RECONNAISSANCE SURVEY (G4) FOR GRAPHITE IN AND AROUND DUMBURUNELI AREA RAYAGADA DISTRICT, ODISHA

(F.No.23/551/2025-NMET/837)

PREPARED FOR

NATIONAL MINERAL EXPLORATION AND DEVELOPMENT TRUST (NMEDT) SECRETARIAT

MINISTRY OF MINES

9TH FLOOR
JEEVAN PRAKASH LIC BUILDING
KASTURBA GANDHI MARG
NEW DELHI-110001

PREPARED BY

MMPL PRIVATE LIMITED

(NABET AEA/25/009)
APA, AEA & MPPA ACCREDITED
ISO 9001:2015, ISO 14001:2018, ISO 45001:2018 CERTIFIED

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MMPL PRIVATE LIMITED

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अध्याय 1: सारांश

ग्रेफाइट के लिए डम्बुरुनेली ब्लॉक, जिला रायगड़ा, ओडिशा में F.No.23/551/2025-NMET/837 के अंतर्गत अन्वेषण सर्वेक्षण (G-4 चरण) किया गया। यह क्षेत्र ईस्टर्न घाट्स मोबाइल बेल्ट के पश्चिमी खोंडालाइट ज़ोन में स्थित है। ग्रेफाइट की उपस्थिति तथा संबद्ध शैल-इकाइयों का निर्धारण करने हेतु टोपोशीट सं. 65 M/11 के मध्य भाग में 72.14 वर्ग कि.मी. क्षेत्र का 1:12,500 मापनी पर भूवैज्ञानिक मानचित्रण किया गया। मृदा आवरण के नीचे अनुमानित ग्रेफाइट पट्टियों की उपसतही निरंतरता की पुष्टि के लिए 5 लाइन कि.मी. का स्वस्फूर्त विभव (SP) भूभौतिकीय सर्वेक्षण तथा कुल 150 घन मीटर ट्रेंचिंग एवं पिटिंग कार्य संपन्न किया गया। सतह पर ग्रेफाइट की प्रकट मोटाई एवं ग्रेड निर्धारित करने हेतु 12 ग्रूवों (G-1 से G-12) से 84 शैल नमूने, 7 ट्रेंचों (T-1 से T-7; कुल आयतन 123 घन मीटर) से 60 ट्रेंच नमूने तथा 6 पिटों (P-1 से P-6; कुल आयतन 28 घन मीटर) से 6 पिट नमूने संकलित किए गए। उपसतही खनिजीकरण के अध्ययन हेतु 7 बोरहोल में कुल 462 मीटर ड्रिलिंग की गई है तथा 2% F.C कट-ऑफ पर क्रॉस-सेक्शनल एरिया पद्धति एवं Leapfrog सॉफ्टवेयर द्वारा अन्वेषण संसाधन (334) का आकलन किया गया।

इस क्षेत्र में प्रमुख रूप से खोंडालाइट, ग्रेनाइट ग्नाइस, चार्नोकाइट, लेप्टिनाइट तथा क्वार्ट्जो-फेल्डस्पैथिक ग्रेफाइट ग्नाइस शैल-इकाइयाँ पाई गईं। अधिकांश शैलों में सामान्यतः उत्तर-पश्चिम–दक्षिण-पूर्व (NW-SE) दिशा की ग्नाइसिक संरचना विद्यमान है, जिसका नति कोण 45°–70° दक्षिण-पश्चिम की ओर है। शैलों में सिलिमेनाइट, गार्नेट, ऑर्थोक्लेज, प्लेजियोक्लेज, क्वार्ट्ज, ऑर्थोपायरोक्सीन तथा क्लिनोपायरोक्सीन की उपस्थिति ग्रैनुलाइट फेसीज़ कायांतरण का संकेत देती है।

इस क्षेत्र में प्रमुख ग्रेफाइट खनिजीकरण ग्नाइसिक प्रकार का है तथा ग्रेफाइट की सूक्ष्म प्रसारित फ्लेक्स सामान्यतः खोंडालाइट एवं ग्रेनाइट ग्नाइस में ग्नाइसिक संरचना के समानांतर पाई जाती हैं। पेट्रोग्राफिक अध्ययन के आधार पर ग्रेफाइट फ्लेक्स को जम्बो फ्लेक्स (>300 μm) के रूप में वर्गीकृत किया गया है, जिनका आकार स्थानीय रूप से 1000 μm तक पहुँचता है।

उत्साहवर्धक विश्लेषणात्मक परिणामों वाले प्रमुख ग्रेफाइट पट्टे पिचुलीगुरहा ग्राम (19°21'27.12"N, 83°34'19.89"E), लांजी ग्राम (19°21'51.62"N, 83°35'11.46"E), भलेरी ग्राम (19°21'16.07"N, 83°34'45.45"E) तथा धुआँबरही ग्राम (19°21'25.13"N, 83°35'59.33"E) के समीप स्थित हैं, जिन्हें क्रमशः ज़ोन-1, ज़ोन-2, ज़ोन-3 तथा ज़ोन-4 के रूप में वर्गीकृत किया गया है। इन क्षेत्रों से संकलित शैल नमूनों में स्थिर कार्बन (Fixed Carbon) का अधिकतम मान 17.04% प्राप्त हुआ।

आर्थिक दृष्टि से महत्त्वपूर्ण ग्रेफाइट क्षेत्रों के मूल्यांकन हेतु कुल 150 BRS एवं PT नमूनों तथा 225 कोर नमूनों का विश्लेषण किया गया। समन्वित भूवैज्ञानिक एवं भूभौतिकीय अध्ययनों से ज्ञात हुआ कि ज़ोन-1 में ग्रेफाइट खनिजीकरण की अनुमानित स्ट्राइक लंबाई लगभग 500 मीटर तथा चौड़ाई 30–50 मीटर है। बोरहोल ORDN-1, ORDN-2 एवं ORDN-3 में प्रतिच्छेदित ग्रेफाइट का औसत स्थिर कार्बन (F.C %) क्रमशः 3.4%, 5.19% एवं 2.74% है। इसी प्रकार, ज़ोन-3 में खनिजीकरण की अनुमानित स्ट्राइक लंबाई लगभग 250 मीटर तथा चौड़ाई 20–30 मीटर है, जहाँ ORDN-4 एवं ORDN-5 में औसत ग्रेफाइट ग्रेड (F.C %) क्रमशः 3.66% एवं 3.09% प्राप्त हुआ। ज़ोन-4 में खनिजीकरण की अनुमानित स्ट्राइक लंबाई लगभग 400 मीटर तथा चौड़ाई 40–50 मीटर है, जहाँ ORDN-6 एवं ORDN-7 में औसत ग्रेफाइट ग्रेड (F.C %) क्रमशः 4% एवं 3.4% प्राप्त हुआ। ज़ोन-2 में घने काजू (Cashew) बागान तथा स्थानीय ग्रामीणों के असहयोग के कारण कोई बोरहोल ड्रिल नहीं किया जा सका। अतः सतही भूवैज्ञानिक साक्ष्यों के आधार पर ही ज़ोन-2 में खनिजीकरण की अनुमानित स्ट्राइक लंबाई 100 मीटर, चौड़ाई 60 मीटर तथा ग्रेफाइट का औसत ग्रेड (F.C %) 7.56% (ग्रूव नमूनों के आधार पर) निर्धारित किया गया। ज़ोन-1, ज़ोन-3 तथा ज़ोन-4 के लिए क्रमशः 0.199 मिलियन टन, 0.062 मिलियन टन तथा 0.144 मिलियन टन का अन्वेषण संसाधन (334) आकलित किया गया।

CHAPTER 1: SUMMARY

Reconnaissance survey (G-4 stage) was carried out for graphite in Dumburuneli block of Rayagada district, Odisha, under F.No.23/551/2025-NMET/837. The area belongs to the western khondalite zone of the Eastern Ghats Mobile Belt. An area of 72.14 sq. km constituting the central part of toposheet no. 65 M/11 was mapped on 1:12,500 scale to decipher the graphite occurrences and associated lithounits. 5 line km of geophysical SP survey and a combined 150 cubic meters of trenching and pitting were completed to verify subsurface continuity of inferred graphite bands beneath soil cover. 84 bed rock samples from 12 grooves (G-1 to G-12), 60 trench samples from 7 trenches (T-1 to T-7 having cumulative 123 cum volume) and 6 pit samples from 6 pits (P-1 to P-6 having a cumulative 28 cum volume) were collected to ascertain the apparent widths and grade of graphite on surface. Seven boreholes with a total of 462 meters were drilled to study subsurface mineralisation, and a reconnaissance resource (334) was estimated by cross-sectional area method and Leapfrog software at 2% F.C cut-off.

Khondalite, granite gneiss, charnockite, leptynite and quartzo-feldspathic graphite gneiss are the major lithological units encountered in the area. Most rocks are foliated with a general NW-SE gneissosity dipping 45°–70° towards the south-west. Sillimanite, garnet, orthoclase, plagioclase, quartz, orthopyroxene and clinopyroxene indicate granulite facies metamorphism.

The major graphite mineralization encountered in this area is of gneissose type and minor disseminations of graphite flakes are generally found in the khondalites and granite gneisses, oriented parallel to the gneissosity. The graphite flakes are petrographically categorised as jumbo flakes (>300 µm), locally reaching up to 1000 µm in size.

Major graphite bands with encouraging analytical results are located near Pichuligurha village (19°21'27.12"N, 83°34'19.89"E), Lanji village (19°21'51.62"N, 83°35'11.46"E), Bhaleri village (19°21'16.07"N, 83°34'45.45"E) and Dhuanbarhi village (19°21'25.13"N, 83°35'59.33"E), grouped as Zone 1, Zone 2, Zone 3 and Zone 4, respectively. The maximum fixed carbon value in bed rock samples from these zones is 17.04%.

A total of 150 BRS and PT samples and 225 core samples were analysed to investigate the graphite zones of economic interest. Integrated geological and geophysical studies indicate that graphite mineralisation in Zone 1 has an inferred strike length of about 500 m and width of 30–50 m. The average graphite grade (F.C %) intersected in boreholes ORDN-1, ORDN-2 and ORDN-3 is 3.4%, 5.19% and 2.74%, respectively. Similarly, Zone 3 has an inferred strike length of about 250 m, width of 20–30 m, and average graphite grades of 3.66% and 3.09% in ORDN-4 and ORDN-5, while Zone 4 has an inferred strike length of about 400 m, width of 40–50 m, and average grades of 4% and 3.4% in ORDN-6 and ORDN-7. No borehole could be drilled in Zone 2 as the area falls within dense cashew plantation and villagers refused to cooperate. So the inferred strike length and width of mineralisation in Zone 2, only on the basis of surface geological evidences is approximately 100 m and 60 m (3 inferred bands of 5 to 16 m thicknesses) respectively while the average grade of graphite (F.C %) is 7.56% (based on groove samples). A gross reconnaissance resource (334) of 0.199 million tonne for Zone 1, 0.062 million tonne for Zone 3 and 0.144 million tonne for Zone 4 was estimated by cross-sectional area method.

CHAPTER 2: INTRODUCTION

Graphite is a natural form of carbon having a layered structure and a greasy feel in fingers. It's a soft mineral, and its two main naturally occurring types are micro-crystalline (amorphous) and flaky graphite. Both of these are commercial varieties of graphite. India has a significant amount of graphite, with total resources estimated at 211.62 million tonnes as of April 1, 2020 as per NMI (IMYB, 2023) database, based on UNFC system. The majority of these resources are in Arunachal Pradesh (36%), Jammu and Kashmir (29%), Jharkhand (9%), and Odisha (9%). India, although produced 30,168 tonnes of graphite in 2020-2021, it was a 13% drop from the previous year. During that time, Odisha was the largest producer, contributing 42% of the country's total output. Graphite is listed as critical mineral in the list of 30 critical minerals for India issued by ministry of Mines in June, 2023.

In pursuance of NMEDT-mineral exploration project F.No.23/551/2025-NMET/837, Reconnaissance Survey (G4 Stage) for graphite was carried out by the team of geologists of MMPL Private Limited in selected areas of Rayagada district, Odisha falling in toposheet No. 65M/11 during the period from 11.03.2025 to 20.05.2026. An area of 72.14 sq. km was mapped on a scale of 1:12500 and 84 nos. of bed rock samples, 66 nos. of trench and pit samples were collected to determine the strike length and grade of graphite bands. A total of 5 line km of Geophysical SP survey and 150 cubic meters of trenching and pitting were completed to find the extension of graphite mineralization. 7 scout boreholes were drilled in 3 graphite bearing zones to study the depth persistence and continuity of bands in the subsurface. Finally, a gross reconnaissance resource was estimated with 2% F.C cut-off for graphite.

2.1 Acknowledgements

The team would like to thank several individuals and organizations for their crucial support in this project. Ongoing guidance from Mr. Sanjeev Ganeriwala, Managing Director of MMPL Private Limited is gratefully acknowledged, and the team appreciates the company for providing necessary resources for smooth operation of this project. Sincere thanks go to the National Mineral Exploration and Development Trust, Ministry of Mines, Government of India, for approval and funding the project. The Directorate of Geology and Mining and various local authorities, including the District Collectorate, Divisional Forest Office, and SP office in Rayagada are acknowledged thankfully for their help and cooperation.

2.2 Details of the Project

The project was approved by the National Mineral Exploration and Development Trust under F.No.23/551/2025-NMET/837 for “Reconnaissance Survey (G4) for Graphite in and around Dumburuneli area, Rayagada District, Odisha”.

2.3 Investigating Agency

MMPL Private Limited conducted this exploration program under F.No.23/551/2025-NMET/837 which was approved by NMEDT on 10th February, 2025.

2.4 Objectives of Investigation

The primary objectives of the project are as follows:-

1. **Geological Mapping of graphite-bearing outcrops and associated lithological units**: This objective involves conducting Large Scale Geological Mapping of graphite-bearing outcrops and related lithological units on a 1:12,500 scale along with recording of structural data. The goal is to identify and delineate mappable rock units and to study the distribution of graphite bearing zones and its structural control within the study area.
2. **Assessment of graphite resources and grade at G4 stage of exploration**: At this stage of investigation (G4), the aim is to assess the tentative resource and grade of graphite bands. This involves estimation of graphite resource in the identified areas based on geological mapping, drilling and sampling. The grade assessment includes determining the quality and composition of the graphite through proximate analysis (including fixed carbon content, ash content, sulphur content, volatile matter and moisture content). In addition to that, 14 elements are to be analysed through ICPMS to check their anomalous concentrations, if any.
3. **Delineation of potential blocks for upgrading to G3 stage**: This objective seeks to identify geologically and geochemically promising areas or blocks within the study area for further exploration and advancement to the G3 stage.

2.5 Basis of taking up investigation

Graphite bands of economic values are found in the Eastern Ghats Mobile Belt (EGMB). These graphite deposits are mostly linked with khondalite rocks. Their formation is influenced by the type of rock and the structures. Graphite is commonly seen along the contact zones between Khondalite and Granite Gneiss along the foliation in the rocks. Most graphite bodies are lens-shaped and show pinch-and-swell features. Earlier studies by Acharya and Dash (1984) confirmed graphite occurrences in Rayagada district. Later, Nanda and Pati (1988, 1989) also reported graphite in the area. Mohanty and Pattanaik (1989–90) described graphite mineralization at locations like Durgi, Barangapadar, Rangamati, and Kanapulisi, which are located close to the present block. Recently in 2025, MMPL Pvt Ltd had successfully completed G4 Stage Reconnaissance Project for Graphite mineralisation within Darukona and Kanapulisi which are areas surrounding the present block. Also, recent reconnaissance surveys near Bhaleri village, graphite-bearing rocks of various sizes were noticed in gneissic rocks. A few grab samples collected by geologists from MMPL Private Ltd. showed fixed carbon (F.C) content ranging from 4.48% to 14.35%. To better understand the location, quality, and potential of these graphite occurrences, a G4 stage exploration has been proposed.

2.6 Nature and Quantum of the work

Table 2.1: Quantum of Work Approved vs Achieved					
Sl. no	**Item of work**	**Quantum approved**	**Quantum achieved**	**Remarks**	**Annexures/Plates**
1	Geological mapping (on 1:12500)	72.14 sq. km	72.14 sq. km	Completed	Plate-I (A) & I (B)
2	Bedrock sampling	50 Nos.	84 Nos.	Completed	
3	Geophysical survey (SP survey)	5 L.km	5 L.km	Completed	
4	Technological Survey				
	(a) Pitting (where BRS is not available)	50 cu.m	28 cu.m	Completed	Plate-X (B)
	(b) Trenching	100 cu.m	123 cu.m		Plate-X (A)
	(c) Drilling	500 m	462 m	Completed	Plate-IX
5	Laboratory studies				
	(a) Proximate analysis for graphite (BRS: 50; PT:100; BH Core: 100)	250 Nos.	375 Nos. (BRS: 84; PT: 66; Core: 225)	Completed	Annexure-I, II & X
	(a) Proximate analysis for graphite 10% external check	25 Nos.	25 Nos.	Completed	Annexure-XI
	(c) Analysis for associated REE + Vanadium (ICPMS 14 elements)	20 Nos.	20 Nos.	Completed	Annexure-XII
	(d) Petrochemical studies (PCS)	10 Nos.	10 Nos.	Completed	Annexure-XIII
6	Petrographic studies				
	a) Preparation of thin sections	10 Nos.	10 Nos.	Completed	
	b) Study of thin section	10 Nos.	10 Nos.	Completed	
	c) Digital photographs	10 Nos.	10 Nos.	Completed	

2.7 List of Personnel Involved

Table 2.2 : List of Personnel involved with the Project	
GUIDANCE, SUPERVISION AND MONITORING	
NABET Designation	**Name of Personnel**
Project Coordinator	Shri Ambika Prasad Samantaray, CEO & President
Technical Area Expert	Shri Pradipta Tarafdar, Advisory, Geology
Technical Area Expert	Dr Suman Krishna Sit, Sr. Vice President, Geology
Technical Area Expert	Shri Sourabh Sarkar, General Manager, Geology
Team member	Dr. Suvendu Mondal, Dy. General Manager, Geophysics
Team member	Ms. Anusrita Thakur, Manager, Geology
Team member	Ms. Moulipriya Bhakta, Dy. Manager, Geology
Team member	Mr. Harihar Maity, Senior Surveyor
PROJECT EXECUTION AND TECHNICAL DELIVERY	
Responsibility	**Name of Personnel and Designation**
Geoscience Investigation	Mr. Syamantak Pal (Geologist, Team member, NABET) and Mr. Debashis Kar (Geologist, Team member, NABET)
Petrographic studies	Ms. Medha Sarkar (Geologist, Team member, NABET)
Geophysical SP survey	Mr. Swarnendu Mondal (Geophysicist, Team member, NABET)
DGPS survey	Mr. Anuj Mahato (Surveyor) and Mr Pintu Ray (Surveyor)
Drilling Activities	Mr. Bimal Dawn (Drill Co-ordinator)
	Mr. Bichitrananda Mohanta (Drill Supervisor) and Mr. Biswajit Dom (Drill Operator)
Logging & Sampling	Mr. Syamantak Pal and Mr. Debashis Kar
Digitization of field data by ARC GIS & AUTOCAD software	Mr. Syamantak Pal
	Mr. Mrinmoy Ghosh (Executive GIS Analyst)
Geological report preparation and documentation	Mr. Syamantak Pal
LEAPFROG Modelling	Ms. Moulipriya Bhakta

2.8 Mode of operation of different work component and associated agencies

Large Scale Mapping (Reconnaissance survey) on 1:12,500 scale, surface & sub-surface sampling (BRS, PTS and core sampling), petrographic studies, geophysical survey, pitting, trenching, DGPS survey and sub-surface exploration (Drilling) work were conducted by the in-house strength of MMPL Private Limited.

Proximate analysis of BRS and PT samples of graphite bearing rocks were carried out by IGI Laboratory, while proximate analysis of core samples were done by NMCI Laboratory. Analysis by ICPMS and PCS analysis were done by SHIVA Laboratory. Check sample analysis for BRS and PT samples were done by NMCI Laboratory while for the core samples, it was done by IGI Laboratory and SHIVA Laboratory.

CHAPTER 3: PROPERTY DESCRIPTION

3.1 Village, district and state details

The area of investigation is part of the Rayagada district, Odisha (**Figure 3.2)**. The main localities are Bhaleri, Bandugurha, Dhuanbadi, Lanji, Panugurha, Sindupanga, Lakshmipur, Dharmagurha, Dumburuneli, Minahala, Hikiriguma, Ichhapai, Juani, Muratili, Retili etc.

3.2 Concerned Toposheet

The area of investigation falls to the western part of the survey of India toposheet no. 65M/11, within the Bissamcuttack tehsil.

3.3 Geo-Coordinates of the corner points of the Investigated Area

Table 3.1 : Geo-coordinates of the corner points of the investigated area

Point Corners	Latitude	Longitude
A	19°25' 0" N	83°32' 30" E
B	19°25' 0" N	83°37' 30" E
C	19°21' 3.6" N	83°37' 30" E
D	19°21' 3.6" N	83°35' 0" E
E	19°20' 0" N	83°35' 0" E
F	19°20' 0" N	83°32' 30" E

3.4 Land Use/Cover

The land cover of the designated area includes high hill ranges in the northern, eastern and southern parts together with agricultural lands, nalas and forestlands. Nearly 30% of area is under forest cover within Zone 1 consisting of dry, mixed deciduous forest and scrub; 70% of area is under forest cover within Zone 2 consisting of dry, mixed deciduous forest and scrub; 25% of area is under forest cover within Zone 4 consisting of dry deciduous scrub and no forest cover is present within Zone 3.

3.5 Forest type

The northern, southern & eastern part of the area are densely covered with vegetation, which can be classified under tropical dry, deciduous, and mixed forests. The project area covers major parts of Dumburuneli reserve forest and minor parts of Chengili reserve forest and Kankubadi reserve forest.

3.6 Free hold details

The total area of the block is freehold.

3.7 Location

Geographically the block is approximately 30 km northeast of Rayagada, the district headquarters. The block is bounded by latitudes 19º20’00’’ N and 19º25’00’’ N and longitudes 83º32’30’’ E and 83º37’30’’ E.

Geologically the area belongs to the Western Khondalite Zone of Eastern Ghats Mobile Belt. According to the classification of graphite zones of Odisha, it falls in part of southern graphite zone occurring in the south-western side of Tumudibandh, within the Tumudibandh Graphite Belt.

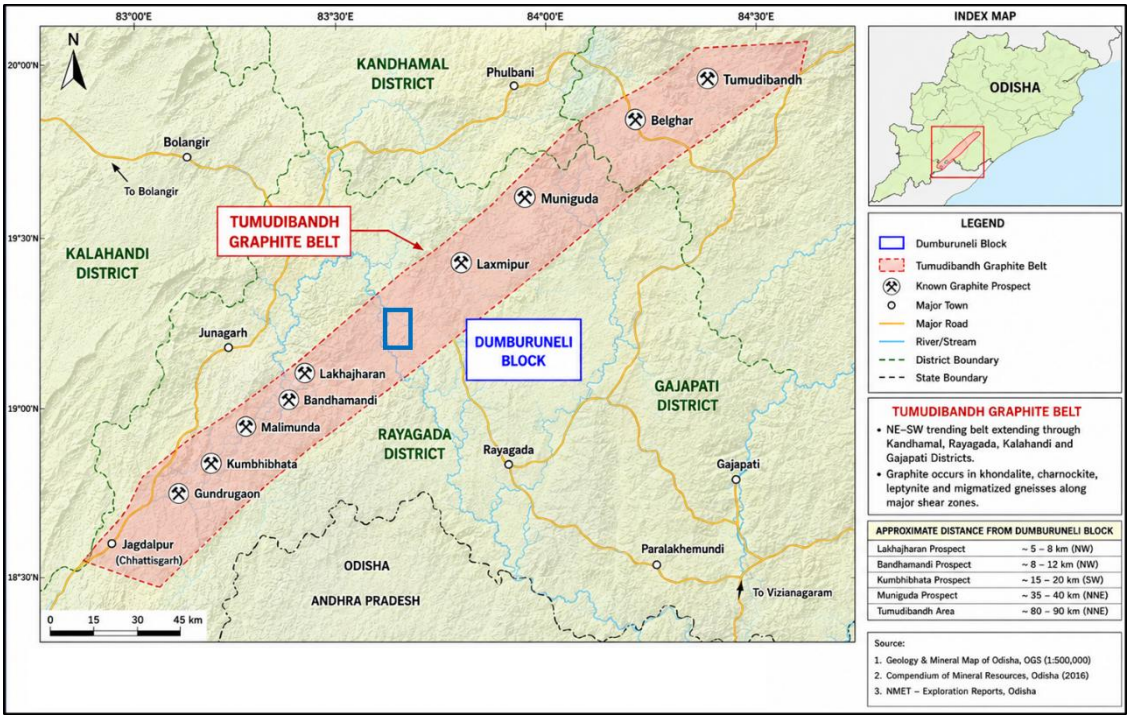


Fig 3.1: Disposition of the Dumburuneli Block within the Tumudibandh Graphite Belt

3.8 Accessibility

The Dumburuneli Block is well connected by road and rail, with Muniguda Railway Station, located approximately 10 to 15 km from the block, serving as the nearest major railhead. Other nearby railway station include Bissamcuttack (5 to 8 km) while Rayagada Junction, the principal railway station in the district, is situated about 55 to 60 km away. The nearest operational airport is Jeypore Airport, approximately 160 to 180 km from the block. The State-highway SH-46 is connecting the area to the National-highway NH-326 (**Fig 3.4**). Suitable accommodation and logistical support for exploration personnel are available at Muniguda and Rayagada, where hotels, guest houses, fuel stations, banking facilities, and other essential services are present, while few rented houses are available at Bissamcuttack as well. The block lies within the Tumudibandh Graphite Belt of the Eastern Ghats Mobile Belt and is located close to several known graphite occurrences, including Lakhajharan, Bandhamandi, Malimunda, Kumbhibhata, Gundrugaon, and the Muniguda area. Prominent tourist attractions in the vicinity include Deomali Peak, Chatikona, and Jagannath Temple at Rayagada, while no nationally protected archaeological monument is known to occur within the block area based on available published records.

3.9 Climate and Vegetation

The region exhibits a humid tropical climate with distinct seasonal variations, where summer temperatures reach extreme levels of up to 48°C, while the monsoon season extends from mid-June through September, delivering an average annual precipitation of around 130 cm, and winter months are characterized by cooler, more pleasant temperatures. The hill slopes are predominantly covered by tropical forests with underlying khondalite rock type that demonstrates high susceptibility to weathering processes, supporting diverse deciduous species including *Shorea robusta* (Sal), *Madhuca latifolia*, tamarind, mahul, and bamboo on the upper slopes, while lower slope vegetation comprises economically significant species such as jackfruit, kendu, mango, and banana. The invasive species *Chromolaena odorata* forms common bush throughout the area. The alluvial plains and fertile soils support intensive cultivation of staple crops including paddy, wheat, and various pulses, while hill slope agriculture focuses on cash crops, with cashew and cotton cultivation being particularly prevalent in the region, reflecting the adaptability of the area to varied topographical conditions and climatic patterns.

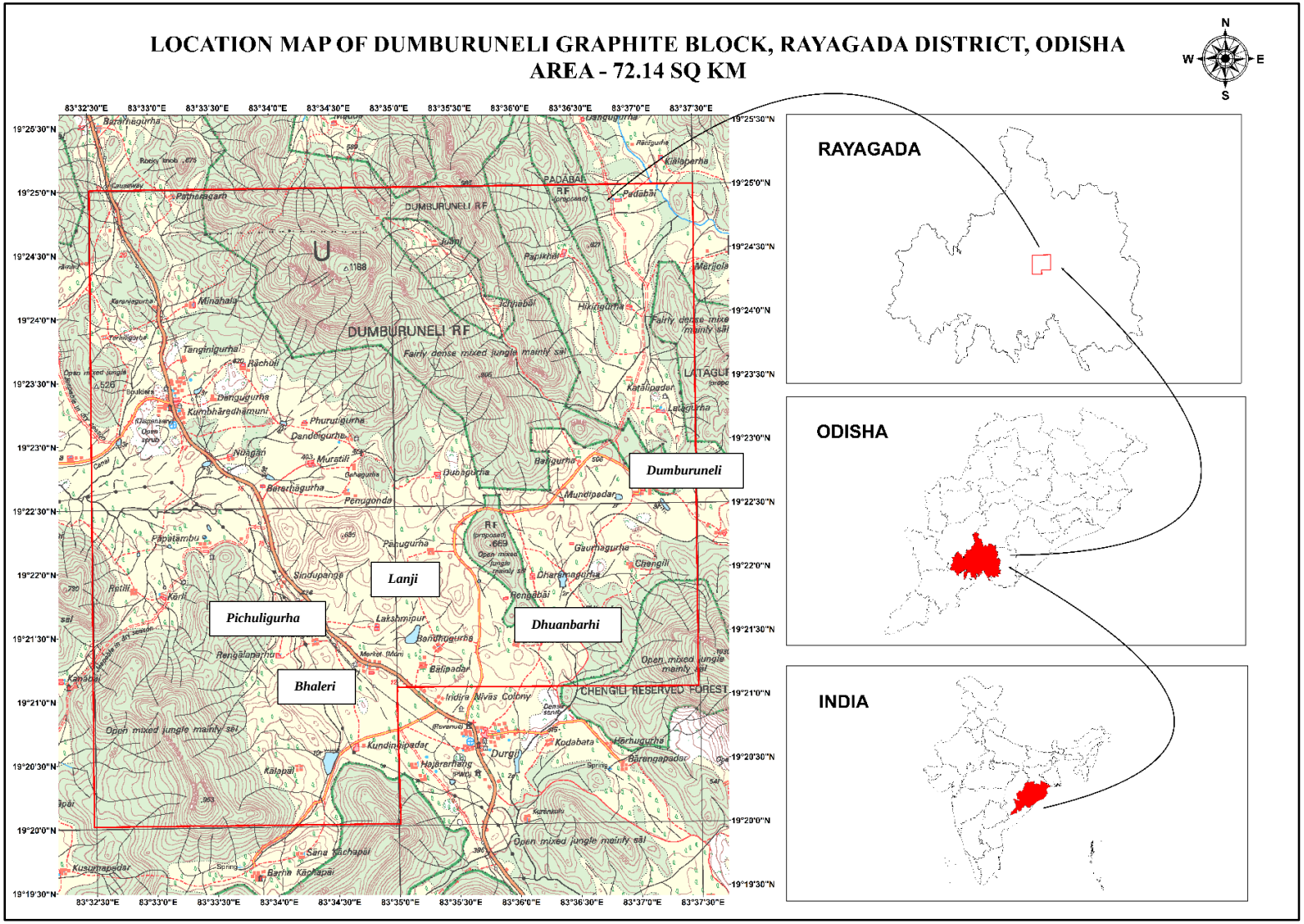


Fig 3.2: Location Map of the Dumburuneli Graphite Block, Rayagada District, Odisha

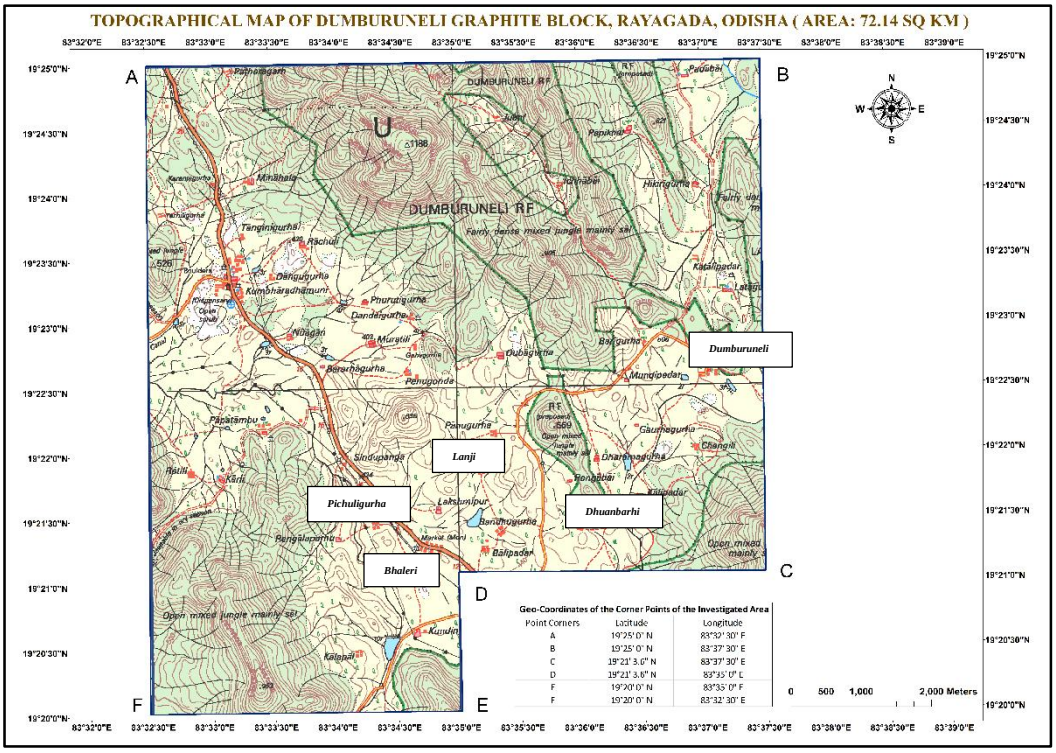


Fig 3.3: Topographical Map of the Dumburuneli Graphite Block, Rayagada District, Odisha

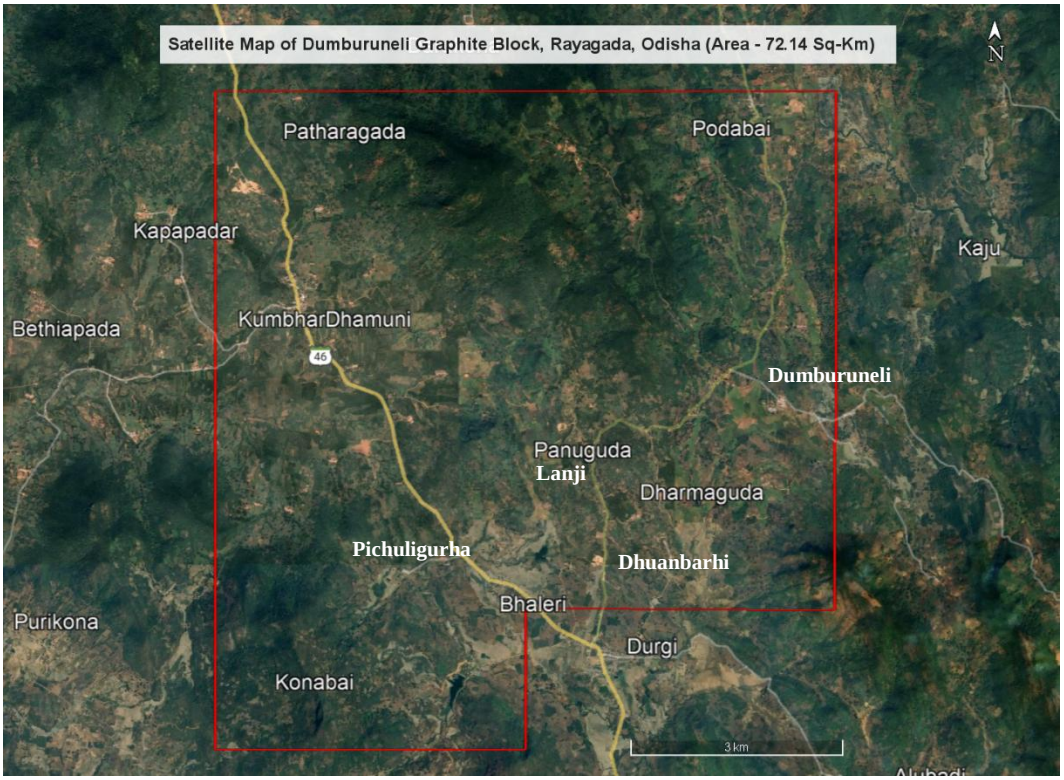


Fig 3.4: Satellite Map of the Dumburuneli Graphite Block, Rayagada District, Odisha

3.10 Flora and Fauna

The regional biodiversity encompasses a diverse array of flora and fauna adapted to the tropical ecosystem. The dominant flora species include mahul (*Bauhinia vahlii*), tamarind (*Tamarindus indica*), bamboo (*Bambusa vulgaris*), jackfruit (*Artocarpus heterophyllus*), kendu (*Diospyros melanoxylon*), mango (*Mangifera indica*), and banana (*Musa paradisiaca* L.), representing both native forest vegetation and economically important cultivated species. The faunal diversity is equally notable, with reptilian species such as chameleons and various snake species including gliding snakes, mammalian species including mongoose and wild buffalo, and avian species notably represented by peacocks, collectively forming a complex ecological community characteristic of tropical forest ecosystems.

3.11 Geomorphology

The region exhibits moderately rugged terrain with elevations ranging from 200–250 m in the southeast to about 1188 m in the north-central region. Drainage follows a dendritic to sub-dendritic pattern, with streams flowing south-easterly towards the boundary, featuring confluence zones and seasonal channels. Watershed divides occur along northern and western ridges, with asymmetric valleys which appears steeper to the north and gentler to the south. Landforms include ridge-and-valley hill systems and V-shaped valleys that widen near confluences, likely containing alluvial deposits. Topography reflects structural and lithological control, shaped by active stream erosion and monsoon-driven processes in a tropical humid setting. Higher altitudes are occupied by Khondalites whereas other lithological units are restricted to lower altitudes.

3.12 Local Infrastructure

Situated within the Eastern Ghats Mobile Belt, the area exhibits an undulating landscape characterized by prominent hill ranges, intervening valleys, and seasonal drainage channels. Despite the challenging terrain, several villages—including Bhaleri, Bandugurha, Panugurha, Kumbhardhamuni, Juani, Rachuli, Balipdar, Dhuanbadi, Retili and others —have developed within the region. The local tribal communities have adapted to these conditions by cultivating agricultural lands, even on relatively steep slopes. Most settlements are well connected through metalled roads and are equipped with electricity for domestic purposes, ensuring basic infrastructure and accessibility.

3.13 Environment

Rayagada district was established in early 1992 after separating from Koraput district in south-western Odisha. It spans 7,073 square kilometres. About 94% of the population lives in rural areas and relies on irrigation-based farming. The district has valuable minerals such as graphite, manganese, bauxite, china-clay, limestone, quartz, and gemstones, which support local industries. Agriculture and industry are the main drivers of Rayagada's economy and are vital for the community's prosperity. Tourism also plays an important role by taking advantage of the district’s natural beauty and cultural sites, creating economic opportunities for the local people.

CHAPTER 4: PREVIOUS WORKS

- Parts of the area and the surroundings were covered by systematic geological mapping earlier by Dey (1940-41), Dey and Chakraborty (1944-45) and Muktinath (1941-42). This was carried out at the standard one-inch scale, which is 1:63,360 (1 inch to 1 mile). Then, Chaudhury and Acharya (1977-78), Malviya and Mathur (1980-81) and Dasgupta (1981-82) have studied parts of it and gave a general geological account of the area comprising field relationships and basic petrography of the lithological units. These were primarily carried out at the 1:50,000 scale. They have grouped the lithological units under Eastern Ghats Supergroup (Complex).

- Officers of the Directorate of Geology, Odisha, Mohanty & Vajani first reported graphite occurrences around Sollagudi, Naringapanga, Khallupadar, Mudra, Bongna, Berli and Sabinala villages of Rayagada District during 1982–83. Preliminary investigations indicated graphite occurrences beneath thick soil cover with F.C values ranging from 7% to 49%. The graphite mineralization occurs within migmatised khondalite as stratiform bodies exhibiting concordant relationships with the host rock, suggesting structural control on mineralization.

- During 1983–84, Parida and Pani of the Directorate of Geology, Odisha carried out geological mapping in the Narigapanga–Bandhamandi area and reported seven graphite occurrences. Among these, the Bandhamandi occurrence was found to be of low grade, with fixed carbon (F.C.) content varying from 4.56% to 21.38%.

- In recent years, according to Nanda and Pati (1988, 1989), these areas are dominated by lithounit of khondalite group. These constitute nearly 75-80% of the areas and are coarsely banded, gneissic, of variable grain size and appearance. They have the characteristic brownish look on the surface due to alteration of garnet and kaolinisation of feldspars. However, fresh outcrops can be seen in quarries and road cuttings e.g. in Kailashkotta-Kolnara ghat section, in Hathikhamba-Bhagurhi road section and in Kailashkotta-Lalibi forest track. In hand specimens, the fresh ones are hard, compact, well foliated, and rich in quartz in which occur variable proportions of orthoclase, garnet and sillimanite. Some of the rare varieties rich in dark coloured spinel occur as thin lenses near Bhagurhi 1 km northeast of Lalibi. In general there is wide range of variation in the modal distribution of constituent mineral phases. A thin band of qtz + gt + sill +graphite schist with films rich in graphite was observed 1 km northeast of Parikuthi on the northern slope of the small hillock.

- Pasayat and Adhikari (1988) reported occurrences of graphite in different villages of Rayagada district like Bhaleri, Pichuligurha, Sindupanga, Jagdalpur, Dukum, Minahola etc.

- Later on, Nanda and Rauta (Field Season 2015–16) of the Directorate of Geology, Odisha carried out G4-level investigation around Panchubai village, Rayagada District, and estimated a reconnaissance resource of 0.032 million tonnes of graphite from ten graphite bodies. Among these, the Naringapanga graphite body was the most significant, with an estimated resource of 0.029 million tonnes.

- Sahoo and Rauta of the Directorate of Geology, Odisha carried out G2-level exploration around Naringapanga during the Field Season 2016–17 to assess the grade and resource potential of graphite for delineation of an auctionable mineral block. A total of 19 boreholes (404.45 m) were drilled over a 0.36 km² area, resulting in the estimation of an indicated geological resource of 0.142 million tonnes of graphite with an average fixed carbon (F.C.) content of 2.817%. The Naringapanga graphite block was subsequently auctioned successfully by the Government of Odisha in 2021.

- The Directorate of Mines and Geology (DoMG), Odisha, has completed G2-level exploration in the Jagdalpur Block, which has subsequently been auctioned successfully. DoMG Odisha has also completed G2-level exploration in the Khalpadar Block, delineating a graphite-mineralized zone of approximately 1 km strike length and 300 m width, with mineralization extending to an optimum vertical depth of about 132 m. The drilling programme was executed through an outsourced drilling agency.

- To the North of the present Dumburuneli block, recently in 2025, MMPL Pvt Ltd had successfully completed G4 Stage Reconnaissance Project for Graphite mineralisation within Darukona Area, of Rayagada district, located within the 65M/11 toposheet. Three graphite-bearing zones, designated as Zone A, Zone B, and Zone C, delineated based on an integrated analysis of surface and subsurface geological data. In Zone A, eight interpreted graphite bands with thicknesses ranging from 0.7 m to 5.0 m identified. These bands exhibit fixed carbon (FC) content exceeding 2%, with values ranging from 2.14% to 4.97% FC. The total graphite resource estimated for this zone is approximately 0.079 million tonnes. Zone B comprises four interpreted graphite bands, with thicknesses varying between 1.9 m and 12.6 m. The graphite in this zone also contains more than 2% FC, with values ranging from 3.42% to 5.16% FC. The estimated resource for Zone B stands at 0.031 million tonnes. In Zone C, two graphite bands delineated, exhibiting thicknesses between 2.23 m and 8.23 m. These bands contain graphite with FC content ranging from 2.89% to 3.52%. The total resource estimated for Zone C is approximately 0.085 million tonnes.

- To the South of the present block, recently in 2025, MMPL Pvt Ltd had successfully completed G4 Stage Reconnaissance Project for Graphite mineralisation within Kanapulisi area, of Rayagada district, located within the 65M/11 toposheet. Graphite mineralization encountered in this area are of disseminations and gneissose type. The small disseminated graphite flakes are generally found in khondalite and granite gneiss, oriented parallel to the foliation. Major graphite bands with encouraging analytical results are located near Kodabata (19°20'39.0"N, 83°36'14.0"E), Tala Barangapadar (19°20'27.0"N, 83°36'51.0"E) and Alubarhi (19°19'45.0"N, 83°38'09.0"E) villages. The minimum and maximum values of fixed carbon in the samples collected from these bands are 2.05% and 10.64% respectively. In total 269 numbers of bed rock smaples and core samples were analysied to trace the graphite zone of economic interest. A total resource of 0.120 million tonne was estimated for Zone A and 0.056 million tonne for Zone B.

- No published records of systematic ground geophysical investigations for graphite within the present block is available, although NGPM data of the region is available.

CHAPTER 5: GEOLOGY OF THE AREA

5.1 Regional Geology

The exploration block forms part of the Eastern Ghats Mobile Belt (EGMB), a Mesoproterozoic high-grade granulite terrain extending along the eastern margin of the Indian Peninsula from the Brahmani River in northern Odisha to Ongole in southeastern Andhra Pradesh. The belt extends for nearly 1,000 km, with an average width of about 100 km, attaining a maximum width of approximately 300 km in northern Odisha and narrowing to about 30 km in the southern part. Its continuity is interrupted by the Phanerozoic Mahanadi and Godavari grabens containing Gondwana sedimentary successions (Ramakrishnan et al., 1998; Mahalik, 1996).

The Eastern Ghats are a discontinuous mountain chain parallel to the Bay of Bengal coast. The EGMB represents a deeply exhumed granulite-facies orogenic belt that has undergone repeated episodes of deformation, high-grade metamorphism, partial melting, migmatization and charnockitization. The belt is interpreted as a Proterozoic convergent orogeny produced by oblique continental collision and subsequent tectono-thermal reworking (Mahalik, 1996; Ramakrishnan et al., 1998; Dobmeier & Raith, 2003).

