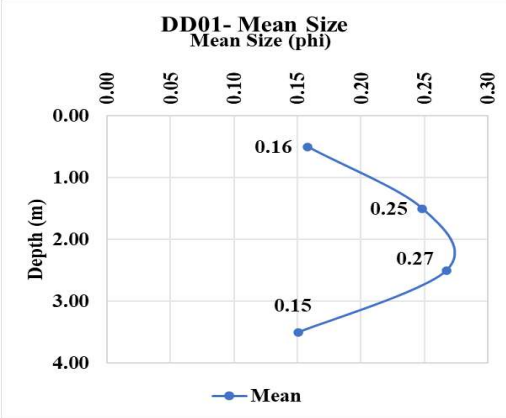
Grain size analysis helps to classify unconsolidated material and also provides a clue about the sediment transport and depositional conditions. The sediments in the study area are along the dune face and consists mainly of sand, whereas gravels and clay are noticed at a deeper depth. The entire area is divided in to two sectors, namely Dandi-Onjal and Surwada sector. The southern extremity of the Dandi-Onjal sector and the Surwada sector constitutes gravelly to slightly gravelly sand. Along the southernmost extremity of the Dandi-Onjal area, the bottom layers have thick layer of clay sediments.

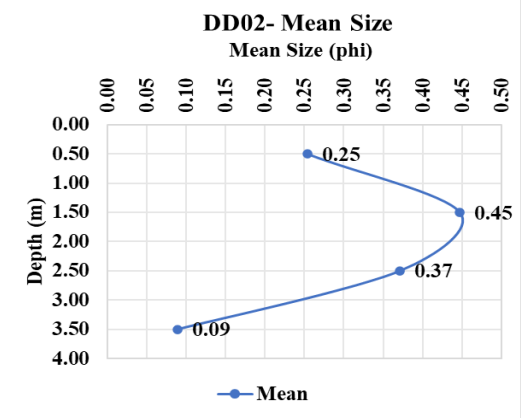
Granulometric study of all 160 samples from 37 borehole location reveals that the sediment does not exhibit a uniformity in the distribution. The sand is medium to fine and range in size between 0.07Φ and 1.27Φ. Skewness ranges from -0.68 to 0.75 and sediments are coarsely skewed, symmetrical skewed to finely skewed. Kurtosis values range between 0.59 and 2.96 and typically have a leptokurtic, mesokurtic to platykurtic distribution. The medium to fine sand sediments are moderately well sorted to poorly-sorted, coarsely to finely skewed and platykurtic to leptokurtic in nature (Annexure 5).

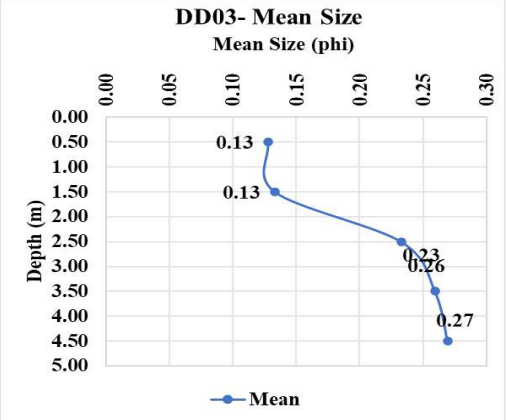
Heavy minerals especially TTM (titanomagnetite) and ilmenite are generally enriched in fine sand (+120#), very fine sand (+230#) and silt sized grains (-230#) of dune sediments. Heavy minerals are not generally observed higher quantity in the coarser fractions i.e.; medium to very coarse sand.

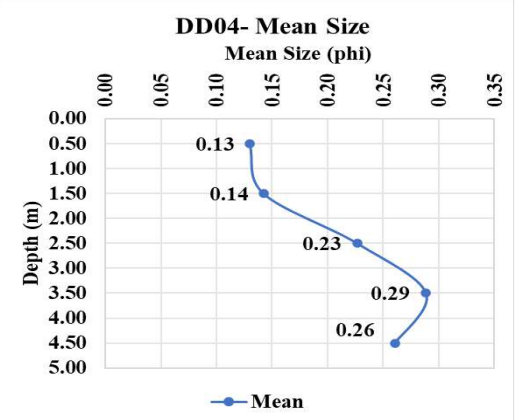
The proportion of very fine sand is comparatively more among the sediments. Fine sand (-60 to +120 mesh) dominates generally in this coastal stretch followed by very fine sand (-120 to +230 mesh) and medium sand (-35 to +60 mesh). Black sand was identified mainly in fine sand and very fine sand fractions.

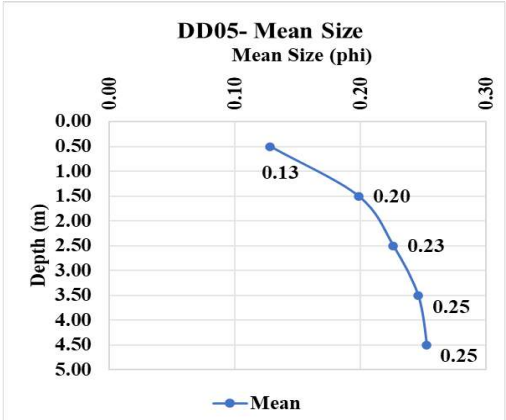
The dune sands of Dandi-Onjal sector exhibit a trend of very fine, fine to medium fine sand whereas Surwada sector is characterized by fine to medium gravelly sand. Generally, the degree of sorting decreases towards the depth in both sectors. As per Folk classification, the sediment type in the Dandi-Onjal-Surwada block area falls in sand (s), gravelly sand (gS), slightly gravelly sand ((g)S), silty sand (siS), sandy silt (sSI) and sandy gravel (sG).

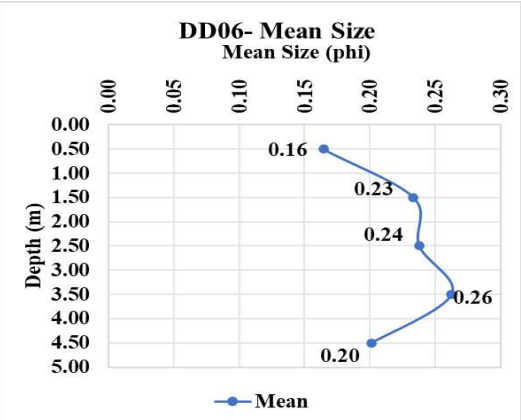

DD01- Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25 0.30
Depth (m)
0.00 1.00 2.00 3.00 4.00
0.16
0.25
0.27
0.15
Mean

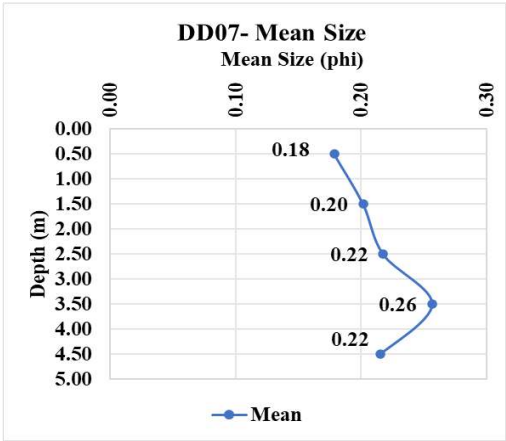

DD02- Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00
0.25
0.45
0.37
0.09
Mean

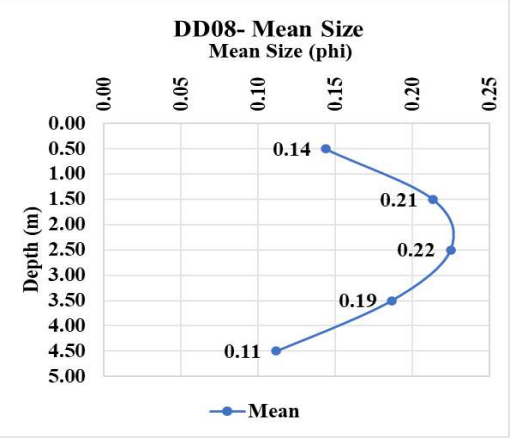

DD03- Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25 0.30
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
0.13
0.13
0.23
0.26
0.27
Mean

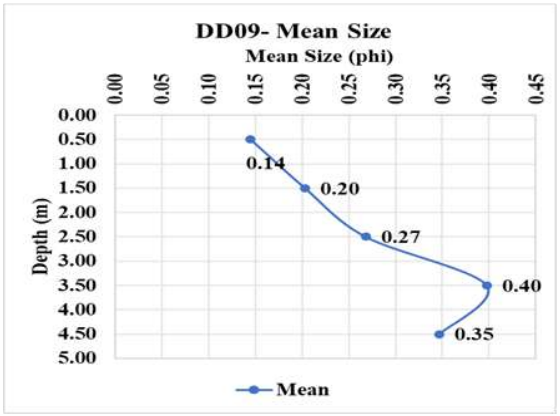

DD04- Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25 0.30 0.35
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
0.13
0.14
0.23
0.29
0.26
Mean

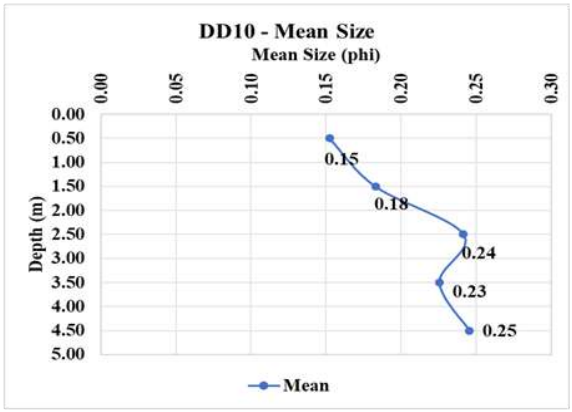

DD05- Mean Size
Mean Size (phi)
0.00 0.10 0.20 0.30
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
0.13
0.20
0.23
0.25
0.25
Mean

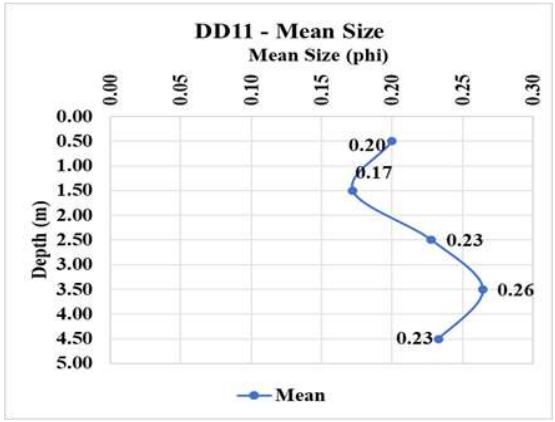

DD06- Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25 0.30
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
0.16
0.23
0.24
0.26
0.20
Mean

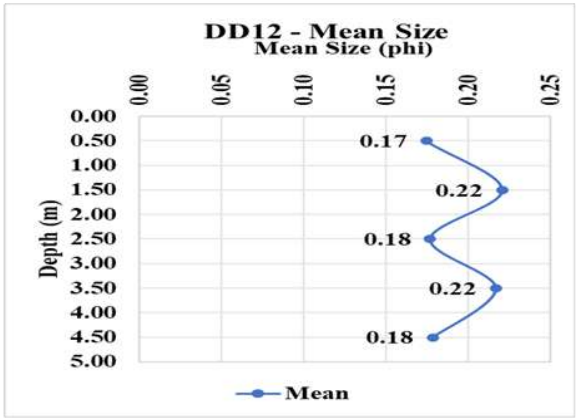

DD07- Mean Size
Mean Size (phi)
0.00 0.10 0.20 0.30
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
0.18
0.20
0.22
0.26
0.22
Mean

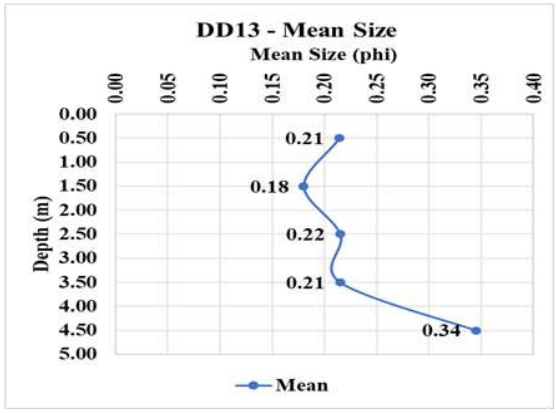

DD08- Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25
Depth (m)
0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 4.00 4.50 5.00
0.14
0.21
0.22
0.19
0.11
Mean

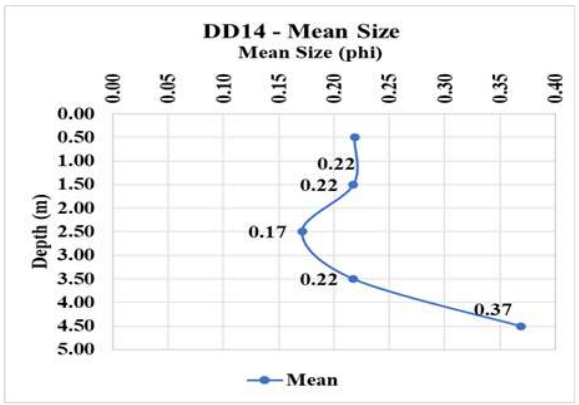

DD09- Mean Size
Mean Size (phi)
Depth (m)
0.14
0.20
0.27
0.40
0.35
Mean

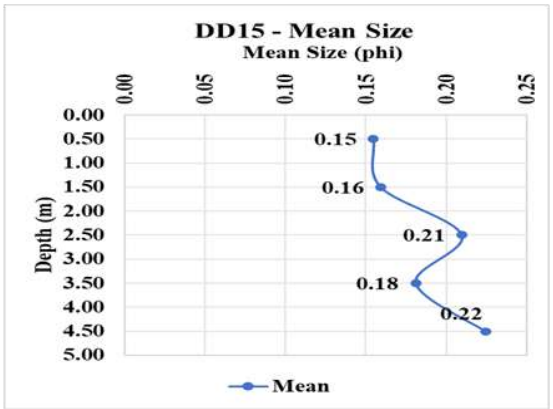

DD10 - Mean Size
Mean Size (phi)
Depth (m)
0.15
0.18
0.24
0.23
0.25
Mean

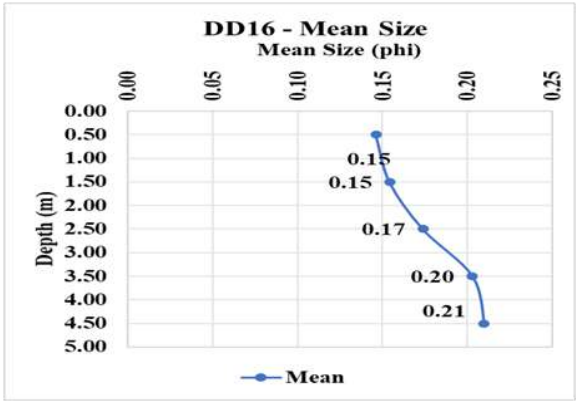

DD11 - Mean Size
Mean Size (phi)
Depth (m)
0.20
0.17
0.23
0.26
0.23
Mean

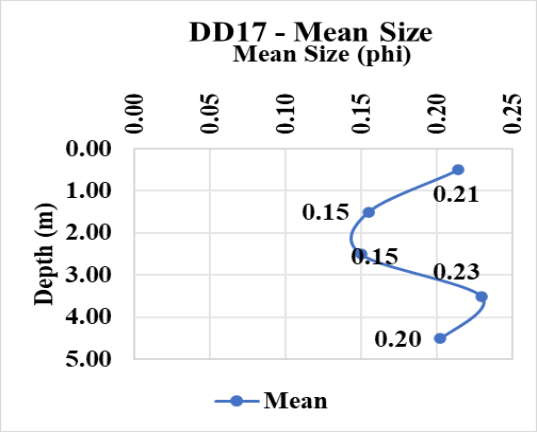

DD12 - Mean Size
Mean Size (phi)
Depth (m)
0.17
0.22
0.18
0.22
0.18
Mean

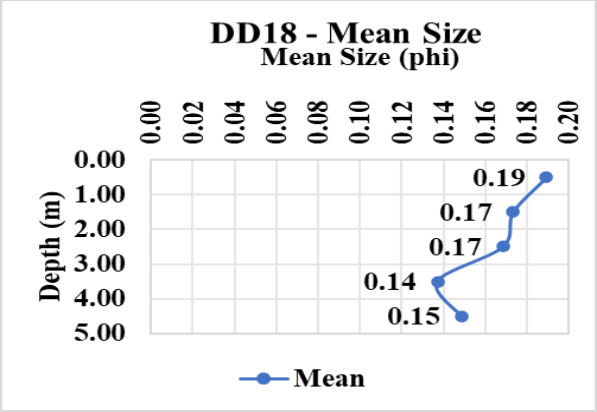

DD13 - Mean Size
Mean Size (phi)
Depth (m)
0.21
0.18
0.22
0.21
0.34
Mean

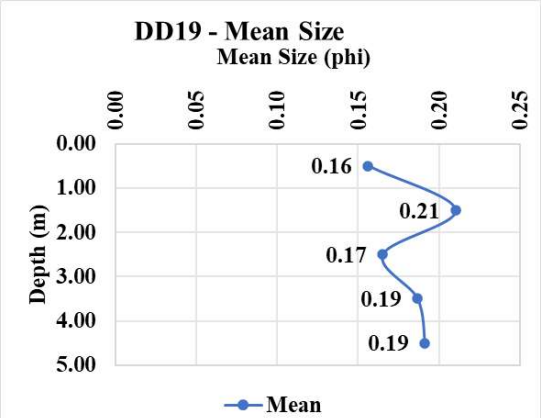

DD14 - Mean Size
Mean Size (phi)
Depth (m)
0.22
0.22
0.17
0.22
0.37
Mean

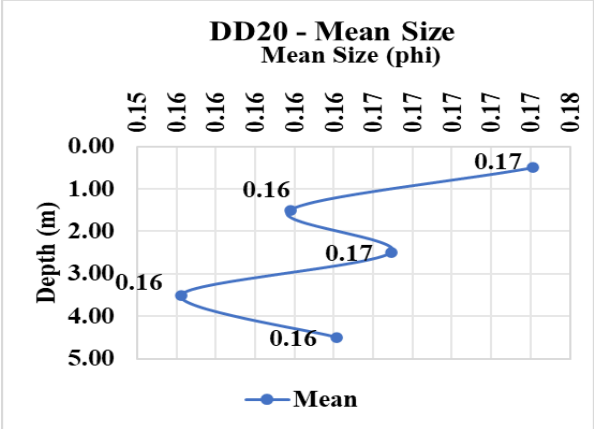

DD15 - Mean Size
Mean Size (phi)
Depth (m)
0.15
0.16
0.21
0.18
0.22
Mean

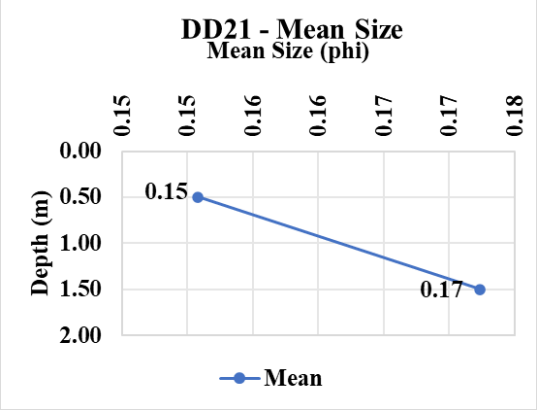

DD16 - Mean Size
Mean Size (phi)
Depth (m)
0.15
0.15
0.17
0.20
0.21
Mean

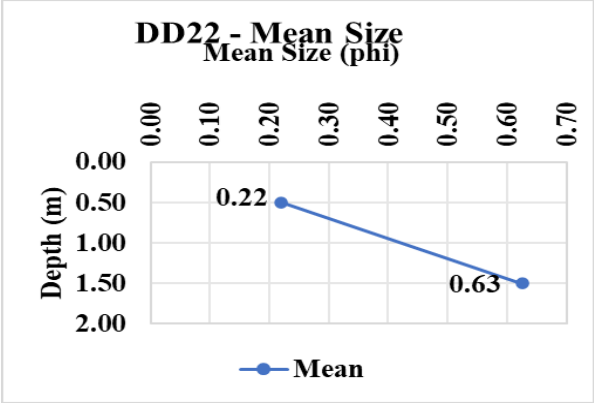

DD17 - Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25
Depth (m)
0.00 1.00 2.00 3.00 4.00 5.00
0.15 0.21 0.15 0.23 0.20
Mean

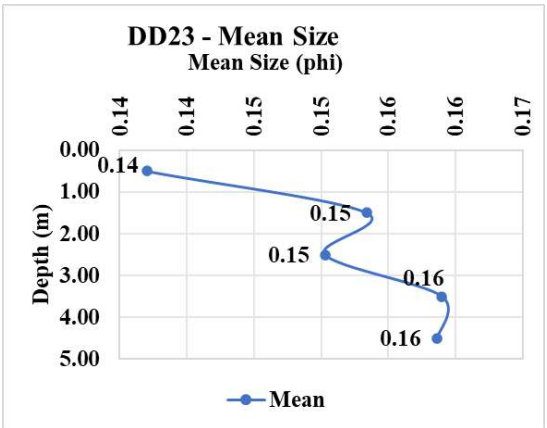

DD18 - Mean Size
Mean Size (phi)
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20
Depth (m)
0.00 1.00 2.00 3.00 4.00 5.00
0.19 0.17 0.17 0.14 0.15
Mean

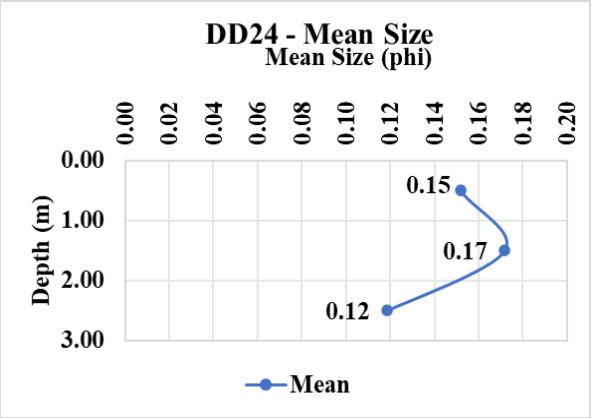

DD19 - Mean Size
Mean Size (phi)
0.00 0.05 0.10 0.15 0.20 0.25
Depth (m)
0.00 1.00 2.00 3.00 4.00 5.00
0.16 0.21 0.17 0.19 0.19
Mean

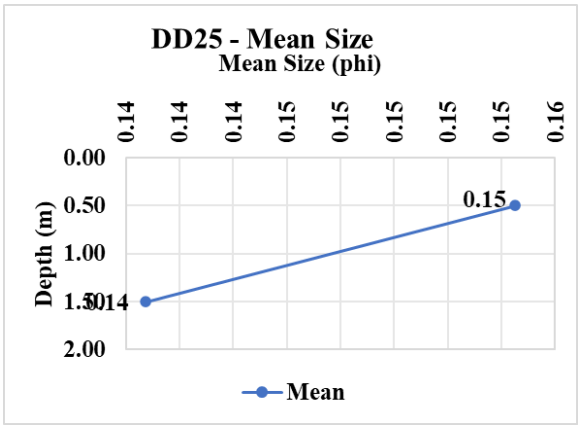

DD20 - Mean Size
Mean Size (phi)
0.15 0.16 0.16 0.16 0.16 0.16 0.17 0.17 0.17 0.17 0.17 0.18
Depth (m)
0.00 1.00 2.00 3.00 4.00 5.00
0.17 0.16 0.17 0.16 0.16
Mean

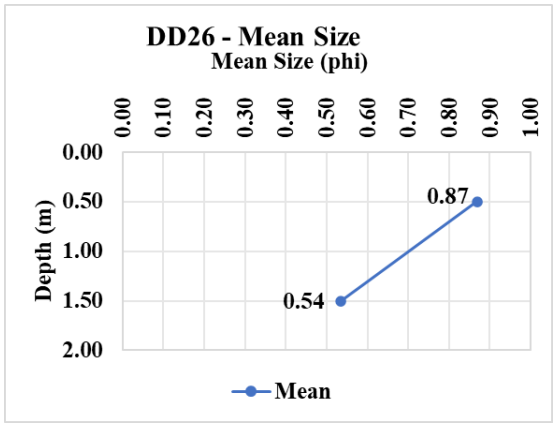

DD21 - Mean Size
Mean Size (phi)
0.15 0.15 0.16 0.16 0.17 0.17 0.18
Depth (m)
0.00 0.50 1.00 1.50 2.00
0.15 0.17
Mean

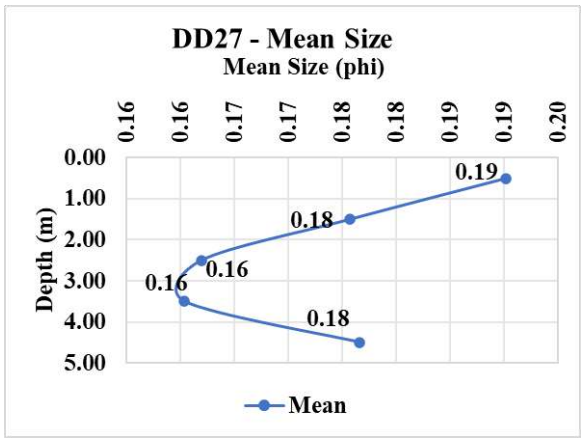

DD22 - Mean Size
Mean Size (phi)
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70
Depth (m)
0.00 0.50 1.00 1.50 2.00
0.22 0.63
Mean


DD23 - Mean Size
Mean Size (phi)
0.14 0.14 0.15 0.15 0.16 0.16 0.17
Depth (m)
0.00 1.00 2.00 3.00 4.00 5.00
0.14 0.15 0.15 0.16 0.16
Mean


DD24 - Mean Size
Mean Size (phi)
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14 0.16 0.18 0.20
Depth (m)
0.00 1.00 2.00 3.00
0.15 0.17 0.12
Mean


DD25 - Mean Size
Mean Size (phi)
0.14 0.14 0.14 0.15 0.15 0.15 0.15 0.15 0.16
0.00
0.50
1.00
1.50
2.00
Depth (m)
0.15
0.14
Mean


DD26 - Mean Size
Mean Size (phi)
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00
0.00
0.50
1.00
1.50
2.00
Depth (m)
0.87
0.54
Mean


DD27 - Mean Size
Mean Size (phi)
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0.00
1.00
2.00
3.00
4.00
5.00
Depth (m)
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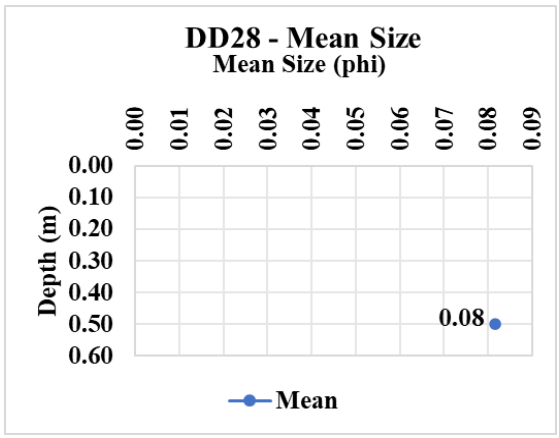
0.18
0.16
0.16
0.18
Mean


DD28 - Mean Size
Mean Size (phi)
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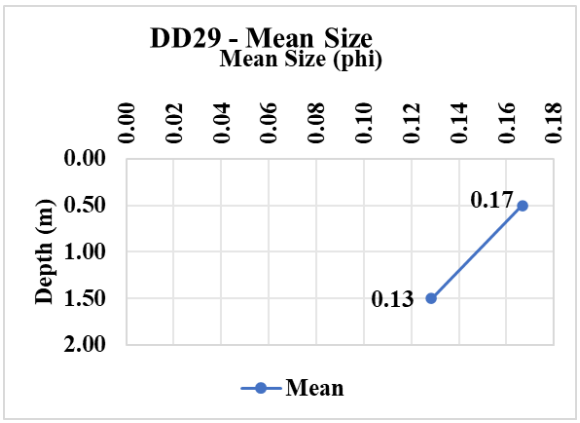
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Depth (m)
0.08
Mean


DD29 - Mean Size
Mean Size (phi)
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0.50
1.00
1.50
2.00
Depth (m)
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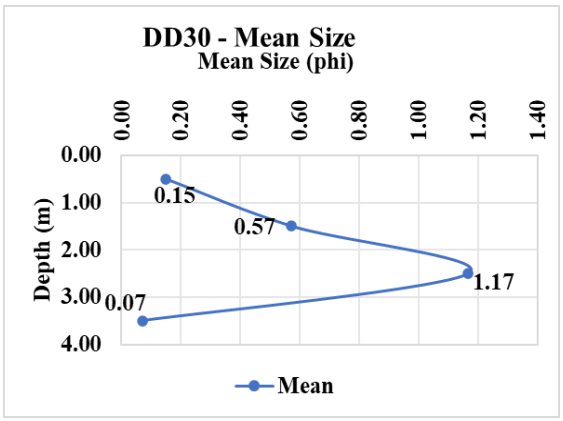
0.13
Mean


DD30 - Mean Size
Mean Size (phi)
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0.00
1.00
2.00
3.00
4.00
Depth (m)
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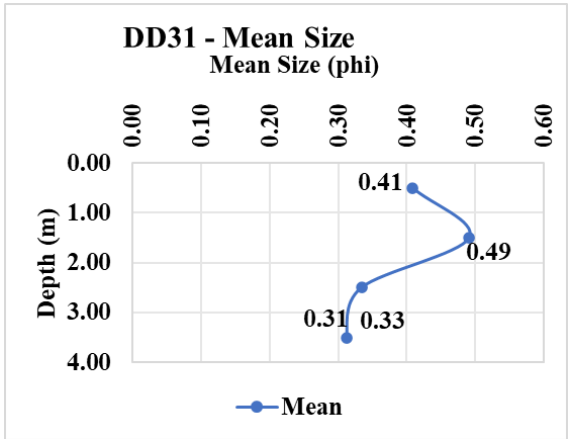
0.57
1.17
0.07
Mean


DD31 - Mean Size
Mean Size (phi)
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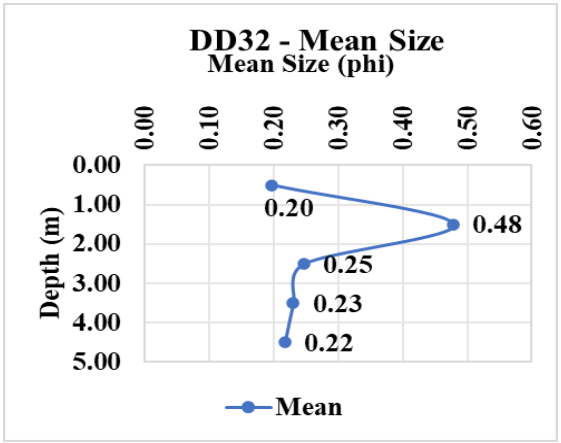
0.00
1.00
2.00
3.00
4.00
Depth (m)
0.41
0.49
0.31
0.33
Mean


DD32 - Mean Size
Mean Size (phi)
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0.00
1.00
2.00
3.00
4.00
5.00
Depth (m)
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0.48
0.25
0.23
0.22
Mean

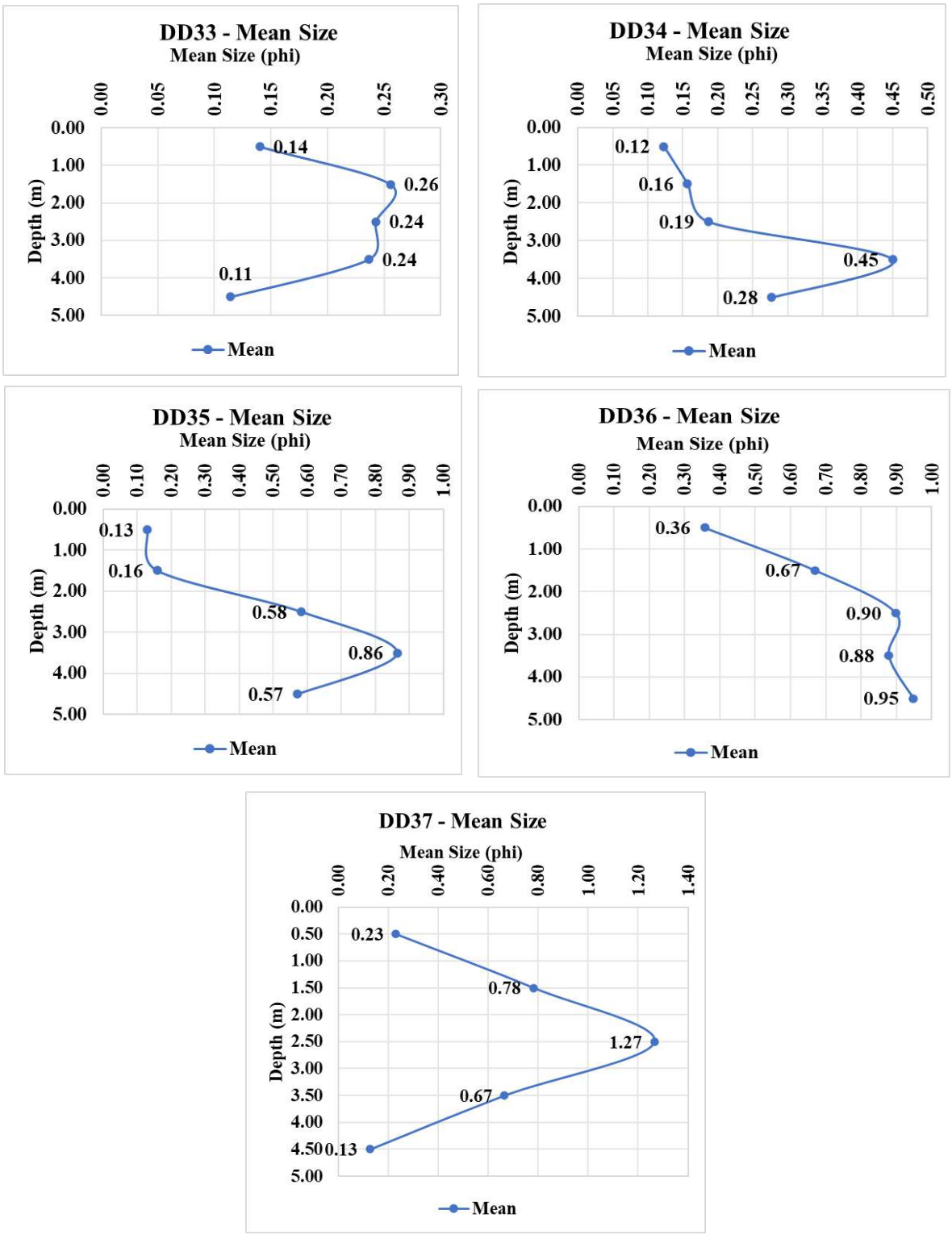


Figure 9.6 Downcore variation of sediment size in 37 boreholes

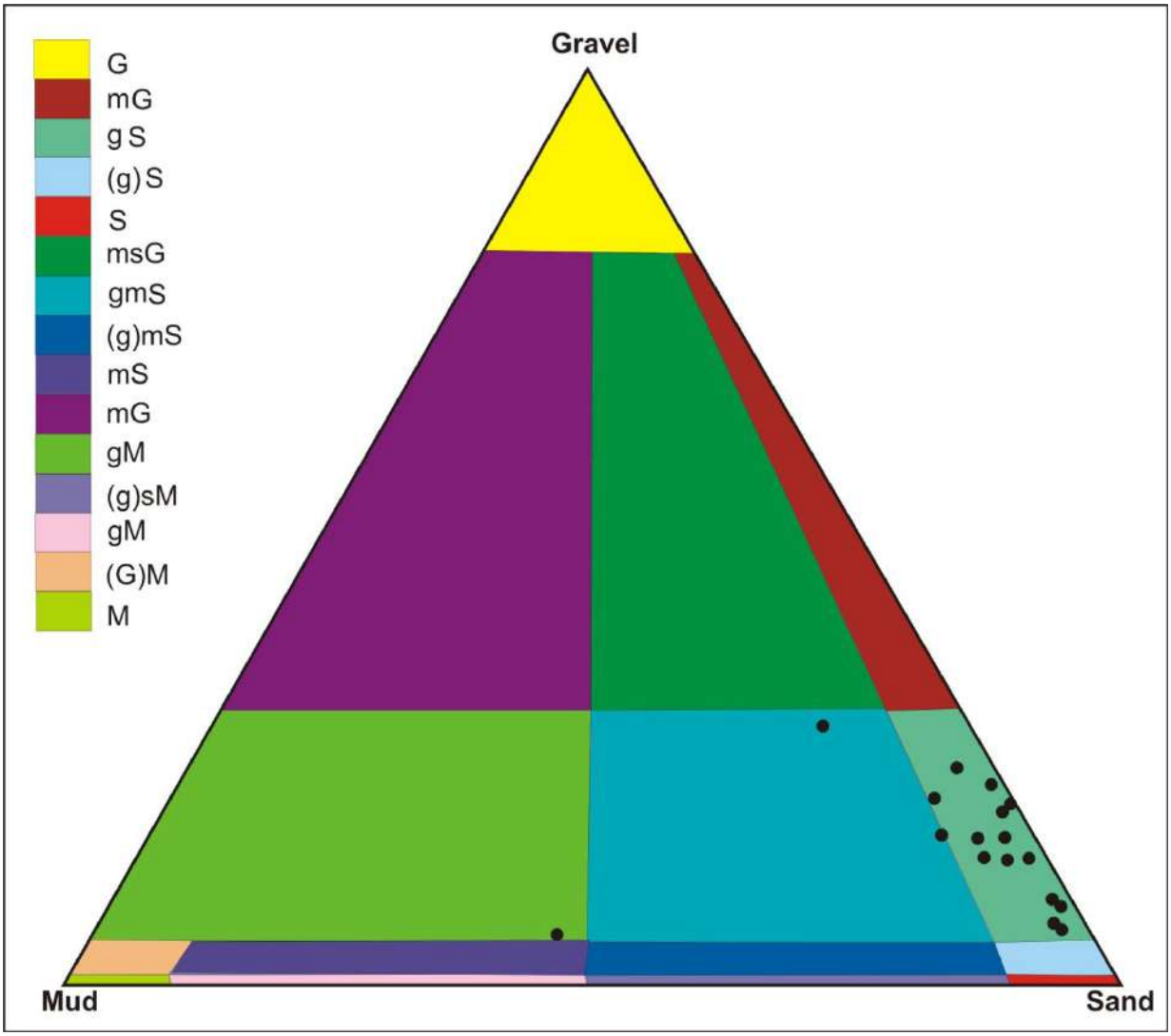


Figure 9.7: Folk Classification (1954)

9.6 Chemical Analysis by XRF

Geochemical analysis for the estimation of major elements in sand samples is by making a fusion bead followed by WDXRF analysis for oxides, - Al_2O_3, BaO, CaO, Cr_2O_3, Fe_2O_3, K_2O, MgO, MnO, Na_2O, P_2O_5, SiO_2, TiO_2, SO_3, V_2O_5 and LOI. XRF analysis on different types of samples were carried out., viz, A, B and C fractions separately, 230 fractions of composites of A, B and C, hand magnet separated samples etc. A total of 139 samples were proposed for chemical analysis, but 164 samples were analyzed by WDXRF.

9.6.1 XRF analysis of A, B and C fractions

XRF analysis of 72 samples of LIRMS magnetics, REDMS magnetics and REDMS middling's was initially carried from boreholes DD02, DD03, DD15, DD33 and DD36 to assess the major oxide concentrations.

The weight percentage of Fe_2O_3 is found to be varying between 11.90% to 31.03%, TiO_2 varies between 2.12% to 18.31% and V_2O_5 varies from <0.05% to a maximum of 0.23%. The average values of V_2O_5 are 0.08%, TiO_2 5.61% and 18.93% Fe_2O_3 in this fraction. The results are attached as Annexure 8.

As per the previous work of GSI, the values were low in terms of weight percentage of V_2O_5, Fe_2O_3 and TiO_2. The Petrographic studies of the samples confirmed that rock fragments are the major constituents in the magnetic fractions. So, chemical analysis was carried out to identify the heavy mineral concentration on different sieve fractions from boreholes DD03 and DD15.The analysis suggest +230# fractions of A, B, C magnetic fractions show enrichment of Fe, Ti and V.

9.6.2 XRF Analysis of different sieve fractions

The chemical analysis results of samples analyzed from boreholes DD03 and DD15 for different sieve fractions of magnetics and middlings suggest that +230# fractions of A and B are having high values of TiO_2 and V_2O_5 compared to that of other sieve fractions. High TiO_2 value of 39.13wt% is observed in DD15/1-2/B/ASTM-230 and the corresponding V_2O_5 value is 0.26wt%. V_2O_5 value >0.1% is considered to be potential. In the A fraction of DD03, V_2O_5 concentration of 0.42% has been recorded, and the corresponding TiO_2 content is 24.12% (Annexure 9).

Table 9.1: XRF Analysis data of different sieve fractions (magnetic fractions)

Sl no	Sample No	Fe_2O_3 (wt%)	TiO_2 (wt%)	V_2O_5 (wt%)
1	DD03/1-2/A/ASTM-120	20.10	5.19	0.09
2	DD03/1-2/A/ASTM-230	33.24	14.64	0.24
3	DD15/1-2/A/ASTM-60	17.40	3.65	0.07
4	DD15/1-2/A/ASTM-120	25.20	7.60	0.17
5	DD15/1-2/A/ASTM-230	48.81	24.12	.42

Sl no	Sample No	Fe_2O_3 (wt%)	TiO_2 (wt%)	V_2O_5 (wt%)
6	DD15/1-2/A/ASTM-(-230)	31.95	16.15	0.18
7	DD15/1-2/B/ASTM-120	18.76	6.13	0.08
8	DD15/1-2/B/ASTM-230	43.59	39.13	0.26
9	DD15/1-2/C/ASTM-120	17.42	2.65	0.07
10	DD15/1-2/C/ASTM-230	29.19	16.62	0.11

The sieve analysis of DD03 and DD15 and their corresponding XRF values confirms the mineral potential within +230# fraction. So, 480 samples (160 samples of A, B and C) were sieved and 69 samples were analyzed for major oxides by XRF.

Additionally, 2 samples from +230# fractions of LIRMS magnetics were separated by using handmagnet and were analyzed by WDXRF.

Table 9.2. Chemical Analysis data for magnetic and less magnetic samples in +230# fraction of LIRMS magnetics.

Sample No	Chemical analysis data		
	Fe_2O_3 (wt. %)	TiO_2 (wt. %)	V_2O_5 (wt. %)
DD15/1-2/A/ASTM230/MT	**59.84**	**21.87**	**.67**
DD15/1-2/A/ASTM230/NMT	**36.79**	**26.17**	**.18**

High values of V_2O_5 are observed in the highly magnetic fraction (V_2O_5-0.67%) and high TiO_2 value is observed in the less magnetic fraction (TiO_2-26.17%). This confirms that the vanadium is more concentrated in the highly magnetic fraction and titanium is in the less magnetic fraction respectively.

9.6.3 XRF analysis on +230 fractions (A+B+C)

The chemical results of 69 samples from 14 boreholes along the depth with respect to +230 fractions of magnetics (LIRMS) and magnetics and middlings of REDMS are discussed below.

The geochemical analysis of composite samples of +230 sieve sizes of LIRMS magnetics, REDMS magnetics and REDMS middlings (A+B+C) of the Dandi-Onjal-Surwada block area

suggests much of the area has more or less consistent values of titanium and vanadium. The highest concentrations of oxides such as V_2O_5 (DD11) and TiO_2 (DD07) are observed in the northernmost portion of the Dandi-Onjal sector, where as Fe_2O_3 is observed in the southernmost portion (DD23/4-5). Surwada sector is having a low value of Fe_2O_3, V_2O_5 and TiO_2 compared to Dandi-Onjal sector (Annexure 10).

The concentration (wt%) of Fe_2O_3 is found to be varying between 14.27% in DD35/4-5 to 51.64% in DD23/4-5, TiO_2 varies between 3.043% in DD33/4-5 to 24.895% in DD07/2-3 and V_2O_5 varies from 0.025% in DD23/4-5 and DD33/4-5 to a maximum of 0.315% in DD11/2-3. The average values of V_2O_5 are 0.194%, TiO_2 14.83% and 31.35% Fe2O3 in this fraction.

The surface sediments (@1m) generally have low value of TiO_2 and Fe_2O_3 compared to the bottom layers. Similarly, as the sand sediments change to gravelly sand or silty sand in the southern extremity of the Dandi-Onjal area and in the Surwada sector, value of oxides are observed to be low.

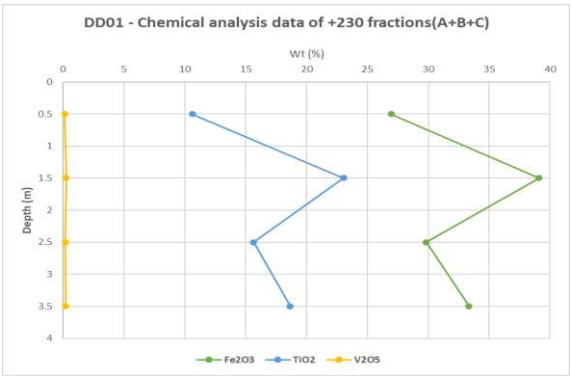
Though the highest values of LIRMS magnetics (33.31% to 64.13%) and REDMS magnetics (0.079% to 14.07%) are observed in the Surwada sector, the elemental concentrations of Ti and V analysed by XRF are found to be least. This may due to the presence of rock fragments masking the heavy minerals as they are immature sediments and not completely weathered and TTM and ilmenite are not separated out fully.

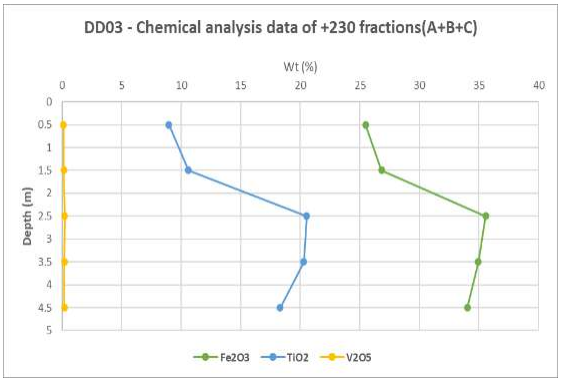
Dandi-Onjal area can be considered as the potential area for Ti and V mineralization, as the wt% of TiO_2 reflects high value between 8.975% to a maximum of 24.895% and V_2O_5 varies between 0.025% to 0.315%. As the sediments are purely segregated in to sand fractions, high value of oxides of Ti and V are observed.

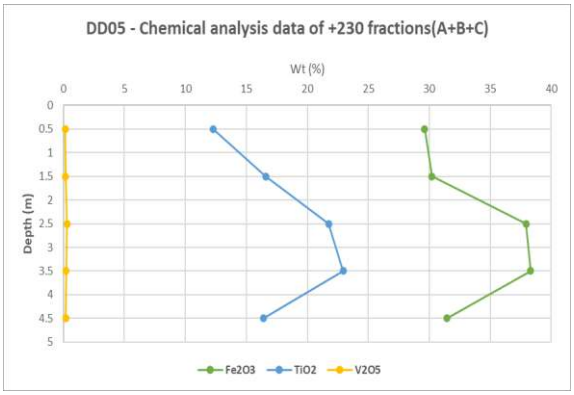
Concentration of V_2O_5 more than 0.1% is considered to be potential. Here, in the explored area, 67 samples of (ABC)230# fraction are having more than 0.1% V2O5, whereas 43 samples are having ≥14% TiO2 and 13 samples have TiO2 between 10 and 14% and 13 samples below 10% out of 69 samples analyzed. These factors suggest the 230 fractions of A+B+C can be considered to be potential ore. As far as V_2O_5 concerned, 97% of the total samples analyzed covering entire sediment column in the area are having more than this cut-off value.

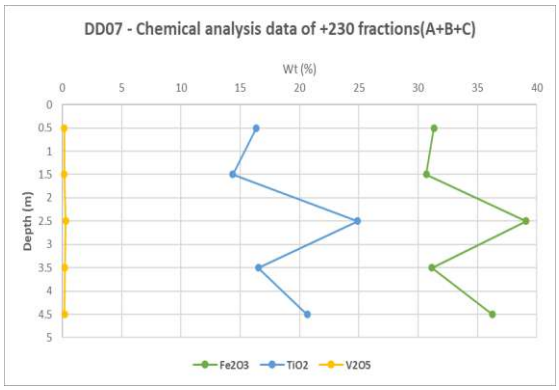
Table 9.3: Oxide range and sample count

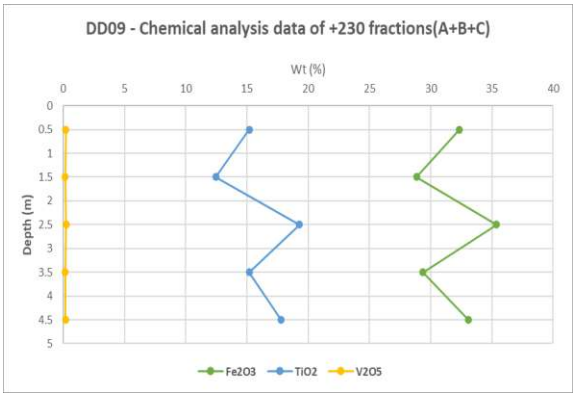
Oxide	Range	No of samples (Out of 69)
TiO_2	≥14%	43
	≥10 and <14%	13
	<10%	13
V_2O_5	≥0.1%	67
	<0.1%	2

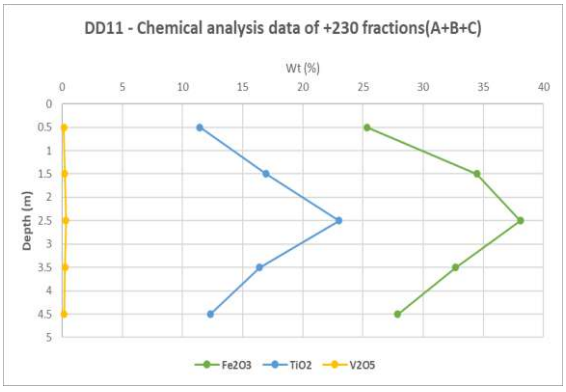


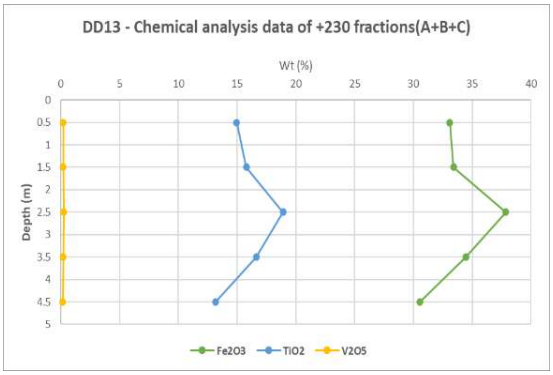


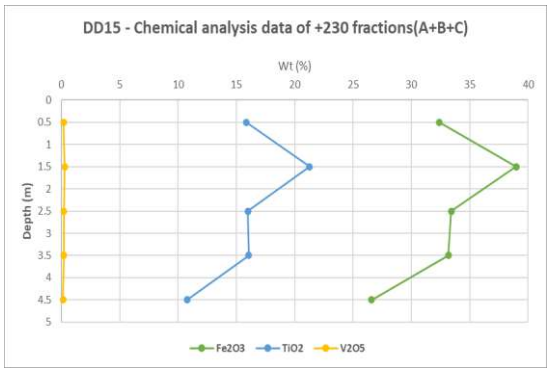


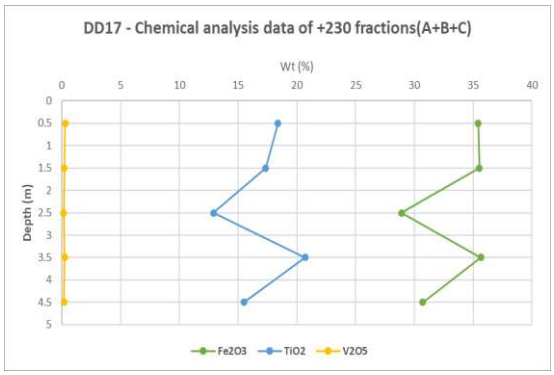


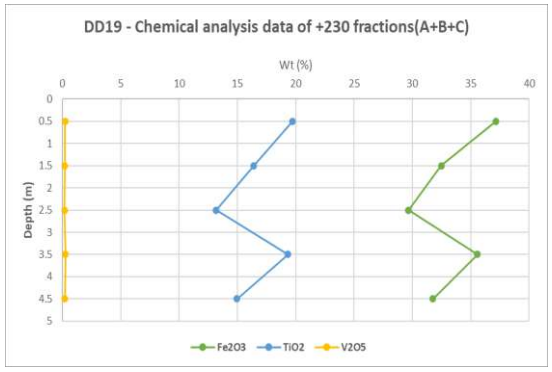


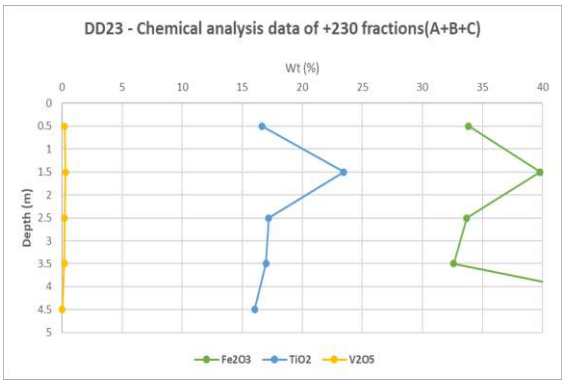


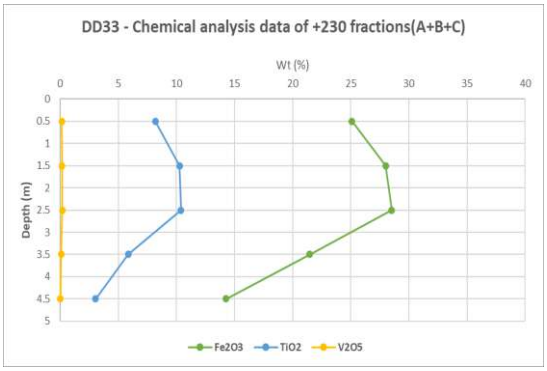


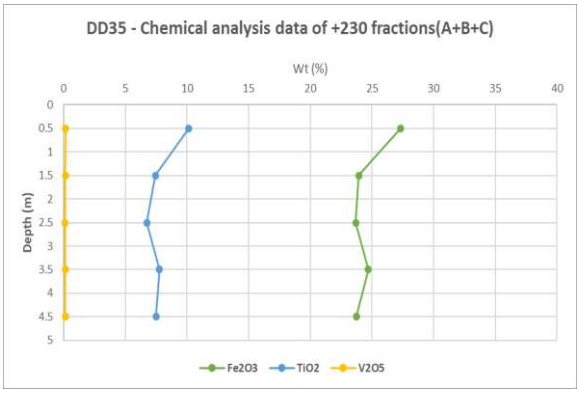












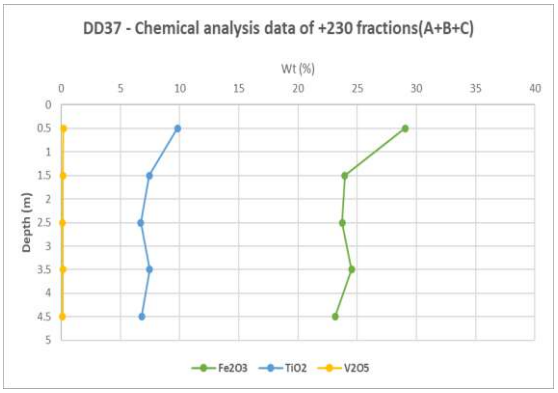


Figure 9.7 (a): Downcore variation of TiO_2, Fe_2O_3 and V_2O_5 in +230 #fractions of A+B+C Magnetics

9.6.4 XRF Analysis of hand magnet separated samples from different sieve fractions (Bulk sample)

In order to study the concentration pattern of vanadium, iron and titanium in the bulk sample, different sieve sizes (35#, 60#, 120#, 230#, -230#) of magnetic fractions (A+B+C) were separated using a hand magnet to separate highly magnetic fraction (Mt) and less magnetic fraction (Nmt). All the 10 (5*2) sub-fractions were analyzed for Fe_2O_3, TiO_2, and V_2O_5 at Shiva Analyticals Pvt Ltd, Bangalore which is a NABL accredited lab. The XRF analysis employed lithium borate fusion bead followed by WDXRF following the standard procedure IGI/GDM/TPM-48.

Based on the hand magnet separated data, it can be estimated that 7.447 kg of the bulk sample yielded 27.009wt% of hand magnetic fractions (Mt) and 31.77wt% of non-hand magnetic fractions (Nmt) from sieve sizes 35#, 60#, 120#, 230#, -230#, 6.9wt% of magnetic fractions from +5#, +10# and +18# mesh sizes and 34.32wt% of non-magnetic fractions (D+E).

The Fe_2O_3 content of the sieve sizes (35#, 60#, 120#, 230#, -230#) ranges between 12.11% to 47.77%, followed by TiO_2 varying between 2.26% to 17.10% and V_2O_5 ranging between <0.05% to 0.50 %.

In the hand magnetic fraction, the TiO_2 content ranges from 3.21% to 17.10%, with an average of 9.66%; the V_2O_5 content ranges from 0.06% to 0.50%, averaging 0.26%; and the Fe_2O_3 content ranges from 15.81% to 47.77%, with an average of 30.78%.

In the non-hand magnetic fraction, the TiO_2 content ranges from 2.26% to 11.88%, with an average of 6.31%; the V_2O_5 content ranges from <0.05% to 0.09%, with an average of 0.07%; and the Fe_2O_3 content ranges from 12.11% to 24.57%, with an average of 18.40%.

The analytical data reveal that the +230Mt is having high values of Fe_2O_3, TiO_2, and V_2O_5 which is 47.77%, 17.10% and 0.50% respectively, followed by -230Mt, +120Mt and +60Mt which suggests vanadium is mostly concentrated in the titaniferous magnetite. Table 9.4 shows the weight% of hand magnetic and non-hand magnetic fractions and table 9.5 shows the chemical analysis results of the samples analyzed (Annexure 11). Apart from +230# fraction, +120# fraction can also be considered as potential ore fraction.

Table 9.4: sieve data of less magnetic (NMt) and highly magnetic fractions (Mt)

Sl.no	Sample No	Sieve size (ϕ) in mm	wt% of Mt in the bulk sample	wt% of Nmt in the bulk sample
1	DD/ABC/35#	0.5	3.022	1.804
2	DD/ABC/60#	0.25	13.858	4.619
3	DD/ABC/120#	0.125	7.896	16.141
4	DD/ABC/230#	0.063	2.079	7.840
5	DD/ABC/-230#	0.031	0.154	1.363

Table 9.5. Chemical Analysis data for magnetic and less magnetic samples in Bulk sediment sample of 7.447 kg

Sample No	Wt% of sieve fractions in Bulk	Chemical analysis data		
		Fe_2O_3 (Wt%)	TiO_2 (Wt%)	V_2O_5 (Wt%)
DD/ABC/35#/Mt	3.022	15.81	3.21	0.06
DD/ABC/35#/Nmt	1.804	12.11	2.26	<0.05
DD/ABC/60#/Mt	13.858	17.13	3.63	0.08
DD/ABC/60#/Nmt	4.619	15.04	2.52	<0.05

DD/ABC/120#/Mt	7.896	27.47	8.22	0.20
DD/ABC/120#/Nmt	16.141	19.89	6.07	0.06
DD/ABC/230#/Mt	2.079	47.77	17.10	0.50
DD/ABC/230#/Nmt	7.840	24.57	11.88	0.09
DD/ABC/-230#/Mt	0.154	45.73	16.14	0.46
DD/ABC/-230#/Nmt	1.362	20.41	8.80	0.06

Similarly, the silt fraction (DD/-230/Silt) were also analyzed to assess the heavy mineral concentration and the wt% of Fe_2O_3, TiO_2 and V_2O_5 that are 20.26%, 8.40% and 0.12% respectively.

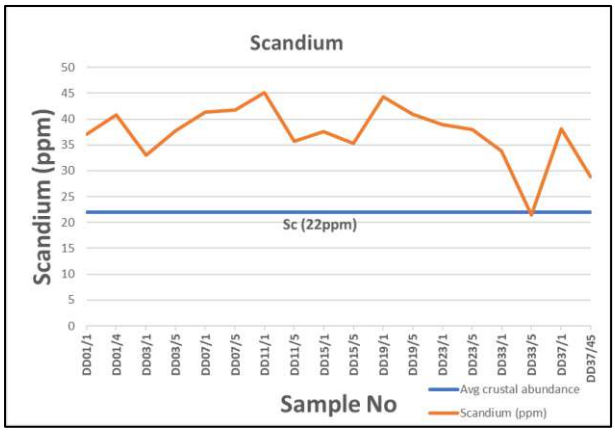
9.7 ICP-MS Analysis

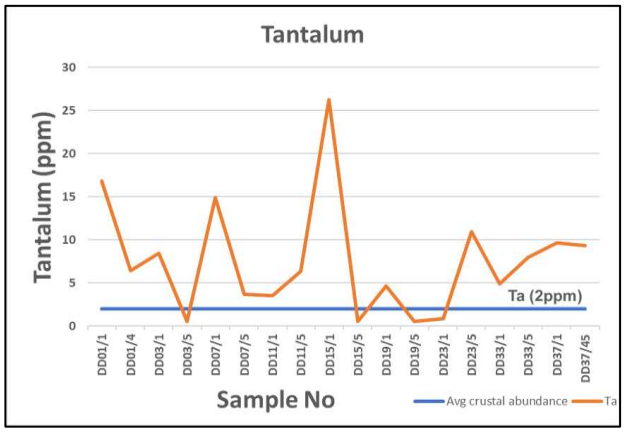
ICP-MS Analysis was carried out in 27 geological samples to understand the concentration of trace elements and rare earth elements (REE). 18 samples analyzed were +230# fractions of magnetic samples (A+B+C) and the remaining 9 samples were hand magnet separated fractions from the bulk sample.

9.7.1 ICP-MS Analysis on +230 fractions (A+B+C)

The concentrations of the 17 elements (La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Sc, Nb, Ta) in the 230 fractions of 18 magnetic samples are shown in Annexure 12.

The ΣLREE (La, Ce, Pr, Nd, Sm) varies between 95.11ppm to 276.26ppm and ΣHREE (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu) varies between 20.6ppm to 33.79ppm. The total rare earth elements (ΣREE) ranges between 197.47ppm to 308. 45ppm.The average crustal abundance of niobium, tantalum and scandium on the earth's crust is 20ppm, 2 ppm and 22ppm respectively (Parker, R. L., & Fleischer, M.1968, & Taylor. 1964). Scandium varies between 21.5ppm to 45.05ppm, niobium varies between 0.5ppm to 33.52ppm and tantalum varies between 0.5ppm to 26.22ppm.





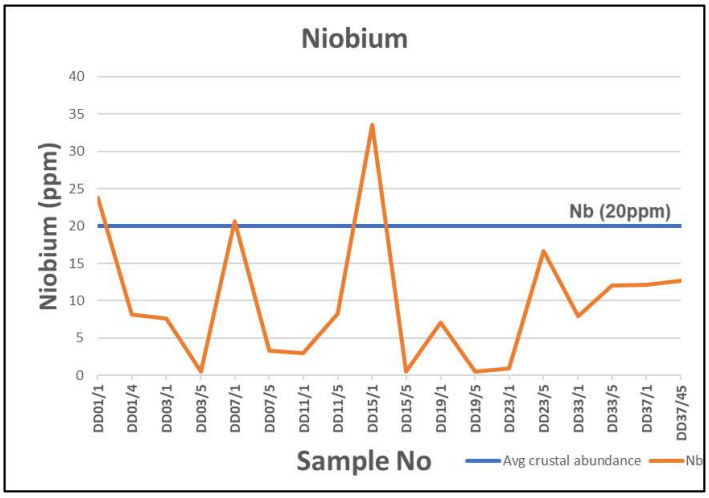
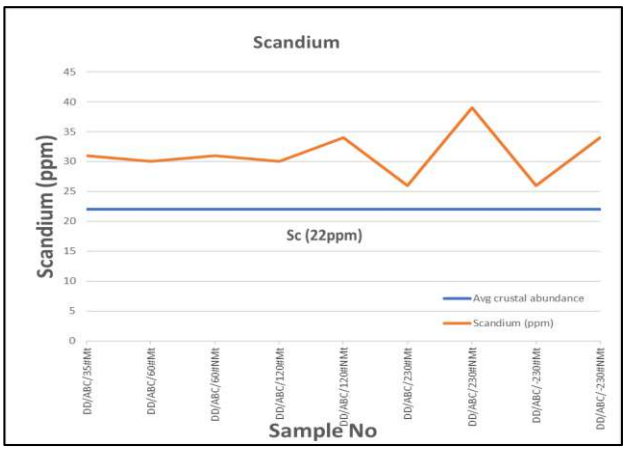


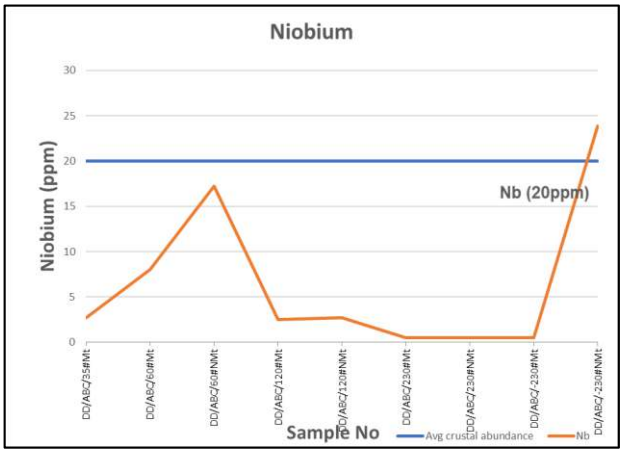
Figure 9.8 Distribution of Sc, Nb and Ta in +230 fraction

9.7.2 ICPMS Analysis of hand magnet separated samples from different sieve fractions (Bulk sample)

Concentrations of 45 elements (Li, Be, B, Sc, Co, Ga, Ge, Rb, Y, Nb, Mo, Cd, In, Sn, Sb, Te, Cs, Cu, Ni, Pb, Sr, Zn, Zr, La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Tl, Bi, Th, U) in different sieve fractions of 9 magnetic samples were analysed by ICPMS. The results are attached in Annexure 13.