Geophysical studies, particularly gravity modelling and deep seismic investigations, indicate an eastward-dipping crustal section with crustal thickness varying from about 38–40 km beneath the EGMB and comparatively high Bouguer gravity anomalies, suggesting the presence of dense lower-crustal material beneath the mobile belt (Mahalik, 1996; Krishna et al., 1994).

The regional geological framework of Odisha was divided by Mahalik (1996) into three tectonic sectors based on lithological association, structural grain and tectono-thermal evolution. The northern sector is characterized predominantly by ENE–WSW to NE–SW structural trends, whereas the southern sector exhibits pronounced NW–SE structural orientations owing to the influence of the Nagavalli–Vamsadhara Shear Zone, one of the major transcurrent shear systems affecting the southern Eastern Ghats. This regional shear system modified the structural grain of the southern EGMB and contributed to the development of NW–SE structural trends in southern Odisha and northern Andhra Pradesh (Mahalik, 1996; Biswal & Sinha, 2003).

The EGMB has traditionally been subdivided into four major litho-tectonic zones together with a transitional zone on the basis of lithology, protolith affinity, metamorphic evolution and structural disposition (Ramakrishnan et al., 1998; Mahalik, 1996). More recently, Behera and Mahakul (2024) refined this litho-tectonic framework by integrating updated geological mapping, structural relationships and mineral exploration data, demonstrating that graphite and manganese bearing meta-sedimentary horizons are preferentially confined to specific khondalite dominated litho-tectonic domains and associated regional shear corridors (Behera & Mahakul, 2024). These comprise the Western Charnockite Zone, Western

Khondalite Zone, Central Migmatite–Charnockite Zone, Eastern Khondalite Zone and the Transition Zone.

The Western Charnockite Zone: It primarily consists of charnockites and enderbites, with smaller amounts of basic and ultrabasic rocks, and some intercalated metapelitic khondalites and basic granulites. There are multiple generations of charnockites, with the earliest showing deformation, gneissic textures, garnet mineralization, and alignment with khondalites.

The Western Khondalite Zone: It features metapelitic khondalites, interspersed with quartzites, calc-silicate gneisses, marbles, and remarkable high-magnesium-aluminum granulites with sapphirine mineralization. This zone also includes intrusive charnockite bodies and massif-type anorthosite complexes found in Bolangir, Turrkel, and Jugsaipatna. Metamorphosed basic sills and lava flows are represented by basic granulite bodies situated within the khondalite succession, along with other plutonic intrusions.

The Central Migmatite-Charnockite Zone: It largely consists of migmatites and garnet-bearing diatexites alongside leptynites, high-magnesium-aluminum granulites, and calc-silicate rocks, which are intruded by charnockites and porphyritic granites. Massif-type anorthosite bodies can also be found here. The migmatites formed through high-grade metamorphic processes, involving the selective melting of siliceous granulites. Geochemical studies of charnockites show similarities to tholeiitic and calc-alkaline basaltic parent rocks. Initial charnockites occur locally on granulitic gneisses and migmatites, linked to CO_2-rich fluid movement and charnockitization processes affecting appropriately composed meta-sediments.

The Eastern Khondalite Zone: It shares similar rock characteristics with the Western Khondalite Zone but does not contain anorthosite bodies. Leptynites mixed with khondalites in the Chilka Lake area produced granitoids by dehydration melting in metapelitic rocks of different compositions. Trails of sillimanite inclusions within garnets suggest that partial melting took place in khondalites. In the northern Rengali domain, several shear zones allowed for the intrusion of alkaline rocks and created fluid pathways for charnockitization and migmatization of granulitic rocks. Ultrabasic intrusions appear as boudinaged bodies within highly deformed khondalite masses in shear zones, with associated co-magmatic anorthosites present as metamorphosed and tectonized layers.

The Transition Zone: It lies along the western and south-western edges of the EGMB and contains a mixed rock-type of cratonic and Western Charnockite Zone. Granulites in this zone show retrograde metamorphism to amphibolite facies at the boundaries of shear zones.

The present exploration block lies within the Rayagada segment of the Tumudibandh Graphite Belt, one of the most important graphite-bearing metallogenic belts of the Eastern Ghats Mobile Belt. The belt extends from Tumudibandh in Kandhamal district through Rayagada into northern Andhra Pradesh and hosts numerous graphite occurrences including Naringapanga, Bandhamandi, Panchubai, Jagdalpur, Khalpadar, Kumbhibhata and Gundrugaon. Graphite mineralization is predominantly confined to graphite-bearing khondalite, garnet–sillimanite gneiss and associated meta-sedimentary granulites, occurring as conformable bands, lenses and disseminated horizons parallel to the regional foliation. The localization and continuity of graphite mineralization are strongly controlled by regional ductile shear zones. Nash et al. (1996) interpreted the Tumudibandh Shear Zone as one of the

principal litho-structural boundaries within the northern Eastern Ghats using Landsat Thematic Mapper imagery and demonstrated that it represents a major NE–SW-trending ductile shear corridor separating distinct litho-tectonic domains. The shear zone is characterized by intense deformation, mylonitization and repeated tectonic reactivation, which facilitated metamorphic fluid migration and structural thickening of graphite-bearing horizons. Recent litho-tectonic synthesis by Behera and Mahakul (2024) further demonstrates that graphite and manganese bearing meta-sedimentary horizons are preferentially developed within specific khondalite domains and high-strain corridors, thereby emphasizing the importance of regional shear systems in controlling graphite mineralization throughout the Tumudibandh Graphite Belt.

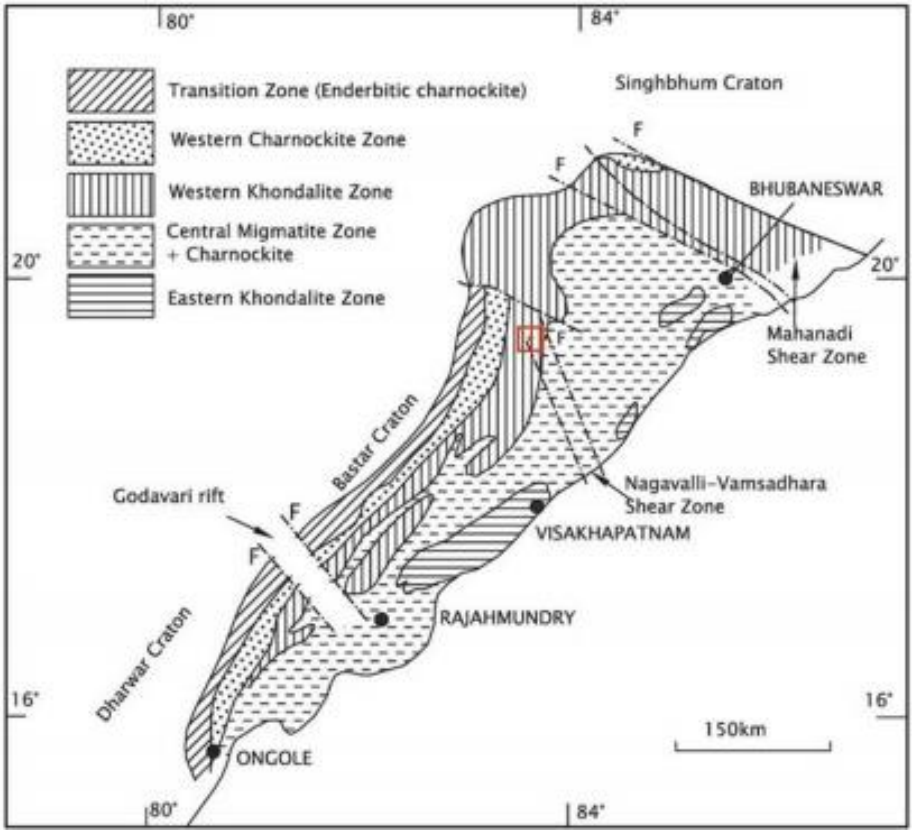


Fig 5.1: Location of the study area on the map of Eastern Ghats Mobile Belt (Ramkrishnan et al. 1998; Dasgupta and Sengupta 2002; Biswal and Sinha 2003)

5.2 Stratigraphic Column

On the basis of different geological investigations and evidences a tentative stratigraphic column was proposed by Ramakrishnan et al., (1994).

Table 5.1 : Stratigraphic Sequence of Eastern Ghats [Ramakrishnan et al., (1994)]	
AGE	**LITHOLOGICAL UNITS**
800-900 Ma	Alkaline rocks, granitoids
1000-1100 Ma	-------Eastern Ghats orogeny--------
	Development of eastern Ghats front of upgraded cratonic rocks
	Incipient and massive charnockite and garnetiferous gneiss with biotite and sillimanite
1300-1400 Ma	Emplacement of alkaline rocks (Feldspathoid gneiss and anorthosite)
Khondalite Group (WKZ, CMZ, EKZ)	Garnet-sillimanite-Quartzo-feldspathic graphite gneiss
	Cordierite-sapphirine-spinel rocks
	Calc silicate rocks and rare marbles
	Quartzite rich in garnet
1600-1800 Ma (WCZ)	Evolution of purana basin
2600-2800 Ma	Charnockite with enclaves of basic granulite, high grade schists including BIF and layered basic complexes, representing original cratonic basement (?) in migmatitic amphibolite facies
3000 Ma	Vestigial events (?)

5.3 Regional Structure

The Eastern Ghats in Peninsular India exhibit a northeast-southwest trending pattern and consist of detached hill ranges extending from Cuttack to the Nilgiris. The Eastern Ghats Mobile Belt can be differentiated from the southern granulite terrain based on several distinctive characteristics including lithological polarity differences, the occurrence of manganese and marble deposits, widespread garnetiferous gneiss, specific structural alignments, and distinct age relationships as documented by Ramakrishnan in 1998.

Within Odisha, the Eastern Ghats Complex is predominantly composed of meta-sedimentary rocks including khondalite, quartzite, acid gneiss, and calc-silicate granulite. These formations are closely associated with basic granulite containing two pyroxenes, charnockite, porphyroblastic acid gneiss, and leptynite. These diverse rock types create banded assemblages that are extensively penetrated by quartz-feldspar neosomes and pegmatites,

resulting in migmatite formation. This process creates paleosome neosome mixtures of varying degrees across different locations, which represents the characteristic migmatite complex typical of the Eastern Ghats as described by Halden et al (1982).

The structural complexity of these lithological layers is remarkable, with parallel bands of more or less foliated graphite within the Eastern Ghats Complex of Odisha displaying diverse orientations. Despite the regional northeast-southwest trend of the Eastern Ghats, these rock units have undergone four successive phases of folding. The first phase produced isoclinal to tight intrafolial folds, followed by asymmetrical to isoclinal intrafolial folds in the second phase. The third phase created open folds, while the fourth phase resulted in warp folds, as documented by various researchers including Krishnan (1953), Halden et al (1982), Park and Dash (1984), and Acharya and Dash (1984).

The orientation patterns of major lithological units vary significantly across different regions of Odisha. In the western and southern portions, these units trend northeast-southwest to north-northeast-south-southwest. However, in the eastern areas, the major lithological units exhibit orientations ranging from north-northwest-south-southeast to northwest-southeast, with some areas showing east-west trending patterns (Mahalik (1996); Biswal & Sinha (2003); Behera & Mahakul (2024)).

5.4 Metamorphism

The structural and thermal features of the Eastern Ghats Mobile Belt (EGMB) are defined by a series of unique mineral groups that illustrate its development from peak heating to isobaric cooling. It starts with the common khondalites, which include the garnet-sillimanite-perthite-plagioclase-quartz ± graphite suite. This suite was originally described by Walker (1902) and was seen by Sen et al (1995) as the leftover material from extensive crustal melting.

In close association with these are the leptynites. Bhattacharya (1997) identified them as products of dehydration melting. They are marked by a garnet-plagioclase-perthite-quartz group formed during the breakdown of biotite at high temperatures. The belt’s distinct fluid environment and cooling history are recorded in calc-silicate granulites. Here, the complex wollastonite-scapolite-plagioclase-garnet-calcite-clinopyroxene-sphene association shows signs of high CO_2 activity and isobaric cooling paths (Dasgupta, 1993; Sengupta et al., 1990). Moreover, the basic granulites with orthopyroxene-clinopyroxene-plagioclase ± garnet serve as main indicators of the belt's deep crustal position (Dasgupta et al., 1991).

The clear signs of Ultra-High Temperature (UHT) metamorphism are found in Mg-Al granulites. The diagnostic sapphirine, spinel, orthopyroxene, garnet, quartz/corundum, cordierite, sillimanite reported by Lal et al. (1987) and Dasgupta et al. (1995) confirms heating peaks over 1000°C. This rock framework is supported by the enderbite-charnockite suite, which includes orthopyroxene-plagioclase-quartz-perthite combinations. Bhattacharya (1996) and Gupta (2004) classify this suite as a mix of igneous and metamorphic processes that serve as the structural base of the mobile belt.

The thermal evolution of the Eastern Ghats terrain is defined by extreme granulite facies conditions, with peak temperatures reaching 950°C to 1040°C and pressures of 8 to 10 kbar (Dasgupta, 1995; Dasgupta & Sengupta, 2002). This ultra-high temperature (UHT) metamorphism followed an anticlockwise P-T path, driven by lithospheric-scale thermal disturbances resulting from the under-plating or intra-plating of basic magma (Dasgupta & Sengupta, 2002). These peak conditions were widespread, with specific evidence documented in Vijaynagaram (Sarkar et al., 2003) and Chilka Lake (Bhattacharya, 2004), where dehydration melting also took place (Sen & Bhattacharya, 1997). Following this peak, the terrain underwent a three-phase metamorphic reconstitution involving near-isothermal decompression and subsequent retrograde cooling to 750°C to 800°C at 6 to 7 kbar, eventually reaching amphibolite facies (Dasgupta & Sengupta, 2002; Sarkar et al., 2003).

Regional variations within the belt provide further insight into these complex processes, such as the Mg-Al granulites in Visakhapatnam, which formed between 930°C to 740°C (Lal et al., 1987; Lal, 1997), and the northern enderbites where basic magma influx pushed temperatures above 950°C (Bose et al., 2003). While much of the belt follows an anticlockwise trajectory, the Deobhog area preserves relict kyanite that indicates a clockwise P-T path involving decompression and isobaric cooling (Patel et al., 2001). In the Gangarajumuduguli sector, the influx of CO_2-rich fluids facilitated the formation of charnockites under dry conditions at 860°C and 9 kbar (Mohan et al., 2003). These deep-seated processes are corroborated by the geochemistry of megacrystic granites, whose high strontium ratios and trace element signatures point to a crustal melting origin at temperatures up to 1000°C (Divakara Rao et al., 1998, 2001).

CHAPTER 6: GEOSCIENCE INVESTIGATION

6.1 Geological Mapping

An area of 72.14 sq. km was covered through Large Scale Mapping, on 1:12,500 scale, (**Plate I (A)** & **I (B)**) in and around the villages Bhaleri, Pichuligurha, Bandugurha, Dhuanbadi, Lanji, Panugurha, Sindupanga, Kumbhardhamuni and others for investigation of graphite. The block is bounded by latitudes 19º20'00'' N and 19º25'00'' N and longitudes 83º32'30'' E and 83º37'30'' E and located in the Rayagada district of Odisha.

Table 6.1 : Lithostratigraphic succession of the study area

AGE	LITHOLOGICAL UNITS
1000-1100 Ma	-------Eastern Ghats orogeny--------
	Incipient and massive charnockite, leptynite, migmatites and garnetiferous gneiss with biotite and sillimanite
Khondalite Group	Garnet-sillimanite-Quartzo-feldspathic graphite gneiss
	Quartzite rich in garnet
3000 Ma	Vestigial events (?)

6.1.1 Description of major lithological units

Khondalite

Khondalite is possibly the oldest rock unit in the study area and shows extensive migmatization along with various degrees of alteration (**Fig 6.1 a**). It is dominant lithological unit and covers an area of 43 sq.km which is 59.60 % of the study area. This rock is often visible in natural stream cuts and on many hillocks in the region. When examined in hand specimens, khondalite has a distinct reddish-brown colour and a medium to coarse-grained texture. It is hard, compact with well-defined layers. The main minerals found in khondalite include garnet, sillimanite, quartz, and feldspar. Occasionally, there are small amounts of graphite flakes and opaque minerals as accessories (**Fig 6.3**). This mineral association indicates that the rock underwent granulite facies metamorphism during its geological history. The rock often forms banded structures with quartzo-feldspathic gneiss and frequently shows evidence of silicification. The characteristic reddish colour comes from iron that has been leached from the garnet crystals during weathering. Graphite flakes are sometimes found spread throughout the matrix. Structural measurements show that the foliation trends mostly in a NW-SE direction, with dip angles between 45° and 75° towards southwest. The rock has experienced

intense weathering and alteration of its minerals, leading to a moderately fissile quality in some areas, particularly affecting the plagioclase porphyroblasts, which show significant alteration.

Granite Gneiss

Granite gneiss is the second most common rock type in the study area, covering 18 square kilometres or 24.95 % of the study area (**Fig 6.1 b**). This rock is mainly found at lower elevations, especially along the foothills and valley floors. Here, it appears as surface boulders which are closely linked to migmatised khondalites. It shows crude foliation and exfoliation weathering patterns. There are two distinct varieties: porphyritic granite gneiss (limited outcrops), which forms small oval-shaped hillocks, and foliated granite gneiss (plenty of outcrops) found along the foothills. When examined in hand specimens, granite gneiss has a pinkish-white colour and a coarse-grained texture, with crude foliation. It contains primary minerals like garnet, quartz, and feldspar, as well as some opaques as accessory minerals (**Fig 6.4**) and occasional graphite flakes along foliation planes near Dharmagurha and Sindupanga villages. The structural orientation displays a consistent NW-SE trend of foliation, with dip angles ranging from 40° to 75° towards southwest.

Charnockite

Charnockite is the third most abundant rock type in the study area, covering 7 square kilometres or 9.70 % of the study area (**Fig 6.2 a**). This hard and massive rock has a medium grain size. It shows bouldery outcrops with smooth transitions to khondalite and with clear gneissic patterns with exfoliation weathering. The gneissosity is defined by the arrangement of quartz and feldspar crystals in preferred directions. Alternate dark bands of granulated hypersthene prisms and biotite flakes, as well as light bands rich in quartz and feldspar together define the gneissosity. In terms of mineral content, charnockite includes main components like plagioclase, orthoclase, hypersthene, and quartz. Biotite is present as a minor constituent (**Fig 6.5 & 6.12**).

Leptynite

Leptynite appears as narrow bands within khondalites (**Fig 6.2 b**). It has gradational contacts and a close relationship with the host rock. This light-coloured, medium to fine-grained rock exhibits both granulitic and gneissose textures. It is rich in garnet, quartz and feldspar, resembling granite gneiss but with a charnockitic texture. The feldspar content is proportionately greater than quartz (**Fig 6.6**). The leptynite shows gradual transitions parallel to the strike toward charnockite and migmatite. It often mixes with charnockitic rocks, especially near contacts with khondalite. Based on its field relationships and petrographic features, the leptynite is seen as the result of reconstitution, recrystallization, and migmatization processes affecting impure arkosic sandstones. All observed outcrops are found close to or directly at lithological contacts within the Khondalite Group.

Migmatite

Migmatitic rock units show complex structural and compositional relationships. They appear as distinct patches mixed with khondalite, granite gneiss, and charnockite. The migmatites have varying paleosomic bands, lenses, and schlierens of charnockite and khondalites. These patterns show progressive assimilation stages, marked by quartz-feldspar rich neosomic zones, and feature nebulitic, stromatic, and banded structures with localized megacrystic feldspar development. (**Fig 6.2 c**)

Compositionally, these migmatites vary from pinkish, garnet-biotite banded varieties to those characterized by centimetre-scale, bluish-grey patches and clots. A critical field observation is the gradual transition between the migmatites and the parent khondalites; the foliation generally remains continuous across these zones, suggesting a genetic link rather than an external intrusion. Texturally, the preservation of metamorphic paleosomes alongside neosomes—the latter displaying igneous-like flow structures confirms that these rocks represent a site of significant remobilization. These features collectively indicate that the migmatites formed through in-situ partial melting (anatexis), where local thermal peaks triggered the generation and segregation of melt within the country rock.

Quartzo-feldspathic graphite gneiss

The dominant graphite-bearing lithology in the study area is the quartzo-feldspathic graphite gneiss (**Fig 6.2 d**). It has a diverse mix of minerals, including quartz, plagioclase, and K-feldspar, with varying amounts of biotite and graphite, which creates the primary layering (**Fig 6.7, 6.8 & 6.9**). This gneiss shows clear compositional bands. There are graphite-rich, dark bands (ranges from few millimetres to 3 to 5 cm in thickness) that alternate with lighter bands made mostly of quartz and feldspar. The graphite appears as concentrated in bands with flakes of different sizes, mostly between 1 and 5 mm. It is closely linked with biotite, which helps define the overall foliation of the rocks. The graphite-rich rocks are mainly found at sharp contact zones between khondalite units—which often have minor graphite flakes—and granite gneiss or migmatitic complexes. This pattern suggests that structural or metamorphic processes had a control in the localization of the graphite. Local processes of migmatization have impacted the graphite-bearing gneisses, shown by folded and flow-like deformation structures in the graphite rich bands.

Quartzite

The quartzite is brownish-white in colour, medium to coarse grained, hard and compact composed predominantly of quartz with small proportions of garnet (**Fig 6.2 e**). Although they do not occur as mappable units, but they are observed near Kalipadar & Karanjagurha village and also show a sharp contact with charnockite near Rengalpaharu village.

In the study area, the contacts between khondalite, charnockite, leptynite, granite gneiss and migmatite are predominantly conformable to gradational, although locally modified into tectonic contacts by later deformation. Khondalite commonly grades into leptynite through progressive quartz–feldspar enrichment, while leptynite forms a transitional lithology between khondalite and charnockite. Charnockite occurs both as concordant bands and as larger intrusive bodies; incipient charnockites exhibit diffuse contacts with khondalite owing to in-situ charnockitization. Granite gneiss is intimately associated with these lithologies as concordant sheets or gneissic bodies and commonly grades into migmatite through partial melting and at places possibly by lit-par-lit injection of quartzo-feldspathic neosome. Migmatites represent zones of extensive anatexis where original lithological boundaries have become diffuse. These contact relationships are also observed in the core as they are predominantly conformable to gradational, with migmatization producing diffuse transitions between khondalite and migmatised khondalite as well as between granite gneiss and migmatised granite gneiss. Leptynite and charnockite occur mainly as concordant bands parallel to the regional foliation. The graphite bands (mostly quartzo-feldspathic graphite gneiss) are consistently confined within the khondalite–migmatised khondalite sequence and are parallel to the lithological contacts. Although no mappable unit of quartzite is observed on the surface, but significant amount of garnetiferous quartzite has been intersected within few boreholes. Bands of khondalite with traces of graphite, are mapped near Juani, north of Hikiriguma, west of Kalipadar, SE of Guaragurha, E of Kalipadar, N of Sindupanga, W of Pichuligarha, N and NW of Lakshmipur, NE of Dhuanbari and SE of Lanji. These have disseminated graphite flakes within them but are not concentrated enough to become economically viable. But this lithology is an important indicator as the economic graphite bands are always associated in proximity to them.

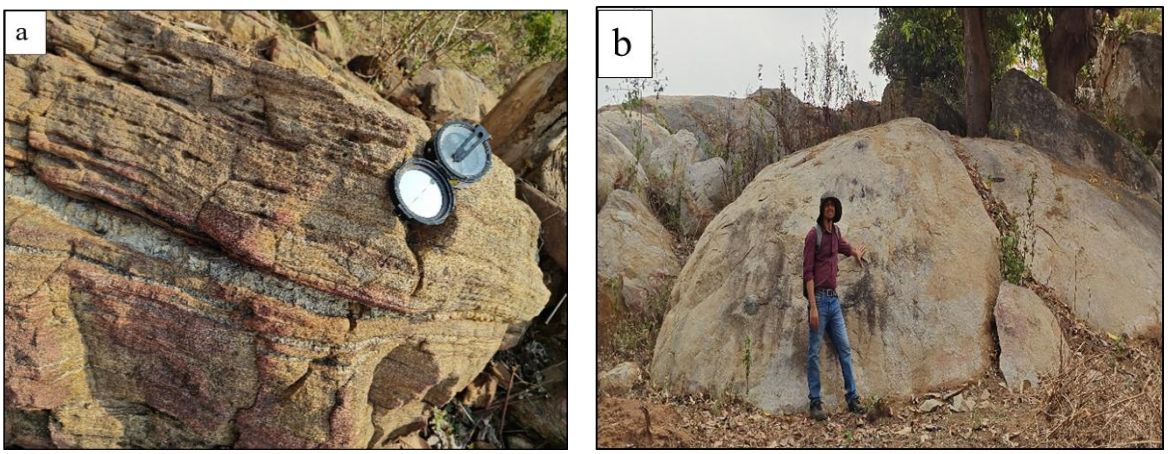


Fig 6.1: (a) Khondalite showing well developed foliation planes (b) Granite-gneiss showing a domal shaped outcrop

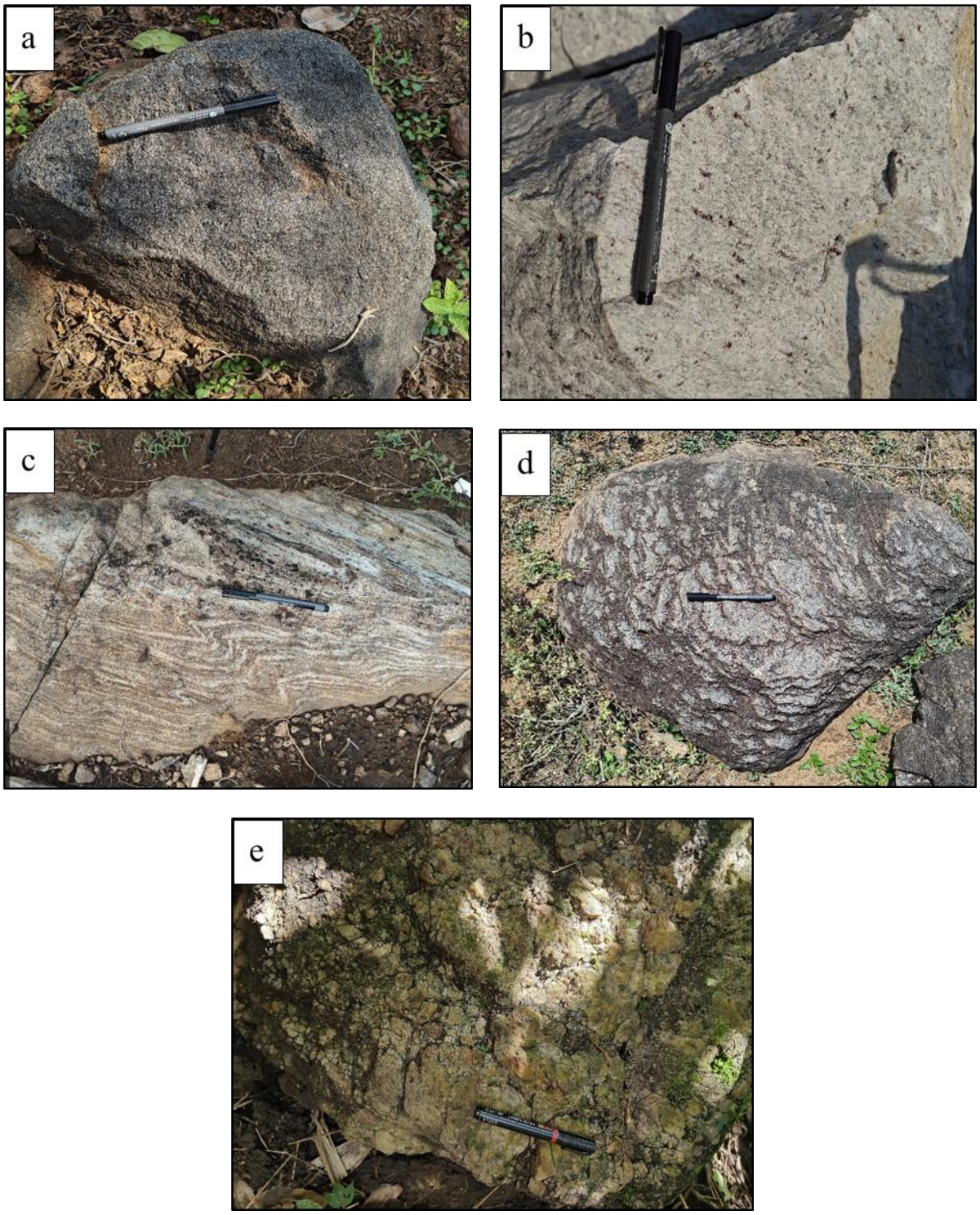


Fig 6.2: (a) Charnockite outcrop exposed near Kalapai village (b) Leptynite outcrop exposed near Rengalparu village (c) Migmatite showing flow bandings (d) Quartzo-feldspathic graphite gneiss outcrop exposed near Pichuliguda village (e) Quartzite outcrop exposed near Karanjagurha village

6.1.2 Petrographic Studies

Introduction

Petrographic investigations were conducted on ten representative samples, comprising five surface bedrock samples and five borehole core samples, collected from the Dumburuneli Graphite Block, Rayagada District, Odisha. The area falls within the Eastern Ghats Mobile Belt (EGMB) and the study was undertaken to characterize the mineralogical composition, textural attributes, metamorphic features, and evidence of graphite mineralisation within the various lithological units encountered in the area. Detailed microscopic examination of polished thin sections were conducted under transmitted and reflected light to establish the petrographic characteristics of the host rocks and to assess the mode of occurrence and relationship of graphite mineralization with the associated lithologies.

The Eastern Ghats Mobile Belt represents a high-grade metamorphic terrain comprising metamorphic rocks of granulite-facies that have undergone multiple phases of deformation, metamorphism, migmatization, and tectono-thermal reworking. The investigated samples comprise a suite of metamorphic lithologies including khondalite, leptynite, graphite-bearing gneiss along with charnockite and granite gneiss.

Petrographic studies reveal that graphite mineralization is primarily hosted within quartzo-feldspathic gneisses and khondalites, where graphite occurs predominantly as flaky crystalline in nature and aligned mostly along the dominant foliation planes. The preferred orientation of graphite flakes along the metamorphic fabric indicates strong structural control on graphite concentration and distribution.

The examined samples display a variety of metamorphic textures including granoblastic, nematoblastic and xenoblastic, together with evidence of recrystallization, mineral segregation, porphyroblast development, and localized retrograde alteration. The mineralogical assemblages and textural relationships observed in the thin sections provide valuable insights into the metamorphic evolution of the host rocks and the geological controls governing graphite mineralization within the Dumburuneli Graphite Prospect.

Petrographic Observations

Detailed petrographic investigations of the examined thin sections were undertaken to characterize the mineralogical composition, textural features, and metamorphic attributes. The sample-wise petrographic observations and lithological interpretations are presented below.

Bedrock Samples

Sample: DS-86

Rock Type: Khondalite

The thin section reveals a medium- to coarse-grained garnet–sillimanite-bearing quartzo-feldspathic metamorphic rock exhibiting a well-developed foliation defined by the preferred orientation of sillimanite. Quartz and subordinate plagioclase constitute the dominant felsic phases forming the groundmass.

Porphyroblasts of garnet occur with sub-idioblastic to xenoblastic grain boundaries and remain isotropic under crossed polars. Several garnet grains contain minute quartz inclusions, indicating syn to post-tectonic garnet growth during metamorphism. Many garnet grains exhibit reaction rims and varying degrees of alteration, ranging from marginal replacement to complete pseudomorphic substitution by opaque iron oxide phases. These alteration products, interpreted as haematite and/or goethite, form precipitation rims around garnet grain boundaries and suggest retrograde oxidation and fluid-assisted alteration following peak metamorphism. Fine opaque inclusions are also present within garnet and along grain boundaries.

Sillimanite occurs as abundant elongated prismatic grains aligned parallel to the foliation, reinforcing the metamorphic fabric. Sections parallel to the elongation of the grains display high order interference colours and commonly exhibit transverse fractures, whereas transverse sections appear as idioblastic outlines and first order interference colour with well-developed cleavage traces. Based on published literature, sillimanite in the khondalite suite is interpreted to have formed during high-temperature, high-grade regional metamorphism of aluminium-rich pelitic sedimentary protoliths. The development of sillimanite reflects metamorphic conditions characteristic of granulite facies, where Al-rich precursor sediments underwent prograde metamorphism, resulting in the formation of the characteristic sillimanite-bearing khondalite assemblage.

Quartz occur as interlocking xenoblastic grains, locally exhibiting undulose extinction. Plagioclase are present as subordinate grains within the quartzo-feldspathic matrix. Opaque minerals, likely hematite and/or goethite, occur as fine disseminated grains associated with feldspars and along grain boundaries.

The mineral assemblage of garnet–sillimanite–quartz–plagioclase, together with the well-developed foliation and porphyroblastic texture, is indicative of high-grade regional metamorphism under granulite-facies. Based on the observed mineralogy and textural characteristics, the rock is identified as **Khondalite**.

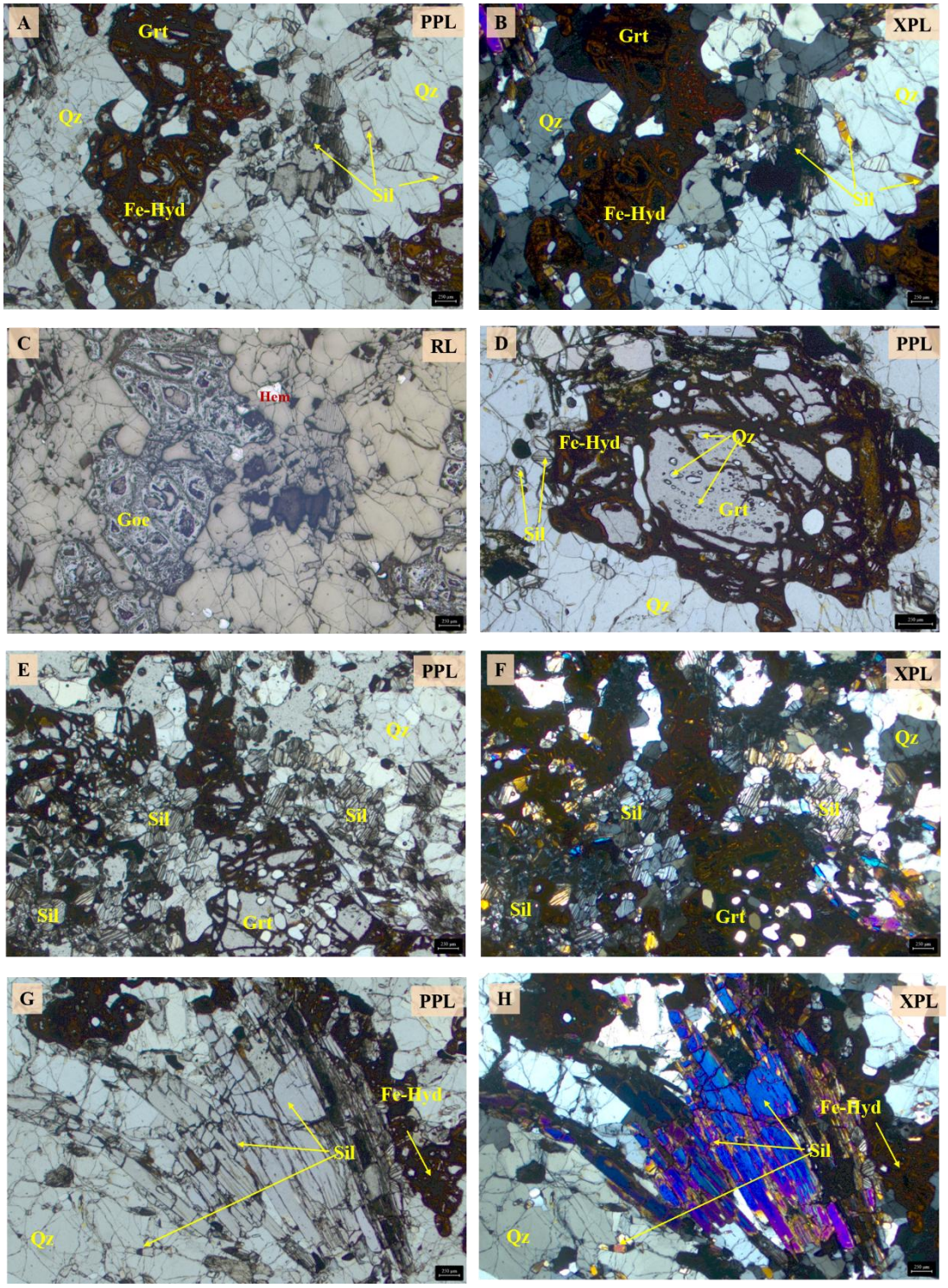


Fig 6.3: Photomicrographs of thin section DS-86 (Khondalite) showing the characteristic garnet–sillimanite–quartz–feldspar assemblage and associated metamorphic textures. (A–C) PPL, XPL, and reflected-light images of the same field showing altered garnet porphyroblasts within a sillimanite-bearing quartzo-feldspathic matrix; the reflected-light image highlights opaque iron oxide phases (haematite and/or goethite) formed by garnet alteration. (D) Garnet porphyroblast displaying iron oxide alteration along its margins and containing quartz inclusions. (E–F) PPL and XPL images of the garnet–sillimanite-bearing quartzo-feldspathic matrix showing a weak preferred mineral orientation and metamorphic fabric. (G–H) PPL and XPL images of elongated prismatic sillimanite grains, with the XPL view emphasizing their characteristic morphology and interference colours.

Sample: DS-632

Rock Type: Garnetiferous–biotite quartzo-feldspathic gneiss

The thin section is composed predominantly of a quartzo-feldspathic assemblage comprising quartz, plagioclase, minor microcline, garnet, and biotite. The rock exhibits a weakly foliated to moderately foliated fabric defined by the preferred orientation of biotite flakes within a recrystallized quartzo-feldspathic matrix. The overall appearance is leucocratic, with ferromagnesian minerals occurring as disseminated constituents throughout the rock.

Quartz is the dominant mineral phase and occur as medium to coarse-grained xenoblastic grains forming an interlocking polygonal mosaic. The quartz grains display recrystallized grain boundaries and locally develop triple-junction contacts, indicative of high-temperature equilibration and static recrystallization. Plagioclase occur as sub-idioblastic to xenoblastic grains intimately associated with quartz and commonly exhibit polysynthetic twinning under crossed polars. Minor microcline is present within the feldspathic fraction and contribute to the felsic character of the rock.

Garnet occurs as medium-grained sub-idioblastic to xenoblastic porphyroblasts dispersed throughout the matrix. The garnet grains exhibit irregular outlines and are locally fractured, suggesting post-crystallization deformation. In places, the garnet grains appear aligned parallel to the dominant fabric, indicating growth during progressive metamorphism and subsequent participation in deformation. Biotite occur as elongate flakes and exhibit strong pleochroism under plane-polarized light and moderate to high interference colours under crossed polars. The preferred orientation of biotite defines the principal foliation and imparts a lepidoblastic character to the rock.

The rock exhibits a predominantly granoblastic to lepidoblastic texture characterized by extensive recrystallization of quartz and feldspar, polygonal grain boundaries, and equilibrium grain boundary relationships. The mineral assemblage of quartz, plagioclase, microcline, garnet and biotite, together with the recrystallized polygonal matrix, indicates metamorphism under upper amphibolite- to granulite-facies condition.

Based on the observed mineral assemblage, texture, and metamorphic fabric, the rock is classified as a **Garnetiferous-biotite quartzo-feldspathic gneiss.** The petrographic characteristics reflect high-grade regional metamorphism accompanied by significant recrystallization and development of a weak to moderate foliation within a dominantly quartzo-feldspathic protolith.

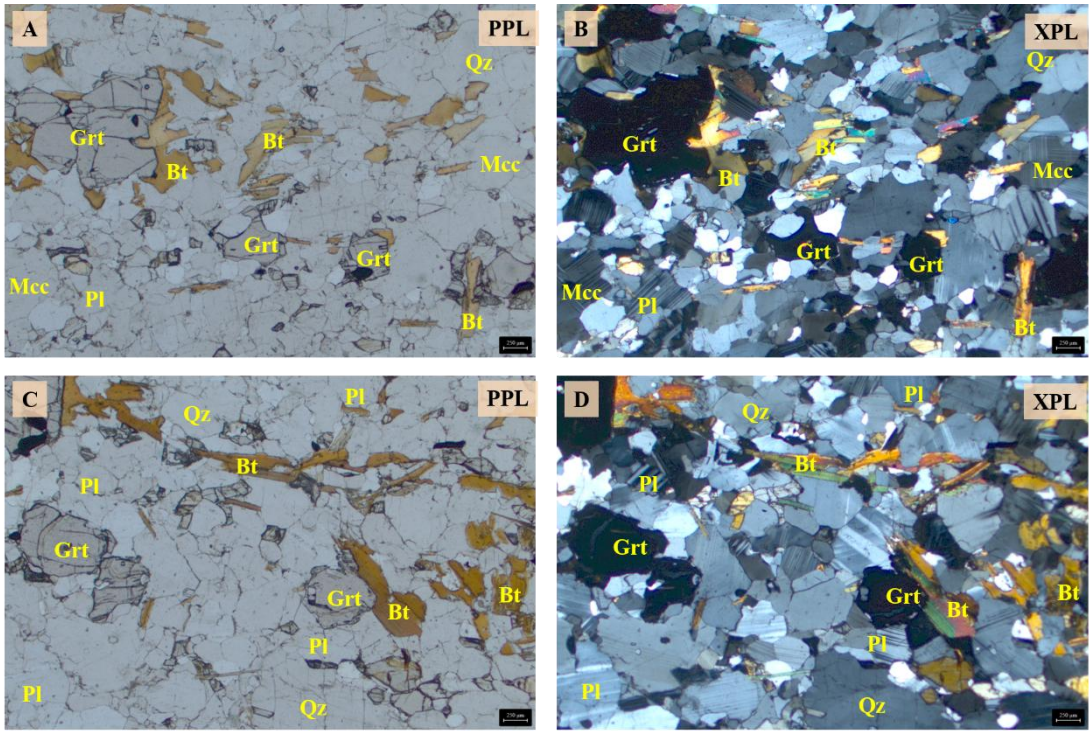


Fig 6.4: Photomicrographs of thin section DS-632 (Garnetiferous–biotite quartzo-feldspathic gneiss) under plane-polarized light (A, C) and crossed polars (B, D), showing a recrystallized quartzo-feldspathic matrix comprising quartz (Qz), plagioclase (Pl), and microcline (Mcc), together with garnet (Grt) porphyroblasts and aligned biotite (Bt) flakes. The rock exhibits a granoblastic to lepidoblastic texture characterized by polygonal quartz-feldspar aggregates & foliation defined by biotite, and equilibrium grain-boundary relationships indicative of high-grade metamorphism.

Sample: DS-1112

Rock Type: Charnockite

The thin section comprises a medium-grained charnockite exhibiting a predominantly granoblastic texture characterized by an equigranular mosaic of mutually adjusted mineral grains. The rock displays extensive recrystallization, resulting in polygonal grain boundaries and an interlocking framework typical of high-grade granulite-facies metamorphism. The overall fabric is massive, with no preferred mineral orientation observed within the examined section.

Plagioclase constitute the dominant felsic phase and occur as medium-grained sub-idioblastic to xenoblastic grains forming the principal framework of the rock. Many grains exhibit well-developed polysynthetic twinning under crossed polars and are intimately inter-grown with ferromagnesian minerals. Microcline grains showing characteristic cross hatch twining under cross polars are also present as xenoblastic interstitial grains within the feldspathic matrix.

The pyroxenes identified in thin section predominantly exhibit straight extinction under crossed polars, indicating that orthopyroxene is the dominant pyroxene phase. A minor proportion of pyroxene grains displays inclined extinction together with relatively higher-order interference colours, confirming the subordinate presence of clinopyroxene. Based on visual modal estimation, clinopyroxene constitutes approximately 2 vol.% of the rock.

No garnet was identified during petrographic examination of the thin section and is therefore not included in the mineralogical description.

The estimated modal mineral composition is as follows: plagioclase (~32 vol.%), hornblende (~28 vol.%), orthopyroxene (~20 vol.%), quartz (~12 vol.%), microcline (~5 vol.%), clinopyroxene (~2 vol.%), and opaque and other accessory minerals (~1 vol.%). These proportions are based on visual modal estimation during optical petrographic analysis.

Orthopyroxenes occur as medium-grained sub-idioblastic grains distributed throughout the rock and represent the principal mafic constituent. The mineral displays moderate pleochroism under plane-polarized light and characteristic low first-order interference colours under crossed polars. Several orthopyroxene grains exhibit partial to complete pseudomorphic replacement by hornblende along grain boundaries and fractures, with some grains being entirely transformed into hornblende. The hornblende occurs as irregular aggregates, indicating hydration-induced alteration of the primary orthopyroxenes.

The rock exhibits a well-equilibrated granoblastic texture with extensive grain-boundary adjustment and recrystallization, reflecting metamorphism under high-temperature, granulite-facies. Based on the observed mineral assemblage, textural attributes, and mineralogical relationships, the rock is classified as a **Charnockite**, representing an orthopyroxene-bearing felsic granulite formed under granulite-facies metamorphic conditions and subsequently affected by minor hydration-related alteration.