Scandium varies between 26ppm to 39ppm, niobium varies between <0.5ppm to 23.9ppm and tantalum varies between <0.5ppm to 4.8ppm.





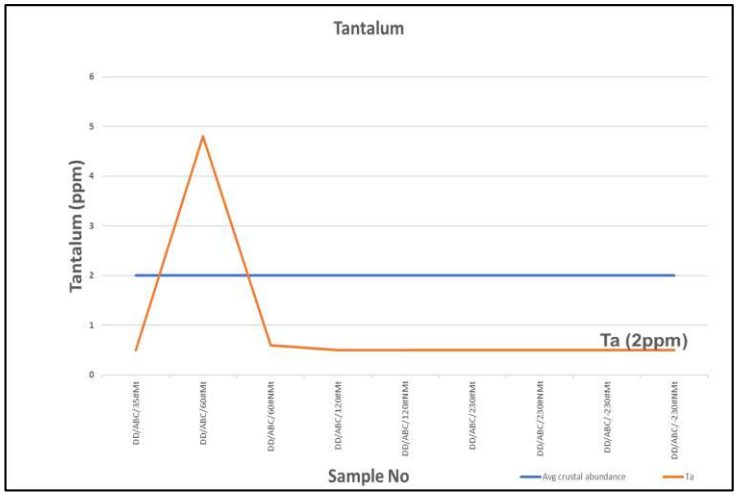


Figure 9.9 Distribution of Sc, Nb and Ta in the hand magnet separated fractions

The concentrations of ΣLREE (La, Ce, Pr, Nd, Sm) varies between 80ppm to 409.2ppm and ΣHREE (Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu) varies between 23.4 ppm to 45.4ppm. The total rare earth elements (ΣREE) ranges between 103.4ppm to 454.6ppm.

9.8 XRD Analysis

X-ray diffraction (XRD) analysis was carried on fractions A230#, B230#, C230#, A60+120# and C60+120# obtained through sieving of samples of two-level magnetic separation, as well as on non-magnetic light minerals (NMLM) and non-magnetic heavy minerals (NMHM) separated using the gravity (bromoform) and on the silt fractions to identify the mineral phases present in each sample. There are two A230# fractions, one B230# fraction, one C230# fraction, one A60+120# fraction, one C60+120# fraction, two non-magnetic heavies (NMHM), one non-magnetic lights (NMLM) and one silt fraction among the ten samples analyzed.

The results show that A fraction is mostly composed of spinel minerals such as magnetite/ titanomagnetite/magnesioferrite etc. with presence of pyroxenes (Cpx) and plagioclase (pl). The presence of Cpx and plagioclase indicates that the presence of rock fragments. The result is attached in table 9.6.

Spinel minerals such as magnetite, titanomagnetite and magnesioferrite etc. have similar spinel crystal structure and comparable lattice parameters and their X-ray diffraction (XRD) patterns are quite similar making distinction between these types of minerals challenging in polymineralic

samples. However, the chemical analysis data suggest the spinel group mineral would be vanadiferous titano-magnetite. Based on the EPMA followed by thin section studies, it is confirmed that the spinel type minerals are Fe-Ti oxide or TTM (ilmenite and ilmeno-magnetite and magnetite grains). Other minerals present along with A (+230#) fraction in traces are hematite, quartz, clay minerals, ilmenite and feldspar. The likely phases identified are ilmenite and k-feldspar. The dominance of spinel minerals (magnetite, titanomagnetite, magnesioferrite) with Cpx and plagioclase suggests a primary igneous origin from the intermediate to mafic igneous rock such as basalt (Deccan Basalt Supergroup).

B (+230#) fraction consists of pyroxene, ilmenite, plagioclase, quartz, amphibole, dolomite and clay minerals.

C (+230#) fraction is composed of pyroxenes (mainly Cpx), plagioclase and quartz with minor amount of clay minerals, hematite and ilmenite. Spinel, amphibolite, calcite, talc, dolomite are the phases identified in the XRD studies

The A (60#+120#) is compositionally same that of A (+230#) with greater amount of plagioclase and Cpx than the spinel. C (60#+120#) is having plagioclase, quartz and pyroxenes.

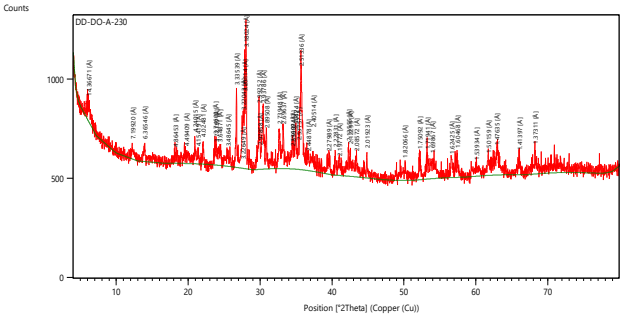
The nonmagnetic heavy minerals (NMHM) identified are clinopyroxene with hematite. The nonmagnetic light minerals (NMLM) are calcite and quartz with traces of zeolite.

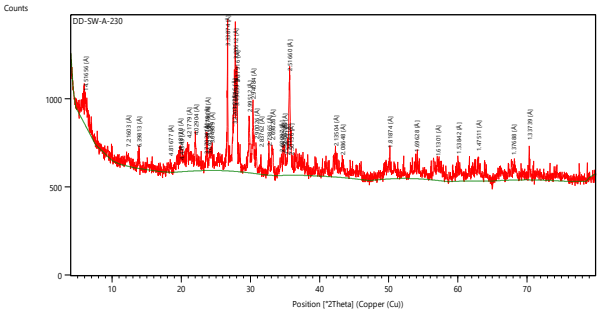
Compositionally, silt fractions (-230#) also have significant amount heavy minerals such as plagioclase, quartz, pyroxenes (mainly cpx), and spinel (mainly magnetite type) with traces of clay minerals, calcite, amphibolite and mica. The likely phases are hematite, ilmenite and zeolite. The result is attached as Annexure 14.

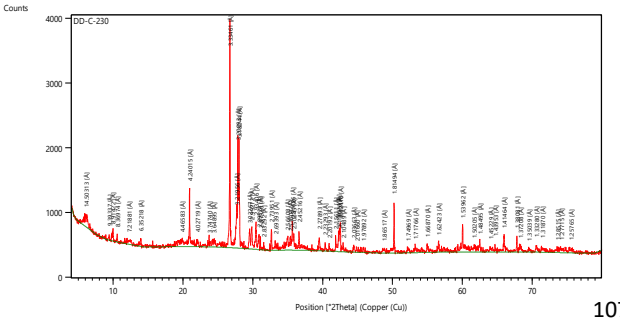
In XRD analysis minerals like magnetite, titanomagnetite, magnesioferrite, pyroxene, plagioclase, quartz with trace amount of ilmenite, hematite, amphibole and secondary minerals such as calcite, dolomite, zeolite, talc was identified. The presence of minerals such as spinel group of minerals, ilmenite and hematite suggests source rock would be basalt. The presence of amphibole, K-feldspar, talc, dolomite, quartz may be suggesting these minerals are derived from metamorphic sources. Overall, the data implies a complex provenance of igneous and metamorphic rocks.

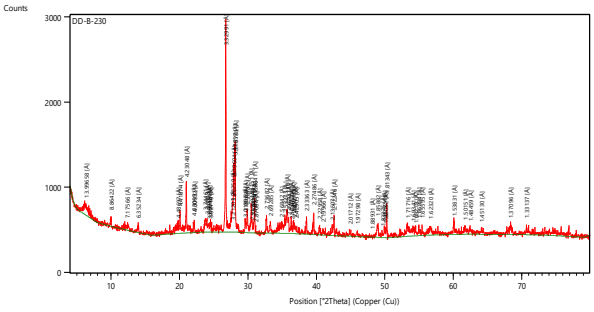
Table 9.6: Mineral phases detected by XRD analysis

Sl. No	Sample no	Mineral Phases detected		
		Good/Considerable amount	Trace amount	Likely phases
1	DD/DO/A/230	Spinel (mainly magnetite type), pyroxenes (mainly Cpx), plagiclase	Quartz, hematite, clay minerals (Smectite/ kaolinite	Ilmenite, K feldspar
2	DD/SW/A/230	Spinel (mainly magnetite type), pyroxenes (mainly Cpx), plagioclase	Quartz, hematite, clay minerals (smectite/kaolinite)	Ilmenite, K feldspar
3	DD/B/230	Quartz, plagioclase, pyroxenes (mainly Cpx), spinel (mainly magnetite type)	Clay minerals (smectite/kaolinite), hematite, Ilmenite	Amphibole, dolomite
4	DD/C/230	Quartz, plagioclase, pyroxenes (mainly Cpx)	Clay minerals (smectite/kaolinite), hematite, Ilmenite	Spinel, amphibole, calcite, talc, zeolite, dolomite
5	DD/DO/D	Clinopyroxenes		Hematite
6	DD/SW/D	Clinopyroxenes	Plagioclase	Hematite
7	DD/E	Plagioclase, calcite, quartz	Zeolite	Pyroxenes, K feldspar
8	DD/A/60+120	Plagioclase, pyroxenes (mainly Cpx), spinel (mainly magnetite type), quartz	Clay minerals (smectite/kaolinite), hematite	Ilmenite, zeolite, amphibole
9	DD/C/60+120	Plagioclase, quartz, pyroxenes (mainly Cpx)	Clay minerals (smectite/kaolinite), spinel, hematite, calcite	Zeolite, ilmenite
10	DD/-230/Silt	Plagioclase, quartz, pyroxenes (mainly cpx), spinel (magnetite type)	Clay minerals (smectite/kaolinite), calcite, amphibole, mica	Hematite, ilmenite, zeolite









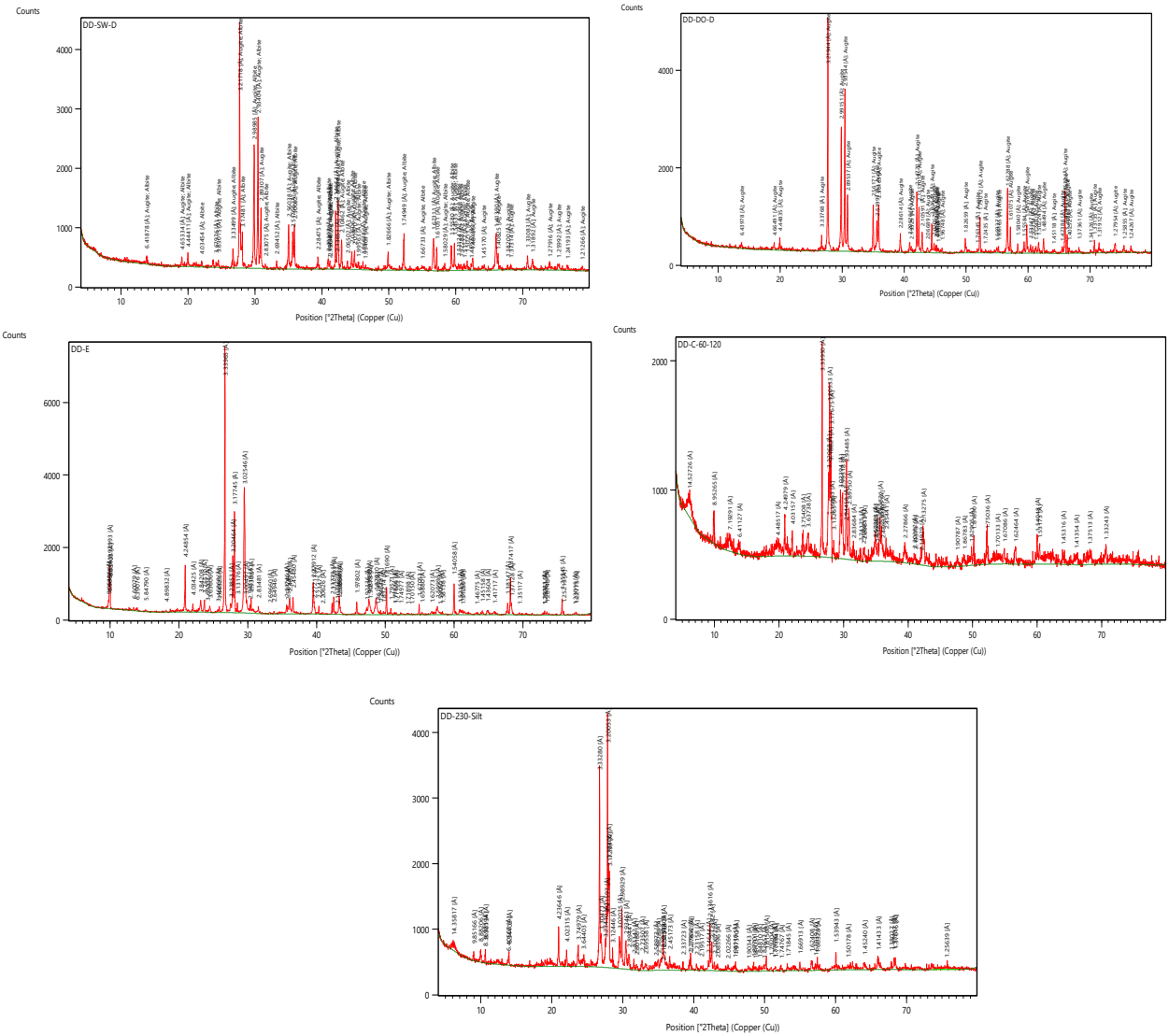


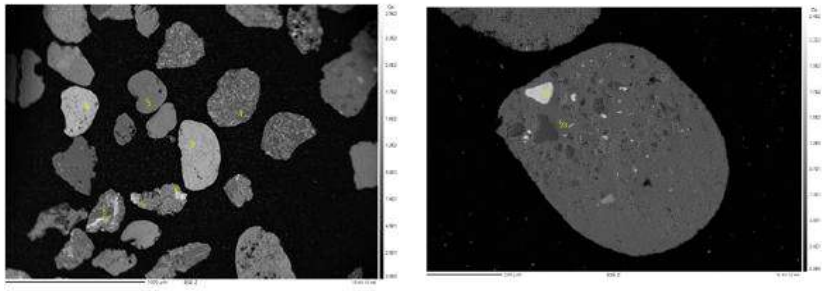
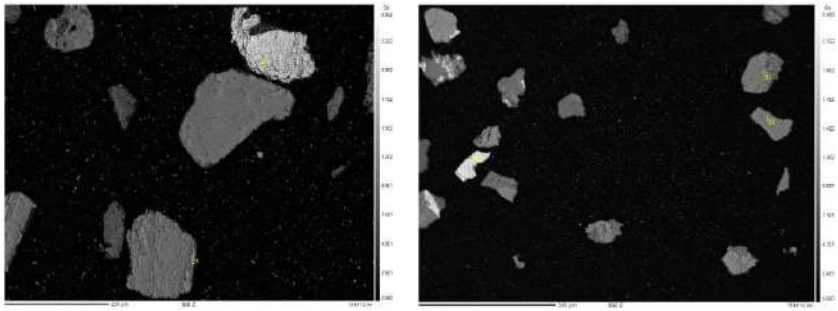
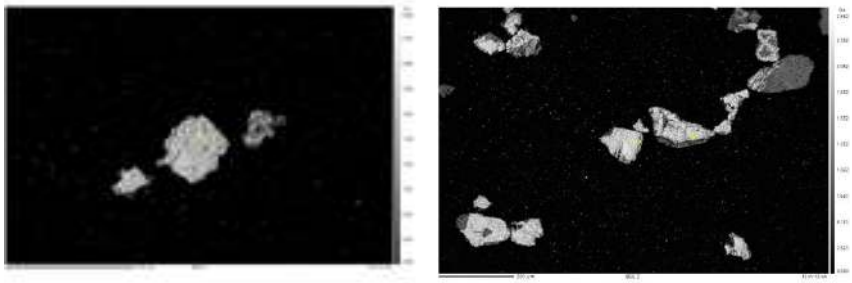
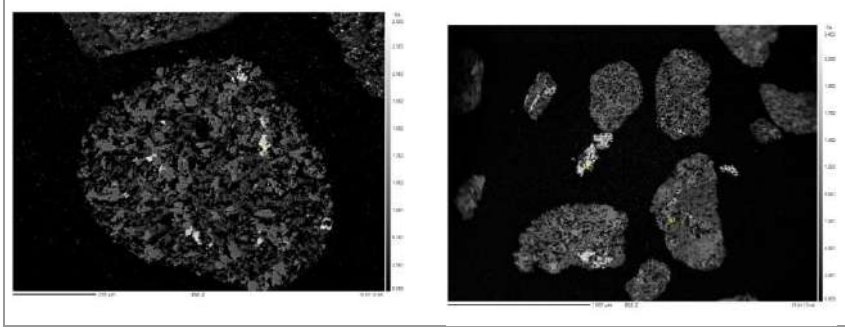
Figure 9.10: X-ray spectra of the samples measured with Cu detector

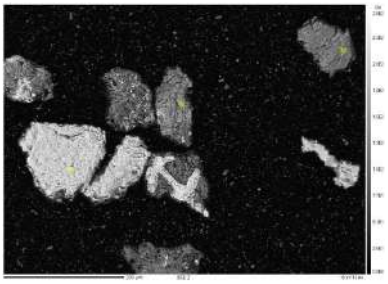
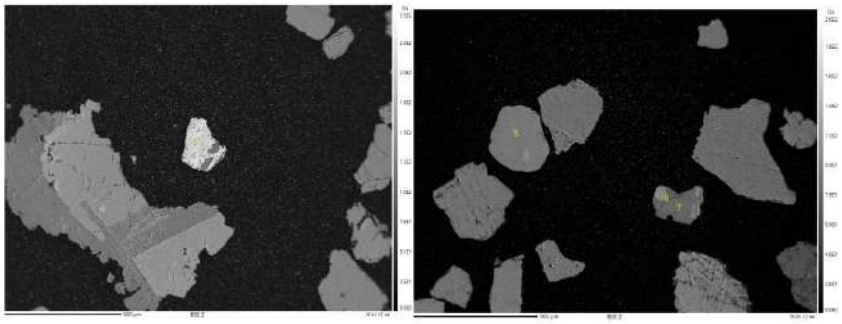
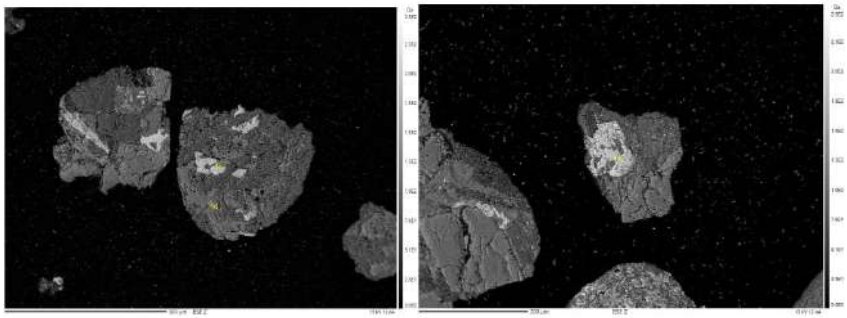
9.9 EPMA/ Mineral chemistry

For understanding the mineral chemistry of various heavy mineral phases in the area, Electron Probe Micro Analysis (EPMA) studies were carried out for 52 grains.

The results of EPMA analysis with Back scattered Electron (BSE) images are attached in Annexure 15.

Table 9.7: BSE images and mineral chemistry

Sample No and BSE images	Minerals Present
DD/C/60+120 	Plagioclase, Fe-hydroxide, Ilmenite, Clinopyroxene, Epidote, Albite
DD/C/230 	Ti-Fe hydroxide, Cpx, Ilmenite, ilmenite, Amphibole
DD/230/A/Mt 	Ilmenite, Fe-Ti oxide/hydroxide
DD/A/60+120 	Fe-Ti oxide with rock fragments, Fe-Ti hydroxide, Ilmenite, plagioclase, Fe-Ti oxide altered, Cpx

DD/A/230 	Fe-Ti oxide, Cpx
DD/SW/D 	Ilmenite, Cpx, Glauconite, Sphene, Epidote, Feldspar
DD/B/60+120 	Ilmenite, Cpx, Amphibole, Sphene

Interpretation of the Electron Microprobe Analytical results of the Mineral grains:

9.9.1 Fe-Ti Mineral phases:

Microprobe analysis identifies three distinct mineral phases of Fe-Ti Minerals viz (i) Ilmenites (ii) Titaniferous magnetites and (iii) Sphenes.

9.9.1.a Ilmenite: The ilmenite grains occur in all mineral fractions of the samples studied. They have almost equal proportion of TiO_2 and FeO (Table 9. 8 & Figure 9.10), though TiO_2 (average=50.5) is higher than FeO (average=47.4 wt %). The TiO_2 range from 49.23 wt% to 51.19 wt %. FeO has a range between 44.18 wt % to 48.46 wt %. Except for MgO and MnO, no

other elemental concentration is noted in ilmenites. The MgO in ilmenite varies between 0.63 and 1.76 wt % whereas that of MnO has more consistent distribution from 0.4 to 0.73 wt %. Presence of Ba (0.12 wt % to 0.33 wt %) and MnO (0.43wt % to 0.73 wt %) may indicate replacement of Ba with Ti and Mn with Fe respectively. In binary diagram, distinct decrease in TiO2 content is recorded with the increase of FeO (Figure 9.11). However, there is a steep positive correlation is recorded in MgO with the increase in FeO/TiO_2 ratio. V_2O_3 in ilmenites ranges between 0.08 to 0.85 wt %.

Table 9.8: EPMA analysis of Ilmenites and sphene

TABLE 9.8										
EPMA analysis of Ilmenites									**Sphene**	
DD-C-60-120-			**DD-C-230**		**DD-A-60+120**	**DD-B-60-120**			**DD-B-60-120**	**DD-SW-D**
	19	22	28	32	45	12	15		14	6
SiO_2	0.06	0.05	0	0.13	0.15	0.07	0		31.38	33.25
Al_2O_3	0	0.24	0	0.45	0.18	0.08	0.1		5.8	3.94
TiO_2	50.58	49.23	51.12	51.19	51.12	49.85	50.36		28.1	26.79
CaO	0	0.28	0.03	0.05	0.27	0.12	0.17		27.57	26.11
Na_2O	0	0.08	0.03	0.09	0.04	0	0.05		0.05	0
K_2O	0	0	0.01	0.03	0.02	0.04	0.01		0.06	0.05
FeO	48.46	47.87	48.13	47.6	44.18	48.31	47.22		3.01	5.04
MgO	0.64	1.11	0.65	0.63	1.76	0.91	1.38		0.36	0.35
P_2O_5	0	0	0.02	0	0.03	0.06	0		0.34	0.3
Cr_2O_3	0.04	0	0	0.06	0.01	0.06	0.01		0	0
MnO	0.5	0.43	0.4	0.73	0.5	0.57	0.53		0.12	0.03
NiO	0	0	0	0	0	0.07	0		0.02	0.04
ZnO	0.12	0.05	0	0	0	0.03	0		0.32	0.05
BaO	0.29	0.12	0.4	0.16	0.33	0.28	0.15		0.12	0.24
Total	100.7	99.46	100.8	101.1	98.59	100.45	99.97		97.22	96.19

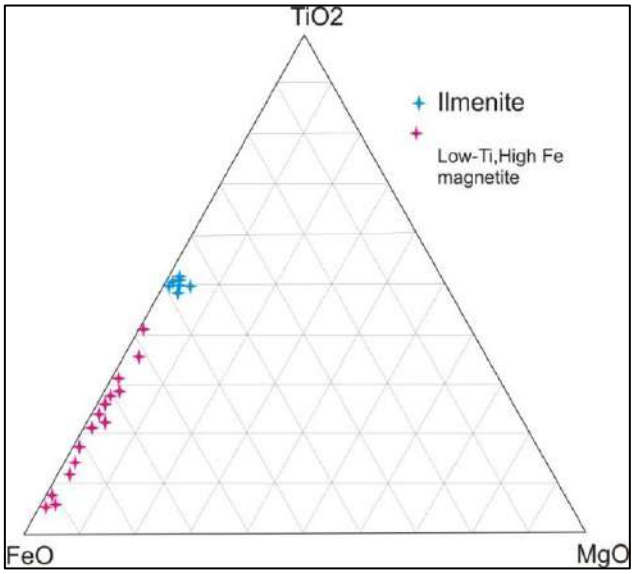


Figure 9.11: Distribution of Ilmenite and Ti-bearing-magnetite in ternary TiO_2-FeO-MgO diagram

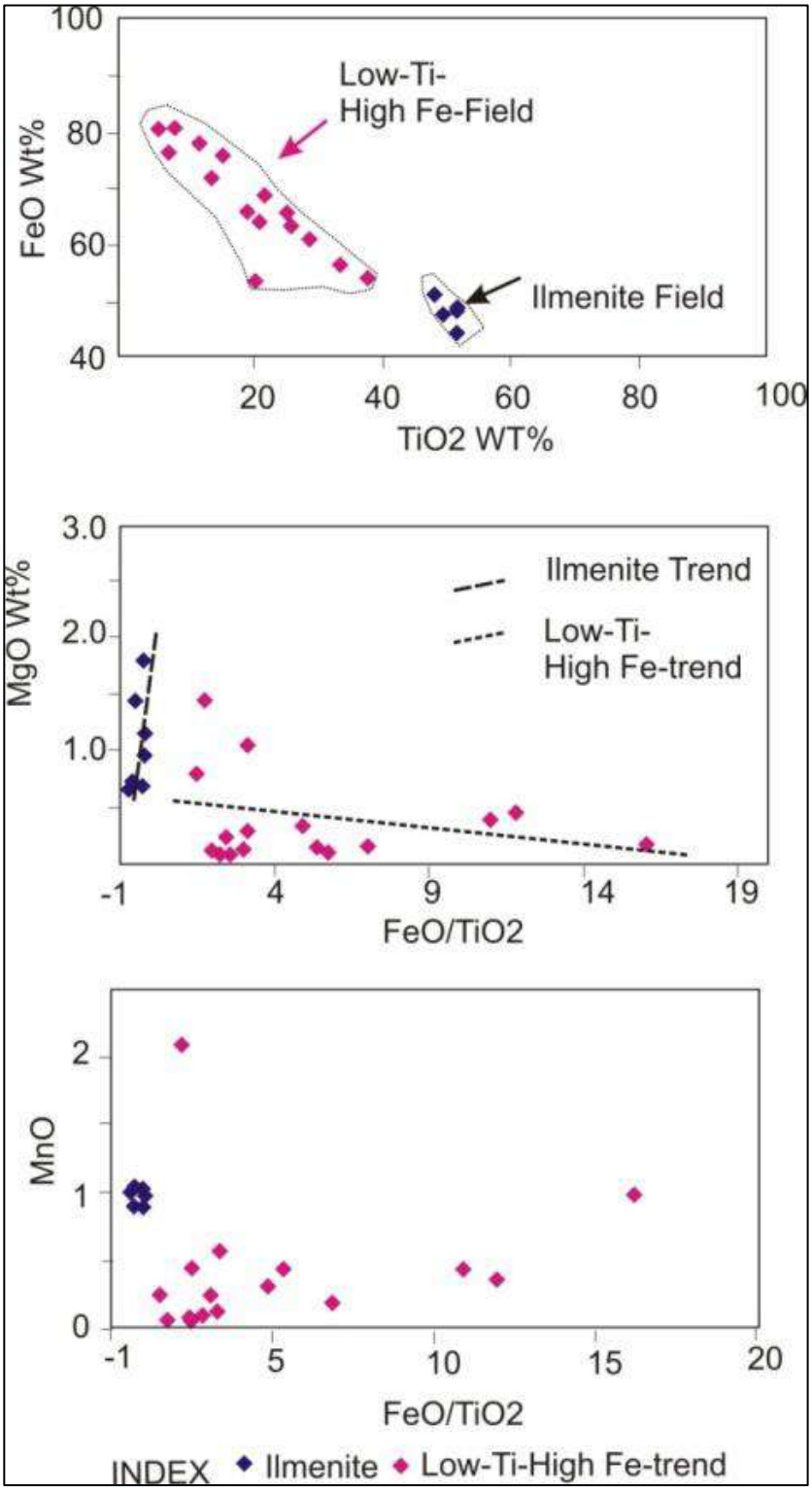


Figure 9.12: Binary diagram showing distribution of ilmenite and High-Fe low Ti bearing magnetites

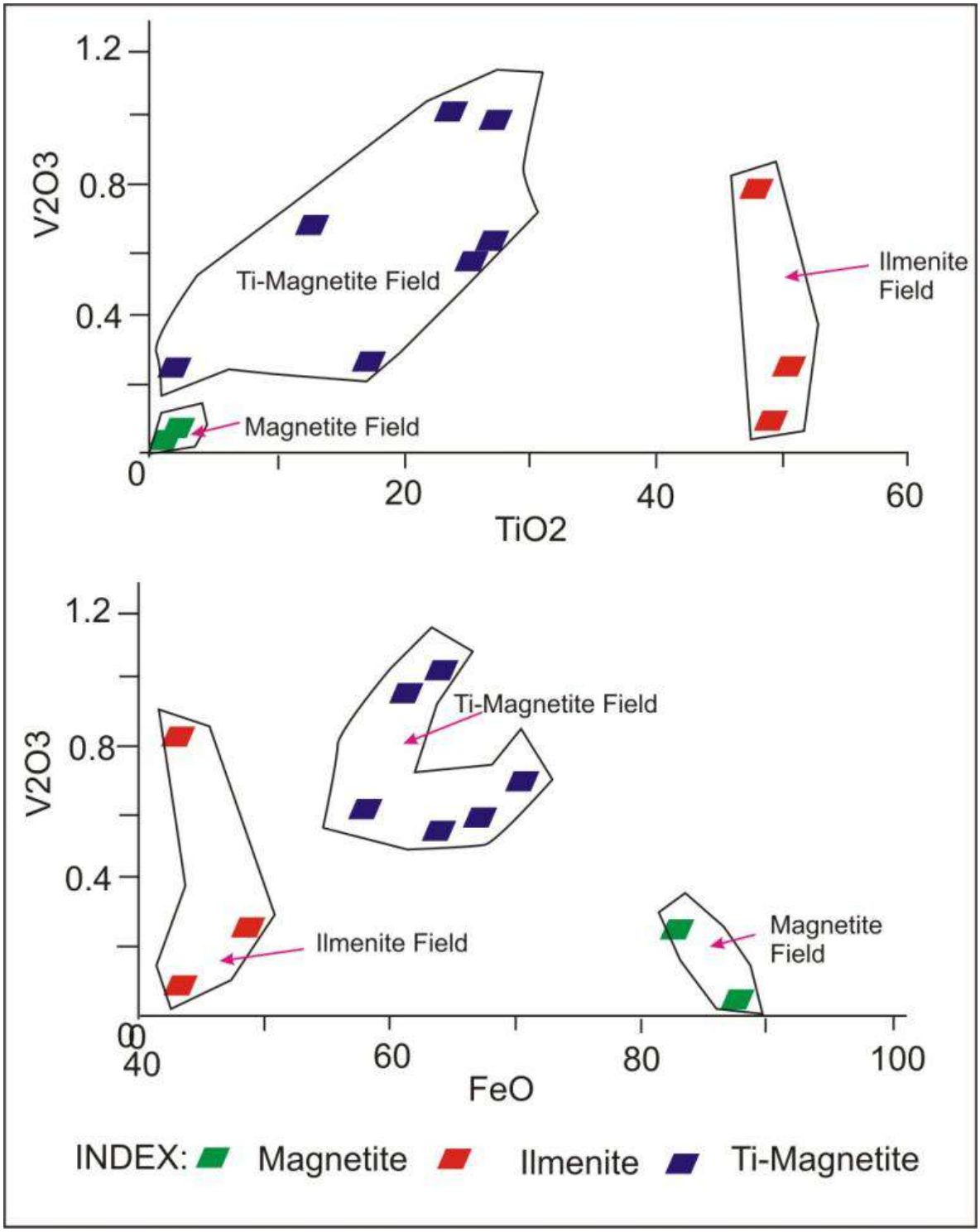


Figure 9.13: Binary diagram showing distribution of V_2O_3 with respect to FeO and TiO_2. (Note all the variants of Fe-Ti minerals plot in distinct/independent field)

Table 9.9: EPMA analysis of Titaniferous Magnetites

TABLE No 9.9: EPMA analysis of Titaniferous Magnetites											
EPMA analysis of Titaniferous Magnetites											
	DD-C-60-120-		DD-C-230	DD-A-230	DD-230-A-Mt						
	6	17	25	47	36	37	38	49	50	51	52
SiO_2	0.42	0.18	0.05	0.27	0.73	1.54	0.25	0.07	2.8	0.29	0.5
Al_2O_3	0.88	1.96	0.11	1.7	1.59	0.63	1.5	0.7	0.95	0.44	0.8
TiO_2	7.29	6.4	19.56	20.96	11.18	28.33	25.63	25.91	19.63	13.41	15.35
CaO	0.44	0.45	0	0.11	0.28	1.46	0.1	0.07	1.86	0.14	0.06
Na_2O	0.11	0.02	0.07	0.08	0.08	0	0.07	0.04	0.13	0.24	0.01
K_2O	0.01	0	0	0	0	0.02	0.01	0	0.02	0.03	0
FeO	80.8	75.93	65.47	63.86	77.31	61.08	65.04	63.65	54.14	71.41	75.78
MgO	0.41	0.46	3.01	1.06	0.13	0.05	0.07	0.22	0.11	0.09	0.35
P_2O_5	0	0	0	0	0	0	0	0.03	0	0	0
Cr_2O_3	0.01	0.07	0.09	0.51	0.04	0.03	0.09	0	0.12	0.05	0.01
MnO	0.41	0.36	0.58	0.24	0.23	2.07	0.42	0	0.07	0.43	0.35
NiO	0	0	0.05	0	0	0.03	0.05	0.01	0.03	0	0
ZnO	0.01	0.47	0	0.1	0.21	0.27	0	0	0.03	0.4	0
BaO	0	0	0	0.13	0	0.12	0.15	0.13	0.13	0.07	0.04
Total	90.78	86.3	89.01	89.02	91.79	95.64	93.37	90.84	80.02	87	93.24

	DD-SW-D		DD-B-60-120	DD-A-60+120	
	9	2	18	42	
SiO_2	0.14	0.2	2.76	0.03	
Al_2O_3	0.41	0.2	0.24	1.1	
TiO_2	37.39	33.6	5.01	21.67	
CaO	0.12	0.04	0.54	0.03	
Na_2O	0.08	0.06	0.08	0.08	
K_2O	0	0.02	0.05	0.01	
FeO	54.29	56.48	80.51	68.36	
MgO	0.8	1.43	0.18	0.3	
P_2O_5	0.02	0	0	0	
Cr_2O_3	0	0.02	0.1	0.1	
MnO	0.26	0.05	0.98	0.08	
NiO	0	0.01	0	0.04	
ZnO	0.09	0.18	0.57	0.3	
BaO	0.25	0.22	0	0.18	
Total	93.84	92.51	91.01	92.29	

Table 9.10: EPMA analysis showing Vanadium in Fe-Ti Minerals											
	High Fe (magnetite)		Ilmenite			Ti-Magnetite	DDA/60-120				
	DD/C/230	DDA/60-120	DDA/60-120			DD/C/230	4 / 1	5 / 1	6 / 1	8 / 1	11 / 1
SiO_2	5.28	0.79	0.03	4.48	0.42	0.02	0.22	0.07	0.3	0.5	2.31
Al_2O_3	1.46	0.33	0.07	1.51	0.26	0.08	1.41	2.1	1.94	1.1	0.84
TiO_2	1.34	0.22	50.82	44.64	49.2	17.84	27.54	23.59	27.59	27.15	13.38
CaO	0.41	0.27	0	2.72	0.23	0.02	0.14	0.13	0.04	0.09	0.33
Na_2O	0	0	0	0	0	0.08	0.05	0.13	0.08	0	0.14
K_2O	0.38	0.03	0	0.02	0.02	0.01	0.01	0	0	0.01	0
FeO	83.06	87.79	48.21	42.58	43.22	71.8	58.2	62.89	61.25	65.86	72.39
MgO	0.21	0	0.62	0.5	0.48	2.98	0.31	0	0.04	0.51	0
P_2O_5	0	0	0	0	0.04	0	0	0	0	0	0.14
Cr_2O_3	0.02	0.05	0.04	0.08	0.26	0.09	0.15	0.15	0.09	0.17	0.23
MnO	0.18	0.07	0.4	0.15	1.26	0.53	0.46	3.54	1.99	0.31	0.54
NiO	0.03	0	0.04	0.04	0.02	0	0	0	0	0	0
ZnO	0	0	0	0.13	0.06	0	0.33	1.31	0.12	0.33	0.64
V_2O_3	0.25	0.01	0.26	0.86	0.08	0.26	0.6	1.01	0.97	0.55	0.67
Total	92.62	89.56	100.49	97.7	95.56	93.7	89.41	94.91	94.41	96.58	91.6

9.9.1.b The Titaniferous Magnetite: The titaniferous magnetite grains occur in all mineral fractions of the samples studied. They are enriched in FeO and possess low to moderate amounts of TiO_2 (Table.9.9.; Figure.9.10). FeO has a range between 54.14 wt % to 80.8 wt %. The TiO_2 range from 6.4wt% to 28.33 wt %. Except for Al_2O_3 and MnO, no other elemental concentration is noted in ilmenites. In TiO_2-FeO-MgO ternary diagram, the analysis shows a wide range from pure ilmenite to the FeO end (magnetite end). In binary TiO_2 vs FeO diagram, distinct decrease in TiO_2 content is recorded with the increase of FeO (Figure.9.11). In FeO/TiO_2 ratio vs MgO diagram, MgO shows distinct negative trend whereas in FeO/TiO_2 ratio vs MnO diagram distinct positive trend could be seen. V_2O_3 in high Fe, low Ti-bearing magnetites range between 0.01 to 0.25 wt % whereas in high-Ti bearing Titaniferous magnetites range between 0.06 to 1.01 wt %. In V_2O_3 vs FeO and V_2O_3 vs TiO_2 binary diagrams the analysis for each of these Ti-bearing minerals define independent clusters. Whereas elemental correlations between V_2O_3 and FeO and V_2O_3 vs TiO_2 are not clearly discernible for High-Fe minerals and for ilmenites (maybe due to the paucity of the data), there appears to be positive correlation for the Ti-magnetite minerals.

Concentration of sphene in the mineral separates is very less. Two grains analyzed indicate CaO 26.11 and 27.57 wt%, TiO_2 26.79 and 28.1 wt%, SiO_2 31.38 and 33.25 wt% and Al_2O_3 3.94 and 5.8 wt %.

The EPMA analysis of the Fe-TiO_2 mineral grains suggests (i) a uniform distribution of FeO and TiO_2 which may reflect a common igneous source and (ii) a wide variation in the elemental concentrations of the titaniferous magnetite grains together with their consistent variation trends with reference to MgO and MnO may reflect inherent variations in mineral compositions during the late-magmatic processes.

9.9.2 Silicate Minerals:

Pyroxene: Clinopyroxene is the most abundant silicate mineral analyzed. This has augite composition, plot in augite field with a distinct trend towards hedenbergite field. The grains appear to point towards preponderance of mafic provenance (basalts/diorites) for the pyroxene.

Feldspar: Both plagioclase and orthoclase feldspar are analyzed. In a ternary diagram that discriminate the fields of different variants of feldspars, the grains plot in (i) Bytownite (ii) albite and (iii) orthoclase fields. Presence of high calcic- plagioclase (bytownite) indicate a mafic provenance whereas presence of albite and orthoclase indicate a felsic (alkaline rocks) provenance for the marine detritus.

Carbonate: Carbonate minerals analyzed are mainly foraminifera shells. The analysis indicates very high CaO and minor amounts of P_2O_5 and CaO. In ternary diagram that shows the classification of carbonate minerals, the analyzed grains plot towards the calcite end. In binary diagram showing the plots of carbonate in P_2O_5 vs MnO and P_2O_5 vs CaO diagram. The analyzed samples show positive trends in both these diagrams (Figure 9.15).

Other silicate grains: The other silicate grains analyzed during EPMA study are (i) amphiboles (hornblende/tremolites) (ii) epidote and (iii) high Mg-silicates.

Table 9.11: EPMA analysis of Clinopyroxenes

	DD-C-230					DD-A-60+120		
	CPx	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**
SiO_2	48.15	50.97	49.24	48.8	48.51	51.57	52.29	49.98
Al_2O_3	2.66	2.32	2.79	5.87	2.83	1.8	1.76	2.69
TiO_2	0.93	0.88	0.88	1.56	1.39	0.64	0.76	1.31
CaO	18.89	21.01	19.04	19.14	18.21	20.26	18.33	17.14
Na_2O	0.31	0.27	0.36	0.25	0.28	0.21	0.18	0.17
K_2O	0	0	0.02	0	0	0.01	0.01	0.04
FeO	8.96	7.4	8.45	9.52	11.95	8.31	9.06	15.26
MgO	15.2	15.82	15.22	14.78	14.57	16.31	17.39	12.78
P_2O_5	0.08	0.17	0.1	0.22	0.14	0.21	0.15	0.07
Cr_2O_3	0.86	0.12	0.7	0.08	0.38	0.18	0.36	0.12
MnO	0.09	0.05	0.1	0.19	0.37	0.07	0.33	0.35
	96.13	99.01	96.9	100.41	98.63	99.57	100.62	99.91

	DD-A-230		DD-SW-D				DD-B-60+120	
	CPx	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**
SiO_2	50.04	50.02	49.58	50.44	50.28	50.67	49.69	49.08
Al_2O_3	2.09	2.06	3.02	3.17	2.67	2.01	1.94	1.21
TiO_2	1.35	1.4	0.92	0.76	0.96	0.67	1.28	0.96
CaO	17.61	17.6	20.8	21.2	19.42	19.23	17.1	17.85
Na_2O	0.27	0.19	0.24	0.21	0.25	0.18	0.23	0.19
K_2O	0	0	0	0.01	0.01	0	0.03	0.01
FeO	14.25	14.63	7.2	6.14	8.94	8.62	16.41	14.21
MgO	13.89	14.5	15.32	16.05	15.62	16.47	12.97	13.46
P_2O_5	0.25	0.15	0.18	0.19	0.13	0.18	0.12	0.13
Cr_2O_3	0.01	0	0.52	0.68	0.26	0.43	0	0.22
MnO	0.23	0.23	0.13	0.08	0.16	0.24	0.28	0.22
	99.99	100.78	97.91	98.93	98.7	98.7	100.05	97.5

	DD-C-60-120-					
	CPx	**CPx**	**CPx**	**CPx**	**CPx**	**CPx**
SiO_2	50.63	50.35	49.79	50.92	52.45	50.59
Al_2O_3	2.04	2.4	1.98	1.39	1.34	2.98
TiO_2	1.16	0.98	1	0.9	0.68	0.86
CaO	18.1	19.23	18.93	18.12	14.98	20.17
Na_2O	0.28	0.19	0.32	0.25	0.21	0.23
K_2O	0.01	0	0.01	0	0.01	0
FeO	12.23	9.48	11.88	14.52	12.11	7.39
MgO	15.01	15.54	14.18	13.47	18.24	16.19
P_2O_5	0.18	0.15	0.15	0.26	0.14	0.15

Cr_2O_3	0.05	0.25	0.11	0.05	0.1	0.81
MnO	0.39	0.3	0.2	0.27	0.37	0.18
Total	100.23	98.91	98.56	100.54	100.74	99.6

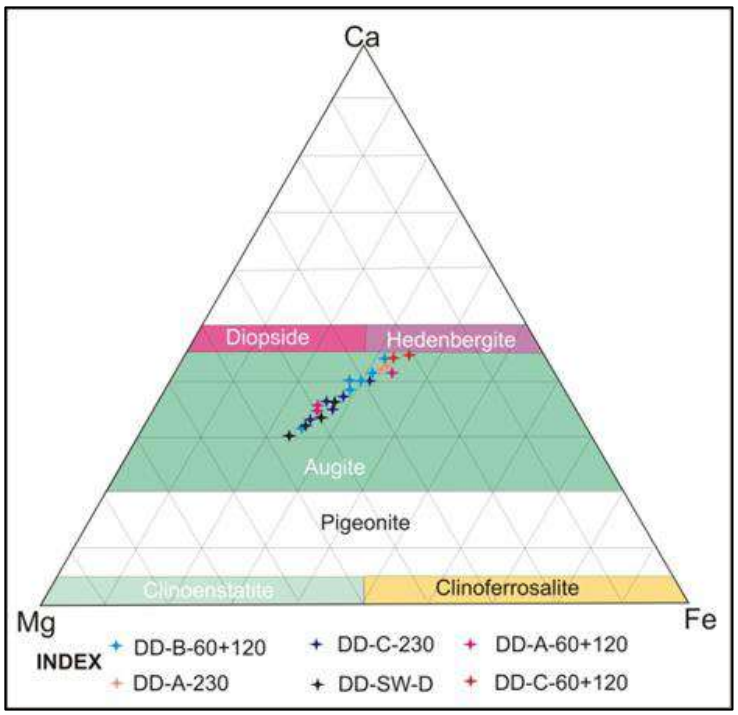


Figure 9.14: Ternary diagram showing classification of Pyroxene minerals. Note the Dandi-Onjal pyroxene plots distinctly in Augite Field. It shows distinct trend towards hedenbergite field.

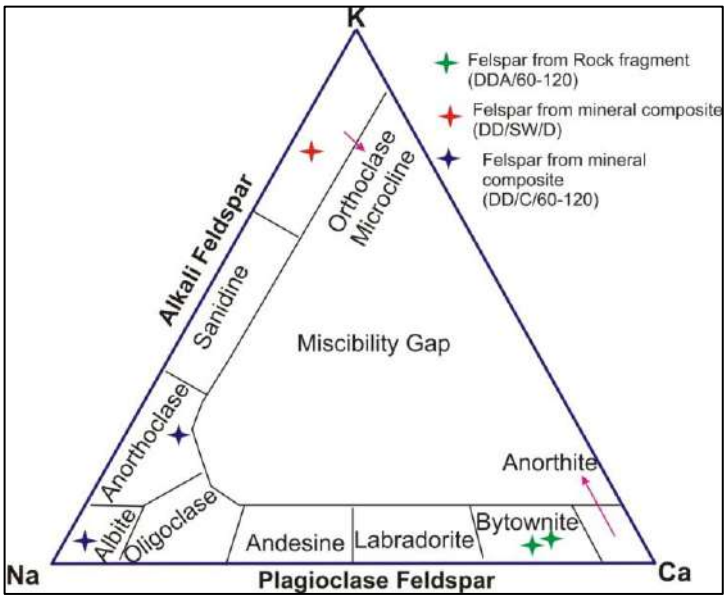


Figure 9.15: Ternary diagram showing feldspar classification. Note the detrital grains of feldspar from the area plot in bytownite, albite and orthoclase fields.

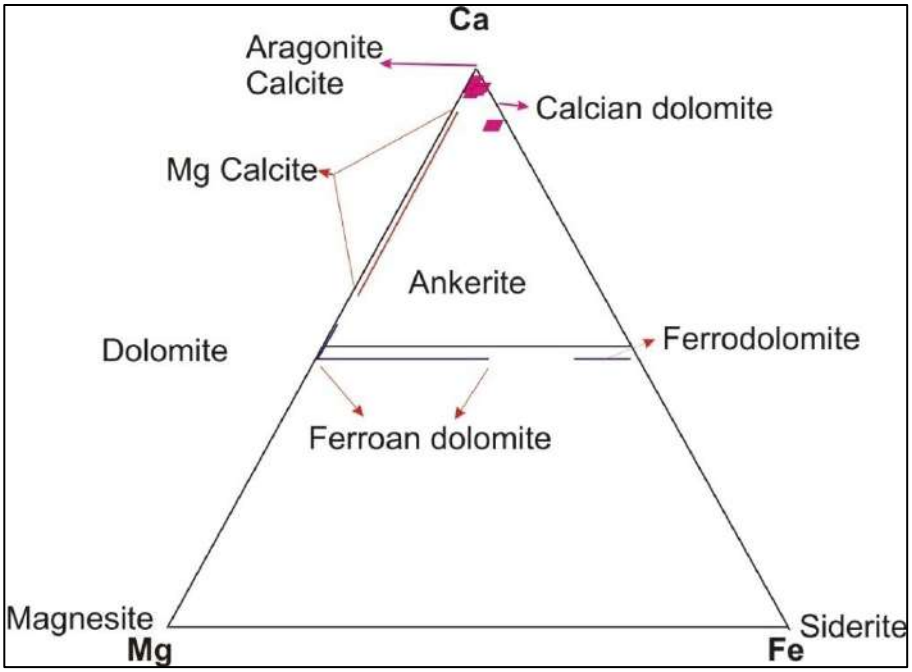


Figure 9.16: Ternary diagram showing classification of carbonate minerals. Note the samples from the study area falls in calcite/aragonite field.

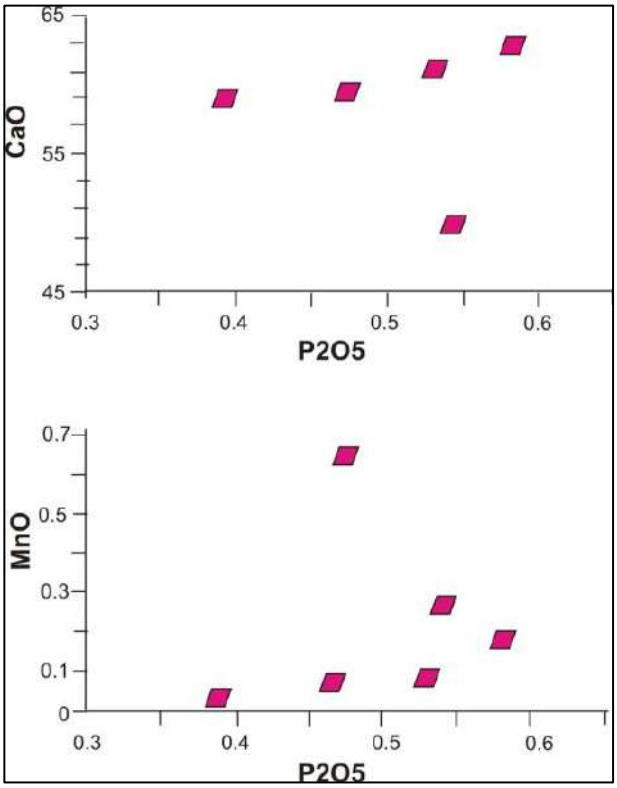


Figure 9.17: Binary diagram showing the plots of carbonate in P_2O_5 vs MnO and P_2O_5 vs CaO diagram. The analyzed samples show positive trends in both these diagrams

TABLE 9.12: EPMA analysis of carbonate (Foram Shells)						
EPMA analysis of Carbonate (Foram shell)						
	DD-C-60-120-					
	Foram	**Foram**	**Foram**	**Foram**	**Foram**	**Foram**
SiO_2	0.04	0	0.13	0.05	1.55	0.01
Al_2O_3	0.03	0	0.09	0.01	0.78	0
TiO_2	0	0	0.01	0.01	0	0
CaO	63.19	58.52	58.78	58.99	50.08	60.92
Na_2O	0.03	0.1	0.14	0.05	0.04	0.03
K_2O	0	0	0.01	0	0.12	0.02
MgO	0.16	0.14	2.24	0.09	3.4	0.96
FeO	0.08	0.09	0.15	0	3.35	0.06
P_2O_5	0.59	0.39	0.48	0.47	0.54	0.54
Cr_2O_3	0.01	0	0.02	0.04	0.07	0.04
MnO	0.21	0.01	0.65	0.09	0.3	0.06
NiO	0.01	0.04	0	0.02	0	0.02
ZnO	0	0.03	0	0	0	0.23
BaO	0	0	0	0.03	0	0
Total	64.35	59.34	62.7	59.84	60.23	62.89

Table 9.13: EPMA analysis of Feldspar						
	39 / DDA60+120	**43 / DDA60120**	**4 / DDSWD**	**1 / /DDC60120/1**	**5 / /DDC60120/1**	
	Plagio*	**Plagio***	**K-Feldspar**	**Plagioclase**	**Albite**	
SiO_2	51.16	51.33	65.21	67.77	65.79	
Al_2O_3	29.67	29.37	16.94	19.76	18.96	
TiO_2	0.11	0.1	0.07	0.05	0	
CaO	13.95	13.84	0.26	1.17	0.79	
Na_2O	3.53	3.66	3.02	6.81	11.05	
K_2O	0.22	0.16	10.29	2.27	0.03	
FeO	0.98	0.54	1.6	1.92	0.35	
MgO	0.2	0.14	0.29	0.22	0.04	
P_2O_5	0.14	0.18	0.05	0.22	0.02	
Cr_2O_3	0	0	0.03	0.05	0.2	
MnO	0	0.09	0.04	0.14	0.08	
NiO	0	0	0.03	0	0	
ZnO	0.32	0	0	0.04	0	
BaO	0	0	0.09	0	0	
Total	100.27	99.4	97.91	100.43	97.32	

*From Rock Fragment							
	35 / DDC230	**26 / DDC230**	**7 / DD-SW-D**	**14 / DDC60+120/1**	**17 / 1 DDB60+120**	**5 / DD-SW-D**	**10 /DD SWD/1**
	Amphibole		**Epidote**		**High Mg Silicates**		
SiO_2	46.21	49.11	42.18	42.3	36.22	53	20.64
Al_2O_3	0.99	1.57	20.31	18.53	11.68	3.28	13.07
TiO_2	0.81	0.93	0.08	0.08	1.96	0.04	0.04
CaO	12.8	13.64	24.95	26.32	10.67	0.11	0.52
K_2O	0.01	0	0.09	0.04	0.42	0.01	0
Na_2O	0.21	0.18	0.01	0	1.19	9.18	0.27
FeO	21.09	19.04	0.32	0.05	6.8	5.36	1.64
MgO	11.74	13.64	4.83	6.92	23.65	22.17	51.35
P_2O_5	0.08	0.04	0.28	0.16	0.47	0.04	0.32
Cr_2O_3	0	0	0	0.02	0	0	0.04
MnO	0.49	0.41	0.01	0	0.24	0	0
NiO	0	0	0	0.05	0	0.02	0
ZnO	0	0.2	0	0	0.08	0	0
BaO	0	0	0	0	0.01	0	0.01
Total	94.42	98.76	93.05	94.47	93.4	93.21	87.89

9.10 Petrographic work on grain mounts

Table 9.14: Summary of petrographic and EPMA studies

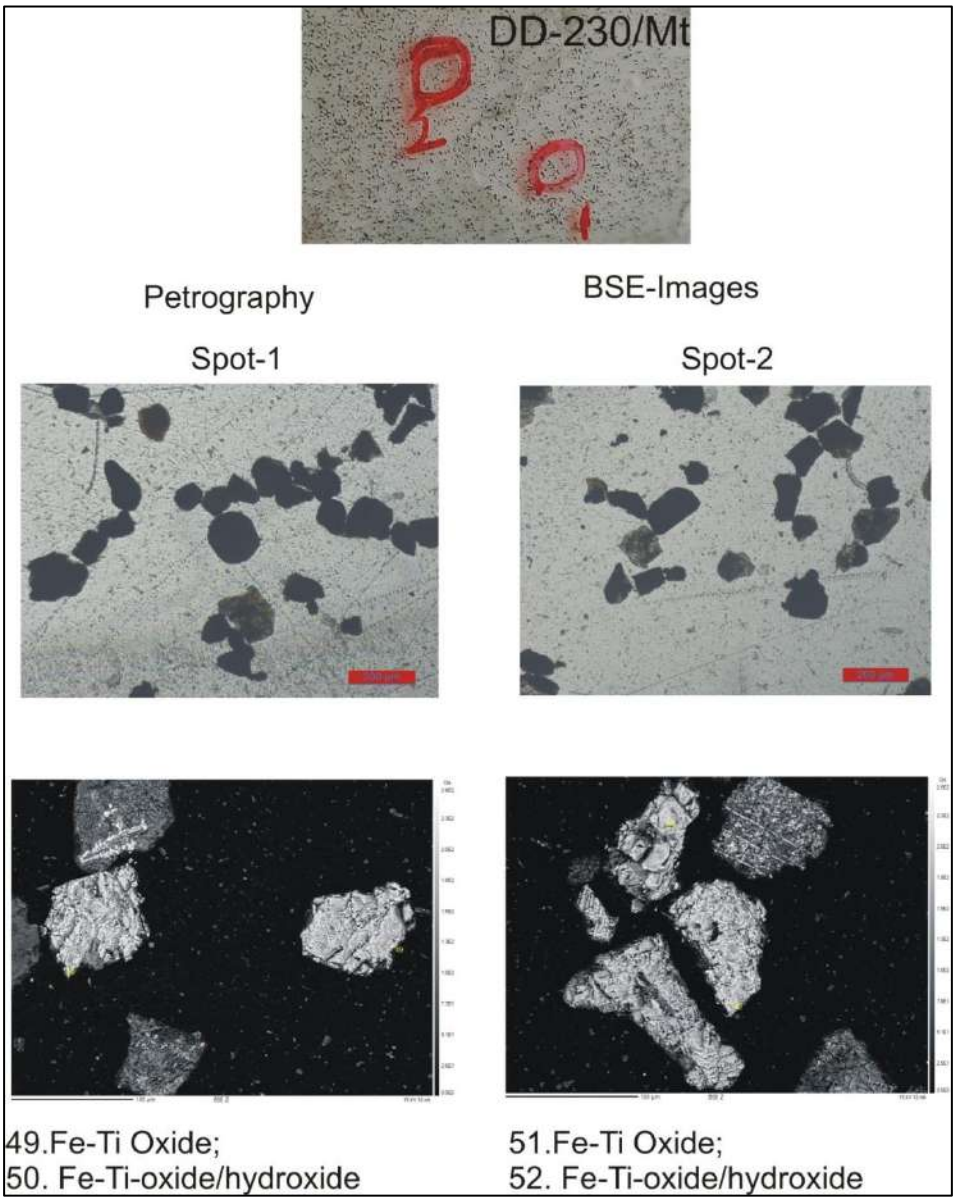
Sample Number	**Minerals Studied under microscope - (in order of abundance)**	**Minerals BSE Images/EPMA analysis**	**Photomicrograph /BSE plate appended**
DD/A/230-+230 frac LIRMS, Mt	Major: Ilmenite, magnetite. Minor: Pyroxene, epidote, Rare: Monazite/apatite (?)	Ilmenite Ti-Magneite	PLATE-I: Petrography&BSE
DD/230/A/Mt	Major Ilmenite, Ti-magnetite Minor: Pyroxene	Ilmenite Ti-Magnetite	PLATE-II Petrography&BSE
DD-A/60+120	Major: Rock Fragment, Ilmenite Minor: Pyroxene, Plagioclase	Ilmenite, clinopyroxene, plagioclase	PLATE-III Petrography&BSE
DD/B/60-120	Major: Rock Fragment, Ilmenite, magnetite Minor: Pyroxene, Plagioclase Rare: Phlogopite	Ilmenite, Fe-hydroxide (Ti-magnetite), clinopyroxene, sphene, amphibole	PLATE-IV Petrography&BSE
DD-C-60-120	Major: Ilmenite, magnetite, carbonate Minor: Pyroxene, plagioclase	Ilmenite, magnetite, clinopyroxene, carbonate	PLATE-V Petrography&BSE
DD-C-230	Major: Ilmenite, magnetite Minor: Pyroxene, amphibole, aluminosilicate, sphene	Ilmenite, magnetite, clinopyroxene, amphibole, epidote, sphene	PLATE-VI Petrography&BSE
DD-SW-D (with six spots)	Major: Ilmenite, magnetite		PLATE-VII Petrography&BSE

Sample Number	Minerals Studied under microscope - (in order of abundance)	Minerals BSE Images/EPMA analysis	Photomicrograph /BSE plate appended
	Minor: Pyroxene, plagioclase, carbonate, epidote Rare: Green spinel (?),	Ilmenite, magnetite, clinopyroxene, amphibole, epidote	
DD-B-230	Major: Pyroxene, plagioclase, carbonate, epidote Minor: Ilmenite, magnetite Rare: Green spinel (?),	Not determined	PLATE-VIII
DD-DO-D	Manor: Amphiboles, Al-silicate, Minor: Fe-Ti opaque, monazite (?)		PLATE-IX
DD-SW-D (duplicate slide, seven spots marked)	Pyroxene, epidote, Al-mineral, rock fragment Minor: Ilmenite, magnetite Rare: Sphene		PLATE-X

Note:

1. All sections represent grain mounts with variable polishing of the grains.
2. During petrographic studies the minerals are suspected based on fewer optical properties (form, cleavages etc). They are since confirmed with the EPMA data.
3. In attached plates, photomicrographs related to petrography are represented as per the spots marked on the thin section slides shown at the top of each plate.
4. Numbers marked in BSE images and also towards the bottom of each image represent the analysis number marked during the microprobe analysis of the grain mount.

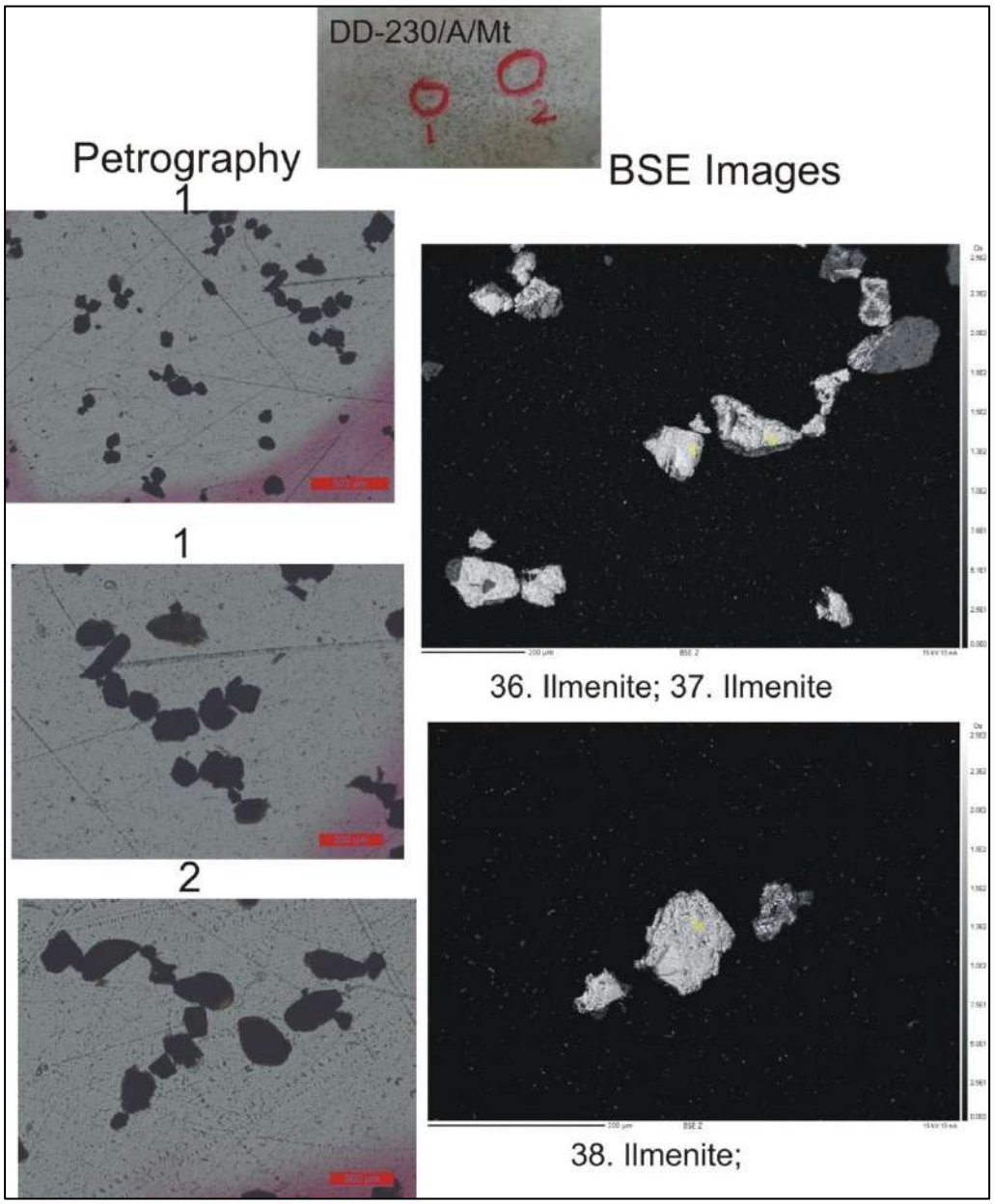
PLATE-I: DD-230/Mt



Spot-1: Ilmenite – coarse, well rounded dark opaques. –Magnetites (?) – fine grained, irregular boundaries, brownish edges. Pyroxene - subhedral, square translucent grains. Epidote-variegated interference colors.