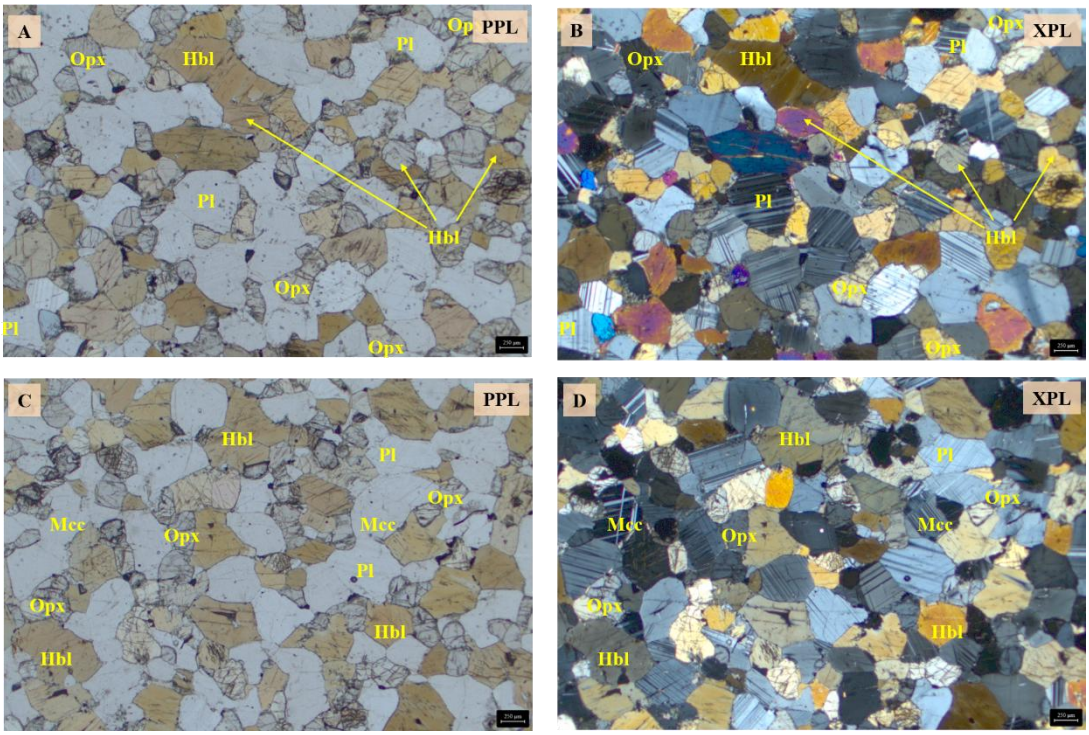


Fig 6.5: Photomicrographs of thin section DS-1112 (Charnockite) under plane-polarized light (A, C) and crossed polars (B, D), showing a granoblastic mosaic of orthopyroxene (Opx), hornblende (Hbl), plagioclase (Pl), and minor microcline (Mcc). The rock exhibits interlocking grain boundaries, extensive recrystallization, and localized replacement of orthopyroxene by hornblende, indicative of granulite-facies metamorphism followed by limited retrograde hydration.

Sample: DS-1204

Rock Type: Leptynite

The thin section comprises a highly leucocratic, quartz-dominated metamorphic rock exhibiting a well-recrystallized granoblastic fabric characteristic of high-grade metamorphism. The mineral assemblage is composed predominantly of quartz, with subordinate plagioclase and minor garnet.

Quartz is the dominant mineral phase, constituting approximately 75 vol.% of the rock based on visual modal estimation. It occurs as medium- to coarse-grained xenoblastic crystals forming an interlocking mosaic. The larger quartz grains exhibit an elongate to platy habit with a preferred orientation, imparting a weak foliation to the rock. Several grains display undulose extinction, while localized fine-grained polygonal quartz aggregates with a sugary texture indicate dynamic recrystallization and grain-boundary migration during high-grade metamorphism.

Plagioclase is a subordinate constituent, comprising approximately 20 vol.% of the rock. It occurs as fine- to medium-grained sub-idioblastic to xenoblastic grains, predominantly occupying interstitial spaces within the quartz-rich framework. In the fine-grained recrystallized domains, quartz and plagioclase occur in nearly equal proportions, reflecting localized recrystallization.

Garnet constitutes approximately 5 vol.% of the modal mineral assemblage and occurs as scattered medium-grained sub-idioblastic porphyroblasts within the matrix. Many garnet crystals enclose abundant quartz inclusions, suggesting syn-metamorphic porphyroblast growth accompanied by the entrapment of pre-existing matrix minerals during recrystallization.

The rock exhibits a granoblastic texture marked by extensive recrystallization, mutual grain-boundary adjustment, and a quartz-defined planar fabric. The overwhelmingly quartzo-feldspathic composition, paucity of mafic minerals, and presence of inclusion-rich garnet porphyroblasts indicate metamorphism under upper amphibolite to granulite-facies conditions. Based on the mineralogical composition and textural characteristics, the rock is identified as **Leptynite**.

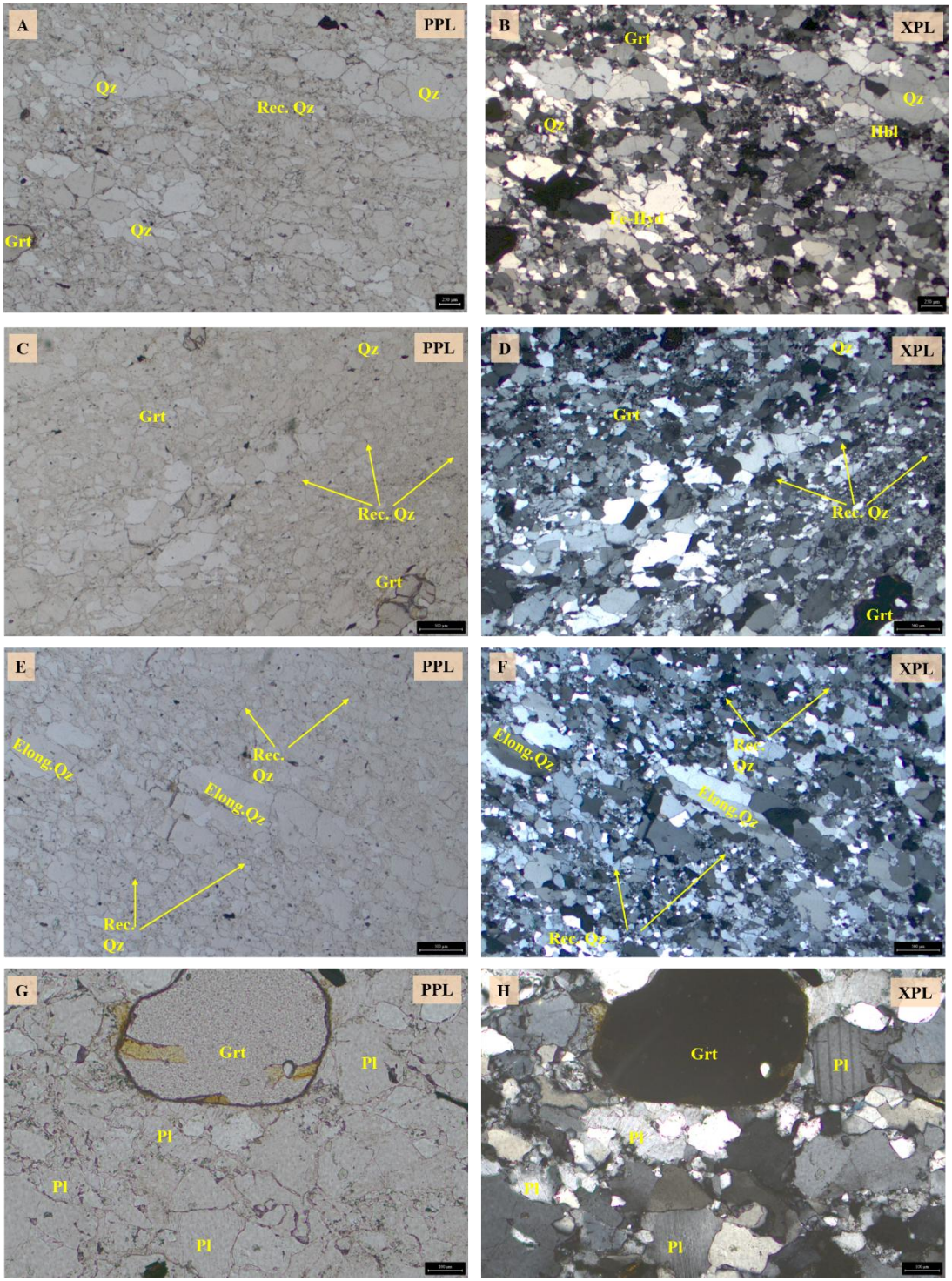


Fig 6.6: Photomicrographs of thin section DS-1204 (Leptynite) under plane-polarized light (A, C) and crossed polars (B, D), showing a quartz-dominated mineral assemblage with subordinate plagioclase and garnet. (A, B) Fine-grained recrystallized quartz aggregates displaying a characteristic sugary texture within the quartzo-feldspathic matrix. (C, D) (E, F) Elongated quartz grains exhibiting preferred orientation and undulose extinction (G, H) shows garnet porphyroblasts and abundant quartz with minor plagioclase phases, indicative of the quartzo-feldspathic protolith.

Sample: DS-1362

Rock Type: Quartzo-feldspathic graphite gneiss

The thin section represents a graphite-bearing quartzo-feldspathic gneiss characterized by a well-developed foliation defined by the preferred orientation of quartz, feldspar, and graphite flakes. The rock is predominantly composed of quartz and feldspar, which constitute the major framework minerals, with graphite occurring as a significant accessory phase intimately associated with the metamorphic fabric.

Quartz occur as medium to coarse-grained xenoblastic grains forming an interlocking recrystallized mosaic. Many quartz grains are elongated parallel to the dominant foliation and locally exhibit undulose extinction, reflecting deformation under high-grade metamorphic conditions. Quartz grains show minor grain boundary modification with recrystallization indicated by local development of finer quartz domains. Feldspar occur as minor phase as sub-idioblastic to xenoblastic grains interstitial to the quartz-rich matrix and contribute to the development of the gneissic fabric. Biotite occurs as subordinate, fine-grained flakes scattered throughout the thin section. The quartzo-feldspathic assemblage exhibits evidence of dynamic recrystallization and grain-boundary adjustment typical of high-grade regional metamorphism.

Graphite occur as mostly coarse to very coarse-grained flaky crystals disseminated throughout the matrix and mostly concentrated along foliation planes, where it forms discontinuous streaks and laminae. The graphite flakes exhibit a pronounced preferred orientation parallel to the gneissic fabric, indicating strong structural control on graphite concentration during metamorphism. Several graphite flakes display bending, curvature, and local warping, suggesting syn to post-crystallization deformation associated with continued tectono-metamorphic activity following graphite formation.

The graphite mineralization is notable for its exceptionally coarse flake size, with flakes attaining lengths of up to approximately 744 μm, corresponding to the very coarse/jumbo flake category (>300 μm) recognized from graphite classification schemes. The preservation of large, well-developed flakes, together with their preferred orientation and deformation features, are indicative of graphite crystallization under high-grade regional metamorphism.

The mineral assemblage, well-developed foliation, recrystallized quartzo-feldspathic matrix, and abundance of coarse flaky graphite collectively indicate metamorphism under upper amphibolite to granulite-facies conditions. The intimate association of graphite with the metamorphic fabric demonstrates that graphite enrichment is structurally controlled and closely linked to the regional metamorphic evolution of the host rock. Based on the observed mineralogical and textural characteristics, the rock is classified as **Quartzo-feldspathic graphite gneiss**.

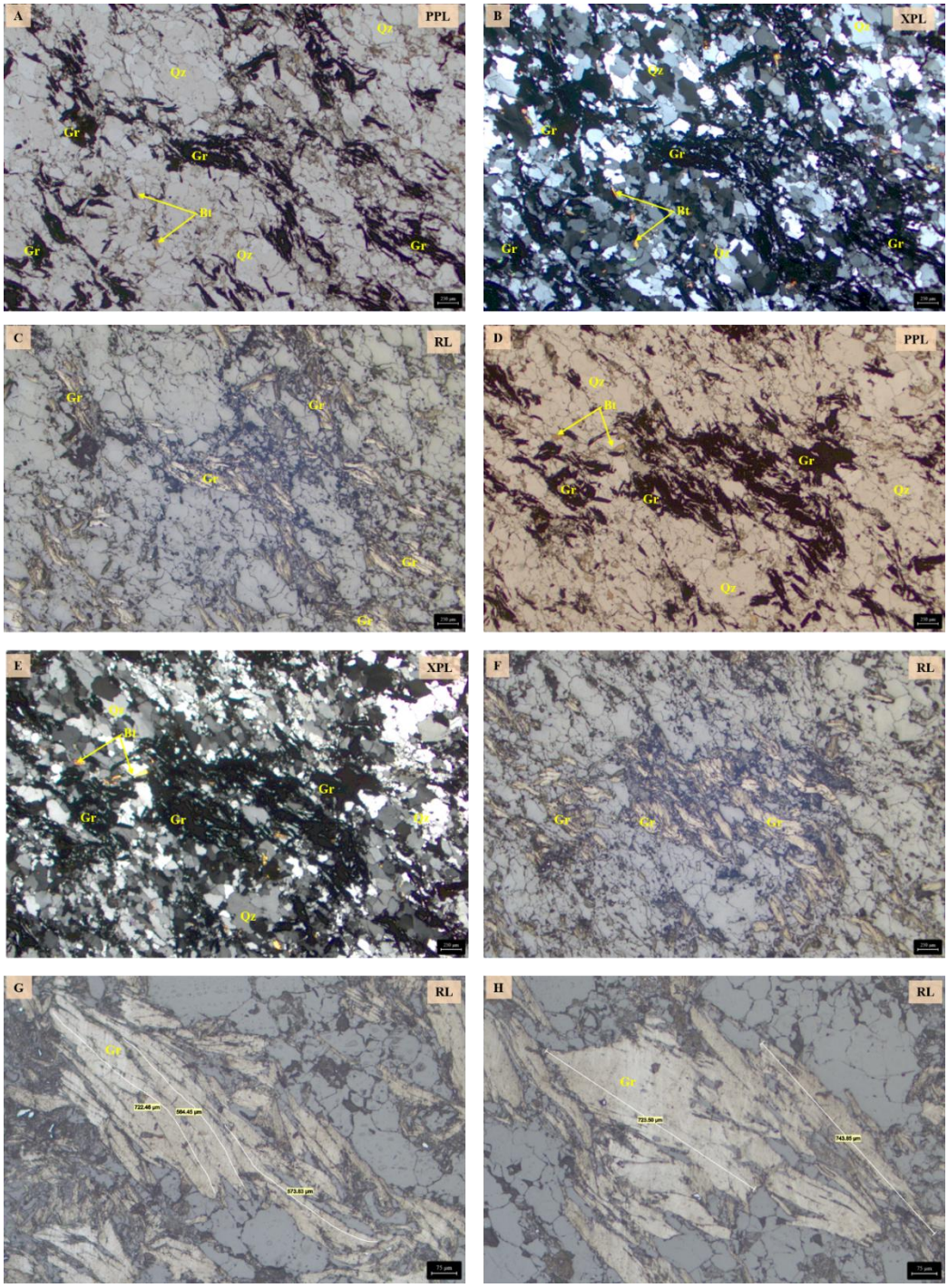


Fig 6.7: Photomicrographs of thin section DS-1362 (Graphite-Bearing Gneiss) illustrating graphite mineralization within a foliated quartzo-feldspathic gneiss. Images (A, D) under PPL and corresponding XPL views (B, E) show disseminated flaky graphite within the quartz–feldspar matrix. Quartz grains show minor grain boundary modification with recrystallization indicated by local development of finer quartz domains. Images (C, F) (reflected light) show graphite flakes aligned parallel to the dominant foliation, reflecting structural control on graphite distribution. The elongated quartz and feldspar grains define the gneissic fabric, with local streaky concentrations of graphite along foliation planes. Images (G–H) show relatively coarser graphite flakes occurring along foliation, sub-parallel to the elongation direction of quartz and feldspar grains.

Core Samples

Sample: ORDN-3/CS-17

Rock Type: Quartzo-feldspathic graphite gneiss

The thin section comprises a graphite-bearing quartzo-feldspathic gneiss characterized by a medium to coarse-grained granoblastic texture and compositional patches of quartz–feldspar-rich and graphite–pyrite–biotite-rich domains. A weak planar fabric is defined by the preferred alignment of graphite flakes and subtly elongated recrystallized quartz–feldspar aggregates.

Quartz and feldspar constitute the dominant mineral framework and occur as interlocking xenoblastic to sub-idioblastic grains displaying extensive recrystallization. Both phases exhibit advanced textural re-equilibration marked by grain-boundary migration, polygonization, grain growth, static recrystallization, and crystal lattice recovery. Fine-grained recrystallized silica aggregates occur along the margins of larger quartz and feldspar grains, forming interstitial mosaics indicative of silica remobilization and recrystallization. Feldspar locally preserves incomplete lamellar twinning and minor lattice distortion, reflecting relic strain signatures.

The felsic domains exhibit pronounced annealing textures, including strain-free polygonal grains, equigranular mosaics, straight grain boundaries, and locally developed ~120° triple junctions, indicating extensive static recrystallization. Localized finer-grained quartz aggregates, slightly sutured grain boundaries, and weak grain elongation reflect limited dynamic recrystallization and a minor late-stage ductile overprint.

Graphite and pyrite constitute the principal opaque phases. Under reflected light, graphite occur as coarse to very coarse-grained flakes, streaky aggregates, discontinuous films, and graphite-rich domains concentrated along foliation-parallel domains and localized micro-shear zones. The graphite-rich layers locally exhibit gentle folding and warping, indicating minor post-recrystallization deformation. Graphite is predominantly coarse to very large/jumbo-flake in nature, with individual flakes commonly exceeding 300 μm and locally attaining lengths of up to approximately 800 μm.

Pyrite and chalcopyrite (very limited occurrence) occur as disseminated subhedral to anhedral grains and small aggregates, predominantly within graphite-rich domains. The sulphide grains are commonly locally associated with graphite patches, suggesting late-stage sulphide introduction or remobilization along deformation-controlled fluid pathways.

Overall, the thin section records high-temperature metamorphic re-equilibration characterized by extensive annealing and static recrystallization, subsequently overprinted by weak ductile deformation. The mineralogical and textural relationships indicate structural control on the concentration of graphite and associated sulphides during metamorphic evolution. Based on the observed mineralogical assemblage, textural characteristics, and metamorphic fabric, the rock is classified as a **Quartzo-feldspathic graphite gneiss.**

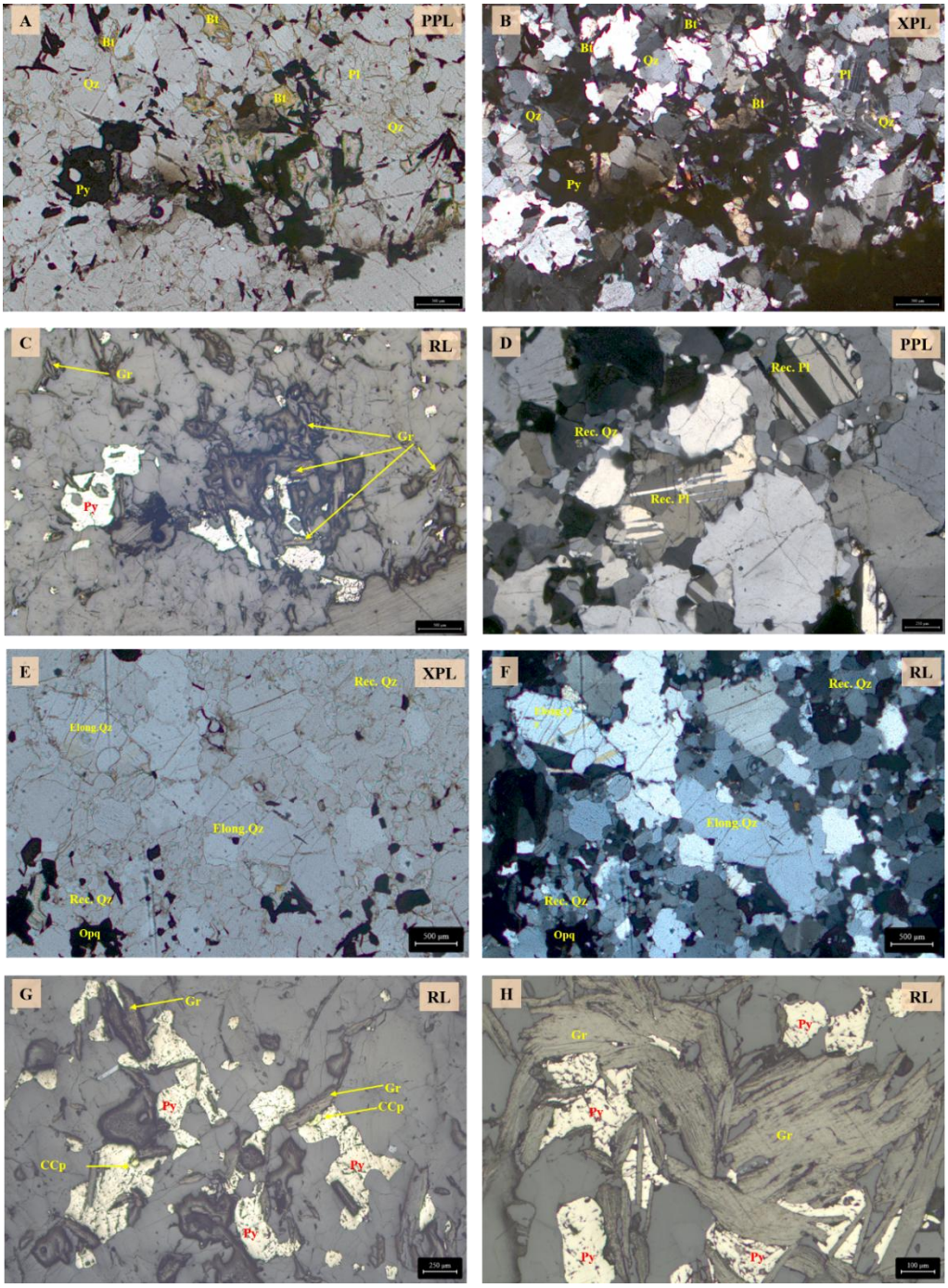


Fig 6.8: Photomicrographs of thin section ORDN-3/CS-17 (Graphite-bearing quartzo-feldspathic gneiss) showing granoblastic quartz–feldspar-rich domains, extensive recrystallization, and graphite–pyrite mineralization. (A) Quartzo-feldspathic domain exhibiting granoblastic texture under plane-polarized light (PPL); (B) the same domain under crossed polars (XPL), showing recrystallized quartz and feldspar grains; (C) reflected light image showing graphite and pyrite as the dominant opaque phases; (D) recrystallized quartz and plagioclase grains with fine-grained recrystallized silica and quartz developed along grain boundaries; (E) elongated quartz grains and grain-boundary recrystallization under PPL; (F) the same field under XPL highlighting recrystallized quartz aggregates and annealing textures; (G) reflected light image showing coarse graphite flakes associated with pyrite; (H) reflected light photomicrograph displaying very large/jumbo graphite flakes with local warping/flexural deformation and associated pyrite-chalcopyrite mineralization.

Sample: ORDN-2/CS-20

Rock Type: Quartzo-feldspathic graphite gneiss

The thin section comprises a foliated graphite-bearing gneiss characterized by alternating graphite–minor biotite-rich and quartz–feldspar-rich domains, defining a well-developed gneissic fabric. The foliation is pervasive throughout the section and is expressed by compositional banding and the preferred orientation of platy & flaky minerals.

Quartz and feldspar constitute the dominant frame work grains and occur as medium-grained xenoblastic grains forming the leucocratic bands. Quartz grains commonly exhibit elongation parallel to the foliation and local recrystallization, while feldspars probably plagioclase, occur inter-grown with quartz, very fine grained and feebly showing lamellar like twining under high magnification, collectively forming a granoblastic quartzo-feldspathic matrix.

Graphite occur as abundant medium to coarse-grained flakes concentrated along foliation planes and strongly aligned with the dominant metamorphic fabric, imparting a pronounced planar anisotropy to the rock. The graphite flakes locally exhibit kinking and bending, indicating minor post-crystallization ductile deformation. Biotite occur in close association with graphite and contribute to the development of the foliation.

Reflected light observations reveal graphite associated with subordinate pyrite mineralization. Pyrite occur as fine to medium-grained reflective grains disseminated within graphite-rich layers and locally concentrated along foliation surfaces and inter-granular sites.

The well-developed gneissic banding, preferred mineral orientation, recrystallized quartzo-feldspathic matrix, and concentration of graphite along foliation planes indicate metamorphic differentiation under moderate to high-grade regional metamorphic conditions. Based on the observed mineralogical assemblage, textural characteristics, and metamorphic fabric, the rock is classified as a **Quartzo-feldspathic graphite gneiss.**

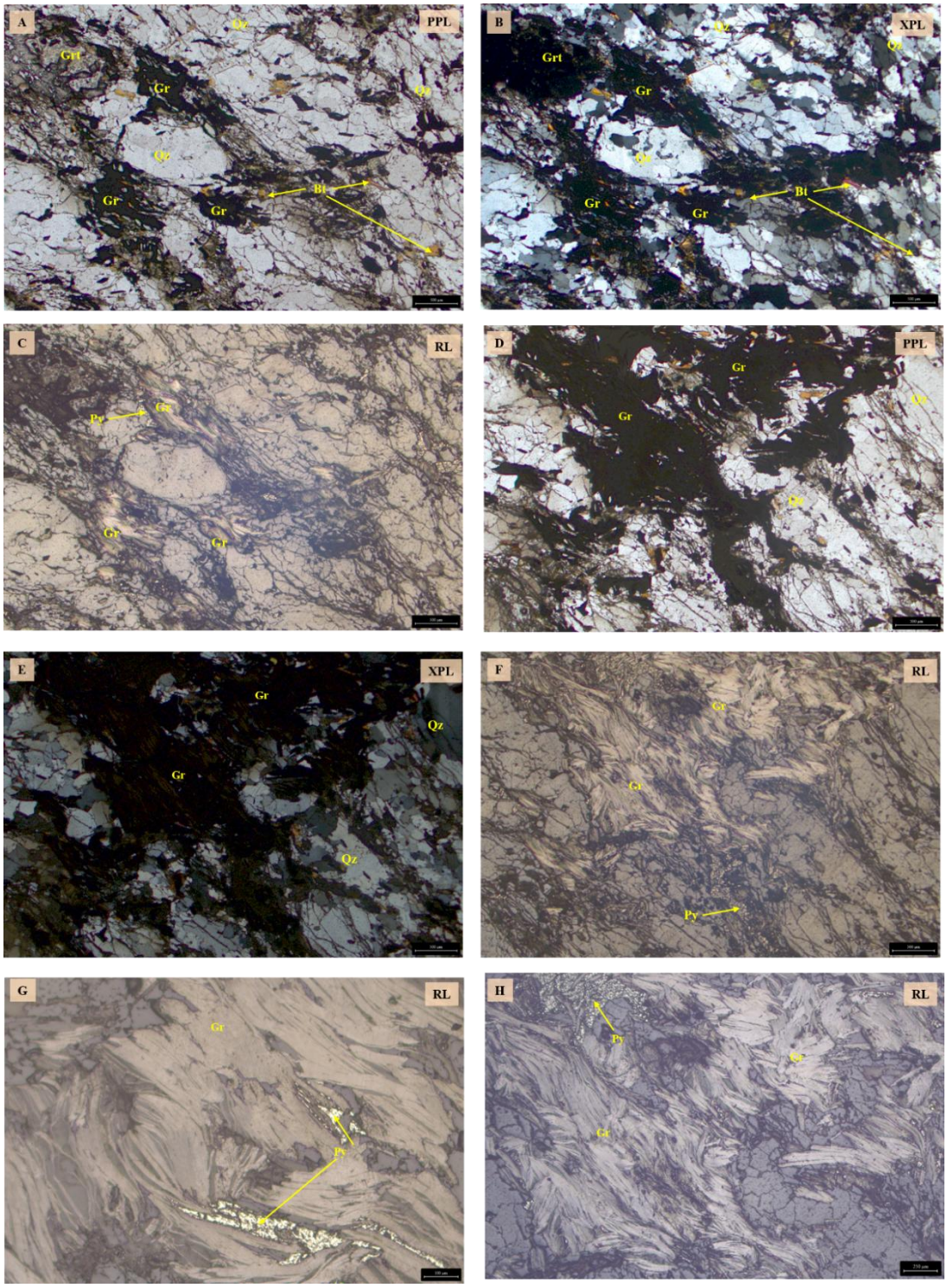


Fig 6.9: Photomicrographs of thin section ORDN-2/CS-20 (Graphite-bearing gneiss) showing a foliated quartzo-feldspathic and graphite-rich assemblage. (A, B) Quartzo-feldspathic domain under PPL and XPL showing recrystallized quartz–feldspar aggregates; (D, E) graphite-rich foliated domain under PPL and XPL highlighting the preferred orientation of graphite and biotite along the metamorphic fabric; (C, F) reflected light images showing graphite associated with minor pyrite mineralization; and (G, H) coarse graphite flakes displaying local kinking/warping along foliation planes with subordinate pyrite occurring within graphite-rich domains.

Sample: ORDN-7/CS-21

Rock Type: Graphite bearing gneiss

The thin section comprises a graphite-bearing quartzo-feldspathic gneiss exhibiting a well-developed gneissic fabric defined by alternating quartz–feldspar-rich leucocratic domains and graphite and chlorite-rich melanocratic domains. The foliation is pervasive throughout the section and is expressed by compositional banding and preferred mineral orientation.

Quartz and feldspar constitute the major framework minerals and form a granoblastic quartzo-feldspathic matrix. Quartz occur as medium-grained xenoblastic grains, commonly elongated parallel to foliation and locally displaying recrystallization. Feldspars are intimately inter-grown with quartz and contribute to the development of the leucocratic bands. The feldspar grains are very fine-grained and cannot be distinguished into individual feldspar types, even under magnification.

Graphite occur as flakes concentrated within discrete graphite and chlorite-rich domains and along foliation planes. The graphite flakes exhibit a strong preferred orientation parallel to the foliation, imparting a pronounced planar anisotropy to the rock. Graphite occur predominantly as coarse to jumbo-sized flakes, with individual crystals reaching lengths up to 1115 μm, indicative of a well-developed flaky graphite morphology. In addition to individual flakes, graphite locally display fine branching and splitting from primary flakes, producing interconnected graphite networks along the foliation. Some flakes exhibit kink and bending, indicating minor post-crystallization ductile deformation.

Reflected light examination reveals graphite associated with subordinate pyrite mineralization. Pyrite occurs as fine to medium-grained reflective crystals disseminated within graphite-rich domains and locally concentrated along foliation planes, intergranular sites, and weak structural planes.

The mineralogical assemblage and textural characteristics indicate metamorphic differentiation and mineral segregation under moderate to high-grade regional metamorphic conditions. The development of compositional banding, recrystallized quartzo-feldspathic domains, and structurally controlled graphite concentration are consistent with the evolution of a foliated **Graphite bearing gneiss.**

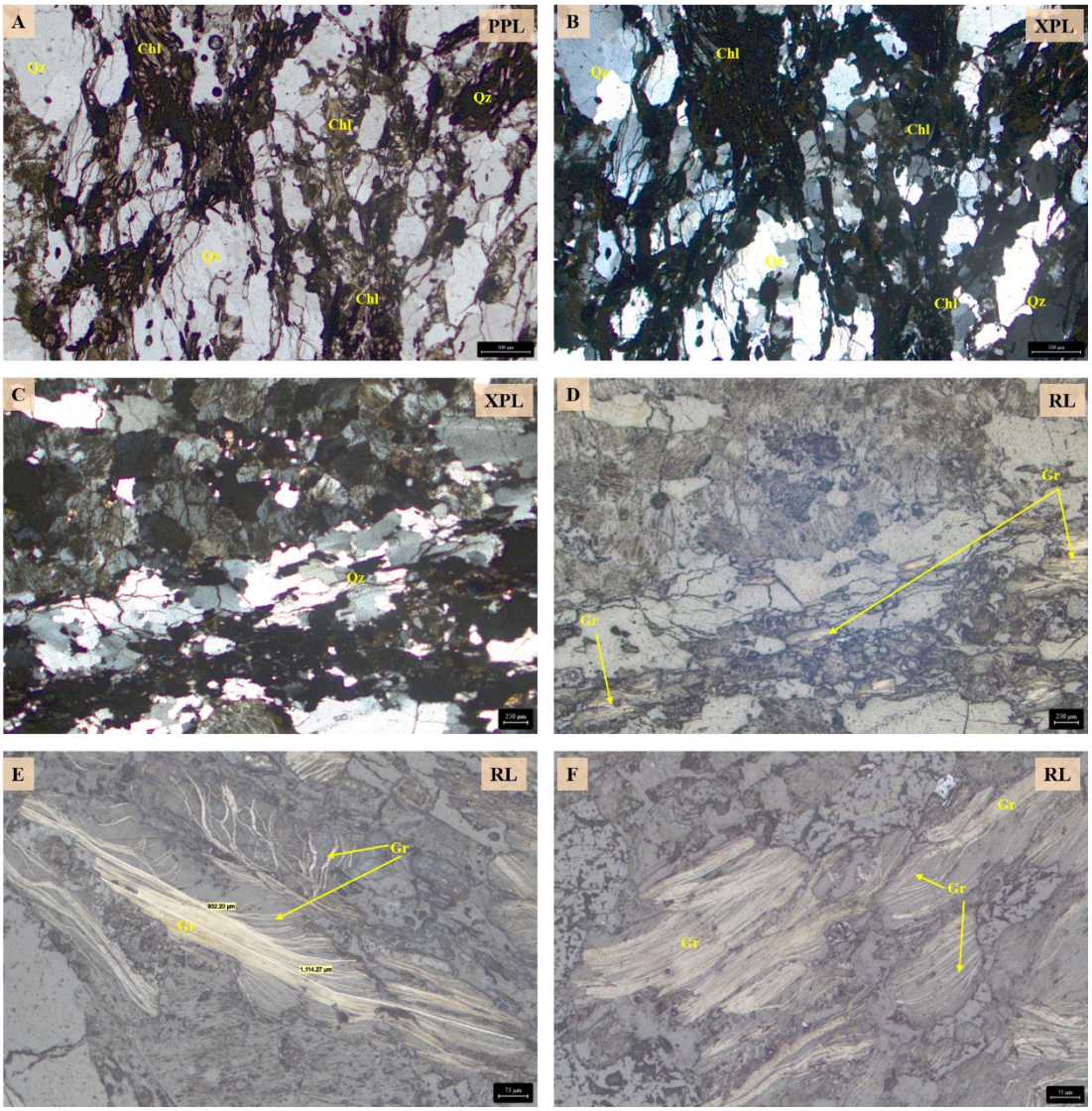


Fig 6.10: Photomicrographs of thin section ORDN-7/CS-21 (Graphite-bearing gneiss) showing a foliated quartzo-feldspathic and graphite-rich assemblage. (A–C) Quartzo-feldspathic domains under PPL and XPL exhibiting recrystallized quartz–feldspar aggregates and a granoblastic texture. (D–F) Reflected light photomicrographs showing graphite-rich foliated domains with strongly aligned graphite flakes defining the metamorphic fabric. The graphite occurs as coarse to very coarse/jumbo-sized flakes, locally displaying kinking, bending, branching, and splitting from primary flakes to form interconnected graphite networks along foliation planes. Subordinate pyrite occurs as disseminated grains within the graphite-rich domains.

Sample: ORDN-5/CS-16

Rock Type: Graphite bearing khondalite

The thin section comprises a graphite-bearing garnet–sillimanite gneiss. The texture defined by the intimate association of quartz, garnet, sillimanite, and biotite. A weak to moderate metamorphic fabric is developed by the preferred orientation of elongated sillimanite crystals and associated mineral aggregates. The rock is composed predominantly of quartz, garnet, and sillimanite, with subordinate biotite and opaque phases.

Quartz form a recrystallized xenoblastic mosaic constituting the dominant matrix phase. The grains exhibit interlocking contacts and local textural equilibration resulting from recrystallization during high-grade metamorphism. Garnet occur as medium to coarse-grained idioblastic to sub-idioblastic porphyroblasts dispersed throughout the matrix. The garnet porphyroblasts are fractured and commonly contain abundant acicular to fibrous sillimanite inclusions, imparting a poikiloblastic character. In places, the enclosed sillimanite form dense fibrolitic aggregates within the garnet crystals.

Sillimanite is abundant and occur both as inclusions within garnet and as discrete crystals within the matrix. The mineral typically forms elongated prismatic to acicular crystals and fibrolitic aggregates showing a pronounced preferred orientation. Individual sillimanite crystals commonly exhibit transverse fracturing and collectively define the nematoblastic component of the rock fabric. Biotite occur as subordinate flakes interstitial to the major silicate phases and is locally associated with opaque phases.

Opaque phases occur predominantly along intergranular spaces and grain boundaries within the silicate framework. Reflected light examination indicates that the opaque assemblage is dominated by graphite and pyrite, which commonly coexist. Graphite occur as coarse to very coarse-grained flakes and irregular aggregates, locally attaining lengths of up to approximately 522 µm. Pyrite occur as subhedral to anhedral grains and aggregates are intimately associated with graphite-rich domains. The frequent spatial association of graphite and pyrite suggests a common genetic association alongside structurally controlled mineralisation.

The assemblage garnet + sillimanite + quartz + biotite ± graphite ± pyrite, together with the porphyroblastic garnet, fibrolitic sillimanite, and extensive recrystallization, is indicative of high-grade metamorphism under upper amphibolite to granulite-facies. Based on the observed mineralogical and textural characteristics, the rock is classified as **Graphite-bearing khondalite.**

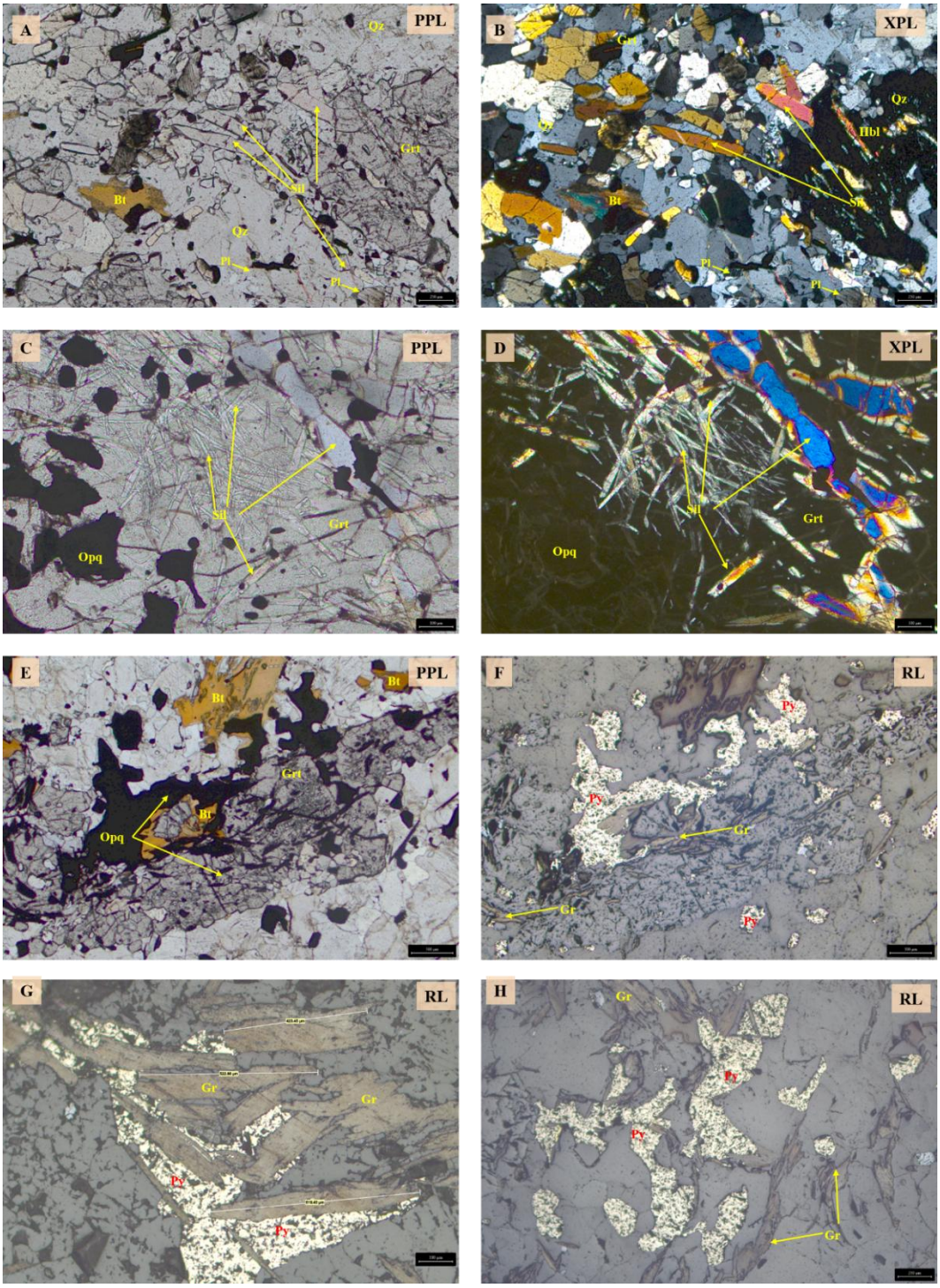


Fig 6.11: Photomicrographs of thin section ORDN-5/CS-16 (Graphite-bearing khondalite) showing a grano-nematoblastic garnet–sillimanite–quartz assemblage, typical of high-grade metamorphism. (A, B) Recrystallized quartzo-feldspathic matrix containing sillimanite, garnet and biotite; (C, D) poikiloblastic garnet hosting abundant fibrolitic sillimanite inclusions; (E) association of garnet, biotite and opaque phases within the silicate framework; (F) reflected light image showing graphite and pyrite mineralization; and (G, H) coarse graphite flakes intimately associated with pyrite within graphite-rich domains.

Sample: ORDN-3/CR

Rock Type: Charnockite

Compared to its bedrock equivalent, this borehole core sample collected from an approximate depth of 43m from surface is distinctly finer grained and displays a more thoroughly recrystallized and texturally equilibrated fabric. The rock is composed predominantly of quartz, plagioclase, microcline and orthopyroxene, forming an equigranular mosaic of interlocking recrystallized grains.

Quartz occur as xenoblastic grains with polygonal grain boundaries and mutual interlocking contacts. Plagioclase is present as sub-idioblastic to xenoblastic grains intimately associated with quartz within the felsic framework. Locally developed polygonal grain mosaics and ~120° triple-junction grain contacts indicate advanced textural equilibration under high-temperature metamorphic conditions.

Pyroxenes observed under optical microscopy predominantly exhibit straight extinction, indicating that orthopyroxene is the dominant pyroxene phase. A minor proportion of grains display inclined extinction and higher-order interference colours, confirming the subordinate presence of clinopyroxene (~2 vol.%). Garnet was not observed in the examined thin section. Based on visual modal estimation, the sample comprises plagioclase (~32%), hornblende (~28%), orthopyroxene (~20%), quartz (~12%), microcline (~5%), clinopyroxene (~2%), and opaque and accessory minerals (~1%).

Orthopyroxene, predominantly hypersthene, occurs as fine- to medium-grained crystals disseminated throughout the quartzo-feldspathic matrix and exhibits characteristic pleochroism. It constitutes the principal mafic mineral and commonly occurs in intergrowth with the felsic phases. Biotite and other mafic minerals are present in subordinate amounts. Compared to the corresponding surface bedrock sample, the borehole core sample exhibits a markedly lower degree of alteration of orthopyroxene to hornblende.

The rock exhibits a well-developed granoblastic texture characterized by equidimensional recrystallized grains, polygonal grain boundaries, and the absence of any significant preferred mineral orientation or foliation. Reflected light observations reveal sparse disseminated opaque phases occurring as isolated grains, inclusions, and occasional fracture fillings. These opaque phases are dominated by magnetite, with minor pyrite occurring as discrete grains and inclusions.

The mineral assemblage of orthopyroxene, quartz, and plagioclase, together with the granoblastic-polygonal texture, textural equilibration, and absence of penetrative foliation, is indicative of metamorphism under granulite-facies conditions. Based on the observed mineralogical and textural characteristics, the rock is classified as a **Charnockite.**

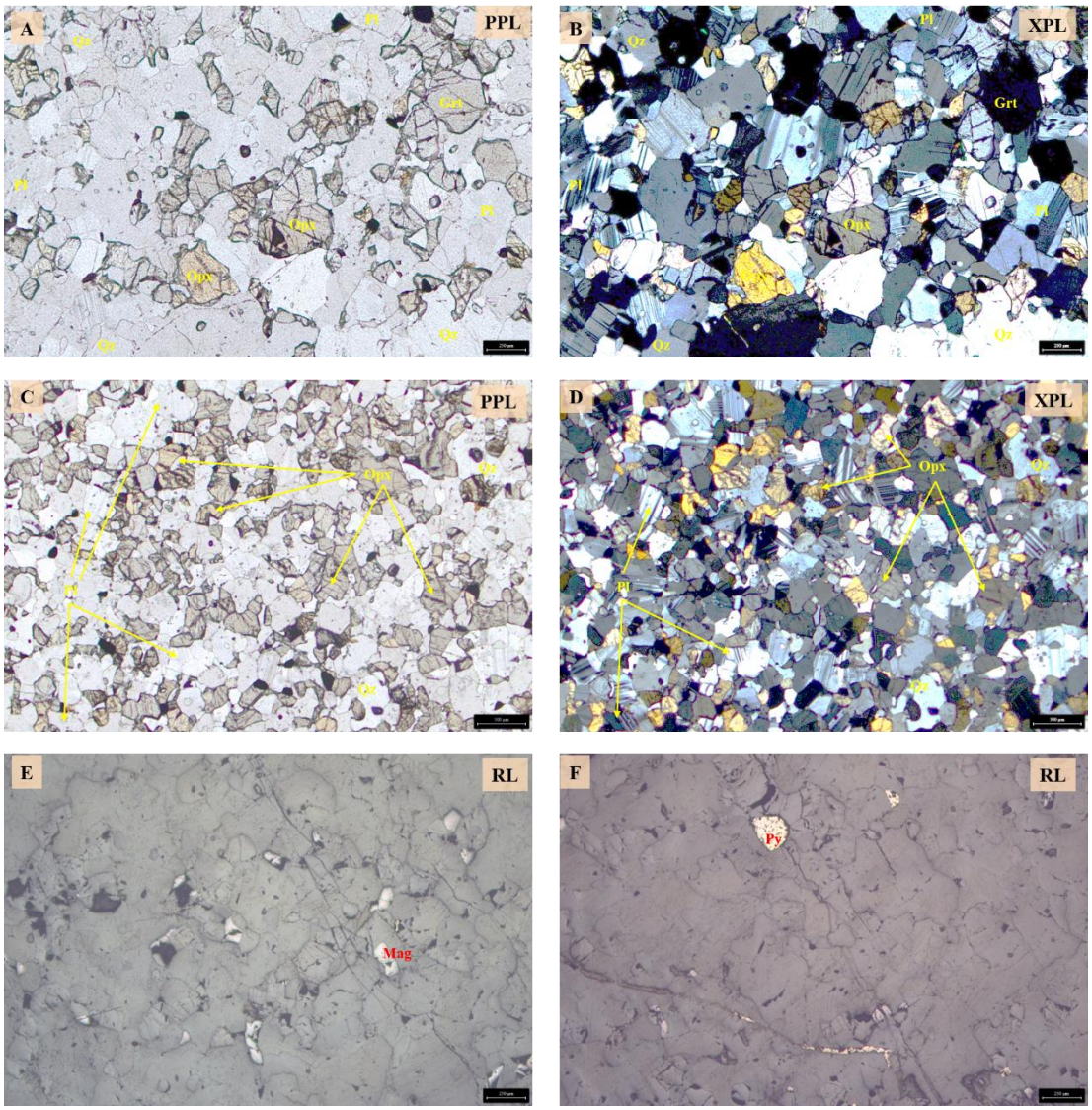


Fig 6.12: Photomicrographs of thin section ORDN-3/CR(Charnockite) under plane-polarized light (A, C) and crossed polars (B, D), showing a granoblastic to granoblastic-polygonal mosaic of orthopyroxene (Opx), quartz (Qz), plagioclase (Pl), and minor microcline (Mcc). The rock is characterized by interlocking recrystallized grains, polygonal grain boundaries with mutually adjusted grain contacts, and locally developed triple-junction boundaries indicative of textural equilibration under high-temperature granulite-facies conditions. Minor retrograde hydration is evidenced by limited alteration of orthopyroxene. (E, F) Reflected light photomicrographs showing sparse disseminated opaque minerals, dominated by magnetite with minor pyrite occurring as isolated discrete grains.

Summary

Petrographic investigations indicate that the graphite mineralization within the Dumburuneli Graphite Block is syngenetic and metamorphogenic in origin, having formed through graphitization of carbonaceous sedimentary precursors during upper amphibolite- to granulite-facies regional metamorphism. Subsequent tectono-metamorphic reworking promoted recrystallization, flake coarsening, and structural concentration of graphite along the regional metamorphic fabric. The host lithologies comprise predominantly graphite-bearing gneiss and graphite-bearing khondalite, with associated quartzo-feldspathic gneiss, khondalite, leptynite, and charnockite, all exhibiting well-developed granoblastic to nematoblastic textures and extensive recrystallization.

Graphite occurs predominantly as medium- to very coarse-grained flaky crystals, with numerous flakes belonging to the jumbo-flake category (>300 μm) and locally attaining lengths of approximately 1.1 mm. It is present as disseminated flakes within the quartzo-feldspathic matrix and as discontinuous streaks, foliation-parallel bands, and locally interconnected graphite networks. The flakes exhibit a pronounced preferred orientation parallel to the gneissic foliation, indicating strong structural control on graphite concentration. Local branching, splitting, bending, kinking, and warping of graphite flakes record progressive recrystallization and minor post-crystallization deformation during tectonic evolution.

The graphite-bearing rocks are composed predominantly of quartz and feldspar, which together constitute the major gangue minerals. Biotite occurs in subordinate amounts closely associated with graphite-rich bands and foliation, while chlorite is locally developed as a retrograde alteration product within graphite-bearing domains. Garnet and sillimanite are characteristic constituents of the graphite-bearing khondalite. Reflected light studies show that graphite is consistently associated with minor pyrite and trace to subordinate chalcopyrite, occurring as disseminated grains and small aggregates within graphite-rich domains, along foliation planes and grain boundaries. Iron oxide phases are present only in minor amounts, mainly as alteration products replacing garnet and as sparse disseminated opaque minerals, with magnetite occurring only as an accessory phase in charnockitic rocks. Overall, sulphide and iron oxide minerals collectively constitute only a minor proportion of the graphite-bearing assemblage relative to the dominant silicate gangue.

From a beneficiation perspective, the petrographic characteristics indicate that the graphite mineralization is dominated by coarse- to jumbo-flake crystalline graphite hosted within a recrystallized quartzo-feldspathic matrix, with graphite occurring largely as discrete flakes concentrated along foliation planes and graphite-rich domains. The principal gangue minerals comprise quartz and feldspar, with subordinate biotite and locally developed chlorite, whereas sulphide minerals are represented majorly by pyrite with subordinate to negligible occurrence of chalcopyrite. Iron-bearing phases are limited to sparse Fe-oxide alteration products and accessory magnetite. The nature of the graphite flakes, together with the relatively low abundance of sulphide and Fe-bearing accessory minerals, suggests that selective liberation of graphite from the silicate gangue may be achieved through appropriately controlled comminution while preserving flake size. Furthermore, the identified sulphide and iron-bearing accessory minerals represent the principal impurity phases requiring rejection during flotation and subsequent concentrate purification.

However, these observations should be supplemented by detailed mineralogical characterization and geo-metallurgical investigations, including, liberation analysis, mineral chemistry, and variability studies, to establish robust ore-processing domains, optimise the beneficiation flow-sheet, and comprehensively evaluate the economic potential of the flake graphite mineralization within the study area.

REFFERENCES:

Mineral in photomicrograph	**IMA-CNMNC Abbreviation (Warr, 2021)**	**Mineral in photomicrograph**	**IMA-CNMNC Abbreviation (Warr, 2021)**
Quartz	Qz	Chalcopyrite	Ccp
Garnet	Grt	Magnetite	Mag
Sillimanite	Sil	Hematite	Hem
Biotite	Bt	Goethite	Goe
Plagioclase	Pl	Opaque minerals	Opq
Microcline	Mcc	Iron hydroxide	Fe-Hyd
Orthopyroxene	Opx	Plane Polarized Light	PPL
Clinopyroxene	Cpx	Cross Polarized Light	XPL
Hornblende	Hbl	Reflected Light	RL
Graphite	Gr	Recrystallized	Rec.
Pyrite	Py	Elongated	Elong.

6.1.3 Structure

Primary structural features are not observed in rocks of meta-sediments as those have suffered polyphase deformation and granulite facies of metamorphism.

Diastrophic structures are manifested in the form of foliation, joint, mineral lineation, folds, stretched quartzo feldspathic lenses etc.

Foliation: The rocks of the Eastern Ghats Mobile Belt (EGMB) in the study area show well-developed foliation. They have a consistent regional trend, with orientations ranging from WNW-ESE to NW-SE and dip amounts ranging from 40° to 70° dipping mostly towards SW but local changes of dip direction towards NE is not uncommon. In the Khondalite Group, foliation stands out due to the parallel alignment of sillimanite needles and biotite flakes with the garnets together forming thin bands. Similarly in the granite gneiss, foliation planes are marked by the linear arrangement of biotite flakes and elongated quartz and feldspar crystals, which create a clear metamorphic fabric throughout the region (**Fig 6.13 a**).

The study area occupies the Rayagada sector of the central Eastern Ghats Mobile Belt (EGMB), which forms part of the high-grade granulite terrain characterized by a complex polyphase deformational history involving at least four deformation phases (D1–D4). The dominant WNW–ESE to NW–SE striking foliation mapped within the block possibly represents the regional penetrative gneissosity (S2), developed during the principal ductile deformation associated with peak granulite-facies metamorphism. This regional foliation is expressed continuously across khondalites, charnockites, granite gneisses and migmatites and is defined by compositional banding together with the preferred orientation of sillimanite, biotite, orthopyroxene and feldspar.

Lineation: Mineral lineation is observed throughout the area. It is characterized by the preferred alignment of sillimanite needles and biotite flakes in khondalites and granite gneiss often having a pitch of nearly 50° or more. Additionally, charnockites often show lineation arising from the arrangement of orthopyroxene crystals.

Joints: The primary joint sets include: (i) N-S to N21°E-S21°W, (ii) N19°W-S19°E, (iii) east-west trending joints, and (iv) foliation-parallel joints that run WNW-ESE, with dips ranging from 28° to 84° either north or south (**Fig 6.13 c**). Rock-specific joint orientations reveal granite gneiss has two main sets at 60°/72° (dipping southeast) and 325°/40° (dipping northeast). Charnockite shows joints at 55°/65° (dipping southeast) and 120°/80° (dipping southwest).

Flow structures: These are clearly present in the migmatised rocks of the study area. They appear as two different types of deformation features. Flow banding occurs in both migmatised charnockite and migmatised khondalite units. This banding results from the directional movement of magma during partial melting under extreme high temperatures typical of granulite facies metamorphism. Additionally, flow folding is seen in migmatised charnockite. This folding (**Fig 6.13 b**) develops through simple shear deformation within layers during the mobilization process. Together, these features indicate intense high-grade metamorphic conditions and related melting in the region.

The regional structure of the Rayagada sector reflects polyphase folding typical of the EGMB. Earlier isoclinal folds (F1/F2) are largely transposed within the dominant gneissic foliation and are therefore difficult to recognize at the present mapping scale. Open to tight F3 folds locally warp the regional foliation, producing minor variations in strike and dip, while later F4 deformation is expressed by gentle warping and localized brittle reactivation. Although no such mappable folding structures were recorded, the observed local reversals in foliation dip from SW to NE within the study area are interpreted as the result of these later folding events.

No major shear zone was mapped within the study block. However, the penetrative foliation, mineral lineation and localized flow structures in migmatites indicate that the rocks experienced intense ductile deformation during regional granulite-facies metamorphism.

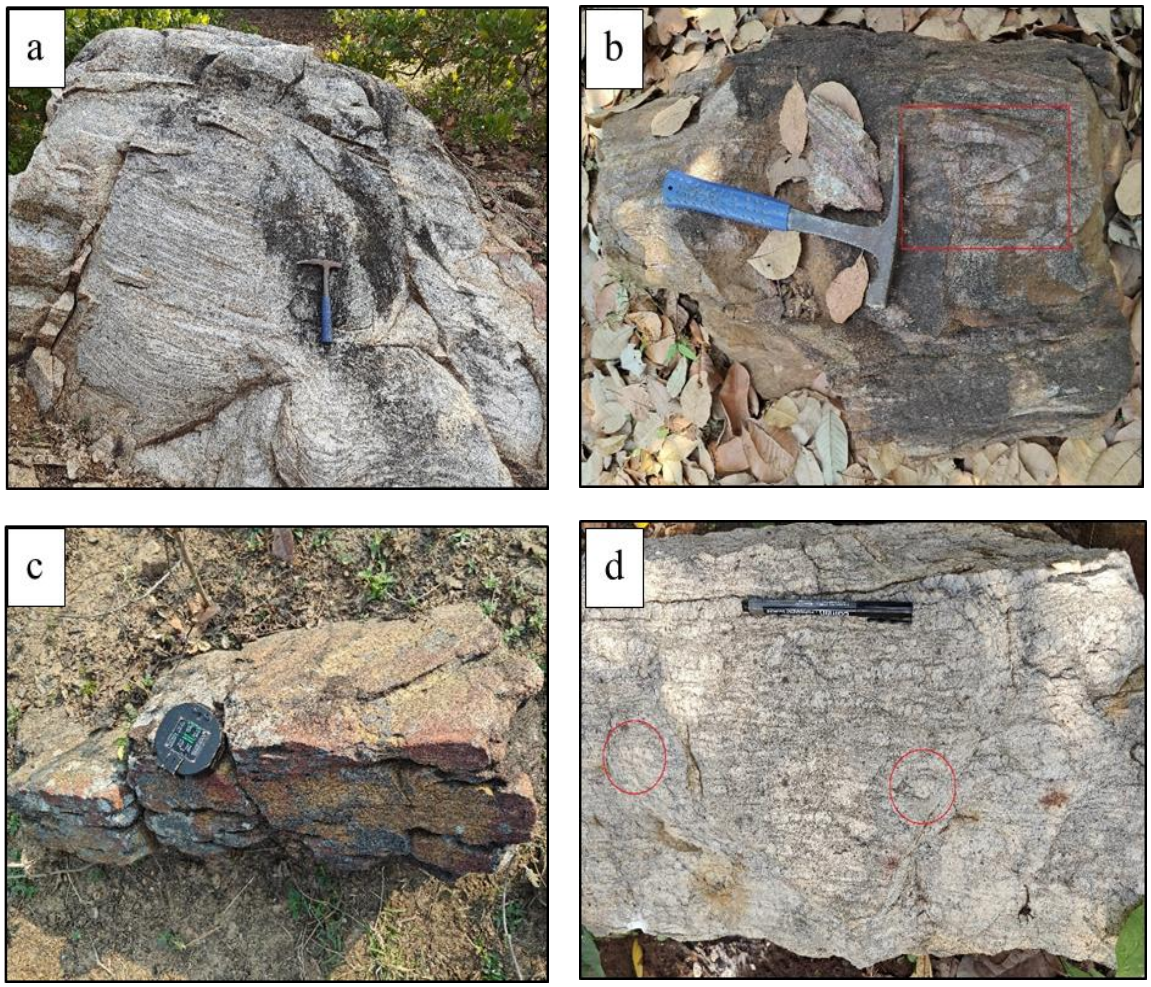


Fig 6.13: (a) Granite-gneiss showing foliations (b) Migmatite showing tight folding within the flow bandings (c) Well developed foliations and joints in near orthogonal arrangement within Khondalite (d) Augen shaped feldspars within Leptynite

6.1.4 Metamorphism

The lithological units in the study area show distinct mineral groups that indicate granulite facies metamorphic conditions. These include quartz, K-feldspar, sillimanite, garnet, and plagioclase in Khondalite. In Granite gneiss, the minerals consist of quartz, K-feldspar, garnet, plagioclase, and biotite. Charnockite contains quartz, plagioclase, orthopyroxene, and possibly biotite and Leptynite features quartz, plagioclase, and garnet. Thin section analysis shows evidence of localized retrograde metamorphism. This process involves the breakdown of pyroxenes to form hornblende. (**Figure 6.5** and **6.12**)

6.1.5 Mineralogy of Ore zones and texture

In the investigated area, fine graphite flakes are mainly found in khondalite and along the gneissic planes of granite gneiss. Charnockite does not contain graphite. The main economic deposits are located in Quartzo-feldspathic graphite gneiss, where mineralization is most noticeable. The graphite flakes are usually aligned with the foliation planes, giving a unique gneissose texture. They have also suffered the effects of migmatization. Graphite flakes are observed along the grain boundaries of related gangue minerals such as quartz, feldspar, sillimanite, and biotite.

Previous investigations have established several graphite occurrences within and around the present block, indicating the regional potential of the graphite belt. Among these, Panugurha, reported by Pasayat and Adhikari (1988), comprises a narrow graphite-bearing zone hosted within charnockite and associated pegmatite, containing an estimated 5–10% fixed carbon but exhibiting limited thickness and strike continuity. Other occurrences reported by GSI and the Directorate of Geology, Odisha, around the study area include Parikuthi, Narigapanga, Bandhamandi, Sollagudi, Khallupadar, Mudra, Berli, Sabinala and Bongna, where graphite occurs as disseminated to lensoidal bodies within khondalite and associated granulite-facies rocks. These investigations were largely reconnaissance in nature and demonstrated the occurrences of graphite mineralization.

The graphite mineralization encountered in the Dumburuneli block is comparable to other graphite deposits and explored areas of the EGMB in southern Odisha, particularly those around Kashipur, Petguda and the Tumudibandh graphite belt. These deposits are typically hosted within quartzo-feldspathic graphite gneiss occurring along contacts between khondalite, charnockite and associated granulite facies rocks. Exploration in these deposits has established lensoidal to tabular graphite bodies extending from a few tens of metres to over 1 km along strike, generally 3–30 m thick, with moderate to steep south-westerly or north-easterly dips. F.C grades commonly range between 5% and 15%, with localized higher-grade pockets exceeding 20% F.C.

6.1.6 Trenching and Pitting

Trenches are planned on the basis of surface geological data collected from the field, in order to check the existence of the ore body below soil cover. In the investigated area trenches were planned on the basis of geological data, to check whether the inferred graphite bands drawn on the basis of limited outcrops had strike continuity, or not.

The following steps followed for placing any trench in the graphite bearing zone –

- Every trench was placed at roughly 100 m strike interval with respect to groove lines on either side of it, where outcrops are not available on the surface.
- The longest axis of a trench was across the strike of the inferred graphite bands.
- If any lithology (bedrock) was exposed along the trench, samples were collected from floor and wall of the trench with the help of chisel and hammer. Length of each sample is normally considered 1 m but it may vary for some samples depending on exposed width of lithology (bedrock).

Seven trenches (**Fig 6.15 & 6.16**) for a cumulative volume of 123 cubic meters (**Table 6.2**) were made to find the extension and strike continuity of the inferred graphite bands within the graphite bearing zones (**Plate-X (A)**). Three trenches encountered quartzo-feldspathic graphite gneiss and their weighted average of F.C was greater than 2%. All the other lithounits encountered in the trenches had specks of graphite flakes in them. A total of 60 trench samples were collected for chemical analysis. (**Annexure II**)

Six pits (**Fig 6.14 b**) of various dimensions were placed in the graphite bearing zones (**Plate-X (B)**) for a cumulative volume of 28.14 cubic meters (**Table 6.2**). Pit locations were chosen where trenches could not be placed. Three pits encountered quartzo-feldspathic graphite gneiss and their weighted average of F.C was greater than 2%. The other three pits did not expose any bed rock. A total of 6 pit samples were collected for chemical analysis (**Annexure II**).

Table 6.2: Trench and Pit volume details

Sample Type		Dimension (L*W*H)	Volume (c.u.m)
Trench	T1	20*1*1	20
	T2	12*1*1	12
	T3	18*1*1	18
	T4	20*1*1	20
	T5	15*1*1	15
	T6	18*1*1	18
	T7	20*1*1	20
	Total Volume		**123**
Pit	P1	2*2*1.5	6
	P2	1.5*1.5*1.5	3.38
	P3	1.5*1.5*1.5	3.38
	P4	2*2*1.5	6
	P5	1.5*1.5*1.5	3.38
	P6	2*2*1.5	6
	Total Volume		**28.14**

Fig 6.14: (a) Trench within Graphite Zone 1 near Pichuligurha village (b) Pit within Graphite Zone 3 near Bhaleri village

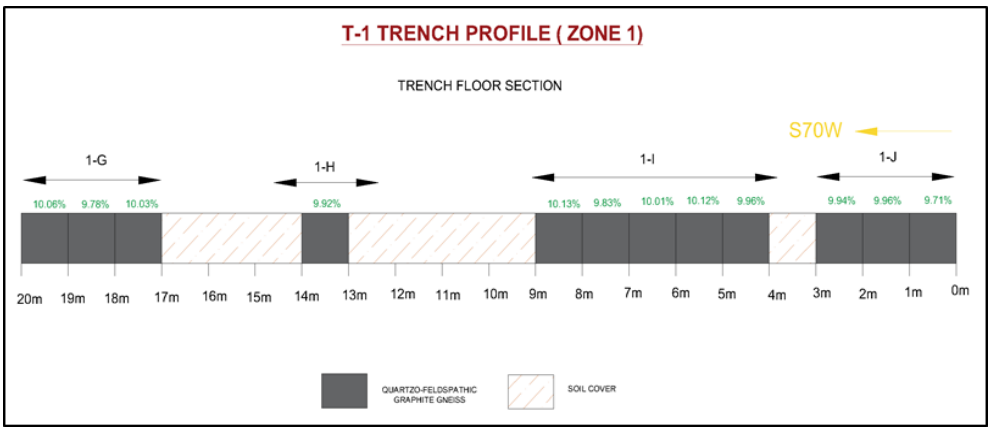


Fig 6.15: Trench profile of T-1 trench in Zone 1

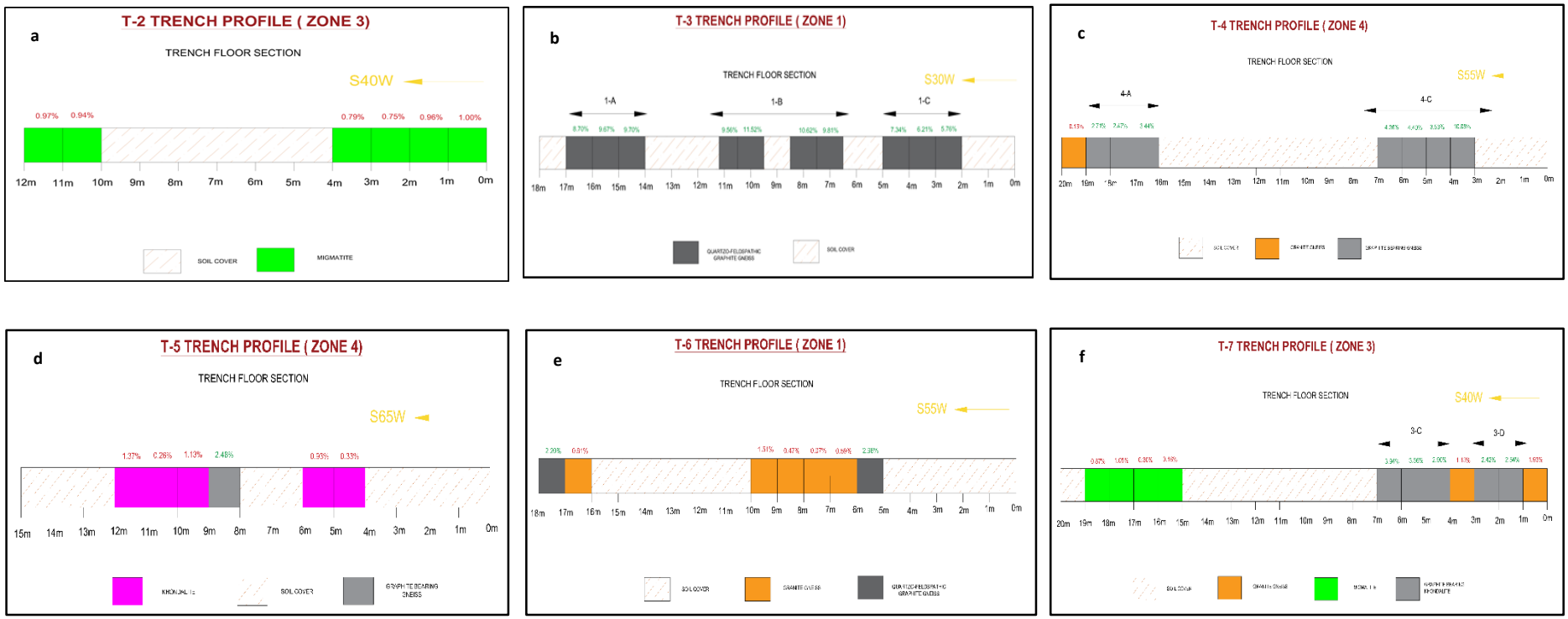


Fig 6.16: Trench profile of (a) T-2 trench in Zone 3 (b) T-3 trench in Zone 1 (c) T-4 trench in Zone 4 (d) T-5 trench in Zone 4 (e) T-6 trench in Zone 1 and (f) T-7 trench in Zone 3

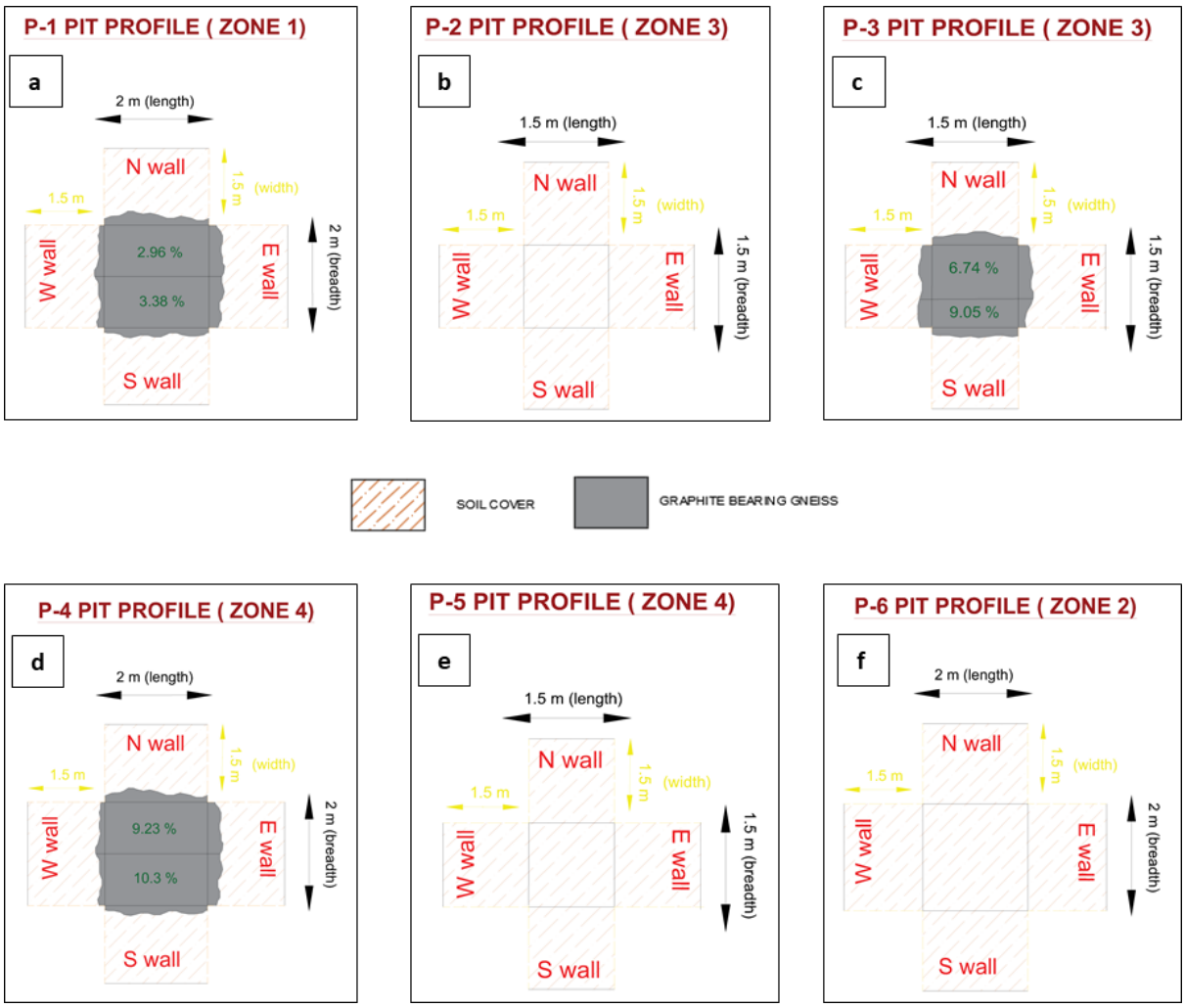


Fig 6.17: Pit profile of (a) P-1 pit in Zone 1 (b) P-2 pit in Zone 3 (c) P-3 pit in Zone 3 (d) P-4 pit in Zone 4 (e) P-5 pit in Zone 4 and (f) P-6 pit in Zone 2

6.1.7 Ore Zones

A total of 4 graphite bearing zones (**Table 6.3**) have been encountered during the field traverses. The dominant graphite-bearing lithology is the quartzo-feldspathic graphite gneiss. Structural data were noted for the outcrops and outcrops with similar structural orientation, disposition and proximity were considered to generate the inferred graphite bands. Based on these inferred bands, grooves were placed at approximately 200m strike intervals from one another where graphite outcrops were present. The chemical analysis results of the grooves showing weighted average of F.C greater than 2% were taken into consideration. The detailed descriptions of the zones are as follows:-

ZONE-1: The graphite zone is located about 300 meters south of Pichuligurha village (**Plate-I (B)**). Graphite mineralization occurs at the contact zone between khondalites and granite gneiss and khondalites and leptynites evident by the presence of quartzo-feldspathic graphite gneiss outcrops. Based on integrated geological and geophysical data, the interpreted strike length of this zone is 500 m, with an average surface width of about 30 – 50 m. The strike of the bands vary from 115° to 155° while the dip amount vary from 60° to 70°, dipping south-westerly. Chemical analyses of bed rock samples (BRS) shows weighted average of F.C% ranging from 2.06% to 12.21% for 29 samples.

ZONE-2: The graphite zone is located about 400 meters east of Lanji village (**Plate-I (B)**). Graphite mineralization occurs at the contact between khondalites and charnockites evident by the presence of outcrops of weathered quartzo-feldspathic graphite gneiss, giving a schistose appearance. Based on integrated geological and geophysical data, the interpreted strike length of this zone is 100 - 150 m, with an average surface width of about 60 m containing 3 inferred bands of 5 - 16 m thicknesses. Attitude of the inferred graphite bands in the zone is roughly 150°/60°, dipping south-westerly. Chemical analyses of bed rock samples (BRS) shows weighted average F.C% ranging from 4% to 12.64% for 15 samples.

ZONE-3: The graphite zone is located about 200 meters south-east of Bhaleri (**Plate-I (B)**). Graphite mineralization occurs at the contact zone between khondalites and granite gneiss evident by the presence of quartzo-feldspathic graphite gneiss outcrops having migmatised appearance. Based on integrated geological and geophysical data, the interpreted strike length of this zone is 250 m, with an average surface width of about 20 - 30 m. The strike of the bands vary from 120° to 150°, while the dip amount is considered as 65°, dipping south-westerly. Chemical analyses of bed rock samples (BRS) shows weighted average F.C% ranging from 2% to 9.11% for 18 samples.

ZONE-4: The graphite zone is located about 250 meters south-west of Dhuanbarhi village (**PLATE-I (B)**). Graphite mineralization occurs at the contact zone between khondalites and granite gneiss evident by the presence of quartzo-feldspathic graphite gneiss outcrops. Based on integrated geological and geophysical data, the interpreted strike length of this zone is 400 m, with an average surface width of about 40 - 50 m. The strike of the bands vary from 130° to 160°, while the dip amount is considered as 60°, dipping south-westerly. Chemical analyses of bed rock samples (BRS) shows weighted average F.C% ranging from 12.59% to 20.3% for 22 samples.

6.2 Geophysical Exploration

Introduction

Graphite is a critical mineral of the 21st century, essential to the global energy transition primarily as an anode material in lithium-ion batteries for electric vehicles and energy storage. It also serves vital roles in steelmaking, refractory manufacturing, industrial lubrication, graphene production and nuclear reactor moderation, giving it significant strategic and geopolitical importance.

Rising global demand has driven the need for effective geophysical exploration methods, especially for concealed deposits. The Self-Potential (SP) method is particularly well-suited for this purpose - it is passive, non-invasive, and cost-effective. Graphite's high electrical conductivity generates measurable electrochemical potential differences at the surface, producing characteristic negative SP anomalies above graphitic horizons. These anomalies reflect graphite content, crystallinity, depth and water table position. Higher graphite concentration (fixed carbon %) increases electronic conductivity, thereby generating stronger negative SP anomalies. Similarly, higher crystallinity of graphite further enhances electronic conductivity, producing sharper and well-defined negative SP anomalies. Shallower conductors produce higher amplitude and narrower SP anomalies, while deeper conductors generate broader and more attenuated responses. SP anomalies over graphitic horizons are generated by electrochemical redox processes at the interface between the electronically conductive graphite and the surrounding groundwater, a shallower water table enhances the electrochemical contrast and consequently strengthens the SP response (Telford et al., 1990 & Sato and Mooney, 1960).

SP surveys are especially effective in metamorphic terrains where graphitic horizons occur within schists and gneisses along foliation planes or shear zones. The method reliably delineates subsurface conductors with minimal infrastructure. This study presents a systematic SP survey over a designated exploration block, aimed at detecting and mapping concealed graphite mineralization through negative SP anomaly analysis.

Project Area Location

The Dumburuneli Graphite Block is situated in the southern part of Odisha within Rayagada District, approximately 30 km northeast of Rayagada town, the district headquarters. The block extends between latitudes 19°20'00"N and 19°25'00"N, and longitudes 83°32'30"E and 83°37'30"E, covering an area of about 72.14 sq. km. The area falls within Survey of India Toposheet No. 65M/11.

Prior to the present geophysical investigation, detailed geological mapping was undertaken across the entire block to delineate lithological units, structural features, and surface manifestations of graphite mineralization. Based on the geological observations and the spatial distribution of graphite occurrences, the block was divided into four prospective zones, namely Zone-1 (Z1), Zone-2 (Z2), Zone-3 (Z3), and Zone-4 (Z4) located in or around Pichuligurha. Lanji, Bhaleri and Dhuanbarhi respectively (**Figure 6.15**). These zones are characterised by

favourable lithological and structural settings that are considered conducive to graphite mineralisation. Consequently, they were identified as priority targets for detailed Self-Potential (SP) geophysical investigations under the present study.

Geology

The Dumburuneli graphite block forms part of the Western Khondalite Zone of the Eastern Ghats Mobile Belt (EGMB). The area is predominantly occupied by khondalite, granite gneiss, charnockite, leptynite, migmatite and quartzo-feldspathic graphite gneiss. Khondalite is the dominant lithology, while granite gneiss occurs mainly along foothills and valley floors. The rocks have undergone granulite facies metamorphism and exhibit well-developed foliation and gneissosity trending predominantly NW–SE to WNW–ESE with moderate to steep south-westerly dips. Graphite mineralization is mainly hosted within quartzo-feldspathic graphite gneiss occurring along contact zones between khondalite and granite gneiss, leptynite or charnockite. The graphite-bearing horizons are structurally controlled by foliation and gneissic banding and show significant strike continuity along the regional structural trend. The graphite mineralization in the Dumburuneli block is predominantly hosted within quartzo-feldspathic graphite gneiss occurring along lithological contact zones between khondalite, granite gneiss, leptynite and locally charnockite. The mineralization is structurally controlled by the regional gneissosity and foliation, which generally trend NW–SE to WNW–ESE and dip south-westerly. Graphite flakes occur parallel to the foliation planes and form laterally persistent gneissose bands exhibiting significant strike continuity.

Table 6.3 : Details of geological information of the graphite zones

Sl. No	Zone ID	Location	Attitude	Interpreted strike length of inferred graphite bands (m)	Type of deposition	Control on mineralization
1	Zone-1	South of Pichuligurha village	115-155º/60-70º Southwesterly	500	Quartzo-feldspathic graphite gneiss	Foliation
2	Zone-2	East of Lanji village	150º/60º Southwesterly	100	Graphite bearing weathered Khondalite	Foliation
3	Zone-3	South of Bhaleri village	120-150º/65-70º Southwesterly	250	Graphite bearing Khondalite	Foliation
4	Zone-4	Southwest of Dhuanbarhi village	130-160º/55-60º Southwesterly	400	Graphite bearing Gneiss	Foliation

Major objective

The primary objective of the SP survey was to delineate concealed graphite-bearing horizons, establish their strike continuity beneath soil cover, correlate geophysical responses with geology, identify structurally controlled graphite mineralization associated with quartzo-feldspathic graphite gneiss along lithological contacts, and generate potential subsurface targets for further exploration and drilling.

SP Data Acquisition

Self-Potential (SP) Survey

Self-Potential (SP) data over the Dumburuneli Graphite Block were acquired using the Fixed Base Method following standard field operating procedures. A total survey coverage of approximately 5.0 line-kilometres was completed through 16 profiles distributed across four prioritized zones of investigation, namely Zone-1 (Z1), Zone-2 (Z2), Zone-3 (Z3) and Zone-4 (Z4) (Figure 6.16). Profile lengths were designed according to the spatial extent of the target zones, terrain accessibility, and field feasibility. The profile lengths ranged from approximately 710-720 m in Zone-1, 230-240 m in Zone-2, 190-220 m in Zone-3, and 200-270 m in Zone-4. Details of individual profiles are provided in **Table 6.5**.

The field survey was carried out during May–June 2025. Measurements were acquired at a uniform station interval of 10 m along all profiles. Inter-profile spacing was maintained variably (**Table 6.5**) depending on the geometry of the target zones, local topographic conditions, and the prevailing geological and structural framework. To maximize the probability of intersecting graphitic horizons, survey profiles were generally oriented perpendicular to the regional geological strike (**Figure 6.16**). In areas with known surface occurrences of graphite mineralization, profiles were strategically positioned to traverse the mineralized trends directly. In contrast, profiles in areas lacking surface manifestations were extended to investigate the potential continuity of concealed or blind graphitic bodies beneath the overburden.

SP measurements were recorded using an IGIS DC Resistivity Meter (Model DDR-3) equipped with two copper sulphate porous-pot electrodes. Positional information, including latitude, longitude, and elevation, was collected using Differential Global Positioning System (DGPS) equipment. A Universal Base Station was established for the entire survey block, supplemented by Local Base Stations within individual zones to maintain data continuity and quality control. Repeat observations were conducted at selected stations to ensure data consistency, accuracy and reliability. The geographic coordinates (in decimal degrees, WGS-1984 datum) and the corresponding UTM Zone 44N coordinates of the Universal Base Station established for the entire survey block. No separate local coordinate system was used, all positional references are based on the WGS-1984 datum projected to UTM Zone 44N, as detailed in **Table 6.4**.

Figure 6.18 (a) illustrates the boundary of the Dumburuneli Graphite Block together with the DGPS-surveyed SP profile locations. **Figure 6.18 (b)** presents an enlarged view of the SP survey layout, highlighting the profile orientations and the distribution of the four investigation zones (Zone-1 to Zone-4), which are delineated by yellow square boxes. **Figure 6.20** is showing the survey direction for each profile for their respective zone.

Table 6.4 Coordinate of Universal Base Station			
Geographic Coordinate System (WGS-1984)			
Base type	**Latitude**	**Longitude**	**Elevation**
Universal Base	19.355561	83.584761	449.12
Local Coordinate System (UTM)			
Base type	**Easting**	**Northing**	**Elevation**
Universal Base	771535.124	2142201.186	449.12

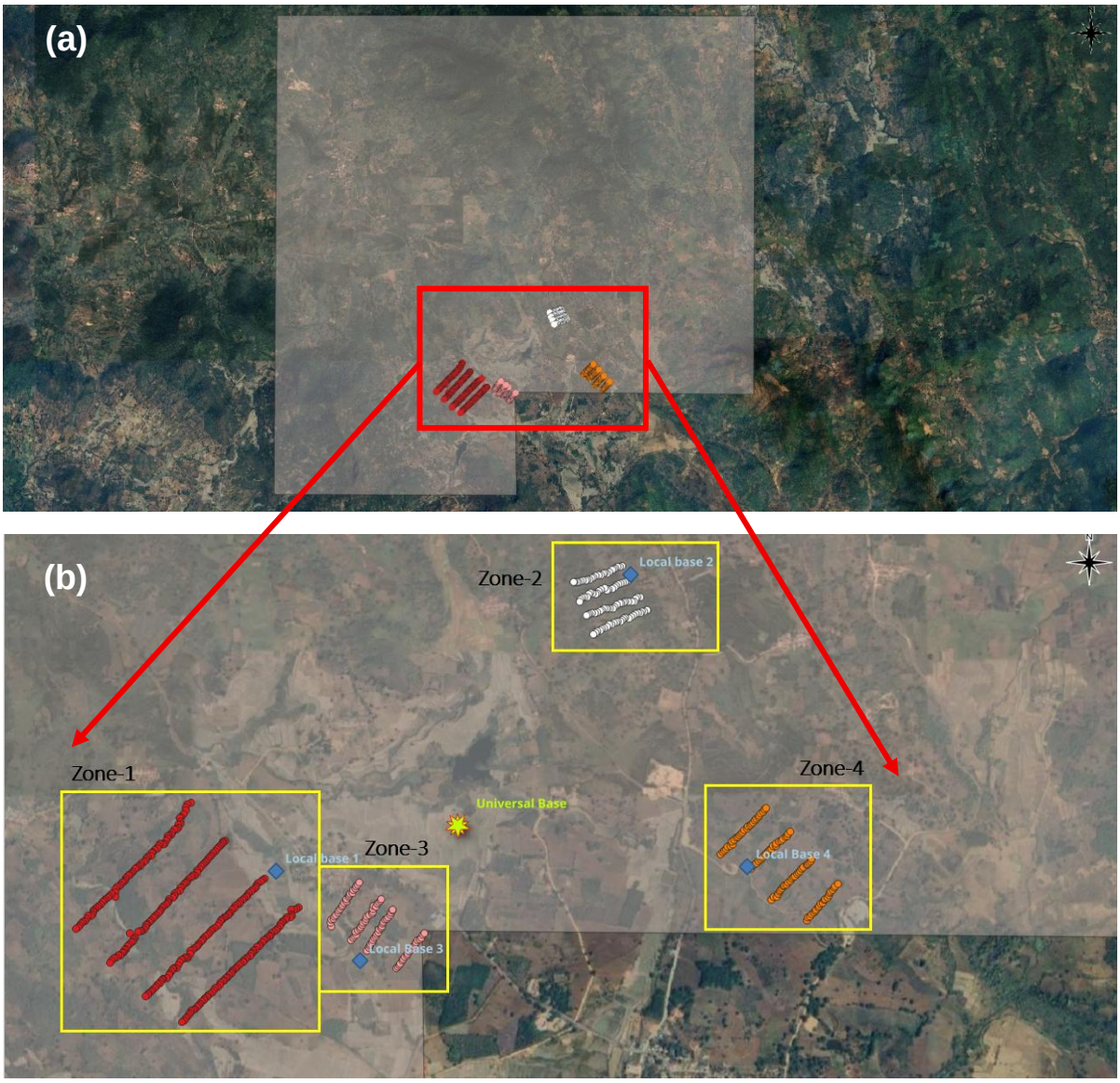


Fig 6.18: (a) Map showing the block boundary along with the SP survey traverses (b) Zoomed-in view of the SP profiles, showing the profile orientations and the corresponding zones (Z1 to Z4), marked with yellow square boxes.