Spot-2: Same as above. Suspected monazite grain

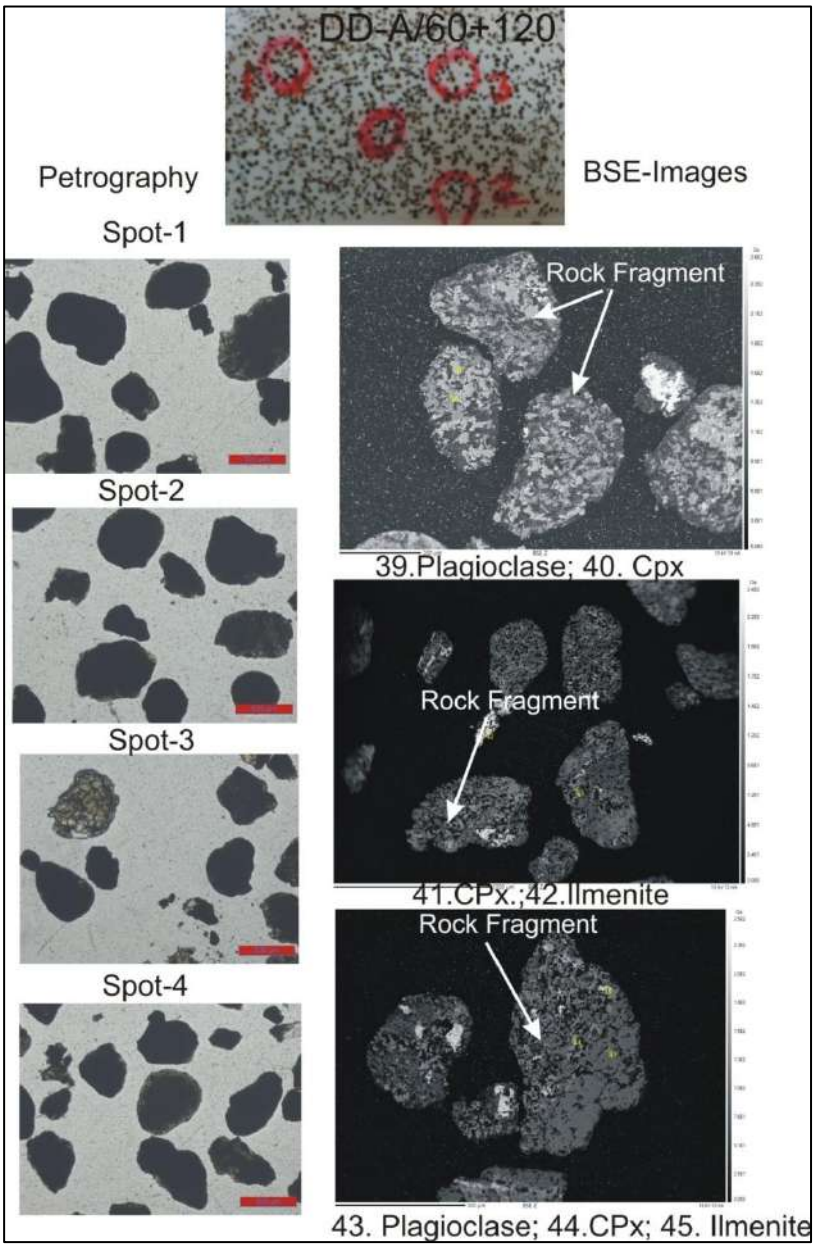
PLATE-II: DD-230/A/Mt



Spot-1: Fine grained minerals. Ilmenite dominant mineral phase; well rounded, oval shaped, dark (blackish) opaque mineral, fractured. Magnetites – very fine grained, irregular boundaries, brownish edges. Spot-2: Same as above. Suspected monazite grain.

Spot-2: Same as above.

PLATE-III: DD-A60+120

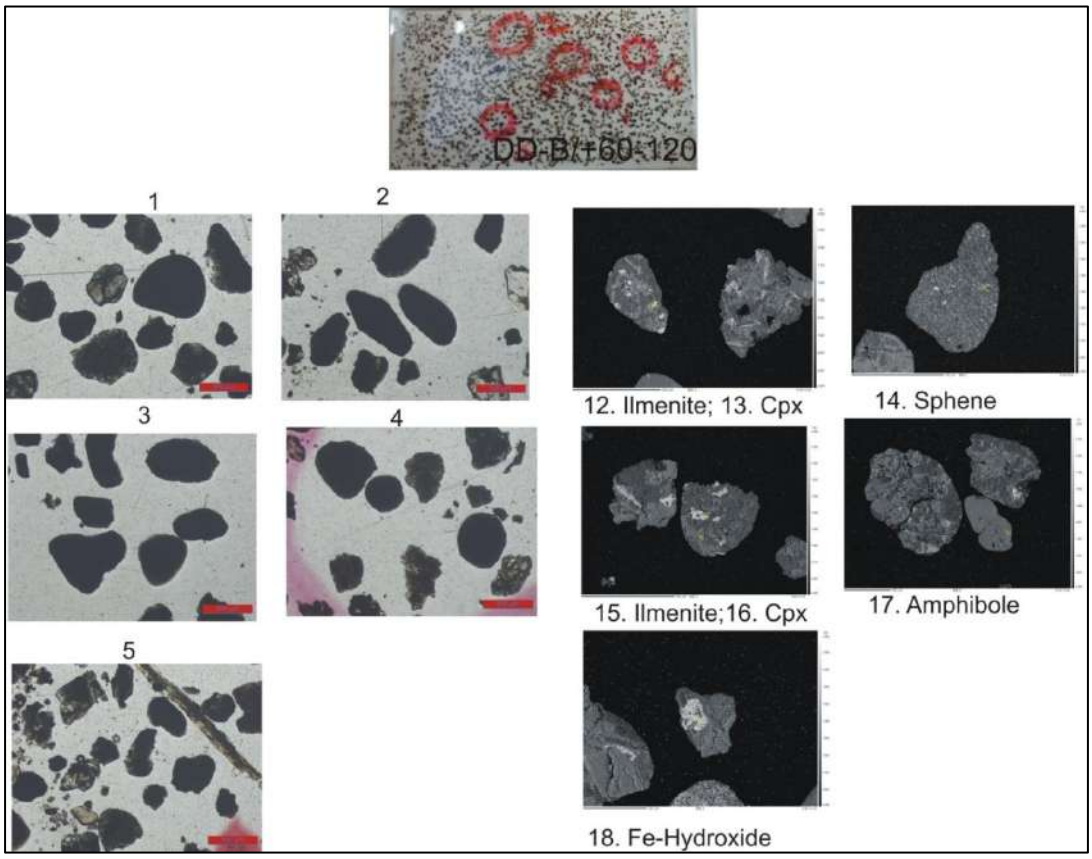


Spots-1 to 4:

Rock Fragments; subrounded to subhedral, contains mineral aggregates of clinopyroxene (dark, square grains with pyroxenic cleavages), plagioclase (light coloured, low birefringence) and tiny opaque mineral.

Ilmenite: Well rounded to subrounded independent grains (also occur as inclusions in rock fragments (please see the BSE images).

PLATE-IV - DD-B/60-120



Spot-1: Larger size, well rounded Ilmenite, small size grains of Ti-magnetite, sub-hedral grains of translucent clinopyroxene and brownish grains of sphene.

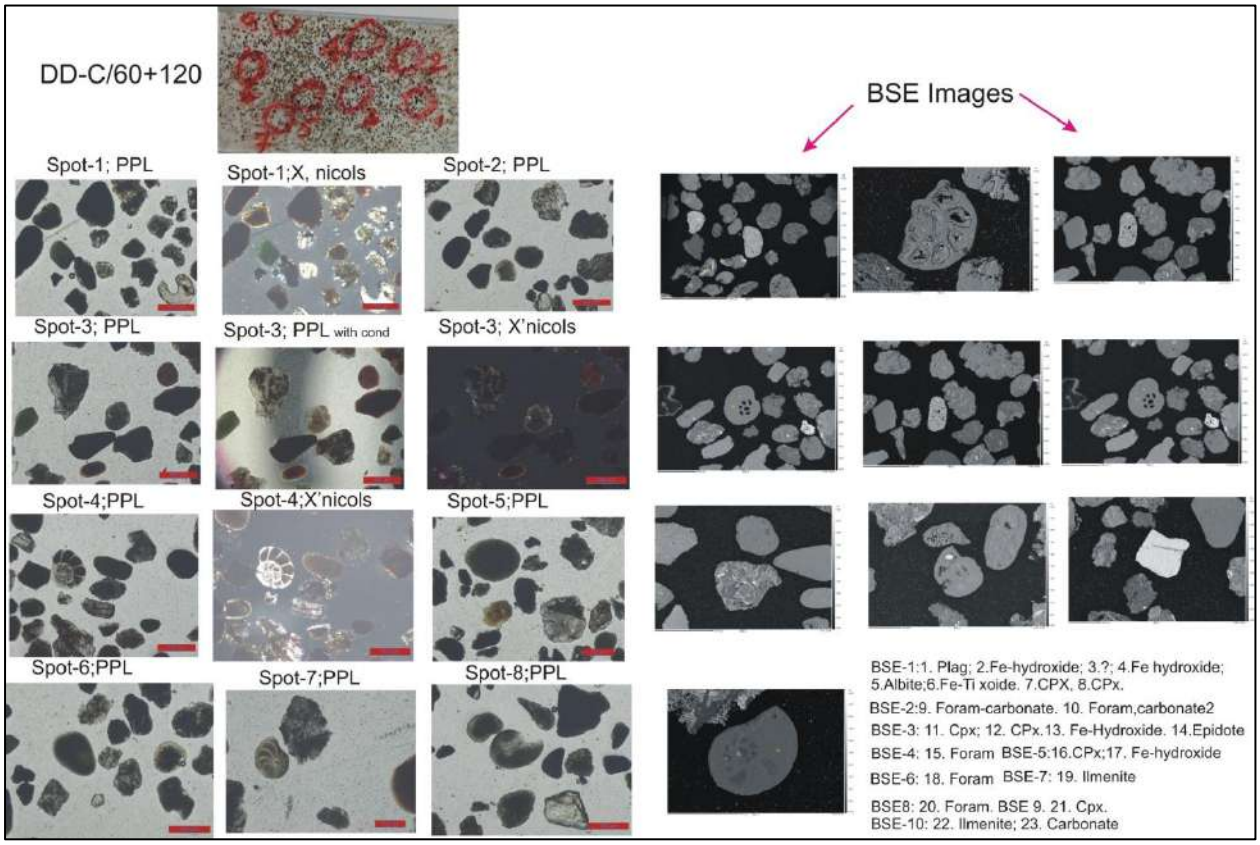
Rock fragments have tiny inclusions of ilmenite. Please see BSE image (top left) – each grain has light grey slender laths of plagioclase embedded (sub-ophitic texture) in dark grey pyroxene. The tiny shinning grains represent ilmenite.

Spot-2 and 3: Ilmenite grains are fairly elongated in shape. Rock fragments are fewer in number. Small size opaque grains with brownish margins may represent magnetite. Occasional laths of colorless grain may represent plagioclase.

Sopt-4: Well-rounded ilmenite. Pyroxene occur as square silicate grains. Finer size opaque minerals represent Ti-magnetite

Spot-5: Silicate dominant spot. Elongated flakes of mica. Brown color (may be phlogopite). Pyroxene also occurs.

PLATE-V - DD-C/60-120



Spot-1: Ilmenite and Ti-magnetite mineral dominates. Among silicate minerals, pyroxene is more. A green subrounded mineral is suspected as glauconite (please see petrography image 'Spot-1, X'nicol).

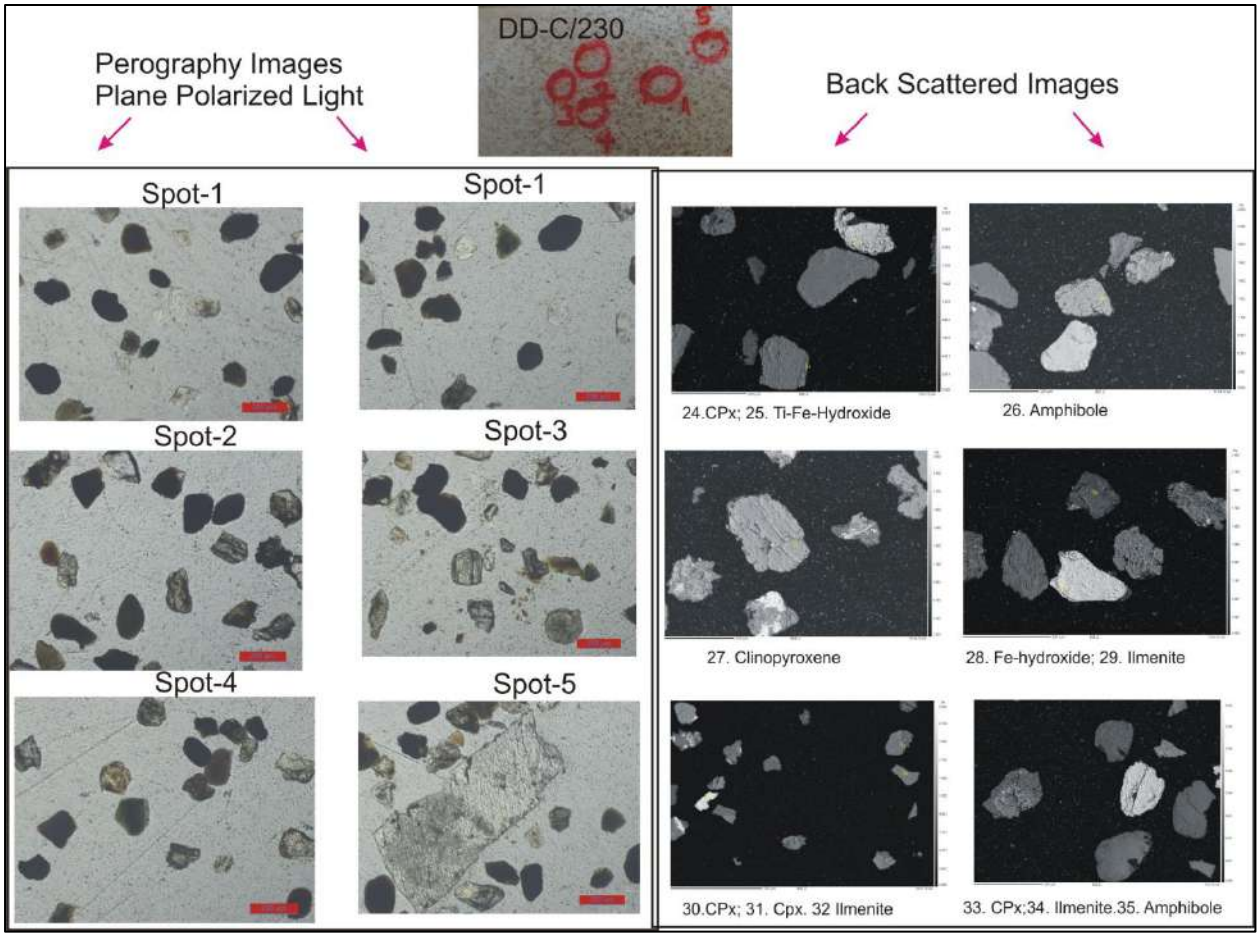
Spot-2: Ilmenite and Ti-magnetite mineral; pyroxene and plagioclase occur.

Spot-3: Ti-Magnetite, ilmenite and pyroxene. Green mineral (glauconite) also occurs.

Spot-4 to 6: Fe-Ti-opaques (ilmenite, Ti-magnetite) and Pyroxene and alumino-silicate (kyanite? high relief, colorless, turbid sub-angular to sub-hedral grains).

Foraminifera: Fragments of Foraminifera shells. Well developed with clear foram features.

PLATE-VI- DD-C/230



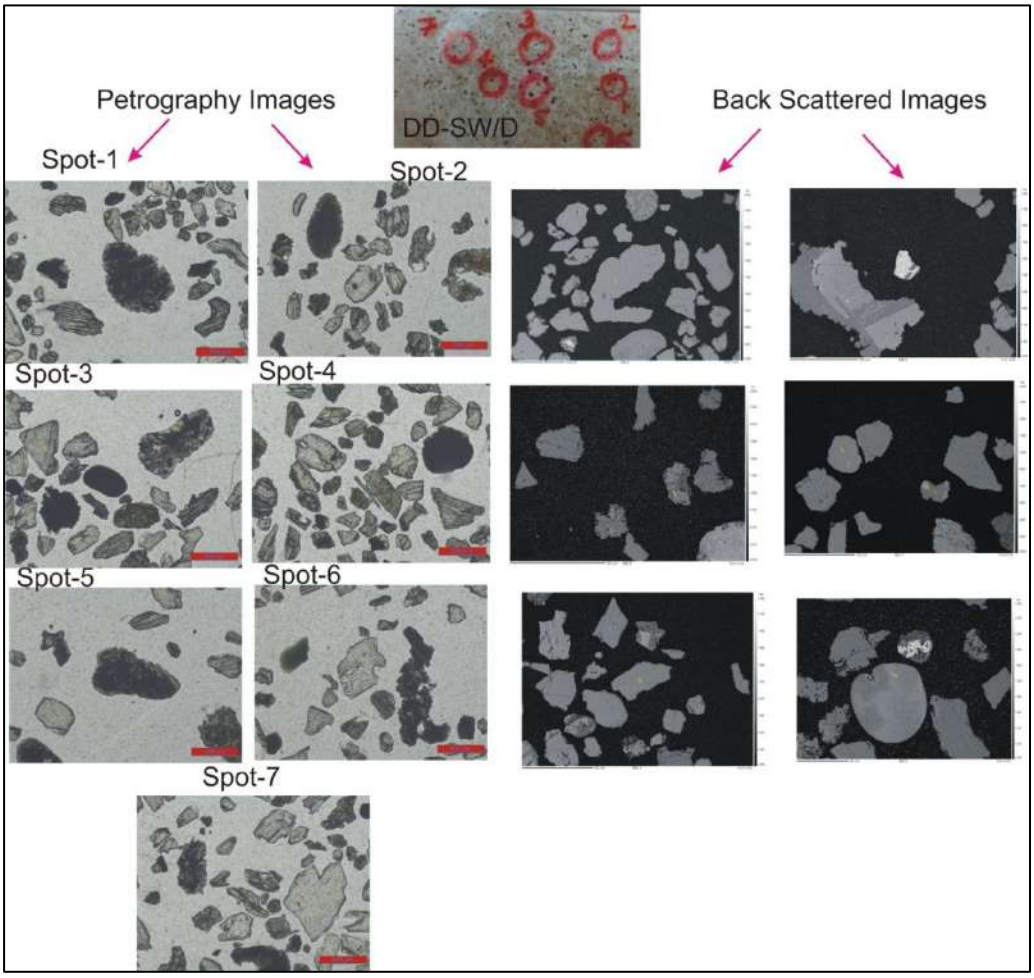
Spot-1: Ilmenite and magnetite grains. Colorless, high relief silicates.

Spot-2: Silicate dominant spot. Pyroxene is ubiquitous. Reddish silicate grain may be rutile. Green silicate mineral, slender, subhedral, green color may be tremolite. Ilmenite, Ti-magnetite occur.

Spot-3 & 4: Silicate dominant spot. Silicates are represented by (i) rounded to subhedral brownish grain (sphene), colorless to pale green square grains with two sets of cleavages to perpendicular each other (pyroxene), elongated long, slender grains, green in colour, low extinction angle ~18° (amphibole). Tiny bipyramidal grains of zircon noticed.

Spot-5: Besides the minerals recorded inspot3 & 4, this spot contains a large, colorless tabular turbid grain, high relief with strong borders, parallel extinction. This is suspected as kyanite.

PLATE-VII - DD-SW/D



Spot 1 & 2: Pyroxene and Rock fragments dominates. Fe-Ti opaque minerals are rare/absent.

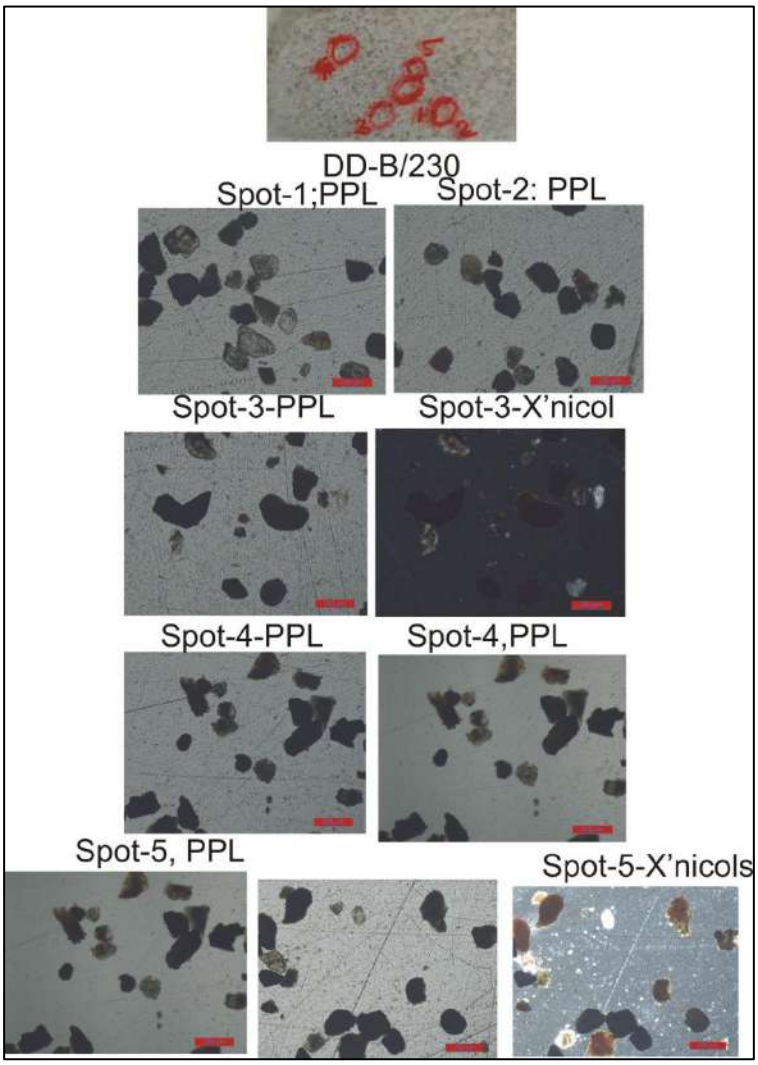
Spot 3: Silicate dominates. Fe-Ti opaques rare/absent. Among silicate pyroxene and high relief colorless mineral (alumino silicate) dominates.

Spot-4: Pyroxene with parallel extinction noticed (orthopyroxene?). The other pyroxene with inclined extinction dominates. High relief colorless mineral also ubiquitous.

Spot-5: Dark elongated, irregular shaped rock fragment of basaltic rock (pyroxene + plagioclase, basaltic texture).

Spot-6 and 7: Same as spot-5. In addition, a green-colored amphibole recorded.

PLATE-VIII - DD-B/230



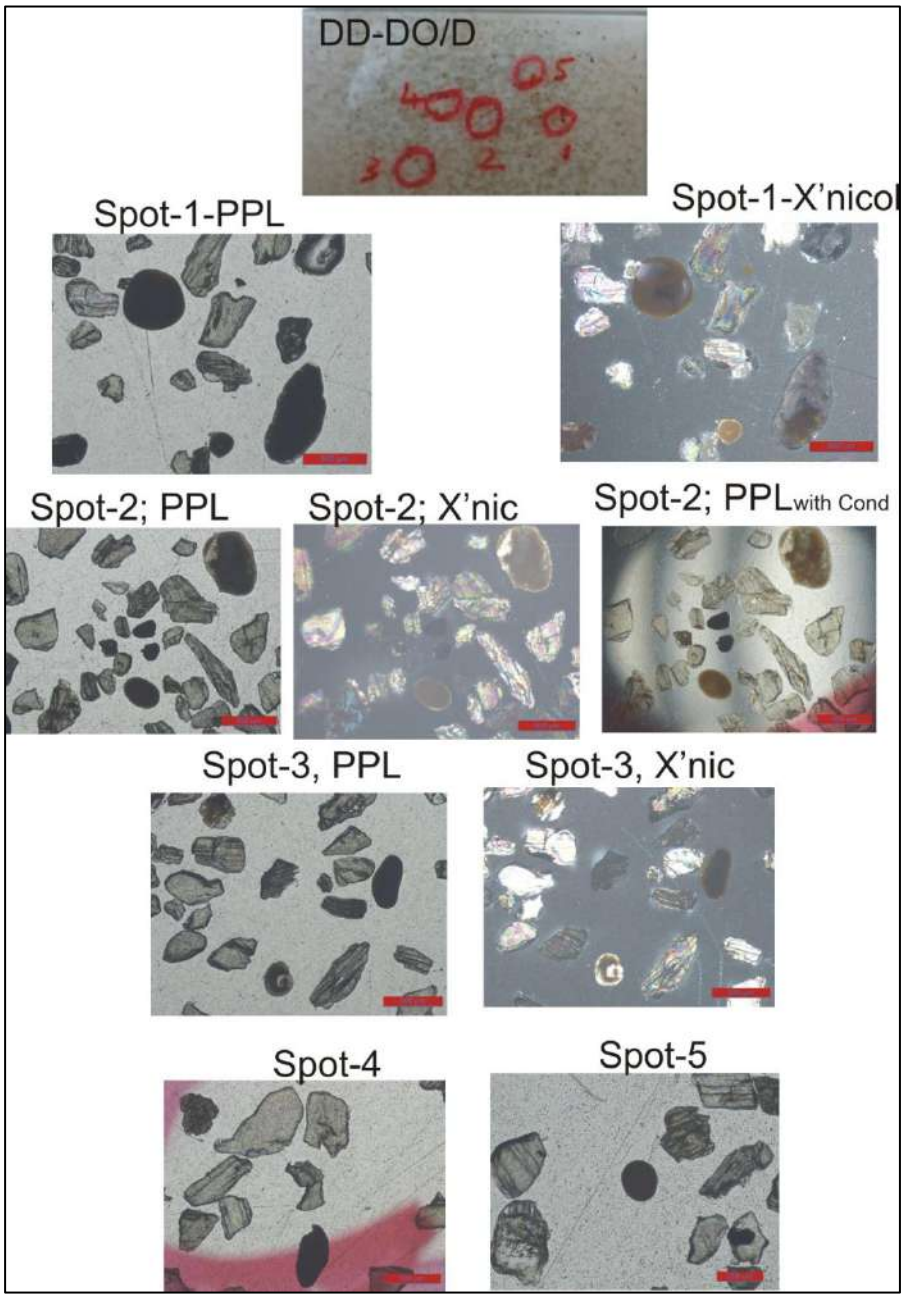
Spot-1: Both silicates and opaque minerals present. Among silicate minerals pyroxene dominates. Occasional grains of amphibole noticed. Epidote is rare. Ilmenite and Ti-magnetite rare.

Spot-2: Ilmenite is most dominant opaque. Ti-magnetite also occur.

Spot-3: Opaque mineral in Knee-bend shape (Rutile???). Ilmenite and magnetite abundant. Tiny grains of pyroxene plagioclase noticed.

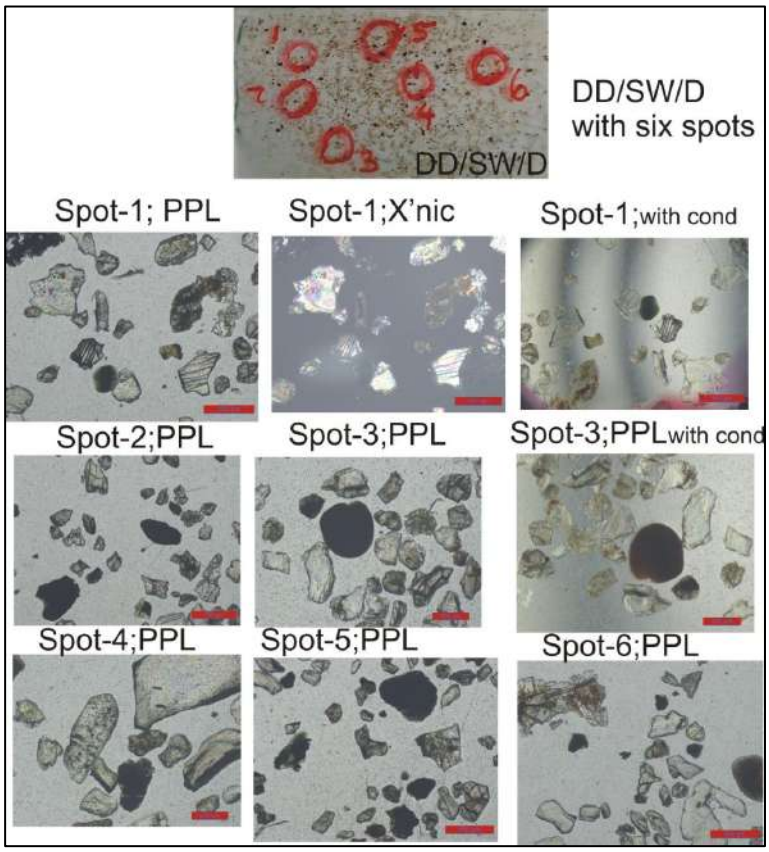
Spot-4 and 5.: Both silicates and opaque minerals present. Among silicate minerals pyroxene dominates. Occasional grains of amphibole noticed. Epidote is rare. Greenish opaque mineral may represent green spinel. Ilmenite and Ti-magnetite rare.

PLATE-IX - DD-DO-D



Spot-1 to 5: Almost identical mineral grain population. Summary for the five spots: Mainly silicate. Pyroxene (short prismatic, square grains), amphibole (long prismatic, green-colored grains) and aluminous silicates (colorless minerals with high relief, stout borders). Carbonates, mainly in the form of rounded foraminifer shells are present. Well-rounded ilmenite and smaller opaque brownish grains of magnetite recorded.

PLATE-X-DD-SW-D



Spot-1: Pyroxene is the most dominant silicate mineral. Epidote is next in abundance. Greenish mineral, possibly glauconite could be present.

Spot-2 & 3: Silicate dominates. Few grains of rounded magnetite (brownish margin, please seen image 'Spot-3, PPL with cond.) noticed.

Spot-4: Colorless, euhedral grain with pyramidal termination and cleavage may represent euhedral crystal of pyroxene. Large mineral fragment with high relief and no cleavages may represent an alumino silicate (kyanite). Brownish mineral aggregate of (basaltic rock fragment present. Sphene noticed. Spot-5 & 6: Mineral and rock fragments of various shapes and sizes. Silicates mainly pyroxene and plagioclase. High relief colorless mineral dominates in Spot-6.

9.11 Check Samples

As per the provisions of NMET, 14 samples from Dandi-Onjal-Surwada block were considered as check samples and analyzed for major oxides at Bureau of Veritas, Gujarat. The

results of check sample analysis are attached in Annexure 16. The analysis employed lithium borate fusion bead followed by WDXRF following the standard procedure IGI/GDM/TPM-48.

9.11.1 Comparison of Primary Vs Check values

The scatter plot and the statistical analysis of Primary Vs Check sample analysis of Fe_2O_3%, TiO_2% and V_2O_5% are given in table 9.16 to 9.14 and fig.9.17 to 9.19. The details are given in Annexure 16.

9.11.1.a. Fe_2O_3: The primary analysis for Fe_2O_3 assay has been checked by analyzing 14 nos. of check samples. The statistical analysis of Fe_2O_3 for primary assay vs check assay is given in Table 9.16 and the scatter plot is shown in fig 9.17. The table 9.16 shows a correlation coefficient of 0.320.

Table 9.15: Comparison table of Primary vs check samples for Fe_2O_3

Comparison Index	Fe2O3 (wt%)	
	Primary samples	Check samples
No. of sample pairs	14	14
Arithmetic Mean	31.52	30.88
Standard Deviation	4.40	3.57
Std. Error of Mean	1.22	0.99
Variance	19.35	12.77
Mean of Deviation	0.63	
Correlation Coefficient	0.3201	

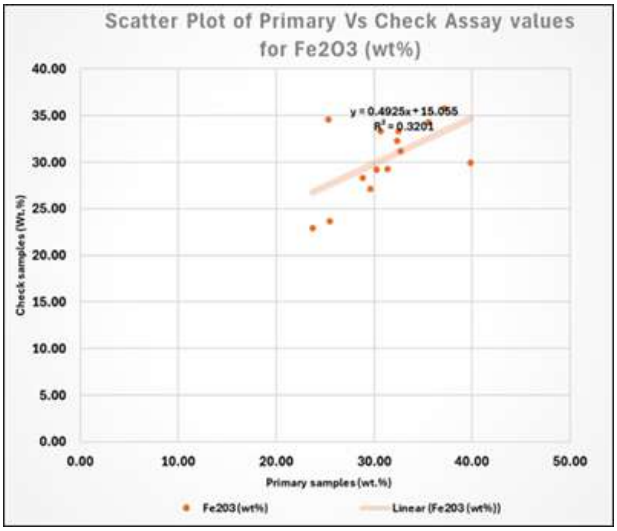


Figure 9.18: Scatter plot for Fe_2O_3

9.11.1 b. TiO_2: The statistical analysis of TiO_2 for primary assay vs check assay is given in Table 9.17and the scatter plot is shown in fig 9.18. The table 9.17 show the correlation coefficient of 0.664.

Table 9.16: Comparison table of Primary vs check samples for TiO_2

Comparison Index	TiO_2 (wt%)	
	Primary samples	Check samples
No. of sample pairs	14	14
Arithmetic Mean	15.290	15.38
Standard Deviation	4.11	3.43
Std. Error of Mean	1.140	0.95
Variance	16.89	11.79
Mean of Deviation	-0.09	
Correlation Coefficient	0.664	

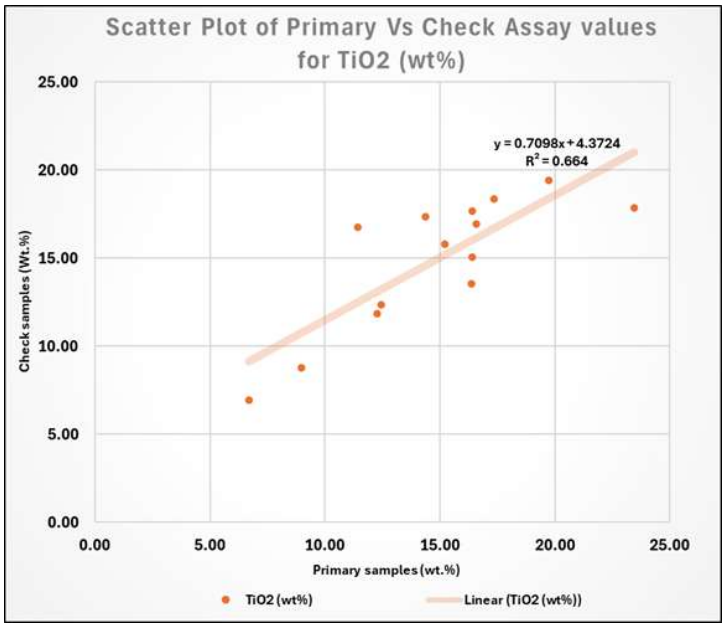


Figure 9.19: Scatter plot for TiO_2

9.11.1.c. V_2O_5: The statistical analysis of V_2O_5 for primary assay vs check assay is given in Table 9.18 and the scatter plot is shown in the fig 9.19. The table 9.18 show the correlation coefficient of 0.3986.

Table 9.17: Comparison table of Primary vs check samples for V_2O_5

Comparison Index	V_2O_5 (wt%)	
	Primary samples	Check samples
No. of sample pairs	14	14
Arithmetic Mean	0.2	0.29
Standard Deviation	0.05	0.06
Std. Error of Mean	0.013	0.02
Variance	0.002	0.003
Mean of Deviation	-0.09	
Correlation Coefficient	0.3986	

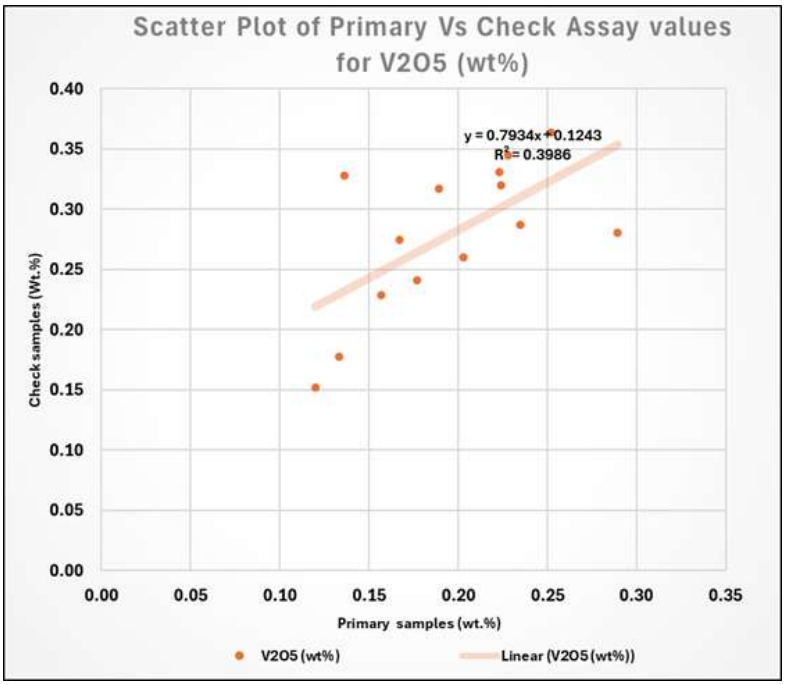


Figure 9.20: Scatter plot for V_2O_5

CHAPTER 10 - RESOURCE ESTIMATION

Characteristically titaniferous magnetite ores vary significantly in composition, containing from 16% to 60% Fe, 1.5% to 38% TiO_2 and 0.1% to 2% V_2O_5 and are also generally low in S and P (Fischer, 1975; Pang et al., 2010). Deposits of titanomagnetite are found in significant quantities throughout the world. Substantial and expanding resources are found in the Panzhihua Complex in Sichuan Province, China (Pang et al., 2010) and the Windimurra Complex, Australia (Ivanic et al., 2010). Most titaniferous magnetite deposits are vanadium-bearing, and many also contain inter-grown or spatially associated ilmenite (Peck and Huminicki, 2016).

The resource estimation was carried out based on the magnetic separation values (160 no's) and chemical analysis results (139no.s). The Total heavy mineral (THM) constitutes LIRMS-magnetics (A fraction), REDMS-magnetics (B Fraction), REDMS-middlings (C fraction) and Non-magnetic heavy minerals (D fraction). Whereas three magnetic fractions viz: LIRMS-magnetics (A fraction), REDMS-magnetics (B Fraction), REDMS-middlings (C fraction) termed as valuable heavy minerals (VHM) or Ore minerals due to their respective average concentrations of key components (Ti and V). The Ti & V concentrations are found higher in #230 ASTM fraction; hence ABC#230 is denoted as Prime Ore.

10.1 Assumption for resource estimation

10.1.1 Dimensions of block

3D block modelling and resource estimation is carried out using Surpac software 2025. During the resource estimation, the unit blocks are considered with dimension of 100mx100m size and 1m vertical thickness, since the borehole sampling was done at 400mx200m interval. The unit blocks are further divided in to sub blocks having dimension 25mx25mx0.25m to get full coverage along the block boundary.

10.1.2 Topography

Topographic digital terrain model (DTM) was created using the elevation data collected during topographic survey. The reference for the elevation is mean sea level (msl). As per the topographic survey data, the highest elevation is 9.49m above msl and lowest elevation within the block is -3.55m with respect to msl. The DTM is considered as one of the constrain during modelling in which, the estimation was done only below the topographic DTM.

10.1.3 Buffer area

The famous Dandi museum and historically important Salt Satyagarh Memorial as well as Smrithi Mantap is situated near to the Dandi coast which is close to exploration area. Therefore, the tourist places having an area of 5,03,459 sq.m has been kept as buffer zone.

10.1.4 Distribution of mineralization.

The distribution of mineralization is assumed to be as linear.

10.1.5 Solid modelling

During section preparation and solid modelling, the thickness is considered till the total depth of boreholes. Both Dandi and Surwada sector boundaries are bounded by beach/sea along the western side and dune is ending towards east. Therefore, the solid model is considered tapering at both sides. The solid model is used as constrain during resource estimation in which resource was calculated with in the solid model.

10.2 Resource estimation by cross section and longitudinal vertical section methods

10.2.1 Resource estimation of Dandi-Onjal sector and Surwada sector

Table 10.1: Statistical analysis of Fe_2O_3, TiO_2 and V_2O_5 in Magnetic fractions (160 samples)

	LIRMS magnetics (A Fraction)			REDMS magnetics (B Fraction)			REDMS middlings (C Fraction)		
	Min (%)	Max (%)	Average (%)	Min (%)	Max (%)	Average (%)	Min (%)	Max (%)	Average (%)
Fe_2O_3	30.01	59.61	45.736	20.61	47.25	33.525	19.04	37.65	29.561
TiO_2	5.54	25.98	18.255	2.89	41.41	17.98	1.47	15.32	7.005
V_2O_5	0.1	0.61	0.386	0.05	0.27	0.131	0.05	0.16	0.085

The statistical table for all fractions and components is given in the table 10.2.

Table 10.2: Statistics of 3D Modelling

	Surwada Sector			Dandi-Onjal Sector		
	Min (wt%)	Max (wt%)	Avg (wt%)	Min (wt%)	Max (wt%)	Avg (wt%)
A fraction (LIRMS Mag.)	33.308	60.936	48.389	14.845	46.643	34.540
B fraction (REDMS Mag.)	0.080	11.661	3.855	0.089	5.554	1.200
C fraction (REDMS Mid.)	12.528	43.474	23.015	5.607	64.705	21.784
D fraction (Non-Mag. heavy minerals)	0.437	4.887	1.645	0.553	12.453	5.112
E fraction (Non-Mag. light minerals)	5.458	29.290	11.800	8.236	42.407	28.943
gravel	0.000	22.251	8.154	0.000	26.622	1.133
clay	0.000	14.607	1.831	0.000	60.336	6.214
A#230	2.057	18.127	5.719	0.006	14.494	5.409
B#230	0.031	1.519	0.221	0.003	4.873	0.227
C#230	1.260	27.445	5.701	0.966	18.545	5.244
ABC#230	3.702	38.477	11.641	1.756	33.950	10.880
Fe_2O_3	14.274	29.022	24.651	25.639	51.639	34.245
TiO_2	3.043	10.146	7.818	9.814	20.662	16.572
V_2O_5	0.025	0.185	0.139	0.025	0.282	0.202
Fe_2O_3 bulk	0.935	9.735	2.852	0.584	8.962	3.761
TiO_2 bulk	0.297	3.614	0.911	0.299	4.592	1.796
V_2O_5 bulk	0.005	0.061	0.016	0.001	0.058	0.022
Bulk density	1.318			1.427		

The statistical analysis of fractions/components reveals that the valuable heavy minerals (VHM) are varying from 1.756 wt% to 33.950 wt% with an average of 10.880 wt% in the Dandi-Onjal sector, whereas it is ranging from 3.702 wt% to 38.477 wt% with an average of 11.641 wt%% in Surwada sector (Table 10.2). The Fe_2O_3 value in total sand body is ranging between 0.584% and 8.962% with an average of 3.761%, whereas 0.935 % to 9.735% with an average of 2.852% in Surwada sector. Minimum and maximum value of TiO_2 is 0.299 % and 4.592% respectively with average of 1.792% in Dandi-Onjal sector while 0.297% and 3.614% respectively with average of 0.911% in Surwada sector. The V_2O_5 values shows minimum of 0.001%, Maximum of 0.058% and average 0.022% in Dandi-Onjal sector. The Surwada sector having minimum, maximum and average value of V_2O_5 is 0.005, 0.061 and 0.016 respectively.

Table 10.3: Overall estimation of sand body with in the block

	Area (sq.km)	Tonnage (MMT)
DANDI-Onjal Sector	2.719	9.947
SURWADA Sector	0.950	2.870
Total	**3.669**	**12.817**

Table 10.4: Sector wise estimation of THM and VHM in the sand body

Fractions	Dandi-Onjal sector		Surwada sector		TOTAL	
	Avg grade %	Tonnage (MMT)	Avg grade %	Tonnage (MMT)	Avg grade %	Tonnage (MMT)
A fraction	34.647	3.006	49.379	1.417	42.013	4.424
B fraction	1.207	0.105	4.100	0.118	2.654	0.222
C fraction	21.870	1.898	22.753	0.653	22.312	2.551
D fraction	5.111	0.443	1.652	0.047	3.382	0.491
	TOTAL THM	**5.452**		**2.236**		**7.687**
	TOTAL VHM	**5.008**		**2.188**		**7.197**

Table 10.5: Sector wise estimation of Prime Ore in the sand body

Sieve fractions	Dandi-Onjal sector		Surwada sector		TOTAL	
	Avg grade %	Tonnage	Avg grade %	Tonnage	Avg grade %	Tonnage
A#230	5.416	0.470	5.442	0.156	5.429	0.626
B#230	0.227	0.020	0.209	0.006	0.218	0.026
C#230	5.254	0.456	5.336	0.153	5.295	0.609
ABC#230	**10.897**	**0.945**	**10.987**	**0.315**	**10.942**	**1.261**

Table 10.6: Sector wise estimation of Fe_2O_3, TiO_2 and V_2O_5 in the sandbody and Orebody.

		In total sand			Grade in Ore Mineral (%)		
SECTOR		**Fe_2O_3**	**TiO_2**	**V_2O_5**	**Fe_2O_3**	**TiO_2**	**V_2O_5**
DANDI	Avg grade %	3.767	1.800	0.022	34.253	16.575	0.202
	Tonnage (MMT)	0.3268	0.1562	0.0019			
SURWADA	Avg grade %	2.707	0.866	0.015	24.860	7.916	0.142
	Tonnage (MMT)	0.0777	0.0249	0.0004			
TOTAL	**Avg grade %**	**3.237**	**1.333**	**0.019**	**29.557**	**12.246**	**0.172**
	Tonnage (MMT)	**0.4045**	**0.1810**	**0.0023**			

10.2.2 Resource estimation of +120# fraction in Bulk sample (7.447kg) of Dandi-Onjal-Surwada Block

In addition to the estimated resource of ore body i.e.; 230# fractions, the resource of 120# fraction is also calculated in bulk sample as discussed above (Section 9.4.4).

Table 10.7: Estimation of Fe_2O_3, TiO_2 and V_2O_5 in the bulk sample

Sample No	wt% of fractions	Tonnage of fractions (MMT)	Oxides	wt%	Tonnage of Oxides (MMT)
DD/ABC/120#Mt	7.896	1.0121	Fe_2O_3	27.47	0.2780
			TiO_2	8.22	0.0832
			V_2O_5	0.2	**0.0020**
DD/ABC/120#NMt	16.141	2.0688	Fe_2O_3	19.89	0.4115
			TiO_2	6.07	0.1256
			V_2O_5	0.06	**0.0012**

10.3 Detailed description of ore zones

The Tonnage of total sand body is calculated as **12.817 MMT (Table 10.3)**. The total tonnages of THM and VHM are **7.687MMT** and **7.197 MMT respectively (Table 10.4). The Prime ore constitutes 10.942% of total sand i.e., 1.261 MMT (Table 10.5).**

10.4 Cut-off grade

The chemical composition of titanomagnetite concentrate processed by industrial smelters in Highveld Steel, South Africa, contains 1.65 wt% V_2O_5 and 12.7 wt% TiO_2, in New Zealand Steel, New Zealand, the concentrate contains 0.56 wt% V_2O_5 and 7.8 wt% TiO_2 whereas in Panzhihua Steel, China, the titanomagnetite concentrate has 0.58 wt% V_2O_5 and 12.7 wt% TiO_2. In NTMK Steel, Russia, the concentrate contains between 0.57-0.66 wt% V_2O_5 and approximately 3 wt% TiO_2 (Geldenhuys et.al., 2020). These details refer to magmatic iron-titanium deposits in layered gabbro except that of New Zealand Steel.

The Dandi-Onjal sector has average grade of 3.767% Fe_2O_3, 1.800% TiO_2, and 0.022% V_2O_5 in the total sand body and 34.253% Fe_2O_3, 16.575% TiO_2 and 0.202% V_2O_5 in the ore body (ABC230#). The Surwada sector has average grade of 2.707% Fe_2O_3, 0.866% TiO_2 and 0.015% V_2O_5 in the total sand body and 24.860% Fe_2O_3, 7.916% TiO_2 and 0.142% V_2O_5 in the ore body (ABC230#).

10.5 Description and correlation of lodes

10.5.1 Univariate Statistics

The descriptive statistics based on the supplied borehole data is as follows.

Table 10.8 Descriptive Statistics of Fe_2O_3, TiO_2 and V_2O_5 (in wt. %).

Descriptive Statistics			
Parameters	**Fe203 wt.%**	**TiO2 wt%**	**V2O5 wt%**
Mean	31.35	14.83	0.19
Standard Error	0.68	0.60	0.01
Median	31.75	15.85	0.20
Standard Deviation	5.65	5.02	0.06
Sample Variance	31.88	25.23	0.003
Kurtosis	1.97	-0.64	0.86
Skewness	0.17	-0.22	-0.45
Range	37.37	21.85	0.29
Minimum	14.27	3.04	0.03

Descriptive Statistics			
Parameters	**Fe_2O_3 wt.%**	**TiO_2 wt%**	**V_2O_5 wt%**
Maximum	51.64	24.90	0.32
Sum	2163.14	1023.24	13.36
Confidence Level (95.0%)	1.36	1.21	0.01

10.5.2 Bivariate Statistics

In geological or geochemical studies, the correlation between Fe_2O_3 and TiO_2, or TiO_2, and V_2O_5, or Fe_2O_3, and V_2O_5 can potentially reveal important information about the origin and processes affecting the sediments being analyzed. A strong positive correlation between oxides often suggests a common source or similar geochemical behavior during weathering, transportation, or deposition. The bivariate statistics show a very good correlation among pairs (bivariate scatter plots) for Fe_2O_3, TiO_2, and V_2O_5, showing a potentially common source. This indicates that iron, titanium, and vanadium-bearing minerals are being concentrated due to similar physical and/ or chemical conditions.

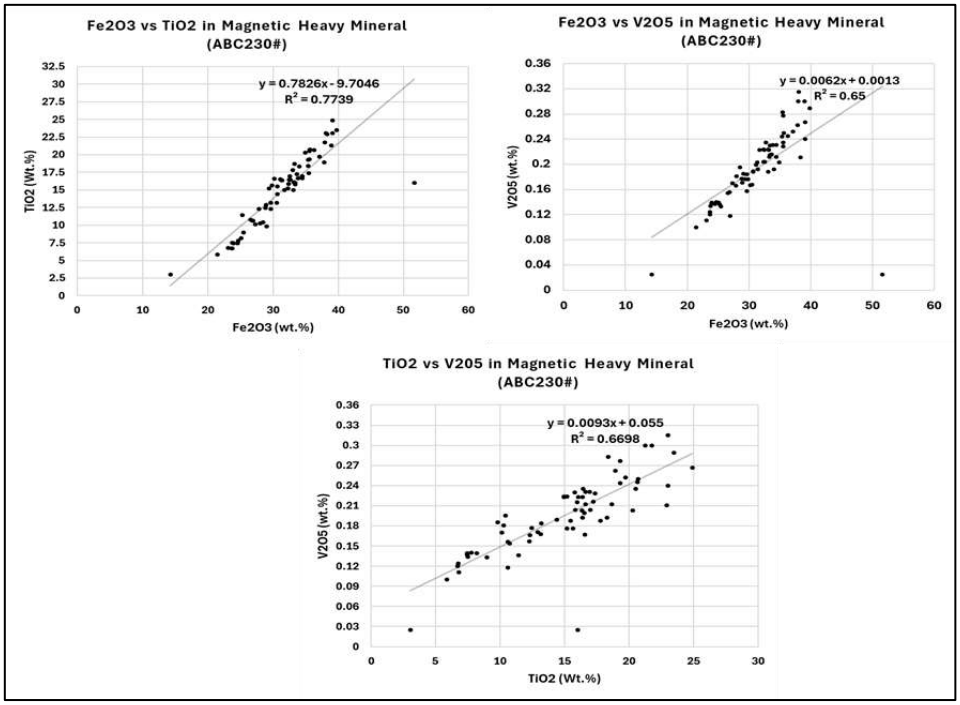
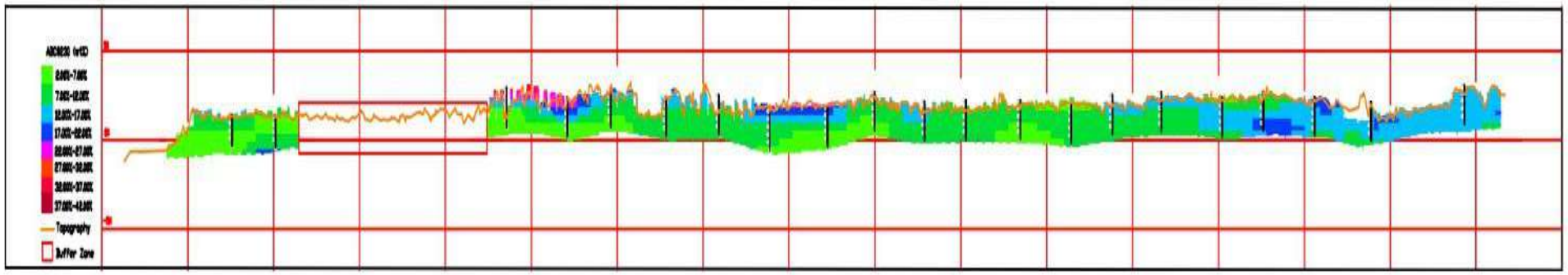


Figure 10.1 Bivariate scatter plots between pairs of Fe_2O_3, TiO_2, and V_2O_5.

10.6 Preparation of LV section and Level plan

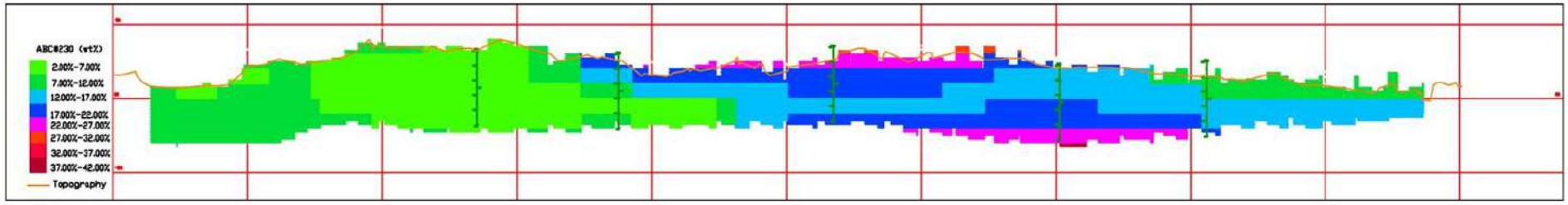
The LV section of Dandi -Onjal & Surwada sectors are given in fig.10.2

Figure 10.2.a LV section of Dandi-Onjal sector



Vertical axis 10X exaggeration

Figure 10.2. b LV section of Surwada sector



Vertical axis 10X exaggeration

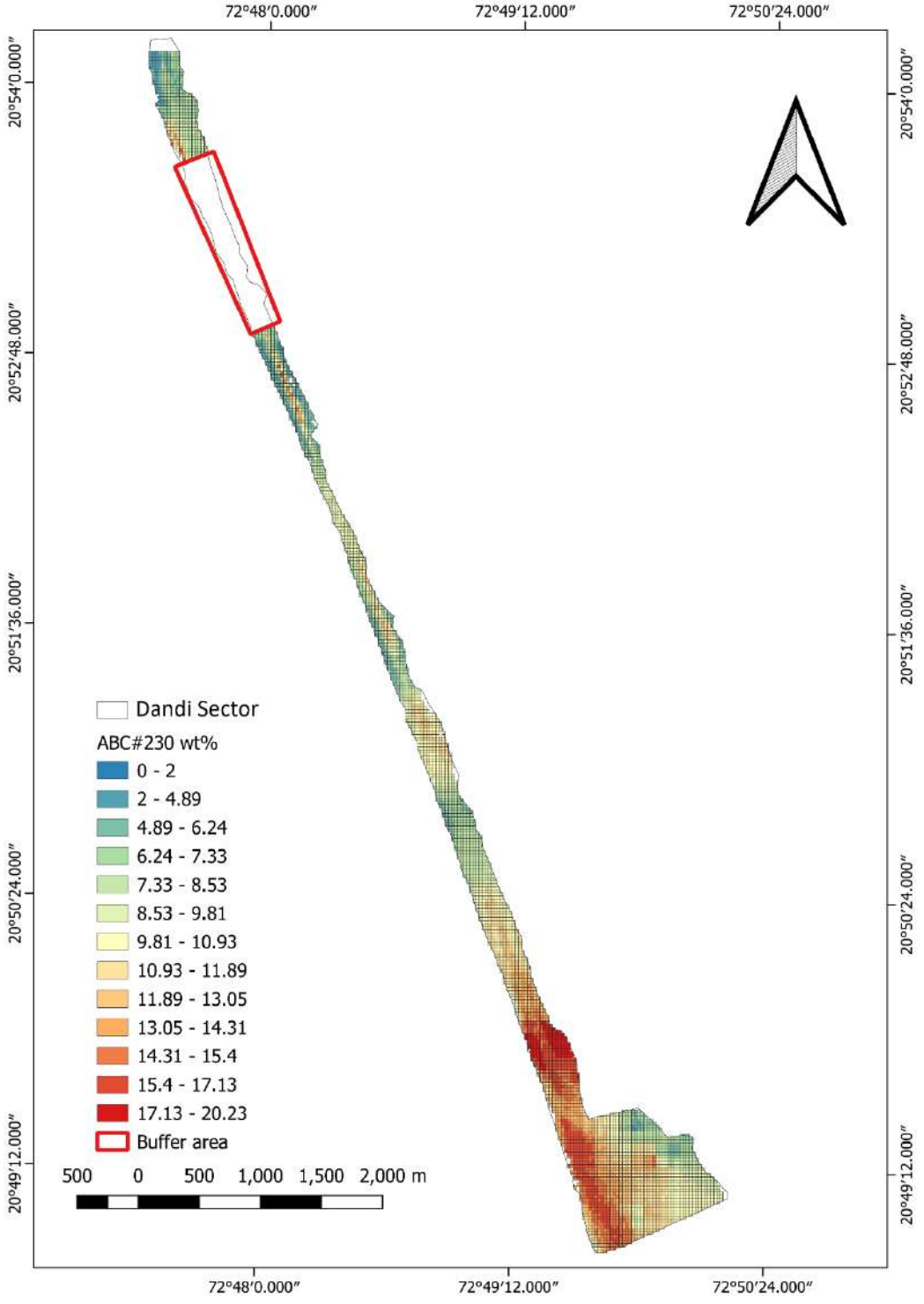


Figure 10.3. Spatial variability map of prime Ore (ABC#230) concentration (wt%) in the sand body, Dandi-Onjal sector, Gujarat

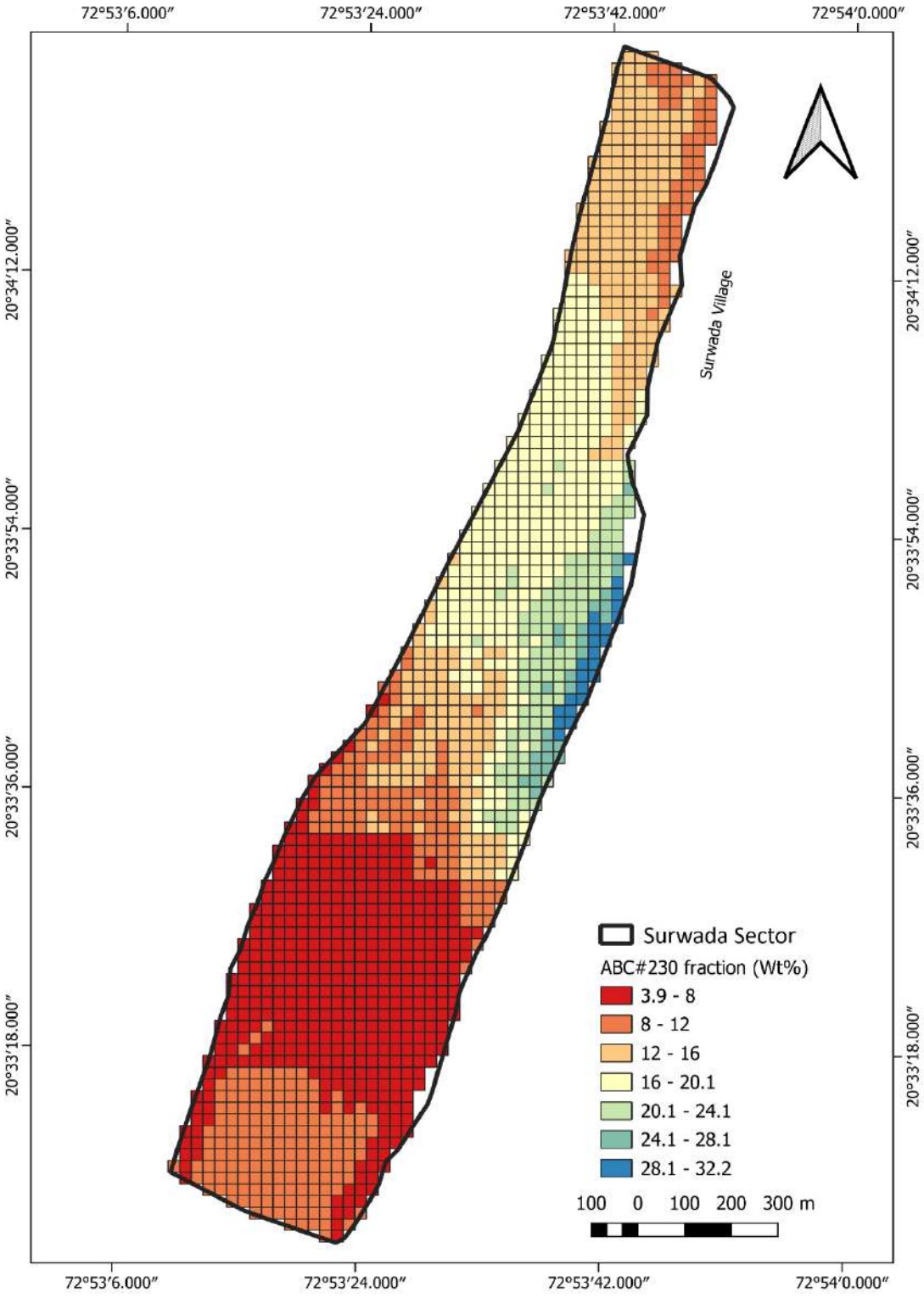


Figure 10.4 Spatial variability map of prime Ore (ABC#230) concentration (wt%) in the sand body, Surwada sector, Gujarat

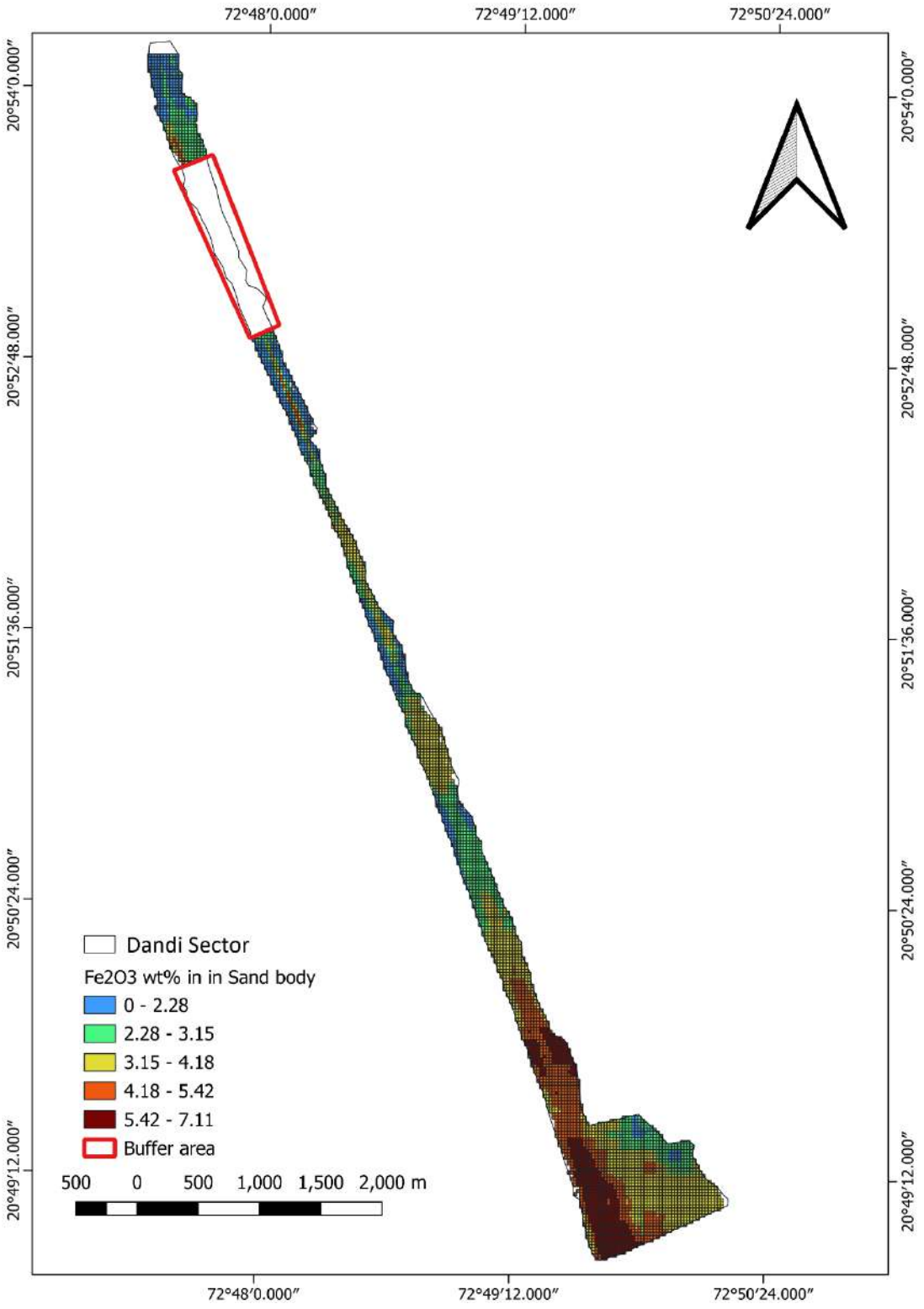


Figure 10.5-Spatial variability map of Fe_2O_3 grade (wt%) in sand body, Dandi-Onjal sector, Gujarat

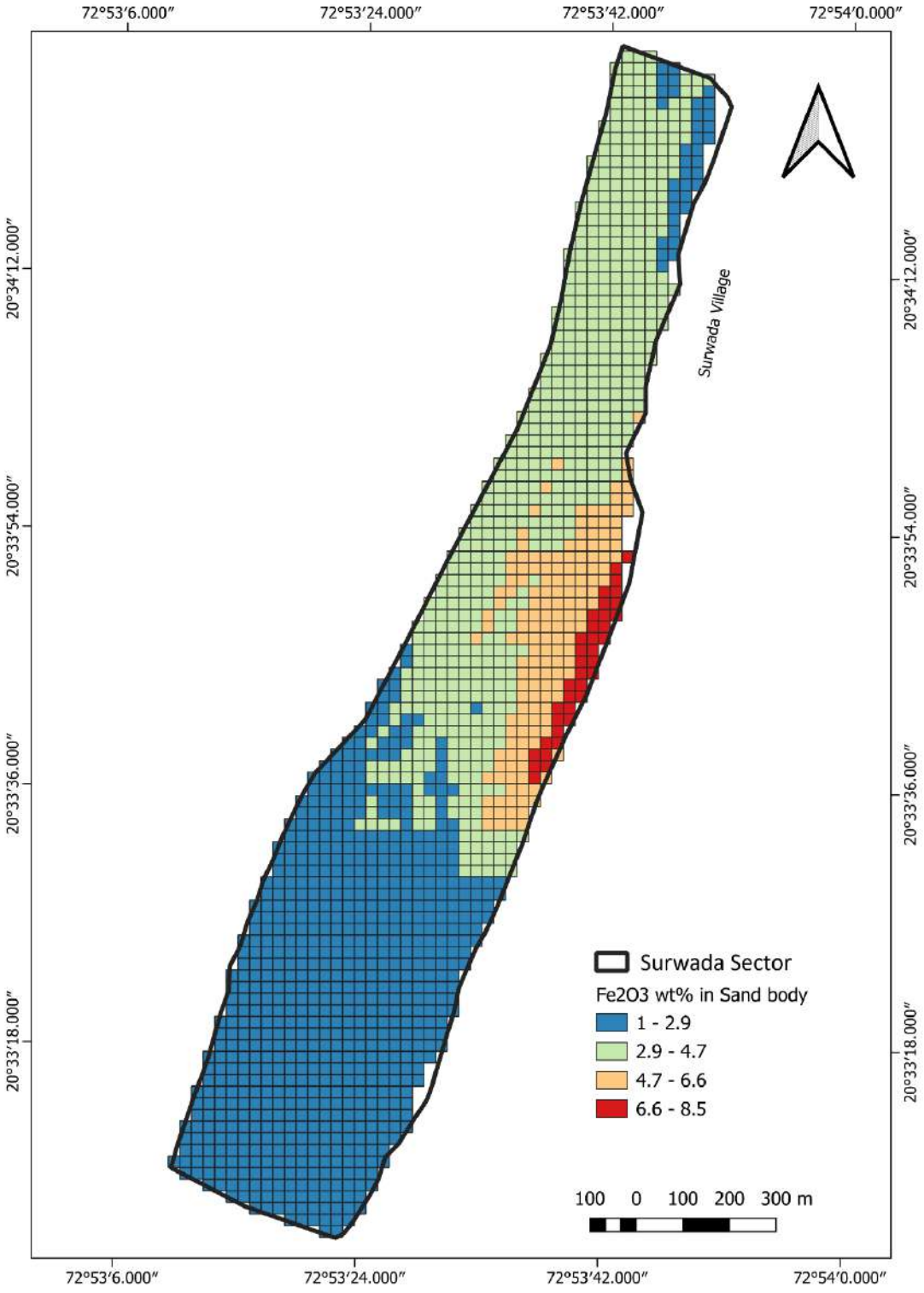


Figure 10.6-Spatial variability map of Fe_2O_3 grade (wt%) in sand body, Surwada sector, Gujarat

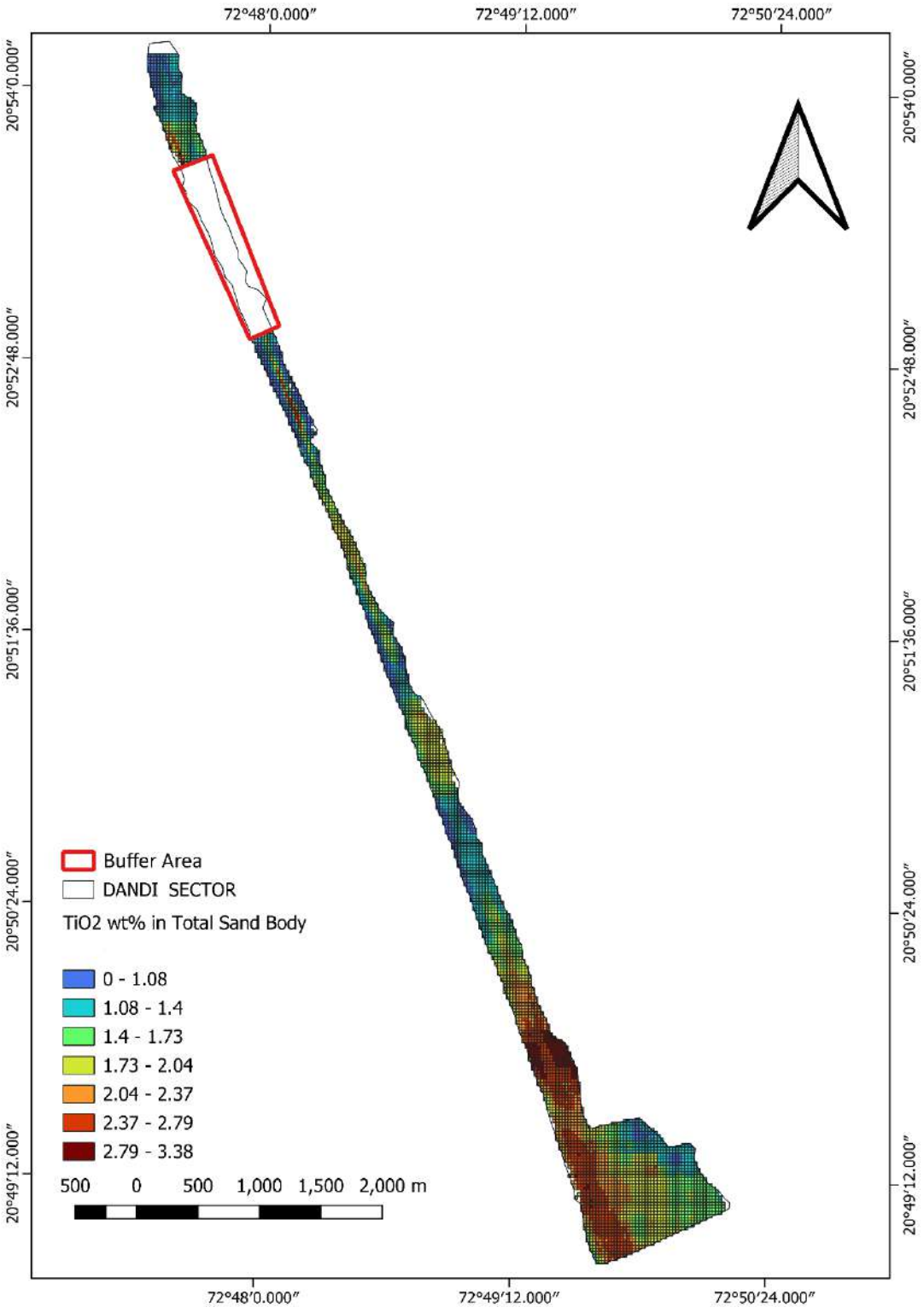


Figure 10.7. Spatial variability map of TiO_2 grade (wt%) in sand body, Dandi-Onjal sector, Gujarat

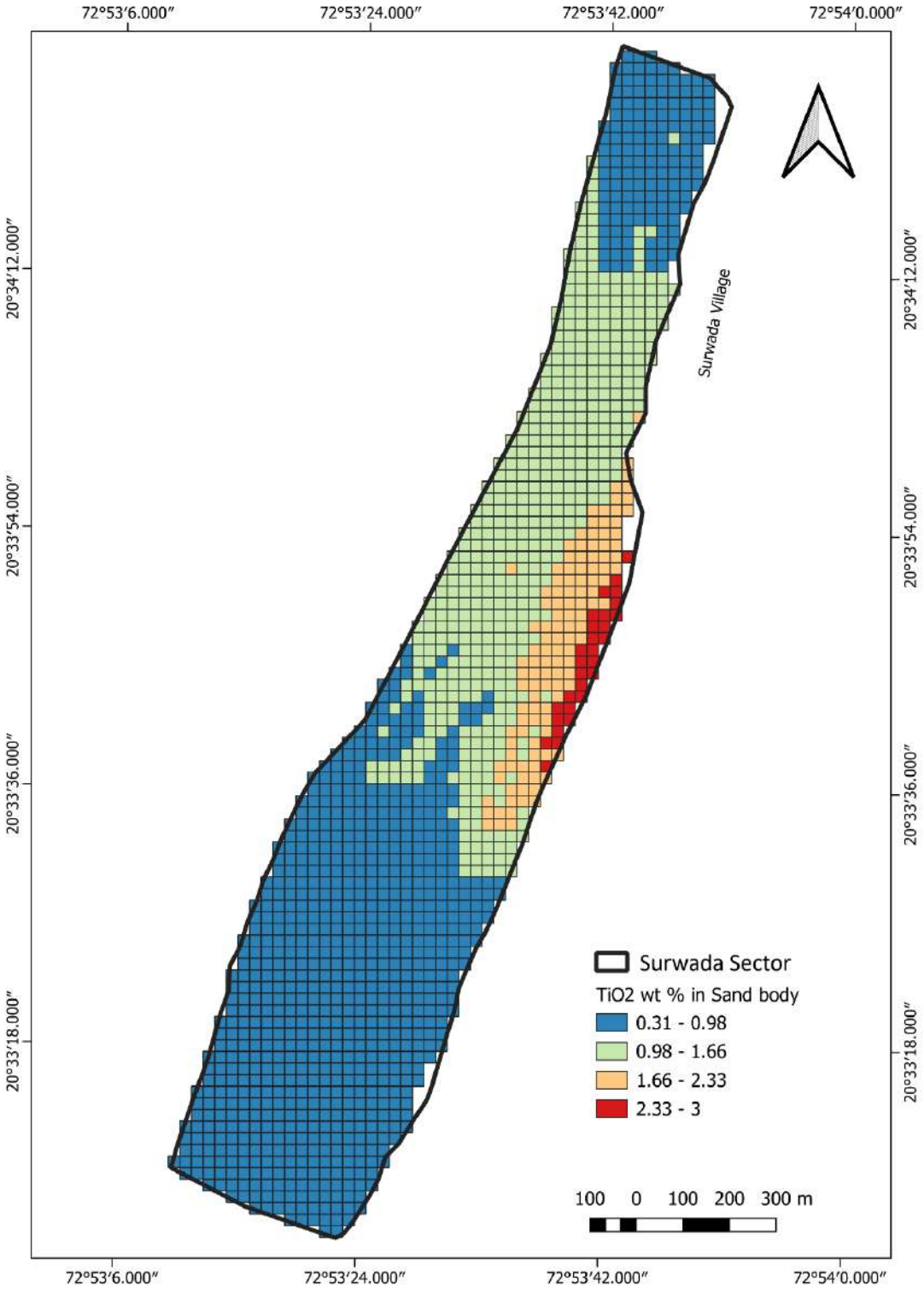


Figure 10.8. Spatial variability map of TiO_2 grade (wt%) in sand body, Surwada sector, Gujarat

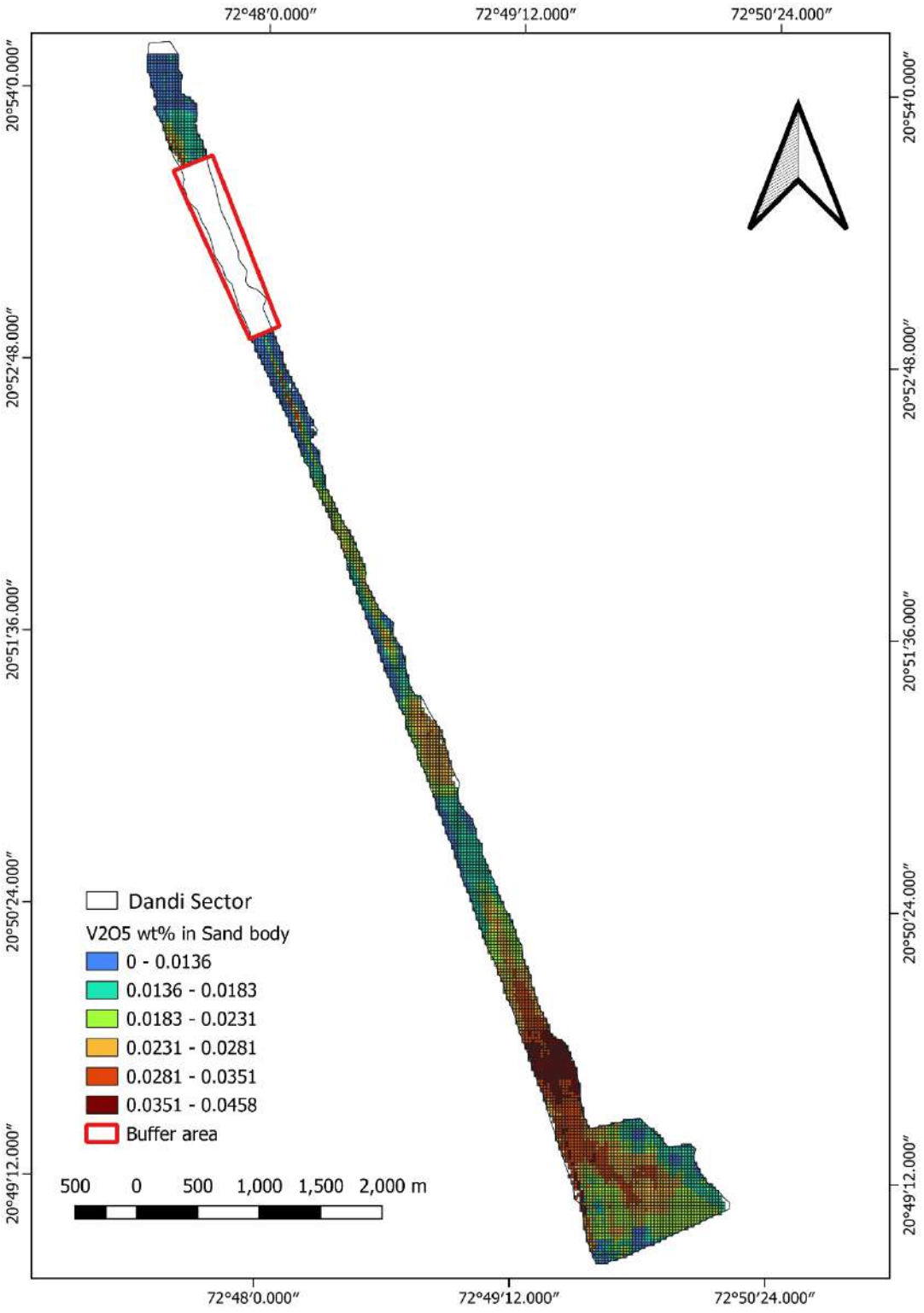


Figure 10.9. Spatial variability map of V_2O_5 grade (wt%) in sand body, Dandi-Onjal sector, Gujarat

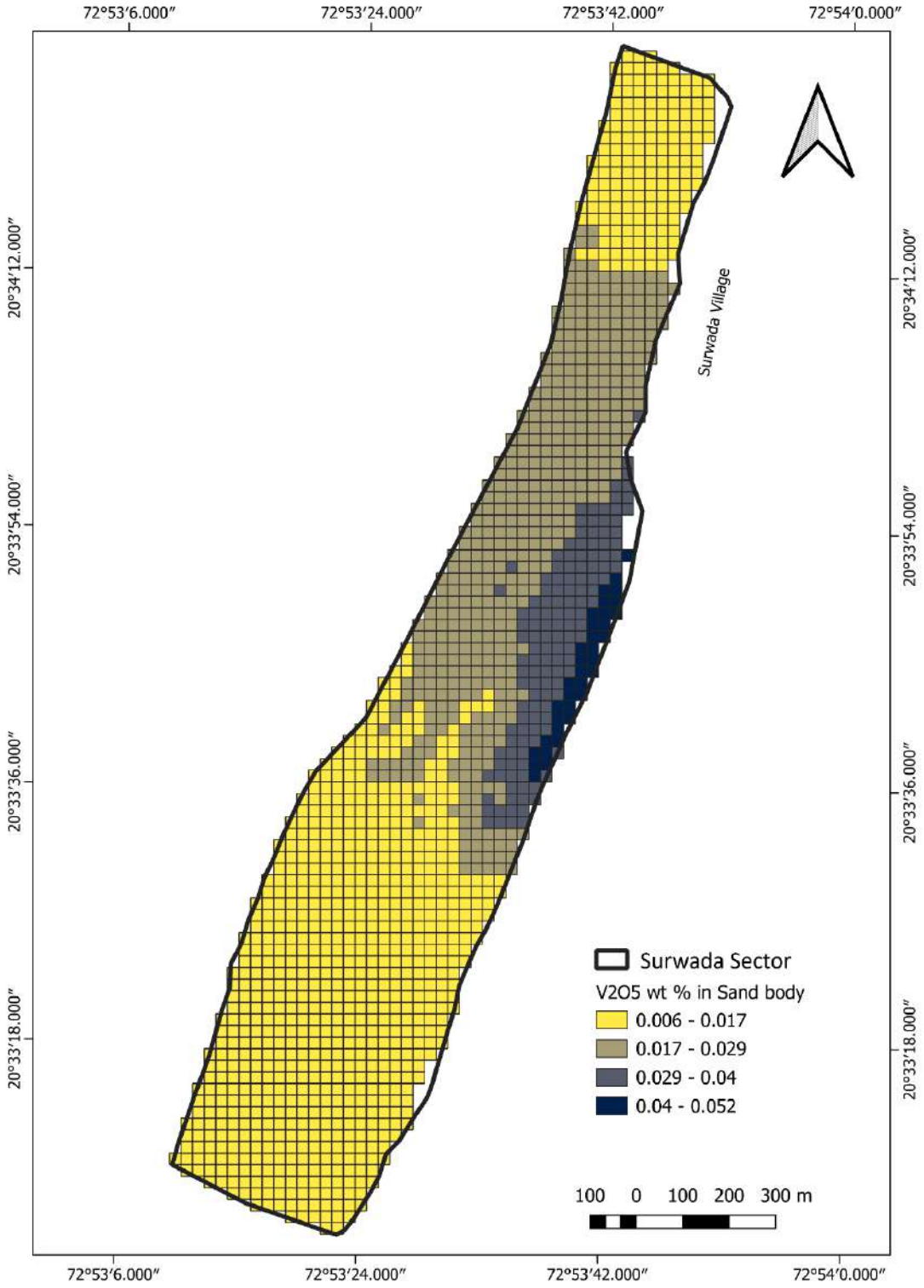


Figure 10.10. Spatial variability map of V_2O_5 grade (wt%) in sand body, Surwada sector, Gujarat

10.7 Specific gravity/bulk density calculation

The concentration of heavy minerals in the beach and dune sands varies along the coastal stretch and samples were selected to represent the entire mineralized body both horizontally and vertically. Subsequently, the dry bulk density was determined for the representative samples, which were selected based on the cumulative weight percentage of magnetic fractions A, B, C and non-magnetic fraction D and Gravel.

Table 10.9: Bulk density calculations

Sl no.	Sample No	wt.% range (A+B+C+D+G)	Bulk density (kg/m3)
1	DD01/3-4	30%-50%	1.22
2	DD13/1-2	50%-55%	1.40
3	DD14/2-3	55%-60%	1.42
4	DD07/4-5	60%-65%	1.49
5	DD18/1-2	65%-70%	1.41
6	DD18/0-1	70%-75%	1.48
7	DD08/2-3	75%-80%	1.36
8	DD35/3-4	80%-85%	1.52
9	DD34/0-1	85%-90%	1.24
10	DD34/1-2	90%-95%	1.24

As per the table mentioned in the table 10.7, BD was applied to all 160 samples. This approach ensures that the bulk density of the selected samples is accurately applied to each mineralized zone during the resource estimation process. These estimated bulk density values were then used in tonnage calculations for individual blocks within the Surpac software. The spatial distribution of Bulk density is given in the figure 10.11 & 10.12.

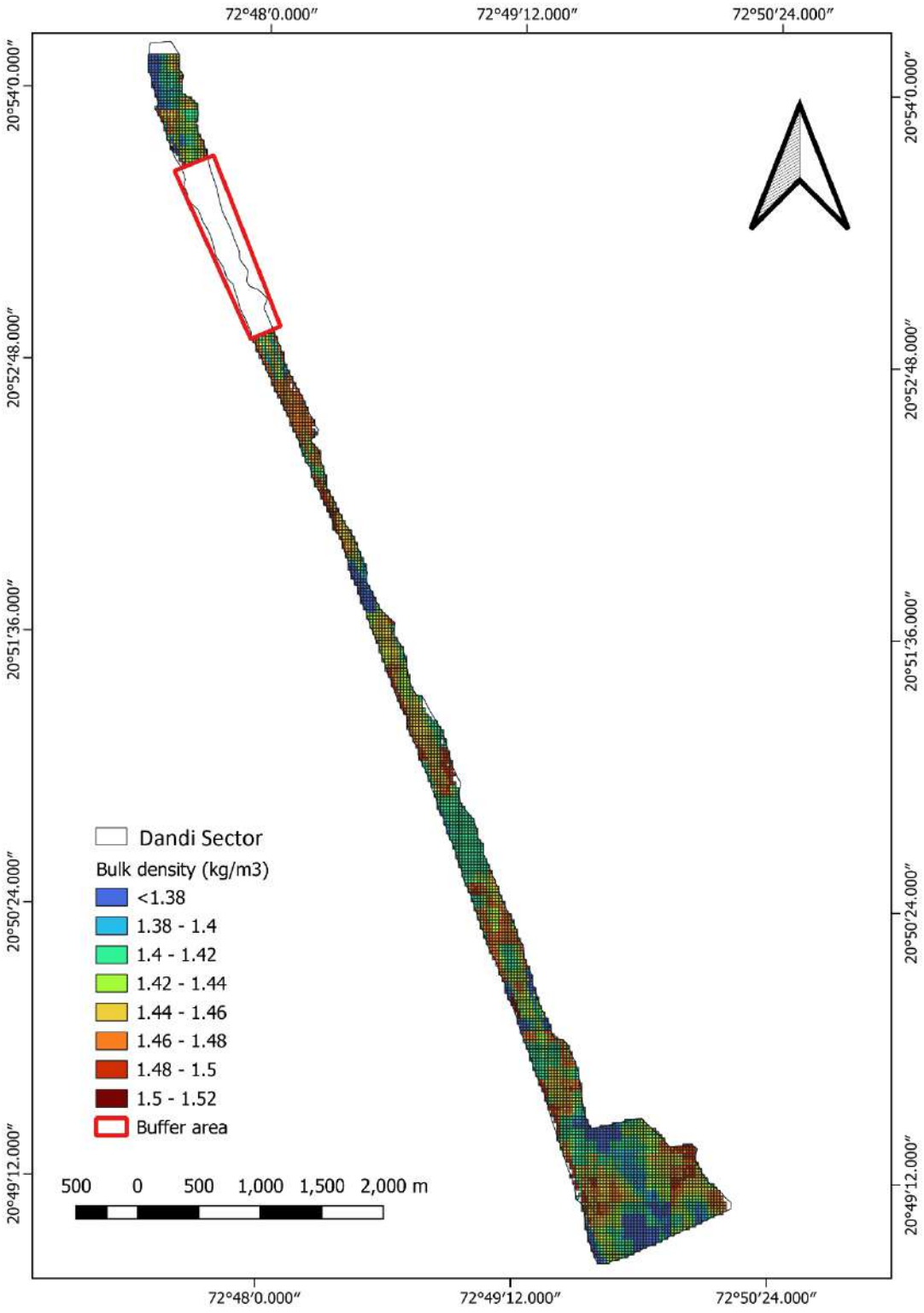


Figure10.11 Spatial variability map of Bulk Density (in sand body) in kg/m3, Dandi-Onjal Sector

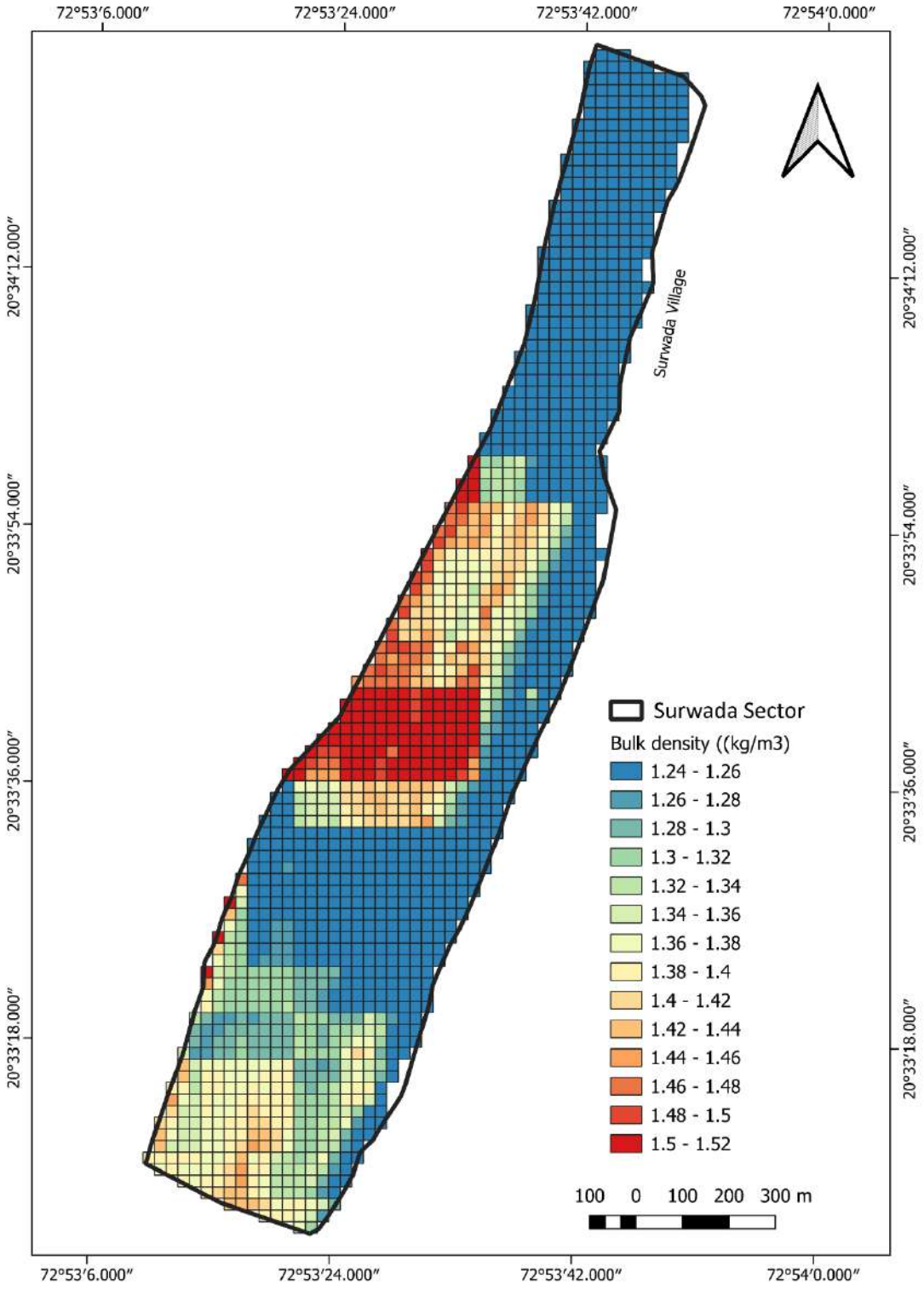


Figure 10.12 Spatial variability map of Bulk Density (in sand body) in kg/m3, Surwada sector.

10.8 Category of resources as per MEMC, 2015 along with UNFC classification.

The exploration has been carried out as per Mineral (Evidence of Mineral Contents) Rule-2015, mineral (Evidence of Mineral Contents) Rule-2021 and the Mineral Resources are estimated as per UNFC norms. Since this is preliminary exploration (G3) with no study on 'E' and 'F' axes. The resource has been classified under UNFC: G3F3E3.

10.9 Recommended block for further exploration

A total of 1.34 Sq.km is recommended for further exploration in Dandi-Onjal sector and the map is attached below.

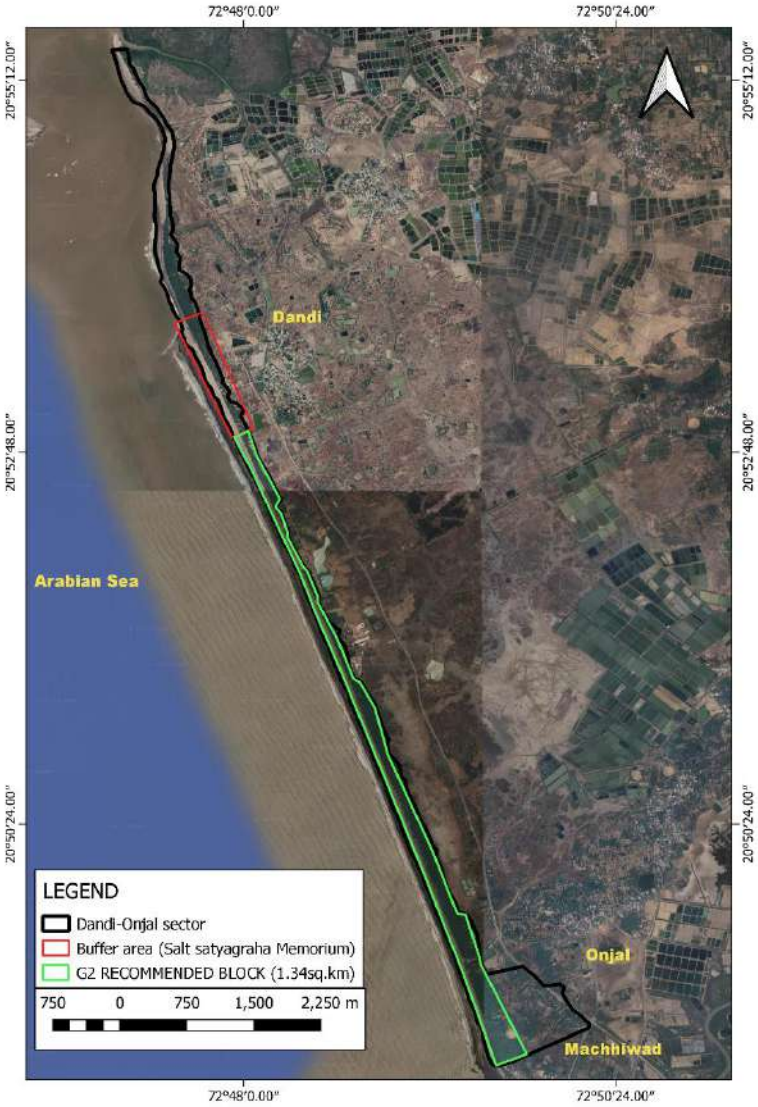


Figure 10.13 Potential area for further exploration in Dandi-Onjal Sector

CHAPTER 11 - CORE PRESERVATION

The samples are split into two equal halves using the coning and quartering method. One half is stored in the inhouse repository (Geo Marine Solutions), while the other is used for analysis. Each representative samples were then stored in a polythene bag and labeled according to a standard numbering system. The samples are labeled with the following format: location - borehole number - depth range (e.g., DD-01-0 to 1.0m).

CHAPTER 12 - CONCLUSION AND RECOMMENDATION

The exploration in the Dandi-Onjal-Surwada Block started in the month of January, 2024. Field components successfully completed as per the approved time schedule. Except chemical (XRF), ICP-MS, EPMA, XRD and Bulk density analyses, all lab works were carried out in-house. The enormous data generated from the field and laboratories were compiled, synthesized and interpreted. Meticulous planning and execution helped us to achieve the target in the field and lab as well, which is considered to be the success of the project. The data collected from the field and generated from labs were utilized to understand, model and estimated the resource by taking adequate care.

The data from the preliminary exploration (G3) carried out in an area of 4.16 sq.km in Dandi-Onjal sector (3.21 sq km) and Surwada sector (0.95 sq km) shows the entire sand body of the explored block stretching 12.5 km in Dandi-Onjal and 2.64 km in Surwada along NNW-SSE parallel to the shore is anomalous and may be termed as titanomagnetite-ilmenite deposit with encouraging grades and tonnages of Fe_2O_3, TiO_2 and V_2O_5.

The total tonnage of the sand body in Dandi-Onjal sector is estimated to be 9.947 MMT, in which 5.008MMT is the VHM that constitutes about 50.34% of the sand body and ABC230# (prime ore) which is about 0.945 MMT, that constitutes about 9.5% of the sand body. The grade of Fe_2O_3 in the total sand is 3.767%, TiO_2 1.800% and V_2O_5 0.022% The total tonnage of Fe_2O_3 in the sand body is estimated as 0.327 MMT, TiO_2 0.156 MMT and V_2O_5 0.002 MMT in the Dandi-Onjal sector explored.

The total tonnage of the sand body in Surwada sector is estimated to be 2.870 MMT, in which 2.188MMT is the VHM that constitutes about 76.24% of the sand body and ABC230# (prime ore) which is about 0.315 MMT, that constitutes about 10.98% of the sand body. The grade of Fe_2O_3 in the total sand is 2.707%, TiO_2 0.866% and V_2O_5 0.015%. Since the ore minerals are already occurring as liberated in the sand, these grades are very significant. The total tonnage of Fe_2O_3 in the sand body is estimated as 0.078 MMT, TiO_2 0.025 MMT and V_2O_5 0.0004 MMT in the Surwada Sector explored.

The tonnage of Fe_2O_3, TiO_2 and V_2O_5 in +120# fraction separated by hand magnet in the bulk sample of 7.447kg representing the Dandi-Onjal-Surwada block is 0.2780MMT, 0.0832MMT and 0.0020MMT respectively.

In EPMA analysis of the Fe-TiO_2 mineral grains, uniform distribution of FeO and TiO_2 reflect a common igneous source and wide variation in the elemental concentrations of the titaniferous magnetite grains together with their consistent variation trends with reference to MgO and MnO reflect inherent variations in mineral compositions during the late-magmatic processes. EPMA, XRD, and XRF analysis data suggests the presence of TTM and ilmenite fractions within the rock fragments, especially in +120# fraction.

The total rare earth elements (ΣREE) of the ABC230# fraction ranges between 197.47ppm to 308. 45ppm. Similarly, scandium varies between 21.5ppm to 45.05ppm, niobium varies between 0.5ppm to 33.52ppm and tantalum varies between 0.5ppm to 26.22ppm.

V_2O_5 >=0.1% in vanadium bearing minerals like TTM and ilmenite is considered to be potential. The low-grade titanium ores (titanomagnetite) are being utilized for iron, titanium and vanadium many parts of the world as exemplified above. Regarding the importance of liberated ore minerals in placer deposits, it is significant because the liberation of ore minerals means that the valuable minerals are already separated from the host rock. This makes the extraction process more efficient and cost-effective compared to deposits where the ore minerals are still locked within the host rock, like the titanomagnetite bands in layered gabbro deposits found in many parts of the world (ex: Bushveld complex, South Africa).

The grades of Fe_2O_3 (34.253%), TiO_2 (16.575%), and V_2O_5 (0.202%) in the ore body of Dand-Onjal sector is considered encouraging with respect to the Windimurra Complex in Western Australia, which is one of the world's largest titanium-vanadium deposits which has TiO_2 concentrations around 2% and average 0.32% V_2O_5.

As per the IBM year book of 2023, the total resource of V_2O_5 estimated in India is 64594 tonnes, which is in the hard rock like titanomagnetite bands in layered gabbro deposits. Therefore, the availability of liberated ore mineral of vanadium in beach placer deposit is very significant.

Further exploration for TTM deposits in the coastal stretch of Gujarat and Maharashtra could potentially increase India's resource position of vanadium.

The exploration has been carried out as per Mineral (Evidence of Mineral Contents) Rule-2015 and the mineral resources are estimated as per UNFC norms. Since this is preliminary exploration (G3) with no study on 'E' and 'F' axes, the resource has been classified under UNFC: G3F3E3.

Recommendations

- Based on the present study, it is recommended that the dune portion of the Dandi-Onjal sector with a potential area of 1.34 sq.km as promising zone for further exploration (G2) (refer fig 10.13).
- Out of 37 boreholes, 20 boreholes are falling within the recommended area (1.34 sq.km).
- Out of 20 boreholes in the recommended area, the weight percentage of A, B, C fractions at bottom most level (4.00-5.00m) ranges between 17.421% to 43.700%, 0.089% to 3.873% and 10.757% to 35.002% respectively. Whereas the wt% of ABC230# fractions vary from 3.912% to 20.671%. The chemical analysis results of ABC230# fraction to the corresponding depth varies from 10.76% to 20.657% TiO_2 and 0.025% to 0.245% V_2O_5. These values are quite encouraging, suggesting there may be downward continuity of mineralization.
- For further G2 exploration, a comprehensive approach is suggested by closer grid spacing as per MEMC rule (2015) and drilling till the mineralization ends.
- Since the vanadium bearing titaniferous magnetite (TTM) is present within the rock fragments of size fraction 120 ASTM, a detailed study of these (120 ASTM) size fractions is also recommended to maximize ore recovery and estimate Ti & V resources.

Reviewers Comments

1. In the light of present exploration studies, G2 level exploration including close space as well as deeper auger drilling is recommended over 1.34 sq km Dune stretch in Dandi - Onjal sector. **It requires to be elaborated based on evaluation of available analysis data.**

Explanation: Recommendations are elaborated

2. Need to check a few spelling mistakes and few copy -paste viz in the Executive summary state is Maharashtra which should be Gujarat.

Explanation: Spelling mistakes are corrected.

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Annexure 1
Boundary coordinates

Annexure-1: Boundary Coordinates of Dandi-Onjal-Surwada Block

Boundary Coordinates of Dandi-Onjal sector

Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)
1	72.7858	20.92325		42	72.79038	20.90561		83	72.7959	20.88767
2	72.78606	20.92264		43	72.79039	20.90511		84	72.79652	20.88681
3	72.78615	20.92237		44	72.79042	20.90486		85	72.79678	20.88602
4	72.78632	20.92182		45	72.79053	20.90462		86	72.79727	20.88559
5	72.78637	20.92146		46	72.79057	20.90429		87	72.79749	20.88493
6	72.78651	20.92107		47	72.79057	20.90381		88	72.79764	20.88456
7	72.78662	20.92058		48	72.79056	20.90341		89	72.79777	20.8841
8	72.78678	20.9201		49	72.79048	20.90289		90	72.79787	20.88381
9	72.78693	20.91969		50	72.79047	20.90248		91	72.79814	20.88327
10	72.78716	20.91924		51	72.79043	20.90197		92	72.79836	20.88285
11	72.78733	20.91884		52	72.79045	20.90154		93	72.79853	20.88249
12	72.78757	20.91841		53	72.79054	20.90107		94	72.79872	20.88211
13	72.7878	20.91813		54	72.79066	20.9007		95	72.79879	20.88157
14	72.78786	20.91798		55	72.79079	20.90018		96	72.79911	20.88122
15	72.78819	20.91762		56	72.7909	20.89973		97	72.79926	20.88075
16	72.78918	20.91727		57	72.79108	20.89927		98	72.79949	20.88038
17	72.78963	20.91685		58	72.79122	20.89881		99	72.79967	20.8799
18	72.78994	20.91646		59	72.79101	20.89836		100	72.7999	20.8796
19	72.79035	20.9161		60	72.79131	20.89793		101	72.80006	20.87914
20	72.7907	20.91565		61	72.79156	20.89752		102	72.80029	20.8788
21	72.79097	20.91523		62	72.79175	20.8971		103	72.80045	20.87834
22	72.7912	20.91483		63	72.79188	20.89668		104	72.8007	20.87797
23	72.79134	20.91438		64	72.79198	20.89622		105	72.80087	20.87753
24	72.79151	20.91396		65	72.79222	20.8958		106	72.80116	20.8772
25	72.79158	20.91352		66	72.79236	20.89537		107	72.80129	20.8767
26	72.79143	20.91305		67	72.79253	20.89495		108	72.80154	20.87632
27	72.7914	20.91255		68	72.79281	20.89452		109	72.80177	20.87592
28	72.79125	20.91212		69	72.79311	20.89411		110	72.80193	20.87551
29	72.79118	20.91173		70	72.7933	20.89368		111	72.80212	20.87509
30	72.79099	20.91118		71	72.79343	20.89325		112	72.80237	20.87474
31	72.79083	20.91072		72	72.7933	20.89276		113	72.80252	20.87424
32	72.79067	20.91021		73	72.79359	20.89235		114	72.80271	20.87385
33	72.79073	20.90984		74	72.79363	20.8919		115	72.80277	20.87342
34	72.79048	20.90929		75	72.79393	20.8915		116	72.80305	20.87303
35	72.79035	20.90877		76	72.79445	20.89105		117	72.80317	20.87262
36	72.79034	20.90832		77	72.79463	20.89068		118	72.80348	20.87225
37	72.79043	20.90783		78	72.79485	20.89018		119	72.8036	20.87186
38	72.79041	20.90744		79	72.79509	20.88983		120	72.80379	20.87138
39	72.79041	20.90698		80	72.7953	20.88943		121	72.80393	20.87094
40	72.79042	20.90648		81	72.7955	20.88903		122	72.80419	20.87053
41	72.79042	20.90614		82	72.79566	20.88852		123	72.80435	20.87012

Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)
124	72.80464	20.86974		165	72.81179	20.85249		206	72.82262	20.82591
125	72.80481	20.86932		166	72.81193	20.85206		207	72.82277	20.82547
126	72.80508	20.86893		167	72.81223	20.85168		208	72.82288	20.82504
127	72.80521	20.86851		168	72.81226	20.8512		209	72.82302	20.82459
128	72.80539	20.86808		169	72.81249	20.85079		210	72.82348	20.82338
129	72.8055	20.86761		170	72.81261	20.85037		211	72.82399	20.82207
130	72.80586	20.86721		171	72.8129	20.84997		212	72.82425	20.8212
131	72.80604	20.86687		172	72.81301	20.84954		213	72.82463	20.82035
132	72.80618	20.86643		173	72.81328	20.84916		214	72.82492	20.81952
133	72.8063	20.866		174	72.81335	20.8487		215	72.8251	20.81863
134	72.80649	20.86557		175	72.81359	20.8483		216	72.82557	20.8183
135	72.80661	20.86514		176	72.81372	20.84786		217	72.82578	20.81693
136	72.80672	20.86469		177	72.81387	20.84743		218	72.82626	20.81514
137	72.80688	20.86426		178	72.814	20.84698		219	72.82645	20.81471
138	72.80708	20.86385		179	72.81426	20.84661		220	72.82664	20.81427
139	72.80733	20.86345		180	72.81438	20.84617		221	72.82684	20.81407
140	72.80743	20.86299		181	72.81456	20.84573		222	72.82713	20.81396
141	72.80762	20.86259		182	72.81468	20.8453		223	72.82738	20.81399
142	72.80776	20.86217		183	72.81496	20.84485		224	72.82895	20.81445
143	72.808	20.86176		184	72.81528	20.84411		225	72.82932	20.81463
144	72.80813	20.86132		185	72.81541	20.84362		226	72.83715	20.81811
145	72.80826	20.86089		186	72.81574	20.84278		227	72.83716	20.81856
146	72.8084	20.86045		187	72.81599	20.84191		228	72.83678	20.81886
147	72.80868	20.86006		188	72.81644	20.84112		229	72.8364	20.81931
148	72.80878	20.85962		189	72.81676	20.84025		230	72.83592	20.81965
149	72.80905	20.85925		190	72.81704	20.83937		231	72.83546	20.81996
150	72.80915	20.8588		191	72.81741	20.83854		232	72.83488	20.82071
151	72.80934	20.85838		192	72.81771	20.83769		233	72.83429	20.82179
152	72.8095	20.85793		193	72.81809	20.83685		234	72.83447	20.82248
153	72.80967	20.85753		194	72.81855	20.83605		235	72.83401	20.82281
154	72.80976	20.85707		195	72.81886	20.8352		236	72.83234	20.82258
155	72.81001	20.85669		196	72.8193	20.83438		237	72.8316	20.82336
156	72.81014	20.85625		197	72.81937	20.83391		238	72.83002	20.82472
157	72.81037	20.85583		198	72.81991	20.8327		239	72.82613	20.82384
158	72.8105	20.8554		199	72.82027	20.83185		240	72.82556	20.82502
159	72.81074	20.85501		200	72.82054	20.83097		241	72.82536	20.82644
160	72.81088	20.85457		201	72.82072	20.83056		242	72.82513	20.82795
161	72.8112	20.8542		202	72.82127	20.82932		243	72.82498	20.82838
162	72.81136	20.85379		203	72.82154	20.82843		244	72.82482	20.82875
163	72.81137	20.85331		204	72.82208	20.82717		245	72.82422	20.83001
164	72.81151	20.85287		205	72.82249	20.82636		246	72.82389	20.83035

Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)
247	72.8231	20.83054		288	72.81124	20.85779		329	72.7997	20.88389
248	72.8228	20.83146		289	72.81114	20.85822		330	72.79998	20.88457
249	72.82233	20.8323		290	72.81099	20.85894		331	72.79926	20.88524
250	72.82214	20.83265		291	72.81075	20.85927		332	72.79857	20.88546
251	72.82186	20.83333		292	72.81013	20.86009		333	72.79832	20.88583
252	72.82165	20.83394		293	72.81032	20.86087		334	72.79841	20.8866
253	72.82148	20.83429		294	72.80997	20.86111		335	72.79776	20.88749
254	72.82133	20.83513		295	72.80913	20.86183		336	72.79774	20.88799
255	72.82075	20.83632		296	72.80856	20.86289		337	72.79722	20.88915
256	72.82068	20.83727		297	72.80811	20.86368		338	72.79698	20.88976
257	72.82026	20.83778		298	72.80802	20.86402		339	72.79679	20.89009
258	72.82015	20.8382		299	72.80808	20.86454		340	72.79636	20.89096
259	72.82001	20.83858		300	72.80787	20.86514		341	72.79611	20.89179
260	72.81964	20.83944		301	72.80766	20.86547		342	72.79588	20.89269
261	72.81943	20.8397		302	72.80748	20.86597		343	72.79541	20.8939
262	72.81918	20.84016		303	72.80712	20.86674		344	72.79523	20.89447
263	72.81876	20.84109		304	72.80692	20.86717		345	72.79512	20.89497
264	72.81856	20.84153		305	72.8061	20.86836		346	72.7951	20.89519
265	72.81828	20.84222		306	72.80592	20.86875		347	72.79475	20.89616
266	72.8177	20.84346		307	72.80561	20.86928		348	72.7944	20.8966
267	72.81748	20.8439		308	72.80546	20.86966		349	72.79417	20.89748
268	72.81741	20.84465		309	72.80526	20.87002		350	72.79433	20.8979
269	72.81694	20.84517		310	72.80508	20.87026		351	72.79438	20.8981
270	72.81685	20.84582		311	72.80475	20.8709		352	72.79433	20.89824
271	72.81665	20.84649		312	72.80473	20.87109		353	72.79419	20.89884
272	72.81596	20.84723		313	72.80475	20.87146		354	72.79372	20.89925
273	72.81564	20.84756		314	72.80455	20.87212		355	72.79304	20.8996
274	72.81552	20.84803		315	72.80437	20.87253		356	72.79311	20.90055
275	72.81544	20.84848		316	72.80424	20.87298		357	72.79318	20.90091
276	72.81561	20.84911		317	72.80415	20.87347		358	72.79278	20.90145
277	72.81504	20.85017		318	72.8035	20.87416		359	72.79285	20.9024
278	72.81468	20.85119		319	72.80412	20.87498		360	72.79214	20.90339
279	72.81455	20.8516		320	72.80382	20.87531		361	72.79241	20.90402
280	72.81415	20.85288		321	72.8037	20.87574		362	72.79231	20.90491
281	72.81313	20.85441		322	72.80339	20.87614		363	72.79211	20.90548
282	72.81264	20.85526		323	72.80281	20.87735		364	72.79209	20.90635
283	72.81251	20.85543		324	72.80208	20.87857		365	72.79201	20.90767
284	72.81197	20.85565		325	72.80141	20.87974		366	72.7919	20.90856
285	72.8115	20.85652		326	72.80127	20.88034		367	72.79207	20.91003
286	72.81136	20.85702		327	72.80101	20.88107		368	72.79214	20.91023
287	72.81129	20.85756		328	72.80047	20.88233		369	72.79212	20.91049

Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)
370	72.79211	20.91077		380	72.78981	20.91785
371	72.79252	20.91278		381	72.78955	20.91826
372	72.79253	20.9132		382	72.78921	20.91914
373	72.79237	20.91409		383	72.78875	20.91988
374	72.7923	20.91451		384	72.78824	20.92092
375	72.79168	20.91531		385	72.78813	20.92129
376	72.79145	20.91584		386	72.78777	20.92166
377	72.79121	20.91621		387	72.78751	20.92334
378	72.79064	20.91701		388	72.7858	20.92325
379	72.79021	20.91745				

Boundary Coordinates of Surwada sector

Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)		Sl no.	Longitude (E)	Latitude (N)
1	72.88619	20.55258		29	72.89548	20.56406		57	72.8886	20.55945
2	72.88773	20.55185		30	72.89573	20.56542		58	72.8884	20.55904
3	72.8896	20.55126		31	72.89548	20.56606		59	72.88823	20.55862
4	72.88977	20.55135		32	72.89538	20.56657		60	72.88802	20.55821
5	72.88997	20.5516		33	72.89577	20.56734		61	72.88789	20.55778
6	72.89017	20.55192		34	72.89577	20.56787		62	72.8877	20.55737
7	72.89028	20.55209		35	72.89597	20.56878		63	72.88757	20.55692
8	72.89047	20.55241		36	72.89645	20.56985		64	72.88735	20.55652
9	72.8906	20.55284		37	72.8964	20.57043		65	72.88734	20.55603
10	72.89086	20.55309		38	72.8967	20.57142		66	72.88718	20.55562
11	72.89111	20.55347		39	72.89693	20.57183		67	72.88693	20.55473
12	72.89144	20.55396		40	72.8971	20.57227		68	72.88661	20.55387
13	72.89149	20.55408		41	72.89746	20.57331		69	72.88631	20.55302
14	72.89156	20.55426		42	72.89737	20.57349		70	72.88619	20.55258
15	72.89163	20.55455		43	72.89701	20.57387				
16	72.89198	20.55569		44	72.8952	20.57446				
17	72.89207	20.55614		45	72.89507	20.57405				
18	72.8924	20.55689		46	72.89487	20.57314				
19	72.89259	20.55721		47	72.89437	20.57135				
20	72.89283	20.5577		48	72.89417	20.57048				
21	72.89301	20.55816		49	72.894	20.56955				
22	72.89323	20.5587		50	72.8938	20.56866				
23	72.89336	20.55899		51	72.89313	20.567				
24	72.89365	20.55985		52	72.89178	20.56454				
25	72.89422	20.56107		53	72.89094	20.56292				
26	72.89462	20.56185		54	72.89008	20.56133				
27	72.89496	20.5627		55	72.88905	20.56028				
28	72.89516	20.56321		56	72.8888	20.55987				

Annexure 2 (a&b)
Topographic Map (1:5000 scale)

Topographic Map of Dandi-Onjal Block,Gujarat.1:5000 scale

N 2316000

N 2315246.0866

N 2314500

N 2313000

N 2311500

N 2310000

N 2308500

N 2307000

N 2305500

N 2304000

N 2303082.5220

N 2302500

N 2301000

E 267000

E 268500

E 270000

E 271500

E 273000

E 273856.7646

E 274500

E 276000

E 277500

N

Purna River

E 268769.8581

Dandi Museum

Dandi Beach

Onjal Beach

Machhivad Villiage

Kanai Creek

Contour(m) (Datum MSL)

- 0m
- 1m
- 2m
- 3m
- 4m
- 5m
- 6m
- 7m
- 8m

Legend:

- Road
- Backshore-Dune boundary
- Sea wall
- Building
- Temple
- TBM

Client:

National Mineral Exploration Trust (NMET)

Ministry of Mines

Government of India

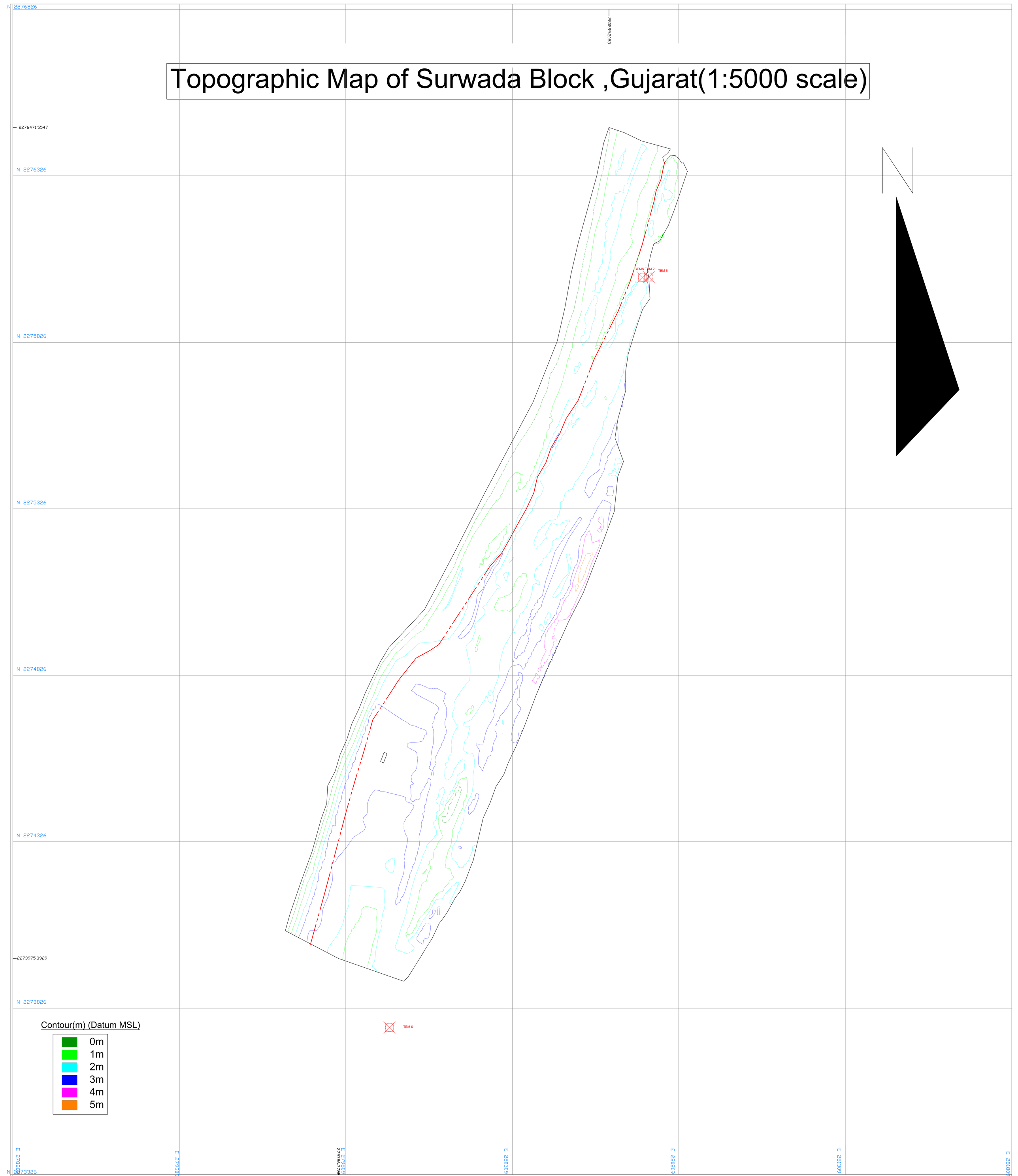
NPEA:

Geo Marine Solutions Private Limited

Door no.15-17-909/9,5th Cross Shivabagh,
Kadri,Mangluru-575005,
Karnataka.
E-mail: mail@geomarinesolutions.in
www.geomarine.in

-200m 0m 200m 400m 600m 800m

Topographic Map of Surwada Block ,Gujarat(1:5000 scale)



Legend:

- Backshore-Dune boundary
- TBM
- Building

Client:

National Mineral Exploration Trust (NMET)
Ministry of Mines
Government of India

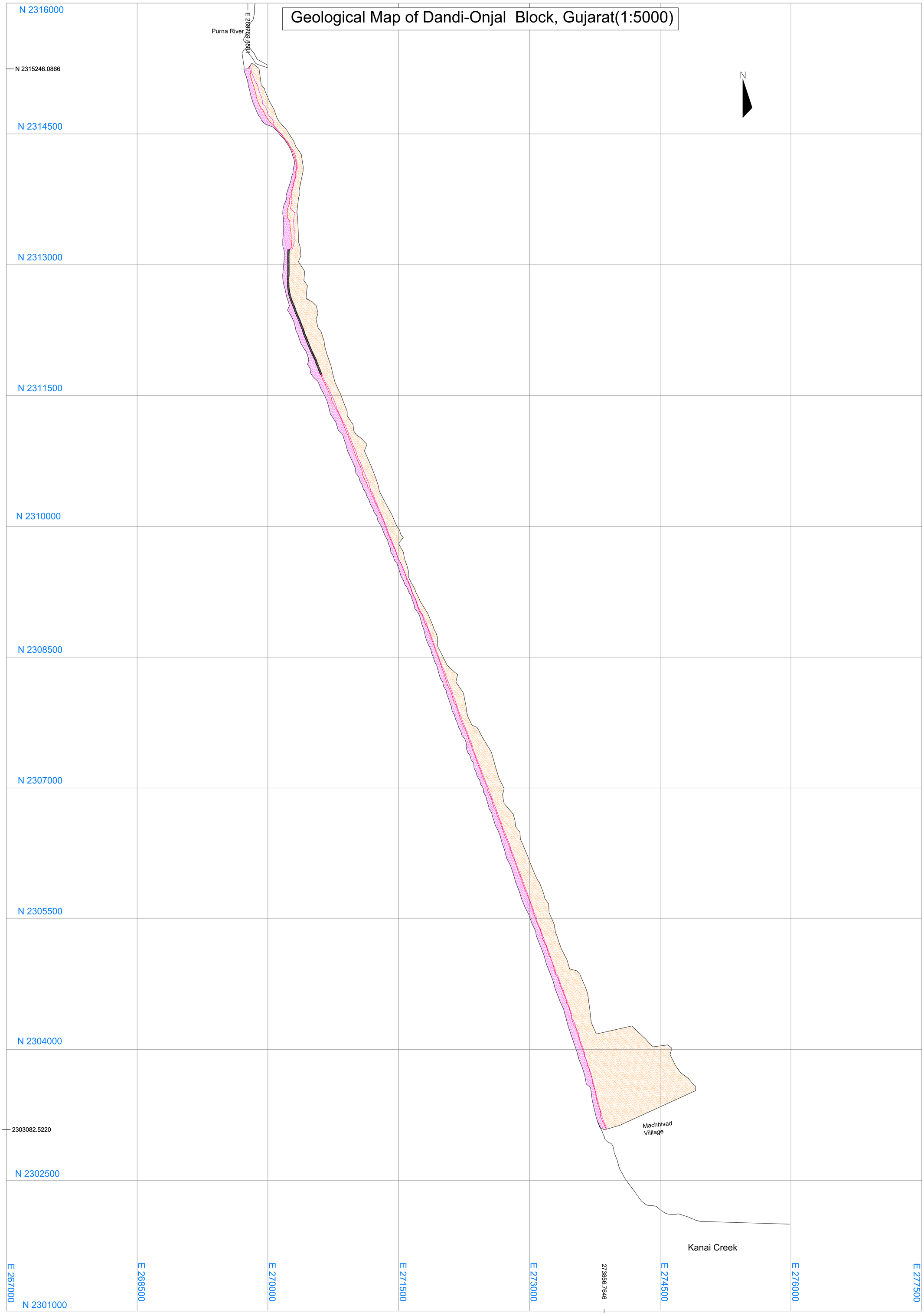
NPEA:

Geo Marine Solutions Private Limited
Door no.15-17-909/9,5th Cross Shivabagh,
Kadri,Mangluru-575005,
Karnataka.
E-mail: mail@geomarinesolutions.in
www.geomarine.in

-200m 0m 200m 400m 600m 800

Annexure 3(a&b)
Geological Map (1:5000 scale)

Geological Map of Dandi-Onjal Block, Gujarat(1:5000)



Morphology:

- Foreshore-Backshore boundary
- Backshore - Dune boundary
- Sea Wall

Geology:

- Alluvium:Beach sand(Recent)
- Alluvium:Dune sand(Recent)

Client:

National Mineral Exploration Trust (NMET)
Ministry of Mines
Government of India

NPEA:

Geo Marine Solutions Private Limited
Door no.15-17-909/9,5th Cross Shivabagh,
Kadri,Mangluru-575005,
Karnataka.
E-mail: mail@geomarinesolutions.in
www.geomarine.in

-200m 0m 200m 400m 600m 800m

Geological Map of Surwada Block , Gujarat(1:5000 Scale)

N

N 2276826

2276471.5547

N 2276326

N 2275826

N 2275326

N 2274826

N 2274326

2273975.3929

N 2273826

N 2273326

E 278809

E 279309

279786.7785

E 279809

E 280309

E 280809

E 281309

E 281809

280599.2053

Morphology:

- Foreshore-Backshore boundary
- Backshore-Dune boundary

Geology:

- Alluvium:Beach sand(Recent)
- Alluvium:Dune sand(Recent)

Client:

National Mineral Exploration Trust (NMET)

Ministry of Mines

Government of India

NPEA:

Geo Marine Solutions Private Limited

Door no.15-17-909/9,5th Cross Shivabagh,
Kadri,Mangaluru-575005,Karnataka.
E-mail: mail@geomarinesolutions.in
www.geomarine.in

-200m 0m 200m 400m 600m 800m

Annexure 4
Magnetic & Gravity Separation data

ANNEXURE-4: MAGNETIC SEPARATION DATA

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
1	DD01/0-1m	0	1	1263.50	0.000	0.000	28.928	0.514	23.150	46.221	5.0843	41.1365	98.813	1.187
2	DD01/1-2m	1	2	1159.50	0.000	0.000	41.311	0.259	14.317	43.596	11.0735	32.5229	99.483	0.517
3	DD01/2-3m	2	3	1320.00	0.000	0.000	40.682	0.530	17.235	40.682	11.6757	29.0061	99.129	0.871
4	DD01/3-4m	3	4	1577.00	0.000	44.737	23.177	0.412	7.641	23.684	6.7500	16.9342	99.651	0.349
5	DD02/0-1m	0	1	1373.00	0.000	0.000	33.430	3.387	28.077	34.122	6.1420	27.9803	99.017	0.983
6	DD02/1-2m	1	2	1169.00	0.458	0.000	34.561	4.414	18.436	41.488	4.2733	37.2151	99.358	0.642
7	DD02/2-3m	2	3	1812.50	0.229	0.000	36.695	3.464	28.412	30.041	3.8153	26.2261	98.841	1.159
8	DD02/3-4m	3	4	1679.50	0.000	0.000	14.647	4.972	66.061	10.360	2.3311	8.0292	96.040	3.960
9	DD03/0-1m	0	1	440.00	0.000	0.000	29.318	2.159	37.045	28.636	1.6036	27.0327	97.159	2.841
10	DD03/1-2m	1	2	1106.50	0.000	0.000	32.038	2.259	27.384	35.291	3.6703	31.6211	96.972	3.028
11	DD03/2-3m	2	3	834.00	0.000	0.000	36.151	3.357	31.595	27.638	2.7914	24.8465	98.741	1.259
12	DD03/3-4m	3	4	950.00	0.000	0.000	37.421	1.684	29.053	31.368	4.7053	26.6632	99.526	0.474
13	DD03/4-5m	4	5	858.50	0.000	0.000	38.439	1.980	35.003	23.471	1.0562	22.4150	98.893	1.107
14	DD04/0-1m	0	1	1297.00	0.000	0.000	29.954	0.925	32.575	33.153	1.0278	32.1257	96.608	3.392
15	DD04/1-2m	1	2	1054.00	0.000	0.000	33.349	1.139	31.120	31.594	3.0014	28.5925	97.201	2.799
16	DD04/2-3m	2	3	1337.00	0.000	0.000	43.156	0.972	31.526	23.672	2.5329	21.1395	99.327	0.673
17	DD04/3-4m	3	4	1548.00	0.332	0.000	43.927	1.321	20.666	31.880	5.8978	25.9821	98.127	1.873
18	DD04/4-5m	4	5	1958.00	0.120	0.000	43.463	0.638	23.067	31.512	4.3486	27.1631	98.800	1.200
19	DD05/0-1m	0	1	1043.00	0.000	0.000	27.517	2.157	27.996	40.173	4.5395	35.6331	97.843	2.157
20	DD05/1-2m	1	2	1355.00	0.000	0.000	34.539	1.882	39.742	21.956	4.6107	17.3450	98.118	1.882
21	DD05/2-3m	2	3	1175.00	0.000	0.000	34.000	2.340	37.362	25.404	3.6074	21.7969	99.106	0.894
22	DD05/3-4m	3	4	1735.00	0.000	0.000	35.389	5.937	31.153	27.522	4.8988	22.6228	100.000	0.000

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
23	DD05/4-5m	4	5	1424.50	0.000	0.000	38.645	3.791	28.466	28.150	2.0831	26.0671	99.052	0.948
24	DD06/0-1m	0	1	1336.00	0.075	0.000	33.907	0.599	25.674	38.473	5.3478	33.1253	98.728	1.272
25	DD06/1-2m	1	2	1502.50	0.000	0.000	40.067	0.566	19.501	39.434	6.6644	32.7699	99.567	0.433
26	DD06/2-3m	2	3	1521.50	0.000	0.000	38.219	0.723	18.140	41.867	6.7824	35.0842	98.948	1.052
27	DD06/3-4m	3	4	1960.50	0.000	0.000	41.826	0.383	15.251	41.597	7.4874	34.1092	99.056	0.944
28	DD06/4-5m	4	5	1143.63	0.537	7.706	34.889	0.262	18.307	37.643	8.2439	29.3995	99.344	0.656
29	DD07/0-1m	0	1	2089.50	0.000	0.000	37.258	0.718	28.212	32.759	4.7501	28.0090	98.947	1.053
30	DD07/1-2m	1	2	1455.00	0.000	0.000	40.790	0.447	22.955	34.845	9.0249	25.8204	99.038	0.962
31	DD07/2-3m	2	3	1406.50	0.000	0.000	44.223	0.071	31.959	23.249	6.5563	16.6929	99.502	0.498
32	DD07/3-4m	3	4	1502.00	0.000	0.000	41.445	0.067	22.337	35.553	3.9819	31.5707	99.401	0.599
33	DD07/4-5m	4	5	1314.10	0.000	5.905	33.787	0.342	20.813	36.337	8.5028	27.8339	97.184	2.816
34	DD08/0-1m	0	1	1038.00	0.000	0.000	32.996	0.626	31.744	33.141	1.6570	31.4836	98.507	1.493
35	DD08/1-2m	1	2	971.50	0.000	0.000	39.321	0.360	27.535	32.012	3.1052	28.9072	99.228	0.772
36	DD08/2-3m	2	3	828.50	0.172	0.000	46.288	0.362	27.891	24.381	2.6820	21.6995	99.095	0.905
37	DD08/3-4m	3	4	928.45	0.000	15.61	26.226	1.292	19.603	36.405	5.7155	30.6891	99.138	0.862
38	DD08/4-5m	4	5	1150.90	0.000	45.91	17.421	0.348	17.291	18.594	1.7665	16.8278	99.566	0.434
39	DD09/0-1m	0	1	691.00	0.000	0.000	33.285	1.664	36.831	25.470	2.6999	22.7705	97.250	2.750
40	DD09/1-2m	1	2	1250.00	0.000	0.000	32.640	1.400	27.728	36.840	4.6050	32.2350	98.608	1.392
41	DD09/2-3m	2	3	1659.00	0.014	0.000	43.460	0.814	24.730	28.180	5.6923	22.4873	97.197	2.803
42	DD09/3-4m	3	4	1476.00	0.246	0.000	38.293	1.106	17.265	41.362	4.0948	37.2670	98.272	1.728
43	DD09/4-5m	4	5	1417.50	0.110	0.000	40.128	0.670	15.282	42.610	5.8376	36.7726	98.801	1.199
44	DD10/0-1m	0	1	1161.00	0.000	0.000	29.888	3.445	25.237	39.104	2.0334	37.0708	97.674	2.326
45	DD10/1-2m	1	2	1215.00	0.000	0.000	34.527	2.099	28.025	34.486	6.2764	28.2092	99.136	0.864
46	DD10/2-3m	2	3	1326.00	0.000	0.000	38.462	3.017	24.585	33.183	6.9683	26.2142	99.246	0.754