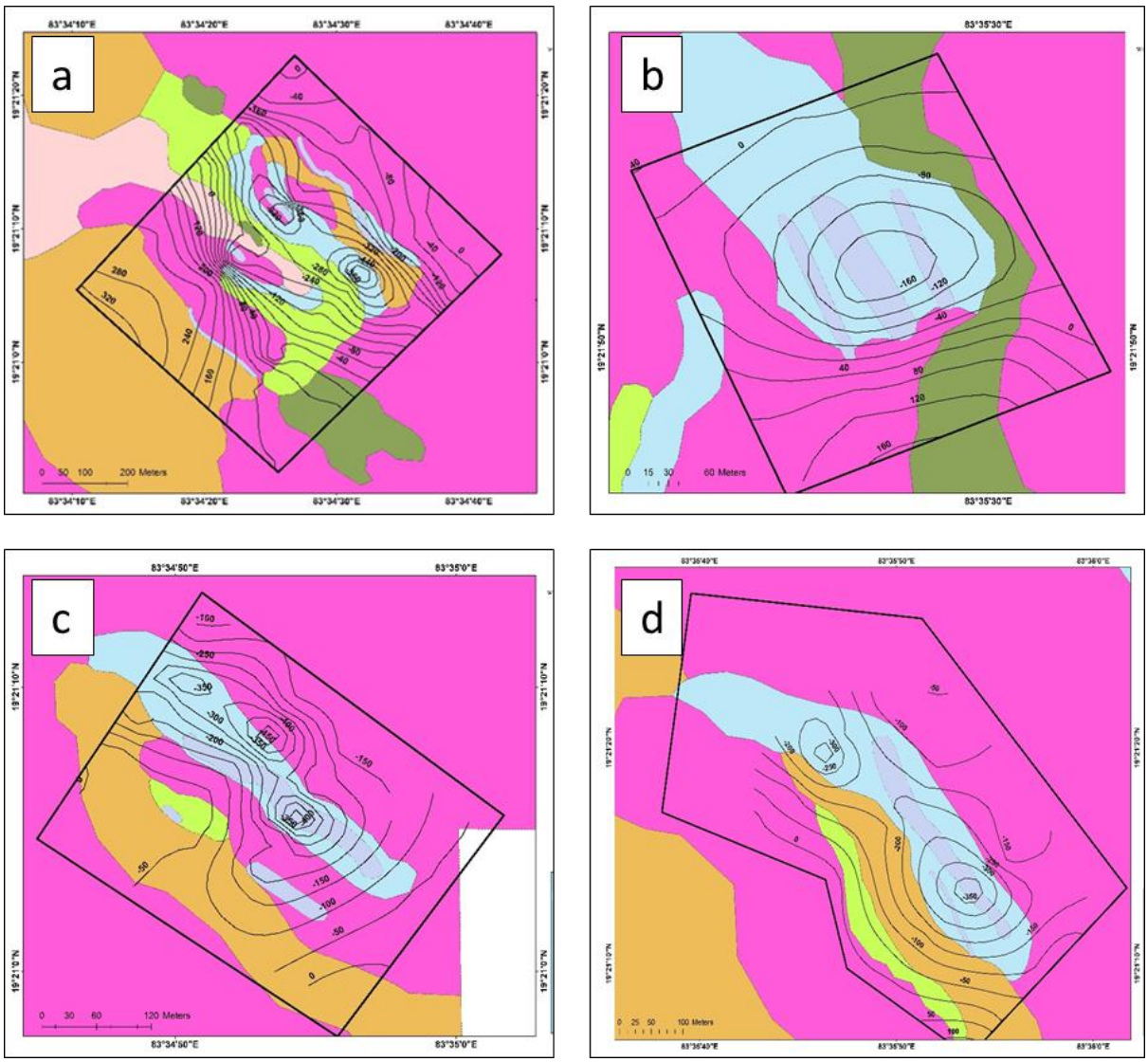


Fig 6.19: SP anomaly zones are overlaid on the geology map for (a) Zone-1, (b) Zone-2, (c) Zone-3 & (d) Zone-4, respectively

Table 6.5 : Detailed parameters of SP Profiles

Zone-ID	Location (Village)	Profile-ID	Line Length (m)	Station Spacing (m)	No of Profiles	Profile Spacing (m)		Geographical Coordinate System		Local Coordinate System (UTM)		Elevation	Profile Orientation
								Latitude	Longitude	Easting	Northing		
Zone -1	Pichuligurha	Profile-01	700	10	4	200	Start Point	19.352291	83.578461	770878.35	2141832.38	417.56	NE-SW
							End Point	19.347764	83.573844	770400.48	2141323.83	414.87	
		Profile-02	710				Start Point	19.353423	83.577112	770734.60	2141955.68	415.74	NE-SW
							End Point	19.348760	83.572396	770246.68	2141431.91	422.41	
		Profile-03	720				Start Point	19.354922	83.575537	770566.68	2142119.22	416.17	NE-SW
							End Point	19.350109	83.570989	770096.53	2141579.09	416.12	
		Profile-04	720				Start Point	19.356443	83.574185	770422.05	2142285.49	421.74	NE-SW
							End Point	19.351445	83.569623	769950.75	2141724.81	419.84	
Zone -2	Lanji	Profile-01	230	10	4	70	Start Point	19.365809	83.591301	772205.46	2143349.68	508.27	NE-SW
							End Point	19.365190	83.589368	772003.31	2143278.10	471.57	
		Profile-02	230				Start Point	19.365272	83.591586	772236.29	2143290.67	512.20	NE-SW
							End Point	19.364403	83.589609	772029.97	2143191.26	495.84	
		Profile-03	240				Start Point	19.364562	83.592015	772282.62	2143212.74	518.92	NE-SW
							End Point	19.363864	83.589863	772057.60	2143132.03	515.87	
		Profile-04	240				Start Point	19.364066	83.592278	772311.05	2143158.25	515.28	NE-SW
							End Point	19.363116	83.590151	772089.08	2143049.67	501.44	
Zone -3	Bhaleri	Profile-01	190	10	4	50	Start Point	19.349891	83.582334	771289.40	2141572.77	432.71	SW-NE
							End Point	19.351256	83.583440	771403.34	2141725.61	432.37	
		Profile-02	210				Start Point	19.350587	83.581157	771164.54	2141647.96	428.21	SW-NE
							End Point	19.352186	83.582193	771270.78	2141826.65	438.70	
		Profile-03	220				Start Point	19.351002	83.580547	771099.71	2141692.91	426.53	SW-NE
							End Point	19.352634	83.581749	771223.34	2141875.60	446.79	
		Profile-04	220				Start Point	19.351551	83.579742	771014.21	2141752.51	421.80	SW-NE
							End Point	19.353279	83.580868	771129.67	2141945.58	440.48	
Zone -4	Dhuanbarhi	Profile-01	270	10	4	90	Start Point	19.354378	83.595207	772635.03	2142089.96	464.87	SW-NE
							End Point	19.356216	83.596985	772818.80	2142296.34	459.25	
		Profile-02	230				Start Point	19.353808	83.596278	772748.54	2142028.54	461.96	SW-NE
							End Point	19.355300	83.597955	772922.33	2142196.42	464.98	
		Profile-03	240				Start Point	19.352592	83.597209	772848.44	2141895.42	461.34	SW-NE
							End Point	19.354198	83.598809	773013.94	2142075.75	461.84	
		Profile-04	200				Start Point	19.351771	83.598604	772996.41	2141806.67	453.29	SW-NE
							End Point	19.353231	83.599851	773125.02	2141970.35	455.00	

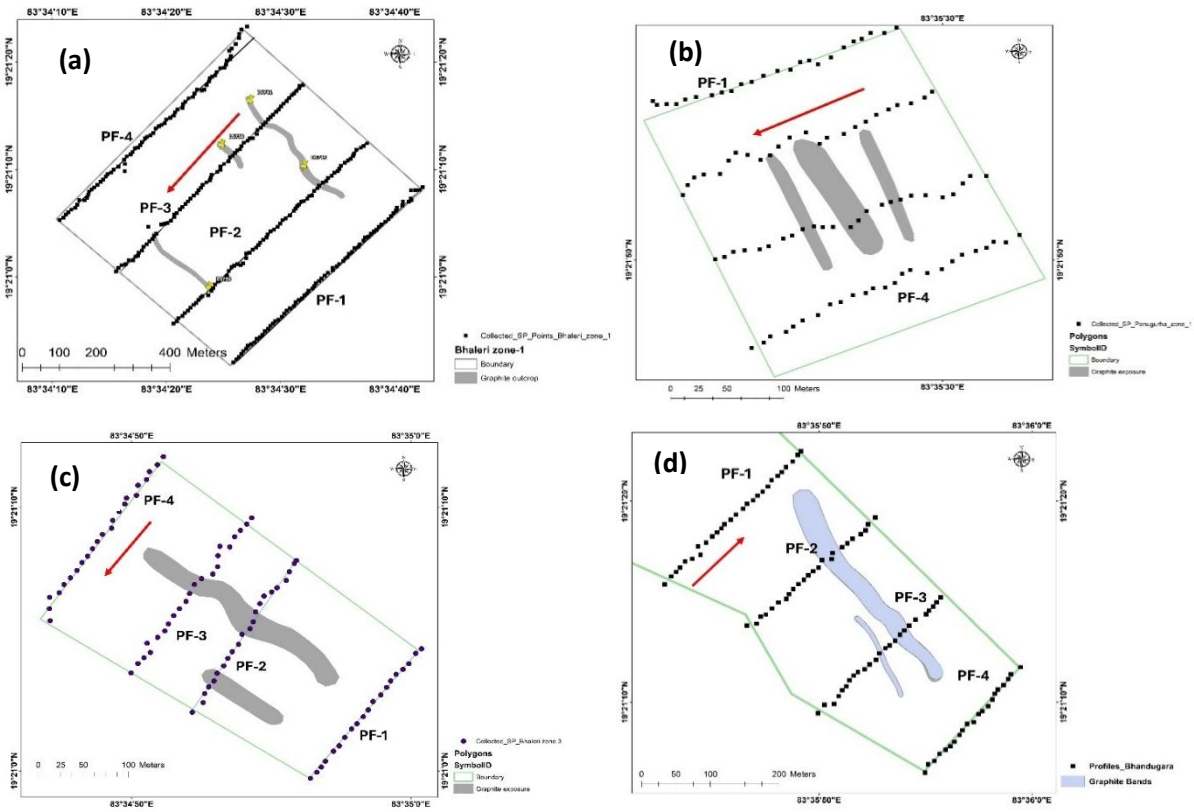


Fig 6.20: (a), (b), (c), and (d) SP profile layout maps for Zone-1, Zone-2, Zone-3, and Zone-4 respectively, showing the survey profile lines labelled as PF-1 to PF-4, with red arrows indicating the profile orientation.

SP Data Processing

Following field data acquisition, the raw SP data were subjected to systematic processing to eliminate noise and enhance signal response associated with subsurface graphitic targets. The base tie value of each Local Base Station was measured with respect to the Universal Base Station, and base tie corrections were applied accordingly to the raw SP values. Subsequently, base station drift corrections were applied to account for temporal variations in the natural earth potential throughout the survey period. Terrain-induced anomalies were identified and removed where necessary. After applying all corrections, the final corrected SP values were computed and assigned to their respective station coordinates obtained from DGPS surveys.

The residual SP anomaly map was prepared using a high-pass filter applied to the observed SP data. However, this process introduced artefacts and breaks in the anomaly continuity, which were verified through field checks and found to be inconsistent with the actual ground conditions. These filtering-induced discontinuities were not geologically meaningful and therefore reduced the reliability of the residual map for interpretation purposes.

Profile-wise SP anomaly variation with distance were plotted and displayed, and contour maps of the overall survey area were generated using Geosoft Oasis Montaj software to delineate the spatial distribution of negative and positive potential anomalies across all four zones (Zone 1 to Zone 4). Anomalous zones were identified based on the magnitude, spatial extent, and polarity of SP responses, wherein significant negative SP anomalies are considered indicative of subsurface graphite mineralisation. The processed and interpreted data were finally integrated with available geological and structural information to facilitate meaningful interpretation and prioritization of subsurface mineralization targets.

Results and Discussion

Zone-1 (Village - Pichuligurha)

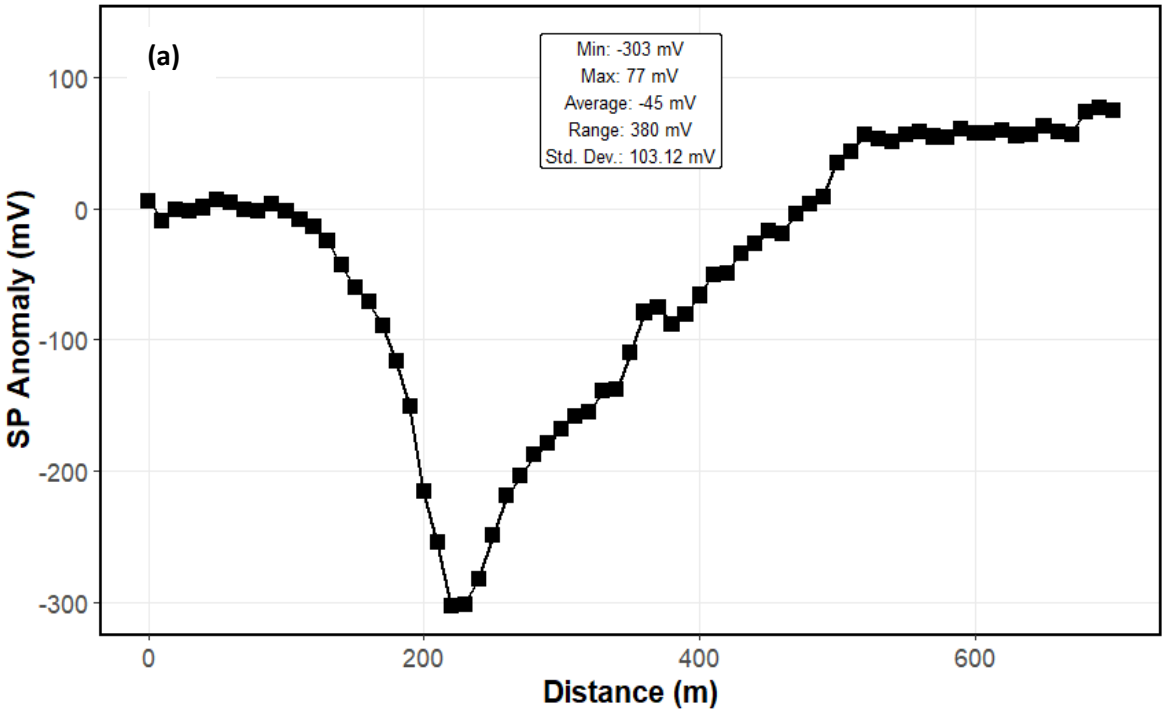
The SP profiles acquired across Zone 1 reveal well-defined negative potential anomalies interpreted to be associated with graphite-bearing horizons. Profile PF-1 exhibits a distinct negative anomaly centred around 220–250 m chainage with a minimum value of approximately -303 mV. The anomaly is characterized by a sharp potential gradient and narrow width, indicating a localized conductive graphite-bearing zone (**Figure 6.21 (a)**).

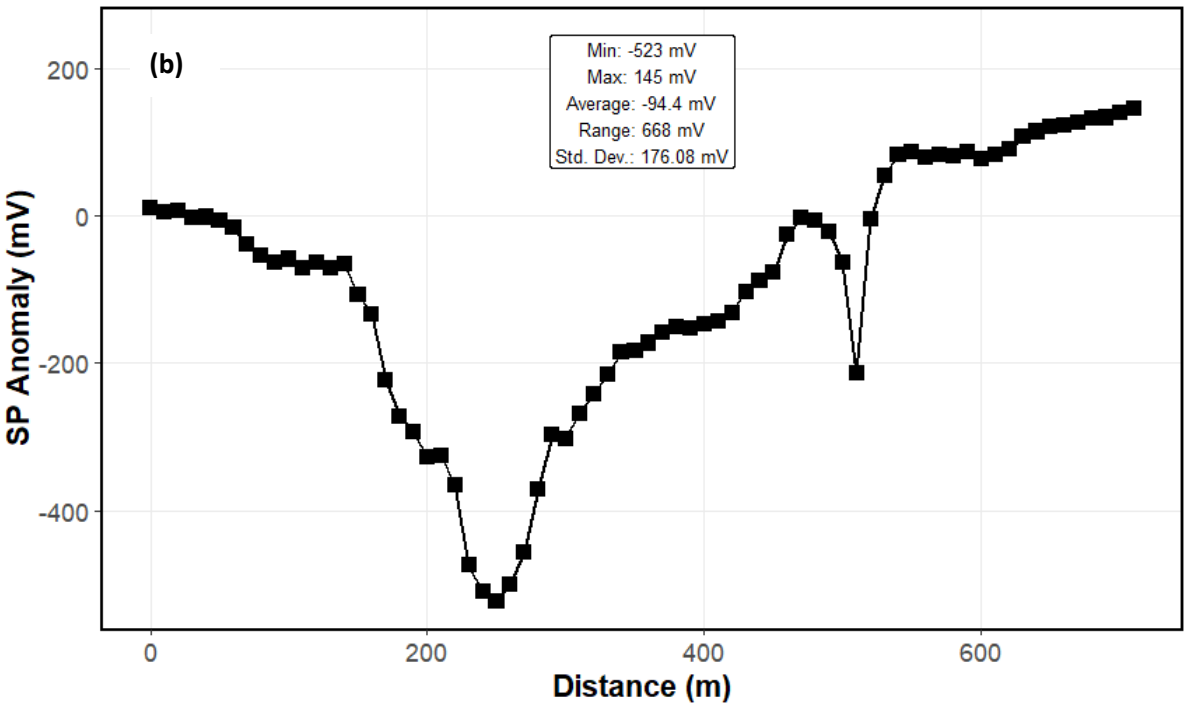
Profile PF-2 records the most intense response within the zone, where a broad negative anomaly between 180 m and 300 m reaches values below -500 mV (**Figure 6.21 (b)**). A secondary negative closure is observed around 500 m chainage with a -200 mV anomaly value, suggesting the presence of an additional conductive horizon or a structurally displaced graphite band. The persistence of negative potentials across a considerable profile length indicates good lateral continuity of graphite mineralization.

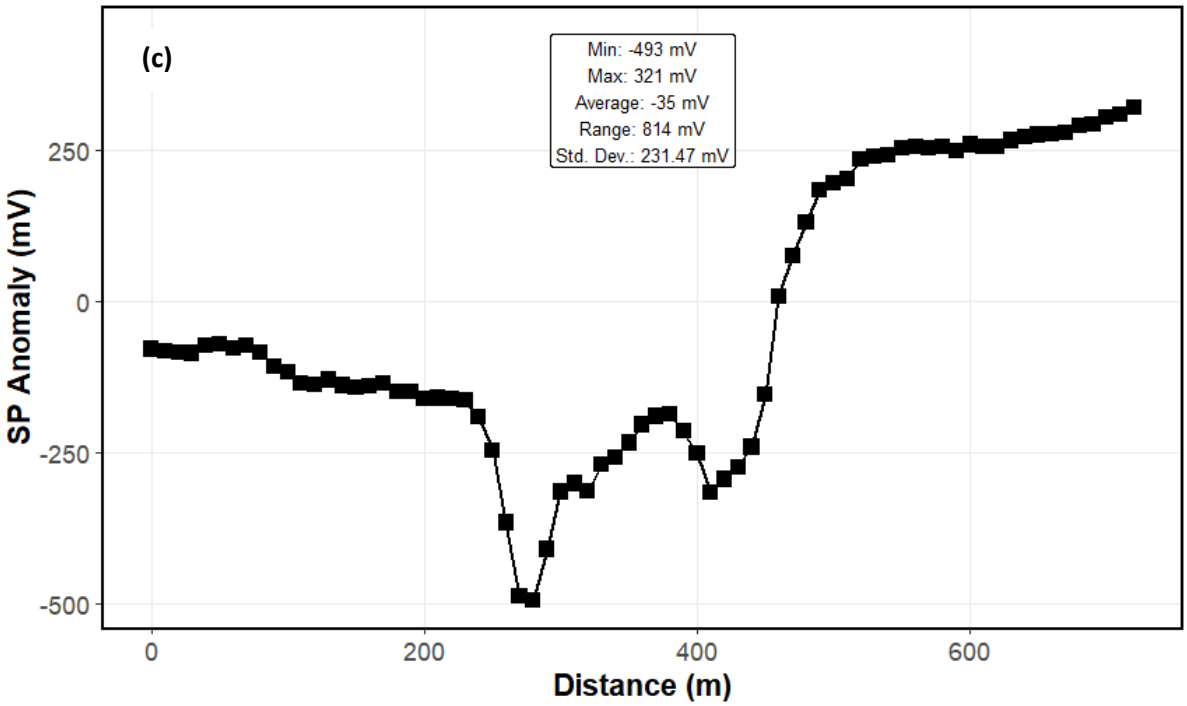
Profile PF-3 shows two prominent negative anomalies centred near 275 m and 415 m chainage, attaining minimum values of approximately -493 mV and -380 mV, respectively (**Figure 6.21 (c)**). These anomalies are interpreted as graphite-bearing bands occurring within the same structural corridor and possibly representing multiple mineralized horizons developed along lithological contacts and foliation planes.

Profile PF-4 exhibits a broad negative anomaly extending from approximately 160 m to 290 m chainage with a minimum value near -293 mV (**Figure 6.21 (d)**). The anomaly geometry and amplitude are comparable to those observed in Profiles PF-2 and PF-3, suggesting continuity of the conductive graphite-bearing horizon across the survey area.

Overall, Zone 1 is characterized by a series of moderate to strong negative SP anomalies ranging from approximately -120 mV to -523 mV. The repeated occurrence of these anomalies across adjacent profiles indicates a laterally persistent conductive zone.


(a)
Min: -303 mV
Max: 77 mV
Average: -45 mV
Range: 380 mV
Std. Dev.: 103.12 mV
SP Anomaly (mV)
100
0
-100
-200
-300
0
200
400
600
Distance (m)


(b)
Min: -523 mV
Max: 145 mV
Average: -94.4 mV
Range: 668 mV
Std. Dev.: 176.08 mV
SP Anomaly (mV)
200
0
-200
-400
0
200
400
600
Distance (m)



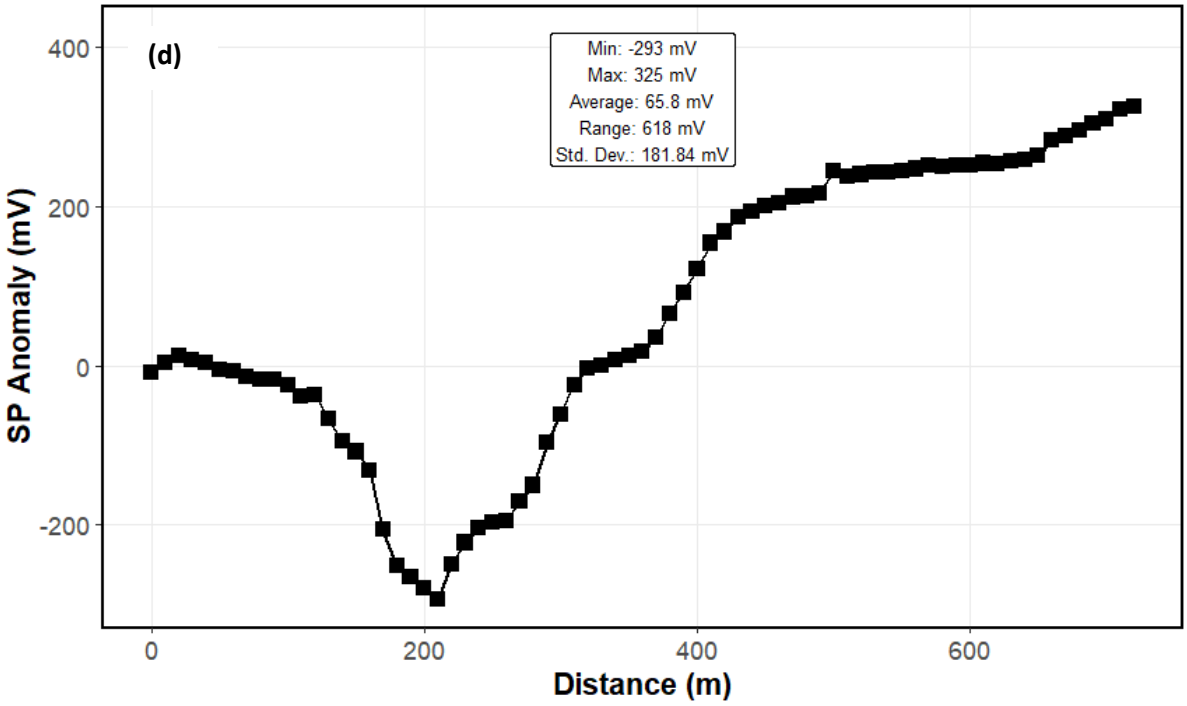


Fig 6.21: (a-d) SP anomaly plots along profiles 1, 2, 3, and 4, respectively for Zone 1

The spatial continuity, anomaly amplitude and geological association with quartzo-feldspathic graphite gneiss suggest that these responses are generated by graphite-rich horizons occurring along lithological contact zones. Several anomalies extend beyond known surface occurrences, indicating potential concealed graphite mineralisation beneath soil cover and weathered overburden.

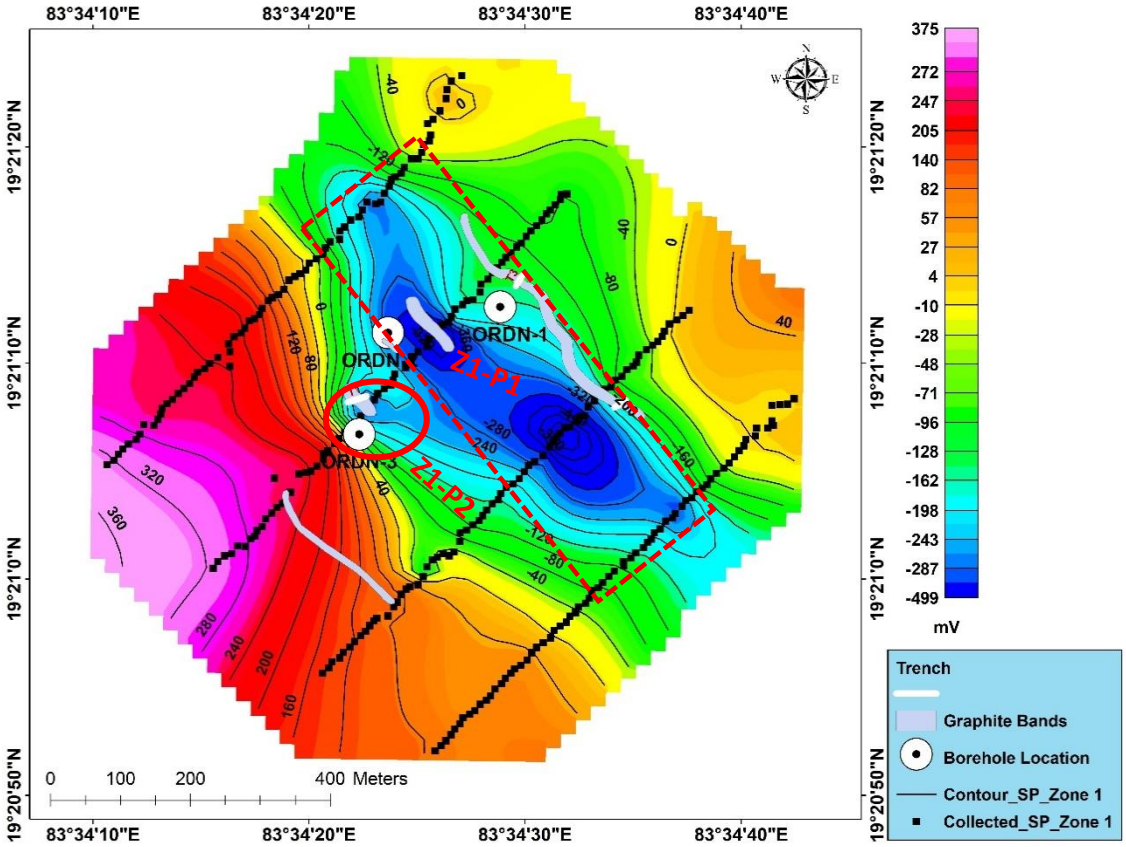


Fig 6.22: SP anomaly map of Zone 1. Z1-P1 and Z1-P2 are promising zones for concealed graphite bands. The locations of the boreholes and trenches are superimposed.

The SP anomaly map of Zone 1 is characterised by a prominent NW–SE trending negative potential corridor with anomaly values decreasing from approximately -50 mV to below -450 mV (**Figure 6.22**). The anomaly pattern comprises a broad central low associated with multiple closed negative contours, indicating the presence of conductive graphite-bearing horizons. The zone Z1-P1 is the main graphite-bearing structural corridor having a strike length ~700m. The progressive tightening of contour spacing around the Z1-P2 zone near central anomaly core reflects steep potential gradients and suggests relatively concentrated graphite mineralization or increased graphite thickness within this sector.

The geometry of the negative anomaly closely follows the strike of the inferred graphite bands and the regional foliation trend, indicating strong structural control on graphite mineralization. Boreholes ORDN-1 (inclination of 45° along azimuth N55°E), ORDN-2 (inclination of 55° along azimuth N55°E) and ORDN-3 (inclination of 45° along azimuth N45°E) are positioned within the core of the negative anomaly zone, generally enclosed by the -200 mV to -350 mV contours. The coincidence of drilling locations, trenches, grooves and negative SP closures provide strong evidence that the observed SP response is directly related to graphite mineralization.

The contour configuration further suggests that the central anomaly is not an isolated feature but forms part of a continuous conductive corridor extending along strike. A subsidiary negative closure observed in the eastern part of the survey area may represent a parallel graphite-bearing horizon, a folded extension of the main graphite band, or a structurally controlled graphite lens concealed beneath soil cover. A notable feature of the SP anomaly map is the slight spatial offset of ~ 130 m between the mapped graphite outcrops and the core of the strongest negative SP anomaly. The graphite-bearing outcrops and trenches occur predominantly along the north-eastern margin of the main anomaly, whereas the deepest negative closure (< -300 mV) is developed further towards the south-west. This displacement is interpreted to be a consequence of the south-westerly dip of the graphite-bearing horizons, whereby the surface exposures represent the up-dip expression of the mineralised band while the strongest SP response is generated by the thicker and more conductive portion of the graphite body at shallow subsurface levels. The observed shift, therefore, suggests down-dip continuation and possible thickening of the graphite-bearing horizon towards the southwest. The anomaly pattern indicates that the principal graphite mineralisation extends beneath the exposed outcrops and remains concealed under soil cover, highlighting the potential for additional subsurface graphite resources beyond the mapped surface occurrences.

An interesting feature is observed in the southern part of the mapped area, where graphite-bearing surface exposures are reported but no significant negative SP anomaly is developed, and was sampled through groove sampling along groove line G6, planned across inferred band C-1. The analytical results yielded a weighted average fixed carbon (F.C %) value of 2.74% over a sampled length of 5.2 m (comprising 5 samples). Although the F.C % value marginally exceeds the economic threshold of 2%, the band does not exhibit a promising surface outcrop expression or significant strike length continuity. The absence of a strong negative SP anomaly over this band, despite the marginally economic F.C % value, is attributed to the thin, discontinuous, and highly weathered nature of the graphite occurrence, which is insufficient to generate a measurable electro-chemical redox potential contrast detectable at surface. Alternatively, the exposed graphite may represent a surface expression without substantial subsurface continuity. The absence of a corresponding negative SP anomaly suggests comparatively lower exploration significance relative to the central anomaly corridor where grooving, trenching, drilling and geophysical evidence show strong agreement.

Overall, the contour pattern demonstrates that the most prospective graphite mineralisation is concentrated within the central NW–SE trending negative SP corridor, while subsidiary anomaly closures indicate additional concealed targets warranting further investigation.

Zone-2: (Village - Lanji)

The SP profiles acquired over Zone 2 exhibit comparatively subdued responses relative to the other graphite-bearing zones. Most traverses are characterized by predominantly positive SP values, indicating that conductive graphite horizons are restricted in extent and occur only locally within the investigated area.

Profile PF-1 is characterized by predominantly positive SP values ranging from approximately 6 mV to 54 mV (**Figure 6.23 (a)**). A broad low-amplitude depression occurs between 90 m and 140 m chainage, where SP values decrease to about 6 mV. However, no distinct negative closure is developed. The subdued response suggests the absence of a significant conductive graphite body beneath this traverse or the presence of only weakly developed and discontinuous graphite mineralization.

Profile PF-2 exhibits a well-defined negative SP anomaly extending between approximately 60 m and 170 m chainage (**Figure 6.23 (b)**). The anomaly reaches a minimum value of about -102 mV near 90–100 m chainage and displays a broad U-shaped geometry. The amplitude and width of the anomaly indicate the presence of a conductive graphite-bearing horizon with moderate lateral continuity. The anomaly likely represents the main graphite zone intersected by the profile.

Profile PF-3 records the strongest response within Zone 2. SP values decrease progressively from approximately -50 mV to a minimum of about -181 mV around 95–105 m chainage before recovering towards positive values (**Figure 6.23 (c)**). The broad and symmetrical nature of the anomaly suggests a relatively continuous graphite-bearing horizon. The coincidence of the anomaly position with that observed in Profile PF-2 indicates strike continuity of the conductive graphite zone across adjacent traverses.

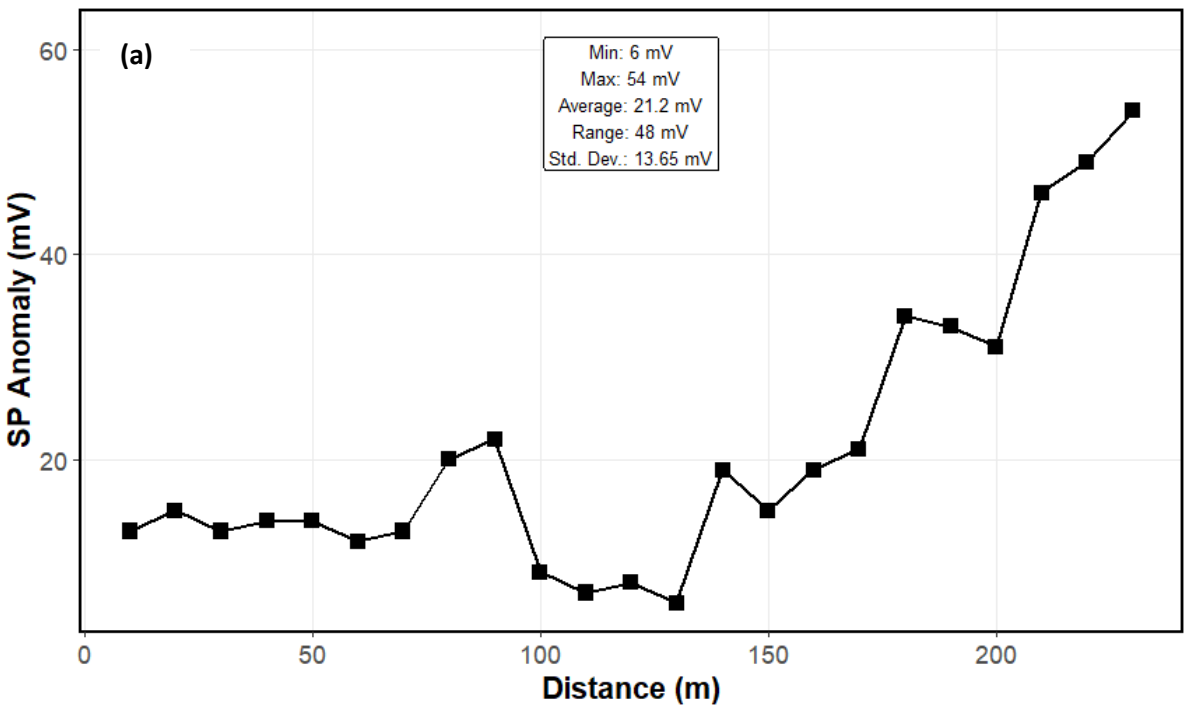
Profile PF-4 is dominated by positive SP values ranging from approximately -22 mV to 111 mV (**Figure 6.23 (d)**). A minor negative response is observed at the beginning of the profile, but no significant negative closure develops along the traverse. The profile therefore represents background conditions outside the main anomalous zone associated with mineralization.

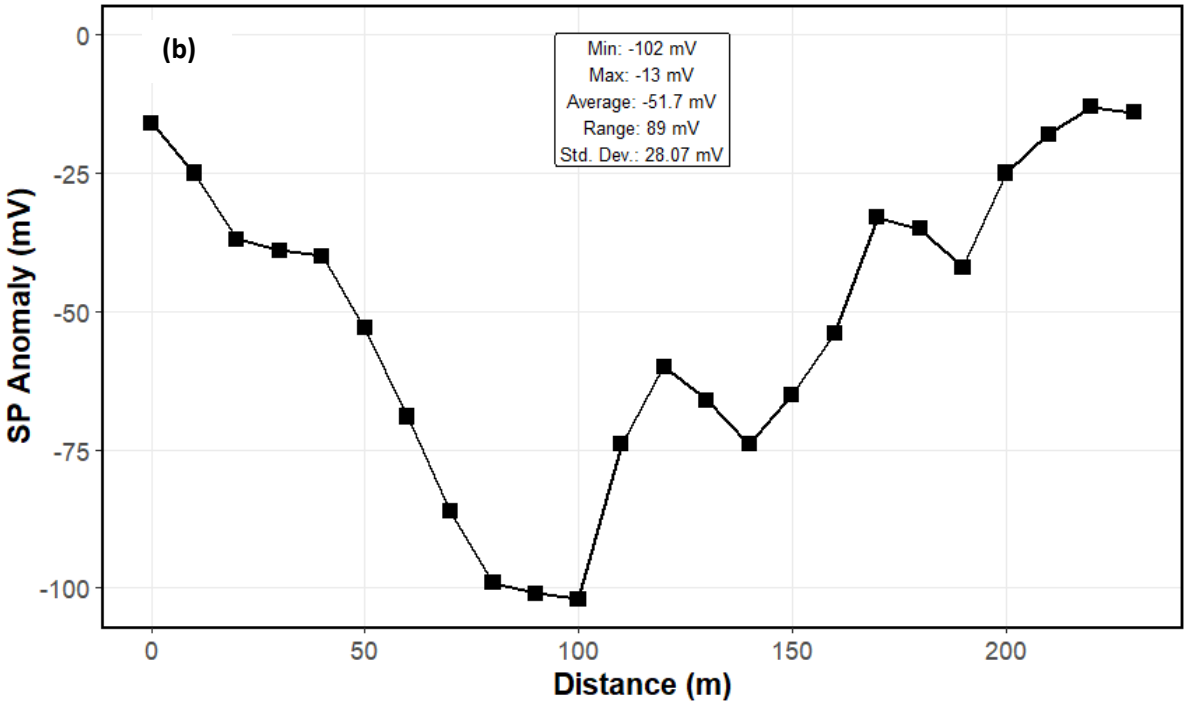
The mapped graphite band in Zone-2 has an inferred strike length ranging from 100 m to 150 m, comprising three discrete inferred graphite bands with individual thicknesses ranging from 5 m to 16 m. A total of 15 groove samples were collected across 3 grooves from the mapped band exposures. The F.C percentage values obtained from laboratory analysis of these samples range from 4% to 12.64%, indicating low to moderate grade graphite mineralization within Zone-2. The SP responses in Zone 2 indicate the presence of a localized graphite-bearing corridor centred around the anomaly observed in Profiles PF-2 and PF-3. The broad negative anomalies recorded in these traverses suggest a conductive graphite horizon extending across multiple profiles, while the absence of comparable responses in PF-1 and PF-4 indicates that the mineralization is spatially restricted. The anomaly pattern supports the interpretation of a relatively narrow but laterally continuous graphite-bearing zone concealed beneath shallow overburden and controlled by the regional structural trend.

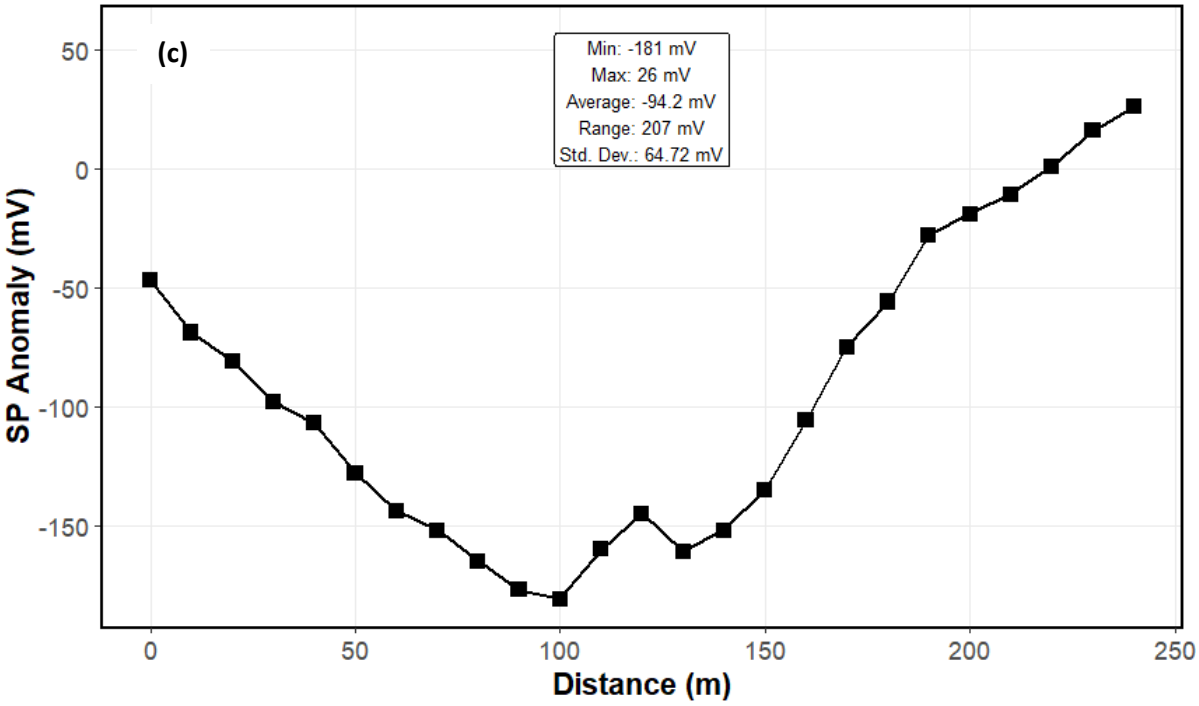
The SP anomaly map of Zone 2 is characterized by a prominent elliptical negative closure with SP values decreasing from approximately -40 mV along the margins to below -160 mV within the anomaly core (**Figure 6.24**). The anomaly exhibits a well-defined and continuous contour pattern, indicating the presence of a localized conductive body beneath shallow cover. The mapped graphite bands occur entirely within the negative anomaly zone and show excellent spatial correlation with the lowest SP values, confirming the graphite-controlled nature of the response.

The anomaly is elongated parallel to the strike of the graphite-bearing horizons, suggesting strong lithological and structural control on mineralization. The progressive inward decrease in SP values and the development of closed contours around the anomaly core indicate increasing graphite concentration and conductivity towards the central part of the zone. The continuity of the negative anomaly beyond the exposed graphite bands suggests that the graphite-bearing horizon extends beneath soil cover and remains open along strike. Overall, the anomaly pattern delineates a coherent graphite-bearing corridor with the central -160 mV closure representing the most prospective target within Zone 2.

The absence of multiple isolated negative closures suggest that graphite mineralization in Zone 2 is concentrated within a single dominant conductive horizon rather than occurring as several disconnected graphite lenses.