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
47	DD10/3-4m	3	4	1612.50	0.000	0.000	34.605	5.147	25.674	33.395	5.3433	28.0521	98.822	1.178
48	DD10/4-5m	4	5	1768.50	0.000	0.000	38.479	3.873	19.706	36.783	2.3173	34.4653	98.841	1.159
49	DD11/0-1m	0	1	1276.00	0.000	0.000	33.817	0.392	22.414	42.594	1.1500	41.4440	99.216	0.784
50	DD11/1-2m	1	2	1087.50	0.000	0.000	38.299	0.322	16.966	43.770	10.2860	33.4841	99.356	0.644
51	DD11/2-3m	2	3	1349.00	0.000	0.000	43.069	0.371	23.017	32.765	13.4664	19.2986	99.222	0.778
52	DD11/3-4m	3	4	2104.50	0.000	0.000	38.109	0.546	26.633	33.737	5.3642	28.3730	99.026	0.974
53	DD11/4-5m	4	5	946.78	0.191	5.839	34.905	0.581	17.873	40.083	3.1265	36.9567	99.472	0.528
54	DD12/0-1m	0	1	806.50	0.000	0.000	39.368	0.372	22.629	37.012	6.6251	30.3867	99.380	0.620
55	DD12/1-2m	1	2	655.00	0.000	0.000	40.458	0.458	20.687	37.481	1.6866	35.7943	99.084	0.916
56	DD12/2-3m	2	3	1105.00	0.000	0.000	38.009	0.543	26.109	34.525	2.9691	31.5557	99.186	0.814
57	DD12/3-4m	3	4	1841.00	0.000	0.000	40.820	0.435	20.016	38.104	2.1719	35.9323	99.375	0.625
58	DD12/4-5m	4	5	1416.12	0.177	3.010	33.013	0.636	19.349	43.146	2.5025	40.6435	99.329	0.671
59	DD13/0-1m	0	1	940.00	0.000	1.117	40.957	0.053	12.766	45.106	4.3753	40.7311	100.000	0.000
60	DD13/1-2m	1	2	1013.50	0.000	1.135	34.731	0.296	13.074	50.715	6.3394	44.3759	99.951	0.049
61	DD13/2-3m	2	3	983.00	0.000	3.357	39.217	0.203	12.614	44.557	7.2629	37.2946	99.949	0.051
62	DD13/3-4m	3	4	1189.50	0.000	4.792	38.672	0.210	12.736	43.590	4.5769	39.0128	100.000	0.000
63	DD13/4-5m	4	5	1427.06	4.397	4.279	32.390	0.105	10.758	43.446	3.8667	39.5793	95.375	4.625
64	DD14/0-1m	0	1	1028.31	0.000	1.051	44.053	0.292	16.289	37.926	6.4854	31.4409	99.611	0.389
65	DD14/1-2m	1	2	1065.73	0.000	1.898	35.703	0.188	10.697	47.057	2.3999	44.6571	95.543	4.457
66	DD14/2-3m	2	3	1270.65	0.000	3.553	38.169	0.236	13.418	44.426	6.2641	38.1620	99.803	0.197
67	DD14/3-4m	3	4	1552.92	0.000	2.957	37.156	0.064	15.809	39.281	5.3815	33.8993	95.267	4.733
68	DD14/4-5m	4	4	1118.97	3.298	2.679	37.213	0.089	12.841	43.701	5.8122	37.8885	99.821	0.179
69	DD15/0-1m	0	1	786.00	0.000	0.000	33.206	1.908	29.707	33.588	6.7847	26.8031	98.410	1.590
70	DD15/1-2m	1	2	1052.00	0.000	0.000	42.681	2.234	33.460	20.865	6.0091	14.8559	99.240	0.760

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
71	DD15/2-3m	2	3	1209.00	0.000	0.000	38.462	4.467	28.329	27.337	2.2416	25.0950	98.594	1.406
72	DD15/3-4m	3	4	1041.00	0.000	0.000	36.840	1.729	35.159	24.688	3.3329	21.3549	98.415	1.585
73	DD15/4-5m	4	5	1381.00	0.000	0.000	37.944	2.534	31.101	27.118	0.4339	26.6841	98.697	1.303
74	DD16/0-1m	0	1	1068.50	0.000	0.000	36.406	0.187	20.590	42.630	12.9595	29.6704	99.813	0.187
75	DD16/1-2m	1	2	1174.00	0.000	1.193	36.797	0.128	18.186	43.271	12.2024	31.0685	99.574	0.426
76	DD16/2-3m	2	3	1161.00	0.000	0.000	38.501	0.345	18.734	41.731	9.2226	32.5087	99.311	0.689
77	DD16/3-4m	3	4	1377.00	0.000	0.000	42.338	0.545	16.376	39.942	5.9513	33.9906	99.201	0.799
78	DD16/4-5m	4	5	1356.50	0.000	0.000	41.504	0.553	25.949	31.220	2.3103	28.9098	99.226	0.774
79	DD17/0-1m	0	1	1040.00	0.000	0.000	46.010	0.144	26.779	26.827	1.9315	24.8954	99.760	0.240
80	DD17/1-2m	1	2	1369.00	0.000	0.000	40.942	0.621	25.822	31.665	2.8182	28.8472	99.050	0.950
81	DD17/2-3m	2	3	635.50	0.000	0.000	32.809	0.865	37.136	27.065	3.5185	23.5468	97.876	2.124
82	DD17/3-4m	3	4	1458.50	0.048	0.000	49.832	0.343	36.819	11.930	0.6681	11.2620	98.972	1.028
83	DD17/4-5m	4	5	1257.50	0.000	0.000	43.698	0.278	29.344	25.567	2.5822	22.9844	98.887	1.113
84	DD18/0-1m	0	1	1536.50	0.000	0.000	43.020	0.163	20.631	35.796	9.1995	26.5962	99.610	0.390
85	DD18/1-2m	1	2	1531.50	0.000	0.000	38.655	0.261	19.393	41.071	9.0767	31.9942	99.380	0.620
86	DD18/2-3m	2	3	1383.00	0.000	0.000	36.117	0.325	21.186	41.866	7.6614	34.2041	99.494	0.506
87	DD18/3-4m	3	4	1296.50	0.000	0.000	36.830	0.540	24.875	36.868	7.0050	29.8635	99.113	0.887
88	DD18/4-5m	4	5	1330.00	0.000	3.759	35.414	0.301	21.729	38.346	8.5128	29.8331	99.549	0.451
89	DD19/0-1m	0	1	1252.50	0.000	0.000	37.086	0.200	38.762	23.553	3.1561	20.3968	99.601	0.399
90	DD19/1-2m	1	2	1464.50	0.000	0.000	37.282	0.205	38.785	22.738	2.4330	20.3052	99.010	0.990
91	DD19/2-3m	2	3	1280.50	0.000	0.000	35.611	0.586	21.476	42.093	6.1035	35.9895	99.766	0.234
92	DD19/3-4m	3	4	1267.00	0.000	0.000	41.871	0.237	28.098	29.045	5.8380	23.2069	99.250	0.750
93	DD19/4-5m	4	5	1541.50	0.000	3.049	39.215	0.097	20.856	35.744	6.1480	29.5964	98.962	1.038
94	DD20/0-1m	0	1	1135.50	0.000	0.000	30.559	3.699	28.622	35.491	3.9750	31.5160	98.371	1.629

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
95	DD20/1-2m	1	2	1167.00	0.000	0.000	31.577	2.699	32.262	32.391	2.6237	29.7671	98.929	1.071
96	DD20/2-3m	2	3	857.00	0.000	0.000	30.863	4.084	28.063	35.531	2.0608	33.4701	98.541	1.459
97	DD20/3-4m	3	4	1368.50	0.000	0.000	34.308	5.225	29.266	29.229	4.2967	24.9324	98.027	1.973
98	DD20/4-5m	4	5	1879.00	0.000	0.000	35.045	3.060	25.040	34.965	4.9651	30.0003	98.111	1.889
99	DD21/0-1m	0	1	942.18	0.000	6.069	37.572	0.159	15.920	40.120	9.7090	30.4107	99.841	0.159
100	DD21/1-2m	1	2	765.36	0.000	66.81	13.458	0.261	6.272	12.870	2.1364	10.7334	99.673	0.327
101	DD22/0-1m	0	1	1120.00	3.527	5.759	37.500	0.179	12.634	40.134	6.3412	33.7927	99.732	0.268
102	DD22/1-2m	1	2	1279.95	28.784	11.052	14.272	0.117	4.758	40.665	3.5379	37.1276	99.648	0.352
103	DD23/0-1m	0	1	1216.50	0.000	0.000	33.991	0.452	20.921	43.568	9.1928	34.3748	98.931	1.069
104	DD23/1-2m	1	2	1271.00	0.000	0.000	39.654	0.551	25.885	33.124	12.3551	20.7685	99.213	0.787
105	DD23/2-3m	2	3	1326.00	0.000	0.000	36.538	0.641	29.902	31.561	8.1743	23.3868	98.643	1.357
106	DD23/3-4m	3	4	1174.50	0.000	0.000	40.783	0.468	27.756	30.098	6.7419	23.3560	99.106	0.894
107	DD23/4-5m	4	5	1346.00	0.000	0.000	36.590	0.929	26.077	34.881	9.2784	25.6027	98.477	1.523
108	DD24/0-1m	0	1	1496.42	0.000	1.565	39.327	0.033	10.926	47.914	10.9244	36.9898	99.766	0.234
109	DD24/1-2m	1	2	1242.05	0.000	3.225	39.008	0.040	13.123	44.443	9.9551	34.4875	99.839	0.161
110	DD24/2-3m	2	3	1027.20	0.000	33.02	26.090	0.146	11.244	29.108	6.3165	22.7917	99.611	0.389
111	DD25/0-1m	0	1	1470.00	0.000	7.619	32.619	0.204	23.673	35.306	6.9200	28.3861	99.422	0.578
112	DD25/1-2m	1	2	965.64	0.000	24.04	31.740	0.104	16.155	27.443	5.5709	21.8719	99.482	0.518
113	DD26/0-1m	0	1	1276.00	1.878	0.000	34.789	5.596	20.276	36.403	3.6403	32.7625	98.942	1.058
114	DD26/1-2m	1	2	1461.00	0.890	0.000	33.456	4.672	12.898	47.365	1.3736	45.9912	99.281	0.719
115	DD27/0-1m	0	1	1125.50	0.000	0.000	42.692	0.133	20.036	36.384	5.7123	30.6716	99.245	0.755
116	DD27/1-2m	1	2	1255.50	0.000	0.000	41.378	0.478	18.917	38.630	6.1035	32.5265	99.403	0.597
117	DD27/2-3m	2	3	1190.00	0.000	0.000	43.655	0.714	21.050	33.655	4.1060	29.5495	99.076	0.924
118	DD27/3-4m	3	4	1904.00	0.053	0.000	39.128	0.919	26.917	31.644	4.6517	26.9923	98.661	1.339

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
119	DD27/4-5m	4	5	1387.21	0.000	4.412	38.711	0.252	19.031	37.305	6.0807	31.2244	99.712	0.288
120	DD28/0-1m	0	1	370.02	0.000	54.06	16.215	0.135	9.729	19.594	3.9775	15.6162	99.730	0.270
121	DD29/0-1m	0	1	830.77	0.000	4.366	37.435	0.181	19.079	38.338	7.1692	31.1686	99.398	0.602
122	DD29/1-2m	1	2	1128.78	0.044	24.21	27.065	0.399	14.130	33.797	5.4752	28.3223	99.646	0.354
123	DD30/0-1m	0	1	1018.00	0.000	0.000	34.971	0.835	30.157	32.613	3.5548	29.0582	98.576	1.424
124	DD30/1-2m	1	2	1397.66	13.812	4.984	31.374	1.072	11.875	36.132	0.6142	35.5177	99.249	0.751
125	DD30/2-3m	2	3	1594.99	16.426	7.147	20.765	1.759	14.844	35.110	0.5618	34.5482	96.050	3.950
126	DD30/3-4m	3	4	510.53	5.119	40.26	12.993	1.168	16.468	20.959	0.5449	20.4138	96.964	3.036
127	DD31/0-1m	0	1	1194.00	0.389	0.000	33.810	3.627	36.294	24.288	0.7772	23.5109	98.409	1.591
128	DD31/1-2m	1	2	1237.00	1.732	0.000	33.825	2.375	31.672	29.264	0.9072	28.3572	98.868	1.132
129	DD31/2-3m	2	3	1278.00	2.347	0.000	28.970	3.188	36.896	26.721	0.7482	25.9732	98.122	1.878
130	DD31/3-4m	3	4	905.00	0.000	0.000	16.354	4.309	53.812	22.928	1.3528	21.5754	97.403	2.597
131	DD32/0-1m	0	1	1246.00	0.000	0.000	52.127	0.682	37.480	9.230	1.3291	7.9005	99.518	0.482
132	DD32/1-2m	1	2	956.50	8.779	0.000	60.024	0.157	18.703	12.023	0.7214	11.3016	99.686	0.314
133	DD32/2-3m	2	3	1361.50	13.967	0.000	43.927	1.579	28.040	10.907	0.8617	10.0454	98.421	1.579
134	DD32/3-4m	3	4	1879.00	6.333	0.000	42.948	1.357	36.668	12.241	1.0772	11.1634	99.548	0.452
135	DD32/4-5m	4	5	1392.50	2.384	0.000	41.981	1.652	38.328	14.542	1.0470	13.4952	98.887	1.113
136	DD33/0-1m	0	1	1194.50	0.000	0.000	39.933	2.721	38.426	15.237	2.8035	12.4330	96.316	3.684
137	DD33/1-2m	1	2	1470.00	0.027	0.000	51.712	3.839	33.299	9.796	0.3037	9.4922	98.673	1.327
138	DD33/2-3m	2	3	1343.00	0.180	0.000	53.788	4.691	31.364	9.270	1.9838	7.2864	99.293	0.707
139	DD33/3-4m	3	4	1632.00	1.367	0.000	48.842	5.978	32.262	9.835	1.9866	7.8480	98.284	1.716
140	DD33/4-5m	4	5	1174.00	0.928	0.000	35.454	6.765	43.523	7.624	0.5413	7.0822	94.293	5.707
141	DD34/0-1m	0	1	1474.50	0.000	0.000	47.406	1.153	36.317	13.496	1.7005	11.7956	98.372	1.628
142	DD34/1-2m	1	2	1337.50	0.000	0.000	53.981	0.336	33.720	10.953	1.6539	9.2993	98.991	1.009

Sl. no.	Sample No.	Depth From	Depth To	Initial Wt.	Gravel	Clay	Magnetics (LIRMS)	Magnetics (REDMS)	Middling's (REDMS)	Non-magnetics (REDMS)	Gravity Separation (Nonmagnetic heavy minerals)	Gravity Separation (Lights)	Total wt.% of fractions	Loss
				(gm)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	(wt%)	%
143	DD34/2-3m	2	3	1272.50	0.314	0.000	64.126	1.179	22.083	7.859	1.6424	6.2161	95.560	4.440
144	DD34/3-4m	3	4	1444.82	13.529	4.279	43.163	1.038	19.788	17.269	1.6750	15.5935	99.066	0.934
145	DD34/4-5m	4	5	1112.39	0.566	8.755	33.736	1.438	33.368	17.979	1.4204	16.5589	95.842	4.158
146	DD35/0-1m	0	1	1420.50	0.000	0.000	46.111	1.056	36.994	14.220	2.6165	11.6038	98.381	1.619
147	DD35/1-2m	1	2	1198.00	0.000	0.000	44.073	2.045	37.688	12.312	1.2435	11.0687	96.119	3.881
148	DD35/2-3m	2	3	1499.27	15.948	3.587	38.695	2.630	20.365	17.642	0.8821	16.7598	98.866	1.134
149	DD35/3-4m	3	4	1609.47	20.907	3.167	43.069	0.808	16.641	15.409	1.0324	14.3764	100.000	0.000
150	DD35/4-5m	4	5	1558.99	20.641	4.682	41.858	1.155	15.115	16.549	0.3806	16.1685	100.000	0.000
151	DD36/0-1m	0	1	1202.00	0.024	0.000	60.542	9.526	17.263	7.488	2.0291	5.4584	94.842	5.158
152	DD36/1-2m	1	2	1717.00	0.641	0.000	61.548	11.487	18.113	7.513	1.7280	5.7851	99.301	0.699
153	DD36/2-3m	2	3	1673.50	9.193	0.000	48.538	13.253	17.931	10.427	2.5547	7.8726	99.343	0.657
154	DD36/3-4m	3	4	1815.00	15.604	0.000	46.464	14.065	11.414	11.570	1.9785	9.5917	99.118	0.882
155	DD36/4-5m	4	5	2790.00	22.761	0.000	40.651	7.852	17.642	10.143	1.3085	8.8349	99.050	0.950
156	DD37/0-1m	0	1	1254.00	0.000	0.000	60.566	0.080	19.936	18.900	3.7421	15.1574	99.482	0.518
157	DD37/1-2m	1	2	1647.45	6.749	2.334	54.519	2.883	22.164	11.351	0.6584	10.6925	100.000	0.000
158	DD37/2-3m	2	3	1192.60	19.638	2.734	49.322	0.713	13.590	14.003	0.9382	13.0648	100.000	0.000
159	DD37/3-4m	3	4	1471.70	19.464	3.785	46.504	0.238	14.959	14.541	0.8434	13.6976	99.490	0.510
160	DD37/4-5m	4	5	1496.62	3.274	14.607	33.308	0.668	12.528	34.177	4.8873	29.2898	98.563	1.437

Annexure 5
Granulometric analysis data

Annexure 5: Granulometric Analysis Results

Sl no.	Sample No.	Median	Mean	SD	Sorting Type	Kurtosis	Skewness Type	Skewness	Kurtosis Type	Granule	Sand	Mud	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Sediment Type (Folk)GSM
		Φ	Φ	Φ						%	%	%	%	%	%	%	%	
1	DD01/0-1	0.16	0.16	1.53	Moderately Well Sorted	1.033	Symmetrical	-0.015	Mesokurtic	0.000	98.292	1.708	0.060	0.336	13.171	58.250	26.474	Sand
2	DD01/1-2	0.25	0.25	1.70	Moderately Sorted	1.095	Symmetrical	-0.012	Mesokurtic	0.000	99.309	0.691	1.811	6.244	42.640	40.000	8.614	Sand
3	DD01/2-3	0.28	0.27	1.64	Moderately Sorted	1.249	Coarse Skewed	-0.226	Leptokurtic	0.753	96.866	2.382	0.547	4.810	58.342	27.689	5.457	Sand
4	DD01/3-4	0.15	0.15	2.61	Poorly Sorted	0.649	Symmetrical	0.091	Very Platykurtic	0.084	55.119	44.797	3.527	7.377	30.850	11.332	2.031	silty Sand
5	DD02/0-1	0.26	0.25	1.70	Moderately Sorted	0.982	Symmetrical	-0.072	Mesokurtic	0.000	99.577	0.423	0.247	9.580	44.130	35.737	9.882	Sand
6	DD02/1-2	0.43	0.45	1.84	Moderately Sorted	1.088	Symmetrical	0.026	Mesokurtic	0.496	99.027	0.477	9.339	29.312	45.129	12.561	2.685	Sand
7	DD02/2-3	0.37	0.37	2.01	Poorly Sorted	1.256	Symmetrical	-0.040	Leptokurtic	0.155	97.455	2.390	7.951	21.226	46.298	17.333	4.625	Sand
8	DD02/3-4	0.06	0.09	2.03	Poorly Sorted	0.977	Very Fine Skewed	0.751	Mesokurtic	0.000	42.959	57.041	0.361	2.193	12.512	11.139	16.754	sandy Silt
9	DD03/0-1	0.13	0.13	1.45	Moderately Well Sorted	1.005	Symmetrical	0.071	Mesokurtic	0.000	97.743	2.257	0.000	0.089	4.259	46.179	47.203	Sand
10	DD03/1-2	0.12	0.13	1.68	Moderately Sorted	0.979	Fine Skewed	0.180	Mesokurtic	0.000	94.537	5.463	0.036	0.889	12.555	36.237	44.810	Sand
11	DD03/2-3	0.25	0.23	1.58	Moderately Well Sorted	1.077	Coarse Skewed	-0.275	Mesokurtic	0.000	98.227	1.773	0.000	1.893	48.444	39.228	8.661	Sand
12	DD03/3-4	0.27	0.26	1.65	Moderately Sorted	1.153	Coarse Skewed	-0.193	Leptokurtic	0.000	97.703	2.297	0.289	6.154	52.964	32.349	5.931	Sand
13	DD03/4-5	0.28	0.27	1.60	Moderately Well Sorted	1.123	Coarse Skewed	-0.207	Leptokurtic	0.000	98.611	1.389	0.017	6.849	57.045	28.684	6.015	Sand
14	DD04/0-1	0.14	0.13	1.46	Moderately Well Sorted	1.088	Coarse Skewed	-0.215	Mesokurtic	0.000	95.142	4.858	0.000	0.043	2.055	60.522	32.519	Sand
15	DD04/1-2	0.14	0.14	1.59	Moderately Well Sorted	0.949	Fine Skewed	0.125	Mesokurtic	0.000	97.512	2.488	0.007	0.371	12.788	44.141	40.180	Sand
16	DD04/2-3	0.23	0.23	1.80	Moderately Sorted	1.103	Symmetrical	-0.039	Mesokurtic	0.153	97.431	2.416	1.435	5.876	36.191	41.675	12.231	Sand
17	DD04/3-4	0.30	0.29	1.88	Moderately Sorted	1.062	Symmetrical	-0.059	Mesokurtic	0.088	98.499	1.413	2.230	15.748	43.922	28.234	8.365	Sand
18	DD04/4-5	0.28	0.26	2.09	Poorly Sorted	1.230	Coarse Skewed	-0.106	Leptokurtic	0.178	95.294	4.527	4.315	10.840	42.209	27.585	10.341	Sand
19	DD05/0-1	0.13	0.13	1.40	Well Sorted	1.012	Symmetrical	-0.051	Mesokurtic	0.000	97.925	2.075	0.000	0.062	2.045	53.108	42.708	Sand
20	DD05/1-2	0.21	0.20	1.67	Moderately Sorted	0.941	Coarse Skewed	-0.181	Mesokurtic	0.000	97.803	2.197	0.000	1.479	36.665	42.203	17.447	Sand
21	DD05/2-3	0.23	0.23	1.58	Moderately Well Sorted	1.060	Coarse Skewed	-0.131	Mesokurtic	0.000	98.509	1.491	0.048	2.722	40.921	45.986	8.831	Sand
22	DD05/3-4	0.26	0.25	1.60	Moderately Well Sorted	1.060	Coarse Skewed	-0.163	Mesokurtic	0.000	98.772	1.228	0.246	4.430	48.447	38.060	7.589	Sand
23	DD05/4-5	0.27	0.25	1.68	Moderately Sorted	1.111	Coarse Skewed	-0.242	Leptokurtic	0.000	97.824	2.176	0.000	6.100	52.724	30.752	8.239	Sand
24	DD06/0-1	0.17	0.16	1.65	Moderately Sorted	0.980	Symmetrical	-0.022	Mesokurtic	0.000	96.987	3.013	0.059	0.920	19.823	50.150	26.035	Sand
25	DD06/1-2	0.24	0.23	1.58	Moderately Well Sorted	1.004	Coarse Skewed	-0.114	Mesokurtic	0.000	99.495	0.505	0.200	3.473	43.116	43.348	9.358	Sand
26	DD06/2-3	0.26	0.24	1.72	Moderately Sorted	1.060	Very Coarse Skewed	-0.303	Mesokurtic	0.000	97.549	2.451	0.000	4.539	51.580	29.788	11.619	Sand
27	DD06/3-4	0.28	0.26	1.70	Moderately Sorted	1.101	Coarse Skewed	-0.154	Mesokurtic	0.000	98.851	1.149	0.772	7.946	51.456	30.124	8.553	Sand
28	DD06/4-5	0.23	0.20	2.04	Poorly Sorted	1.153	Coarse Skewed	-0.210	Leptokurtic	1.551	88.082	10.367	1.595	2.958	38.012	35.100	10.416	slightly gravelly Sand
29	DD07/0-1	0.18	0.18	1.66	Moderately Sorted	1.008	Symmetrical	-0.018	Mesokurtic	0.000	97.755	2.245	0.000	2.011	23.667	50.450	21.615	Sand
30	DD07/1-2	0.22	0.20	1.69	Moderately Sorted	0.942	Coarse Skewed	-0.194	Mesokurtic	0.000	97.635	2.365	0.000	1.965	38.192	40.040	17.419	Sand
31	DD07/2-3	0.23	0.22	1.55	Moderately Well Sorted	1.082	Coarse Skewed	-0.217	Mesokurtic	0.000	97.887	2.113	0.000	0.936	41.058	46.892	8.996	Sand
32	DD07/3-4	0.27	0.26	1.67	Moderately Sorted	1.084	Coarse Skewed	-0.184	Mesokurtic	0.000	98.002	1.998	0.000	7.527	49.901	33.211	7.364	Sand
33	DD07/4-5	0.24	0.22	2.09	Poorly Sorted	1.175	Coarse Skewed	-0.160	Leptokurtic	1.345	90.411	8.244	2.106	5.262	38.620	32.165	12.258	slightly gravelly Sand
34	DD08/0-1	0.14	0.14	1.43	Moderately Well Sorted	1.019	Symmetrical	-0.015	Mesokurtic	0.000	98.806	1.194	0.008	0.048	6.047	60.226	32.477	Sand
35	DD08/1-2	0.22	0.21	1.65	Moderately Sorted	0.977	Coarse Skewed	-0.158	Mesokurtic	0.000	98.526	1.474	0.094	2.630	39.329	42.233	14.239	Sand
36	DD08/2-3	0.24	0.22	1.67	Moderately Sorted	1.062	Coarse Skewed	-0.179	Mesokurtic	0.000	97.662	2.338	0.506	3.183	41.793	41.262	10.900	Sand
37	DD08/3-4	0.22	0.19	2.51	Poorly Sorted	0.865	Coarse Skewed	-0.157	Platykurtic	0.000	82.703	17.297	2.329	12.196	29.888	27.755	10.535	Sand
38	DD08/4-5	0.09	0.11	2.26	Poorly Sorted	0.692	Very Fine Skewed	0.479	Platykurtic	0.000	53.509	46.491	0.479	5.509	17.453	22.305	7.763	silty Sand
39	DD09/0-1	0.14	0.14	1.55	Moderately Well Sorted	0.956	Fine Skewed	0.122	Mesokurtic	0.000	98.393	1.607	0.000	0.349	11.893	47.347	38.805	Sand
40	DD09/1-2	0.21	0.20	1.62	Moderately Well Sorted	1.005	Coarse Skewed	-0.204	Mesokurtic	0.000	97.655	2.345	0.000	0.938	37.262	45.308	14.128	Sand

Annexure 5: Granulometric Analysis Results

Sl no.	Sample No.	Median	Mean	SD	Sorting Type	Kurtosis	Skewness Type	Skewness	Kurtosis Type	Granule	Sand	Mud	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Sediment Type (Folk)GSM
		Φ	Φ	Φ						%	%	%	%	%	%	%	%	
41	DD09/2-3	0.29	0.27	1.73	Moderately Sorted	1.217	Coarse Skewed	-0.238	Leptokurtic	0.000	97.276	2.724	0.472	8.219	55.521	25.876	7.162	Sand
42	DD09/3-4	0.38	0.40	2.14	Poorly Sorted	1.129	Symmetrical	0.020	Leptokurtic	0.651	97.630	1.719	11.818	20.396	42.577	17.427	5.412	Sand
43	DD09/4-5	0.35	0.35	1.93	Moderately Sorted	1.106	Symmetrical	-0.061	Mesokurtic	0.000	98.569	1.431	4.841	23.113	43.980	20.949	5.685	Sand
44	DD10/0-1	0.15	0.15	1.55	Moderately Well Sorted	1.018	Symmetrical	-0.085	Mesokurtic	0.000	96.780	3.220	0.000	0.035	12.405	57.443	26.889	Sand
45	DD10/1-2	0.18	0.18	1.68	Moderately Sorted	0.981	Symmetrical	0.023	Mesokurtic	0.000	98.413	1.587	1.013	1.913	24.255	48.988	22.243	Sand
46	DD10/2-3	0.26	0.24	1.58	Moderately Well Sorted	1.097	Very Coarse Skewed	-0.302	Mesokurtic	0.000	98.377	1.623	0.041	2.269	54.326	33.205	8.536	Sand
47	DD10/3-4	0.24	0.23	1.66	Moderately Sorted	1.047	Coarse Skewed	-0.247	Mesokurtic	0.000	97.750	2.250	0.342	2.552	44.935	38.471	11.437	Sand
48	DD10/4-5	0.27	0.25	1.57	Moderately Well Sorted	1.247	Very Coarse Skewed	-0.370	Leptokurtic	0.000	97.102	2.898	0.016	1.400	59.027	30.431	6.214	Sand
49	DD11/0-1	0.21	0.20	1.51	Moderately Well Sorted	0.988	Coarse Skewed	-0.205	Mesokurtic	0.000	98.505	1.495	0.000	0.144	34.245	51.811	12.305	Sand
50	DD11/1-2	0.17	0.17	1.55	Moderately Well Sorted	0.940	Symmetrical	-0.041	Mesokurtic	0.000	98.699	1.301	0.000	0.313	21.011	54.818	22.557	Sand
51	DD11/2-3	0.25	0.23	1.54	Moderately Well Sorted	1.047	Very Coarse Skewed	-0.338	Mesokurtic	0.000	98.640	1.360	0.044	0.732	49.105	39.207	9.551	Sand
52	DD11/3-4	0.28	0.26	1.66	Moderately Sorted	1.083	Coarse Skewed	-0.205	Mesokurtic	0.000	98.411	1.589	0.000	8.171	53.143	29.557	7.540	Sand
53	DD11/4-5	0.26	0.23	2.17	Poorly Sorted	1.316	Coarse Skewed	-0.147	Leptokurtic	0.090	91.849	8.061	5.187	5.305	42.868	28.389	10.100	Sand
54	DD12/0-1	0.18	0.17	1.50	Moderately Well Sorted	0.949	Symmetrical	-0.076	Mesokurtic	0.000	98.916	1.084	0.015	0.044	20.306	58.929	19.622	Sand
55	DD12/1-2	0.23	0.22	1.50	Moderately Well Sorted	1.072	Coarse Skewed	-0.240	Mesokurtic	0.000	98.280	1.720	0.230	0.292	42.543	47.577	7.639	Sand
56	DD12/2-3	0.18	0.18	1.54	Moderately Well Sorted	0.969	Symmetrical	-0.045	Mesokurtic	0.000	98.854	1.146	0.063	0.350	21.969	56.360	20.110	Sand
57	DD12/3-4	0.23	0.22	1.57	Moderately Well Sorted	1.060	Coarse Skewed	-0.255	Mesokurtic	0.000	97.846	2.154	0.026	0.863	42.548	44.088	10.313	Sand
58	DD12/4-5	0.18	0.18	1.51	Moderately Well Sorted	1.052	Symmetrical	-0.020	Mesokurtic	0.242	98.784	0.975	0.062	0.336	19.838	60.848	17.700	Sand
59	DD13/0-1	0.22	0.21	1.40	Well Sorted	0.972	Coarse Skewed	-0.147	Mesokurtic	0.000	99.742	0.258	0.000	0.132	36.250	56.649	6.707	Sand
60	DD13/1-2	0.18	0.18	1.43	Moderately Well Sorted	1.021	Symmetrical	-0.008	Mesokurtic	0.000	99.726	0.274	0.000	0.244	17.763	66.547	15.167	Sand
61	DD13/2-3	0.23	0.22	1.59	Moderately Well Sorted	1.006	Coarse Skewed	-0.275	Mesokurtic	0.000	98.249	1.751	0.000	0.908	43.510	41.478	12.352	Sand
62	DD13/3-4	0.23	0.21	1.65	Moderately Sorted	0.945	Coarse Skewed	-0.151	Mesokurtic	0.000	99.061	0.939	0.000	3.065	39.826	41.112	15.057	Sand
63	DD13/4-5	0.29	0.34	2.37	Poorly Sorted	1.281	Fine Skewed	0.240	Leptokurtic	0.910	97.165	1.926	14.736	4.060	38.983	31.936	7.450	Sand
64	DD14/0-1	0.24	0.22	1.51	Moderately Well Sorted	1.060	Very Coarse Skewed	-0.347	Mesokurtic	0.000	98.191	1.809	0.000	0.197	45.360	43.463	9.171	Sand
65	DD14/1-2	0.23	0.22	1.51	Moderately Well Sorted	1.093	Coarse Skewed	-0.287	Mesokurtic	0.000	97.833	2.167	0.000	0.286	42.538	47.096	7.906	Sand
66	DD14/2-3	0.18	0.17	1.81	Moderately Sorted	0.915	Coarse Skewed	-0.163	Mesokurtic	0.000	92.859	7.141	0.092	1.212	29.803	40.468	21.284	Sand
67	DD14/3-4	0.23	0.22	1.67	Moderately Sorted	1.135	Coarse Skewed	-0.269	Leptokurtic	0.000	95.976	4.024	0.166	1.648	42.632	41.374	10.155	Sand
68	DD14/4-5	0.32	0.37	2.52	Poorly Sorted	1.673	Very Fine Skewed	0.331	Very Leptokurtic	6.631	93.034	0.335	8.195	8.633	42.641	27.567	5.997	gravelly Sand
69	DD15/0-1	0.16	0.15	1.56	Moderately Well Sorted	1.008	Coarse Skewed	-0.109	Mesokurtic	0.000	96.475	3.525	0.000	0.000	13.746	57.224	25.494	Sand
70	DD15/1-2	0.16	0.16	1.45	Moderately Well Sorted	1.034	Symmetrical	-0.062	Mesokurtic	0.000	98.740	1.260	0.000	0.000	11.212	64.153	23.375	Sand
71	DD15/2-3	0.23	0.21	1.59	Moderately Well Sorted	1.102	Very Coarse Skewed	-0.352	Mesokurtic	0.000	96.450	3.550	0.016	0.238	42.768	42.782	10.633	Sand
72	DD15/3-4	0.18	0.18	1.51	Moderately Well Sorted	1.059	Coarse Skewed	-0.128	Mesokurtic	0.000	97.699	2.301	0.000	0.073	22.135	60.672	14.803	Sand
73	DD15/4-5	0.25	0.22	1.63	Moderately Sorted	1.147	Very Coarse Skewed	-0.417	Leptokurtic	0.000	96.335	3.665	0.083	0.714	50.472	35.393	9.661	Sand
74	DD16/0-1	0.15	0.15	1.37	Well Sorted	1.003	Symmetrical	0.005	Mesokurtic	0.000	99.623	0.377	0.000	0.000	4.663	64.451	30.508	Sand
75	DD16/1-2	0.15	0.15	1.39	Well Sorted	1.034	Symmetrical	-0.024	Mesokurtic	0.000	99.542	0.458	0.000	0.000	6.824	67.982	24.735	Sand
76	DD16/2-3	0.17	0.17	1.48	Moderately Well Sorted	1.038	Symmetrical	-0.066	Mesokurtic	0.000	98.761	1.239	0.000	0.093	17.310	63.590	17.767	Sand
77	DD16/3-4	0.21	0.20	1.50	Moderately Well Sorted	1.030	Coarse Skewed	-0.170	Mesokurtic	0.000	98.433	1.567	0.000	0.262	33.387	54.220	10.565	Sand
78	DD16/4-5	0.23	0.21	1.63	Moderately Sorted	1.042	Coarse Skewed	-0.296	Mesokurtic	0.000	96.912	3.088	0.000	0.787	42.273	41.132	12.717	Sand
79	DD17/0-1	0.22	0.21	1.43	Moderately Well Sorted	1.003	Coarse Skewed	-0.138	Mesokurtic	0.000	99.423	0.577	0.000	0.294	36.185	55.640	7.303	Sand
80	DD17/1-2	0.16	0.15	1.54	Moderately Well Sorted	1.038	Symmetrical	-0.099	Mesokurtic	0.000	96.798	3.202	0.000	0.032	13.022	58.675	25.063	Sand
81	DD17/2-3	0.15	0.15	1.72	Moderately Sorted	1.043	Symmetrical	-0.030	Mesokurtic	0.000	93.980	6.020	0.047	1.524	15.180	48.898	28.332	Sand

Annexure 5: Granulometric Analysis Results

Sl no.	Sample No.	Median	Mean	SD	Sorting Type	Kurtosis	Skewness Type	Skewness	Kurtosis Type	Granule	Sand	Mud	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Sediment Type (Folk)GSM
		Φ	Φ	Φ						%	%	%	%	%	%	%	%	
82	DD17/3-4	0.26	0.23	1.64	Moderately Sorted	1.095	Very Coarse Skewed	-0.369	Mesokurtic	0.000	97.199	2.801	0.101	1.604	51.848	32.995	10.628	Sand
83	DD17/4-5	0.22	0.20	1.62	Moderately Sorted	0.977	Coarse Skewed	-0.218	Mesokurtic	0.000	97.828	2.172	0.000	0.924	38.182	43.679	15.035	Sand
84	DD18/0-1	0.19	0.19	1.51	Moderately Well Sorted	1.024	Coarse Skewed	-0.144	Mesokurtic	0.000	97.947	2.053	0.000	0.117	26.771	57.583	13.473	Sand
85	DD18/1-2	0.17	0.17	1.40	Well Sorted	1.121	Symmetrical	-0.058	Leptokurtic	0.000	98.991	1.009	0.000	0.042	12.655	71.824	14.470	Sand
86	DD18/2-3	0.17	0.17	1.49	Moderately Well Sorted	1.162	Coarse Skewed	-0.134	Leptokurtic	0.000	97.076	2.924	0.000	0.018	14.520	66.053	16.473	Sand
87	DD18/3-4	0.14	0.14	1.46	Moderately Well Sorted	1.039	Symmetrical	-0.084	Mesokurtic	0.000	97.165	2.835	0.000	0.034	4.819	58.459	33.834	Sand
88	DD18/4-5	0.15	0.15	1.49	Moderately Well Sorted	1.032	Symmetrical	-0.059	Mesokurtic	0.000	97.753	2.247	0.000	0.042	9.269	59.532	28.898	Sand
89	DD19/0-1	0.16	0.16	1.44	Moderately Well Sorted	1.107	Symmetrical	-0.088	Mesokurtic	0.000	98.367	1.633	0.000	0.000	9.104	66.576	22.687	Sand
90	DD19/1-2	0.22	0.21	1.63	Moderately Sorted	0.965	Coarse Skewed	-0.102	Mesokurtic	0.000	99.067	0.933	0.000	2.709	36.517	45.310	14.531	Sand
91	DD19/2-3	0.17	0.17	1.54	Moderately Well Sorted	1.035	Symmetrical	0.025	Mesokurtic	0.000	98.954	1.046	0.000	0.960	15.553	57.896	24.545	Sand
92	DD19/3-4	0.19	0.19	1.56	Moderately Well Sorted	0.924	Coarse Skewed	-0.116	Mesokurtic	0.000	98.722	1.278	0.000	0.358	28.980	51.609	17.775	Sand
93	DD19/4-5	0.20	0.19	1.47	Moderately Well Sorted	0.998	Coarse Skewed	-0.196	Mesokurtic	0.000	98.120	1.880	0.000	0.000	27.953	58.385	11.782	Sand
94	DD20/0-1	0.18	0.17	1.54	Moderately Well Sorted	1.002	Coarse Skewed	-0.135	Mesokurtic	0.000	97.533	2.467	0.000	0.053	21.727	57.301	18.429	Sand
95	DD20/1-2	0.16	0.16	1.45	Moderately Well Sorted	1.086	Symmetrical	-0.046	Mesokurtic	0.000	98.872	1.128	0.000	0.119	11.248	65.953	21.551	Sand
96	DD20/2-3	0.17	0.17	1.59	Moderately Well Sorted	1.160	Coarse Skewed	-0.121	Leptokurtic	0.000	96.011	3.989	0.022	0.325	17.669	59.204	18.791	Sand
97	DD20/3-4	0.16	0.16	1.55	Moderately Well Sorted	1.062	Symmetrical	-0.074	Mesokurtic	0.000	97.068	2.932	0.000	0.190	13.312	58.591	24.966	Sand
98	DD20/4-5	0.17	0.16	1.62	Moderately Well Sorted	1.156	Coarse Skewed	-0.156	Leptokurtic	0.000	95.108	4.892	0.000	0.178	17.989	57.837	19.102	Sand
99	DD21/0-1	0.16	0.15	1.75	Moderately Sorted	0.940	Coarse Skewed	-0.117	Mesokurtic	0.000	91.522	8.478	0.121	0.344	19.083	47.325	24.648	Sand
100	DD21/1-2	0.18	0.17	1.91	Moderately Sorted	0.940	Coarse Skewed	-0.127	Mesokurtic	0.000	91.138	8.862	1.176	2.191	28.659	39.331	19.781	Sand
101	DD22/0-1	0.21	0.22	2.48	Poorly Sorted	1.304	Fine Skewed	0.142	Leptokurtic	4.382	88.647	6.971	2.603	8.926	24.524	36.706	15.888	slightly gravelly Sand
102	DD22/1-2	1.28	0.63	4.68	Very Poorly Sorted	1.699	Very Coarse Skewed	-0.538	Very Leptokurtic	21.199	63.111	15.690	46.153	12.138	1.873	1.701	1.245	gravelly Sand
103	DD23/0-1	0.14	0.14	1.42	Moderately Well Sorted	0.992	Symmetrical	0.065	Mesokurtic	0.000	99.128	0.872	0.024	0.029	4.943	53.935	40.198	Sand
104	DD23/1-2	0.16	0.15	1.49	Moderately Well Sorted	1.125	Coarse Skewed	-0.119	Leptokurtic	0.000	97.157	2.843	0.000	0.015	9.760	63.924	23.439	Sand
105	DD23/2-3	0.15	0.15	1.53	Moderately Well Sorted	1.018	Symmetrical	-0.068	Mesokurtic	0.000	97.167	2.833	0.000	0.048	11.168	57.671	28.259	Sand
106	DD23/3-4	0.16	0.16	1.58	Moderately Well Sorted	1.220	Coarse Skewed	-0.171	Leptokurtic	0.000	94.930	5.071	0.000	0.075	14.270	61.367	19.216	Sand
107	DD23/4-5	0.16	0.16	1.61	Moderately Well Sorted	1.110	Coarse Skewed	-0.147	Leptokurtic	0.000	95.130	4.870	0.000	0.086	15.874	57.613	21.554	Sand
108	DD24/0-1	0.15	0.15	1.53	Moderately Well Sorted	0.994	Symmetrical	-0.026	Mesokurtic	0.000	97.796	2.204	0.000	0.117	12.072	56.116	29.481	Sand
109	DD24/1-2	0.18	0.17	1.69	Moderately Sorted	0.997	Coarse Skewed	-0.184	Mesokurtic	0.000	94.709	5.291	0.023	0.337	26.863	47.891	19.588	Sand
110	DD24/2-3	0.13	0.12	1.92	Moderately Sorted	0.662	Symmetrical	-0.094	Very Platykurtic	0.000	66.275	33.725	0.049	0.559	12.998	38.478	14.190	Silty Sand
111	DD25/0-1	0.16	0.15	1.62	Moderately Sorted	1.038	Coarse Skewed	-0.120	Mesokurtic	0.000	95.118	4.882	0.000	0.108	15.396	54.892	24.720	Sand
112	DD25/1-2	0.16	0.14	2.07	Poorly Sorted	0.587	Coarse Skewed	-0.174	Very Platykurtic	0.000	74.145	25.855	0.000	1.444	27.703	33.182	11.816	silty Sand
113	DD26/0-1	0.99	0.87	1.95	Moderately Sorted	1.264	Very Coarse Skewed	-0.387	Leptokurtic	4.377	95.222	0.401	45.257	32.348	9.523	5.564	2.530	slightly gravelly Sand
114	DD26/1-2	0.63	0.54	2.48	Poorly Sorted	0.844	Coarse Skewed	-0.253	Platykurtic	3.698	94.597	1.704	24.587	33.325	14.295	16.912	5.479	slightly gravelly Sand
115	DD27/0-1	0.20	0.19	1.60	Moderately Well Sorted	0.908	Coarse Skewed	-0.159	Mesokurtic	0.000	98.349	1.651	0.000	0.524	33.083	46.195	18.547	Sand
116	DD27/1-2	0.18	0.18	1.59	Moderately Well Sorted	0.917	Symmetrical	-0.056	Mesokurtic	0.000	98.345	1.655	0.048	0.496	24.182	51.290	22.329	Sand
117	DD27/2-3	0.17	0.16	1.63	Moderately Sorted	1.048	Coarse Skewed	-0.101	Mesokurtic	0.000	95.785	4.215	0.063	0.324	18.308	54.172	22.915	Sand
118	DD27/3-4	0.16	0.16	1.61	Moderately Well Sorted	0.903	Symmetrical	-0.010	Mesokurtic	0.000	97.653	2.347	0.027	0.269	19.135	49.015	29.189	Sand
119	DD27/4-5	0.18	0.18	1.61	Moderately Well Sorted	0.945	Symmetrical	-0.093	Mesokurtic	0.000	97.708	2.292	0.000	0.492	25.154	51.094	20.953	Sand
120	DD28/0-1	0.06	0.08	1.76	Moderately Sorted	0.739	Very Fine Skewed	0.684	Platykurtic	0.000	45.013	54.987	0.075	0.225	5.253	26.110	13.349	sandy Silt
121	DD29/0-1	0.18	0.17	1.79	Moderately Sorted	0.856	Coarse Skewed	-0.161	Platykurtic	0.000	93.242	6.758	0.071	0.581	29.960	38.579	24.050	Sand
122	DD29/1-2	0.15	0.13	1.92	Moderately Sorted	0.665	Coarse Skewed	-0.196	Very Platykurtic	0.000	75.342	24.658	0.297	0.581	14.568	47.280	12.617	silty Sand

Annexure 5: Granulometric Analysis Results

Sl no.	Sample No.	Median	Mean	SD	Sorting Type	Kurtosis	Skewness Type	Skewness	Kurtosis Type	Granule	Sand	Mud	Very Coarse Sand	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Sediment Type (Folk)GSM
		Φ	Φ	Φ						%	%	%	%	%	%	%	%	
123	DD30/0-1	0.15	0.15	1.49	Moderately Well Sorted	1.146	Symmetrical	-0.020	Leptokurtic	0.000	98.152	1.848	0.452	0.761	6.847	62.103	27.989	Sand
124	DD30/1-2	0.93	0.57	2.79	Poorly Sorted	1.668	Very Coarse Skewed	-0.684	Very Leptokurtic	0.673	93.073	6.254	45.622	30.929	2.812	5.557	8.152	Sand
125	DD30/2-3	1.36	1.17	3.21	Poorly Sorted	2.101	Very Coarse Skewed	-0.354	Very Leptokurtic	23.272	67.777	8.951	48.759	11.482	1.233	1.625	4.677	gravelly Sand
126	DD30/3-4	0.06	0.07	2.05	Poorly Sorted	2.958	Very Fine Skewed	0.659	Very Leptokurtic	4.300	45.966	49.735	2.475	0.747	0.211	2.469	40.062	gravelly Sand
127	DD31/0-1	0.43	0.41	2.49	Poorly Sorted	0.866	Symmetrical	-0.092	Platykurtic	2.325	95.086	2.589	14.421	28.667	19.484	25.123	7.363	slightly gravelly Sand
128	DD31/1-2	0.53	0.49	2.37	Poorly Sorted	0.786	Coarse Skewed	-0.137	Platykurtic	2.579	96.818	0.604	21.371	29.313	20.169	20.421	5.544	slightly gravelly Sand
129	DD31/2-3	0.30	0.33	2.70	Poorly Sorted	1.067	Fine Skewed	0.181	Mesokurtic	5.899	91.065	3.036	8.293	17.396	25.754	29.143	10.477	gravelly Sand
130	DD31/3-4	0.31	0.31	2.33	Poorly Sorted	0.988	Symmetrical	-0.065	Mesokurtic	0.000	95.432	4.568	8.331	21.203	31.470	24.779	9.644	Sand
131	DD32/0-1	0.19	0.20	1.62	Moderately Sorted	1.140	Symmetrical	0.028	Leptokurtic	0.000	98.364	1.636	0.553	2.826	24.587	56.091	14.307	Sand
132	DD32/1-2	0.47	0.48	2.21	Poorly Sorted	0.859	Symmetrical	-0.024	Platykurtic	1.221	97.878	0.901	20.643	24.923	31.455	16.585	4.271	slightly gravelly Sand
133	DD32/2-3	0.24	0.25	2.05	Poorly Sorted	1.151	Symmetrical	0.096	Leptokurtic	0.000	97.932	2.068	6.200	8.872	32.617	37.194	13.046	Sand
134	DD32/3-4	0.21	0.23	2.24	Poorly Sorted	1.249	Fine Skewed	0.231	Leptokurtic	2.462	95.089	2.450	6.913	6.433	23.047	41.951	16.721	slightly gravelly Sand
135	DD32/4-5	0.20	0.22	2.28	Poorly Sorted	1.096	Fine Skewed	0.195	Mesokurtic	2.305	94.712	2.983	5.064	7.864	23.525	35.440	22.816	slightly gravelly Sand
136	DD33/0-1	0.14	0.14	1.54	Moderately Well Sorted	1.001	Symmetrical	0.065	Mesokurtic	0.000	97.588	2.412	0.037	0.335	9.315	49.539	38.340	Sand
137	DD33/1-2	0.27	0.26	1.67	Moderately Sorted	1.133	Coarse Skewed	-0.131	Leptokurtic	0.152	98.744	1.104	1.790	4.805	50.785	33.263	8.100	Sand
138	DD33/2-3	0.25	0.24	1.62	Moderately Sorted	1.042	Coarse Skewed	-0.140	Mesokurtic	0.000	98.958	1.042	0.350	4.789	46.016	39.116	8.687	Sand
139	DD33/3-4	0.26	0.24	1.97	Moderately Sorted	1.293	Symmetrical	-0.095	Leptokurtic	1.037	95.452	3.511	3.528	3.746	43.563	32.289	12.314	slightly gravelly Sand
140	DD33/4-5	0.09	0.11	2.34	Poorly Sorted	1.218	Very Fine Skewed	0.470	Leptokurtic	1.312	72.982	25.705	4.283	2.876	8.754	15.801	41.269	slightly gravelly Sand
141	DD34/0-1	0.12	0.12	1.44	Moderately Well Sorted	1.007	Symmetrical	-0.069	Mesokurtic	0.000	96.085	3.915	0.000	0.000	2.115	47.817	46.148	Sand
142	DD34/1-2	0.16	0.16	1.58	Moderately Well Sorted	0.991	Symmetrical	0.019	Mesokurtic	0.000	98.004	1.996	0.000	0.625	14.954	53.080	29.346	Sand
143	DD34/2-3	0.19	0.19	1.99	Moderately Sorted	0.932	Symmetrical	-0.064	Mesokurtic	0.260	93.273	6.467	0.963	5.251	30.375	34.307	22.374	Sand
144	DD34/3-4	0.44	0.45	3.76	Poorly Sorted	0.816	Symmetrical	0.057	Platykurtic	14.989	81.332	3.678	13.007	19.014	15.157	16.998	17.144	gravelly Sand
145	DD34/4-5	0.24	0.28	2.95	Poorly Sorted	0.878	Fine Skewed	0.241	Platykurtic	5.458	90.686	3.856	8.662	15.972	17.876	24.490	23.679	gravelly Sand
146	DD35/0-1	0.13	0.13	1.48	Moderately Well Sorted	1.012	Symmetrical	-0.044	Mesokurtic	0.000	96.377	3.623	0.000	0.046	4.417	51.492	40.409	Sand
147	DD35/1-2	0.13	0.16	1.97	Moderately Sorted	1.116	Very Fine Skewed	0.390	Leptokurtic	0.000	96.841	3.159	1.017	9.503	10.891	32.301	43.125	Sand
148	DD35/2-3	0.72	0.58	3.45	Poorly Sorted	0.958	Coarse Skewed	-0.238	Mesokurtic	13.223	81.272	5.504	26.373	22.187	13.021	11.927	7.754	gravelly Sand
149	DD35/3-4	0.88	0.86	3.80	Poorly Sorted	0.769	Coarse Skewed	-0.103	Platykurtic	24.557	73.773	1.670	21.663	18.998	10.880	14.977	7.255	gravelly Sand
150	DD35/4-5	0.72	0.57	3.94	Poorly Sorted	0.822	Coarse Skewed	-0.211	Platykurtic	17.862	74.595	7.543	23.615	17.891	10.183	13.383	9.520	gravelly Sand
151	DD36/0-1	0.36	0.36	1.92	Moderately Sorted	1.495	Symmetrical	-0.065	Leptokurtic	0.000	97.915	2.085	6.147	18.630	52.986	14.611	5.538	Sand
152	DD36/1-2	0.78	0.67	2.17	Poorly Sorted	1.026	Very Coarse Skewed	-0.389	Mesokurtic	1.111	97.427	1.462	39.136	26.290	21.733	5.254	5.014	slightly gravelly Sand
153	DD36/2-3	1.02	0.90	2.54	Poorly Sorted	1.191	Coarse Skewed	-0.197	Leptokurtic	15.807	82.825	1.368	35.355	24.424	14.952	5.240	2.853	gravelly Sand
154	DD36/3-4	1.13	0.88	2.83	Poorly Sorted	1.154	Very Coarse Skewed	-0.394	Leptokurtic	17.277	79.691	3.032	41.602	15.041	12.208	6.402	4.438	gravelly Sand
155	DD36/4-5	1.24	0.95	3.64	Poorly Sorted	0.993	Very Coarse Skewed	-0.345	Mesokurtic	27.479	69.107	3.414	33.583	12.260	8.168	8.188	6.896	gravelly Sand
156	DD37/0-1	0.22	0.23	1.92	Moderately Sorted	0.910	Symmetrical	0.052	Mesokurtic	0.000	98.363	1.637	0.383	13.475	28.538	39.469	16.498	Sand
157	DD37/1-2	0.78	0.78	1.95	Moderately Sorted	1.621	Coarse Skewed	-0.103	Very Leptokurtic	5.516	91.906	2.579	23.998	52.839	10.199	3.279	1.564	gravelly Sand
158	DD37/2-3	1.22	1.27	2.89	Poorly Sorted	0.811	Coarse Skewed	-0.115	Platykurtic	30.114	69.745	0.140	28.925	22.065	9.198	5.995	3.562	sandy Gravel
159	DD37/3-4	0.95	0.67	3.86	Poorly Sorted	0.767	Very Coarse Skewed	-0.302	Platykurtic	18.775	79.744	1.482	29.756	17.580	6.579	9.687	16.142	gravelly Sand
160	DD37/4-5	0.11	0.13	2.43	Poorly Sorted	1.025	Very Fine Skewed	0.404	Mesokurtic	2.048	75.990	21.962	3.446	2.858	14.373	18.322	36.991	slightly gravelly Sand

Annexure 6
Granulometric analysis of Magnetic fractions

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
			(g)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)
1	DD01/0-1/A	A	365.50	0.000	0.000	0.137	0.324	17.836	55.631	23.243	2.504	99.674	0.326
2	DD01/0-1/B	B	6.50	0.000	0.000	0.000	0.768	31.792	33.949	28.214	4.868	99.592	0.408
3	DD01/0-1/C	C	292.50	0.000	0.000	0.000	0.094	4.964	49.617	42.268	2.205	99.147	0.853
4	DD01/1-2/A	A	479.00	0.000	0.000	0.597	7.972	45.026	34.328	10.043	1.392	99.358	0.642
5	DD01/1-2/B	B	3.00	0.000	0.000	1.121	16.678	58.356	9.715	7.880	6.148	99.898	0.102
6	DD01/1-2/C	C	166.00	0.000	0.000	0.363	3.358	22.434	51.782	19.410	1.734	99.082	0.918
7	DD01/2-3/A	A	537.00	0.000	0.000	1.480	3.258	56.568	26.939	7.379	3.592	99.216	0.784
8	DD01/2-3/B	B	7.00	0.000	0.000	0.000	8.092	68.178	10.588	4.327	8.196	99.380	0.620
9	DD01/2-3/C	C	227.50	0.000	0.000	0.988	1.784	36.174	42.509	14.591	3.379	99.424	0.576
10	DD01/3-4/A	A	365.50	0.000	0.000	3.357	8.512	62.547	20.123	5.023	0.367	99.929	0.071
11	DD01/3-4/B	B	6.50	0.000	0.000	1.439	22.745	60.394	8.325	5.092	0.695	98.691	1.309
12	DD01/3-4/C	C	120.50	0.000	0.000	1.770	6.000	41.058	36.623	13.349	0.827	99.627	0.373
13	DD02/0-1/A	A	459.00	0.000	0.000	1.532	6.876	50.161	30.331	9.617	0.889	99.405	0.595
14	DD02/0-1/B	B	46.50	0.000	0.000	3.081	14.222	62.162	12.107	6.255	1.111	98.938	1.062
15	DD02/0-1/C	C	385.50	0.000	0.000	0.626	2.651	30.295	49.385	16.279	0.508	99.743	0.257
16	DD02/1-2/A	A	404.02	0.000	0.000	8.283	30.383	48.483	9.668	2.137	0.499	99.453	0.547
17	DD02/1-2/B	B	51.60	0.000	0.000	16.270	43.110	35.943	2.509	0.931	0.707	99.469	0.531
18	DD02/1-2/C	C	215.52	0.000	0.000	9.036	20.042	38.689	25.498	5.577	0.952	99.794	0.206
19	DD02/2-3/A	A	665.09	0.000	0.000	5.778	17.754	48.621	16.650	4.508	5.692	99.004	0.996
20	DD02/2-3/B	B	62.79	0.000	0.000	16.239	33.865	39.368	4.765	2.084	3.069	99.390	0.610
21	DD02/2-3/C	C	514.96	0.000	0.000	5.648	14.409	41.900	27.960	7.035	2.410	99.362	0.638
22	DD02/3-4/A	A	246.00	0.000	0.000	0.000	1.620	17.609	15.711	26.577	36.912	98.428	1.572

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
23	DD02/3-4/B	B	83.50	0.000	0.000	0.000	3.904	12.439	14.506	24.351	42.984	98.184	1.816
24	DD02/3-4/C	C	1109.50	0.000	0.000	0.000	0.000	18.603	56.815	21.301	3.112	99.832	0.168
25	DD03/0-1/A	A	129.00	0.000	0.000	0.007	0.077	6.192	42.734	43.212	6.290	98.513	1.487
26	DD03/0-1/B	B	9.50	0.000	0.000	0.000	0.455	7.786	28.665	44.641	17.543	99.090	0.910
27	DD03/0-1/C	C	163.00	0.000	0.000	0.000	0.181	2.351	38.382	55.495	3.587	99.996	0.004
28	DD03/1-2/A	A	354.50	0.000	0.000	0.000	0.664	14.652	30.487	50.937	2.927	99.667	0.333
29	DD03/1-2/B	B	25.00	0.000	0.000	0.000	0.659	22.288	21.276	38.229	16.618	99.071	0.929
30	DD03/1-2/C	C	303.00	0.000	0.000	0.006	0.055	5.144	29.108	60.350	4.954	99.617	0.383
31	DD03/2-3/A	A	301.50	0.000	0.000	0.000	2.562	59.333	28.257	7.521	1.595	99.269	0.731
32	DD03/2-3/B	B	28.00	0.000	0.000	0.000	3.383	52.558	15.174	6.537	21.383	99.034	0.966
33	DD03/2-3/C	C	263.50	0.000	0.000	0.000	0.886	36.534	50.626	10.916	1.009	99.972	0.028
34	DD03/3-4/A	A	355.50	0.000	0.000	0.000	4.754	53.081	33.042	6.718	1.602	99.196	0.804
35	DD03/3-4/B	B	16.00	0.000	0.000	0.000	13.108	71.859	9.048	2.608	2.678	99.300	0.700
36	DD03/3-4/C	C	276.00	0.000	0.000	0.000	3.749	47.472	38.259	8.734	1.293	99.508	0.492
37	DD03/4-5/A	A	330.00	0.000	0.000	0.663	4.699	55.596	26.444	9.228	2.844	99.474	0.526
38	DD03/4-5/B	B	17.00	0.000	0.000	0.000	10.650	57.609	15.374	8.890	7.077	99.599	0.401
39	DD03/4-5/C	C	300.50	0.000	0.000	0.006	2.772	44.792	42.093	8.989	0.857	99.509	0.491
40	DD04/0-1/A	A	388.50	0.000	0.000	0.000	0.000	1.216	56.580	35.446	6.010	99.252	0.748
41	DD04/0-1/B	B	12.00	0.000	0.000	0.000	0.000	1.042	40.221	41.917	16.758	99.938	0.062
42	DD04/0-1/C	C	422.50	0.000	0.000	0.000	0.000	0.519	55.013	41.187	3.168	99.886	0.114
43	DD04/1-2/A	A	351.50	0.000	0.000	0.000	1.029	23.850	40.499	30.081	3.952	99.411	0.589
44	DD04/1-2/B	B	12.00	0.000	0.000	0.000	0.806	24.176	20.619	41.890	11.595	99.086	0.914
45	DD04/1-2/C	C	328.00	0.000	0.000	0.000	0.121	8.396	43.805	44.820	2.851	99.992	0.008
46	DD04/2-3/A	A	577.00	0.000	0.000	2.078	5.342	43.649	34.339	12.149	2.098	99.654	0.346
47	DD04/2-3/B	B	13.00	0.000	0.000	6.549	13.752	55.320	15.145	6.542	2.458	99.767	0.233

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
48	DD04/2-3/C	C	421.50	0.000	0.000	1.179	4.998	24.565	53.330	14.650	1.083	99.806	0.194
49	DD04/3-4/A	A	679.99	0.000	0.000	12.515	20.214	48.544	15.097	2.966	0.579	99.916	0.084
50	DD04/3-4/B	B	20.45	0.000	0.000	13.700	24.337	45.807	8.147	4.088	2.368	98.446	1.554
51	DD04/3-4/C	C	319.91	0.000	0.000	8.448	11.442	40.474	30.810	7.252	0.744	99.169	0.831
52	DD04/4-5/A	A	851.00	0.000	0.000	3.382	18.805	46.941	18.848	7.424	3.150	98.550	1.450
53	DD04/4-5/B	B	12.50	0.000	0.000	6.819	33.938	40.442	6.595	4.864	6.024	98.683	1.317
54	DD04/4-5/C	C	451.64	0.000	0.000	4.833	5.638	37.128	40.874	10.175	0.998	99.646	0.354
55	DD05/0-1/A	A	287.00	0.000	0.000	0.000	0.000	4.170	47.176	43.211	4.727	99.284	0.716
56	DD05/0-1/B	B	22.50	0.000	0.000	0.000	1.153	7.087	46.610	36.007	8.680	99.537	0.463
57	DD05/0-1/C	C	292.00	0.000	0.000	0.000	0.000	1.390	46.782	47.766	3.730	99.668	0.332
58	DD05/1-2/A	A	468.00	0.000	0.000	0.000	0.735	41.491	40.267	15.078	1.963	99.534	0.466
59	DD05/1-2/B	B	25.50	0.000	0.000	0.000	1.518	59.345	22.620	12.520	3.299	99.302	0.698
60	DD05/1-2/C	C	538.50	0.000	0.000	0.000	0.278	27.621	49.300	21.422	1.231	99.851	0.149
61	DD05/2-3/A	A	399.50	0.000	0.000	0.107	2.331	46.250	36.525	11.710	2.685	99.609	0.391
62	DD05/2-3/B	B	27.50	0.000	0.000	0.066	8.965	57.313	21.354	7.697	3.428	98.824	1.176
63	DD05/2-3/C	C	439.00	0.000	0.000	0.027	0.877	29.860	54.235	13.436	1.284	99.718	0.282
64	DD05/3-4/A	A	614.00	0.000	0.000	0.436	2.150	52.705	34.589	8.266	1.471	99.618	0.382
65	DD05/3-4/B	B	103.00	0.000	0.000	0.091	5.706	49.166	32.740	10.651	1.018	99.373	0.627
66	DD05/3-4/C	C	540.50	0.000	0.000	0.158	1.495	34.505	51.880	10.981	0.708	99.726	0.274
67	DD05/4-5/A	A	550.50	0.000	0.000	0.297	4.693	58.113	25.091	7.980	3.189	99.364	0.636
68	DD05/4-5/B	B	54.00	0.000	0.000	0.084	10.414	61.308	17.349	7.678	2.356	99.188	0.812
69	DD05/4-5/C	C	405.50	0.000	0.000	0.160	2.793	48.120	39.211	8.203	0.848	99.335	0.665
70	DD06/0-1/A	A	453.00	0.000	0.000	0.000	0.616	21.762	44.749	28.668	3.297	99.092	0.908
71	DD06/0-1/B	B	8.00	0.000	0.000	0.000	1.103	37.020	27.845	25.118	7.984	99.070	0.930
72	DD06/0-1/C	C	343.00	0.000	0.000	0.000	0.264	8.673	47.801	39.423	2.992	99.153	0.847

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
73	DD06/1-2/A	A	602.00	0.000	0.000	0.241	2.605	48.343	35.716	11.174	1.505	99.585	0.415
74	DD06/1-2/B	B	8.50	0.000	0.000	0.458	5.711	71.373	13.386	6.723	0.470	98.120	1.880
75	DD06/1-2/C	C	293.00	0.000	0.000	0.118	1.108	27.265	49.867	19.216	1.517	99.091	0.909
76	DD06/2-3/A	A	581.50	0.000	0.000	0.243	5.409	48.946	27.933	13.687	2.953	99.171	0.829
77	DD06/2-3/B	B	11.00	0.000	0.000	0.000	17.681	54.384	11.078	11.676	5.118	99.937	0.063
78	DD06/2-3/C	C	276.00	0.000	0.000	0.000	4.058	26.325	40.148	26.310	2.846	99.687	0.313
79	DD06/3-4/A	A	820.00	0.000	0.000	0.053	5.520	54.877	25.567	10.069	3.227	99.314	0.686
80	DD06/3-4/B	B	7.50	0.000	0.000	0.000	13.649	56.000	8.959	12.608	6.811	98.027	1.973
81	DD06/3-4/C	C	299.00	0.000	0.000	0.450	5.053	33.384	40.937	17.864	1.943	99.633	0.367
82	DD06/4-5/A	A	399.00	0.000	0.000	2.245	2.472	43.069	36.019	12.314	3.248	99.367	0.633
83	DD06/4-5/B	B	3.00	0.000	0.000	0.000	5.894	50.813	11.179	18.496	12.114	98.496	1.504
84	DD06/4-5/C	C	209.36	0.000	0.000	0.774	1.514	18.634	47.866	26.062	4.272	99.122	0.878
85	DD07/0-1/A	A	778.50	0.000	0.000	0.221	2.634	34.412	39.220	19.796	3.716	99.998	0.002
86	DD07/0-1/B	B	15.00	0.000	0.000	0.069	5.687	47.608	21.459	16.757	6.880	98.460	1.540
87	DD07/0-1/C	C	589.50	0.000	0.000	0.149	1.267	16.522	51.047	28.383	2.407	99.776	0.224
88	DD07/1-2/A	A	593.50	0.000	0.000	0.000	0.785	37.405	38.114	20.265	3.102	99.671	0.329
89	DD07/1-2/B	B	6.50	0.000	0.000	0.000	0.000	40.475	16.092	28.766	14.146	99.478	0.522
90	DD07/1-2/C	C	334.00	0.000	0.000	0.000	0.194	18.094	45.900	33.176	2.345	99.710	0.290
91	DD07/2-3/A	A	622.00	0.000	0.000	0.000	0.671	38.829	46.281	11.173	2.751	99.705	0.295
92	DD07/2-3/B	B	1.00	0.000	0.000	0.000	0.000	13.161	17.861	35.605	31.610	98.237	1.763
93	DD07/2-3/C	C	449.50	0.000	0.000	0.000	0.287	21.983	63.596	11.829	1.236	98.931	1.069
94	DD07/3-4/A	A	622.50	0.000	0.000	0.000	6.599	51.136	30.242	8.322	3.094	99.393	0.607
95	DD07/3-4/B	B	1.00	0.000	0.000	0.000	5.787	22.638	17.191	20.851	33.191	99.660	0.340
96	DD07/3-4/C	C	335.50	0.000	0.000	0.323	2.920	35.683	45.394	13.216	1.973	99.511	0.489
97	DD07/4-5/A	A	444.00	0.000	0.000	1.622	3.735	49.450	28.794	13.541	2.702	99.844	0.156

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
98	DD07/4-5/B	B	4.50	0.000	0.000	1.293	5.531	41.682	9.099	27.966	13.046	98.617	1.383
99	DD07/4-5/C	C	273.50	0.000	0.000	1.184	1.533	18.982	44.645	29.669	3.837	99.849	0.151
100	DD08/0-1/A	A	342.50	0.000	0.000	0.000	0.000	10.539	54.113	32.755	2.495	99.902	0.098
101	DD08/0-1/B	B	6.50	0.000	0.000	0.000	0.000	13.479	36.744	41.770	7.162	99.155	0.845
102	DD08/0-1/C	C	329.50	0.000	0.000	0.000	0.000	3.125	59.581	35.633	1.657	99.996	0.004
103	DD08/1-2/A	A	382.00	0.000	0.000	0.086	1.080	43.493	37.129	15.984	2.104	99.877	0.123
104	DD08/1-2/B	B	3.50	0.000	0.000	0.000	5.431	68.418	10.714	10.301	4.162	99.026	0.974
105	DD08/1-2/C	C	267.50	0.000	0.000	0.052	0.685	20.094	51.105	26.162	1.840	99.938	0.062
106	DD08/2-3/A	A	383.50	0.000	0.000	0.325	5.117	41.116	38.924	10.454	3.608	99.545	0.455
107	DD08/2-3/B	B	3.00	0.000	0.000	0.000	1.568	38.944	17.376	24.128	17.376	99.392	0.608
108	DD08/2-3/C	C	231.08	0.000	0.000	0.581	2.413	34.470	41.724	17.188	3.124	99.501	0.499
109	DD08/3-4/A	A	243.50	0.000	0.000	0.854	15.776	37.604	30.686	12.454	2.156	99.530	0.470
110	DD08/3-4/B	B	12.00	0.000	0.000	2.811	27.762	41.853	13.722	8.665	4.791	99.606	0.394
111	DD08/3-4/C	C	182.00	0.000	0.000	2.467	5.096	22.380	36.253	29.919	3.635	99.752	0.248
112	DD08/4-5/A	A	200.50	0.000	0.000	0.000	0.000	54.427	33.817	10.738	1.015	99.998	0.002
113	DD08/4-5/B	B	4.00	0.000	0.000	0.000	0.000	67.827	18.543	10.040	2.699	99.109	0.891
114	DD08/4-5/C	C	199.00	0.000	0.000	0.000	0.000	29.730	46.662	21.142	2.285	99.820	0.180
115	DD09/0-1/A	A	230.00	0.000	0.000	0.000	0.418	15.413	42.676	38.292	3.099	99.897	0.103
116	DD09/0-1/B	B	11.50	0.000	0.000	0.000	0.587	21.224	28.535	38.319	10.590	99.255	0.745
117	DD09/0-1/C	C	254.50	0.000	0.000	0.000	0.070	5.862	53.009	38.655	2.163	99.758	0.242
118	DD09/1-2/A	A	408.00	0.000	0.000	0.000	0.485	36.178	45.186	15.621	1.770	99.240	0.760
119	DD09/1-2/B	B	17.50	0.000	0.000	0.000	0.397	34.860	28.915	22.606	13.166	99.944	0.056
120	DD09/1-2/C	C	346.60	0.000	0.000	0.000	0.167	16.242	51.504	28.784	3.178	99.875	0.125
121	DD09/2-3/A	A	721.00	0.000	0.000	0.950	4.698	64.867	19.308	7.002	2.912	99.737	0.263
122	DD09/2-3/B	B	13.50	0.000	0.000	0.896	11.504	59.978	8.750	7.443	10.310	98.880	1.120

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
123	DD09/2-3/C	C	410.26	0.000	0.000	0.579	1.490	39.410	42.764	13.866	1.889	99.999	0.001
124	DD09/3-4/A	A	565.21	0.000	0.000	9.482	15.485	51.844	15.172	5.203	2.418	99.604	0.396
125	DD09/3-4/B	B	16.32	0.000	0.000	8.826	38.808	33.874	3.769	4.126	9.314	98.717	1.283
126	DD09/3-4/C	C	254.83	0.000	0.000	4.378	11.755	30.294	35.985	15.328	2.190	99.929	0.071
127	DD09/4-5/A	A	568.81	0.000	0.000	7.344	11.740	53.257	19.451	5.990	1.985	99.768	0.232
128	DD09/4-5/B	B	9.50	0.000	0.000	9.779	21.282	48.403	7.178	5.554	7.003	99.199	0.801
129	DD09/4-5/C	C	216.62	0.000	0.000	3.606	5.360	31.813	39.340	16.540	2.336	98.995	1.005
130	DD10/0-1/A	A	347.00	0.000	0.000	0.000	0.057	18.603	52.458	25.833	2.537	99.489	0.511
131	DD10/0-1/B	B	40.00	0.000	0.000	0.000	0.000	25.757	42.179	27.080	3.604	98.620	1.380
132	DD10/0-1/C	C	293.00	0.000	0.000	0.000	0.013	8.209	57.511	32.810	1.249	99.792	0.208
133	DD10/1-2/A	A	419.50	0.000	0.000	1.769	37.126	35.540	16.310	8.153	1.060	99.958	0.042
134	DD10/1-2/B	B	25.50	0.000	0.000	0.000	3.214	52.872	25.885	13.120	3.163	98.255	1.745
135	DD10/1-2/C	C	340.50	0.000	0.000	0.000	0.392	19.170	52.010	25.650	2.382	99.605	0.395
136	DD10/2-3/A	A	510.00	0.000	0.000	0.000	5.009	56.509	26.904	8.371	2.629	99.422	0.578
137	DD10/2-3/B	B	40.00	0.000	0.000	0.000	13.126	68.253	10.710	3.933	2.376	98.398	1.602
138	DD10/2-3/C	C	326.00	0.000	0.000	0.000	1.950	35.771	46.903	13.618	1.562	99.803	0.197
139	DD10/3-4/A	A	558.00	0.000	0.000	0.102	4.109	53.599	30.062	8.342	2.764	98.978	1.022
140	DD10/3-4/B	B	83.00	0.000	0.000	0.320	7.920	59.487	20.617	7.922	2.457	98.723	1.277
141	DD10/3-4/C	C	414.00	0.000	0.000	0.068	1.629	30.341	51.505	14.068	1.514	99.124	0.876
142	DD10/4-5/A	A	680.50	0.000	0.000	0.000	2.912	61.054	25.669	6.862	2.793	99.290	0.710
143	DD10/4-5/B	B	68.50	0.000	0.000	0.000	7.214	73.610	11.832	3.826	1.760	98.243	1.757
144	DD10/4-5/C	C	348.50	0.000	0.000	0.050	1.395	44.208	43.431	9.551	1.135	99.770	0.230
145	DD11/0-1/A	A	431.50	0.000	0.000	0.033	0.136	21.857	50.538	25.325	2.061	99.950	0.050
146	DD11/0-1/B	B	5.00	0.000	0.000	0.000	0.540	53.594	22.879	17.008	5.137	99.158	0.842
147	DD11/0-1/C	C	286.00	0.000	0.000	0.000	0.065	18.550	56.003	24.143	0.942	99.703	0.297

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
148	DD11/1-2/A	A	416.50	0.000	0.000	0.000	0.548	22.209	50.413	22.603	3.478	99.250	0.750
149	DD11/1-2/B	B	3.50	0.000	0.000	0.000	0.920	52.644	25.000	14.598	6.264	99.425	0.575
150	DD11/1-2/C	C	184.50	0.000	0.000	0.000	0.098	12.585	50.270	33.434	3.378	99.764	0.236
151	DD11/2-3/A	A	581.00	0.000	0.000	0.000	0.000	45.099	39.709	12.768	1.848	99.423	0.577
152	DD11/2-3/B	B	5.00	0.000	0.000	0.000	0.000	62.253	17.763	13.545	6.358	99.919	0.081
153	DD11/2-3/C	C	310.50	0.000	0.000	0.000	0.000	26.507	55.097	16.734	1.344	99.683	0.317
154	DD11/3-4/A	A	802.00	0.000	0.000	0.037	2.823	33.197	41.706	18.380	3.278	99.421	0.579
155	DD11/3-4/B	B	11.50	0.000	0.000	0.000	7.032	52.217	20.497	11.993	6.607	98.346	1.654
156	DD11/3-4/C	C	560.50	0.000	0.000	0.082	0.989	20.216	50.709	25.377	2.257	99.630	0.370
157	DD11/4-5/A	A	330.47	0.000	0.000	3.339	7.969	43.452	32.903	10.404	1.758	99.824	0.176
158	DD11/4-5/B	B	5.50	0.000	0.000	4.008	15.557	57.143	11.637	6.322	3.602	98.269	1.731
159	DD11/4-5/C	C	169.22	0.000	0.000	3.459	2.462	23.437	40.401	26.292	3.902	99.952	0.048
160	DD12/0-1/A	A	317.50	0.000	0.000	0.000	0.000	30.912	48.857	17.216	2.257	99.242	0.758
161	DD12/0-1/B	B	3.00	0.000	0.000	0.000	0.545	56.473	23.164	13.018	5.600	98.800	1.200
162	DD12/0-1/C	C	182.50	0.000	0.000	0.000	0.000	14.564	55.792	26.026	2.447	98.829	1.171
163	DD12/1-2/A	A	265.00	0.000	0.000	0.000	0.700	49.197	39.578	7.484	2.432	99.392	0.608
164	DD12/1-2/B	B	3.00	0.000	0.000	0.000	0.198	62.946	22.160	7.530	6.275	99.108	0.892
165	DD12/1-2/C	C	135.50	0.000	0.000	0.000	0.244	31.095	49.147	15.710	2.448	98.643	1.357
166	DD12/2-3/A	A	420.00	0.000	0.000	0.000	0.112	32.527	46.570	17.262	2.698	99.168	0.832
167	DD12/2-3/B	B	6.00	0.000	0.000	0.000	0.000	42.957	35.670	17.652	2.330	98.609	1.391
168	DD12/2-3/C	C	288.50	0.000	0.000	0.000	0.000	13.042	56.589	27.445	2.294	99.371	0.629
169	DD12/3-4/A	A	751.50	0.000	0.000	0.016	0.618	41.765	39.087	14.376	3.166	99.028	0.972
170	DD12/3-4/B	B	8.00	0.000	0.000	0.000	0.939	67.028	18.838	8.804	4.145	99.754	0.246
171	DD12/3-4/C	C	368.50	0.000	0.000	0.020	0.435	24.450	51.566	19.984	2.555	99.012	0.988
172	DD12/4-5/A	A	467.50	0.000	0.000	0.025	0.352	30.032	48.633	18.467	1.996	99.505	0.495

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
173	DD12/4-5/B	B	9.00	0.000	0.000	0.000	0.601	58.929	24.896	11.027	2.689	98.142	1.858
174	DD12/4-5/C	C	274.00	0.000	0.000	0.000	0.119	14.101	53.408	29.672	2.262	99.563	0.437
175	DD13/0-1/A	A	385.00	0.000	0.000	0.000	0.132	35.524	56.320	7.222	0.504	99.702	0.298
176	DD13/0-1/B	B	0.50	0.000	0.000	0.000	0.000	48.754	29.893	17.438	2.135	98.221	1.779
177	DD13/0-1/C	C	120.00	0.000	0.000	0.020	0.048	26.286	57.395	15.061	1.091	99.902	0.098
178	DD13/1-2/A	A	352.00	0.000	0.000	0.000	0.182	19.638	60.931	17.316	1.420	99.486	0.514
179	DD13/1-2/B	B	3.00	0.000	0.000	0.000	0.000	0.000	56.356	36.695	5.892	98.943	1.057
180	DD13/1-2/C	C	132.50	0.000	0.000	0.000	0.091	14.464	56.223	27.043	2.156	99.977	0.023
181	DD13/2-3/A	A	385.50	0.000	0.000	0.000	0.923	41.363	41.736	14.137	1.753	99.912	0.088
182	DD13/2-3/B	B	2.00	0.000	0.000	0.000	1.374	67.770	13.554	11.181	5.809	99.688	0.312
183	DD13/2-3/C	C	124.00	0.000	0.000	0.000	0.393	21.928	45.574	28.282	3.785	99.962	0.038
184	DD13/3-4/A	A	460.00	0.000	0.000	0.153	2.641	58.589	27.974	9.477	1.163	99.996	0.004
185	DD13/3-4/B	B	2.50	0.000	0.000	1.188	8.401	73.186	9.631	6.322	0.891	99.618	0.382
186	DD13/3-4/C	C	151.50	0.000	0.000	0.090	1.350	32.501	38.472	23.940	3.637	99.990	0.010
187	DD13/4-5/A	A	462.23	0.000	0.000	12.359	6.350	43.775	29.725	6.240	1.276	99.726	0.274
188	DD13/4-5/B	B	1.50	0.000	0.000	0.000	15.154	15.582	47.175	9.846	11.986	99.743	0.257
189	DD13/4-5/C	C	153.52	0.000	0.000	10.926	4.652	23.146	38.435	17.607	5.233	99.999	0.001
190	DD14/0-1/A	A	453.00	0.000	0.000	0.000	0.119	51.469	37.623	9.842	0.709	99.762	0.238
191	DD14/0-1/B	B	3.00	0.000	0.000	0.000	0.264	75.603	16.780	5.995	0.603	99.246	0.754
192	DD14/0-1/C	C	167.50	0.000	0.000	0.000	0.050	28.631	52.426	17.632	1.222	99.959	0.041
193	DD14/1-2/A	A	380.50	0.000	0.000	0.007	0.231	60.618	33.667	4.655	0.571	99.750	0.250
194	DD14/1-2/B	B	2.00	0.000	0.000	0.000	0.000	73.740	21.948	4.021	0.000	99.709	0.291
195	DD14/1-2/C	C	114.00	0.000	0.000	0.000	0.092	40.069	47.989	10.901	0.916	99.967	0.033
196	DD14/2-3/A	A	485.00	0.000	0.000	0.016	2.568	40.414	36.277	18.465	1.863	99.603	0.397
197	DD14/2-3/B	B	3.00	0.000	0.000	0.000	2.919	54.214	16.661	19.318	5.313	98.426	1.574

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
198	DD14/2-3/C	C	170.50	0.000	0.000	0.042	0.522	21.030	39.459	34.267	4.244	99.563	0.437
199	DD14/3-4/A	A	577.00	0.000	0.000	0.131	1.565	49.865	33.984	11.837	2.217	99.599	0.401
200	DD14/3-4/B	B	1.00	0.000	0.000	0.000	2.890	57.225	21.676	17.124	0.000	98.916	1.084
201	DD14/3-4/C	C	245.50	0.000	0.000	0.049	0.695	25.101	43.874	25.241	4.671	99.630	0.370
202	DD14/4-4.9/B	9/B	1.00	0.000	0.000	0.000	25.492	47.972	10.081	13.094	1.390	98.030	1.970
203	DD14/4-5/A	A	416.40	0.000	0.000	4.803	16.781	47.459	23.591	6.662	0.593	99.889	0.111
204	DD14/4-5/C	C	143.69	0.000	0.000	3.574	7.718	27.380	41.091	18.668	1.500	99.931	0.069
205	DD15/0-1/A	A	261.00	0.000	0.000	0.000	0.005	16.352	56.034	23.672	2.983	99.046	0.954
206	DD15/0-1/B	B	15.00	0.000	0.000	0.000	0.000	22.959	45.934	22.944	8.041	99.877	0.123
207	DD15/0-1/C	C	233.50	0.000	0.000	0.000	0.000	7.910	58.207	31.440	2.185	99.742	0.258
208	DD15/1-2/A	A	449.00	0.000	0.000	0.000	0.002	17.029	53.007	26.385	2.960	99.384	0.616
209	DD15/1-2/B	B	23.50	0.000	0.000	0.000	0.000	23.668	44.762	29.539	2.030	100.000	0.000
210	DD15/1-2/C	C	352.00	0.000	0.000	0.000	0.000	7.021	67.381	24.840	0.758	100.000	0.000
211	DD15/2-3/A	A	465.00	0.000	0.000	0.020	0.333	51.938	34.615	10.068	2.360	99.332	0.668
212	DD15/2-3/B	B	54.00	0.000	0.000	0.000	0.827	52.940	32.452	11.152	2.206	99.578	0.422
213	DD15/2-3/C	C	342.50	0.000	0.000	0.000	0.151	36.482	49.199	12.683	1.103	99.617	0.383
214	DD15/3-4/A	A	383.50	0.000	0.000	0.000	0.086	38.646	44.814	12.694	3.125	99.364	0.636
215	DD15/3-4/B	B	18.00	0.000	0.000	0.000	0.000	49.420	33.545	10.249	6.647	99.861	0.139
216	DD15/3-4/C	C	366.00	0.000	0.000	0.000	0.045	19.073	62.885	16.483	1.192	99.679	0.321
217	DD15/4-5/A	A	524.00	0.000	0.000	0.041	1.099	49.087	30.675	13.160	5.228	99.290	0.710
218	DD15/4-5/B	B	35.00	0.000	0.000	0.000	3.202	59.478	21.384	8.274	7.621	99.958	0.042
219	DD15/4-5/C	C	429.50	0.000	0.000	0.024	0.499	27.980	50.395	18.735	2.111	99.745	0.255
220	DD16/0-1/A	A	389.00	0.000	0.000	0.000	0.000	11.871	56.702	29.976	1.247	99.796	0.204
221	DD16/0-1/B	B	2.00	0.000	0.000	0.000	0.000	18.231	65.854	13.105	2.604	99.793	0.207
222	DD16/0-1/C	C	220.00	0.000	0.000	0.000	0.022	4.772	54.412	39.174	1.441	99.821	0.179

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
223	DD16/1-2/A	A	432.00	0.000	0.000	0.000	0.000	13.388	60.408	23.571	2.215	99.582	0.418
224	DD16/1-2/B	B	1.50	0.000	0.000	0.000	0.000	31.452	57.258	11.166	0.000	99.876	0.124
225	DD16/1-2/C	C	213.50	0.000	0.000	0.000	0.000	8.866	60.485	29.175	1.166	99.692	0.308
226	DD16/2-3/A	A	447.00	0.000	0.000	0.000	0.034	23.097	54.833	17.213	2.969	98.147	1.853
227	DD16/2-3/B	B	4.00	0.000	0.000	0.000	0.000	54.170	35.044	8.411	1.924	99.549	0.451
228	DD16/2-3/C	C	217.50	0.000	0.000	0.000	0.000	14.620	56.250	26.010	2.781	99.661	0.339
229	DD16/3-4/A	A	583.00	0.000	0.000	0.000	0.143	46.309	40.174	10.200	2.777	99.603	0.397
230	DD16/3-4/B	B	7.50	0.000	0.000	0.000	0.622	62.662	21.402	11.066	3.653	99.405	0.595
231	DD16/3-4/C	C	225.50	0.000	0.000	0.000	0.220	26.572	51.879	20.075	1.161	99.907	0.093
232	DD16/4-5/A	A	563.00	0.000	0.000	0.000	0.412	45.790	34.186	13.983	4.356	98.727	1.273
233	DD16/4-5/B	B	7.50	0.000	0.000	0.000	1.242	73.022	14.991	7.058	3.684	99.997	0.003
234	DD16/4-5/C	C	352.00	0.000	0.000	0.032	0.394	25.746	46.198	24.123	3.179	99.672	0.328
235	DD17/0-1/A	A	478.50	0.000	0.000	0.000	0.256	52.475	39.338	6.527	0.535	99.131	0.869
236	DD17/0-1/B	B	1.50	0.000	0.000	0.000	0.653	64.133	23.456	10.748	0.891	99.881	0.119
237	DD17/0-1/C	C	278.50	0.000	0.000	0.000	0.042	26.397	63.196	9.292	0.437	99.364	0.636
238	DD17/1-2/A	A	560.50	0.000	0.000	0.000	0.000	20.116	47.856	28.524	3.265	99.761	0.239
239	DD17/1-2/B	B	8.50	0.000	0.000	0.000	0.188	28.062	29.401	35.412	5.021	98.084	1.916
240	DD17/1-2/C	C	353.50	0.000	0.000	0.000	0.000	9.402	63.996	25.263	1.068	99.729	0.271
241	DD17/2-3/A	A	208.50	0.000	0.000	0.551	0.805	22.173	37.101	25.937	12.490	99.058	0.942
242	DD17/2-3/B	B	5.50	0.000	0.000	0.000	0.000	17.327	18.605	33.961	29.630	99.524	0.476
243	DD17/2-3/C	C	236.00	0.000	0.000	0.000	0.097	14.069	47.931	30.515	6.144	98.756	1.244
244	DD17/3-4/A	A	726.79	0.000	0.000	1.974	2.221	50.135	27.915	14.206	2.801	99.252	0.748
245	DD17/3-4/B	B	5.00	0.000	0.000	0.000	9.259	60.806	14.575	8.519	6.732	99.891	0.109
246	DD17/3-4/C	C	537.00	0.000	0.000	0.050	1.040	43.620	42.006	11.584	1.073	99.372	0.628
247	DD17/4-5/A	A	549.50	0.000	0.000	0.032	2.310	49.745	34.427	10.565	2.308	99.387	0.613

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
248	DD17/4-5/B	B	3.50	0.000	0.000	0.000	5.383	55.318	12.970	11.997	13.327	98.995	1.005
249	DD17/4-5/C	C	369.00	0.000	0.000	0.000	0.029	27.308	53.314	16.952	1.702	99.306	0.694
250	DD18/0-1/A	A	661.00	0.000	0.000	0.000	0.074	31.583	50.349	14.593	2.367	98.966	1.034
251	DD18/0-1/B	B	2.50	0.000	0.000	0.000	0.301	54.503	35.487	1.205	8.470	99.967	0.033
252	DD18/0-1/C	C	317.00	0.000	0.000	0.000	0.000	21.773	58.216	18.148	1.551	99.689	0.311
253	DD18/1-2/A	A	592.00	0.000	0.000	0.000	0.019	21.823	59.245	16.009	1.997	99.093	0.907
254	DD18/1-2/B	B	4.00	0.000	0.000	0.000	0.000	41.901	42.083	10.781	3.281	98.047	1.953
255	DD18/1-2/C	C	297.00	0.000	0.000	0.000	0.000	11.144	65.795	21.234	1.581	99.754	0.246
256	DD18/2-3/A	A	499.50	0.000	0.000	0.000	0.000	19.096	56.669	19.533	3.726	99.024	0.976
257	DD18/2-3/B	B	4.50	0.000	0.000	0.000	0.000	34.067	42.921	15.775	5.888	98.652	1.348
258	DD18/2-3/C	C	293.00	0.000	0.000	0.018	0.031	8.724	60.153	27.668	2.755	99.349	0.651
259	DD18/3-4/A	A	477.50	0.000	0.000	0.231	0.016	9.266	52.286	32.412	4.502	98.714	1.286
260	DD18/3-4/B	B	7.00	0.000	0.000	0.000	0.598	19.717	40.126	31.087	6.630	98.157	1.843
261	DD18/3-4/C	C	322.50	0.000	0.000	0.000	0.011	3.971	53.618	38.197	3.935	99.732	0.268
262	DD18/4-5/A	A	471.00	0.000	0.000	0.024	0.024	10.480	51.593	34.200	3.394	99.715	0.285
263	DD18/4-5/B	B	4.00	0.000	0.000	0.000	0.000	26.778	42.726	25.539	4.283	99.327	0.673
264	DD18/4-5/C	C	289.00	0.000	0.000	0.000	0.000	4.700	53.833	39.043	1.680	99.257	0.743
265	DD19/0-1/A	A	464.50	0.000	0.000	0.000	0.000	11.814	60.869	24.829	2.436	99.947	0.053
266	DD19/0-1/B	B	2.50	0.000	0.000	0.000	0.000	13.588	33.029	44.253	8.915	99.785	0.215
267	DD19/0-1/C	C	485.50	0.000	0.000	0.000	0.010	9.110	61.356	27.490	1.900	99.865	0.135
268	DD19/1-2/A	A	546.00	0.000	0.000	0.000	0.267	19.651	46.806	29.593	3.185	99.502	0.498
269	DD19/1-2/B	B	3.00	0.000	0.000	0.000	0.704	19.366	18.380	47.887	12.394	98.732	1.268
270	DD19/1-2/C	C	568.00	0.000	0.000	0.000	0.051	5.859	59.947	31.036	2.536	99.429	0.571
271	DD19/2-3/A	A	456.00	0.000	0.000	0.090	0.120	25.499	59.925	13.437	0.785	99.856	0.144
272	DD19/2-3/B	B	7.50	0.000	0.000	0.000	0.417	44.571	40.447	12.899	1.305	99.639	0.361

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
273	DD19/2-3/C	C	275.00	0.000	0.000	0.000	0.114	12.355	62.652	23.586	1.205	99.913	0.087
274	DD19/3-4/A	A	530.50	0.000	0.000	0.000	0.777	29.037	43.276	22.863	3.837	99.790	0.210
275	DD19/3-4/B	B	3.00	0.000	0.000	0.000	0.000	21.148	23.573	37.518	17.618	99.857	0.143
276	DD19/3-4/C	C	356.00	0.000	0.000	0.000	0.167	11.660	53.206	31.696	3.015	99.744	0.256
277	DD19/4-5/A	A	604.50	0.000	0.000	0.000	0.108	33.808	46.622	15.325	3.712	99.574	0.426
278	DD19/4-5/B	B	1.50	0.000	0.000	0.000	1.400	8.243	20.218	45.956	23.950	99.767	0.233
279	DD19/4-5/C	C	321.50	0.000	0.000	0.000	0.020	11.243	61.203	23.600	3.366	99.432	0.568
280	DD20/0-1/A	A	347.00	0.000	0.000	0.000	0.015	22.894	56.845	17.171	2.313	99.238	0.762
281	DD20/0-1/B	B	42.00	0.000	0.000	0.000	0.047	33.874	43.927	16.954	3.322	98.124	1.876
282	DD20/0-1/C	C	325.00	0.000	0.000	0.000	0.023	11.731	58.431	27.996	1.618	99.799	0.201
283	DD20/1-2/A	A	368.50	0.000	0.000	0.000	0.000	18.500	56.499	21.183	3.095	99.277	0.723
284	DD20/1-2/B	B	31.50	0.000	0.000	0.000	0.000	29.744	45.371	20.058	3.002	98.175	1.825
285	DD20/1-2/C	C	376.50	0.000	0.000	0.000	0.000	11.080	60.827	26.845	1.187	99.940	0.060
286	DD20/2-3/A	A	264.50	0.000	0.000	0.000	0.453	20.451	48.808	22.935	5.824	98.472	1.528
287	DD20/2-3/B	B	35.00	0.000	0.000	0.433	3.651	24.900	42.168	20.474	6.391	98.017	1.983
288	DD20/2-3/C	C	240.50	0.000	0.000	0.000	0.147	9.880	55.347	31.049	3.102	99.525	0.475
289	DD20/3-4/A	A	469.50	0.000	0.000	0.000	0.114	13.291	50.695	28.825	6.580	99.505	0.495
290	DD20/3-4/B	B	71.50	0.000	0.000	0.106	0.602	19.469	36.513	35.049	6.351	98.091	1.909
291	DD20/3-4/C	C	400.50	0.000	0.000	0.000	0.030	7.316	59.771	30.412	2.269	99.797	0.203
292	DD20/4-5/A	A	658.50	0.000	0.000	0.000	0.134	20.428	54.704	19.921	4.431	99.618	0.382
293	DD20/4-5/B	B	57.50	0.000	0.000	0.000	1.223	34.622	40.689	16.837	6.114	99.486	0.514
294	DD20/4-5/C	C	470.50	0.000	0.000	0.000	0.057	10.839	59.643	27.071	2.139	99.750	0.250
295	DD21/0-1/A	A	354.00	0.000	0.000	0.018	0.368	24.663	43.880	27.728	3.301	99.958	0.042
296	DD21/0-1/B	B	1.50	0.000	0.000	0.000	0.000	24.305	22.715	38.278	13.377	98.675	1.325
297	DD21/0-1/C	C	150.00	0.000	0.000	0.000	0.090	7.429	46.082	41.235	4.879	99.715	0.285

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
298	DD21/1-2/A	A	103.00	0.000	0.000	0.964	2.388	41.345	31.507	12.850	9.644	98.698	1.302
299	DD21/1-2/B	B	2.00	0.000	0.000	0.000	2.315	17.222	12.407	19.259	47.315	98.519	1.481
300	DD21/1-2/C	C	48.00	0.000	0.000	3.670	1.076	16.495	26.119	25.622	26.611	99.592	0.408
301	DD22/0-1/A	A	420.00	0.000	0.000	2.348	11.134	38.106	32.729	13.816	1.550	99.683	0.317
302	DD22/0-1/B	B	2.00	0.000	0.000	2.753	19.169	37.558	12.000	22.182	6.130	99.792	0.208
303	DD22/0-1/C	C	141.50	0.000	0.000	3.434	2.718	19.775	38.338	30.876	4.504	99.645	0.355
304	DD22/1-2/A	A	182.68	0.000	0.000	80.770	7.637	5.533	3.482	2.097	0.296	99.816	0.184
305	DD22/1-2/B	B	1.50	0.000	0.000	73.495	18.999	3.440	1.329	1.955	0.000	99.218	0.782
306	DD22/1-2/C	C	60.90	0.000	0.000	59.093	12.477	4.204	9.243	12.352	2.262	99.631	0.369
307	DD23/0-1/A	A	413.50	0.000	0.000	0.000	0.059	7.001	53.455	36.824	2.533	99.872	0.128
308	DD23/0-1/B	B	5.50	0.000	0.000	0.000	0.000	9.222	38.746	44.487	6.087	98.542	1.458
309	DD23/0-1/C	C	254.50	0.000	0.000	0.000	0.000	2.914	48.883	45.832	1.965	99.594	0.406
310	DD23/1-2/A	A	504.00	0.000	0.000	0.000	0.022	8.397	60.796	26.628	3.691	99.534	0.466
311	DD23/1-2/B	B	7.00	0.000	0.000	0.000	0.000	19.545	45.117	26.503	7.141	98.306	1.694
312	DD23/1-2/C	C	329.00	0.000	0.000	0.000	0.000	7.501	57.069	33.444	1.744	99.757	0.243
313	DD23/2-3/A	A	484.50	0.000	0.000	0.000	0.064	17.813	48.822	26.910	5.711	99.319	0.681
314	DD23/2-3/B	B	8.50	0.000	0.000	0.000	0.424	26.831	36.130	21.860	13.822	99.066	0.934
315	DD23/2-3/C	C	396.50	0.000	0.000	0.000	0.009	9.534	52.512	34.706	2.878	99.639	0.361
316	DD23/3-4/A	A	479.00	0.000	0.000	0.000	0.344	21.313	52.626	20.972	4.080	99.335	0.665
317	DD23/3-4/B	B	5.50	0.000	0.000	0.000	3.654	25.702	29.373	21.606	18.482	98.817	1.183
318	DD23/3-4/C	C	326.00	0.000	0.000	0.000	0.041	7.045	62.334	27.254	2.822	99.496	0.504
319	DD23/4-5/A	A	492.50	0.000	0.000	0.000	0.000	20.371	54.097	19.017	5.470	98.955	1.045
320	DD23/4-5/B	B	12.50	0.000	0.000	0.000	1.057	37.996	30.937	17.893	11.084	98.967	1.033
321	DD23/4-5/C	C	351.00	0.000	0.000	0.000	0.030	14.530	56.863	26.185	2.385	99.993	0.007
322	DD24/0-1/A	A	588.50	0.000	0.000	0.000	0.077	22.565	49.859	25.393	1.996	99.890	0.110

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
323	DD24/0-1/B	B	0.50	0.000	0.000	0.000	2.991	7.850	12.897	57.570	18.318	99.626	0.374
324	DD24/0-1/C	C	163.50	0.000	0.000	0.000	0.029	9.127	48.737	40.022	1.929	99.844	0.156
325	DD24/1-2/A	A	484.50	0.000	0.000	0.000	0.262	27.685	46.287	22.542	2.936	99.712	0.288
326	DD24/1-2/B	B	0.50	0.000	0.000	0.000	0.000	11.087	9.783	66.522	10.870	98.261	1.739
327	DD24/1-2/C	C	163.00	0.000	0.000	0.000	0.060	11.877	48.661	35.510	3.410	99.518	0.482
328	DD24/2-3/A	A	268.00	0.000	0.000	0.074	0.421	26.508	48.248	21.497	2.639	99.388	0.612
329	DD24/2-3/B	B	1.50	0.000	0.000	0.000	0.000	36.063	26.850	30.709	5.354	98.976	1.024
330	DD24/2-3/C	C	115.50	0.000	0.000	0.000	0.309	10.800	47.690	35.823	4.573	99.195	0.805
331	DD25/0-1/A	A	479.50	0.000	0.000	0.000	0.171	19.487	50.973	27.411	1.595	99.638	0.362
332	DD25/0-1/B	B	3.00	0.000	0.000	0.000	0.000	10.854	18.256	60.854	9.801	99.766	0.234
333	DD25/0-1/C	C	348.00	0.000	0.000	0.000	0.041	6.684	49.368	41.136	2.558	99.788	0.212
334	DD25/1-2/A	A	306.50	0.000	0.000	0.000	1.709	41.187	39.288	14.828	2.316	99.329	0.671
335	DD25/1-2/B	B	1.00	0.000	0.000	0.000	2.923	36.414	12.875	33.807	13.823	99.842	0.158
336	DD25/1-2/C	C	156.00	0.000	0.000	0.000	0.000	17.549	49.764	29.210	2.272	98.795	1.205
337	DD26/0-1/A	A	443.91	0.000	0.000	14.348	30.340	21.304	21.181	8.957	2.807	98.937	1.063
338	DD26/0-1/B	B	71.40	0.000	0.000	34.505	36.745	12.096	7.854	4.790	3.166	99.156	0.844
339	DD26/0-1/C	C	258.72	0.000	0.000	11.425	17.570	12.458	36.491	18.986	2.205	99.136	0.864
340	DD26/1-2/A	A	488.80	0.000	0.000	1.897	21.622	56.381	11.944	7.021	0.726	99.591	0.409
341	DD26/1-2/B	B	68.26	0.000	0.000	39.072	49.880	6.245	1.186	1.636	0.912	98.930	1.070
342	DD26/1-2/C	C	188.44	0.000	0.000	24.618	34.761	9.146	19.417	10.653	1.090	99.685	0.315
343	DD27/0-1/A	A	480.50	0.000	0.000	0.000	0.310	36.501	43.507	16.846	2.563	99.728	0.272
344	DD27/0-1/B	B	1.50	0.000	0.000	0.000	0.000	9.142	14.768	56.048	18.073	98.031	1.969
345	DD27/0-1/C	C	225.50	0.000	0.000	0.000	0.269	11.990	54.722	30.135	1.892	99.007	0.993
346	DD27/1-2/A	A	519.50	0.000	0.000	0.042	0.270	26.883	52.764	17.386	2.652	99.997	0.003
347	DD27/1-2/B	B	6.00	0.000	0.000	0.000	1.485	61.768	15.697	19.548	0.984	99.482	0.518

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
348	DD27/1-2/C	C	237.50	0.000	0.000	0.000	0.899	34.990	41.487	19.710	2.428	99.514	0.486
349	DD27/2-3/A	A	519.50	0.000	0.000	0.000	0.000	24.255	42.758	26.921	5.495	99.428	0.572
350	DD27/2-3/B	B	8.50	0.000	0.000	0.000	0.000	43.038	24.407	18.678	11.888	98.011	1.989
351	DD27/2-3/C	C	250.50	0.000	0.000	0.000	0.000	10.026	50.305	35.852	3.633	99.817	0.183
352	DD27/3-4/A	A	745.00	0.000	0.000	0.116	0.047	17.887	52.550	24.362	4.832	99.794	0.206
353	DD27/3-4/B	B	17.50	0.000	0.000	0.000	0.857	35.971	26.543	25.480	11.137	99.989	0.011
354	DD27/3-4/C	C	512.50	0.000	0.000	0.070	0.153	7.923	51.430	36.184	3.428	99.187	0.813
355	DD27/4-5/A	A	537.00	0.000	0.000	0.036	0.630	36.137	43.857	17.535	1.632	99.827	0.173
356	DD27/4-5/B	B	3.50	0.000	0.000	0.000	1.481	64.059	16.415	14.756	1.630	98.341	1.659
357	DD27/4-5/C	C	264.00	0.000	0.000	0.000	0.268	11.687	57.974	28.152	1.625	99.706	0.294
358	DD28/0-1/A	A	60.00	0.000	0.000	0.000	0.000	7.789	54.083	32.759	4.856	99.487	0.513
359	DD28/0-1/B	B	0.50	0.000	0.000	0.000	0.000	0.000	10.400	88.000	0.000	98.400	1.600
360	DD28/0-1/C	C	36.00	0.000	0.000	0.036	30.086	4.502	29.626	31.140	3.022	98.414	1.586
361	DD29/0-1/A	A	311.00	0.000	0.000	0.000	0.285	34.378	37.898	22.899	4.016	99.476	0.524
362	DD29/0-1/B	B	1.50	0.000	0.000	0.000	0.000	43.594	15.918	31.614	8.375	99.501	0.499
363	DD29/0-1/C	C	158.50	0.000	0.000	0.000	0.073	11.912	43.366	39.674	4.835	99.860	0.140
364	DD29/1-2/A	A	305.50	0.000	0.000	0.062	2.206	27.264	51.427	17.676	1.034	99.669	0.331
365	DD29/1-2/B	B	4.50	0.000	0.000	0.000	1.042	29.373	47.861	18.954	1.042	98.271	1.729
366	DD29/1-2/C	C	159.50	0.000	0.000	0.663	1.424	13.963	56.298	25.265	1.958	99.571	0.429
367	DD30/0-1/A	A	356.00	0.000	0.000	1.191	0.705	15.226	53.696	24.694	4.038	99.551	0.449
368	DD30/0-1/B	B	8.50	0.000	0.000	1.404	7.043	23.546	35.727	21.867	8.459	98.045	1.955
369	DD30/0-1/C	C	307.00	0.000	0.000	0.220	0.622	6.928	61.991	28.496	1.244	99.501	0.499
370	DD30/1-2/A	A	438.50	0.000	0.000	4.802	55.319	28.707	6.240	3.847	0.814	99.730	0.270
371	DD30/1-2/B	B	14.98	0.000	0.000	54.096	35.156	2.540	1.912	3.471	2.029	99.203	0.797
372	DD30/1-2/C	C	165.97	0.000	0.000	57.480	8.030	2.516	10.361	19.376	1.954	99.717	0.283

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
373	DD30/2-3/A	A	331.19	0.000	0.000	80.492	4.741	2.577	2.095	6.587	3.012	99.504	0.496
374	DD30/2-3/B	B	28.05	0.000	0.000	67.356	15.909	1.426	0.698	6.468	6.461	98.318	1.682
375	DD30/2-3/C	C	236.76	0.000	0.000	53.360	9.280	1.472	5.367	24.590	5.761	99.831	0.169
376	DD30/3-4/A	A	66.33	0.000	0.000	6.058	1.262	2.000	8.553	52.932	28.335	99.140	0.860
377	DD30/3-4/B	B	5.96	0.000	0.000	1.846	0.266	0.657	2.822	45.980	46.939	98.509	1.491
378	DD30/3-4/C	C	84.07	0.000	0.000	1.990	0.268	0.459	6.852	73.479	15.715	98.762	1.238
379	DD31/0-1/A	A	403.69	0.000	0.000	12.643	30.160	20.873	23.528	8.470	3.638	99.312	0.688
380	DD31/0-1/B	B	43.31	0.000	0.000	24.971	42.726	14.688	8.399	3.461	4.514	98.759	1.241
381	DD31/0-1/C	C	433.36	0.000	0.000	7.402	13.654	15.530	48.679	12.609	1.773	99.647	0.353
382	DD31/1-2/A	A	418.41	0.000	0.000	8.589	46.023	25.580	13.477	4.872	0.939	99.480	0.520
383	DD31/1-2/B	B	29.38	0.000	0.000	13.851	54.188	20.280	5.699	3.148	1.625	98.792	1.208
384	DD31/1-2/C	C	391.79	0.000	0.000	13.426	14.916	17.787	38.438	11.602	3.310	99.479	0.521
385	DD31/2-3/A	A	370.24	0.000	0.000	7.554	23.391	28.395	24.752	11.488	3.739	99.320	0.680
386	DD31/2-3/B	B	40.74	0.000	0.000	8.782	30.373	25.335	18.851	9.386	5.434	98.161	1.839
387	DD31/2-3/C	C	471.53	0.000	0.000	7.039	11.263	15.558	46.029	17.762	0.552	98.203	1.797
388	DD31/3-4/A	A	148.00	0.000	0.000	0.069	23.285	36.696	22.675	9.696	6.276	98.698	1.302
389	DD31/3-4/B	B	39.00	0.000	0.000	0.450	43.365	29.497	9.399	6.097	9.457	98.266	1.734
390	DD31/3-4/C	C	487.00	0.000	0.000	0.000	0.149	22.566	40.745	19.304	15.955	98.719	1.281
391	DD32/0-1/A	A	649.50	0.000	0.000	0.589	3.083	31.981	47.924	13.676	1.854	99.107	0.893
392	DD32/0-1/B	B	8.50	0.000	0.000	0.875	6.997	43.764	28.178	15.754	3.175	98.742	1.258
393	DD32/0-1/C	C	467.00	0.000	0.000	0.246	1.137	21.767	59.400	15.857	1.149	99.557	0.443
394	DD32/1-2/A	A	574.13	0.000	0.000	27.959	13.887	36.370	15.666	4.721	1.115	99.718	0.282
395	DD32/1-2/B	B	1.50	0.000	0.000	43.158	16.974	22.434	5.132	7.039	3.553	98.289	1.711
396	DD32/1-2/C	C	178.90	0.000	0.000	21.630	7.168	27.251	31.780	10.144	1.489	99.462	0.538
397	DD32/2-3/A	A	598.07	0.000	0.000	9.478	10.661	33.731	30.814	11.845	2.821	99.350	0.650

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
398	DD32/2-3/B	B	21.50	0.000	0.000	10.693	17.771	11.641	42.957	9.979	5.471	98.512	1.488
399	DD32/2-3/C	C	381.77	0.000	0.000	5.910	1.817	23.441	50.720	16.587	1.206	99.681	0.319
400	DD32/3-4/A	A	807.00	0.000	0.000	7.677	8.655	28.315	34.030	16.066	4.462	99.205	0.795
401	DD32/3-4/B	B	25.50	0.000	0.000	7.658	12.172	36.020	24.664	13.273	4.458	98.244	1.756
402	DD32/3-4/C	C	689.00	0.000	0.000	4.967	3.600	17.544	47.963	22.873	1.983	98.930	1.070
403	DD32/4-5/A	A	584.58	0.000	0.000	6.397	6.672	32.813	26.111	20.892	6.345	99.230	0.770
404	DD32/4-5/B	B	23.00	0.000	0.000	4.187	13.591	35.414	22.929	17.291	4.827	98.238	1.762
405	DD32/4-5/C	C	533.72	0.000	0.000	4.409	2.498	16.937	39.891	31.341	4.081	99.157	0.843
406	DD33/0-1/A	A	477.00	0.000	0.000	0.204	0.356	12.090	48.694	32.252	6.399	99.994	0.006
407	DD33/0-1/B	B	32.50	0.000	0.000	0.000	1.679	21.221	38.762	29.423	8.490	99.576	0.424
408	DD33/0-1/C	C	459.00	0.000	0.000	0.000	0.167	8.943	47.434	40.966	1.956	99.466	0.534
409	DD33/1-2/A	A	760.16	0.000	0.000	0.545	7.237	52.255	29.876	8.517	1.539	99.969	0.031
410	DD33/1-2/B	B	56.44	0.000	0.000	1.547	15.623	62.926	14.094	4.043	1.108	99.342	0.658
411	DD33/1-2/C	C	489.50	0.000	0.000	0.000	2.228	42.370	42.632	10.617	0.839	98.686	1.314
412	DD33/2-3/A	A	722.37	0.000	0.000	1.151	3.694	56.041	29.650	7.274	1.836	99.647	0.353
413	DD33/2-3/B	B	63.00	0.000	0.000	3.351	12.820	63.338	15.585	4.182	0.443	99.719	0.281
414	DD33/2-3/C	C	421.21	0.000	0.000	0.247	2.343	39.678	46.760	9.890	1.061	99.979	0.021
415	DD33/3-4/A	A	797.09	0.000	0.000	2.700	4.302	42.043	27.076	17.977	5.842	99.940	0.060
416	DD33/3-4/B	B	97.57	0.000	0.000	4.048	17.487	52.116	16.914	7.236	1.637	99.437	0.563
417	DD33/3-4/C	C	526.52	0.000	0.000	0.995	2.693	27.087	47.478	19.586	2.141	99.981	0.019
418	DD33/4-5/A	A	416.23	0.000	0.000	2.346	5.635	25.257	22.857	26.901	15.792	98.789	1.211
419	DD33/4-5/B	B	79.42	0.000	0.000	10.150	13.837	14.980	12.046	24.652	23.279	98.945	1.055
420	DD33/4-5/C	C	510.96	0.000	0.000	3.347	3.919	6.174	15.234	63.772	6.887	99.333	0.667
421	DD34/0-1/A	A	699.00	0.000	0.000	0.064	0.064	5.208	52.018	37.065	4.731	99.150	0.850
422	DD34/0-1/B	B	17.00	0.000	0.000	0.000	0.986	9.116	37.632	37.169	13.558	98.460	1.540

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
423	DD34/0-1/C	C	535.50	0.000	0.000	0.000	0.019	2.197	49.414	44.255	3.366	99.251	0.749
424	DD34/1-2/A	A	722.00	0.000	0.000	0.000	0.509	21.590	46.711	27.346	3.839	99.995	0.005
425	DD34/1-2/B	B	4.50	0.000	0.000	0.000	1.458	19.863	19.294	43.303	14.351	98.269	1.731
426	DD34/1-2/C	C	451.00	0.000	0.000	0.000	0.131	8.544	54.364	34.440	2.492	99.971	0.029
427	DD34/2-3/A	A	816.00	0.000	0.000	0.584	11.694	38.405	30.372	13.837	3.835	98.726	1.274
428	DD34/2-3/B	B	15.00	0.000	0.000	1.256	23.103	43.917	17.286	9.293	3.422	98.276	1.724
429	DD34/2-3/C	C	281.00	0.000	0.000	0.504	5.877	30.622	47.852	13.093	1.335	99.282	0.718
430	DD34/3-4/A	A	623.63	0.000	0.000	12.564	26.316	25.004	17.629	14.937	3.166	99.614	0.386
431	DD34/3-4/B	B	15.00	0.000	0.000	29.488	21.111	21.617	5.955	13.553	7.179	98.902	1.098
432	DD34/3-4/C	C	285.91	0.000	0.000	17.178	7.756	13.695	22.539	33.138	5.093	99.399	0.601
433	DD34/4-5/A	A	375.28	0.000	0.000	6.769	15.078	18.058	22.352	29.551	7.757	99.564	0.436
434	DD34/4-5/B	B	16.00	0.000	0.000	21.906	14.798	25.685	12.004	17.910	6.262	98.564	1.436
435	DD34/4-5/C	C	371.18	0.000	0.000	5.886	6.379	7.982	24.390	48.052	6.831	99.520	0.480
436	DD35/0-1/A	A	655.00	0.000	0.000	0.199	1.205	2.606	47.422	40.698	7.314	99.444	0.556
437	DD35/0-1/B	B	15.00	0.000	0.000	0.000	0.000	12.434	47.825	28.455	10.398	99.111	0.889
438	DD35/0-1/C	C	525.50	0.000	0.000	0.000	0.000	1.111	44.348	49.544	4.466	99.469	0.531
439	DD35/1-2/A	A	528.00	0.000	0.000	1.338	14.450	15.913	26.769	33.364	7.783	99.617	0.383
440	DD35/1-2/B	B	24.50	0.000	0.000	4.451	14.333	23.182	24.219	23.711	8.811	98.706	1.294
441	DD35/1-2/C	C	451.50	0.000	0.000	1.173	3.021	6.092	38.511	46.398	4.149	99.345	0.655
442	DD35/2-3/A	A	580.14	0.000	0.000	31.173	30.165	19.281	11.150	6.497	1.386	99.652	0.348
443	DD35/2-3/B	B	39.43	0.000	0.000	27.097	40.469	18.326	5.747	5.080	2.910	99.630	0.370
444	DD35/2-3/C	C	305.32	0.000	0.000	33.371	21.580	11.506	14.535	15.513	3.334	99.839	0.161
445	DD35/3-4/A	A	693.18	0.000	0.000	45.887	17.055	16.016	12.146	7.150	1.178	99.432	0.568
446	DD35/3-4/B	B	13.00	0.000	0.000	34.098	41.939	12.485	3.288	4.257	2.970	99.038	0.962
447	DD35/3-4/C	C	267.83	0.000	0.000	23.046	15.272	10.235	29.127	19.152	3.047	99.880	0.120

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
448	DD35/4-5/A	A	652.56	0.000	0.000	44.456	16.568	16.138	12.218	7.139	2.916	99.434	0.566
449	DD35/4-5/B	B	18.00	0.000	0.000	29.116	35.408	13.369	4.693	7.356	9.876	99.818	0.182
450	DD35/4-5/C	C	235.64	0.000	0.000	22.539	14.127	8.497	23.196	23.926	7.400	99.685	0.315
451	DD36/0-1/A	A	727.72	0.000	0.000	4.836	20.511	55.954	11.603	4.489	2.153	99.547	0.453
452	DD36/0-1/B	B	114.50	0.000	0.000	8.998	25.305	54.644	6.622	2.471	1.247	99.287	0.713
453	DD36/0-1/C	C	207.50	0.000	0.000	0.401	14.405	49.661	25.260	8.470	1.495	99.691	0.309
454	DD36/1-2/A	A	1056.78	0.000	0.000	33.623	28.176	27.709	6.825	2.592	0.826	99.750	0.250
455	DD36/1-2/B	B	197.23	0.000	0.000	40.619	48.103	8.613	1.094	0.648	0.509	99.587	0.413
456	DD36/1-2/C	C	310.99	0.000	0.000	15.256	32.176	22.106	22.808	6.277	1.022	99.644	0.356
457	DD36/2-3/A	A	812.28	0.000	0.000	23.533	50.662	16.319	5.331	2.462	1.223	99.529	0.471
458	DD36/2-3/B	B	221.79	0.000	0.000	57.389	27.130	11.406	2.056	1.315	0.701	99.997	0.003
459	DD36/2-3/C	C	300.08	0.000	0.000	22.008	33.537	15.462	16.588	9.645	2.061	99.301	0.699
460	DD36/3-4/A	A	843.33	0.000	0.000	48.878	20.162	14.960	6.821	4.790	3.699	99.309	0.691
461	DD36/3-4/B	B	255.28	0.000	0.000	46.950	14.260	12.262	13.576	10.618	1.676	99.343	0.657
462	DD36/3-4/C	C	207.17	0.000	0.000	72.927	13.210	6.360	2.515	2.112	1.776	98.901	1.099
463	DD36/4-5/A	A	1134.17	0.000	0.000	45.972	19.477	13.263	7.855	8.120	5.199	99.886	0.114
464	DD36/4-5/B	B	219.08	0.000	0.000	68.447	14.268	7.444	3.073	4.126	2.605	99.963	0.037
465	DD36/4-5/C	C	492.20	0.000	0.000	27.220	18.149	9.184	19.807	22.998	2.623	99.981	0.019
466	DD37/0-1/A	A	759.50	0.000	0.000	0.528	14.122	34.959	33.881	13.139	2.807	99.436	0.564
467	DD37/0-1/B	B	1.00	0.000	0.000	0.000	10.167	22.563	14.763	41.365	11.003	99.861	0.139
468	DD37/0-1/C	C	250.00	0.000	0.000	0.165	4.580	15.281	49.611	27.167	2.193	98.996	1.004
469	DD37/1-2/A	A	898.18	0.000	0.000	41.050	33.948	17.748	4.847	2.018	0.198	99.809	0.191
470	DD37/1-2/B	B	47.50	0.000	0.000	40.607	36.871	17.175	2.510	1.600	0.611	99.374	0.626
471	DD37/1-2/C	C	365.14	0.000	0.000	41.623	26.106	15.091	10.335	5.917	0.791	99.863	0.137
472	DD37/2-3/A	A	588.21	0.000	0.000	39.845	30.162	13.309	9.630	5.889	0.968	99.803	0.197

Annexure 6: Granulometric studies of Magnetic fractions (A, B, C fractions)

Sl. No	Sample no	Fractions	Initial weight	One phi interval								Total wt.% of fractions	Loss
				+5#	+10#	+18#	+35#	+60#	+120#	+230#	-230#		
473	DD37/2-3/B	B	8.50	0.000	0.000	47.217	36.050	10.503	3.062	2.143	0.454	99.429	0.571
474	DD37/2-3/C	C	162.08	0.000	0.000	33.081	9.063	9.520	22.302	22.758	3.090	99.813	0.187
475	DD37/3-4/A	A	684.40	0.000	0.000	62.614	12.751	8.970	6.467	7.770	1.354	99.925	0.075
476	DD37/3-4/B	B	3.50	0.000	0.000	48.492	6.138	6.667	7.222	19.048	12.275	99.841	0.159
477	DD37/3-4/C	C	220.15	0.000	0.000	43.813	5.949	5.027	14.177	26.285	4.703	99.956	0.044
478	DD37/4-5/A	A	498.50	0.000	0.000	0.113	6.289	5.797	52.992	24.406	10.400	99.998	0.002
479	DD37/4-5/B	B	10.00	0.000	0.000	6.938	5.785	25.721	8.992	16.850	35.532	99.818	0.182
480	DD37/4-5/C	C	187.50	0.000	0.000	1.786	2.269	13.556	17.037	53.463	11.199	99.310	0.690

Annexure 7
Average Sieve data of Magnetic fractions (Borehole wise)

Annexure 7- Average Sieve data of Magnetic fractions (Borehole wise)

Sl. No	Sample no	Average Sieve data of Magnetic fractions														
		A18%	A35%	A60%	A120%	A230%	B18%	B35%	B60%	B120%	B230%	C18%	C35%	C60%	C120%	C230%
		(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)	(Wt%)
1	DD01	0.417	1.671	15.317	11.474	3.760	0.002	0.046	0.231	0.073	0.052	0.089	0.317	3.433	7.256	4.025
2	DD02	1.374	4.888	13.486	5.473	2.375	0.346	0.938	1.419	0.352	0.384	0.862	2.133	9.958	16.011	5.417
3	DD03	0.051	0.949	13.839	11.008	7.554	0.000	0.114	0.957	0.413	0.453	0.001	0.484	8.659	12.807	9.243
4	DD04	1.573	3.940	13.776	12.019	6.084	0.058	0.136	0.337	0.181	0.203	0.646	1.056	5.491	12.832	7.166
5	DD05	0.061	0.724	14.463	12.249	5.418	0.002	0.199	1.571	0.906	0.423	0.021	0.340	9.394	16.055	6.532
6	DD06	0.199	1.298	16.687	12.684	5.587	0.001	0.047	0.273	0.077	0.074	0.047	0.414	4.164	8.857	5.227
7	DD07	0.126	1.119	16.630	14.578	5.721	0.001	0.013	0.138	0.056	0.077	0.072	0.293	5.552	12.939	5.706
8	DD08	0.082	1.386	11.791	12.882	5.414	0.007	0.077	0.250	0.115	0.107	0.132	0.372	5.133	11.959	6.566
9	DD09	1.398	2.596	17.271	10.192	5.057	0.034	0.136	0.406	0.208	0.220	0.290	0.658	5.300	11.321	6.164
10	DD10	0.129	3.461	16.321	10.388	3.857	0.003	0.230	1.994	0.768	0.377	0.005	0.257	6.548	12.481	4.862
11	DD11	0.238	0.823	12.628	16.176	6.671	0.005	0.027	0.245	0.083	0.053	0.128	0.147	4.393	10.898	5.279
12	DD12	0.003	0.139	14.280	16.992	5.666	0.000	0.002	0.279	0.124	0.057	0.001	0.032	4.151	11.644	5.209
13	DD13	0.812	0.711	14.886	16.209	4.040	0.000	0.007	0.067	0.056	0.033	0.238	0.148	2.928	5.892	2.794
14	DD14	0.369	1.588	19.186	12.769	3.985	0.000	0.006	0.113	0.030	0.019	0.094	0.238	3.851	6.236	3.005
15	DD15	0.005	0.116	13.107	16.538	6.533	0.000	0.024	1.139	0.890	0.397	0.001	0.043	6.088	18.312	6.573
16	DD16	0.000	0.049	11.350	19.036	7.267	0.000	0.002	0.201	0.103	0.033	0.002	0.029	3.273	10.645	5.558
17	DD17	0.236	0.500	17.275	15.764	6.977	0.000	0.010	0.156	0.093	0.118	0.004	0.088	7.759	16.472	5.917
18	DD18	0.019	0.011	7.209	20.511	8.714	0.000	0.001	0.099	0.130	0.065	0.001	0.002	2.102	12.510	6.342
19	DD19	0.006	0.102	9.241	19.553	8.122	0.000	0.001	0.077	0.083	0.079	0.000	0.020	2.816	17.641	8.317
20	DD20	0.000	0.046	6.174	17.368	7.177	0.005	0.044	1.030	1.545	0.870	0.000	0.014	2.912	16.861	8.213
21	DD21	0.068	0.230	7.415	10.364	6.074	0.000	0.003	0.042	0.034	0.056	0.115	0.041	1.109	4.487	4.086
22	DD22	6.204	2.633	7.540	6.385	2.740	0.046	0.028	0.036	0.011	0.021	1.623	0.469	1.349	2.642	2.244
23	DD23	0.000	0.038	5.673	20.275	9.684	0.000	0.006	0.159	0.216	0.151	0.000	0.004	2.229	14.566	8.603

Annexure 7- Average Sieve data of Magnetic fractions (Borehole wise)

Sl. No	Sample no	Average Sieve data of Magnetic fractions														
		A18%	A35%	A60%	A120%	A230%	B18%	B35%	B60%	B120%	B230%	C18%	C35%	C60%	C120%	C230%
24	DD24	0.006	0.081	8.863	16.751	8.129	0.000	0.000	0.020	0.016	0.030	0.000	0.015	1.257	5.691	4.354
25	DD25	0.000	0.056	6.357	16.627	8.941	0.000	0.000	0.022	0.037	0.124	0.000	0.010	1.582	11.687	9.738
26	DD26	2.813	8.895	13.137	5.682	2.733	1.878	2.193	0.484	0.247	0.172	2.746	4.023	1.853	4.952	2.612
27	DD27	0.015	0.101	11.657	19.323	8.492	0.000	0.004	0.221	0.111	0.115	0.004	0.063	3.098	10.856	6.482
28	DD28	0.000	0.000	1.263	8.770	5.312	0.000	0.000	0.000	0.014	0.119	0.004	2.927	0.438	2.882	3.030
29	DD29	0.008	0.352	10.124	14.053	6.678	0.000	0.002	0.098	0.110	0.066	0.047	0.108	2.123	8.114	5.570
30	DD30	4.856	4.688	3.782	5.570	4.522	0.449	0.180	0.064	0.091	0.218	3.785	0.641	0.671	5.463	6.661
31	DD31	2.345	9.087	7.484	5.848	2.356	0.384	1.418	0.773	0.362	0.191	2.384	3.479	7.288	17.188	6.298
32	DD32	5.447	4.229	15.851	14.699	6.167	0.083	0.149	0.318	0.318	0.148	1.861	0.911	6.551	15.061	6.578
33	DD33	0.627	1.994	18.296	14.434	7.903	0.229	0.646	2.019	0.831	0.650	0.371	0.823	8.283	13.807	11.291
34	DD34	1.622	4.850	11.127	16.900	11.524	0.127	0.144	0.257	0.187	0.216	1.095	1.002	3.163	11.889	10.634
35	DD35	10.223	6.575	5.866	9.665	8.410	0.283	0.421	0.269	0.246	0.208	2.896	2.042	1.608	8.447	9.155
36	DD36	15.289	14.327	14.239	4.035	2.207	5.021	2.932	2.003	0.636	0.460	3.981	3.808	3.539	3.049	1.725
37	DD37	14.302	9.992	8.703	9.714	4.741	0.334	0.276	0.155	0.037	0.050	4.106	1.821	2.027	3.893	4.090

Annexure 8
Chemical analysis assay data of A, B, C fractions.