(b)
Min: -102 mV
Max: -13 mV
Average: -51.7 mV
Range: 89 mV
Std. Dev.: 28.07 mV
SP Anomaly (mV)
0
-25
-50
-75
-100
0
50
100
150
200
Distance (m)


(c)
Min: -181 mV
Max: 26 mV
Average: -94.2 mV
Range: 207 mV
Std. Dev.: 64.72 mV
SP Anomaly (mV)
50
0
-50
-100
-150
0
50
100
150
200
250
Distance (m)

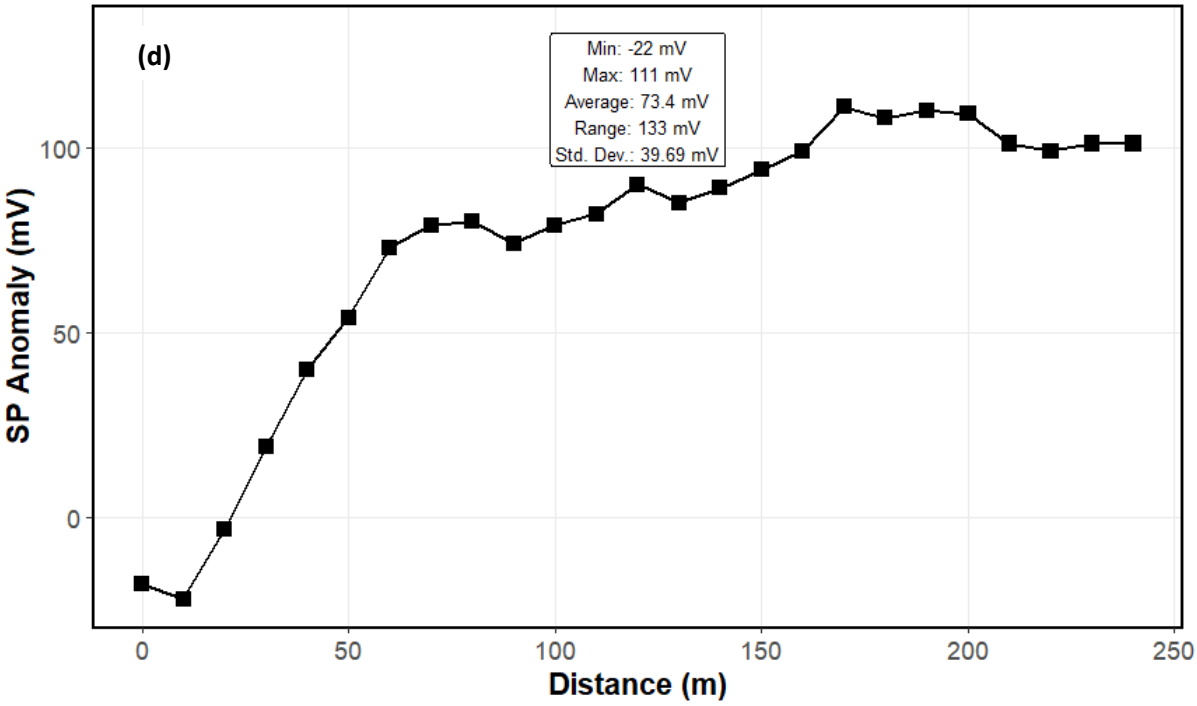


Fig 6.23: (a-d) SP anomaly plots along profiles PF-1, 2, 3, and 4, respectively, for Zone 2

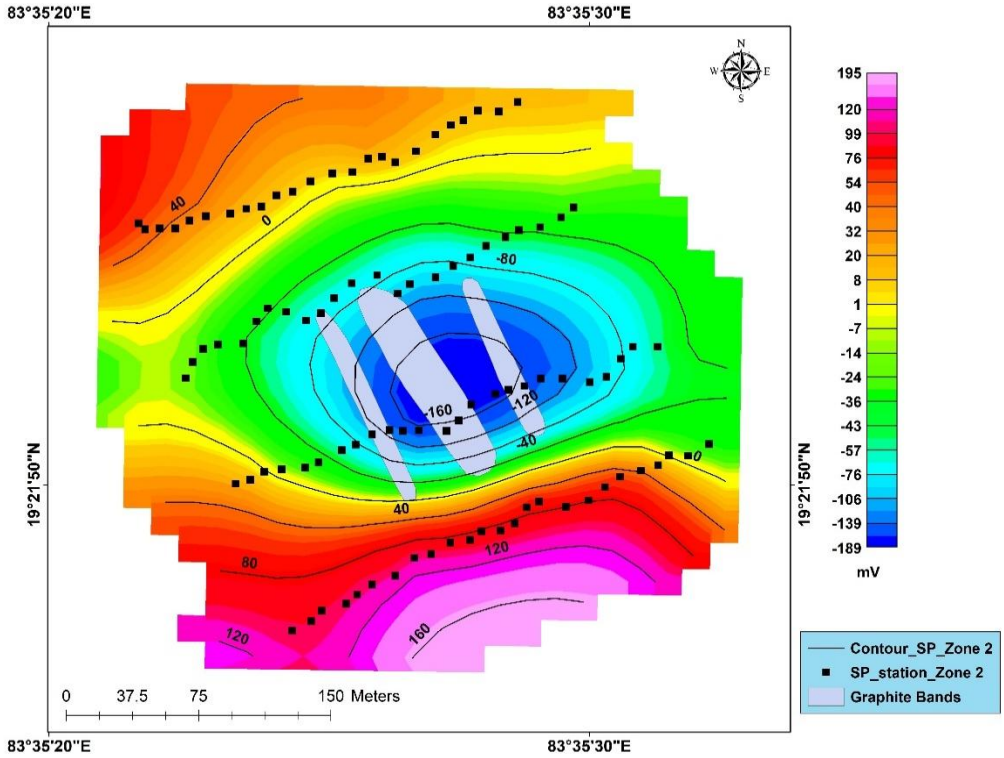


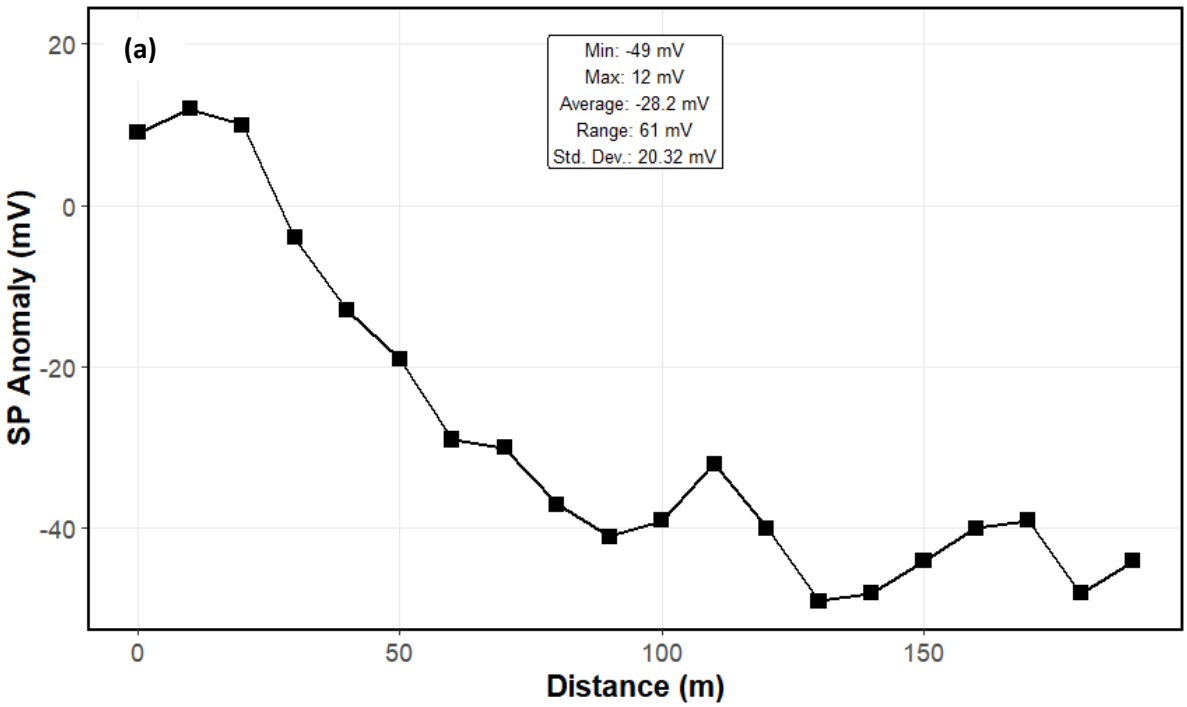
Fig 6.24: SP anomaly map of Zone-2

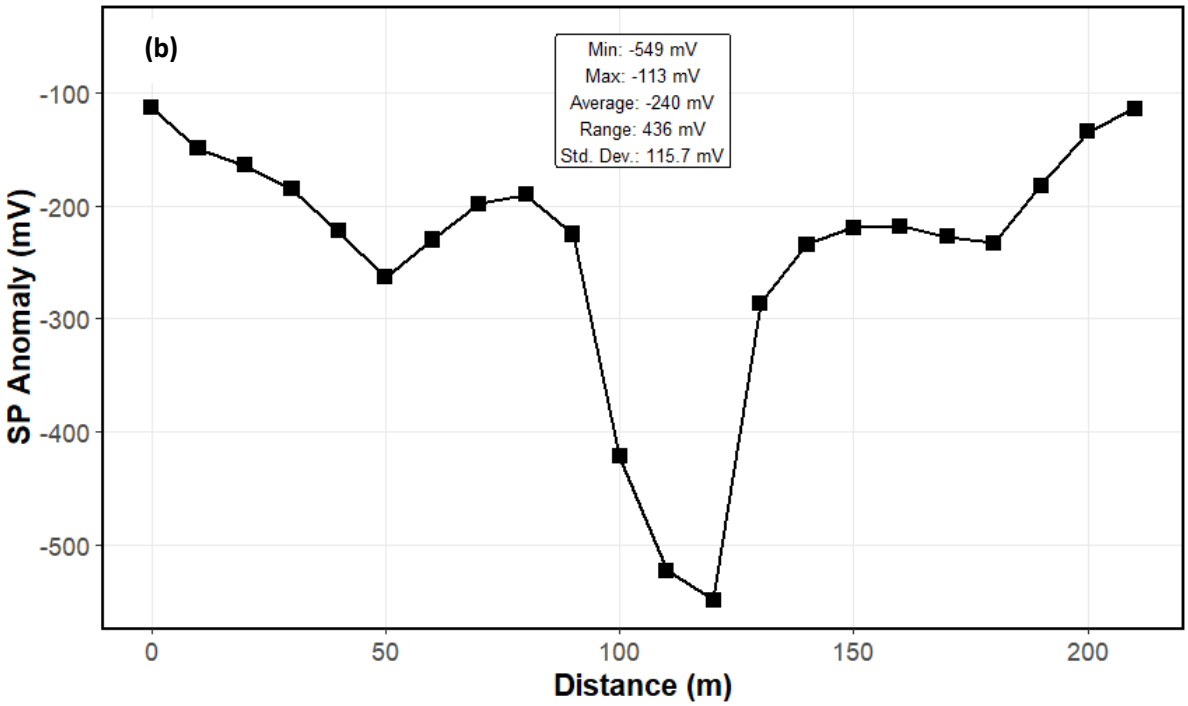
Zone-3: (Village - Bhaleri)

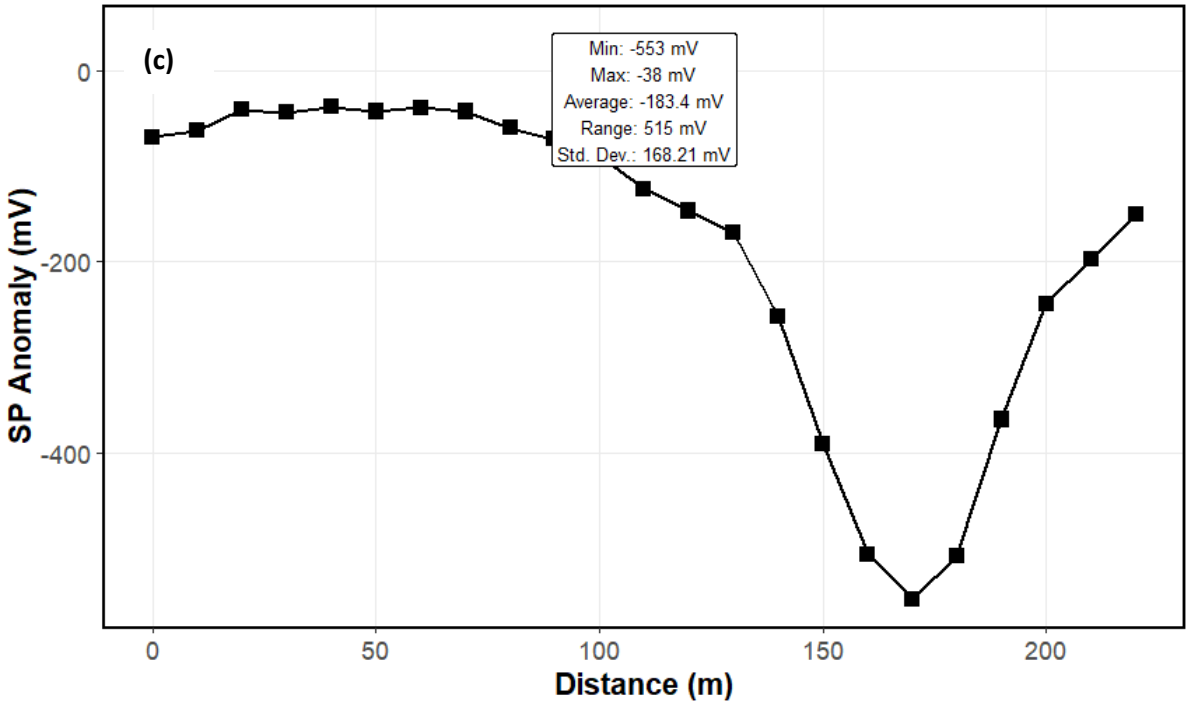
The SP profiles acquired over Zone 3 reveal a well-developed conductive graphite-bearing corridor characterized by strong negative self-potential anomalies. Profile PF-1 exhibits only weak negative values and lacks a distinct anomaly closure, suggesting that the traverse intersects the peripheral part of the mineralized system. In contrast, Profiles PF-2, PF-3 and PF-4 display prominent negative anomalies with minimum values reaching approximately -549 mV, -553 mV and -418 mV, respectively (**Figure 6.25**).

The anomalies are characterized by steep gradients and well-defined negative closures, indicating the presence of highly conductive graphite-bearing horizons. Profile PF-3 records the strongest and broadest anomaly within the zone, suggesting increased graphite concentration, thickness, or lateral continuity. The recurrence of strong negative anomalies across multiple adjacent traverses demonstrates that the conductive graphite horizon persists along strike and forms a coherent mineralized corridor beneath shallow cover.

The anomaly amplitudes observed in Zone 3 are among the highest recorded within the study area and indicate significant graphite enrichment. The continuity of anomaly responses between PF-2, PF-3 and PF-4 suggests that the graphite mineralization is not restricted to isolated lenses but occurs as a laterally continuous graphite-bearing horizon controlled by the regional structural trend.




(b)
Min: -549 mV
Max: -113 mV
Average: -240 mV
Range: 436 mV
Std. Dev.: 115.7 mV
SP Anomaly (mV)
-100
-200
-300
-400
-500
0
50
100
150
200
Distance (m)


(c)
Min: -553 mV
Max: -38 mV
Average: -183.4 mV
Range: 515 mV
Std. Dev.: 168.21 mV
SP Anomaly (mV)
0
-200
-400
0
50
100
150
200
Distance (m)

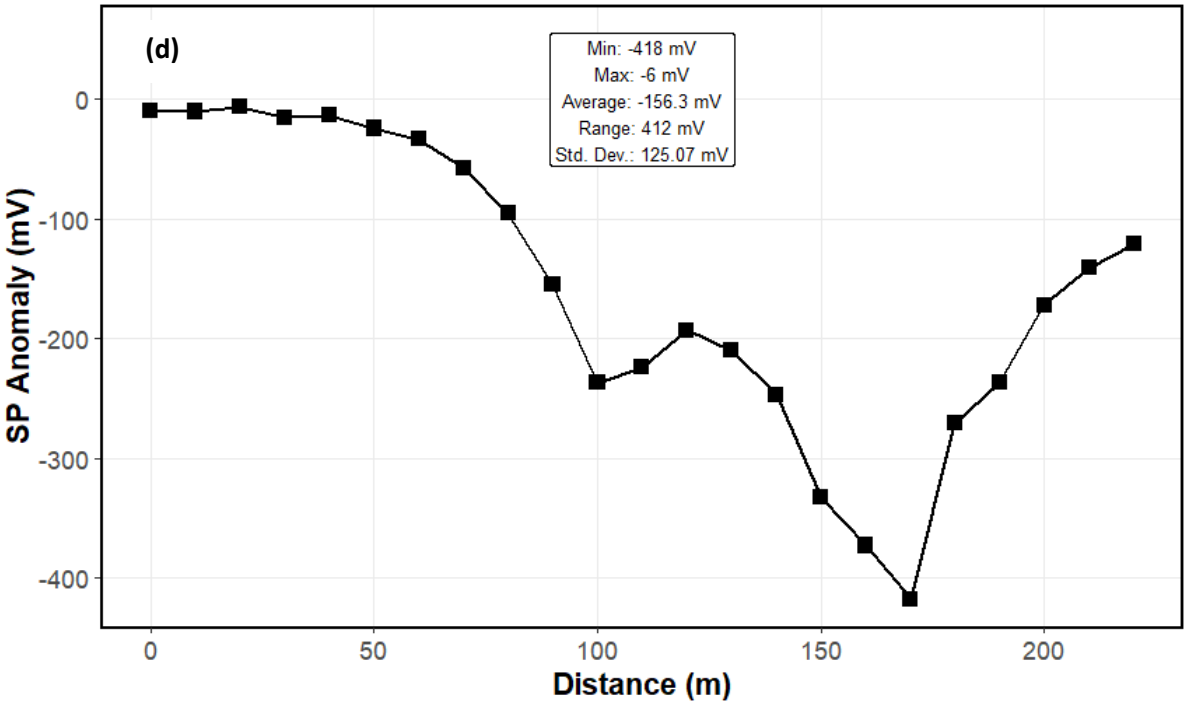


Fig 6.25: (a-d) SP anomaly plots for profiles PF-1-PF-4, respectively, for Zone 3

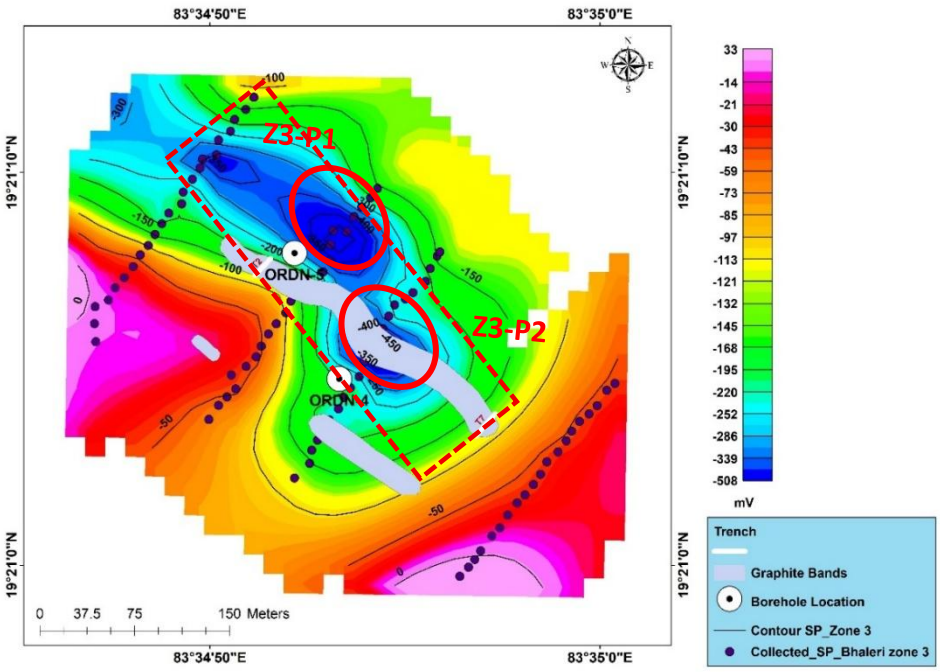


Fig 6.26: SP anomaly map corresponding to the Zone-3, Z3-P1 and Z3-P2 are promising zones for concealed graphite bands. The locations of the boreholes and trenches are superimposed.

The SP anomaly map of Zone 3 is characterised by a prominent NW-SE-trending negative potential corridor, with values decreasing from approximately -150 mV along the margins to below -450 mV within the anomaly cores, marked by a dotted red rectangle having a strike length of 300m (**Figure 6.26**). The anomaly exhibits two well-developed negative closures (Z3-P1 and Z3-P2) connected by a continuous conductive zone, indicating the presence of a laterally persistent graphite-bearing horizon containing localized enrichment centres.

The mapped graphite bands and trench locations show excellent spatial correspondence with the negative SP corridor, while boreholes ORDN-3 and ORDN-4 occur within the main anomaly zone, confirming the association between graphite mineralization and the observed SP response. The strongest anomaly is developed around the central-southern closure, where contour values approach -500 mV, suggesting increased graphite concentration, thickness, or conductivity.

The contour pattern indicates that graphite mineralization is not restricted to isolated lenses but forms a continuous conductive corridor extending beyond the exposed graphite bands. The development of multiple negative closures within the broader anomaly trend suggests local graphite enrichment, possibly controlled by folding, lithological thickening, or structural repetition of graphite-bearing horizons. Overall, Zone 3 represents a highly prospective graphite target characterized by strong anomaly amplitudes, excellent geological correlation, and significant potential for concealed strike continuity beneath shallow cover.

A notable feature of Zone 3 is the spatial offset between the exposed graphite bands and the strongest negative SP closures. The deepest anomaly cores (-400 to -500 mV) occur slightly south and southeast of the mapped surface exposures, suggesting that the exposed graphite bands represent the up-dip expression of a more extensive subsurface conductive horizon. The displacement is interpreted to reflect down-dip continuation and possible thickening of the graphite-bearing horizon beneath shallow cover. In contrast, the small graphite band occurring in the southern part of the area is associated with only weak SP responses and lacks a corresponding negative closure. This suggests that the southern exposure may represent a thin, discontinuous or weakly conductive graphite occurrence with limited subsurface continuity, whereas the main anomaly corridor represents the principal graphite-bearing target within the zone.

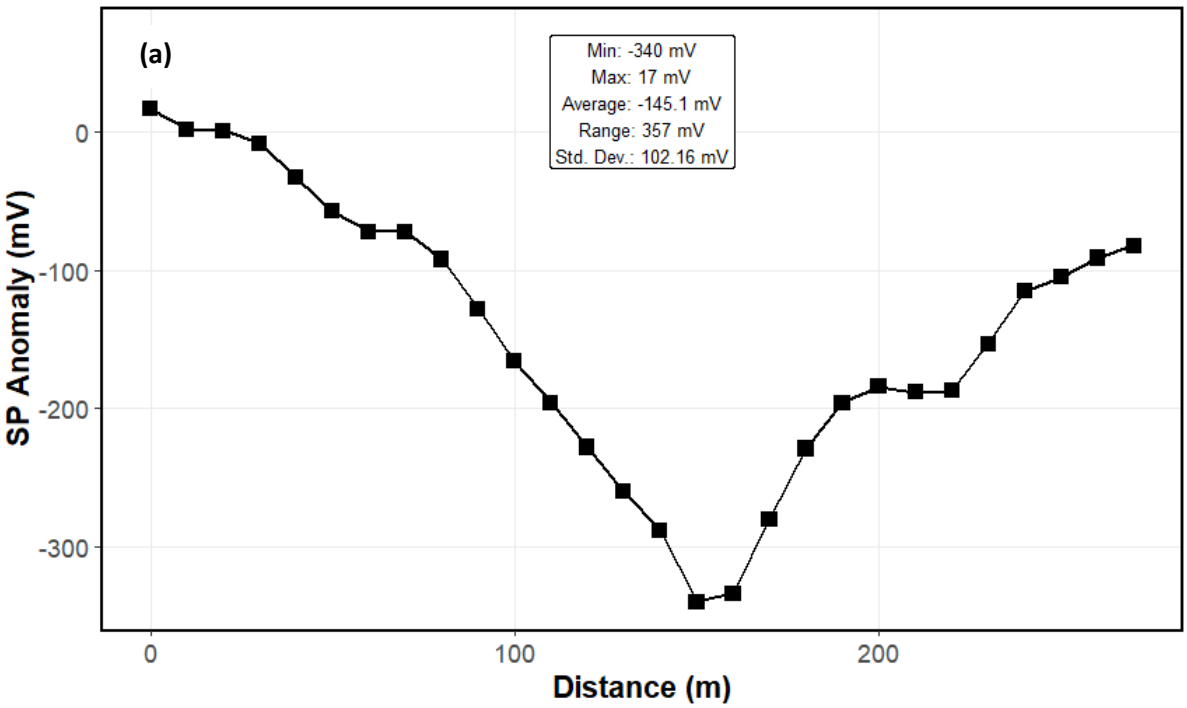
Zone-4: (Village – Dhuanbarhi)

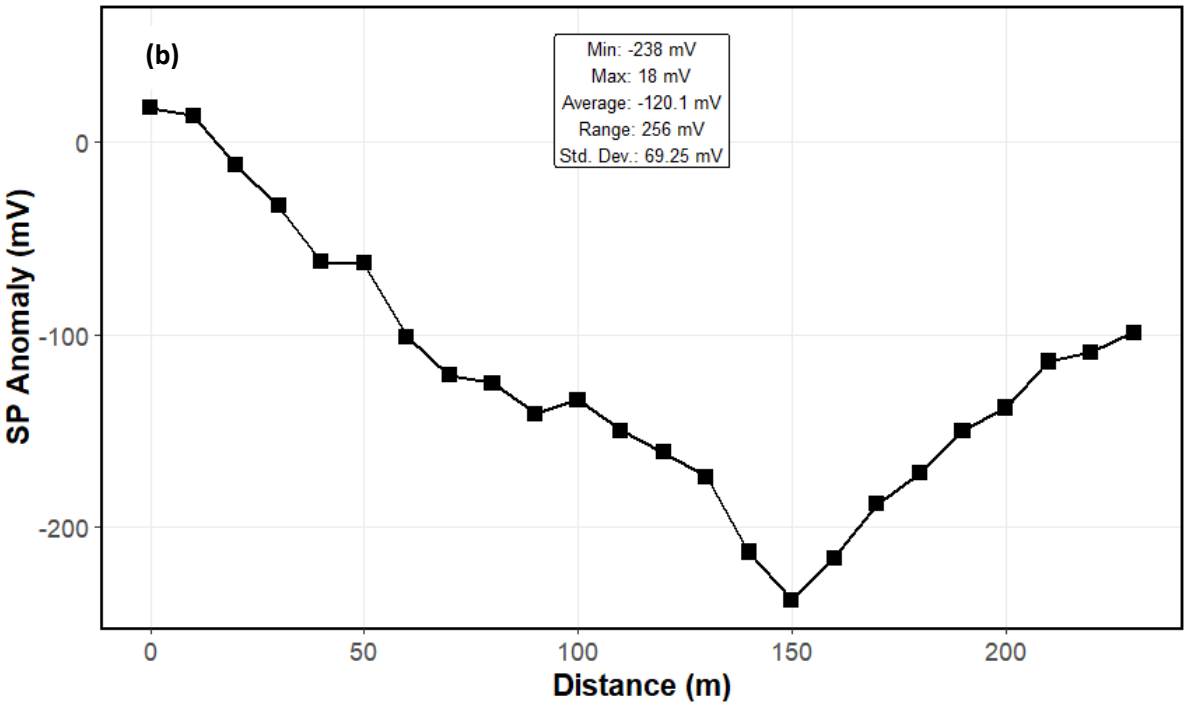
Profile PF-1 shows a broad negative SP anomaly extending from approximately 80 m to 190 m chainage, with the minimum value reaching about -340 mV near 150–160 m. The anomaly is well developed and indicates a conductive graphite-bearing horizon with moderate to strong subsurface continuity (**Figure 6.27**). Profile PF-2 also exhibits a broad negative anomaly, with values decreasing progressively to about -238 mV around 150 m chainage. The anomaly position broadly matches PF-1, suggesting continuation of the same graphite-bearing horizon along strike. Profile PF-3 records the strongest response in Zone 4, with a broad and intense negative anomaly reaching approximately -378 mV around 150–170 m chainage. The high amplitude and wide anomaly width suggest a thicker or more conductive graphite-rich segment within the zone. Profile PF-4 shows comparatively weaker SP response, with values ranging from +63 mV to about -123 mV. The anomaly lacks the strong closure observed in the other profiles and may represent the margin of the conductive corridor or a thinner, discontinuous graphite band. Overall, Zone 4 is characterized by a broad negative SP anomaly corridor, best developed in PF-1, PF-2 and PF-3, where anomaly minima occur consistently around 150–170 m chainage. This repeated anomaly position indicates good lateral continuity of the graphite-bearing horizon. PF-3 represents the strongest segment and may correspond to a local graphite enrichment zone, whereas PF-4 is comparatively lower priority due to its weaker and less coherent response.

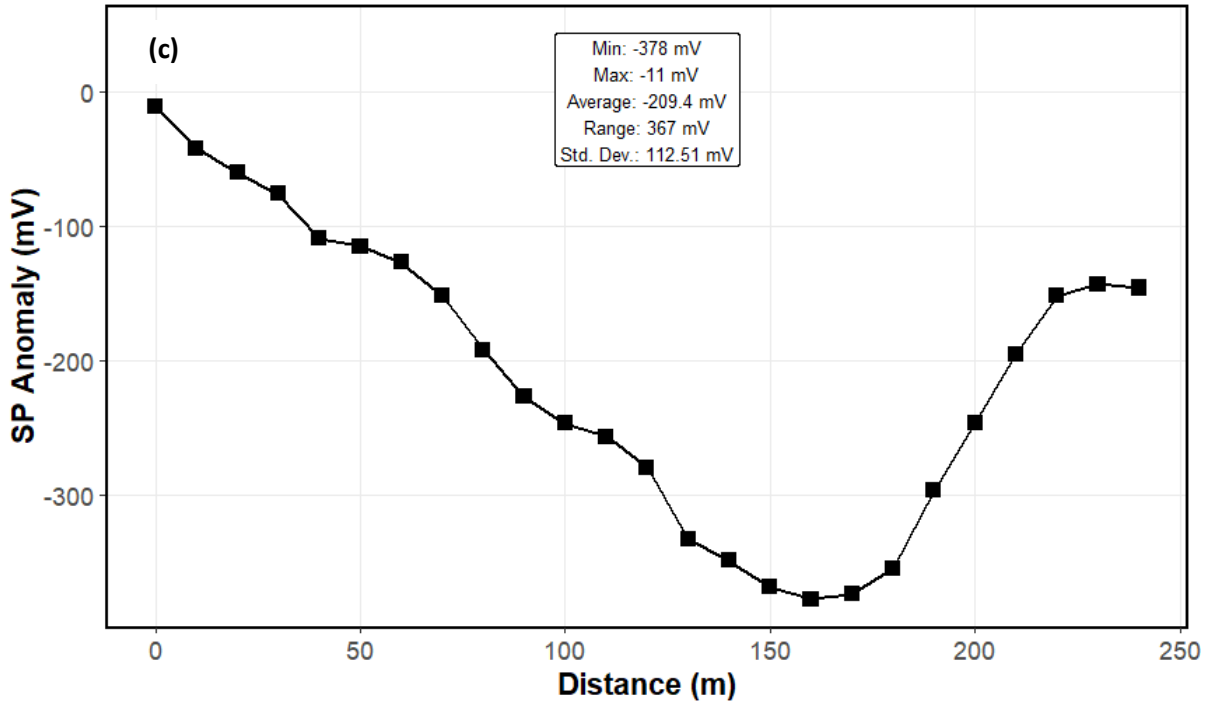
The SP anomaly map of Zone 4 is characterized by two distinct negative anomaly closures i.e. Z4-P1 and Z4-P2 developed along a common NW-SE trending conductive corridor (**Figure 6.28**). The northern anomaly centred around ORDN-7 and the central-southern anomaly centred around ORDN-6 exhibit SP values below -300 mV, indicating the presence of conductive graphite-bearing horizons beneath soil cover.

The mapped graphite bands and trench locations show excellent spatial correlation with the negative SP anomalies, confirming the graphite-controlled nature of the response. The anomaly closures are connected by a broader zone of moderately negative SP values, suggesting that the mineralization occurs within a continuous graphite-bearing horizon that undergoes local thickening or enrichment at specific locations.

A slight spatial offset is observed between the exposed graphite bands and the anomaly cores, indicating that the strongest SP responses are generated by the more conductive subsurface portions of the graphite horizon rather than by the surface exposures alone. The contour pattern suggests that graphite mineralization in Zone 4 occurs as a segmented but laterally continuous conductive corridor containing multiple enrichment centres. The anomaly associated with ORDN-6 represents the strongest and most laterally extensive conductive target within the zone.


(a)
Min: -340 mV
Max: 17 mV
Average: -145.1 mV
Range: 357 mV
Std. Dev.: 102.16 mV
SP Anomaly (mV)
0
-100
-200
-300
0
100
200
Distance (m)


(b)
Min: -238 mV
Max: 18 mV
Average: -120.1 mV
Range: 256 mV
Std. Dev.: 69.25 mV
SP Anomaly (mV)
0
-100
-200
0
50
100
150
200
Distance (m)



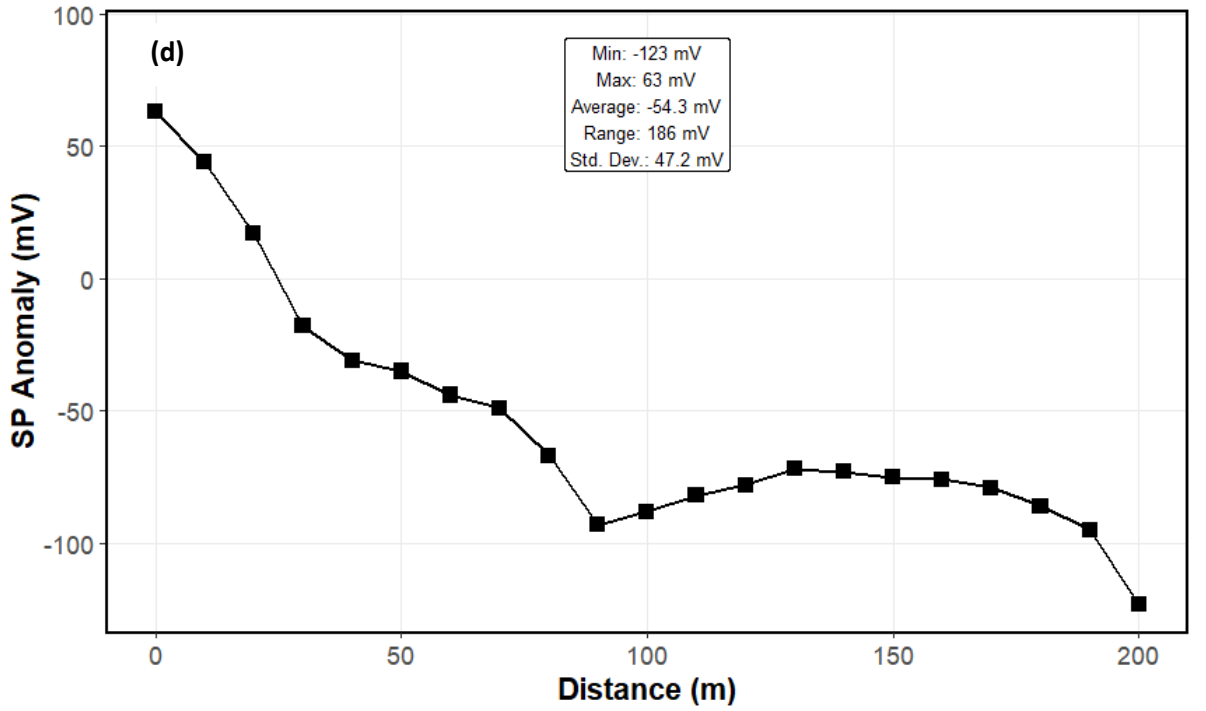


Fig 6.27: (a-d) SP anomaly plots for profiles PF-1-PF-4, respectively, for Zone 4

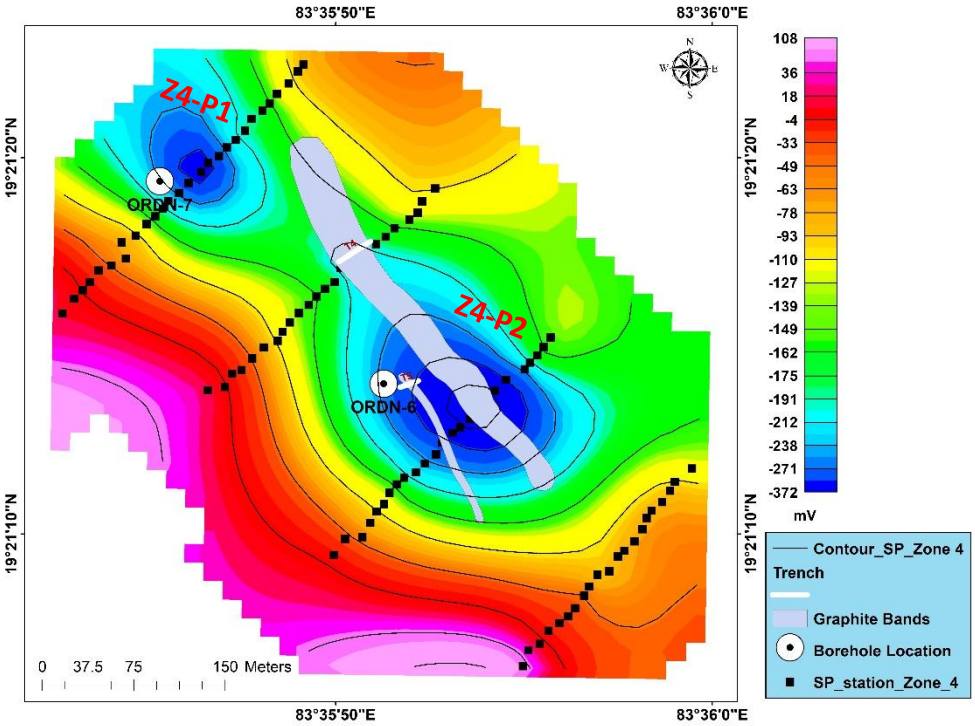


Fig 6.28: SP anomaly map of the Zone-4. Z4-P1 and Z4-P2 are promising zones for concealed graphite bands. The locations of the boreholes and trenches are superimposed.

Summary

The Self-Potential (SP) survey conducted across the four target zones of the Dumburuneli graphite block successfully delineated conductive graphite-bearing horizons and demonstrated the effectiveness of the SP method in tracing both exposed and concealed graphite mineralization. The observed SP responses show excellent spatial correlation with mapped graphite bands, trenches, and borehole locations, confirming that the negative SP anomalies are primarily controlled by graphite mineralization hosted within quartzo-feldspathic graphite gneiss.

Zone 1 is characterized by a broad NW-SE trending conductive corridor containing multiple high-amplitude negative closures, indicating the presence of several graphite enrichment centres within a laterally continuous graphite-bearing horizon. Zone 2 exhibits a relatively compact and localized negative anomaly, suggesting a restricted but coherent graphite-bearing lens. Zone 3 represents one of the most prospective sectors of the block, where strong negative SP anomalies exceeding -500 mV define a continuous graphite corridor containing multiple conductive centres and significant concealed strike continuity. Zone 4 is characterized by two distinct but connected negative closures associated with borehole-validated graphite occurrences, indicating localized graphite enrichment within a continuous mineralized trend.

The SP anomaly maps across all four zones consistently indicate that individual graphite lenses pinch out at approximately 100 m from their widest part, reflecting the lenticular geometry of the graphitic horizons at depth. This geophysical inferred pinch distance is broadly consistent with the surface-observed dimensions of graphite exposures, where the mineralised zones have been mapped with strike lengths ranging from 100 m to 350 m and surface widths of 30 m to 50 m, as confirmed through geological mapping, pitting, trenching, groove sampling and scout drilling.

A notable feature observed in several zones is the spatial offset between exposed graphite bands and the strongest SP anomaly cores. This relationship suggests that the exposed graphite horizons represent the up-dip expression of larger conductive bodies that continue beneath soil cover and may locally thicken or become enriched at shallow subsurface levels. The SP anomaly patterns further indicate that graphite mineralization is not restricted to isolated surface occurrences but forms structurally controlled conductive corridors extending beyond the mapped exposures.

Based on anomaly amplitude, contour geometry, strike continuity and geological correlation, the survey has successfully identified several high-priority graphite targets, particularly within Zones 1 and 3, where strong negative closures and continuous conductive trends indicate significant potential for concealed graphite mineralization. The results demonstrate that SP surveying provides a rapid, cost-effective and reliable tool for delineating graphite-bearing horizons, evaluating their continuity, and generating targets for detailed trenching and exploratory drilling within the Dumburuneli block.

Fig 6.29: (a) SP Equipment – IGIS DC Resistivity Meter (Model DDR-3); (b) SP data acquisition along with DGPS data recording in Zone-2, near Lanji Village; and (c) Porous pot installation

6.3 Geochemical Sampling

The main objective of the geochemical sampling was to demarcate the graphite bearing lithological units with promising concentration preferably with F.C >2% to establish the major zones of interest.

Planning and Preparation

Graphite-bearing zones were first identified during traverse mapping, followed by careful measurement of strike and dip to delineate the zones of interest. Graphite-rich outcrops within these zones were then correlated based on their extension and similarity, enabling the surface length and width of the inferred graphite bands to be traced. Subsequently, groove lines were planned perpendicular to the strike of the outcrops to accurately determine the true width of the exposures followed by collection of PCS and ICPMS samples from suitable lithologies. Finally, 15 nos of BRS and PT samples and 10 nos of core samples were sent to different laboratories as Check Samples to cross check the values of F.C% obtained from the primary laboratory.

Table 6.6 : PCS Sample Details

SL NO	SAMPLE ID	LATITUDE	LONGITUDE	LITHOLOGY	PHOTOMICROGRAPH (Section 6.1.2)
1	DS 86	19.34483	83.57182	Khondalite	Fig 6.3
2	DS 632	19.37540	83.58809	Granite Gneiss	Fig 6.4
3	DS 1112	19.34614	83.56222	Charnockite.	Fig 6.5
4	DS 1204	19.40417	83.54606	Leptynite	Fig 6.6
5	DS 1362	19.35394	83.57498	Quartzo-feldspathic Graphite Gneiss	Fig 6.7
6	ORDN-3/CS-17	19.35186	83.57288	Quartzo-feldspathic graphite gneiss	Fig 6.8
7	ORDN-2/CS-20	19.35317	83.57323	Quartzo-feldspathic graphite gneiss	Fig 6.9
8	ORDN-7/CS-21	19.35538	83.59592	Graphite bearing Gneiss.	Fig 6.10
9	ORDN-5/CS-16	19.35221	83.58116	Graphite bearing Khondalite	Fig 6.11
10	ORDN-3/Country rock	19.35186	83.57288	Charnockite	Fig 6.12

Table 6.7 : ICPMS Sample Details				
SL NO	**SAMPLE ID**	**LATITUDE**	**LONGITUDE**	**LITHOLOGY**
1	DN/Z1/NGB/S1	19.35339	83.57453	Granite Gneiss
2	DN/Z3/NGB/S2	19.35156	83.58130	Khondalite
3	DN/Z4/NGB/S3	19.35456	83.59448	Khondalite
4	DN/Z4/NGB/S4	19.35288	83.59810	Granite Gneiss
5	DN/Z2/NGB/S5	19.36534	83.59062	Khondalite
6	DN/Z1/T3/GBS1	19.35394	83.57498	Quartzo-feldspathic graphite gneiss
7	DN/Z1/T3/GBS2	19.35394	83.57498	
8	DN/Z4/T4/GBS3	19.35494	83.59748	
9	DN/Z4/T4/GBS4	19.35494	83.59748	
10	DN/Z1/T1/GBS5	19.35233	83.57291	
11	ORDN-1/IC-1	19.35350278	83.57468333	Quartzo-feldspathic graphite gneiss
12	ORDN-1/IC-2			Migmatised granite gneiss
13	ORDN-2/IC-1	19.35316667	83.57323333	Quartzo-feldspathic graphite gneiss
14	ORDN-2/IC-2			Migmatised khondalite & Charnockite
15	ORDN-3/IC-1	19.35185833	83.57287778	Quartzo-feldspathic graphite gneiss
16	ORDN-4/IC-1	19.35131667	83.581475	Migmatised Khondalite
17	ORDN-5/IC-1	19.35220556	83.58115833	Migmatised Khondalite
18	ORDN-6/IC-1	19.35388611	83.59757778	Graphite bearing Khondalite
19	ORDN-7/IC-1	19.35538333	83.59592222	Graphite bearing Gneiss
20	ORDN-7/IC-2			Graphite bearing Khondalite

Methodology

Groove lines were placed perpendicular to the strike of the lithological units. To get fresh, representative samples, before sampling, the exposures were cleaned thoroughly to remove any surface contamination. Then, parallel reference lines were marked along each groove. Workers excavated the grooves to a uniform width of about 10 - 12 cm and depth of about 8 - 10 cm with a hammer and chisel, and after removing the weathered zone, fresh graphite-bearing materials were sampled continuously at 1 m interval along the groove length. The collected samples were pulverised, coned and quartered and sieved through 120 mesh and were and sent to the laboratory for analysis. In total, 84 groove samples were collected from 12 groove lines spread across the 4 graphite-bearing zones. Detailed sample information is provided in **Annexure-I**.

A total of 66 samples were collected from trenches and pits, methodology of trench and pit sampling have already been discussed in **Section 6.1.6**. Detailed sample information is provided in **Annexure-II**.

5 PCS samples (**Table 6.6**) have been collected as bed rock samples from 5 different lithounits present within the area viz khondalite (DS 86), granite gneiss (DS 632), charnockite

(DS 1112), leptynite (DS 1204) and quartzo-feldspathic graphite gneiss (DS 1362). The other 5 PCS samples were taken from the core to accurately determine the graphite bearing lithology (ORDN-3/CS-17, ORDN-2/CS-20, ORDN-7/CS-2 and ORDN-5/CS-16) and to confirm the lithology of the mafic rock (ORDN-3/Country rock) intersected in few boreholes. All the 10 PCS samples have been studied for detailed petrographic analysis in **Section 6.1.2**. Detailed sample information is provided in **Annexure-XIII**

10 ICPMS samples (**Table 6.7**) were collected and distributed as 5 surface trench samples (DN/Z1/T3/GBS1, DN/Z1/T3/GBS2, DN/Z4/T4/GBS3, DN/Z4/T4/GBS4, DN/Z1/T1/GBS5) from the two highest graphite mineralised zones, already demarcated, focusing on graphite-rich intervals and the remaining 5 samples selected as bed rock samples viz khondalite (DN/Z3/NGB/S2, DN/Z4/NGB/S3 and DN/Z2/NGB/S5) and granite gneiss (DN/Z1/NGB/S1 and DN/Z4/NGB/S4) from the non-mineralised zones located between these two mineralised blocks to capture a representative contrast. The other 10 ICPMS samples were selected from the core, focussing on graphite bearing lithology (ORDN-1/IC-1, ORDN-2/IC-1, ORDN-3/IC-1, ORDN-6/IC-1 and ORDN-7/IC-1), migmatised khondalite (ORDN-4/IC-1, ORDN-5/IC-1 and ORDN-7/IC-2), migmatised granite gneiss (ORDN-1/IC-2) and a contact between migmatised khondalite and charnockite (ORDN-2/IC-2). Detailed sample information is provided in **Annexure-XII**.

Discussion on analytical results

The PCS analysis shows clear geochemical signatures based on lithology in the study area. Khondalite (DS-86) has relatively high Al_2O_3 (17.78 wt.%) and Fe_2O_3 (10.50 wt.%), which aligns with its aluminous meta-sedimentary composition. Its high LOI (4.81 wt.%) likely comes from the retrograde alteration of garnet to iron oxide phases, such as haematite or goethite, seen in thin sections. Granite gneiss (DS-632) displays higher alkali contents, with K_2O at 1.73 wt.% and Na_2O at 2.82 wt.%. In contrast, leptynite (DS-1204) is rich in silica (SiO_2 73.21 wt.%) and has increased K_2O (4.93 wt.%), reflecting its quartz-feldspar make-up. Charnockite (DS-1112) contains elevated levels of MgO (8.95 wt.%) and CaO (10.55 wt.%), which fit its mineral composition of equigranular granoblastic framework consisting plagioclase and hypersthene with minor hornblende alteration. The quartzo-feldspathic graphite gneiss (DS-1362) shows the highest SiO_2 (85.39 wt.%) and LOI (8.40 wt.%), due to the large amount of quartz and the presence of coarse to jumbo flaky graphite that aligns with the regional foliation. Graphite-bearing core samples (ORDN-2/CS-20, ORDN-3/CS-17, and ORDN-7/CS-21) also have high LOI values (6.49–11.26 wt.%) along with unusual SO_3 contents (1.17–4.51 wt.%). Petrographic studies indicate that pyrite is the main sulphur bearing mineral, appearing as scattered grains closely linked to graphite rich areas, while no sulphate minerals were found in thin sections. The close relationship between coarse flaky graphite and pyrite suggests that sulphide minerals form due to structural controls that accompany graphite enrichment. This is evident in the logging of core samples as well, where quartzo-feldspathic graphite gneiss almost invariably occurs with pyrite specs. Although some graphite bearing samples show relatively higher K_2O levels, the existing petrographic evidence does not fully support that these are due to potassic alteration rather, it demonstrate that this potassium enrichment reflects the close spatial stabilization of microcline feldspar and biotite flakes directly within the graphite-sulphide matrices. This structural and compositional coupling

likely confirms that the mineralizing system was highly focused along localized, fluid-mediated pathways during or immediately following peak granulite-facies metamorphism.

ICPMS analysis shows a unique trace element signature in the graphite bearing layers compared to the surrounding non-mineralized rocks. The non-mineralized granite gneiss and khondalite have higher lithophile elements like Rb, Th, Zr, and LREE, reflecting their felsic to meta-sedimentary nature. In contrast, the graphite-bearing trench and core samples have slightly elevated values (ranging from 20 – 357 ppm) of Cu, Zn, Pb, Mo, and Co, especially in samples 6, 7, 10, 11, 13, 15, and 19. This points to localized concentrations of chalcophile elements in the mineralized layers. This geochemical connection, along with high SO_3 values found in the corresponding PCS analyses and the petrographic evidence of disseminated pyrite closely associated with graphite flakes, suggests that graphite formation may have occurred alongside sulphide-bearing metamorphic fluids during the development of the host rocks. While chalcopyrite was not identified in the petrographic analysis, the copper anomaly may suggest the presence of trace copper sulphides and calls for SEM-EDS studies which was beyond the present scope. Moreover, samples 3, 6, 11, 12, and 15 show slight higher levels of LREE, while samples 8, 9, and 15 have slightly elevated uranium value (around 3.8 ppm), indicating localized concentrations of incompatible elements in the graphite-bearing sequence. These findings may have co-relation with the Burugubanda graphite deposit in the Eastern Ghats. There, graphite-bearing khondalites display LREE-enriched geochemical signatures related to high-grade metamorphism and melting, and later studies showed that graphite tailings might be a potential secondary source of REEs due to their concentration in heavy mineral fractions. The overlap of graphite mineralization with sulphide-related base metal anomalies and localized REE-U enrichment points to a complex mineral forming system likely involving metamorphic remobilization and fluid-assisted concentration of incompatible and chalcophile elements.

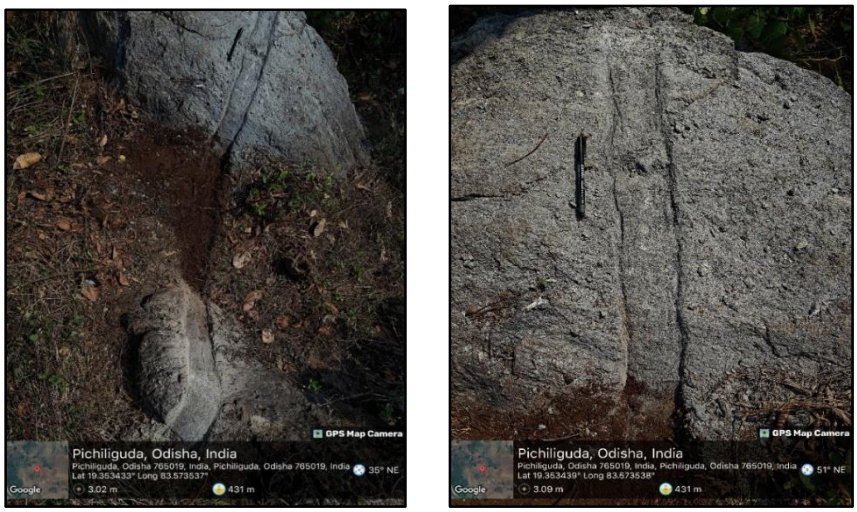


Fig 6.30: Grooves given in Graphite Zone 1

CHAPTER 7:

INTEGRATION OF GEOLOGY, GEOPHYSICS & GEOCHEMICAL EXPLORATION DATA AND IT'S INTERPRETATION

The zone wise integration of geology, geophysics and geochemical exploration is given below:-

ZONE 1

On the basis of geological mapping, four graphite bands were inferred, namely Band A-1 (eastern most), Band B-1 and D-1 (the middle two bands) and Band C-1 (western most) (**Plate-II**).

Sampling have been carried out from two groove lines G2 and G3 on Band A-1 at approximately 200 m strike interval and between these two, trench (T3) and a pit (P1) were excavated. Another trench (T6) was also excavated at approximately 100 m strike interval and towards south-east from G3. On chemical analysis, the samples of G2 showed weighted average of F.C value 6.68% over a zone of 8.5 meters (for 7 samples) while G3 showed weighted average of F.C value 5.81% over a zone of 13.8 meters (for 7 samples). Similarly, the weighted average of F.C value of T3 was 8.87% over a zone of 18 meters (for 10 samples) while P1 generated samples with weighted average of F.C value 3.17% over 2 samples. But the weighted average of F.C value of the samples of T6 was 1.2% over a zone of 18 meters (for 7 samples).

Groove line G1 was planned on Band B-1 which shows weighted average of F.C value 10.03% over a zone of 9.8 meters (for 10 samples).

Groove line G6 was planned on Band C-1 which showed weighted average of F.C value 2.74% over a zone of 5.2 meters (for 5 samples).

Finally, a trench (T1) was planned across Band D-1 which generated a weighted average of F.C value 9.95% over a zone of 20 meters (for 12 samples).

Except for Band C-1 (which shows positive SP values), these encouraging F.C% values (> 2%) of groove lines, trenches and pit of Band A-1, B-1 and D-1 were correlated with self-potential (SP) anomaly zones bounded by negative SP contours ranging from -150 mV to -400 mV. Shape of the SP anomaly follows the major strike direction and orientation of the inferred graphite bands. (**Fig 6.22**)

The SP anomaly zone, bounded by SP contours ranging from -200 mV to -350 mV encompassing the Band B-1 extends about 300 metres northwest to the groove line G1. Additionally, an intense SP anomaly zone, bounded by SP contours ranging from -250 mV to -350 mV, was identified approximately 300 meters to the southeast of G1, following the strike continuity of Band B-1. These anomalies are potentially indicative of subsurface graphite-bearing lithological units.

ZONE 2

On the basis of geological mapping, three graphite bands were inferred, namely Band A-2 (western), Band B-2 (middle) and Band C-2 (eastern), although the outcrop density for this zone was much less compared to the other three zones. (**Plate-III**).

Three groove lines, G4, G5 and G12 were planned across Band B-2, A-2 and C-2 respectively. Also, a pit (P6) was excavated at a distance of about 50 m strike interval towards south-east from G4 on Band B-2.

On chemical analysis the weighted average of F.C value of G4 was 6.53% over a zone of 14.2 meters (for 11 samples), while G5 and G12 showed weighted average of F.C values of 10.13% over a zone of 5.5 meters (for 2 samples) and 6.29% over a zone of 4.2 meters (for 2 samples) respectively. The pit did not generate any sample.

These encouraging F.C% values (> 2%) of groove lines were correlated with self-potential (SP) anomaly zones of negative SP contours ranging from -90 mV to -180 mV. Additionally, the SP anomaly zone extends about 60 meters to the east of groove line G12, potentially indicative of subsurface graphite-bearing lithological units. (**Fig 6.24**)

ZONE 3

On the basis of geological mapping, two graphite bands were inferred, namely Band A-3 (northern) and Band B-3 (southern). (**Plate-IV**).

One groove line each, G7 and G8 were planned across Band A-3 and B-3 respectively. Two trenches, T2 and T7 were planned at approximately 100 m strike interval on either side of G7. A pit (P3) was planned between G7 and T7. Finally, a pit (P2) was also planned, approximately at a distance of 30 m strike interval towards north-west from G8 on Band B-3.

On chemical analysis the weighted average of F.C value of G7 was 5.01% over a zone of 22.2 meters (for 13 samples), while G8 showed weighted average of F.C value 5.63% over a zone of 9.1 meters (for 5 samples). While the trenches T2 and T7 showed weighted average of F.C value 0.9% over a zone of 12 meters (for 6 samples) and 1.89% over a zone of 20 meters (for 11 samples) respectively, the pit P3 shows weighted average of F.C value 7.51% over 2 samples. No sample was generated from pit P2.

These encouraging F.C% values (> 2%) of groove lines and pit were correlated with self-potential (SP) anomaly zones of negative SP contours ranging from -90 mV to -350 mV. Shape of the SP anomaly follows the major strike direction and orientation of the inferred graphite bands. Additionally, the intense SP anomaly zone (SP contours ranging from -150 mV to -400 mV) that coincides with G7 (central part of Band A-3), shows a northerly shift in a parallel manner along the strike extension. It also extends about 250 meters to the north-west of groove line G7, potentially indicative of subsurface graphite-bearing lithounits. (**Fig 6.26**)

ZONE 4

On the basis of geological mapping, two graphite bands were inferred, namely Band A-4 (northern) and Band B-4 (southern). (**Plate-V**).

Two groove lines G9 and G10 were planned across Band A-4 at approximately 100 m strike interval. Between the grooves a pit (P4) was planned. A trench (T4) was planned at a distance of 100 m strike interval towards north-west from G10 on Band A-4. On chemical analysis, G9 showed weighted average of F.C value 17.64% over a zone of 13.5 meters (for 10 samples) while G10 showed weighted average of F.C value 14.44% over a zone of 10.3 meters (for 8 samples). Similarly, the weighted average of F.C value of T4 was 3.89% over a zone of 20 meters (for 8 samples) while 2 samples of P4 generated a weighted average of F.C value 9.75%.

A groove line (G11) and trench (T5) were planned at 100 m strike interval on Band B-4. Also a pit (P5) was planned between the two. On chemical analysis, G11 showed weighted average of F.C value 15.24% over a zone of 5 meters (for 4 samples) while T5 showed weighted average of F.C value 1.08% over a zone of 15 meters (for 6 samples). No sample was generated from pit P5.

These encouraging F.C% values (> 2%) of groove lines, trenches and pit of Band A-4 and B-4 were correlated with self-potential (SP) anomaly zones of negative SP contours ranging from -80 mV to -240 mV and the shape of the SP anomaly follows the major strike direction and orientation of the inferred graphite bands. Additionally, about 300 meters to the north-west of groove line G10, in a parallel direction along the strike, an intense SP anomaly is manifested by SP contours ranging from -60 mV to -160 mV. These anomalies are potentially indicative of subsurface graphite-bearing lithounits. (**Fig 6.28**)

Fig 7.1: Groove line given in Zone 3

Table 7.1 : Summarized zone wise integration of geology, geophysical and geochemical data

Zone ID	Inferred graphite band through mapping	Inferred Length (m)	Inferred Width (m)	Analytical results (F.C %)			SP Values	BH No	Interpreted graphite bands
				BRS	TS	PS			
Zone-1	Band A-1	380	15	G2 - 6.68% (7 samples) G3 - 5.81% (7 samples)	T3 - 8.87% (10 samples) T6 - 1.2 % (7 samples)	P1 - 3.17% (2 samples)	-120 to -240	ORDN-1	1-A, 1-B, 1-C & 1-D
	Band B-1	100	20	G1 - 10.03% (10 samples)	N.A	N.A	-280 to -360	ORDN-2	1-E
	Band D-1	85	25	N.A	T1 - 9.95 % (12 samples)	N.A	-160 to -240	ORDN-3	1-F, 1-G, 1-H, 1-I, 1-J & 1-K
	Band C-1	150	6	G6 - 2.74% (5 samples)	N.A	N.A	+80 to +240	N.A	N.A
Zone - 2	Band A-2	85	10	G5 - 10.13% (2 samples)	N.A	N.A	-80 to -160	N.A	N.A
	Band B-2	100	16	G4 - 6.53% (11 samples)	N.A	P6 - No samples			
	Band C-2	65	8	G12 - 6.29% (2 samples)	N.A	N.A			
Zone - 3	Band A-3	200	25	G7 - 5.01% (13 samples)	T2 - 0.9 % (6 samples) T7 - 1.89 % (11 samples)	P3 - 7.89% (2 samples)	-100 to -450	ORDN-4	3-A, 3-B, 3-C & 3-D
	Band B-3	80	15	G8 - 5.63% (5 samples)	N.A	P2 - No samples	-100 to -200	N.A	3-F
Zone - 4	Band A-4	315	22	G9 - 17.64% (10 samples) G10 - 14.44% (10 samples)	T4 - 3.89 % (8 samples)	P4 - 9.75% (2 samples)	-150 to -350	ORDN-6	4-A, 4-B, 4-C & 4-D
	Band B-4	120	10	G11 - 15.24% (4 samples)	T5 - 1.08 % (6 samples)	P5 - No samples	-150 to -300	N.A	N.A

CHAPTER 8: MINERAL PROSPECT

8.1 Surface Indication

Surface indications of graphite are found in nala sections and their tributaries, where sediments show black streaks of graphite flakes. Even though these flakes are not in-situ, they offer useful clues about nearby outcrops. Similar streaks of graphite flakes are also seen along dried water flow lines at the base of agricultural lands. These were later traced back to outcrops on neighbouring hill slopes. Additionally, higher concentrations of graphite flakes appeared often along the contact zones of khondalites with granite gneiss or charnockites. This highlighted these lithological boundaries as important spots for tracking and defining graphite mineralization.

Fig 8.1: Streaks of graphite flakes seen along water flow line

8.2 Mode of occurrence

In the investigated area, there are two modes of occurrences of graphite mineralisation, which are as follow-

(a) Disseminated type (b) Gneiss type (dominant graphite bearing lithology)

<u>Disseminated type</u>

In this type, graphite flakes are disseminated throughout the host rock. The flakes show parallel alignment to the foliation of the host rock. Khondalite is the dominant lithology having this type of graphite mineralisation, and has been subsequently marked in the geological maps as a separate lithounit (Khondalite with trace of graphite). But disseminated graphite flakes are not uncommon in granite gneiss and a few instances within migmatites as well. Such type of mineralisation has fixed carbon (F.C) less than 2% and are not considered as economically viable.

Gneiss type

In this type of mineralisation the graphite rich layers alternate with the quartz-feldspar rich layers defining the gneissosity of the litho-unit. Such type of mineralisation was found near Pichuligurha, Bhaleri, Dhuanbarhi and Lanji villages. The chemical analysis report shows such types of mineralisation are encouraging (greater than 2% F.C) in nature and with higher values (Up to 20.00 % F.C).

8.3 Details of mineralisation

Potential surface geological evidences for the existence of graphite were observed in four graphite bearing zones. The principal graphite bearing litho-units exposed on the surface are quartzo-feldspathic graphite gneiss associated with khondalite with minor graphite, granite gneiss and migmatites. Analytical results for the samples collected from the graphite bearing litho-units show encouraging values of greater than 2% F.C. The detailed descriptions of the major graphite bearing zones are stated under section 6.1.6.

8.4 Genesis of mineralisation

Banded graphite mineralisation in the area occurs predominantly as quartzo-feldspathic graphite gneiss, khondalite with disseminated graphite specks, and granite gneiss containing minor graphite flakes, all associated with the khondalitic group of rocks. The mineralisation is commonly accompanied by sulphides, principally pyrite, suggesting a genetic association. The coexistence of graphite and pyrite, together with the lithological association with meta-sedimentary khondalites, indicates derivation from carbonaceous sediments deposited in a reducing environment and subsequently subjected to granulite-facies metamorphism. Carbon isotope studies from graphite deposits of the EGMB, including the Rayagada–Koraput graphite belt, have yielded $\delta^{13}C$ values within the range typical of biogenic carbon, supporting an organic precursor for the graphite (Santosh and Wada, 1993; Sanyal et al., 2009; Acharya and Dash, 1984). During high-grade metamorphism and partial melting, de-volatilisation and CO_2 rich metamorphic fluids, promoted re-crystallisation and coarsening of graphite flakes. The widespread occurrence of post-granulite migmatites and leptynites in the study area suggests that anatectic melts and metamorphic fluids may have locally mobilised and redistributed carbon, leading to further enrichment and concentration of graphite along favourable lithological horizons and foliation planes. Accordingly, the graphite mineralisation of the present area is interpreted to be predominantly of metamorphosed sedimentary (biogenic) origin, with subsequent metamorphic re-crystallisation and limited fluid-assisted remobilisation during high-grade metamorphism.

CHAPTER 9: EXPLORATION BY SCOUT DRILLING

In pursuance of the NMEDT mineral exploration project (F.No.23/551/2025-NMET/837), exploratory drilling of 462 m was carried out through seven first-level boreholes planned to intersect graphite-bearing horizons up to 30 m vertical depth, based on integrated surface geological, geochemical and geophysical investigations, to evaluate graphite mineralization in three graphite-bearing zones. Drilling commenced on 21 January 2026 and was completed on 12 March 2026. Based on field occurrence and optical petrographic examination of surface and drill core samples, the graphite occurs as coarse crystalline (flake) graphite occurring within the quartzo-feldspathic graphite gneiss and associated granulite-facies rocks, corresponding to the crystalline graphite (Type-I) category of the occurrence based classification of Ramsdell (1947). The present classification is based solely on optical petrography, as XRD**,** Raman Spectroscopy, TEM and EBSD analyses were beyond scope of the present investigation. However, comparable graphite mineralization from the EGMB has been confirmed to consist of well-crystallized graphite through Raman spectroscopy and XRD (Parthasarathy et al., 2006; Mayachar, 2024), supporting the interpretation adopted in the present study. As per the MEMC Rules, 2015**,** the exploration carried out in the Dumburuneli Block corresponds to the G4 stage, and the mineral occurrence is classified under UNFC Code 334.

9.1 Methodology of drilling

The drilling programme was designed based on the structural attitude of the graphite-bearing horizons interpreted from detailed surface geological mapping and geophysical investigations. The dips of the graphite-bearing bodies, as inferred from surface exposures, vary between 55° and 70° in different graphite-bearing zones. Accordingly, inclined boreholes were planned to intersect the graphite-bearing horizons at an approximate 30 m vertical depth. The boreholes were drilled at an inclination of 45° with respect to the horizontal surface, except borehole ORDN-2, which was drilled at an inclination of 55°.

Drilling was carried out using HQ-size wire line diamond core drilling with a CSD-500L hydraulic diamond core drill rig, which enabled continuous recovery of intact rock cores. Water, with suitable drilling additives wherever required, was used throughout the drilling programme for cooling the drill bit, flushing drill cuttings and maintaining borehole stability. The overall average core recovery achieved was 96%. (**Annexure III – IX**)

9.2 Borehole Planning

Two types of surface data were considered for planning boreholes viz surface geological evidences (outcrops, groove samples, trench and pit samples) and geophysical evidence (SP anomaly data) (**Table 9.1**)

Borehole planning based on geological evidences supported by geophysical evidences

The outcrops of graphite bearing rocks where analytical results were found to be greater than 2 % F.C were considered to construct an inferred graphite band as well as those parts of the band where anomalous SP values were recorded, were treated as the reference location for placing boreholes in order to intersect graphite bearing lithounits at 30 m vertical depth. Five numbers of boreholes namely as ORDN-1, ORDN-2, ORDN-3, ORDN-4 and ORDN-6 were planned on the basis of both geological and geophysical considerations.

Borehole planning based on Geophysical evidences only

When surface geological evidences were not prominent, the centre of maximum SP anomaly zones were considered as the reference points to intersect the graphite band at 30 m vertical depth by placing boreholes at inclination of 45°. Two numbers of boreholes, namely ORDN-5 and ORDN-7 were planned on the basis of geophysical considerations only.

Table 9.1 : Details of zone wise borehole locations (All 1st level)						
Sl No.	**BH Name**	**Zone**	**Location**	**Azimuth**	**Inclination**	**Target**
1	ORDN-1	Zone 1	South of Pichuligurha	N55E	45°	Geological consideration (Analytical results of Trench T3)
2	ORDN-2			N55E	55°	Geological consideration (Analytical results of Groove G1)
3	ORDN-3			N45E	45°	Geological consideration (Analytical results of Trench T1)
4	ORDN-4	Zone 3	South of Bhaleri	N35E	45°	Geological consideration (Analytical results of Groove G7)
5	ORDN-5					SP Anomaly (Geophysical consideration)
6	ORDN-6	Zone 4	South west of Dhuanbarhi	N60E	45°	Geological consideration (Analytical results of Groove G10)
7	ORDN-7					SP Anomaly (Geophysical consideration)

Table 9.2 : Details of drilled boreholes									
Sl No.	**BH Name**	**Latitude**	**Longitude**	**RL of Collar**	**Azimuth**	**Inclination**	**Closing run of BH**	**Start date**	**End Date**
1	ORDN-1	19°21' 12.61" N	83°34' 28.86" E	426 m	N55E	45°	72 m	22.01.2026	01.02.2026
2	ORDN-2	19°21' 11.40" N	83°34' 23.64" E	448 m	N55E	55°	62 m	02.02.2026	08.02.2026
3	ORDN-3	19°21' 6.69" N	83°34' 22.36" E	452 m	N45E	45°	63 m	10.02.2026	16.02.2026
4	ORDN-4	19°21' 4.74" N	83°34' 53.31" E	431 m	N35E	45°	60 m	17.02.2026	21.02.2026
5	ORDN-5	19°21' 7.94" N	83°34' 52.17" E	439 m	N35E	45°	70 m	22.02.2026	27.02.2026
6	ORDN-6	19°21' 13.99" N	83°35' 51.28" E	472 m	N60E	45°	63 m	03.03.2026	07.03.2026
7	ORDN-7	19°21' 19.38" N	83°35' 45.32" E	473 m	N60E	45°	72 m	08.03.2026	12.03.2026

BOREHOLE - ORDN-1

The borehole ORDN-1 was planned on the major graphite bearing Zone-1 targeting the inferred graphite band A-1 (based on geological mapping) (**Plate-II**). The strike of the band varies from 125° to 155° while the dip amount is considered as 65°, dipping south-westerly. The borehole was planned with respect to the trench T3 (weighted average F.C value 8.87% over 10 samples). At a distance of 130 meters along the band A in NW direction from T3 is groove G2 (weighted average of F.C value of 6.68% over 7 samples) and at a distance of 110 meters along band A in SE direction is groove G3 (weighted average of F.C value of 5.81% over 7 samples).

Thus, ORDN-1 was planned with an inclination of 45° with an azimuth towards N55°E and at a horizontal distance of 48 m from the inferred graphite band A-1 in order to check the depth persistence of the graphite band at 30 m vertical depth. The borehole azimuth was slightly altered from the trench orientation to target the band's maximum curvature (15 m adjacent to trench T3), thereby ensuring the intersection of the maximum thickness of mineralised zone.

The inclined depth of the borehole was 72 m (summarised litholog is given in **Annexure-III**). Borehole ORDN-1 penetrated 9m of topsoil and weathered mantle before intersecting the key lithologies which include granite-gneiss, khondalite, migmatised khondalite, quartzo-feldspathic graphite gneiss, garnetiferous quartzite and migmatised granite-gneiss (**Plate-IX**).

A total of 3 graphite bands were intersected (**Table 9.3**) in the borehole within the depth range of 48 to 70 meters with varying thicknesses (1.21 m to 4.95 m). The graphite bearing lithology is the quartzo-feldspathic graphite gneiss. These mineralized units feature graphite-rich layers alternating with quartz-feldspar rich bands with pyrite. The sequence concludes with barren garnetiferous quartzite and migmatised granite gneiss at 72 m depth. The cross sectional view is shown in **Figure 9.1**. The graphite mineralisation is found to occur within the migmatised khondalite lithounit.

BOREHOLE - ORDN-2

The borehole ORDN-2 was planned on the major graphite bearing Zone-1 targeting the inferred graphite band B-1 (based on geological mapping) (**Plate-II**). The strike of the band varies from 140° to 155° while the dip amount is considered as 65°, dipping south-westerly. The borehole was planned with respect to the groove line G1 (weighted average of F.C value 10.03% over 10 samples).

Thus, ORDN-2 was planned with an inclination of 55° with an azimuth towards N55°E and at a horizontal distance of 45 m from the inferred graphite band B-1 in order to check the depth persistence of the graphite band at 30 m vertical depth.

The inclined depth of the borehole was 62 m (summarised litholog given in **Annexure-IV**). Borehole ORDN-2 penetrated 4.28 m of topsoil and weathered mantle before intersecting the key lithologies which include migmatised khondalite, graphite-bearing khondalite, garnetiferous quartzite, leptynite, quartzo-feldspathic graphite gneiss and charnockite (**Plate-IX**).

A single graphite band of 7.17 m thickness was intersected (**Table 9.4**) in the borehole within a depth range of 14 to 57 meters. The graphite bearing lithology is the quartzo-feldspathic graphite gneiss. This mineralized unit is often associated with pyrite. The sequence concludes with barren charnockite at 62 m depth. The cross sectional view is shown in **Figure 9.2**. The graphite mineralisation is found to occur within the migmatised khondalite lithounit.

BOREHOLE - ORDN-3

The borehole ORDN-3 was planned on the major graphite bearing Zone-1 targeting the inferred graphite band D-1 (based on geological mapping) (**Plate-II**). The strike of the band varies from 115° to 155°, while the dip amount is considered as 70°, dipping south-westerly. The borehole was planned with respect to the trench T1 (weighted average of F.C value 9.95% over 12 samples). But it had to be shifted 30 m towards SE to avoid dense kaju plantations within the area.

Thus, ORDN-3 was planned with an inclination of 45° with an azimuth towards N45°E and at a horizontal distance of 30 m from the inferred graphite band D-1 in order to check the depth persistence of the graphite band at 30 m vertical depth.

The inclined depth of the borehole was 63 m (summarised litholog is given in **Annexure-V**). Borehole ORDN-3 penetrated 7.2 m of topsoil and weathered mantle before intersecting the key lithologies which include graphite bearing khondalite, granite-gneiss, graphite bearing gneiss, migmatised khondalite, garnetiferous quartzite, quartzo-feldspathic graphite gneiss and charnockite (**Plate-IX**).

A total of 5 graphite bands were intersected (**Table 9.5**) in the borehole within a depth range of 11 to 61 meters with varying thicknesses (1.04 m to 5.98 m). The main graphite bearing lithologies are the quartzo-feldspathic graphite gneiss, graphite bearing gneiss and graphite bearing khondalite. These mineralized units are often associated with pyrite. The sequence concludes with barren migmatised khondalite at 63 m depth. The cross sectional view is shown in **Figure 9.3**. The graphite mineralisation is mostly occurring at the contact between migmatised khondalite and charnockite or quartzite.

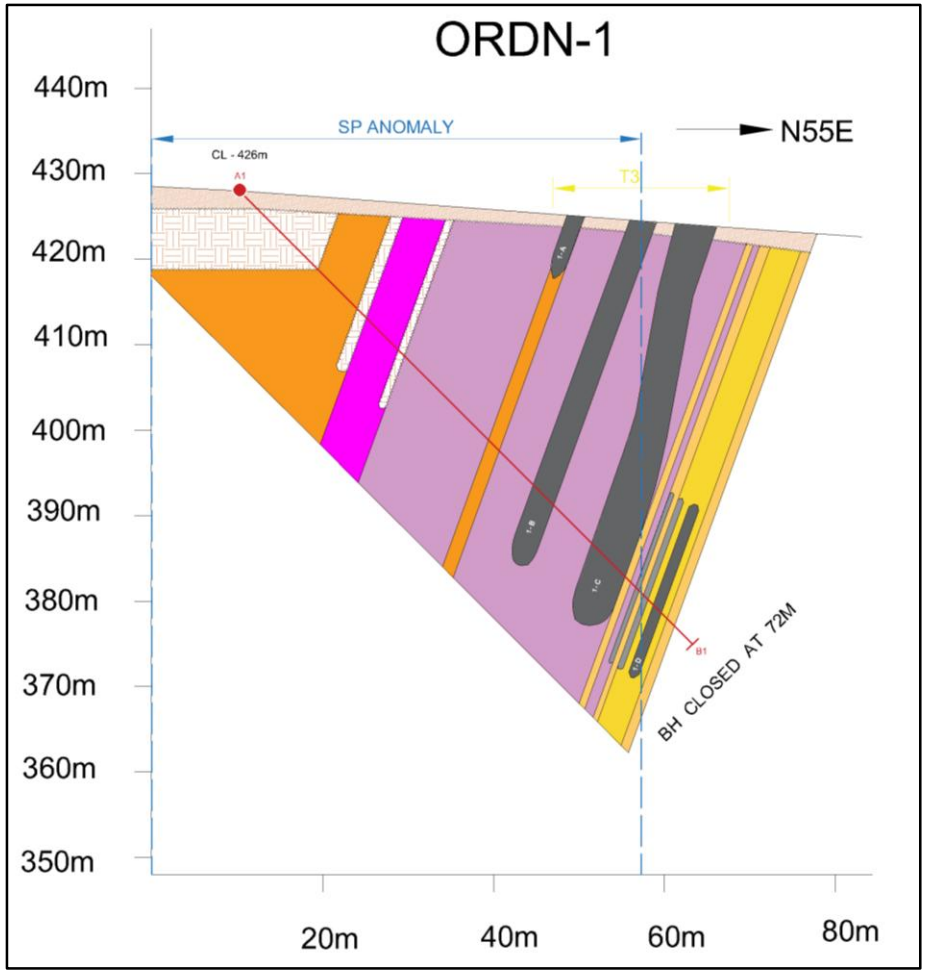
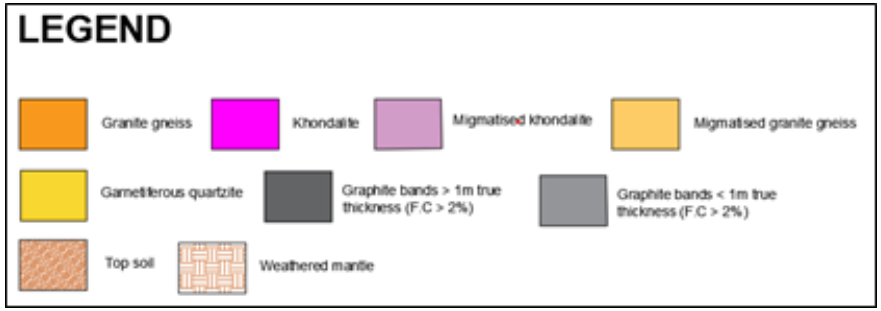


Fig 9.1: Cross-Sectional view of Borehole ORDN-1

Table 9.3 : ORDN-1 intersected graphite bands details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-1/CS-10	48.65	49.65	3.04	Quartzo feldspathic graphite gneiss	4.27	1-B
ORDN-1/CS-11	49.65	50.65				
ORDN-1/CS-12	50.65	52				
ORDN-1/CS-15	58.4	59.4	4.95	Quartzo feldspathic graphite gneiss	3.73	1-C
ORDN-1/CS-16	59.4	60.4				
ORDN-1/CS-17	60.4	61.4				
ORDN-1/CS-18	61.4	62.4				
ORDN-1/CS-19	62.4	63.86				
ORDN-1/CS-26	68.51	69.85	1.21	Quartzo feldspathic graphite gneiss	2.2	1-D



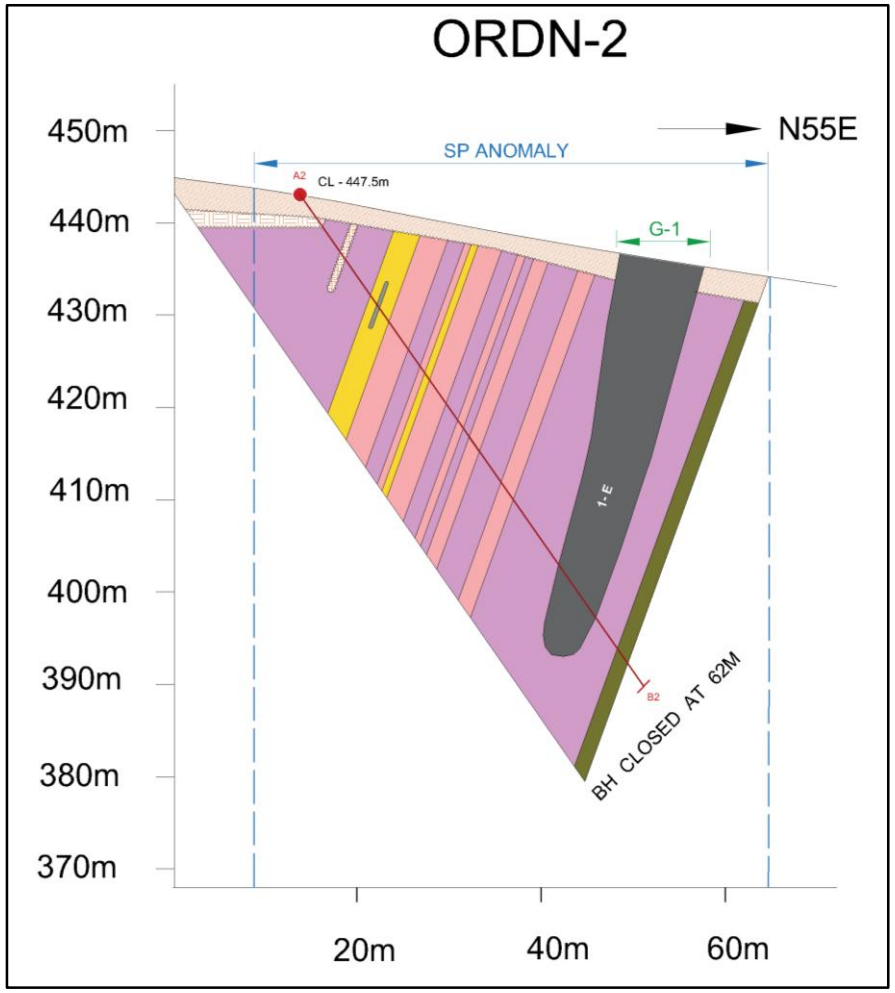
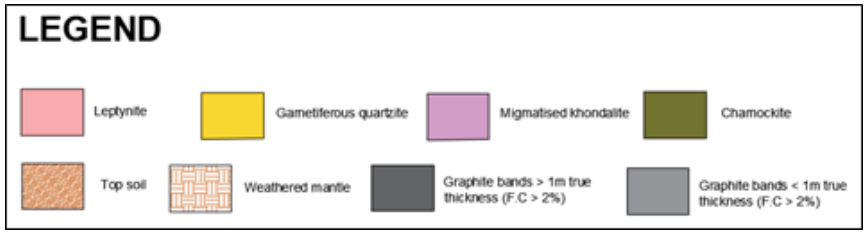


Fig 9.2: Cross-Sectional view of Borehole ORDN-2

Table 9.4 : ORDN-2 intersected graphite bands details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-2/CS-17	48.9	49.9	7.17	Quartzo feldspathic graphite gneiss	5.19	1-E
ORDN-2/CS-18	49.9	50.9				
ORDN-2/CS-19	50.9	51.9				
ORDN-2/CS-20	51.9	52.9				
ORDN-2/CS-21	52.9	53.9				
ORDN-2/CS-22	53.9	54.9				
ORDN-2/CS-23	54.9	55.9				
ORDN-2/CS-24	55.9	56.65				
ORDN-2/CS-25	56.65	57.65				



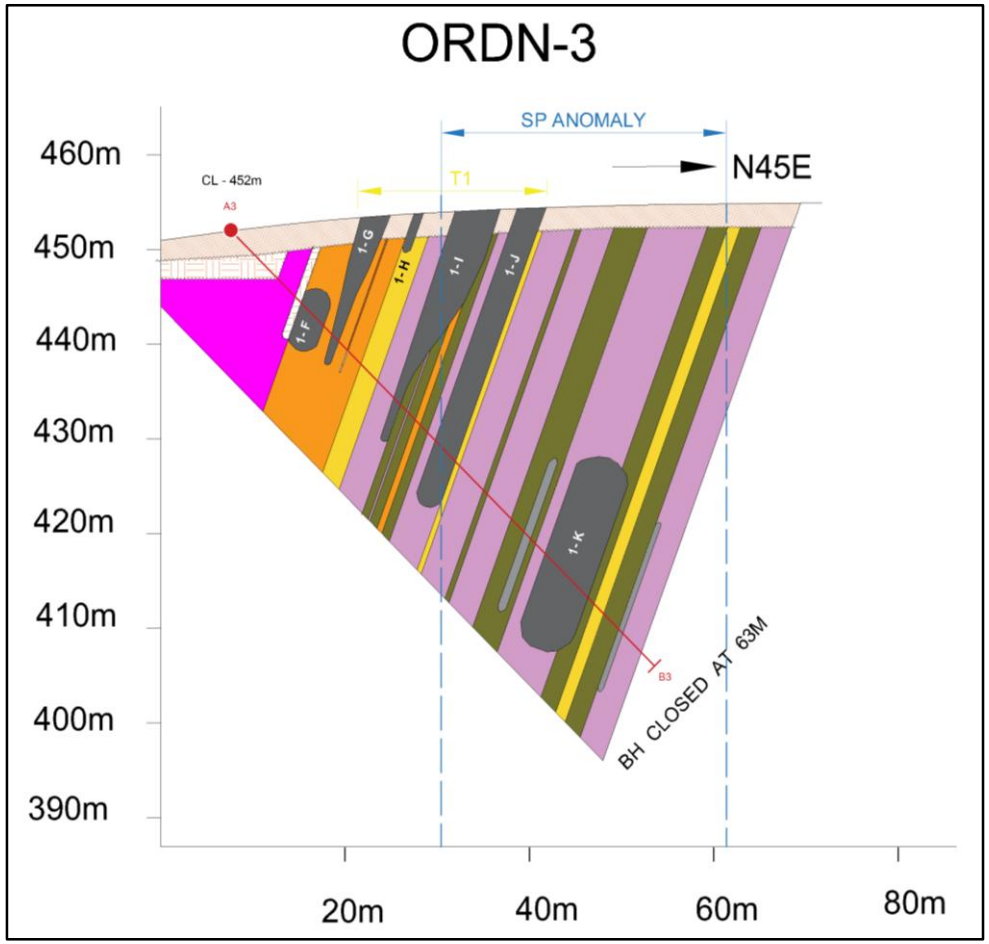
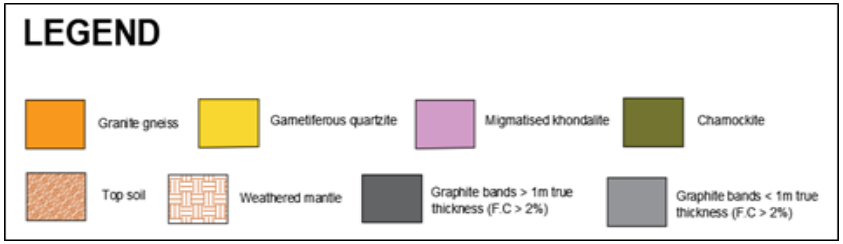


Fig 9.3: Cross-Sectional view of Borehole ORDN-3

Table 9.5 : ORDN-3 intersected graphite bands details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-3/CS-6	10.8	11.8	3.13	Graphite bearing Khondalite	2.25	1-F
ORDN-3/CS-7	11.8	12.8		Graphite bearing Khondalite		
ORDN-3/CS-8	12.8	14.25		Graphite bearing Gneiss		
ORDN-3/CS-10	15.5	16.65	1.04	Graphite bearing Gneiss	2.21	1-G
ORDN-3/CS-12	24.45	25.45	1.45	Graphite bearing Khondalite	2.71	1-I
ORDN-3/CS-13	25.45	26.05				
ORDN-3/CS-16	31.35	32.35	2.85	Quartzo feldspathic graphite gneiss	2.23	1-J
ORDN-3/CS-17	32.35	33.35				
ORDN-3/CS-18	33.35	34.5				
ORDN-3/CS-24	48.2	49.2	5.98	Quartzo feldspathic graphite gneiss	4.29	1-K
ORDN-3/CS-25	49.2	50.2				
ORDN-3/CS-26	50.2	50.9				
ORDN-3/CS-27	50.9	51.6				
ORDN-3/CS-28	51.6	52.6				
ORDN-3/CS-29	52.6	53.6				
ORDN-3/CS-30	53.6	54.8				



BOREHOLE - ORDN-4

The borehole ORDN-4 was planned on the major graphite bearing Zone-3 targeting the inferred graphite band A-3 (based on surface geological evidences) (**Plate-IV**). The strike of the band varies from 120° to 150°, while the dip amount is considered as 65°, dipping south-westerly. The borehole was planned with respect to the groove line G7 (weighted average of F.C value 5.01% over 13 samples).

Thus, ORDN-4 was planned with an inclination of 45° with an azimuth towards N35°E and at a horizontal distance of 38 m from the inferred graphite band A-3 in order to check the depth persistence of the graphite band at 30 m vertical depth.

The inclined depth of the borehole was 60 m (summarised litholog is given in **Annexure-VI**). Borehole ORDN-4 penetrated 7.5 m of topsoil and weathered mantle before intersecting the key lithologies which include migmatised khondalite, garnetiferous quartzite, graphite bearing gneiss, migmatised gneiss and leptynite (**Plate-IX**).

A single graphite band was intersected (**Table 9.6**) in the borehole within 43 to 46 meters depth of 1.7 m thickness. The main graphite bearing lithology is the graphite bearing gneiss. The mineralized unit is associated with pyrite. The sequence concludes with barren migmatised khondalite at 60 m depth. The cross sectional view is shown in **Figure 9.4**. The graphite mineralisation is found to occur at the contact between migmatised khondalite and quartzite.

BOREHOLE - ORDN-5

The borehole ORDN-5 was planned on the major graphite bearing Zone-3 targeting the anomalous SP values (**Figure 6.22**). The borehole was planned in order to trace the occurrence of graphite bearing lithological units at 30m vertical depth of intersection with respect to the central point of maximum SP anomaly zone

Thus, ORDN-5 was planned with an inclination of 45° with an azimuth towards N35°E and at a horizontal distance of 30 m from the central point of the maximum SP anomaly.

The inclined depth of the borehole was 70 m (summarised litholog is given in **Annexure-VII**). Borehole ORDN-5 penetrated 0.75 m of topsoil and weathered mantle before intersecting the key lithologies which include migmatised khondalite, graphite bearing gneiss, migmatised gneiss and granite-gneiss (**Plate-IX**).

A single graphite band was intersected (**Table 9.7**) in the borehole within a depth range of 31 to 37 m with thickness of 4.71 m. The main graphite bearing lithology is the graphite bearing gneiss. This mineralized unit is often associated with pyrite and a yellowish-white altered mineral having a greasy feel with quartz having greenish hue. The sequence concludes with barren migmatised khondalite at 70 m depth. The cross sectional view is shown in **Figure 9.5**. The graphite mineralisation is found to occur within the migmatised khondalite lithounit.