Annexure 8. Chemical Analysis Data of A, B, C fractions

Sl. No.	Sample No.	Borehole	Depth from (m)	Depth To (m)	Fraction	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O5	SiO_2	SO_3	TiO_2	V_2O_5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	**DD02/0-1/A**	DD02	0	1	A	10.43	<0.05	7.13	<0.05	23.37	0.99	4.77	0.25	1.75	0.29	38.99	0.06	7.65	0.14	3.92
2	**DD02/0-1/B**	DD02	0	1	B	11.25	<0.05	8.64	<0.05	17.86	0.98	5.40	0.23	2.08	0.28	43.83	<0.05	5.46	0.07	3.69
3	**DD02/0-1/C**	DD02	0	1	C	7.42	<0.05	12.61	0.16	18.68	0.69	6.84	0.22	0.78	0.13	39.11	<0.05	6.25	0.06	6.86
4	**DD02/1-2/A**	DD02	1	2	A	11.54	<0.05	8.37	<0.05	18.58	1.06	5.07	0.21	2.17	0.31	44.06	<0.05	4.52	0.09	3.83
5	**DD02/1-2/B**	DD02	1	2	B	12.51	<0.05	9.64	<0.05	15.20	0.95	5.29	0.17	2.25	0.28	45.72	<0.05	3.44	0.06	4.30
6	**DD02/1-2/C**	DD02	1	2	C	8.27	<0.05	16.66	0.10	14.02	0.64	6.02	0.23	1.15	0.15	38.44	<0.05	3.49	<0.05	10.62
7	**DD02/2-3/A**	DD02	2	3	A	11.08	<0.05	8.45	<0.05	19.60	1.02	4.99	0.22	2.02	0.29	42.81	<0.05	5.26	0.11	4.01
8	**DD02/2-3/B**	DD02	2	3	B	11.49	<0.05	9.16	<0.05	16.82	1.03	5.18	0.20	2.08	0.27	44.17	<0.05	4.51	0.07	4.85
9	**DD02/2-3/C**	DD02	2	3	C	7.09	<0.05	15.86	0.18	15.97	0.57	6.87	0.22	0.90	0.11	38.04	<0.05	5.70	0.05	8.30
10	**DD02/3-4/A**	DD02	3	4	A	11.99	<0.05	6.83	<0.05	16.06	1.18	4.11	0.17	1.47	0.20	45.97	<0.05	4.00	0.07	7.78
11	**DD02/3-4/B**	DD02	3	4	B	12.54	<0.05	6.17	<0.05	14.50	1.26	3.92	0.13	1.38	0.18	47.32	<0.05	3.64	<0.05	8.76
12	**DD02/3-4/C**	DD02	3	4	C	13.14	<0.05	5.93	<0.05	11.90	1.33	3.63	0.09	1.27	0.14	50.26	<0.05	2.48	<0.05	9.67
13	**DD03/0-1/A**	DD03	0	1	A	8.95	<0.05	5.61	<0.05	27.43	1.13	4.22	0.27	1.27	0.27	34.92	<0.05	10.16	0.17	5.37
14	**DD03/0-1/B**	DD03	0	1	B	8.20	<0.05	5.43	<0.05	25.52	0.93	3.99	0.30	1.08	0.22	33.58	<0.05	14.93	0.12	5.45
15	**DD03/0-1/C**	DD03	0	1	C	9.13	<0.05	7.79	0.09	18.63	0.99	6.06	0.19	0.79	0.15	43.65	<0.05	4.96	0.05	7.34
16	**DD03/1-2/A**	DD03	1	2	A	8.49	<0.05	5.89	0.05	28.59	1.09	4.19	0.29	1.36	0.24	34.27	<0.05	10.51	0.14	4.67
17	**DD03/1-2/B**	DD03	1	2	B	9.04	<0.05	6.06	0.05	23.61	0.95	4.25	0.24	1.22	0.22	36.93	<0.05	11.79	0.10	5.33
18	**DD03/1-2/C**	DD03	1	2	C	9.05	<0.05	7.20	0.09	19.88	0.93	5.85	0.20	0.85	0.14	42.59	<0.05	6.56	0.06	6.42
19	**DD03/2-3/A**	DD03	2	3	A	10.23	<0.05	7.35	<0.05	23.71	1.06	4.89	0.27	1.87	0.29	38.94	<0.05	7.25	0.13	3.80
20	**DD03/2-3/B**	DD03	2	3	B	10.67	<0.05	7.97	<0.05	19.99	0.97	5.25	0.22	1.89	0.27	40.65	<0.05	7.85	0.08	4.03
21	**DD03/2-3/C**	DD03	2	3	C	6.90	<0.05	13.70	0.20	17.54	0.59	7.05	0.23	0.78	0.11	38.94	<0.05	6.72	0.06	7.03
22	**DD03/3-4/A**	DD03	3	4	A	9.87	<0.05	7.57	0.05	24.49	0.94	4.73	0.29	1.71	0.27	37.94	<0.05	8.29	0.16	3.54
23	**DD03/3-4/B**	DD03	3	4	B	11.49	<0.05	8.71	<0.05	17.34	1.04	5.30	0.20	2.14	0.29	43.95	<0.05	4.94	0.07	4.33
24	**DD03/3-4/C**	DD03	3	4	C	6.47	<0.05	14.49	0.21	17.57	0.51	7.31	0.24	0.78	0.11	38.26	<0.05	7.16	0.07	6.69
25	**DD03/4-5/A**	DD03	4	5	A	9.90	<0.05	7.67	<0.05	24.33	0.98	4.77	0.29	1.79	0.28	37.88	<0.05	7.90	0.15	3.86
26	**DD03/4-5/B**	DD03	4	5	B	11.42	<0.05	8.82	<0.05	17.59	0.96	5.37	0.21	2.04	0.28	43.06	<0.05	5.71	0.07	4.31
27	**DD03/4-5/C**	DD03	4	5	C	6.24	<0.05	15.30	0.21	16.56	0.49	7.23	0.23	0.67	0.09	38.53	<0.05	6.72	0.06	7.51
28	**DD15/0-1/A**	DD15	0	1	A	9.01	<0.05	6.76	<0.05	27.29	1.04	4.64	0.31	1.52	0.28	35.59	<0.05	9.25	0.16	3.92
29	**DD15/0-1/B**	DD15	0	1	B	9.25	<0.05	6.86	<0.05	22.66	0.95	4.92	0.24	1.51	0.26	37.49	<0.05	11.09	0.09	4.45
30	**DD15/0-1/C**	DD15	0	1	C	8.19	<0.05	8.68	0.12	21.19	0.82	7.03	0.26	0.81	0.14	40.18	<0.05	7.14	0.08	5.20
31	**DD15/1-2/A**	DD15	1	2	A	7.38	<0.05	7.14	0.08	31.03	0.79	4.99	0.38	1.16	0.22	31.53	<0.05	11.92	0.23	2.95
32	**DD15/1-2/B**	DD15	1	2	B	7.10	<0.05	6.17	0.05	29.77	0.70	4.63	0.33	1.16	0.19	28.94	<0.05	18.31	0.11	2.35
33	**DD15/1-2/C**	DD15	1	2	C	6.50	<0.05	10.92	0.21	21.07	0.61	8.45	0.22	0.53	0.11	39.54	<0.05	7.32	0.09	4.27
34	**DD15/2-3/A**	DD15	2	3	A	10.75	<0.05	7.55	<0.05	20.71	1.09	5.22	0.24	1.94	0.31	41.56	<0.05	5.68	0.11	4.66
35	**DD15/2-3/B**	DD15	2	3	B	10.62	<0.05	8.02	<0.05	19.95	1.00	5.49	0.24	1.95	0.27	40.58	<0.05	7.30	0.08	4.34
36	**DD15/2-3/C**	DD15	2	3	C	8.87	<0.05	12.40	0.09	16.50	0.89	7.05	0.19	0.94	0.16	40.61	<0.05	2.71	<0.05	9.41
37	**DD15/3-4/A**	DD15	3	4	A	9.83	<0.05	7.55	<0.05	23.43	1.04	5.22	0.27	1.70	0.30	39.05	<0.05	6.99	0.14	4.29
38	**DD15/3-4/B**	DD15	3	4	B	10.78	<0.05	8.06	<0.05	18.72	1.03	5.44	0.18	1.89	0.29	42.54	<0.05	5.83	0.08	4.97
39	**DD15/3-4/C**	DD15	3	4	C	7.42	<0.05	12.21	0.16	16.72	0.71	7.97	0.21	0.80	0.13	42.88	<0.05	4.22	0.06	6.39
40	**DD15/4-5/A**	DD15	4	5	A	10.81	<0.05	7.37	<0.05	20.52	1.21	5.01	0.23	1.98	0.32	41.24	<0.05	5.50	0.10	5.53
41	**DD15/4-5/B**	DD15	4	5	B	11.55	<0.05	7.60	<0.05	17.98	1.13	5.08	0.19	2.04	0.30	42.95	<0.05	5.31	0.07	5.64
42	**DD15/4-5/C**	DD15	4	5	C	9.20	<0.05	13.30	0.07	14.07	0.90	5.38	0.20	1.06	0.16	41.17	<0.05	2.76	<0.05	11.55

Annexure 8. Chemical Analysis Data of A, B, C fractions

Sl. No.	Sample No.	Borehole	Depth from (m)	Depth To (m)	Fraction	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O5	SiO_2	SO_3	TiO_2	V_2O_5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
43	**DD33/0-1/A**	DD33	0	1	A	10.39	<0.05	5.26	<0.05	25.79	1.08	4.42	0.27	1.46	0.24	37.65	<0.05	7.58	0.15	5.51
44	**DD33/0-1/B**	DD33	0	1	B	10.98	<0.05	5.90	<0.05	20.78	1.05	4.89	0.21	1.49	0.21	40.75	<0.05	7.36	0.08	6.15
45	**DD33/0-1/C**	DD33	0	1	C	11.00	<0.05	6.41	0.06	18.17	1.06	6.16	0.15	1.09	0.13	44.29	<0.05	3.74	0.05	7.56
46	**DD33/1-2/A**	DD33	1	2	A	11.46	<0.05	7.17	<0.05	20.39	1.03	5.24	0.22	1.94	0.26	42.57	<0.05	4.90	0.10	4.58
47	**DD33/1-2/B**	DD33	1	2	B	12.06	<0.05	7.86	<0.05	17.79	1.04	5.43	0.17	2.28	0.26	44.12	<0.05	3.72	0.06	5.06
48	**DD33/1-2/C**	DD33	1	2	C	11.20	<0.05	7.80	0.08	17.20	0.99	6.97	0.15	1.28	0.15	45.68	<0.05	2.88	0.05	5.45
49	**DD33/2-3/A**	DD33	2	3	A	11.03	<0.05	6.88	<0.05	21.29	1.03	5.11	0.26	1.96	0.26	41.63	<0.05	5.44	0.11	4.80
50	**DD33/2-3/B**	DD33	2	3	B	12.16	<0.05	7.58	<0.05	17.42	0.96	5.44	0.18	2.14	0.25	44.21	<0.05	4.36	0.06	5.09
51	**DD33/2-3/C**	DD33	2	3	C	10.73	<0.05	8.09	0.10	17.67	1.00	7.25	0.16	1.37	0.14	44.68	<0.05	2.92	0.05	5.72
52	**DD33/3-4/A**	DD33	3	4	A	11.62	<0.05	6.36	<0.05	19.64	1.11	4.90	0.21	2.05	0.25	42.59	<0.05	4.56	0.09	6.45
53	**DD33/3-4/B**	DD33	3	4	B	12.31	<0.05	7.14	<0.05	16.84	1.03	5.17	0.16	2.19	0.24	44.41	<0.05	3.72	0.06	6.56
54	**DD33/3-4/C**	DD33	3	4	C	11.88	<0.05	6.68	0.06	16.14	1.09	5.86	0.15	1.59	0.14	45.88	<0.05	2.44	<0.05	7.92
55	**DD33/4-5/A**	DD33	4	5	A	11.43	<0.05	4.48	<0.05	21.13	1.16	4.07	0.21	1.70	0.21	41.93	0.06	6.15	0.09	7.22
56	**DD33/4-5/B**	DD33	4	5	B	11.29	<0.05	4.64	<0.05	18.45	1.16	4.01	0.15	1.68	0.18	43.68	0.08	6.65	0.06	7.82
57	**DD33/4-5/C**	DD33	4	5	C	11.23	<0.05	4.93	<0.05	12.33	1.12	3.93	0.08	1.60	0.12	54.86	<0.05	2.14	<0.05	7.43
58	**DD36/0-1/A**	DD36	0	1	A	11.86	<0.05	8.37	<0.05	18.12	0.88	5.48	0.20	2.00	0.25	44.48	<0.05	3.81	0.08	4.30
59	**DD36/0-1/B**	DD36	0	1	B	11.56	<0.05	9.14	<0.05	17.32	0.80	5.84	0.17	2.05	0.24	44.34	<0.05	4.00	0.06	4.32
60	**DD36/0-1/C**	DD36	0	1	C	10.43	<0.05	9.85	0.13	15.17	0.68	7.84	0.16	1.17	0.12	47.60	<0.05	2.37	0.06	4.32
61	**DD36/1-2/A**	DD36	1	2	A	12.23	<0.05	8.32	<0.05	17.43	0.90	5.39	0.17	1.99	0.25	44.86	<0.05	3.77	0.08	4.47
62	**DD36/1-2/B**	DD36	1	2	B	13.09	<0.05	9.01	<0.05	15.14	0.83	5.42	0.17	2.18	0.25	46.43	<0.05	2.94	0.06	4.34
63	**DD36/1-2/C**	DD36	1	2	C	11.89	<0.05	9.47	0.07	15.02	0.75	6.46	0.14	1.59	0.17	46.50	<0.05	2.95	0.05	4.83
64	**DD36/2-3/A**	DD36	2	3	A	12.83	<0.05	8.16	<0.05	16.52	0.96	5.13	0.17	2.10	0.27	45.60	<0.05	3.34	0.06	4.72
65	**DD36/2-3/B**	DD36	2	3	B	12.84	<0.05	9.30	<0.05	15.82	0.90	5.42	0.15	2.22	0.25	45.37	<0.05	3.07	0.05	4.46
66	**DD36/2-3/C**	DD36	2	3	C	13.10	<0.05	8.48	<0.05	13.99	0.87	5.64	0.16	1.67	0.17	47.92	<0.05	2.39	<0.05	5.40
67	**DD36/3-4/A**	DD36	3	4	A	12.79	<0.05	8.22	<0.05	16.36	0.98	5.10	0.21	2.12	0.26	45.73	<0.05	3.31	0.06	4.73
68	**DD36/3-4/B**	DD36	3	4	B	12.80	<0.05	9.67	<0.05	13.38	0.82	5.33	0.16	1.72	0.18	47.25	<0.05	2.26	<0.05	6.25
69	**DD36/3-4/C**	DD36	3	4	C	13.49	<0.05	9.17	<0.05	14.53	0.84	5.29	0.16	2.11	0.24	46.90	<0.05	2.83	<0.05	4.27
70	**DD36/4-5/A**	DD36	4	5	A	12.54	<0.05	7.89	<0.05	17.32	0.96	5.04	0.19	1.98	0.26	44.87	<0.05	3.91	0.07	4.81
71	**DD36/4-5/B**	DD36	4	5	B	13.24	<0.05	9.03	<0.05	15.24	0.86	5.35	0.18	2.14	0.25	46.52	<0.05	3.20	0.06	3.81
72	**DD36/4-5/C**	DD36	4	5	C	12.85	<0.05	8.83	<0.05	13.69	0.85	5.51	0.11	1.73	0.18	48.44	<0.05	2.34	<0.05	5.28

Annexure 9
Chemical analysis assay data of +60#, +120# & +230# sieve fractions

Annexure 9. Chemical Analysis Data of 60#, 120# & 230# sieve fractions

Sl. No.	Sample No.	Bore hole	Depth from (m)	Depth To (m)	Fraction	Al2O3	BaO	CaO	Cr2O3	Fe2O3	K2O	MgO	MnO	Na2O	P2O5	SiO2	SO3	TiO2	V2O5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	**DD03/1-2/A/ASTM-120**	**DD03**	1	2	A120#	10.80	<0.05	6.44	<0.05	20.10	1.36	4.38	0.18	1.74	0.33	42.91	<0.05	5.19	0.09	6.28
2	**DD03/1-2/A/ASTM-230**	**DD03**	1	2	A230#	7.11	<0.05	4.60	0.07	33.24	0.83	3.63	0.37	0.83	0.20	29.79	<0.05	14.64	0.24	4.21
3	**DD15/1-2/A/ASTM-60**	**DD15**	1	2	A60#	11.52	<0.05	8.40	<0.05	17.40	1.12	5.52	0.19	2.14	0.33	45.25	<0.05	3.65	0.07	4.24
4	**DD15/1-2/A/ASTM-120**	**DD15**	1	2	A120#	8.26	<0.05	8.45	0.06	25.20	0.90	5.84	0.28	1.25	0.25	37.78	<0.05	7.60	0.17	3.80
5	**DD15/1-2/A/ ASTM-230**	**DD15**	1	2	A230#	3.47	<0.05	3.60	0.12	48.81	0.38	2.87	0.60	0.39	0.10	13.84	<0.05	24.12	0.42	1.02
6	**DD15/1-2/A/ ASTM-(-230)**	**DD15**	1	2	A(-230#)	6.86	<0.05	6.69	0.10	31.95	0.61	4.96	0.39	1.00	0.18	26.97	<0.05	16.15	0.18	3.65
7	**DD15/1-2/A/ASTM-230/MT**	**DD15**	1	2	A230Mt	3.11	<0.05	2.12	0.06	59.84	0.28	1.37	0.80	0.20	0.10	8.40	<0.05	21.87	0.67	0.82
8	**DD15/1-2/A/ASTM-230/NMT**	**DD15**	1	2	A230NMt	4.25	<0.05	4.72	0.15	36.79	0.44	3.97	0.42	0.49	0.11	20.92	<0.05	26.17	0.18	1.15
9	**DD15/1-2/B/ASTM-120**	**DD15**	1	2	B120#	9.82	<0.05	8.87	<0.05	18.76	0.96	6.15	0.19	1.70	0.28	42.56	<0.05	6.13	0.08	4.31
10	**DD15/1-2/B/ASTM-230**	**DD15**	1	2	B230#	2.20	<0.05	1.90	0.06	43.59	0.22	2.08	0.56	0.17	0.06	9.57	<0.05	39.13	0.26	<0.1
11	**DD15/1-2/C/ASTM-120**	**DD15**	1	2	C120#	6.68	<0.05	12.95	0.17	17.42	0.69	9.83	0.20	0.58	0.11	43.50	<0.05	2.65	0.07	5.04
12	**DD15/1-2/C/ASTM-230**	**DD15**	1	2	C230#	4.61	<0.05	8.59	0.30	29.19	0.40	6.27	0.35	0.33	0.08	30.33	<0.05	16.62	0.11	2.48

Annexure 10
Chemical analysis assay data of ABC230# fraction

Annexure 10. Chemical Analysis Data of ABC230# fractions

Sl. No.	Sample No.	Bore hole	Depth from (m)	Depth To (m)	Fraction	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	SO3	TiO_2	V_2O_5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	DD01/0-1/230	DD01	0	1	ABC230#	7.44	<0.05	7.13	0.11	26.94	0.89	5.16	0.28	0.81	0.18	35.62	<0.05	10.61	0.12	4.55
2	DD01/1-2/230	DD01	1	2	ABC230#	4.71	<0.05	4.99	0.24	39.11	0.46	3.72	0.48	0.47	0.11	20.71	<0.05	23.03	0.24	1.48
3	DD01/2-3/230	DD01	2	3	ABC230#	6.42	<0.05	8.47	0.16	29.84	0.62	4.48	0.36	0.82	0.16	28.39	<0.05	15.66	0.18	4.24
4	DD01/3-4/230	DD01	3	4	ABC230#	5.83	<0.05	5.90	0.20	33.34	0.62	4.29	0.41	0.64	0.14	26.81	<0.05	18.66	0.21	2.74
5	DD03/0-1/230	DD03	0	1	ABC230#	7.41	<0.05	7.41	0.08	25.49	0.85	5.36	0.24	0.79	0.16	38.00	<0.05	8.98	0.13	4.93
6	DD03/1-2/230	DD03	1	2	ABC230#	7.59	<0.05	6.01	0.10	26.83	0.85	4.81	0.27	0.80	0.16	37.32	<0.05	10.61	0.16	4.29
7	DD03/2-3/230	DD03	2	3	ABC230#	5.16	<0.05	6.48	0.23	35.57	0.48	4.03	0.45	0.57	0.13	23.46	<0.05	20.53	0.24	2.35
8	DD03/3-4/230	DD03	3	4	ABC230#	5.45	<0.05	7.09	0.22	34.93	0.49	3.93	0.44	0.65	0.13	23.02	<0.05	20.28	0.20	2.85
9	DD03/4-5/230	DD05	4	5	ABC230#	5.43	<0.05	7.32	0.20	34.01	0.55	4.21	0.40	0.66	0.14	25.29	<0.05	18.30	0.19	2.99
10	DD05/0-1/230	DD05	0	1	ABC230#	6.99	<0.05	6.48	0.10	29.63	0.80	5.11	0.32	0.79	0.16	33.44	<0.05	12.27	0.16	3.56
11	DD05/1-2/230	DD05	1	2	ABC230#	5.98	<0.05	6.60	0.19	30.21	0.59	4.24	0.36	0.63	0.13	31.06	<0.05	16.59	0.17	2.99
12	DD05/2-3/230	DD05	2	3	ABC230#	4.42	<0.05	6.19	0.22	37.94	0.46	4.08	0.49	0.52	0.13	21.35	<0.05	21.75	0.30	1.83
13	DD05/3-4/230	DD05	3	4	ABC230#	4.18	<0.05	5.92	0.26	38.32	0.43	3.86	0.46	0.47	0.12	20.60	<0.05	22.93	0.21	1.92
14	DD05/4-5/230	DD07	4	5	ABC230#	6.01	<0.05	7.79	0.17	31.43	0.58	4.26	0.39	0.74	0.16	27.29	<0.05	16.39	0.19	4.31
15	DD07/0-1/230	DD07	0	1	ABC230#	6.38	<0.05	7.77	0.16	31.33	0.58	4.37	0.41	0.75	0.15	27.57	<0.05	16.36	0.20	3.67
16	DD07/1-2/230	DD07	1	2	ABC230#	6.37	<0.05	7.39	0.15	30.68	0.63	5.29	0.36	0.61	0.15	31.00	<0.05	14.38	0.19	2.55
17	DD07/2-3/230	DD07	2	3	ABC230#	4.05	<0.05	5.44	0.28	39.11	0.37	3.72	0.49	0.44	0.12	19.35	<0.05	24.90	0.27	1.12
18	DD07/3-4/230	DD 07	3	4	ABC230#	6.13	<0.05	7.93	0.18	31.15	0.56	4.69	0.42	0.70	0.15	27.51	<0.05	16.53	0.20	3.60
19	DD07/4-5/230	DD09	4	5	ABC230#	4.73	<0.05	6.27	0.23	36.28	0.48	4.27	0.44	0.47	0.12	23.21	<0.05	20.66	0.25	2.33
20	DD09/0-1/230	DD09	0	1	ABC230#	5.49	<0.05	7.33	0.14	32.35	0.56	5.27	0.37	0.53	0.13	29.11	<0.05	15.20	0.22	3.07
21	DD09/1-2/230	DD09	1	2	ABC230#	6.58	<0.05	7.61	0.13	28.85	0.70	5.44	0.32	0.67	0.16	32.95	<0.05	12.45	0.18	3.74
22	DD09/2-3/230	DD09	2	3	ABC230#	4.97	<0.05	7.14	0.20	35.39	0.52	4.42	0.42	0.59	0.13	23.72	<0.05	19.29	0.24	2.71
23	DD09/3-4/230	DD09	3	4	ABC230#	6.27	<0.05	8.84	0.16	29.37	0.62	4.40	0.38	0.79	0.16	28.45	<0.05	15.20	0.18	4.92
24	DD09/4-5/230	DD11	4	5	ABC230#	5.60	<0.05	7.56	0.20	33.08	0.56	4.71	0.42	0.70	0.14	25.54	<0.05	17.80	0.19	3.24

Annexure 10. Chemical Analysis Data of ABC230# fractions

Sl. No.	Sample No.	Bore hole	Depth from (m)	Depth To (m)	Fraction	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	SO3	TiO_2	V_2O_5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
25	DD11/0-1/230	DD11	0	1	ABC230#	6.25	<0.05	8.64	0.24	25.31	0.62	6.48	0.29	0.51	0.13	35.07	<0.05	11.44	0.14	4.67
26	DD11/1-2/230	DD11	1	2	ABC230#	5.88	<0.05	5.70	0.12	34.46	0.62	4.86	0.39	0.54	0.16	26.76	<0.05	16.94	0.23	3.11
27	DD11/2-3/230	DD11	2	3	ABC230#	4.31	<0.05	5.46	0.35	38.09	0.42	4.20	0.52	0.46	0.12	21.19	<0.05	23.01	0.32	1.31
28	DD11/3-4/230	DD11	3	4	ABC230#	5.68	<0.05	6.66	0.15	32.71	0.57	4.95	0.38	0.52	0.15	28.27	<0.05	16.42	0.24	3.07
29	DD11/4-5/230	DD13	4	5	ABC230#	7.18	<0.05	7.73	0.13	27.88	0.76	5.12	0.33	0.84	0.16	32.59	<0.05	12.32	0.17	4.59
30	DD13/0-1/230	DD13	0	1	ABC230#	6.33	<0.05	6.17	0.11	33.09	0.66	4.99	0.41	0.62	0.18	28.43	<0.05	14.98	0.22	3.62
31	DD13/1-2/230	DD13	1	2	ABC230#	6.28	<0.05	5.92	0.10	33.42	0.66	5.04	0.42	0.62	0.17	28.41	<0.05	15.78	0.23	2.77
32	DD13/2-3/230	DD13	2	3	ABC230#	5.40	<0.05	5.35	0.13	37.86	0.59	4.65	0.47	0.58	0.15	23.33	<0.05	18.92	0.26	2.09
33	DD13/3-4/230	DD13	3	4	ABC230#	6.41	<0.05	6.08	0.15	34.46	0.65	4.66	0.42	0.77	0.17	26.42	<0.05	16.62	0.21	2.75
34	DD13/4-5/230	DD15	4	5	ABC230#	7.12	<0.05	7.14	0.12	30.54	0.77	5.10	0.38	0.84	0.18	29.94	<0.05	13.14	0.17	4.37
35	DD15/0-1/230	DD15	0	1	ABC230#	6.12	<0.05	6.09	0.14	32.38	0.63	4.60	0.37	0.63	0.14	29.64	<0.05	15.85	0.20	2.98
36	DD15/1-2/230	DD15	1	2	ABC230#	4.32	<0.05	5.75	0.19	38.98	0.38	4.34	0.48	0.34	0.10	21.84	<0.05	21.27	0.30	1.42
37	DD15/2-3/230	DD15	2	3	ABC230#	5.99	<0.05	6.91	0.15	33.41	0.61	4.74	0.40	0.71	0.15	27.00	<0.05	15.99	0.22	3.47
38	DD15/3-4/230	DD15	3	4	ABC230#	5.45	<0.05	7.33	0.16	33.17	0.56	5.10	0.40	0.56	0.13	27.71	<0.05	16.07	0.22	2.88
39	DD15/4-5/230	DD17	4	5	ABC230#	7.53	<0.05	8.21	0.11	26.58	0.76	5.25	0.32	0.80	0.17	33.52	<0.05	10.76	0.15	5.59
40	DD17/0-1/230	DD17	0	1	ABC230#	4.72	<0.05	7.23	0.19	35.44	0.45	4.94	0.48	0.46	0.12	24.65	<0.05	18.40	0.28	2.36
41	DD17/1-2/230	DD17	1	2	ABC230#	4.99	<0.05	6.65	0.17	35.54	0.51	5.02	0.42	0.49	0.13	25.92	<0.05	17.36	0.23	2.29
42	DD17/2-3/230	DD17	2	3	ABC230#	6.92	<0.05	7.17	0.12	28.90	0.79	5.08	0.33	0.76	0.16	31.79	<0.05	12.91	0.17	4.65
43	DD17/3-4/230	DD17	3	4	ABC230#	5.03	<0.05	6.07	0.20	35.66	0.45	4.20	0.45	0.46	0.13	23.44	<0.05	20.72	0.25	2.58
44	DD17/4-5/230	DD17	4	5	ABC230#	6.09	<0.05	6.82	0.17	30.70	0.61	4.87	0.35	0.62	0.14	30.13	<0.05	15.48	0.19	3.57
45	DD19/0-1/230	DD19	0	1	ABC230#	4.61	<0.05	6.51	0.18	37.17	0.44	4.68	0.43	0.38	0.12	23.06	<0.05	19.73	0.25	2.16
46	DD19/1-2/230	DD19	1	2	ABC230#	5.74	<0.05	6.80	0.16	32.47	0.56	4.74	0.38	0.54	0.13	28.51	<0.05	16.40	0.22	3.08
47	DD19/2-3/230	DD19	2	3	ABC230#	6.82	<0.05	6.78	0.14	29.68	0.79	5.57	0.35	0.81	0.17	32.02	<0.05	13.18	0.18	3.31
48	DD19/3-4/230	DD19	3	4	ABC230#	4.94	<0.05	6.04	0.18	35.57	0.50	4.49	0.44	0.46	0.13	25.12	<0.05	19.33	0.28	2.26

Annexure 10. Chemical Analysis Data of ABC230# fractions

Sl. No.	Sample No.	Bore hole	Depth from (m)	Depth To (m)	Fraction	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	SO3	TiO_2	V_2O_5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
49	DD19/4-5/230	DD19	4	5	ABC230#	6.16	<0.05	6.88	0.12	31.75	0.65	5.04	0.38	0.72	0.16	29.55	<0.05	14.97	0.22	3.17
50	DD23/0-1/230	DD23	0	1	ABC230#	6.48	<0.05	5.19	0.13	33.85	0.70	4.56	0.41	0.68	0.15	28.03	<0.05	16.63	0.23	2.77
51	DD23/1-2/230	DD23	1	2	ABC230#	4.35	<0.05	4.59	0.22	39.81	0.41	3.81	0.50	0.37	0.11	20.70	<0.05	23.46	0.29	1.12
52	DD23/2-3/230	DD23	2	3	ABC230#	5.88	<0.05	5.85	0.17	33.69	0.60	4.44	0.41	0.62	0.13	27.86	<0.05	17.21	0.22	2.71
53	DD23/3-4/230	DD23	3	4	ABC230#	5.73	<0.05	6.33	0.16	32.59	0.60	4.65	0.39	0.57	0.14	28.55	<0.05	16.98	0.20	2.88
54	DD23/4-5/230	DD23	4	5	ABC230#	3.85	<0.05	4.63	0.20	51.64	0.44	2.80	<0.05	0.16	0.10	17.03	<0.05	16.03	<0.05	2.66
55	DD33/0-1/230	DD33	0	1	ABC230#	9.35	<0.05	5.77	0.07	25.11	0.93	5.33	0.24	0.98	0.15	39.03	<0.05	8.20	0.14	4.55
56	DD33/1-2/230	DD33	1	2	ABC230#	7.96	<0.05	6.56	0.09	27.99	0.74	5.92	0.31	0.90	0.14	35.66	<0.05	10.28	0.18	3.12
57	DD33/2-3/230	DD33	2	3	ABC230#	8.03	<0.05	6.40	0.09	28.52	0.79	5.76	0.31	1.02	0.14	35.04	<0.05	10.40	0.20	3.12
58	DD33/3-4/230	DD33	3	4	ABC230#	11.02	<0.05	5.04	<0.05	21.48	1.14	4.77	0.18	1.53	0.17	42.96	<0.05	5.86	0.10	5.53
59	DD33/4-5/230	DD33	4	5	ABC230#	10.87	<0.05	4.39	<0.05	14.27	1.14	3.81	0.10	1.63	0.13	55.37	<0.05	3.04	<0.05	5.01
60	DD35/0-1/230	DD35	0	1	ABC230#	7.87	<0.05	6.15	0.09	27.33	0.74	5.52	0.29	0.78	0.14	36.91	<0.05	10.15	0.17	3.70
61	DD35/1-2/230	DD35	1	2	ABC230#	8.85	<0.05	6.31	0.07	23.94	0.86	5.62	0.23	0.87	0.16	40.96	<0.05	7.46	0.14	4.39
62	DD35/2-3/230	DD35	2	3	ABC230#	9.74	<0.05	6.21	0.06	23.70	0.98	5.42	0.25	1.00	0.18	40.26	<0.05	6.74	0.12	5.21
63	DD35/3-4/230	DD35	3	4	ABC230#	8.79	<0.05	6.93	0.07	24.70	0.91	5.81	0.25	0.97	0.17	39.22	<0.05	7.77	0.14	4.12
64	DD35/4-5/230	DD35	4	5	ABC230#	8.77	<0.05	6.15	0.06	23.74	0.95	5.31	0.23	1.08	0.17	41.80	<0.05	7.48	0.13	3.98
65	DD37/0-1/230	DD37	0	1	ABC230#	8.44	<0.05	6.06	0.07	29.06	0.84	5.53	0.32	0.86	0.17	34.18	<0.05	9.84	0.19	4.29
66	DD37/1-2/230	DD37	1	2	ABC230#	9.34	<0.05	6.68	0.07	23.95	0.85	5.54	0.24	1.03	0.16	40.16	<0.05	7.45	0.14	4.22
67	DD37/2-3/230	DD37	2	3	ABC230#	9.91	<0.05	5.77	<0.05	23.73	0.97	5.35	0.22	0.98	0.18	40.73	<0.05	6.71	0.12	5.13
68	DD37/3-4/230	DD37	3	4	ABC230#	9.13	<0.05	6.07	0.06	24.53	0.92	5.42	0.24	0.91	0.17	40.22	<0.05	7.46	0.14	4.57
69	DD37/4-5/230	DD37	4	5	ABC230#	9.98	<0.05	4.49	<0.05	23.14	1.10	4.62	0.21	1.19	0.19	43.08	<0.05	6.80	0.11	4.91

Annexure 11
Chemical analysis data of Bulk samples (7.447kg)

Annexure 11. Chemical Analysis Data of Bulk sample (7.447kg)

Sl. No.	Sample No.	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	V_2O_5	LOI
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	DD/ABC/35#Mt	12.47	<0.05	8.33	<0.05	15.81	1.04	5.21	0.2	2.41	0.3	46.8	0.05	3.21	0.06	3.94
2	DD/ABC/35#NMt	11.87	<0.05	11.3	<0.05	12.11	0.92	4.94	0.15	1.74	0.18	45.48	<0.05	2.26	<0.05	8.81
3	DD/ABC/60#Mt	11.97	<0.05	7.94	<0.05	17.13	1.13	5.37	0.2	2.26	0.31	45.41	<0.05	3.63	0.08	4.41
4	DD/ABC/60#NMt	10.45	<0.05	10.9	0.07	15.04	0.88	6.18	0.17	1.57	0.19	44.66	<0.05	2.52	<0.05	7.19
5	DD/ABC/120#Mt	9.42	<0.05	5.84	<0.05	27.47	1.14	4.27	0.3	1.58	0.31	36.59	<0.05	8.22	0.2	4.42
6	DD/ABC/120#NMt	9.2	<0.05	8.18	0.1	19.89	1.03	6.43	0.21	1.12	0.18	40.85	<0.05	6.07	0.06	6.53
7	DD/ABC/230#Mt	5.11	<0.05	3.56	0.07	47.77	0.65	2.69	0.61	0.68	0.16	18.11	<0.05	17.1	0.5	2.69
8	DD/ABC/230#NMt	7.31	<0.05	7.16	0.16	24.57	0.81	5.47	0.29	0.91	0.14	36.13	<0.05	11.88	0.09	4.86
9	DD/ABC/-230#Mt	5.9	<0.05	3.56	0.09	45.73	0.63	2.61	0.61	0.64	0.18	19.27	<0.05	16.14	0.46	3.84
10	DD/ABC/-230#NMt	9.55	<0.05	7.76	0.09	20.41	0.9	5.16	0.25	1.45	0.18	38.56	<0.05	8.8	0.06	6.52
11	DD/-230/Silt	8.95	<0.05	8.03	0.08	20.26	0.78	4.89	0.22	1.31	0.17	41.34	<0.05	8.4	0.12	5.24

Annexure 12
ICP-MS analysis data of ABC230# fraction

Annexure 12. ICP-MS Data of ABC230# fraction

Sl. No.	Sample No.	Sc	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Ta
		ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)
1	**DD01/0-1/230**	37.02	23.75	27.53	56.26	7.43	31.55	7.77	2.12	8.07	1.37	7.31	1.58	4.44	0.65	4.14	0.6	16.78
2	**DD01/3-4/230**	40.82	8.16	42.51	86.67	10.44	40.18	8.45	1.78	8.63	1.38	6.71	1.39	4.1	0.59	4.23	0.64	6.44
3	**DD03/0-1/230**	33.04	7.67	25.8	57.35	7.22	29.12	7.16	2	7.61	1.32	6.89	1.35	4.05	0.55	3.79	0.53	8.43
4	**DD03/4-5/230**	37.77	<0.5	62.69	133.68	14.93	54.45	10.51	1.76	10.53	1.64	7.11	1.41	4.15	0.61	4.31	0.67	<0.5
5	**DD07/0-1/230**	41.4	20.68	45.09	91.98	11.04	44.12	9.61	2.08	9.96	1.59	8.11	1.61	4.58	0.63	4.47	0.69	14.87
6	**DD07/4-5/230**	41.74	3.36	57.66	119.11	13.6	50.74	9.81	1.74	10.05	1.57	7.3	1.44	4.44	0.66	4.51	0.7	3.71
7	**DD11/0-1/230**	45.05	2.98	54.5	108.27	13	49.84	10.49	1.8	10.37	1.6	7.59	1.56	4.55	0.62	4.22	0.64	3.51
8	**DD11/4-5/230**	35.76	8.23	33.26	71.78	8.7	35.22	7.84	2	8.33	1.41	7	1.45	4.06	0.57	3.97	0.57	6.35
9	**DD15/0-1/230**	37.65	33.52	34.37	72.61	8.75	34.61	7.8	1.89	8.27	1.36	6.97	1.42	4.16	0.61	4.2	0.61	26.22
10	**DD15/4-5/230**	35.27	<0.5	42.37	86.58	10.69	43.18	9.57	2.27	10.07	1.67	7.99	1.61	4.69	0.63	4.26	0.6	<0.5
11	**DD19/0-1/230**	44.37	7.13	50.73	101.94	11.97	45.78	9.48	1.85	9.78	1.51	7.56	1.53	4.46	0.65	4.43	0.68	4.64
12	**DD19/4-5/230**	40.95	<0.5	34.24	70.99	8.68	35.45	8.2	2.07	8.7	1.42	7.48	1.52	4.5	0.66	4.48	0.66	<0.5
13	**DD23/0-1/230**	38.95	0.94	25.99	54.82	7.09	29.9	7.31	2.05	7.9	1.37	7.32	1.53	4.37	0.64	4.34	0.64	0.86
14	**DD23/4-5/230**	38	16.63	38	79.88	9.67	38.06	8.31	1.82	8.6	1.38	6.91	1.4	4.15	0.59	4.26	0.64	10.93
15	**DD33/0-1/230**	33.8	7.93	21.22	44.7	5.96	26.44	6.61	2.06	7.16	1.21	6.28	1.33	3.84	0.5	3.49	<0.5	4.91
16	**DD33/4-5/230**	21.5	12.09	19.26	42.24	5.44	22.75	5.42	1.64	5.76	0.97	4.82	1.01	2.83	<0.5	2.57	<0.5	7.92
17	**DD37/0-1/230**	38.16	12.18	19.97	46	6.08	25.96	6.87	2.13	7.46	1.25	6.86	1.36	3.88	0.52	3.36	<0.5	9.6
18	**DD37/4-5/230**	28.85	12.7	23.24	50.48	6.73	29.22	7.2	2.24	7.75	1.39	6.92	1.45	4.03	0.53	3.66	<0.5	9.28

Annexure 13
ICP-MS analysis data of Bulk sample (7.447 kg)

Annexure 13. ICP-MS Analysis Data of Bulk sample (7.447kg)

Sl. No.	Sample No.	Li	Be	B	Sc	Co	Ga	Ge	Se	Rb	Y	Nb	Mo	Cd	In	Sn	Sb	Te
		ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)
1	**DD/ABC/35#Mt**	1.1	<5	31.0	131.0	22.2	<0.5	<0.5	30.8	39.3	2.7	0.6	1.1	<0.5	<0.5	0.9	1.3	1.1
2	**DD/ABC/60#Mt**	0.9	<5	30.0	64.4	21.9	<0.5	<0.5	32.4	41.1	8.0	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	0.9
3	**DD/ABC/60#NMt**	0.8	<5	31.0	69.2	21.7	<0.5	<0.5	36.8	34.3	17.2	1.0	2.9	<0.5	10.3	<0.5	<0.5	0.8
4	**DD/ABC/120#Mt**	1.0	<5	30.0	78.9	29.6	<0.5	<0.5	38.1	44.4	2.5	<0.5	<0.5	0.9	228.2	<0.5	<0.5	1.0
5	**DD/ABC/120#NMt**	0.8	<5	34.0	69.5	19.6	<0.5	<0.5	46.4	29.4	2.7	<0.5	0.8	0.8	252.6	<0.5	0.7	0.8
6	**DD/ABC/230#Mt**	0.6	<5	26.0	98.6	37.0	<0.5	<0.5	24.5	31.8	<0.5	<0.5	0.6	0.8	206.2	<0.5	<0.5	0.6
7	**DD/ABC/230#NMt**	<0.5	<5	39.0	67.1	19.6	<0.5	<0.5	32.9	30.5	<0.5	<0.5	1.1	1.6	444.8	<0.5	<0.5	<0.5
8	**DD/ABC/-230#Mt**	0.6	<5	26.0	102.0	36.7	<0.5	<0.5	24.5	32.5	<0.5	<0.5	0.6	0.7	193.0	<0.5	<0.5	0.6
9	**DD/ABC/-230#NMt**	<0.5	<5	34.0	61.7	25.1	<0.5	<0.5	34.9	39.5	23.9	<0.5	0.6	1.5	204.9	<0.5	<0.5	<0.5

Sl. No.	Sample No.	Cs	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
		ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)
1	**DD/ABC/35#Mt**	0.6	22.9	50.3	7.3	32.4	8.1	2.5	10.1	1.4	7.4	1.4	3.7	0.5	3.3	<0.5	7.5	<0.5
2	**DD/ABC/60#Mt**	0.6	23.6	51.2	7.4	33.3	8.2	2.6	10.6	1.4	7.8	1.4	3.9	<0.5	3.5	<0.5	5.2	4.8
3	**DD/ABC/60#NMt**	0.9	18.7	38.2	5.5	24.9	6.0	2.0	8.1	1.1	6.2	1.2	3.0	<0.5	2.9	<0.5	3.7	0.6
4	**DD/ABC/120#Mt**	0.9	27.7	60.3	8.6	36.6	9.4	2.9	11.7	1.6	9.0	1.6	4.5	0.6	4.0	<0.5	3.5	<0.5
5	**DD/ABC/120#NMt**	1.1	15.7	32.9	4.9	21.2	5.3	1.8	7.1	0.9	5.6	1.1	3.0	<0.5	2.9	<0.5	3.0	<0.5
6	**DD/ABC/230#Mt**	0.7	25.3	57.1	6.9	28.4	6.7	2.2	9.2	1.2	6.6	1.3	3.5	<0.5	3.4	<0.5	2.8	<0.5
7	**DD/ABC/230#NMt**	0.9	38.5	76.3	9.6	37.1	7.7	1.7	10.7	1.1	5.9	1.1	3.4	<0.5	3.4	<0.5	8.2	<0.5
8	**DD/ABC/-230#Mt**	0.8	24.1	57.4	6.7	28.8	7.1	2.2	9.7	1.2	6.7	1.2	3.6	<0.5	3.5	<0.5	2.9	<0.5
9	**DD/ABC/-230#NMt**	1.1	96.1	191.3	22.6	83.8	15.4	2.4	22.1	2.1	8.8	1.5	4.0	<0.5	3.5	<0.5	4.0	<0.5

Sl. No.	Sample No.	W	Tl	Bi	Th	U
		ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)	ppm(mg/kg)
1	**DD/ABC/35#Mt**	<0.5	<0.5	<0.5	4.0	0.7
2	**DD/ABC/60#Mt**	5.5	<0.5	<0.5	3.2	0.7
3	**DD/ABC/60#NMt**	6.8	<0.5	<0.5	3.0	0.5
4	**DD/ABC/120#Mt**	<0.5	<0.5	0.6	3.4	1.0
5	**DD/ABC/120#NMt**	<0.5	<0.5	0.6	1.9	0.6
6	**DD/ABC/230#Mt**	<0.5	<0.5	0.5	3.2	1.3
7	**DD/ABC/230#NMt**	<0.5	<0.5	0.6	12.9	1.2
8	**DD/ABC/-230#Mt**	<0.5	<0.5	<0.5	4.1	1.5
9	**DD/ABC/-230#NMt**	8.4	<0.5	<0.5	31.3	2.6

Annexure 14
XRD Analysis result

GOVERNMENT OF INDIA
GEOLOGICAL SURVEY OF INDIA

National Centre of Excellence in Geoscience Research
Mineral Physics Division, 15 A&B Kyd Street, Kolkata

Report of XRD analysis of samples received from: A.C.Dinesh, Chief Technology Officer, GeoMarine Solutions Pvt.Ltd.,15-17-909/9, 5th Cross ShivaBagh, Kadri, Mangalore -575005, Karnataka.

No. of samples: 10 **CHQ Lab. No**. MPHD/COM/16/10

Samples were analysed in PANalytical X'Pert PRO powder diffractometer

Anchor Scan Parameters

Raw Data Origin:	XRD measurement (*.XRDML)
Scan Axis:	Gonio
Start Position [°2Th.]:	4.0054
End Position [°2Th.]:	79.9784
Step Size [°2Th.]:	0.0170
Scan Step Time [s]:	50.8000
Scan Type:	Continuous
PSD Mode:	Scanning
PSD Length [°2Th.]:	2.12
Offset [°2Th.]:	0.0000
Divergence Slit Type:	Fixed
Divergence Slit Size [°]:	0.4354
Specimen Length [mm]:	10.00
Measurement Temperature [°C]:	25.00
Anode Material:	Cu
K-Alpha1 [Å]:	1.54060
Generator Settings:	30 mA, 40 kV
Diffractometer Type:	0000000083041433
Diffractometer Number:	0
Goniometer Radius [mm]:	240.00
Dist. Focus-Diverg. Slit [mm]:	100.00
Incident Beam Monochromator:	No
Spinning:	Yes

Analysed by: Dr. Deepthy R., Mineralogist (Sr.)... Deepthy 13/03/2025

Supervised by: Sri J. Mukherjee, Director (Min.Phy.).....

SL. No.	Sample No.	Mineral Phases detected			Remarks
		Good/Considerable amount	Trace amount	Likely Phases	
1	DD/DO/A/230	Spinel (mainly magnetite type), Pyroxenes (mainly Cpx), Plagioclase	Quartz, Hematite, Clay minerals (Smectite/Kaolinite)	Ilmenite, K feldspar	
2	DD/SW/A/230	Spinel (mainly magnetite type), Pyroxenes (mainly Cpx), Plagioclase	Quartz, Hematite, Clay minerals (Smectite/Kaolinite)	Ilmenite, K feldspar	
3	DD/B/230	Quartz, Plagioclase, Pyroxenes (mainly Cpx), Spinel (mainly magnetite type)	Clay minerals (Smectite/Kaolinite) Hematite, Ilmenite	Amphibole, Dolomite	
4	DD/C/230	Quartz, Plagioclase, Pyroxenes (mainly Cpx)	Clay minerals (Smectite/Kaolinite) Hematite, Ilmenite	Spinel, Amphibole, Calcite, Talc, Zeolite, Dolomite	
5	DD/DO/D	Clinopyroxenes		Hematite	
6	DD/SW/D	Clinopyroxenes	Plagioclase	Hematite	

Analysed by: Dr. Deepthy R., Mineralogist (Sr.)... 13/3/2025

Supervised by: Sri J. Mukherjee, Director (Min.Phy.)..... 13/03/2025

SL. No.	Sample No.	Mineral Phases detected			Remarks
		Good/Considerable amount	Trace amount	Likely Phases	
7	DD/E	Plagioclase, Calcite, Quartz	Zeolite	Pyroxenes, K feldspar	
8	DD/A/60+120	Plagioclase, Pyroxenes (mainly Cpx), Spinel (mainly magnetite type), Quartz	Clay minerals (Smectite/Kaolinite), Hematite	Ilmenite, Zeolite, Amphibole	
9	DD/C/60+120	Plagioclase, Quartz, Pyroxenes (mainly Cpx)	Clay minerals (Smectite/Kaolinite), Spinel, Hematite, Calcite	Zeolite, Ilmenite	
10	DD/-230/Silt	Plagioclase, Quartz, Pyroxenes (mainly Cpx), Spinel (mainly magnetite type)	Clay minerals (Smectite/Kaolinite), Calcite, Amphibole, Mica	Hematite, Ilmenite, Zeolite	

Note:

Spinel minerals such as magnetite, titanomagnetite and magnesioferrite etc. have similar spinel crystal structure and comparable lattice parameters and their X-ray diffraction (XRD) patterns are quite similar making distinction between these types of minerals challenging in polymineralic samples. For more details, analytical method like Electron Probe Micro-Analysis (EPMA) is recommended.

Analysed by: Dr. Deepthy R., Mineralogist (Sr.)... Deepthy 13/03/2025

Supervised by: Sri J. Mukherjee, Director (Min.Phy.)..... 13/03/2025

Annexure 15
EPMA analysis result

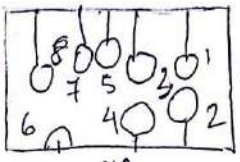
Geo Marine

EPMA Laboratory, GSI, KOLKATA

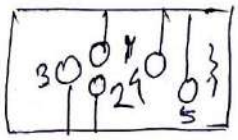
Date:..7/4/25 Slide No(s):..... EPMA no:..... Area:..~~Geovale~~

(561 SxFive ~~Geovale~~)

Sl no.	Mineral	Remarks (561 SxFive GM)	Results	Figure/s
DD/c/60/120 1	Plag	Check polish	C-1	
2.	Fe-hydroxide			
3		"		
BSE-1 4	Fe-hydroxide			
5	Albite			
6	Fe-Ti oxide			
7	cpx			
8	cpx			
BSE-2 9	foram	carbonate		
10	foram	"		
11	~~Amph~~ cpx		C-2	
12	cpx			
BSE-3 13	Fe-hydroxide			
14	Epidote			
BSE-4 ← 15	foram		C-4	
BSE-5 16.	~~Amphibole~~ cpx			
17.	Fe-hydroxide		C-3	
BSE-6 ← 18.	Forum		C-5	
BSE-7 ← 19.	~~Fe-hydroxide~~ Ilmenite			
BSE-8 ← 20.	Forum		C-7	
BSE-9 ← 21.	cpx			
BSE-10 22.	~~Fe-hydroxide~~ Ilmenite		C-6	
23.	carbonate			
DC/c/230 24.	cpx		C-3	
BSE-11 25.	Ti-Fe-hydroxide			
BSE-12 ← 26.	Amphibole		C-2	
BSE-13 ← 27.	cpx			
BSE-14 28.	~~Fe-hydroxide~~ Ilmenite		C-1	
29.				
BSE-15 30.	cpx		C-4	
31.	cpx			
32.	~~Fe-hydroxide~~ Ilmenite			
BSE-16 33.	cpx		C-5	
34.	~~Fe-hydroxide~~ Ilmenite			
35.	Amphibole			



DD/e/60/120



DD/c/230

EPMA Laboratory, GSI, KOLKATA

Date:..... Slide No(s):..... EPMA no:..... Area:.....

Sl no.	Mineral	Remarks	Results	Figure/s
36.	Ilmenite	Bad polish	c-2	
37.	Ilmenite			
38.	Ilmenite.		c-1	
39.	Plagioclase		c-1	
40.	Cpx			
41.	Cpx		c-4	
42.	Ilmenite →	Bad polish.		
43.	Plagioclase		c-3	
44.	Cpx.			
45.	Ilmenite.			
46	cpx		c-1	
47.	~~Ilmenite~~	Fe-Ti-oxide		
48.	Cpx			
49.	~~cpx~~	Fe-Ti oxide/hydroxide	c-2	
50.		"		
51.		"	c-1	
52.		"		
		(561 SXFive P2M1)		
1.	~~Feldspar~~, cpx → BSE25		c-5	
2.	Ilmenite → BSE26			
3.	cpx	BSE27	c-3	
4.	feldspar			
5.	Glaucophane	BSE28	c-4	
6.	Sphene			
7.	Epidote			
8.	cpx → BSE 29		c-6	
9.	Fe-Ti oxide	BSE 30	c-2	
10.	chlorite			
11.	Cpx → BSE 31		c-1	

DD/220/A/Mt
BSE-17
BSE-18

DD/A/60+120
BSE-19

BSE-20

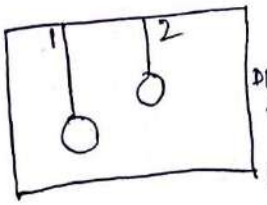
BSE-21

DD/A/230
BSE-22

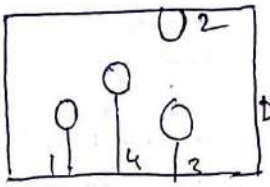
DD/230/A/Mt
BSE-24

BSE-23

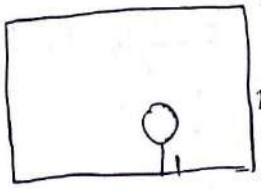
DD/SW/D



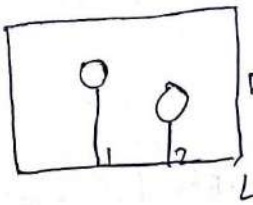
DD/230/A/Mt
Upper



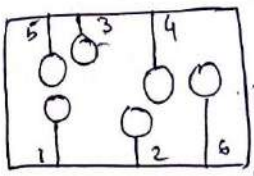
DD/A/60+120
Lower.



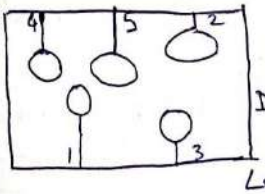
DD/A/230
Upper



DD/230/A/Mt
Lower



DD/SW/D
Upper



DD/B/60+120
Lower

Date:.....

EPMA Laboratory, GSI, KOLKATA

Slide No(s):..... EPMA no:..... Area:.....

DD/B/60+120

Sl no.	Mineral	Remarks	Results	Figure/s
12.	Ilmenite	~~BSE 32~~	C-3	
13.	Cpx			
14.	Sphene	→ BSE 33	C-1	
15.	Ilmenite	~~BSE 34~~	C-4	
16.	Cpx			
17.	Amph	(Bad Polish) → BSE 35	C-5	
18.	Fe hydroxide.	→ BSE 36	C-2	

EPMA Laboratory, GSI, KOLKATA

Date: 23/4/25 Slide No(s):..... EPMA no:..... Area: GeoMarine

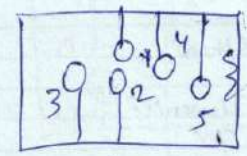
(561 SXFive (M2)

Sl no.	Mineral	Remarks	Results	Figure/s
1.	Fe-Ti oxide			
2.	Fe-hydroxide → BSE-38			
3.	ilmenite → BSE-37			
4.	Fe-Ti oxide	within Rock fragments → BSE-39		
5.	"	BSE-40		
6.	"			
7.	Fe-oxide			
8.	Fe-Ti oxide.			
9.	Fe-Ti " ~~or~~ altered			
10.	Fe-Ti oxide			
11.	Fe-Ti oxide altered.			

DD/C/234

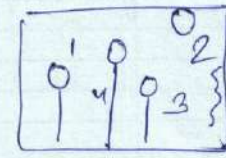
DD/A/60+120

BSE-41



DD/C/230

Lr.



DD/A/60+1

up

	Oxide (Det.Lim ppm(A)								
	Na2O	**SiO2**	**Al2O3**	**MgO**	**P2O5**	**K2O**	**CaO**	**TiO2**	**FeO**
1 / 1 .	0.24	49.58	3.02	15.32	0.18	0	20.8	0.92	7.2
2 / 1 .	0.06	0.2	0.2	1.43	0	0.02	0.04	33.6	56.48
3 / 1 .	0.21	50.44	3.17	16.05	0.19	0.01	21.2	0.76	6.14
4 / 1 .	3.02	65.21	16.94	0.29	0.05	10.29	0.26	0.07	1.6
5 / 1 .	0.01	53	3.28	5.36	0.04	9.18	0.11	0.04	22.17
6 / 1 .	0	33.25	3.94	0.35	0.3	0.05	26.11	26.79	5.04
7 / 1 .	0.09	42.18	20.31	0.32	0.28	0.01	24.95	0.08	4.83
8 / 1 .	0.25	50.28	2.67	15.62	0.13	0.01	19.42	0.96	8.94
9 / 1 .	0.08	0.14	0.41	0.8	0.02	0	0.12	37.39	54.29
10 / 1 .	0	20.64	13.07	1.64	0.32	0.27	0.52	0.04	51.35
11 / 1 .	0.18	50.67	2.01	16.47	0.18	0	19.23	0.67	8.62
12 / 1 .	0	0.07	0.08	0.91	0.06	0.04	0.12	49.85	48.31
13 / 1 .	0.23	49.69	1.94	12.97	0.12	0.03	17.1	1.28	16.41
14 / 1 .	0.05	31.38	5.8	0.36	0.34	0.06	27.57	28.1	3.01
15 / 1 .	0.05	0	0.1	1.38	0	0.01	0.17	50.36	47.22
16 / 1 .	0.19	49.08	1.21	13.46	0.13	0.01	17.85	0.96	14.21
17 / 1 .	0.42	36.22	11.68	6.8	0.47	1.19	10.67	1.96	23.65
18 / 1 .	0.08	2.76	0.24	0.18	0	0.05	0.54	5.01	80.51

	Oxide (Det.Lim ppm(A)									
	Cr2O3	**MnO**	**NiO**	**ZnO**	**BaO**	**Total**	**Na**	**Si**	**Al**	**Mg**
1 / 1 .	**0.52**	0.13	0	0.31	0	98.23	716	690	494	543
2 / 1 .	**0.02**	0.05	0.01	0.18	0.22	92.51	1026	512	607	731
3 / 1 .	**0.68**	0.08	0.03	0.02	0	98.98	885	742	532	537
4 / 1 .	**0.03**	0.04	0.03	0	0.09	97.91	817	765	592	474
5 / 1 .	**0**	0	0.02	0	0	93.21	841	704	541	685
6 / 1 .	**0**	0.03	0.04	0.05	0.24	96.19		626	559	615
7 / 1 .	**0**	0.01	0	0	0	93.05	738	687	632	563
8 / 1 .	**0.26**	0.16	0	0	0	98.7	757	710	512	545
9 / 1 .	**0**	0.26	0	0.09	0.25	93.84	1133	558	515	604
10 / 1 .	**0.04**	0	0	0	0.01	87.89		612	619	720
11 / 1 .	**0.43**	0.24	0	0	0	98.7	789	723	462	551
12 / 1 .	**0.06**	0.57	0.07	0.03	0.28	100.45		578	590	731
13 / 1 .	**0**	0.28	0	0.17	0	100.23	836	749	463	671
14 / 1 .	**0**	0.12	0.02	0.32	0.12	97.22	763	686	579	602
15 / 1 .	**0.01**	0.53	0	0	0.15	99.97	1019	643	575	817
16 / 1 .	**0.22**	0.22	0	0.17	0	97.72	826	735	489	617
17 / 1 .	**0**	0.24	0	0.08	0.01	93.4	930	738	591	487
18 / 1 .	**0.1**	0.98	0	0.57	0	91.01	1321	685	630	894

	Oxide Det.Lim ppm(A)									
	P	**K**	**Ca**	**Ti**	**Fe**	**Cr**	**Mn**	**Ni**	**Zn**	**Ba**
1 / 1 .	624		543	440	1363	962	1688		5552	
2 / 1 .		368	370	606	2523	988	2684	1650	6541	1964
3 / 1 .	598	324	568	394	1333	940	2223	1431	6387	1338
4 / 1 .	570	508	392	424	1161	778	2173	1302		1404
5 / 1 .	612	524	436	439	1737			1465		
6 / 1 .	669	364	617	566	1380		2274	1424	6154	1923
7 / 1 .	590	345	580	425	1314		2433			
8 / 1 .	699	321	537	409	1408	993	2436			
9 / 1 .	632		337	559	2245		2708		5986	1925
10 / 1 .	714	395	382	429	2362	959				1347
11 / 1 .	603		550	434	1271	824	2096			
12 / 1 .	678	347	363	664	2351	950	2091	1585	7453	2235
13 / 1 .	680	358	571	450	1621	1008	2390		4959	
14 / 1 .	593	305	618	563	1325		1993	1424	5430	2024
15 / 1 .		366	336	639	2266	1033	2330			2307
16 / 1 .	655	343	545	447	1689	944	2750		4968	1424
17 / 1 .	669	407	500	464	1854		2218		6175	1489
18 / 1 .		384	406	464	2759	803	1956		6831	

	Oxide Det.Lim ppm(A)								
	Na2O	**SiO2**	**Al2O3**	**MgO**	**P2O5**	**K2O**	**CaO**	**TiO2**	**FeO**
1 / 1 .	6.81	67.77	19.76	0.22	0.22	2.27	1.17	0.05	1.92
2 / 1 .	0.06	18.61	11.99	1.74	0.26	1.48	0.34	0.6	50.87
3 / 1 .	0.07	46.86	16.26	4.22	0.2	5.79	0.35	0.21	20.2
4 / 1 .	0.03	3.41	7.62	0.74	1.74	0.03	0.31	0.12	66.04
5 / 1 .	11.05	65.79	18.96	0.04	0.02	0.03	0.79	0	0.35
6 / 1 .	0.11	0.42	0.88	0.41	0	0.01	0.44	7.29	80.8
7 / 1 .	0.28	50.63	2.04	15.01	0.18	0.01	18.1	1.16	12.23
8 / 1 .	0.19	50.35	2.4	15.54	0.15	0	19.23	0.98	9.48
9 / 1 .	0.03	0.04	0.03	0.16	0.59	0	63.19	0	0.08
10 / 1 .	0.1	0	0	0.14	0.39	0	58.52	0	0.09
11 / 1 .	0.32	49.79	1.98	14.18	0.15	0.01	18.93	1	11.88
12 / 1 .	0.25	50.92	1.39	13.47	0.26	0	18.12	0.9	14.52
13 / 1 .	0.04	30.35	8.67	0.81	0.58	0.38	0.38	0.34	42.17
14 / 1 .	0.04	42.3	18.53	0.05	0.16	0	26.32	0.08	6.92
15 / 1 .	0.14	0.13	0.09	2.24	0.48	0.01	58.78	0.01	0.15
16 / 1 .	0.21	52.45	1.34	18.24	0.14	0.01	14.98	0.68	12.11
17 / 1 .	0.02	0.18	1.96	0.46	0	0	0.45	6.4	75.93
18 / 1 .	0.05	0.05	0.01	0.09	0.47	0	58.99	0.01	0
19 / 1 .	0	0.06	0	0.64	0	0	0	50.58	48.46
20 / 1 .	0.04	1.55	0.78	3.4	0.54	0.12	50.08	0	3.35
21 / 1 .	0.23	50.59	2.98	16.19	0.15	0	20.17	0.86	7.39
22 / 1 .	0.08	0.05	0.24	1.11	0	0	0.28	49.23	47.87
23 / 1 .	0.03	0.01	0	0.96	0.54	0.02	60.92	0	0.06
24 / 1 .	0.31	48.15	2.66	15.2	0.08	0	18.89	0.93	8.96
25 / 1 .	0.07	0.05	0.11	3.01	0	0	0	19.56	65.47
26 / 1 .	0.18	49.11	1.57	13.64	0.04	0	13.64	0.93	19.04
27 / 1 .	0.27	50.97	2.32	15.82	0.17	0	21.01	0.88	7.4
28 / 1 .	0.03	0	0	0.65	0.02	0.01	0.03	51.12	48.13

29 / 1 .	0.83	46.02	24.91	0.11	0.08	0.29	12.62	0.02	0.49	
30 / 1 .	0.36	49.24	2.79	15.22	0.1	0.02	19.04	0.88	8.45	
31 / 1 .	0.25	48.8	5.87	14.78	0.22	0	19.14	1.56	9.52	
32 / 1 .	0.09	0.13	0.45	0.63	0	0.03	0.05	51.19	47.6	
33 / 1 .	0.28	48.51	2.83	14.57	0.14	0	18.21	1.39	11.95	
34 / 1 .	0.04	0.1	0.27	0.75	0.02	0.01	0.03	50.56	46.3	
35 / 1 .	0.21	46.21	0.99	11.74	0.08	0.01	12.8	0.81	21.09	
36 / 1 .	0.08	0.73	1.59	0.13	0	0	0.28	11.18	77.31	
37 / 1 .	0	1.54	0.63	0.05	0	0.02	1.46	28.33	61.08	
38 / 1 .	0.07	0.25	1.5	0.07	0	0.01	0.1	25.63	65.04	
39 / 1 .	3.53	51.16	29.67	0.2	0.14	0.22	13.95	0.11	0.98	
40 / 1 .	0.21	51.57	1.8	16.31	0.21	0.01	20.26	0.64	8.31	
41 / 1 .	0.18	52.29	1.76	17.39	0.15	0.01	18.33	0.76	9.06	
42 / 1 .	0.08	0.03	1.1	0.3	0	0.01	0.03	21.67	68.36	
43 / 1 .	3.66	51.33	29.37	0.14	0.18	0.16	13.84	0.1	0.54	
44 / 1 .	0.17	49.98	2.69	12.78	0.07	0.04	17.14	1.31	15.26	
45 / 1 .	0.04	0.15	0.18	1.76	0.03	0.02	0.27	51.12	44.18	
46 / 1 .	0.27	50.04	2.09	13.89	0.25	0	17.61	1.35	14.25	
47 / 1 .	0.08	0.27	1.7	1.06	0	0	0.11	20.96	63.86	
48 / 1 .	0.19	50.02	2.06	14.5	0.15	0	17.6	1.4	14.63	
49 / 1 .	0.04	0.07	0.7	0.22	0.03	0	0.07	25.91	63.65	
50 / 1 .	0.13	2.8	0.95	0.11	0	0.02	1.86	19.63	54.14	
51 / 1 .	0.24	0.29	0.44	0.09	0	0.03	0.14	13.41	71.41	
52 / 1 .	0.01	0.5	0.8	0.35	0	0	0.06	15.35	75.78	

	Oxide Det.Lim ppm(A)									
	Cr2O3	**MnO**	**NiO**	**ZnO**	**BaO**	**Total**	**Na**	**Si**	**Al**	**Mg**
1 / 1 .	0.05	0.14	0	0.04	0	100.43	803	765	605	555
2 / 1 .	0.06	0.23	0.03	0	0.03	86.29	1026	649	621	619
3 / 1 .	0	0.1	0	0	0.05	94.32	818	732	601	499
4 / 1 .	0.1	0.15	0	0.17	0.04	80.52	1257	564	616	787
5 / 1 .	0.2	0.08	0	0	0	97.32	893	777	573	474
6 / 1 .	0.01	0.41	0	0.01	0	90.78	1185	589	607	767
7 / 1 .	0.05	0.39	0.04	0	0.1	100.23	765	655	567	654
8 / 1 .	0.25	0.3	0	0.04	0.01	98.91	906	685	504	605
9 / 1 .	0.01	0.21	0.01	0	0	64.35	944	431	421	674
10 / 1 .	0	0.01	0.04	0.03	0	59.34	964			566
11 / 1 .	0.11	0.2	0	0	0	98.56	672	758	578	581
12 / 1 .	0.05	0.27	0	0.38	0.02	100.54	759	795	466	665
13 / 1 .	0.28	0.49	0	0.32	0.05	84.85	1084	735	628	666
14 / 1 .	0.02	0	0.05	0	0	94.47	776	660	623	612
15 / 1 .	0.02	0.65	0	0	0	62.7	725	448	454	674
16 / 1 .	0.1	0.37	0.01	0.11	0	100.74	663	757	518	699
17 / 1 .	0.07	0.36	0	0.47	0	86.3	1348	646	618	724
18 / 1 .	0.04	0.09	0.02	0	0.03	59.84	900	460	466	555
19 / 1 .	0.04	0.5	0	0.12	0.29	100.69		527		658
20 / 1 .	0.07	0.3	0	0	0	60.23	812	445	447	629
21 / 1 .	0.81	0.18	0.03	0.03	0	99.6	739	742	522	566
22 / 1 .	0	0.43	0	0.05	0.12	99.46	1144	547	547	764
23 / 1 .	0.04	0.06	0.02	0.23	0	62.89	755	476		614
24 / 1 .	0.86	0.09	0	0.22	0	96.34	793	725	470	539
25 / 1 .	0.09	0.58	0.05	0	0	89.01	1197	585	651	891
26 / 1 .	0	0.41	0	0.2	0	98.76	756	700	474	584
27 / 1 .	0.12	0.05	0	0	0	99.01	738	731	565	622

28 / 1 .	0	0.4	0	0	0.4	100.8	1145		614	589
29 / 1 .	0.01	0	0.02	0	0	85.39	793	725	585	528
30 / 1 .	0.7	0.1	0	0	0.03	96.93	767	687	537	628
31 / 1 .	0.08	0.19	0	0	0	100.41	748	682	547	571
32 / 1 .	0.06	0.73	0	0	0.16	101.1	1142	527	637	751
33 / 1 .	0.38	0.37	0	0	0	98.64	869	691	576	663
34 / 1 .	0.04	0.34	0	0	0.34	98.8	1169	534	517	773
35 / 1 .	0	0.49	0	0	0	94.42	973	722	532	535
36 / 1 .	0.04	0.23	0	0.21	0	91.79	1102	671	624	695
37 / 1 .	0.03	2.07	0.03	0.27	0.12	95.64		602	560	730
38 / 1 .	0.09	0.42	0.05	0	0.15	93.37	1118	530	560	683
39 / 1 .	0	0	0	0.32	0	100.27	925	676	636	352
40 / 1 .	0.18	0.07	0.06	0	0	99.61	698	690	504	542
41 / 1 .	0.36	0.33	0	0	0	100.64	755	687	532	558
42 / 1 .	0.1	0.08	0.04	0.3	0.18	92.29	1191	591	493	577
43 / 1 .	0	0.09	0	0	0	99.4	833	648	558	493
44 / 1 .	0.12	0.35	0	0	0	99.89	759	662	499	595
45 / 1 .	0.01	0.5	0	0	0.33	98.59	1086	561	552	661
46 / 1 .	0.01	0.23	0	0	0	99.97	755	699	497	596
47 / 1 .	0.51	0.24	0	0.1	0.13	89.02	898	615	698	809
48 / 1 .	0	0.23	0.06	0	0	100.85	976	702	538	578
49 / 1 .	0	0	0.01	0	0.13	90.84	1125	649	551	967
50 / 1 .	0.12	0.07	0.03	0.03	0.13	80.02	1204	611	643	658
51 / 1 .	0.05	0.43	0	0.4	0.07	87	1392	449	315	594
52 / 1 .	0.01	0.35	0	0	0.04	93.24	1386	685	637	804

	Oxide Det.Lim ppm(A)									
	P	**K**	**Ca**	**Ti**	**Fe**	**Cr**	**Mn**	**Ni**	**Zn**	**Ba**
1 / 1 .	639	397	340	398	962	948	1255		4766	
2 / 1 .	701	381	384	419	2152	855	1812	1487		1401
3 / 1 .	664	499	389	415	1673		2232			1252
4 / 1 .	715	374	366	383	2550	806	2089		6173	1293
5 / 1 .	625	334	340		1143	701	1868			
6 / 1 .		395	390	481	2625	900	2886		8242	
7 / 1 .	604	344	569	454	1556	935	2405	1517		1330
8 / 1 .	662		562	401	1413	1029	1838		5807	1343
9 / 1 .	491		880		1163	1002	1473	1281		
10 / 1 .	581		833	431	1217		1847	1335	6097	
11 / 1 .	681	331	583	426	1655	875	2406			
12 / 1 .	539	340	571	451	1615	928	1980		4963	1402
13 / 1 .	664	364	366	417	2042	862	2112		4773	1292
14 / 1 .	703		634	381	1247	920		1229		
15 / 1 .	575	292	851	400	1309	1001	2008			
16 / 1 .	642	341	518	376	1372	1033	2277	1549	6053	
17 / 1 .		398	383	451	2683	818	2373		7163	
18 / 1 .	536	280	847	408		857	1848	1396		1339
19 / 1 .				659	2371	995	2821		6563	2280
20 / 1 .	598	321	797	440	1160	735	2411			
21 / 1 .	637		590	400	1498	1064	1844	1533	6535	
22 / 1 .			344	653	2333		2210		6938	2368

23 / 1 .	507	287	848	421	1140	891	2008	1302	6322	
24 / 1 .	707		524	418	1415	898	2541		4993	
25 / 1 .			396	535	2563	955	2441	1630		
26 / 1 .	695		445	457	1856		2110		5998	
27 / 1 .	658		578	433	1381	1117	2670			
28 / 1 .	626	367	343	657	2329		2634			2219
29 / 1 .	639	311	501	400	1054	922		1302		
30 / 1 .	679	372	585	431	1360	1060	2290			1364
31 / 1 .	614	345	562	409	1440	973	2146			
32 / 1 .		332	384	683	2279	928	2538			2349
33 / 1 .	672		577	441	1488	1060	1654			
34 / 1 .	630	344	341	660	2179	1054	2539			2256
35 / 1 .	711	348	493	418	1753		2099			
36 / 1 .			374	472	2489	887	2520		7159	
37 / 1 .		338	363	532	2300	970	2174	1570	6308	1872
38 / 1 .		370	370	526	2422	910	2504	1405		1791
39 / 1 .	559	349	489	360	1008				4885	
40 / 1 .	550	313	549	381	1339	947	2545	1303		
41 / 1 .	625	326	515	401	1371	1006	2331	1499		
42 / 1 .		357	363	502	2440	877	2791	1532	5779	1631
43 / 1 .	590	347	490	372	1166		1857			
44 / 1 .	691	295	519	404	1458	986	2192			
45 / 1 .	636	351	339	629	2100	1027	2760			2150
46 / 1 .	625		557	430	1502	973	2268			
47 / 1 .			393	519	2656	903	2544		7219	1784
48 / 1 .	647	358	554	423	1640		2959	1425		
49 / 1 .	633		379	553	2619	1172	2988	1590		1902
50 / 1 .		333	373	501	2342	819	3003	1420	7578	1621
51 / 1 .	724	356	373	468	2621	937	2201		6649	1654
52 / 1 .			394	498	2598	996	2767			1754

	Oxide Det.Lim ppm(A)								
	Na2O	**SiO2**	**Al2O3**	**MgO**	**P2O5**	**K2O**	**CaO**	**TiO2**	**FeO**
1 / 1 .	0.08	0.02	0.08	2.98	0	0.01	0.02	17.84	71.8
2 / 1 .	0	5.28	1.46	0.21	0	0.38	0.41	1.34	83.06
3 / 1 .	0	0.03	0.07	0.62	0	0	0	50.82	48.21
4 / 1 .	0.05	0.22	1.41	0.31	0	0.01	0.14	27.54	58.2
5 / 1 .	0.13	0.07	2.1	0	0	0	0.13	23.59	62.89
6 / 1 .	0.08	0.3	1.94	0.04	0	0	0.04	27.59	61.25
7 / 1 .	0	0.79	0.33	0	0	0.03	0.27	0.22	87.79
8 / 1 .	0	0.5	1.1	0.51	0	0.01	0.09	27.15	65.86
9 / 1 .	0	4.48	1.51	0.5	0	0.02	2.72	44.64	42.58
10 / 1 .	0	0.42	0.26	0.48	0.04	0.02	0.23	49.2	43.22
11 / 1 .	0.14	2.31	0.84	0	0.14	0	0.33	13.38	72.39

	Oxide Det.Lim ppm(A)									
	Cr2O3	**MnO**	**NiO**	**ZnO**	**V2O3**	**Total**	**Na**	**Si**	**Al**	**Mg**
1 / 1 .	0.09	0.53	0	0	0.26	93.7	915	648	643	690
2 / 1 .	0.02	0.18	0.03	0	0.25	92.62		686	679	827
3 / 1 .	0.04	0.4	0.04	0	0.26	100.49		548	555	618
4 / 1 .	0.15	0.46	0	0.33	0.6	89.41	1149	601	618	740
5 / 1 .	0.15	3.54	0	1.31	1.01	94.91	810	642	645	
6 / 1 .	0.09	1.99	0	0.12	0.97	94.41	1117	605	688	740
7 / 1 .	0.05	0.07	0	0	0.01	89.56		678	704	876
8 / 1 .	0.17	0.31	0	0.33	0.55	96.58		538	605	758
9 / 1 .	0.08	0.15	0.04	0.13	0.86	97.7		560	633	738
10 / 1 .	0.26	1.26	0.02	0.06	0.08	95.56		487	499	601
11 / 1 .	0.23	0.54	0	0.64	0.67	91.6	1009	697	745	908

	Oxide Det.Lim ppm(A)									
	P	**K**	**Ca**	**Ti**	**Fe**	**Cr**	**Mn**	**Ni**	**Zn**	**V**
1 / 1 .		371	367	518	2771	905	2334			216
2 / 1 .		364	389	438	2732	899	1836	1646		440
3 / 1 .				668	2322	1009	2830	1611		115
4 / 1 .		374	405	546	2315	971	2159	1611	6346	282
5 / 1 .			377	544	2493	892	2459		5504	373
6 / 1 .			378	543	2559	1055	2843		7407	342
7 / 1 .		398	383	439	2744	796	2233			298
8 / 1 .		370	393	556	2546	971	2260		7236	277
9 / 1 .		358	395	634	2228	1076	2460	1548	7853	282
10 / 1 .	655	343	348	635	2200	1037	1973	1488	6398	42
11 / 1 .	652	413	375	515	2491	881	1995		8002	357

Annexure 16
Check sample results

Annexure 16. XRF analysis of Check samples

Sl. No.	Sample No.	Bore hole	Depth from (m)	Depth To (m)	Fraction	Al_2O_3	BaO	CaO	Cr_2O_3	Fe_2O_3	K_2O	MgO	MnO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	V_2O_5	LOI
						%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
1	**DD03/0-1/230**	**DD03**	0	1	ABC230	6.55	<0.05	6.10	0.09	23.67	0.74	5.46	0.32	0.79	0.16	40.89	<0.05	8.78	0.18	5.98
2	**DD05/0-1/230**	**DD05**	0	1	ABC230	6.08	<0.05	5.46	0.10	27.13	0.73	5.33	0.37	0.80	0.17	36.88	<0.05	11.84	0.23	4.64
3	**DD05/1-2/230**	**DD05**	1	2	ABC230	4.92	<0.05	5.70	0.16	29.20	0.56	4.36	0.39	0.66	0.13	32.81	<0.05	16.95	0.28	3.64
4	**DD07/0-1/230**	**DD07**	0	1	ABC230	5.77	<0.05	6.34	0.11	29.23	0.58	5.55	0.40	0.67	0.15	32.28	<0.05	13.56	0.26	4.74
5	**DD07/1-2/230**	**DD07**	1	2	ABC230	4.33	0.05	5.46	0.12	33.29	0.54	4.82	0.45	0.58	0.14	28.86	<0.05	17.37	0.32	3.45
6	**DD09/0-1/230**	**DD09**	0	1	ABC230	4.31	0.05	5.98	0.12	32.31	0.56	5.00	0.44	0.56	0.14	30.91	<0.05	15.80	0.32	3.32
7	**DD09/1-2/230**	**DD09**	1	2	ABC230	4.90	<0.05	6.71	0.11	28.29	0.68	5.53	0.39	0.73	0.16	34.69	<0.05	12.37	0.24	4.90
8	**DD11/0-1/230**	**DD11**	0	1	ABC230	4.74	0.05	4.98	0.10	34.59	0.60	5.02	0.46	0.59	0.16	27.47	<0.05	16.74	0.33	3.90
9	**DD11/3-4/230**	**DD11**	3	4	ABC230	5.01	<0.05	6.05	0.10	31.16	0.58	5.34	0.42	0.62	0.15	30.42	<0.05	15.06	0.29	4.51
10	**DD17/1-2/230**	**DD17**	1	2	ABC230	3.62	0.06	5.78	0.16	34.31	0.47	5.06	0.46	0.48	0.14	27.63	<0.05	18.35	0.35	2.95
11	**DD19/0-1/230**	**DD19**	0	1	ABC230	3.41	0.07	5.87	0.17	35.75	0.45	4.73	0.48	0.47	0.13	25.44	<0.05	19.41	0.36	3.08
12	**DD19/1-2/230**	**DD19**	1	2	ABC230	3.29	0.05	5.94	0.16	33.30	0.55	4.52	0.45	0.55	0.13	29.19	<0.05	17.65	0.33	3.69
13	**DD23/1-2/230**	**DD23**	1	2	ABC230	4.36	0.06	5.84	0.17	29.94	0.57	4.36	0.40	0.66	0.14	33.04	<0.05	17.87	0.28	2.00
14	**DD37/2-3/230**	**DD37**	2	3	ABC230	7.12	<0.05	5.06	0.07	22.94	0.94	5.43	0.29	0.99	0.17	42.88	<0.05	6.92	0.15	6.77

Annexure 17
Borehole log sheet

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-01
Azimuth	----------
Inclination	Vertical
RL-Collar	3.217 m MSL
Total depth of BH	4.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2312581.927N
Longitude (E)	270379.009E
Date of Commencement	10/11/2024
Date of Completion	10/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark colored sand with presence of Heavy Mineral (HM).	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine to medium grained, dark colored sand with presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine to medium grained, dark colored sand with presence of HM	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine to medium-grained sand extends up to 3.5 meters, with thick clay sediments beyond this depth, where penetration becomes difficult.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-02
Azimuth	----------
Inclination	Vertical
RL-Collar	3.035 m MSL
Total depth of BH	4.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2312249.864N
Longitude (E)	270506.068E
Date of Commencement	10/11/2024
Date of Completion	10/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark colored sand with presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, dark colored sand with presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Medium grained, dark colored sand with few granules.HM is present.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Thick black clayey sand in which penetration is difficult beyond this depth.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-03
Azimuth	----------
Inclination	Vertical
RL-Collar	6.656 m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2310467.973N
Longitude (E)	271178.537E
Date of Commencement	1/10/2024
Date of Completion	1/10/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained black colored sand with presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained black colored sand with presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained black colored sand with presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained black colored sand with presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained black colored sand with presence of HM.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-04
Azimuth	----------
Inclination	Vertical
RL-Collar	5.434 m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2310059.349N
Longitude (E)	271354.91E
Date of Commencement	1/10/2024
Date of Completion	1/10/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand in which the presence of HM is expected.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine to medium grained, black colored sand in which the presence of HM is expected. Shell fragments are present.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Medium grained, black colored sand. Shell fragments are present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-05
Azimuth	----------
Inclination	Vertical
RL-Collar	6.681m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2309713.685N
Longitude (E)	271481.676E
Date of Commencement	1/10/2024
Date of Completion	1/10/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with presence of HM is expected.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with presence of HM is expected.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine to medium grained, black colored sand with the presence of HM.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-06
Azimuth	----------
Inclination	Vertical
RL-Collar	5.549m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2309331.561N
Longitude (E)	271642.506E
Date of Commencement	5/10/2024
Date of Completion	5/10/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Very fine to fine grained sand. A thick band of dark colored clay is present at the end. Water table is encountered.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-07
Azimuth	----------
Inclination	Vertical
RL-Collar	5.797m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2308972.605N
Longitude (E)	271795.436E
Date of Commencement	2/10/2024
Date of Completion	2/10/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained dark colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine to silty clay is present. Clay patch is encountered at a depth of 4.85m.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-08
Azimuth	----------
Inclination	Vertical
RL-Collar	3.718m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2308558.037N
Longitude (E)	271944.1E
Date of Commencement	9/11/2024
Date of Completion	9/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark coloured sand with the presence of HM. Clayey sand is present at the bottom. Clayey sand of 10-15cm thickness is recovered.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, dark coloured sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, dark coloured sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM. Clayey sand is present at the bottom. Clayey sand of 10-15cm thickness is recovered.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained sand with clayey patch.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-09
Azimuth	----------
Inclination	Vertical
RL-Collar	4.205m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2308181.399N
Longitude (E)	272112.388E
Date of Commencement	9/11/2024
Date of Completion	9/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine to medium grained, dark colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Medium grained, dark colored sand with the presence of HM. Thick black clay is present at the bottom.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-10
Azimuth	----------
Inclination	Vertical
RL-Collar	6.17m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2307834.342N
Longitude (E)	272249.399E
Date of Commencement	25/09/2024
Date of Completion	25/09/2024

S.No	Bore Hole Log Details (Runwise)									Core details
	From (m)	To (m)	Length (m)	Recovered Length (m)	True Length (m)	Recovery %	RQD	Litho Code	Lithological description	Box No
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM. Shell fragments present.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine to medium grained, black colored sand with HM presence. Penetration is difficult between 4.8 to 4.9 m.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-11
Azimuth	----------
Inclination	Vertical
RL-Collar	4.954 m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2307467.925N
Longitude (E)	272394.81E
Date of Commencement	26/09/2024
Date of Completion	26/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery (%)**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Black colored, poorly sorted sand with the presence of HM. Penetration is difficult between 4.5 to 4.6m. Shell fragments are present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-12
Azimuth	----------
Inclination	Vertical
RL-Collar	5.072 m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2307072.163N
Longitude (E)	272514.998E
Date of Commencement	24/09/2024
Date of Completion	25/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained, black colored sand with micaceous content. Watertable is encountered at 5m	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-13
Azimuth	----------
Inclination	Vertical
RL-Collar	5.085 m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2306722.174N
Longitude (E)	272673.359E
Date of Commencement	24/09/2024
Date of Completion	24/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Medium to coarse grained, black colored sand with granules/gravels. Sediments are well rounded and poorly sorted. Water table is encountered.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-14
Azimuth	----------
Inclination	Vertical
RL-Collar	4.6m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2306313.321N
Longitude (E)	272822.396E
Date of Commencement	23/09/2024
Date of Completion	23/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100.00	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100.00	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100.00	NA	SAND	Fine grained sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100.00	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100.00	NA	SAND	Fine to medium grained sand with gravel. A thick band of black clay of 5 to 10 cm thickness is present. Water table is encountered.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-15
Azimuth	----------
Inclination	Vertical
RL-Collar	5.788m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2305906.02N
Longitude (E)	272941.412E
Date of Commencement	23/09/2024
Date of Completion	23/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-16
Azimuth	----------
Inclination	Vertical
RL-Collar	6.144m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2305545.473N
Longitude (E)	273084.084E
Date of Commencement	22/09/2024
Date of Completion	23/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM. Penetration is difficult.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-17
Azimuth	----------
Inclination	Vertical
RL-Collar	5.43m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Dandi
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2305152.066N
Longitude (E)	273261.054E
Date of Commencement	22/09/2024
Date of Completion	22/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained sand with the presence of HM. A small patch of black thick clay having thickness of 5-10cm is encountered at a depth of 3.3m.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine sand with presence of HM. Watertable is encountered and penetration become hard.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-18
Azimuth	----------
Inclination	Vertical
RL-Collar	6.199m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Onjal
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2304792.477N
Longitude (E)	273380.363E
Date of Commencement	21/09/2024
Date of Completion	21/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-19
Azimuth	----------
Inclination	Vertical
RL-Collar	5.555m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Onjal
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2304450.275N
Longitude (E)	273530.067E
Date of Commencement	21/09/2024
Date of Completion	21/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Very fine to fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained sand with presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained clayey sand with black color.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-20
Azimuth	----------
Inclination	Vertical
RL-Collar	4.882m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Onjal
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303998.444N
Longitude (E)	273694.465E
Date of Commencement	27/09/2024
Date of Completion	27/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained sand with presence of HM. Water-table is encountered at 4.5m.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-21
Azimuth	----------
Inclination	Vertical
RL-Collar	1.202m MSL
Total depth of BH	2.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Onjal
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2304124.464N
Longitude (E)	273785.449E
Date of Commencement	7/11/2024
Date of Completion	7/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Very fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Thick silty clay of black color having few sand grains. Water table is encountered at 1.0m	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-22
Azimuth	----------
Inclination	Vertical
RL-Collar	1.717m MSL
Total depth of BH	2.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Onjal
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2304131.509N
Longitude (E)	274181.968E
Date of Commencement	7/11/2024
Date of Completion	7/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100.00	NA	SAND	Fine grained, black colored sand with the presence of HM. Few granules/ pebbles are present at the bottom.	1
2	1.00	2.00	1.00	1.00	2.00	100.00	NA	SAND	Coarse to very coarse-grained sand grains and gravels present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-23
Azimuth	----------
Inclination	Vertical
RL-Collar	7.556 m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Onjal
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303704.591N
Longitude (E)	273758.982E
Date of Commencement	27/09/2024
Date of Completion	27/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-24
Azimuth	----------
Inclination	Vertical
RL-Collar	1.745m MSL
Total depth of BH	3.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303721.508N
Longitude (E)	274085.338E
Date of Commencement	11/11/2024
Date of Completion	11/11/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Medium grained, dark colored sand with the presence of HM till 2.6m, beyond which thick black clay is present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-25
Azimuth	----------
Inclination	Vertical
RL-Collar	0.956m MSL
Total depth of BH	2.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303836.545N
Longitude (E)	274270.571E
Date of Commencement	11-11-2024
Date of Completion	11-11-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark colored sand with the presence of humus. HM may present. Thick clay bed is present at the bottom.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained sand with the presence of thick clay bed. Penetration is difficult beyond this depth.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-26
Azimuth	----------
Inclination	Vertical
RL-Collar	2.865m MSL
Total depth of BH	2.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303898.554N
Longitude (E)	274435.548E
Date of Commencement	28/09/2024
Date of Completion	28/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained clayey sand with humus up to 0.5m, beyond which medium to coarse grained sand with HM is present.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Medium to coarse grained sand. Shell fragments are present. Water table is encountered.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-27
Azimuth	----------
Inclination	Vertical
RL-Collar	7.085m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303312.95N
Longitude (E)	273965.808E
Date of Commencement	28/09/2024
Date of Completion	28/09/2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-28
Azimuth	----------
Inclination	Vertical
RL-Collar	1.775m MSL
Total depth of BH	1.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303381.5N
Longitude (E)	274162.849E
Date of Commencement	8-11-2024
Date of Completion	8-11-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1	1.00	100.00	NA	SAND	Fine grained, black colored sand is present up to 0.5m depth, beyond which thick layer of clay is present between 0.5 to 1m.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-29
Azimuth	----------
Inclination	Vertical
RL-Collar	0.704m MSL
Total depth of BH	2.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303451.097N
Longitude (E)	274318.071E
Date of Commencement	8-11-2024
Date of Completion	8-11-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark coloured sand with humus.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained sand with thick clay present at bottom.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-30
Azimuth	----------
Inclination	Vertical
RL-Collar	1.499m MSL
Total depth of BH	3.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303623.61N
Longitude (E)	274567.375E
Date of Commencement	8-11-2024
Date of Completion	8-11-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black coloured sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Medium to coarse grained sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Coarse grained sand with thick clay present at bottom.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-31
Azimuth	----------
Inclination	Vertical
RL-Collar	2.593m MSL
Total depth of BH	4.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Machhiwad
Taluk	Jalalpore
District & State	Navasari, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2303611.517N
Longitude (E)	274725.603E
Date of Commencement	7-11-2024
Date of Completion	8-11-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1	1.00	100	NA	SAND	Fine grained, dark colored silty sand with the presence of HM. Gravels present.	1
2	1.00	2.00	1.00	1	2.00	100	NA	SAND	Dark colored sand with few gravels and HM is present.	1
3	2.00	3.00	1.00	1	3.00	100	NA	SAND	Fine grained sand with the presence of HM.	1
4	3.00	4.00	1.00	1	4.00	100	NA	SAND	Fine grained, dark colored silty sand with clay of thickness 25-30cm is present at the bottom. Watertable is encountered at 3m.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-32
Azimuth	----------
Inclination	Vertical
RL-Collar	2.497m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Surwada
Taluk	Jalalpore
District & State	Valsad, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2276130.01N
Longitude (E)	280612E
Date of Commencement	3-10-2024
Date of Completion	3-10-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Medium to coarse grained sand with the presence of HM. Shell fragments present.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Medium to coarse grained sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine to medium grained, black colored sand with gravels and HM. Shell fragments present.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine to medium grained sand with presence of HM. Shell fragments present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	**G3**
Bore Hole ID	DD-33
Azimuth	----------
Inclination	Vertical
RL-Collar	2.248m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Surwada
Taluk	Jalalpore
District & State	Valsad, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2275748.384N
Longitude (E)	280502.441E
Date of Commencement	3-10-2024
Date of Completion	3-10-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Size**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine to medium grained, black colored sand with the presence of HM. Shell fragments present.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine to medium grained, black colored sand with the presence of HM. Shell fragments present.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine to medium grained, black colored sand with the presence of HM. Shell fragments present. Watertable is encountered due to high tide.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Fine to medium grained, black colored sand with the presence of HMShell fragments present.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Fine to medium grained, black colored sand.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-34
Azimuth	----------
Inclination	Vertical
RL-Collar	3.494m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Surwada
Taluk	Jalalpore
District & State	Valsad, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2275289.642N
Longitude (E)	280334.98E
Date of Commencement	4-10-2024
Date of Completion	4-10-2024

S.No	Bore Hole Log Details (Runwise)									Core details
	From (m)	To (m)	Length (m)	Recovered Length (m)	True Length (m)	Recovery %	RQD	Litho Code	Lithological description	Box No
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine grained, black to brown colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Fine to medium grained, black to brown colored sand with the presence of HM.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Medium to coarse grained sand with the presence of HM. Shell fragments are present.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Medium to coarse grained sand with the presence of HM. Shell fragments are present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-35
Azimuth	----------
Inclination	Vertical
RL-Collar	3.013m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Surwada
Taluk	Jalalpore
District & State	Valsad, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2274996.75N
Longitude (E)	280175.547E
Date of Commencement	4-10-2024
Date of Completion	4-10-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, black colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Fine to medium grained, black colored sand with the presence of HM.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Coarse grained sand with granules. Shell fragments are present. HM is expected to present.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Coarse grained sand with granules. Shell fragments are present. HM is expected to present. Water table is encountered.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Coarse grained gravelly sand with shell fragments are present.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-36
Azimuth	----------
Inclination	Vertical
RL-Collar	3.235m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

Location- Village	Magod Dungri
Taluk	Jalalpore
District & State	Valsad, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2274581.629N
Longitude (E)	280069.847E
Date of Commencement	5-10-2024
Date of Completion	5-10-2024

S.No	**Bore Hole Log Details (Runwise)**									**Core details**
	From (m)	**To (m)**	**Length (m)**	**Recovered Length (m)**	**True Length (m)**	**Recovery %**	**RQD**	**Litho Code**	**Lithological description**	**Box No**
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine to medium grained, black colored sand with humus.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Medium to coarse grained, black to brown colored sand.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	Coarse to very coarse-grained sand with gravels and fine sand. Shell fragments are present. Watertable is encountered.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	Very coarse-grained sand with granules and pebbles. Hard to penetrate.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	Coarse grained granules and pebbles.	1

Block	Dandi-Onjal-Surwada
Commodity	Heavy mineral
Exploration level	G3
Bore Hole ID	DD-37
Azimuth	----------
Inclination	Vertical
RL-Collar	2.699m MSL
Total depth of BH	5.0m
Type & Make of Rig	Manual Auger Drilling

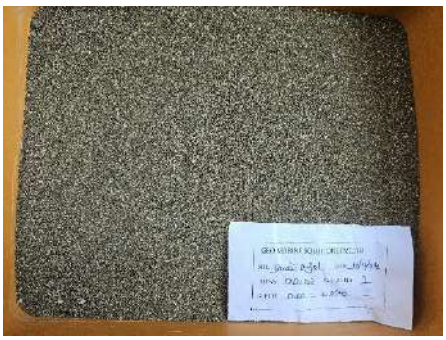
Location- Village	Magod Dungri
Taluk	Jalalpore
District & State	Valsad, Gujarat
S.O.I. Toposheet	46D/13 & 14
Latitude (N)	2274234.619N
Longitude (E)	279847.617E
Date of Commencement	5-10-2024
Date of Completion	5-10-2024

S.No	Bore Hole Log Details (Runwise)									Core details
	From (m)	To (m)	Length (m)	Recovered Length (m)	True Length (m)	Recovery %	RQD	Litho Code	Lithological description	Box No
1	0.00	1.00	1.00	1.00	1.00	100	NA	SAND	Fine grained, dark colored sand with the presence of HM.	1
2	1.00	2.00	1.00	1.00	2.00	100	NA	SAND	Medium to coarse grained, dark colored sand with shell fragments. Watertable is encountered.	1
3	2.00	3.00	1.00	1.00	3.00	100	NA	SAND	coarse grained, dark colored sand with shell fragments.	1
4	3.00	4.00	1.00	1.00	4.00	100	NA	SAND	coarse grained, dark colored sand with shell fragments. Poorly sorted sediments.	1
5	4.00	5.00	1.00	1.00	5.00	100	NA	SAND	coarse grained, dark colored sand with granules. Poorly sorted sediments.	1

Annexure 18
Sample photographs

DD-01

DD-02



DD-03

DD-04

DD-05

DD-06

DD-07

DD-08

DD-09

DD-10

DD-11

DD-12

DD-13

DD-14

DD-15

DD-16

DD-17

DD-18

DD-19

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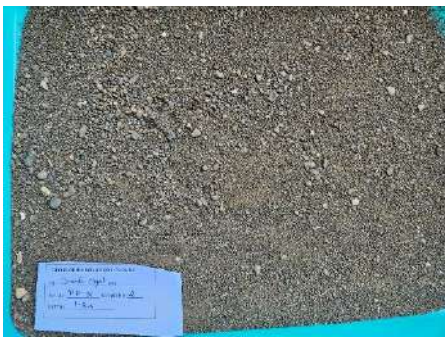
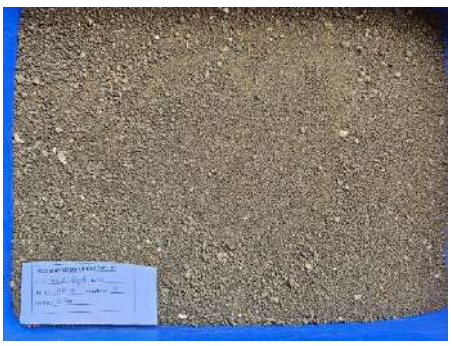
DD-29

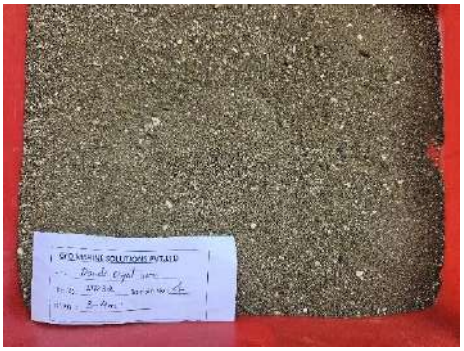
DD-30

DD-31





DD-32



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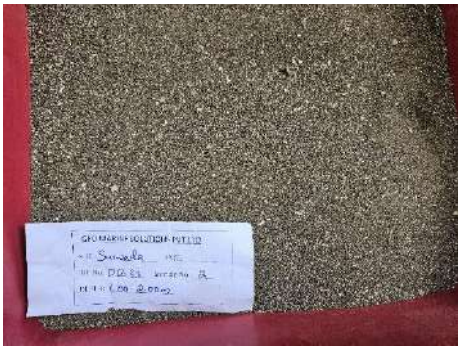
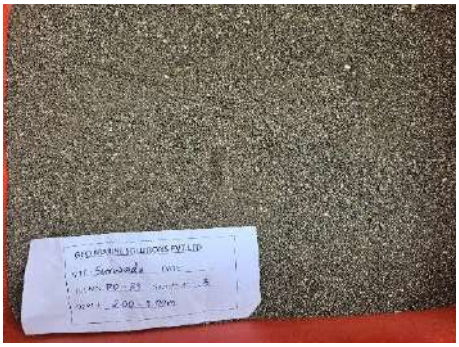



DD-34

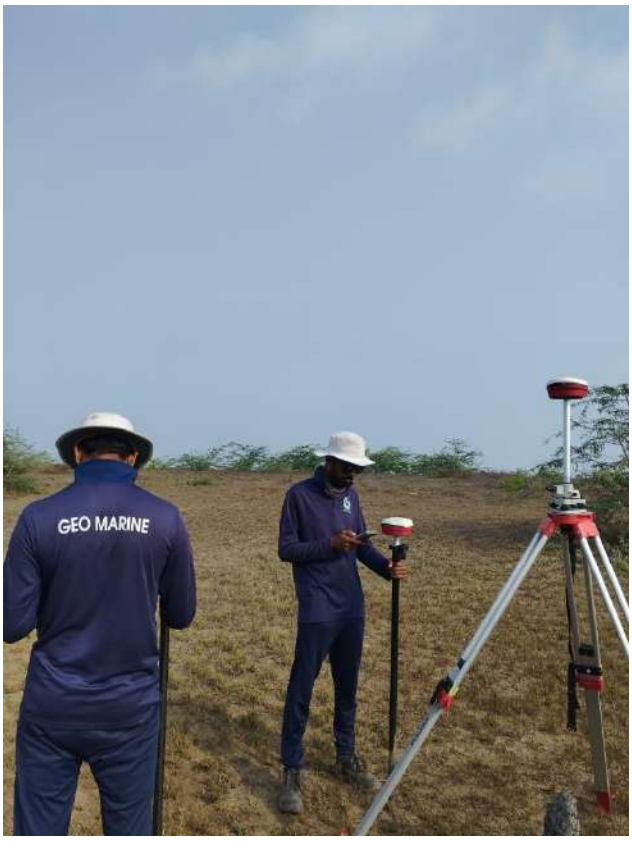
DD-35

DD-36

DD-37

Annexure 19
Field photographs

Topographic Survey and Geological Mapping



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Unnamed Road, Machhiwad, Onjal, Gujarat 390412, India
Lat 20.81707°
Long 72.829689°
30/09/24 12:25 PM GMT +05:30
Google

02/10/2024 18:03

GEOLOGICAL MAPPING

FIELD VERIFICATION BY GSI, OFFICIAL AT DANDI-ONJAL-SURWADA BLOCK ON 29th & 30th Octo 2024

AUGER SAMPLING IN BOREHOLE LOCATIOS AT DANDI-ONJAL-SURWADA BLOCK

Dandi, Gujarat, India
Dandi, Gujarat, India
Lat 20.849792°
Long 72.813674°
26/09/24 10:49 AM GMT +05:30
Google

Dandi, Gujarat, India
Dandi, Gujarat, India
Lat 20.849792°
Long 72.813674°
24/09/24 03:36 PM GMT +05:30
Google

24/09/2024 15:35

Dandi, Gujarat, India
VR56+5J, Dandi, Gujarat 396412, India
Lat 20.857224°
Long 72.811258°
26/09/24 05:13 PM GMT +05:30
Google

Panar, Gujarat, India
Panar, Gujarat 396460, India
Lat 20.813131°
Long 72.856533°
27/09/24 02:37 PM GMT +05:30
Google

27/09/2024 14:36

27/09/2024 12:24

Onjal, Gujarat, India
RR5M+PR6, Bandar Rd, Machhlwad, Onjal, Gujarat 396412, India
Lat 20.809816°
Long 72.834746°
28/09/24 10:07 AM GMT +05:30
Google

Dandi, Gujarat, India
Samarpan Ashram Marg, Dandi, Gujarat 396412, India
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Long 72.800513°
01/10/24 10:11 AM GMT +05:30
Google

Onjal, Gujarat, India
RR5M+PR6, Bandar Rd, Machhiwad, Onjal, Gujarat 396412, India
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Google

28/09/2024 15:08

01/10/2024 14:42

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VRF3+GHS, Dandi, Gujarat 396412, India
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02/10/24 10:08 AM GMT +05:30
Google

02/10/2024 10:07

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Google

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VRF3+GHS, Dandi, Gujarat 396412, India
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Long 72.804052°
02/10/24 10:08 AM GMT +05:30
Google

Surwada, Gujarat, India
HVFX+457, Surwada, Gujarat 396007, India
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Long 72.897146°
03/10/24 01:57 PM GMT +05:30
Google

03/10/2024 11:44

03/10/2024 11:18

Valsad, Gujarat, India
JV4V+83W, Valsad, Gujarat 396001, India
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Long 72.893823°
04/10/24 11:04 AM GMT +05:30
Google

Surwada, Gujarat, India
Surwada, Gujarat, India
Lat 20.554226°
Long 72.888054°
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Google

Surwada, Gujarat, India
HV4Q+WG, Surwada, Gujarat, India
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Long 72.890306°
05/10/24 10:32 AM GMT +05:30
Google

Meh Machhiwad, Gujarat, India
GVXW+7H3, Meh Machhiwad, Gujarat 396020, India
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Long 72.895669°
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Google

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Rrjr+c56, Onjal, Gujarat 396412, India
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Google

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08/11/24 12:33 PM GMT +05:30
Google

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Google

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07/11/24 02:31 PM GMT +05:30
Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.818688° Long 72.833419°
08/11/24 02:24 PM GMT +05:30
Google

Dandi, Gujarat, India
Samarpan Ashram Marg, Dandi, Gujarat 396412, India
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09/11/24 12:40 PM GMT +05:30
Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.82112° Long 72.832531°
08/11/24 04:03 PM GMT +05:30
Google

Onjal, Gujarat, India
Rr7j+5rj, High School Rd, Machhiwad, Onjal, Gujarat 396412, India
Lat 20.815677° Long 72.832162°
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Google

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Samarpan Ashram Marg, Dandi, Gujarat 396412, India
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09/11/24 03:31 PM GMT +05:30
Google

Dandi, Gujarat, India
Vqwr+qv, Dandi, Gujarat 396412, India
Lat 20.896384° Long 72.793882°
10/11/24 01:43 PM GMT +05:30
Google

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Vqwr+qv, Dandi, Gujarat 396412, India
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10/11/24 11:38 AM GMT +05:30
Google

Dandi, Gujarat, India
Samarpan Ashram Marg, Dandi, Gujarat 396412, India
Lat 20.863252° Long 72.808042°
09/11/24 03:56 PM GMT +05:30
Google

Dandi, Gujarat, India
Vqwr+qv, Dandi, Gujarat 396412, India
Lat 20.896384° Long 72.793882°
10/11/24 01:43 PM GMT +05:30
Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.82088° Long 72.830961°
11/11/24 12:22 PM GMT +05:30
Google

Panar, Gujarat, India
Panar, Gujarat 396460, India
Lat 20.810362° Long 72.85764°
11/11/24 12:06 PM GMT +05:30
Google

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Vqxv+q7w, Dandi, Gujarat 396412, India
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Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.903634° Long 72.791546°
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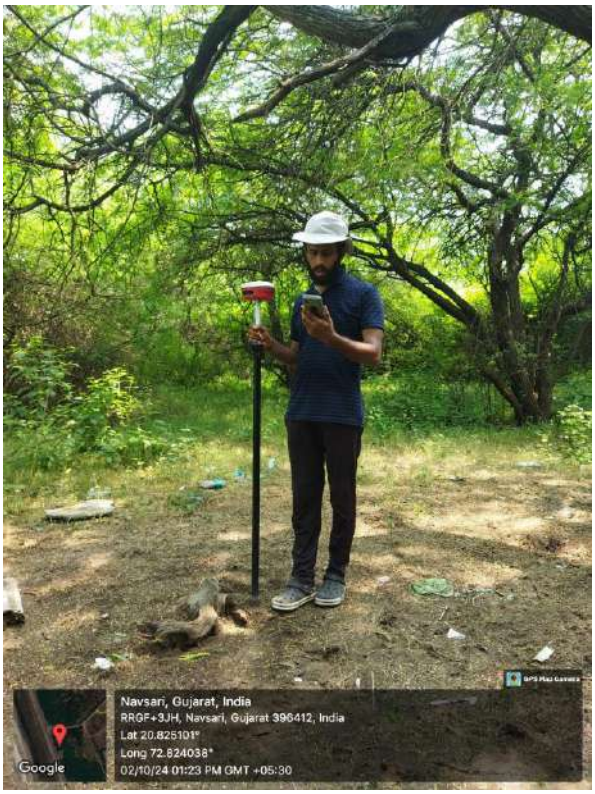
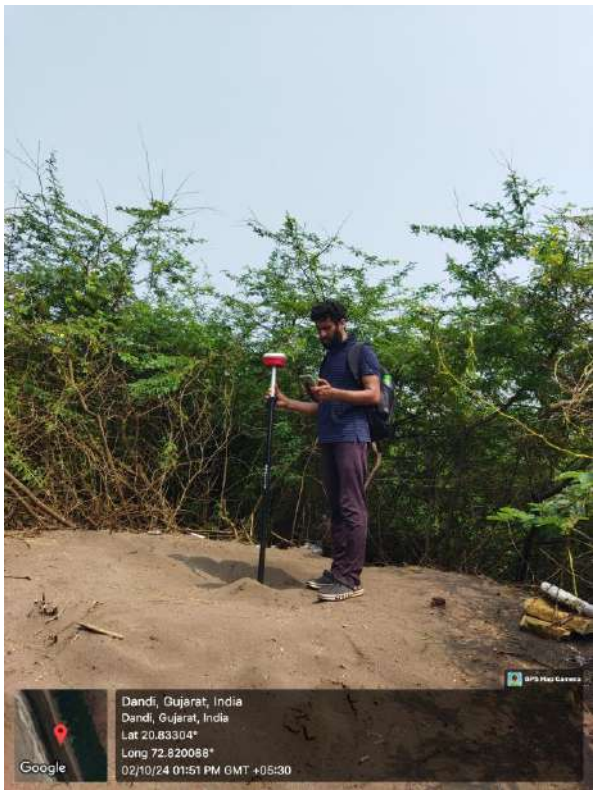
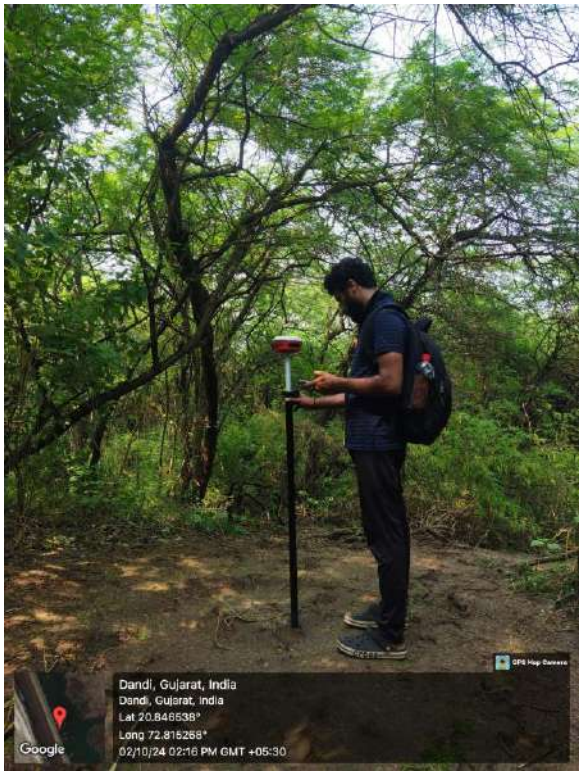
Google

SAMPLING TEAM OF GEO MARINE SOLUTIONS PVT. LTD

LOCATING BH POINTS USING DGPS



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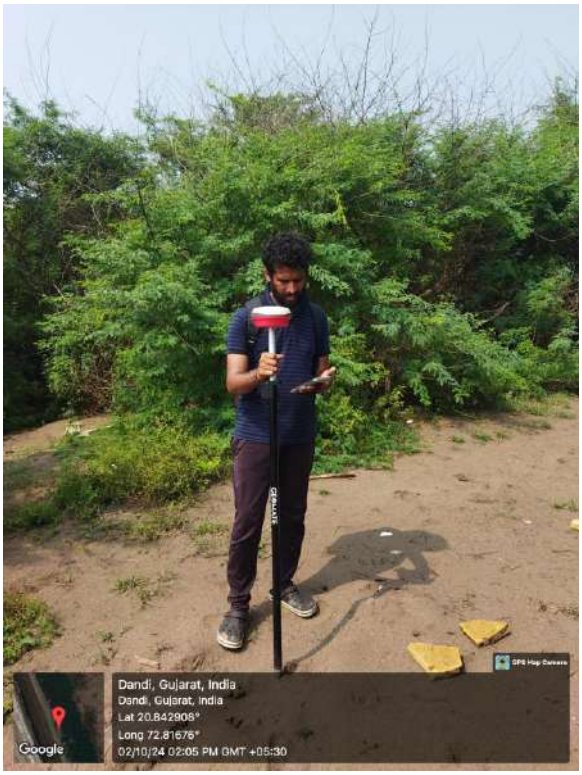
Google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Long 72.81676°
02/10/24 02:05 PM GMT +05:30
Google

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Dandi, Gujarat, India
Lat 20.836002°
Long 72.819294°
02/10/24 01:57 PM GMT +05:30
Google

Dandi, Gujarat, India
Dandi, Gujarat, India
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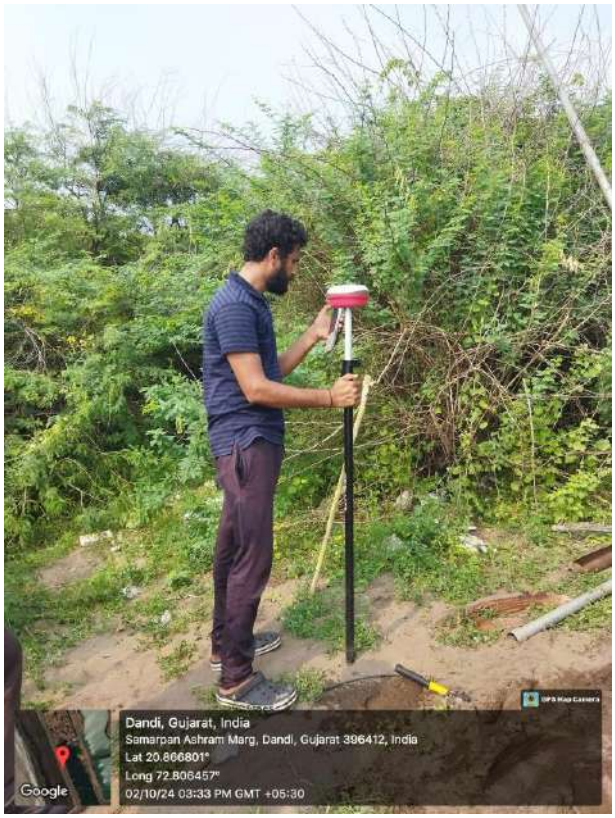
Long 72.814224°
02/10/24 02:32 PM GMT +05:30
Google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Long 72.806457°
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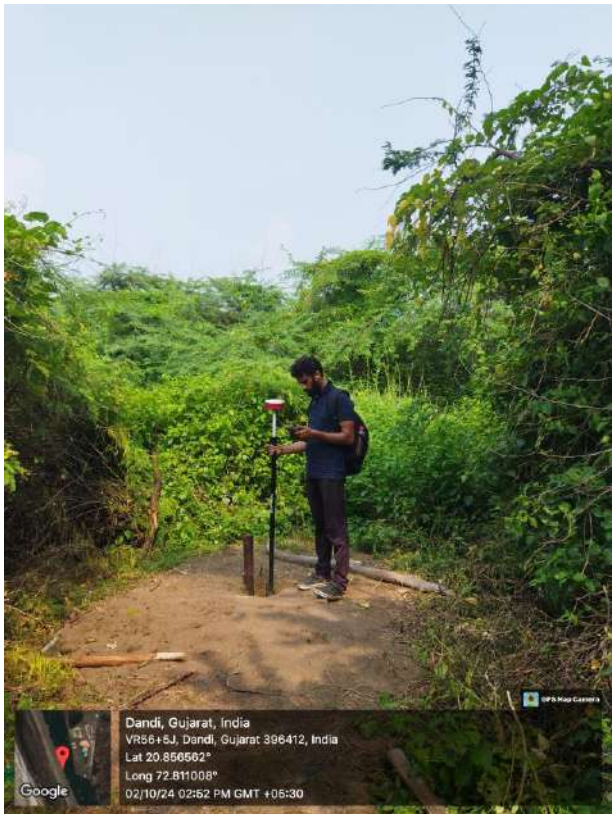
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Google

Dandi, Gujarat, India
Dandi, Gujarat, India
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Long 72.812452°
02/10/24 02:41 PM GMT +05:30
Google

Dandi, Gujarat, India
Samarpan Ashram Marg, Dandi, Gujarat 396412, India
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Long 72.800441°
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Google

Dandi, Gujarat, India
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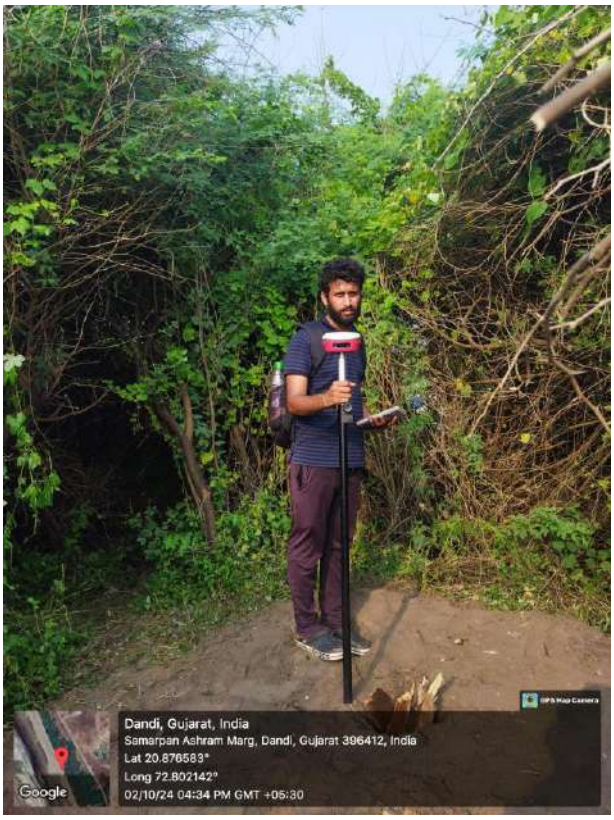
Google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Google

Dandi, Gujarat, India
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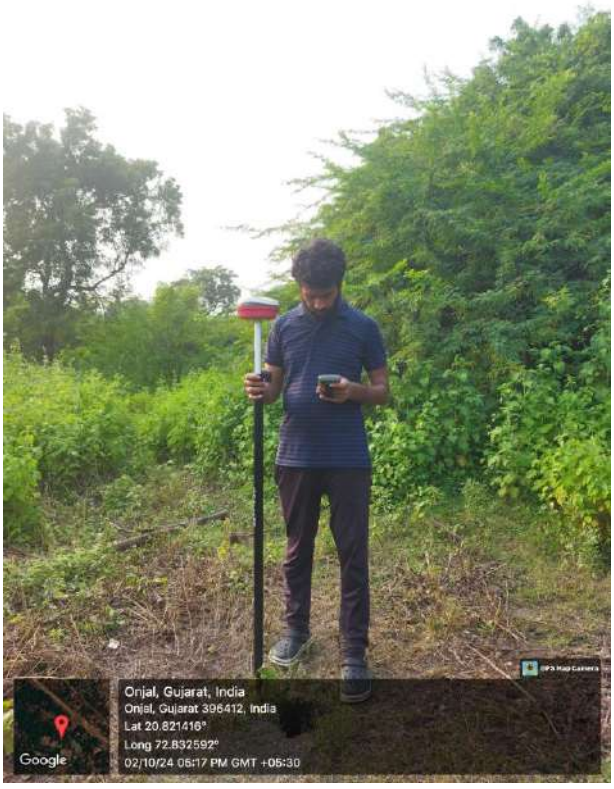
Google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Long 72.832592°
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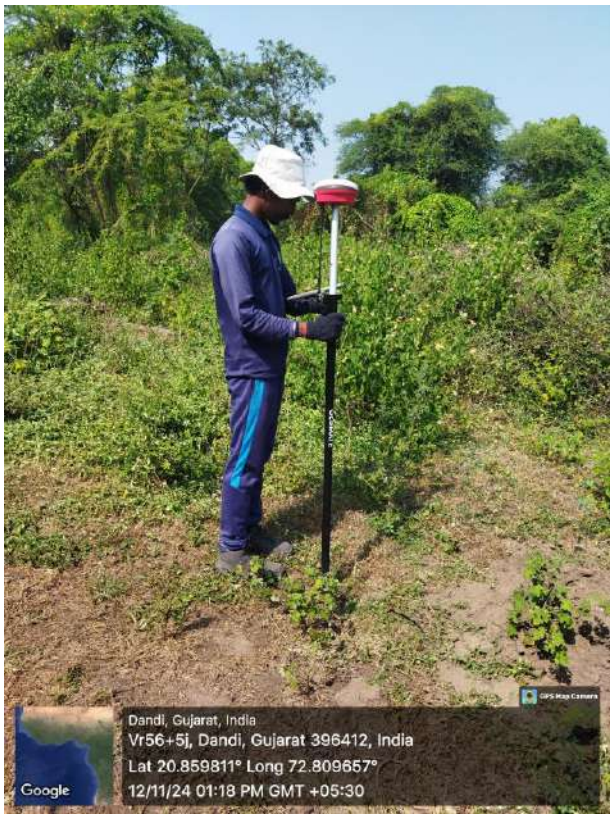
Google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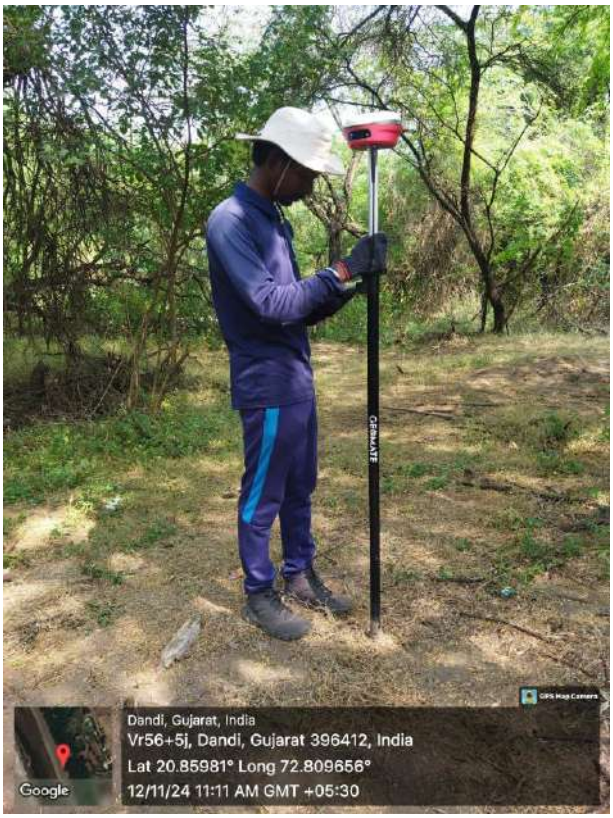
Google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Google

Dandi, Gujarat, India
Samarpan Ashram Marg, Dandi, Gujarat 396412, India
Lat 20.863201° Long 72.808022°
12/11/24 10:58 AM GMT +05:30
Google

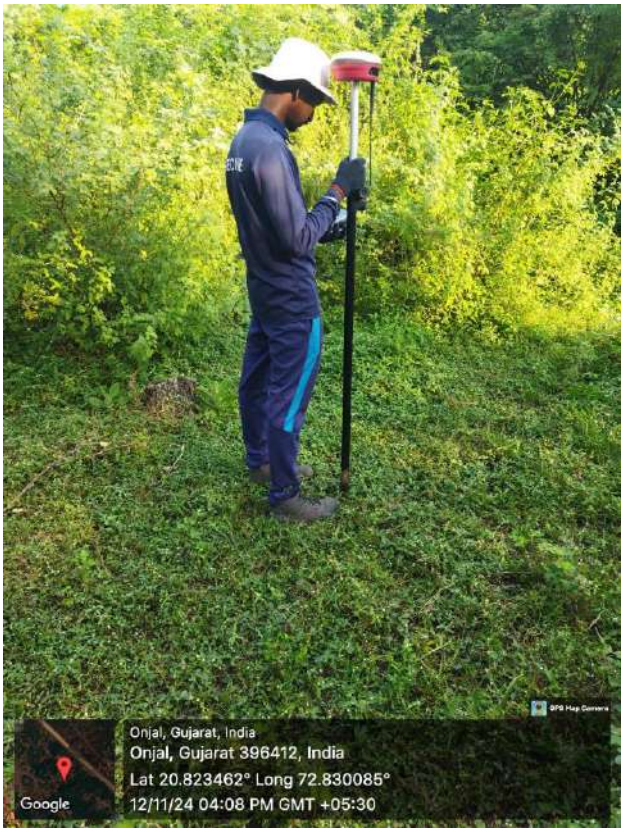
Dandi, Gujarat, India
Vr56+5j, Dandi, Gujarat 396412, India
Lat 20.859811° Long 72.809657°
12/11/24 01:26 PM GMT +05:30
Google

Onjal, Gujarat, India
Machhiwad Rd, Machhiwad, Onjal, Gujarat 396412, India
Lat 20.818887° Long 72.835371°
12/11/24 03:11 PM GMT +05:30
Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.820896° Long 72.830948°
12/11/24 02:48 PM GMT +05:30
Google

Dandi, Gujarat, India
Vr56+5j, Dandi, Gujarat 396412, India
Lat 20.859811° Long 72.809657°
12/11/24 01:42 PM GMT +05:30
Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.819002° Long 72.833864°
12/11/24 03:20 PM GMT +05:30
Google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Onjal, Gujarat 396412, India
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Google

Onjal, Gujarat, India
Onjal, Gujarat 396412, India
Lat 20.818792° Long 72.833391°
12/11/24 03:24 PM GMT +05:30
Google

Onjal, Gujarat, India
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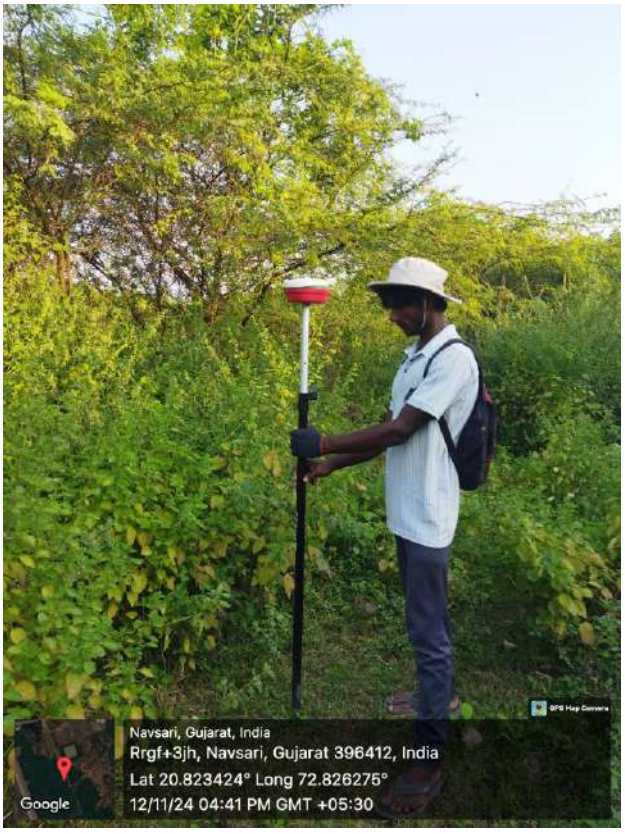
Google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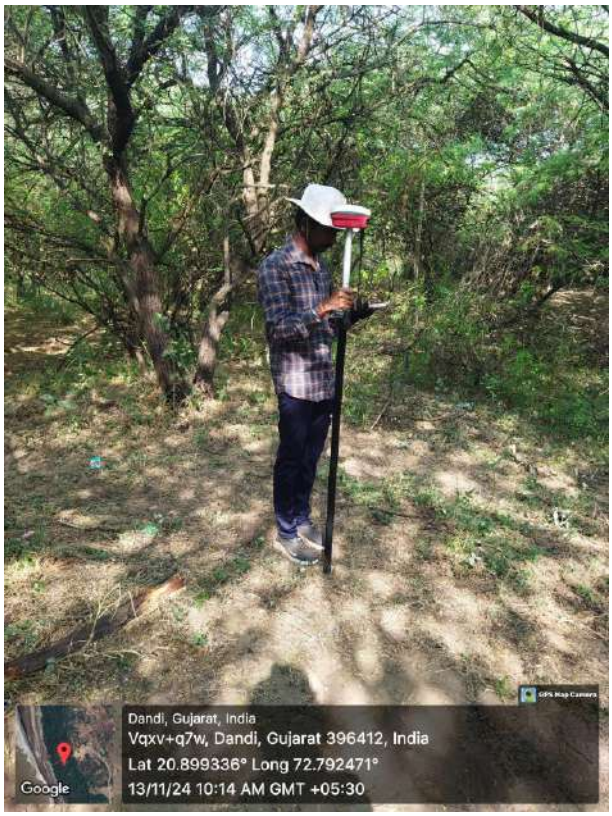
Google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Google

Dandi, Gujarat, India
Vqwr+qv, Dandi, Gujarat 396412, India
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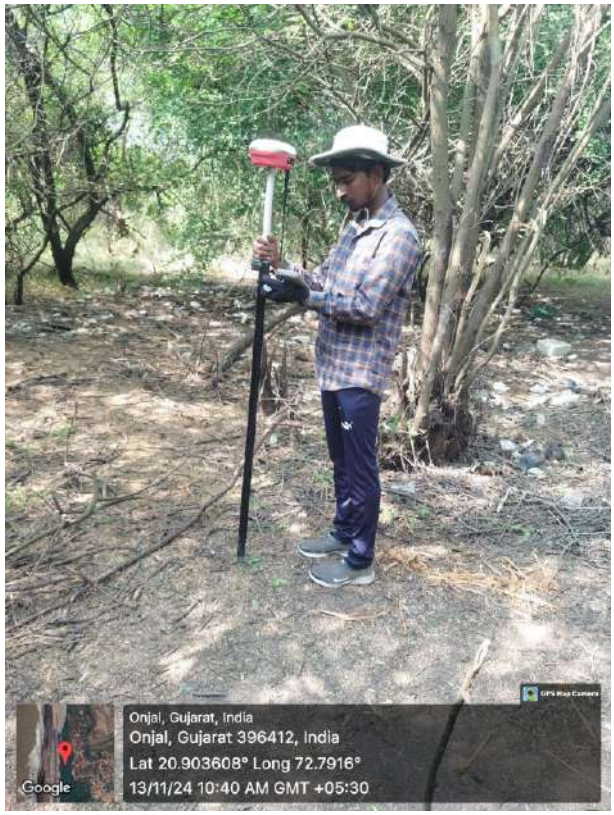
Google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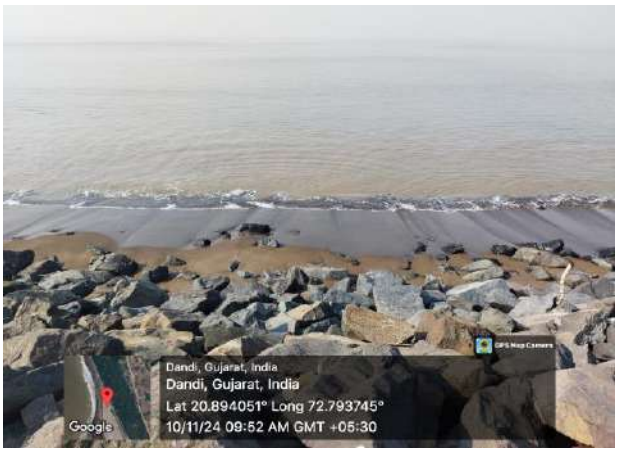
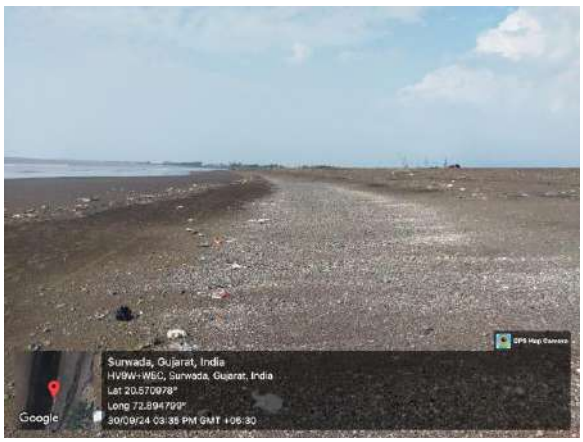
Onjal, Gujarat 396412, India
Lat 20.903608° Long 72.7916°
13/11/24 10:40 AM GMT +05:30
Google

RAMDOM SCENARIC VIEW IN DANDI-ONJAL-SURWADA BLOCK

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HV8W+W6C, Surwada, Gujarat, India
Lat 20.570978°
Long 72.894799°
30/09/24 03:35 PM GMT +05:30
Google

Navsari, Gujarat, India
Rrgf+3jh, Navsari, Gujarat 396412, India
Lat 20.825329° Long 72.823414°
07/11/24 10:34 AM GMT +05:30
Google

****

Annexure 20
AMD Results

भारत सरकार Government of India
परमाणु ऊर्जा विभाग Department of Atomic Energy
परमाणु खनिज अन्वेषण एवं अनुसंधान निदेशालय
Atomic Minerals Directorate for Exploration and Research

1-10-153/156, पखनि परिसर AMD Complex,
बेगमपेट, हैदराबाद Begumpet, Hyderabad
Telephone No.040-277637024, 27776204
Fax No.040-27762940
E-mail:amdhyd@gov.in

संNo.AMD-75(1)/2025-PMSG

मई May 05, 2025

ANALYSIS REPORT

Samples received from : Shri A.C. Dinesh,
Chief Technology officer,
Geo marine Solutions Pvt. Ltd,
15-17-909/9, 5th Cross Shivabagh,
Kadri, Mangalore – 575 005

Reference Letter No. : Letter no. GEMS/NMET/AMD/2025/2 dated 21.04.2025 and E-mail dated 03.04.2025 & 22.04.2025

Nature of samples : Dune sand sample

Analysed at : Physics Laboratory, AMD, Hyderabad

RADIOMETRIC ANALYSIS REPORT

S. No.	Sample No.	Monazite equivalent (%)
1.	DD03	0.015
2.	DD11	0.011
3.	DD23	0.014
4.	DD32	0.010
5.	DD37	0.011

(निरोज कुमार पंडा Niroj Kumar Panda)
प्रधान Head
योजना एवं प्रबंधन सेवा वर्ग Planning and Management Services Group