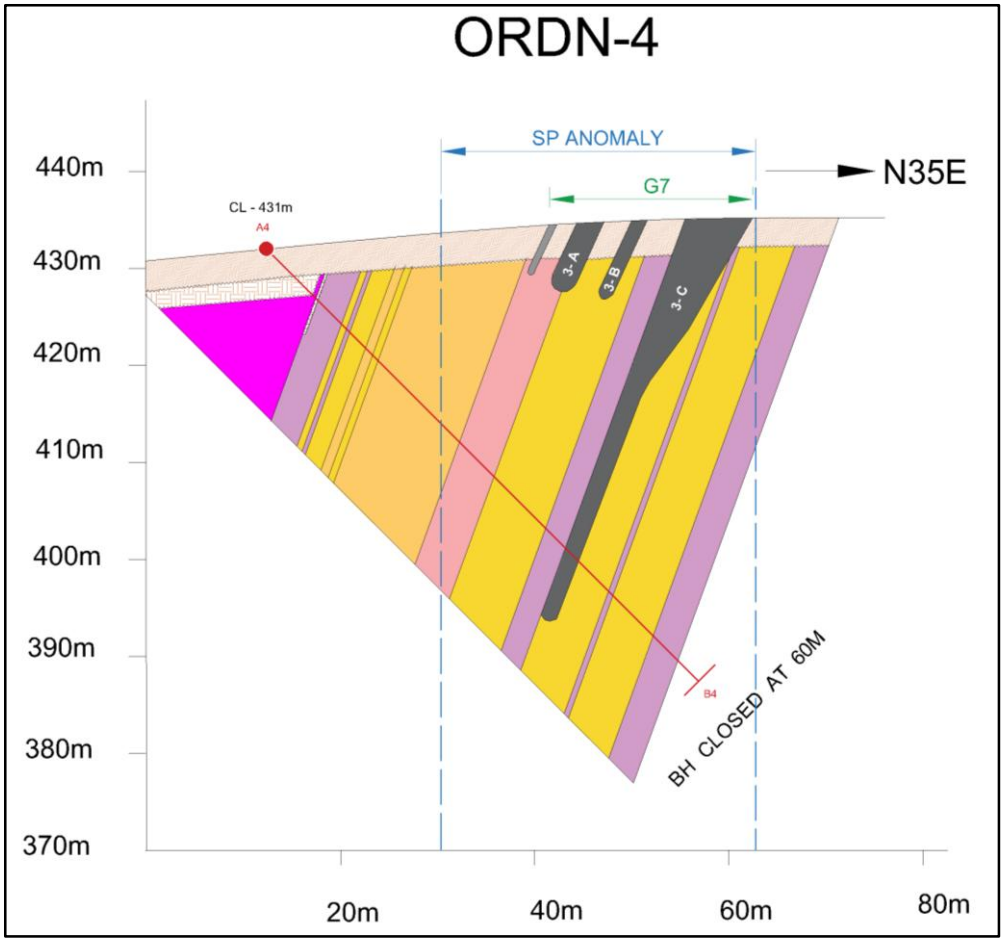
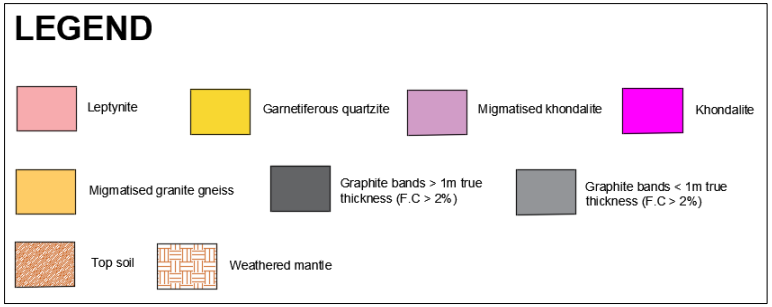


Fig 9.4: Cross-Sectional view of Borehole ORDN-4

Table 9.6 : ORDN-4 intersected graphite band details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-4/CS-28	43.6	44.6	1.54	Graphite bearing gneiss	3.66	3-C
ORDN-4/CS-29	44.6	45.3				



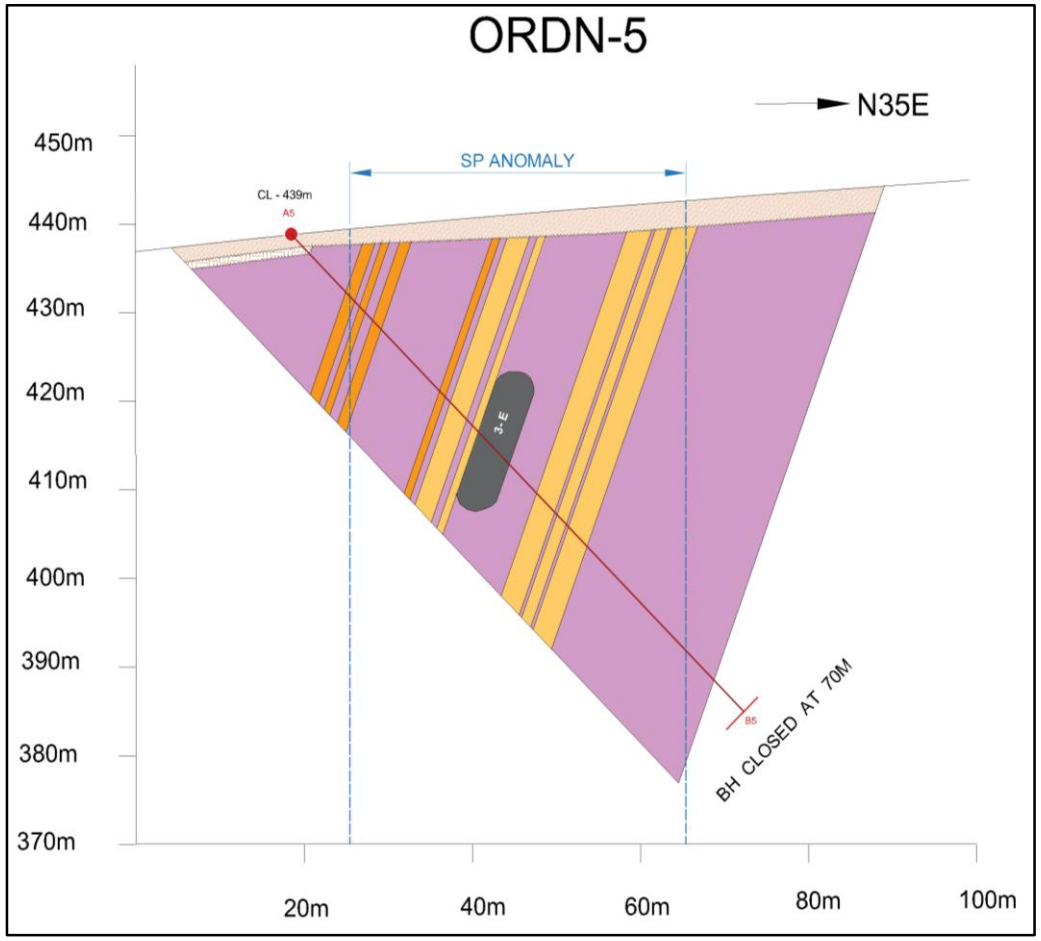


Table 9.7 : ORDN-5 intersected graphite band details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-5/CS-17	31.5	32.5	4.71	Graphite bearing gneiss	3.09	3-E
ORDN-5/CS-18	32.5	33.45				
ORDN-5/CS-19	33.45	34.45				
ORDN-5/CS-20	34.45	35.45				
ORDN-5/CS-21	35.45	36.7				

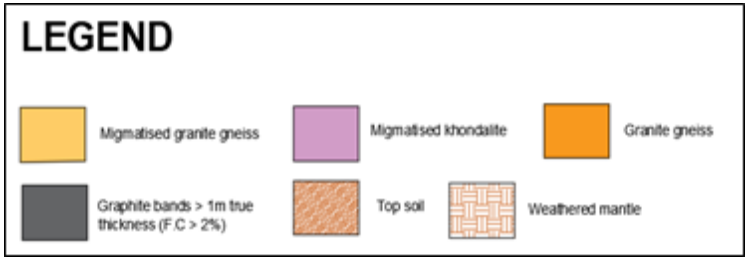


Fig 9.5: Cross-Sectional view of Borehole ORDN-5

BOREHOLE - ORDN-6

The borehole ORDN-6 was planned on the major graphite bearing Zone-4 targeting the inferred graphite band A-4 (based on surface geological evidences) (**Plate-V**). The strike of the band varies from 130° to 160°, while the dip amount is considered as 60°, dipping south-westerly. The borehole was planned with respect to the groove line G10 (weighted average of F.C value 14.43% over 8 samples).

Thus, ORDN-6 was planned with an inclination of 45° with an azimuth towards N60°E and at a horizontal distance of 46 m from the inferred graphite band A-4 in order to check the depth persistence of the graphite band at 30 m vertical depth.

The inclined depth of the borehole was 63 m (summarised litholog is given in **Annexure-VIII**). Borehole ORDN-6 penetrated 16.5 m of topsoil, weathered mantle and weathered khondalite before intersecting the key lithologies which include migmatised khondalite, graphite bearing weathered mantle, graphite bearing khondalite and migmatised gneiss. The lithologies encountered were highly fractured and altered (**Plate-IX**).

A total of 3 graphite bands were intersected (**Table 9.8**) in the borehole within the depth range of 19 to 60 meters with varying thicknesses (1.2 m to 4 m). The main graphite bearing lithologies are the graphite bearing weathered mantle and graphite bearing khondalite. These mineralized units are often associated with alteration and fracturing. The sequence concludes with migmatised khondalite at 63 m depth. The cross sectional view is shown in **Figure 9.6**. The graphite mineralisation is found to occur within the fractured khondalitic lithounit.

BOREHOLE - ORDN-7

The borehole ORDN-7 was planned on the major graphite bearing Zone-4 targeting the anomalous SP values (**Figure 6.24**). The borehole was planned in order to trace the occurrence of graphite bearing lithological units at 30m vertical depth of intersection with respect to the central point of maximum SP anomaly zone

Thus, ORDN-7 was planned with an inclination of 45° with an azimuth towards N60°E and at a horizontal distance of 30 m from the central point of the maximum SP anomaly.

The inclined depth of the borehole was 72 m (summarised litholog is given in **Annexure-IX**). Borehole ORDN-7 penetrated 5.7 m of topsoil and weathered mantle before intersecting the key lithologies which include khondalite, graphite bearing khondalite, migmatised khondalite, graphite bearing gneiss and charnockite (**Plate-IX**).

A total of 3 graphite bands were intersected (**Table 9.9**) in the borehole within the depth range of 7 to 45 meters with varying thicknesses (1 m to 10.95 m). The main graphite bearing lithologies are the graphite bearing gneiss and graphite bearing khondalite. The sequence concludes with migmatised khondalite at 72 m depth. The cross sectional view is shown in **Figure 9.7**. The graphite mineralisation is found to occur within the migmatised khondalite lithounit.

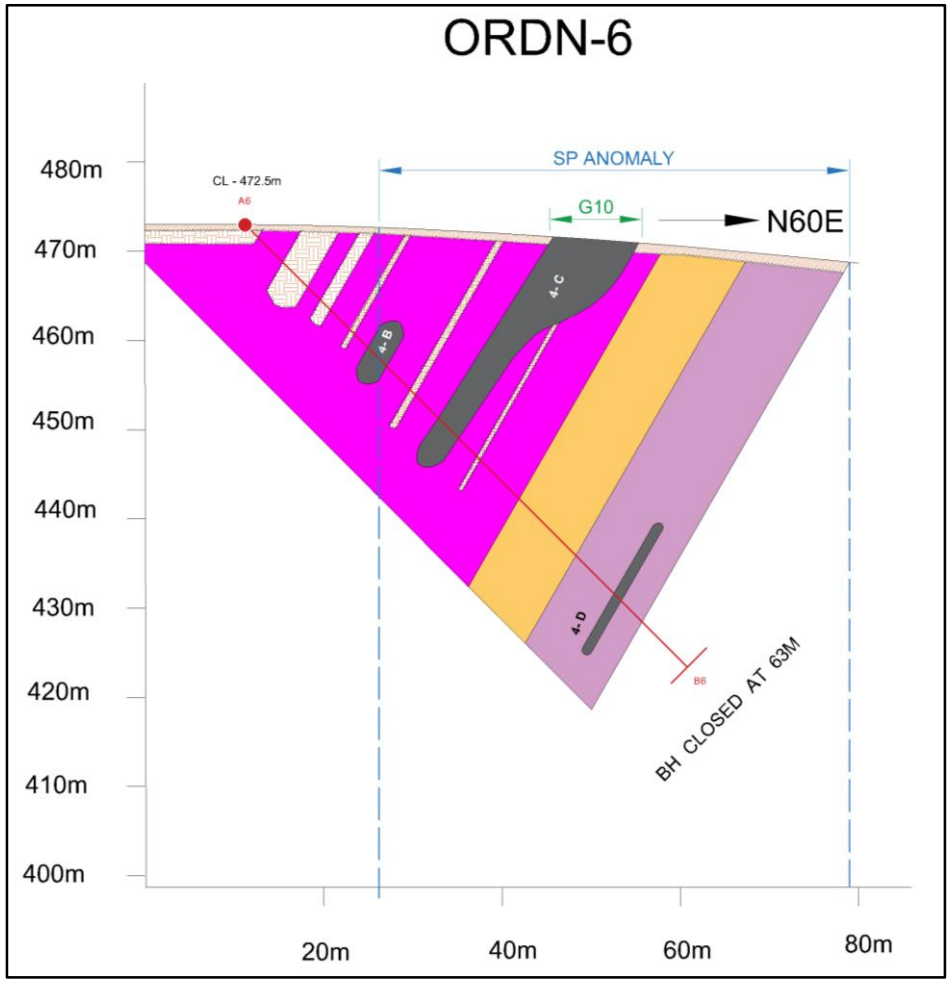
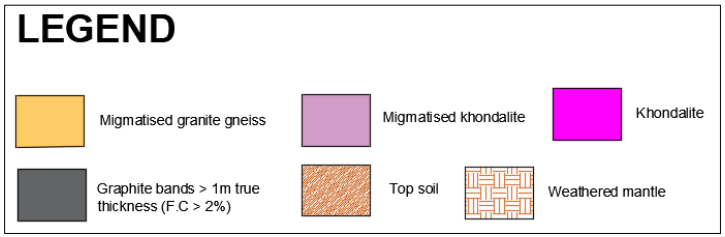


Fig 9.6: Cross-Sectional view of Borehole ORDN-6

Table 9.8 : ORDN-6 intersected graphite bands details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-6/CS-2	19.5	20.5	2.9	Graphite bearing Weathered Mantle	4.76	4-B
ORDN-6/CS-3	20.5	21.5				
ORDN-6/CS-4	21.5	22.5				
ORDN-6/CS-10	30.7	31.7	3.86	Graphite bearing Khondalite & Weathered Mantle	3.01	4-C
ORDN-6/CS-11	31.7	32.7				
ORDN-6/CS-12	32.7	33.7				
ORDN-6/CS-13	33.7	34.7				
ORDN-6/CS-27	58.5	59.7	1.16	Graphite bearing Khondalite	4.22	4-D



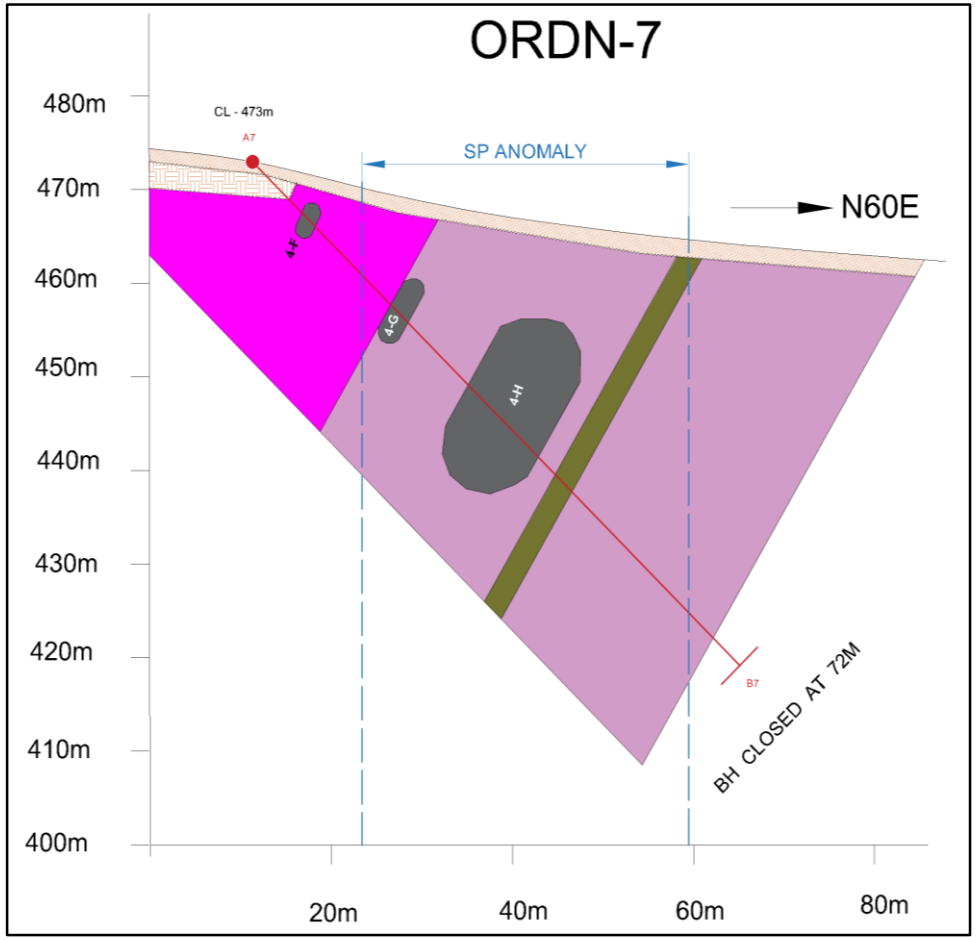
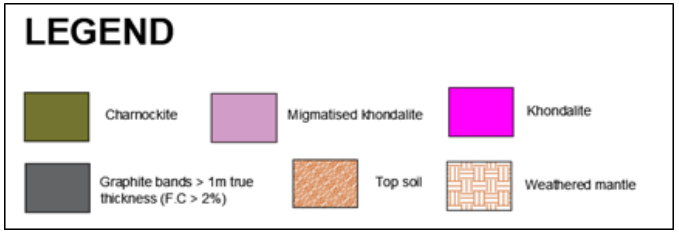


Fig 9.7: Cross-Sectional view of Borehole ORDN-7

Table 9.9 : ORDN-7 intersected graphite bands details

Sample No.	Depth From (m)	Depth To (m)	True thickness (m)	Lithology	Wt Avg FC %	Tentative Band
ORDN-7/CS-5	7.7	8.7	2.03	Graphite bearing Khondalite	2.15	4-F
ORDN-7/CS-6	8.7	9.8				
ORDN-7/CS-9	21.6	22.6	2.61	Graphite bearing Khondalite	3.14	4-G
ORDN-7/CS-10	22.6	23.6				
ORDN-7/CS-11	23.6	24.3				
ORDN-7/CS-14	33.7	34.7	10.58	Graphite bearing gneiss	4.91	4-H
ORDN-7/CS-15	34.7	35.7				
ORDN-7/CS-16	35.7	36.7				
ORDN-7/CS-17	36.7	37.7				
ORDN-7/CS-18	37.7	38.7				
ORDN-7/CS-19	38.7	39.7				
ORDN-7/CS-20	39.7	40.7				
ORDN-7/CS-21	40.7	41.7				
ORDN-7/CS-22	41.7	42.7				
ORDN-7/CS-23	42.7	43.7				
ORDN-7/CS-24	43.7	44.65				



GRAPHITE ZONE 2

Three graphite bands were inferred, namely band A-2, band B-2 and band C-2 (based on surface geological evidences) (**Plate-III**). Unfortunately, no boreholes could be planned for this zone, as the area is covered with dense cashew plantation and the villagers outright refused to cooperate with us.

9.3 Logging

Lithological logging is a key component of the exploration process. It provides essential data to delineate ore band thickness, identify structural features, and determine the true dip of mineralized bodies. Accurate logging is vital for reliable resource estimation, geological modelling, and systematic drill core sampling. Standardized logging records geological and geotechnical parameters, including run intervals, lithological descriptions, structural orientations, Rock Quality Designation (RQD), and total core recovery. (**Annexure III – IX**)

For the graphite Zone 1 and 3 the core angle with respect to the various litho-contacts and foliations ranges from 60° to 65° while for Zone 4 the core angle ranges from 70° to 75°. As a result, the dip value of the foliation planes and the graphite bands for Zone 1 and 3 have been considered as nearly 70° and for Zone 4 it is considered as 60° (as majority of boreholes were drilled at an inclination of 45°).

During lithological logging, while the quartzo-feldspathic graphite gneiss invariably showed a migmatitic appearance (**Fig 9.8**), the khondalite and granite gneiss were recognised as two distinct variants, namely migmatised and non-migmatised types. The migmatised varieties are characterised by the presence of leucosome and melanosome patches, streaks and clots, irregular felsic segregations, diffuse compositional banding, and locally developed flow structures (**Fig 9.9 a & c**). In contrast, the non-migmatised varieties preserve their primary metamorphic fabric. The non-migmatised granite gneiss displays intermittent gneissic banding with alternating felsic and mafic layers, whereas the non-migmatised khondalite is characterised by persistent foliation defined by sillimanite–biotite-rich layers, a comparatively fractured appearance, and locally developed secondary veinlets along foliation planes (**Fig 9.9 b**). The distinction between these variants was consistently used during core logging to delineate lithological boundaries.

Fig 9.8: Quartzo-feldspathic graphite gneiss showing a migmatitic appearance in core

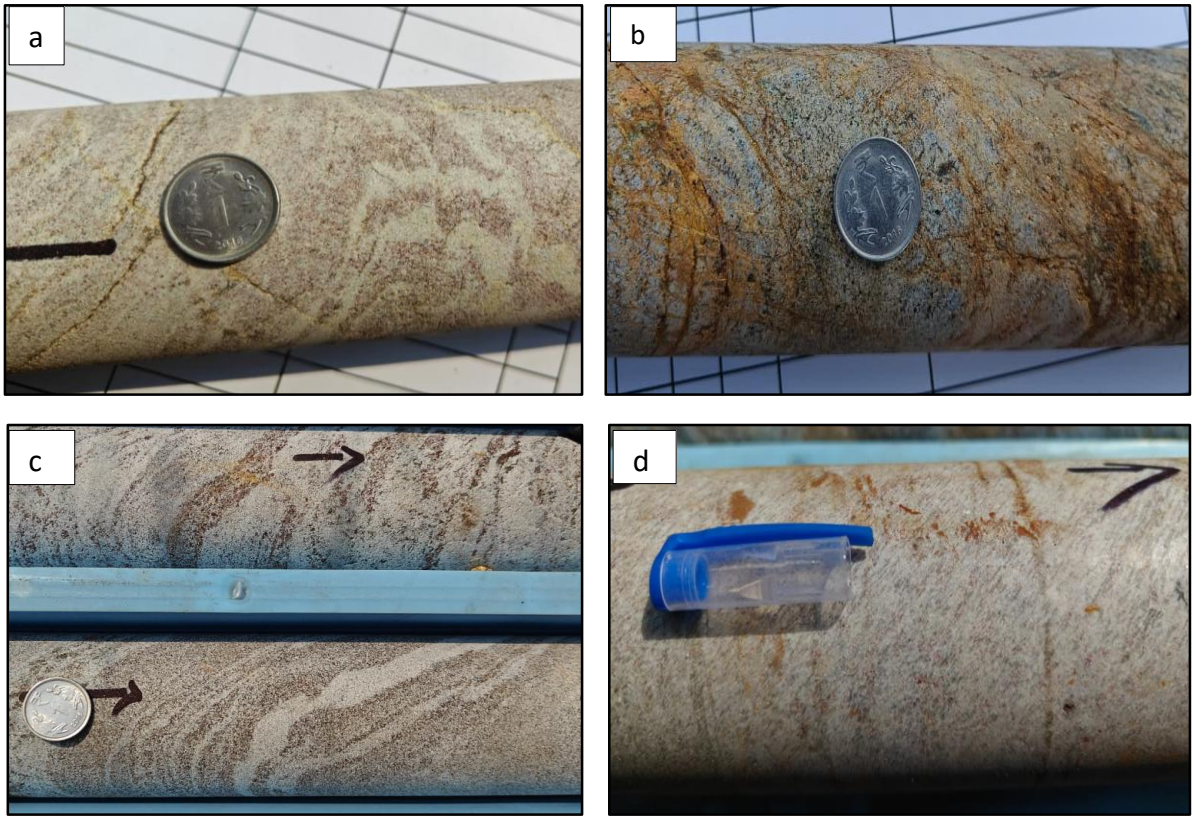


Fig 9.9: (a) Migmatised khondalite in core (b) Non-migmatised khondalite in core showing alteration and fractured appearance (c) Migmatised granite gneiss in core (d) Leptynite in core showing stretched quartz blebs

9.4 Mineralogy of the ore zone, sampling and sample preparation

Generally three types of graphite bearing lithounits were encountered with variable mineralogy during ore zone sampling. These are as follows:-

1) **Quartzo-feldspathic graphite gneiss** – It is a greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Presence of biotite also observed. Overall the lithounit has a migmatitic appearance (**Fig 9.8**).

2) **Graphite bearing khondalite** – It is reddish white in colour, fractured with large flakes of graphite in foliation planes and also in disseminated form.

3) **Graphite bearing gneiss** – It is a greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue.

DRILL CORE SAMPLING METHODOLOGY

1) Borehole datasheets are maintained simultaneously with each successive running borehole logs.

2) After completion of each borehole the mineralised zone is separated referring to the logging data.

3) Samples are collected at consistent 1-meter interval along graphite bearing zones that were visually demarcated during logging. This protocol applies to both the mineralized zones and any internal parting (<2 m) encountered. Samples having lengths ≥0.5 m to ≤1.5 m are considered as a single sample in certain scenarios - when the mineralized zone is say 1.7 m thick, 2 samples of 1 m and 0.7 m have been considered; conversely if mineralised zone is 1.4 m thick, then a single 1.4 m sample have been considered.

4) To accurately define the limits of mineralization, sampling extends 1 meter into either wall of country rock. Each sample is physically demarcated using a metal tag labelled with the specific depth.

5) Detailed information like core box number, run length, depth etc. are labelled on the top of the box as well inside the boxes.

6) Finally core boxes are winded with GI wires and preserved in camp for despatch to nearby repository of GSI

Proximate analysis were carried out by NMCI Inspections & Survey Co. Pvt. Ltd.

9.5 Chemical analysis and laboratory procedures

Upon laboratory submission, samples undergo proximate analysis to quantify Fixed Carbon (FC) content, adhering strictly to the IS 14852:2000 standard established by the Bureau of Indian Standards (BIS). The analytical protocol involves the systematic determination of moisture, volatile matter (VM), and ash content. The Fixed Carbon value is subsequently derived as the arithmetic remainder after deducting the cumulative percentages of these constituents from the total sample mass (100%).

DETERMINATION OF MOISTURE

Approximately 5 g of the sample is accurately weighed into a tared porcelain dish and covered with a watch glass. The assembly is placed in a constant-temperature air oven maintained at 150°C ± 10°C. Upon insertion, the watch glass is removed to allow for evaporation. After a heating duration of two hours, the dish is recovered with the watch glass prior to removal from the oven. The sample is then cooled to ambient temperature in a desiccator and weighed.

$$\text{Moisture \%} = A/B \times 100$$

Where, A = loss in weight in g of the material after heating and B = weight in g of the material taken

DETERMINATION OF VOLATILE MATTER

Approximately 1 g of moisture-free sample is transferred into a pre-weighed volatile matter crucible, secured with a tight-fitting lid. The assembly is then placed in a muffle furnace and heated at 925°C ± 25°C for exactly 7 minutes. To ensure uniform thermal distribution, the crucible must be supported such that it does not come into direct contact with the furnace floor. Following the heating period, the crucible is transferred to a desiccator to cool to ambient temperature before final weighing. The Volatile Matter (VM) content is then calculated using the following formula:

$$\text{Volatile matter \%} = A/B \times 100$$

Where A = loss in weight in g of the moisture free sample after heating up to 925°C ± 25°C B = weight in g of the moisture free sample taken.

DETERMINATION OF ASH

A test portion of approximately 1 g of moisture-free sample is weighed into a silica crucible. The specimen is placed in a muffle furnace and heated progressively: reaching 500 ± 10°C within the first hour, and advancing to 775 ± 10°C by the second hour. A consistent, slow airflow is maintained within the furnace to ensure complete oxidation. The temperature is then stabilized at 925 ± 25°C for a duration of one hour. Following incineration, the crucible is cooled in a desiccator and weighed. This heating and cooling cycle is repeated until constant mass is achieved. The following formula is used for calculation of ash content:

$$\text{Ash \%} = A/B \times 100$$

Where A = Weight of ash in g B = weight in of the sample taken.

After determination of these parameters, FC is calculated with the formula:

$$\text{FC \%} = 100 - (\text{VM \%} + \text{Ash \%})$$

Where, FC = Fixed carbon VM = Volatile matter Ash = Ash content

PROXIMATE ANALYSIS

A total 225 numbers of core samples were analysed for proximate analysis. The analysis was carried out by the NMCI laboratory. The detailed result is given in **Annexure X**.

CHECK SAMPLES

10 numbers of core samples were submitted to IGI Lab and SHIVA Lab for check analysis. They were selected on the basis of anomalous high values of F.C % reported in the core samples by the primary lab. The analytical results are given in the **Annexure –XI**.

Comparison of the primary and check analyses shows good agreement, with an average F.C variation of about 0.96%. Sulphur contents are generally low, although a few core samples record elevated values (up to 3.71%), possibly due to high amount of pyrite.

ICPMS ANALYSIS

A total 10 numbers of core samples were analysed for minor and trace elements by SHIVA Laboratory. The procedure used - Acid digestion followed by ICPOES finish (SOP/OM/051) and Acid digestion followed by ICPMS finish (SOP/OM/052). The analysis result is given in **Annexure – XII**. Detailed discussion has been done in **Section 6.3**.

PCS ANALYSIS

A total 5 numbers of core samples were analysed for major oxides (including vanadium) by SHIVA Laboratory. The procedure used - Borate Fusion Bead followed by WDXRF finish (SOP/OM/105) and Loss on Ignition followed by Gravimetry finish (SOP/OM/103). The analysis result is given in **Annexure – XIII**. Detailed discussion has been done in **Section 6.3**.

9.6 Details of boreholes drilled in ore zones and their correlation

The details of the intersected mineralised zones are given in **Table 10.3**

Fig 9.10: (a) Field geologist studying the drill cores and (b) Geologists and drilling personnel after completion of the final borehole ORDN-7 in the block

CHAPTER 10: RESOURCE ESTIMATION

Graphite mineralization occurs within distinct host zones, identified through geological mapping and geophysical surveys. To assess subsurface continuity, a 462-meter drilling program with seven boreholes was carried out. The interpretation of the drill core shows that each mineralized zone has multiple separate graphite bands, which have a clear pinch-and-swell morphology. Due to the variability observed between neighbouring boreholes, the resource was modelled based on the principles of banded-type mineralization. Resource estimation used the cross-section method with a Fixed Carbon cut-off grade of 2%.

10.1 Detailed description of the Ore zones

The detailed descriptions of the graphite bearing zones in terms of surface evidences were given previously in chapter 7. In this section the description is given based on subsurface evidences. Zone wise descriptions are as follow –

ZONE 1

The Zone 1 is situated in the southern side of the Pichuligurha village. Three boreholes ORDN-1, ORDN-2 and ORDN-3 were drilled (**Plate-VI**) to check the depth persistence of the three different mapped graphite bands (A-1, B-1 and D-1 (**Plate-II**)) up to 30 meters of vertical depth.

Based on the surface and subsurface evidences, a total of **eleven** number of graphite bands (**Plate-VI**) are interpreted for this zone. The bands which have intersected in the boreholes are – **1-B**, **1-C** and **1-D** in ORDN-1, **1-E** in ORDN-2 and **1-F**, **1-G**, **1-I**, **1-J** and **1-K** in ORDN-3. All the intersected bands are considered to dip 70°, south-westerly. Apart from these, the bands encountered only on the surface are – **1-A** and **1-H**. The maximum and minimum thicknesses of the bands are 9.8 m and 1 m respectively. The average F.C for the bands ranges between **2.2%** and **10.03%** (**Table 10.3**). The sectional view of the graphite bands of average F.C greater than 2% encountered in the boreholes are shown in **Plate-IX**.

ZONE 2

Three graphite bands were inferred, namely band A-2, band B-2 and band C-2 (based on surface geological evidences) (**Plate-III**). Unfortunately, no boreholes were drilled, as the area is covered with dense cashew plantation and the villagers outright refused to cooperate with us. Detailed description of the zone is provided in chapter 7.

ZONE 3

The Zone 3 is situated in the southern side of the Bhaleri village. Two boreholes ORDN-4, and ORDN-5 were drilled (**Plate-VII**) to check the depth persistence of the two different mapped graphite bands (A-3 and B-3 (**Plate-IV**)) up to 30 meters of vertical depth.

Based on the surface and subsurface evidences, a total of **six** number of graphite bands (**Plate-VII**) are interpreted for this zone. The bands which have intersected in the boreholes are – **3-C** in ORDN-4 and **3-E** in ORDN-5. All the intersected bands are considered to dip 70°, south-westerly. Apart from these, the bands encountered only on the surface are – **3-A**, **3-B**, **3-D**, and **3-F**. The maximum and minimum thicknesses of the bands encountered are 5.5 m and 1.54 m respectively. The average F.C of the bands ranges between **2.48%** and **8.19%** (**Table 10.3**). The sectional view of the graphite bands of average F.C greater than 2% encountered in the boreholes are shown in **Plate-IX**.

ZONE 4

The Zone 4 is situated in the south-western side of the Dhuanbarhi village. Two boreholes ORDN-6, and ORDN-7 were drilled (**Plate-VIII**) to check the depth persistence of the two different mapped graphite bands (A-4 and B-4 (**Plate-V**)) up to 30 meters of vertical depth.

Based on the surface and subsurface evidences, a total of **eight** number of graphite bands (**Plate-VIII**) are interpreted for this zone. The bands which have intersected in the boreholes are – **4-B**, **4-C** and **4-D** in ORDN-6 and **4-F**, **4-G** and **4-H** in ORDN-7. All the intersected bands are considered to dip 60°, south-westerly. Apart from these, the bands encountered only on the surface are – **4-A** and **4-E**. The maximum and minimum thicknesses of the bands encountered are 10.58 m and 1.16 m respectively. The average F.C of the bands ranges between **2.15%** and **17.64%** (**Table 10.3**). The sectional view of the graphite bands of average F.C greater than 2% encountered in the boreholes are shown in **Plate-IX**.

10.2 Cut-off grade

For the purpose of resource estimation, graphite bands with F.C values of greater than 2% were only considered.

10.3 Bulk-density calculation

As per the quantum of work sanctioned, bulk density studies (**Table 10.1**) was carried out by SHIVA Laboratory for 3 number of samples.

Table 10.1 : Bulk density result for selected samples		
Sl No	**Sample No.**	**Bulk density (g/cm^3)**
1	ORDN-2/CS-20	2.62
2	ORDN-5/CS-21	2.74
3	ORDN-7/CS-22	2.61

10.4 Assumptions for resource estimation

The following factors were assumed for resource estimation –

- All samples with 2 or >2 % F.C having true thickness of 1 m or more are considered for demarcation of mineralised zone/band.
- Parting of 1 m or less thickness with <2% F.C occurring between two mineralised zones is merged with mineralised band if combined weighted average does not fall below 2% F.C.
- If adjacent length has high F.C % (>1.50 % F.C), it is merged if combined weighted average does not fall below 2% F.C.
- True thicknesses of the graphite bearing bands were calculated trigonometrically.
- The volume was calculated by $V = Strike\ influence\ \times dip\ influence \times true\ thickness$.
- Strike influence of 50% of interval between two successive sample points (BH or Groove or Trench) was considered for the side having geological confidence and 25% was taken for the side of less geological confidence.
- Upward along dip face, dip influence of 25% of the distance from the surface to the point of intersection along borehole was taken for the bands having no surficial expression or outcrops and 50% considered for the bands having surficial expression or outcrops.
- Downward along dip face, dip influence of 50% of the distance from the surface to the point of intersection along borehole was taken for bands having surficial expression as well as intersected in borehole, and dip influence of 25% considered for bands which have not been intersected in boreholes. Also, downward along dip face from intersected band, dip influence is considered to be 25% of length from intersection point to the surface as no 2nd level BH were drilled which may account for geological confidence.
- Weighted average grade for graphite bearing band was calculated using the formula $\sum(l_1 \times A_1 + l_2 \times A_2 \ldots\ldots.) \div (\sum(l_1 + l_2 \ldots\ldots)$ where $l_1 = sample\ length$ and $A_1 = Fixed\ carbon\ percentage$
- Resource of graphite was estimated by using the formula

$$T_g = V_g \times \rho_g$$

Where, $T_g = Resource\ of\ graphite, V_g = Volume\ of\ graphite\ band,$
$\rho_g = average\ bulk\ density\ of\ graphite\ band$

Table 10.2 : Strike extension of the interpreted graphite bands for resource estimation

Zone ID	Interpreted graphite bands	Sample Point	Interpreted NW strike extension	Interpreted SE strike extension	Total strike extension
Zone-1	1-A	Trench T3	7.5	7.5	15
	1-B	ORDN-1	62	55	117
		Trench T3	54	63	117
		Groove G2	27	54	81
		Groove G3	55	27.5	82.5
	1-C	ORDN-1	62	27.5	89.5
		Trench T3	54	31.5	85.5
		Groove G2	27	54	81
	1-D	ORDN-1	31	27.5	58.5
	1-E	ORDN-2	13.75	27.5	41.25
	1-F	ORDN-3	11	11	22
	1-G	ORDN-3	22	11	33
		Trench T1	11	22	33
	1-H	Trench T1	10	10	20
	1-I	ORDN-3	18	9	27
		Trench T1	9	18	27
	1-J	ORDN-3	16	8	24
		Trench T1	8	16	24
	1-K	ORDN-3	8	8	16
Zone - 3	3-A	Groove G7	21	27.5	48.5
	3-B	Groove G7	21	27.5	48.5
	3-C	ORDN-4	21	55	76
		Groove G7	21	55	76
		Trench T7	55	27.5	82.5
	3-D	Trench T7	27.5	27.5	55
	3-E	ORDN-5	21	21	42
	3-F	Groove G8	15	15	30
Zone - 4	4-A	Trench T4	26	26	52
	4-B	ORDN-6	26	31.5	57.5
	4-C	ORDN-6	52	63	115
		Groove G9	63	31.5	94.5
		Groove G10	52	63	115
		Trench T4	26	52	78
	4-D	ORDN-6	26	31.5	57.5
	4-E	Groove G11	25.5	25.5	51
	4-F	ORDN-7	31.5	31.5	63
	4-G	ORDN-7	31.5	31.5	63
	4-H	ORDN-7	31.5	31.5	63

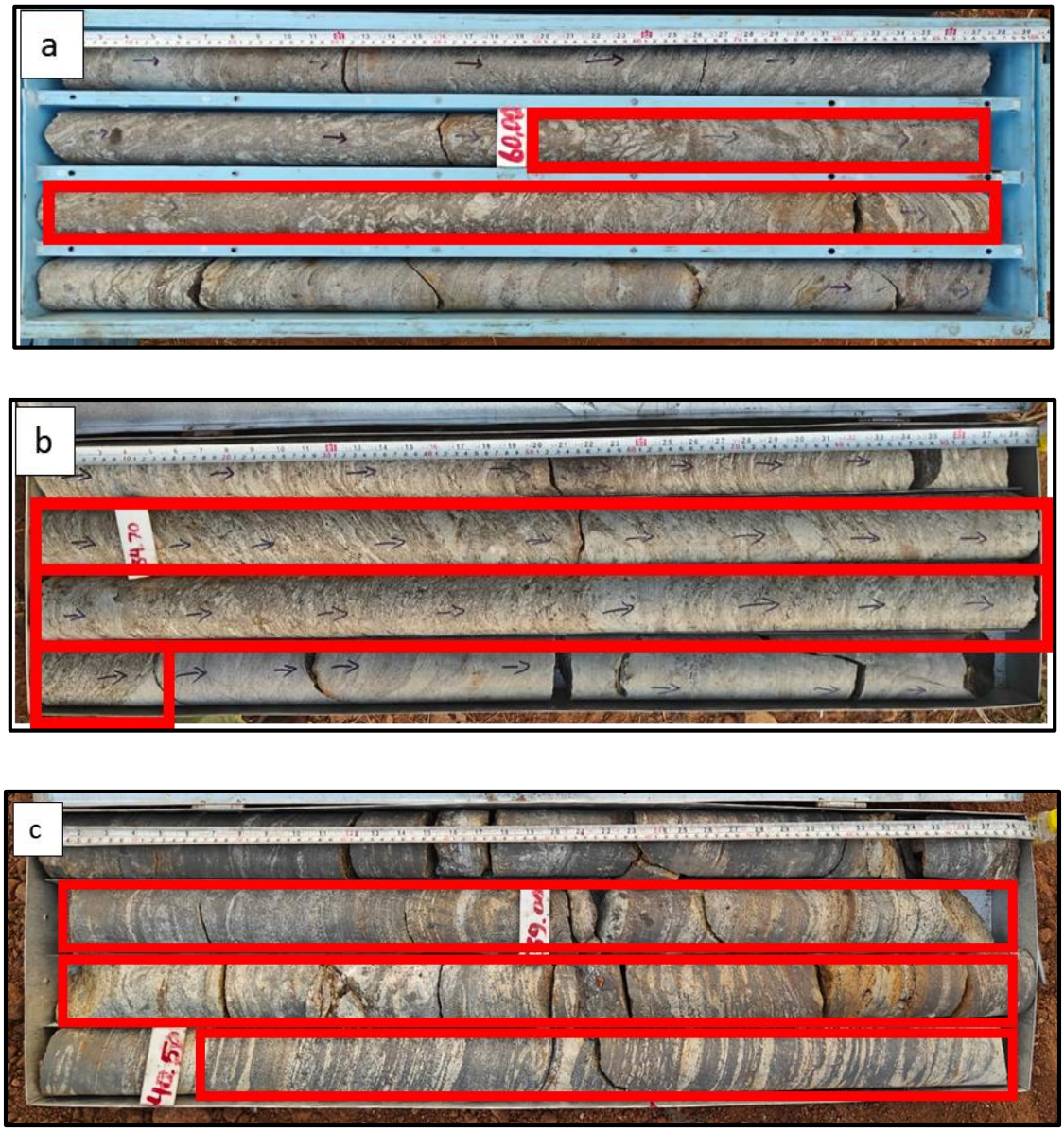


Fig 10.1: (a) Quartzo-feldspathic graphite gneiss intersected in ORDN-1 (b) Graphite bearing khondalite intersected in ORDN-5 and (c) Graphite bearing gneiss intersected in ORDN-7

10.5 Resource estimation by cross-sectional method

The reconnaissance resource (UNFC Code 334) for graphite was estimated by cross sectional area method based on the assumptions described in section 10.4. The **Table 10.3** is representing the zone wise estimated resource in million tonnes. Cumulative resource for graphite at 2% F.C cut off for Zone 1, Zone 3 and Zone 4 are **0.199 million tonnes**, **0.062 million tonnes** and **0.144 million tonnes** respectively.

Table 10.3 : Resource for graphite at 2% cut-off in cross-sectional area method

Sample type	Depth		Tentative band	Inferred Strike influence (m)	Average Dip influence (m)	True thickness (m)	Apparent thickness (m)	Volume (m3)	Average Bulk Density (g/cc)	Weighted Average FC%	Band-wise Resource at 2% cut-off (million tonnes)
	From	To									
Trench T3			1-C	85.5	20	3	3	5130	2.62	6.44	0.0134
			1-B	117	17	3.7	3.7	7359.3	2.62	8.22	0.0193
			1-A	15	7	3	3	315	2.62	9.36	0.0008
ORDN-1	48.65	52	1-B	117	25.5	3.04	3.35	9069.84	2.62	4.27	0.0238
	58.4	63.86	1-C	89.5	30	4.95	5.46	13290.75	2.62	3.73	0.0348
	68.51	69.85	1-D	58.5	23.25	1.21	1.34	1645.75125	2.62	2.2	0.0043
Groove G2			1-C	81	15	2	2	2430	2.62	6.32	0.0064
			1-B	81	15	5	5	6075	2.62	6.8	0.0159
Groove G3			1-B	82.5	15	6	6	7425	2.62	5.89	0.0195
Groove G1			1-E	41.25	18	9.8	9.8	7276.5	2.62	10.03	0.0191
ORDN-2	48.9	57.65	1-E	41.25	27	7.17	8.75	7985.5875	2.62	5.19	0.0209
Trench T1			1-J	24	13.5	3	3	972	2.62	9.87	0.0025
			1-I	27	10.75	5	5	1451.25	2.62	10.01	0.0038
			1-H	20	4.5	1	1	90	2.62	9.92	0.0002
			1-G	33	6.75	3	3	668.25	2.62	9.96	0.0018
ORDN-3	10.8	14.25	1-F	22	5.6	3.13	3.45	385.616	2.62	2.25	0.0010
	15.5	16.65	1-G	33	10.12	1.04	1.15	347.3184	2.62	2.21	0.0009

	24.45	26.05	1-I	27	16.12	1.45	1.6	631.098	2.62	2.71	0.0016
	31.35	34.5	1-J	24	20.25	2.85	3.15	1385.1	2.62	2.23	0.0036
	48.2	54.8	1-K	16	20	5.98	6.6	1913.6	2.62	4.29	0.0050
Cumulative resource of graphite for Zone 1 at 2% cut-off of F.C											**0.1986**
Groove G7			3-C	76	18.5	5.5	5.5	7733	2.74	3.04	0.0212
			3-B	48.5	8	1.6	1.6	620.8	2.74	5.10	0.0017
			3-A	48.5	7	2.9	2.9	984.55	2.74	8.19	0.0027
ORDN-4	43.6	45.3	3-C	76	27.75	1.54	1.7	3247.86	2.74	3.66	0.0089
Trench T7			3-D	55	15	2	2	1650	2.74	2.48	0.0045
			3-C	82.5	15	3	3	3712.5	2.74	3.46	0.0102
ORDN-5	31.5	36.7	3-E	42	13.5	4.71	5.2	2670.57	2.74	3.09	0.0073
Groove G8			3-F	30	15	4.7	4.7	2115	2.74	5.63	0.0058
Cumulative resource of graphite for Zone 3 at 2% cut-off of F.C											**0.0623**
Groove G10			4-C	115	12.75	7.8	7.8	11436.75	2.61	14.43	0.0298
ORDN-6	19.5	22.5	4-B	57.5	8	2.9	3	1334	2.61	4.76	0.0035
	30.7	34.7	4-C	115	19.12	3.86	4	8487.368	2.61	3.01	0.0222
	58.5	59.7	4-D	57.5	22	1.16	1.2	1467.4	2.61	4.22	0.0038
Groove G9			4-C	94.5	15	9.5	9.5	13466.25	2.61	17.64	0.0351
Trench T4			4-C	78	15	4	4	4680	2.61	5.6	0.0122
			4-A	52	15	3	3	2340	2.61	2.87	0.0061
ORDN-7	7.7	9.8	4-F	63	2.25	2.03	2.1	287.7525	2.61	2.15	0.0008
	21.6	24.3	4-G	63	6.5	2.61	2.7	1068.795	2.61	3.14	0.0028
	33.7	44.65	4-H	63	12	10.58	10.95	7998.48	2.61	4.91	0.0209
Groove G11			4-E	51	15	3.6	3.6	2754	2.61	15.24	0.0072
Cumulative resource of graphite for Zone 4 at 2% cut-off of F.C											**0.1444**

10.6 Resource estimation by LEAPFROG Software

The resource estimation involves a systematic geological, structural, and modelling based workflow. The first step in this process is the correlation of graphite bands intersected in the boreholes. This correlation is carried out by examining the depth of occurrence of each band and the parting thickness between successive mineralised horizons. By correlating these parameters across the drilling grid, a continuous geological understanding of the subsurface lithological sequence is developed.

1. COMPILATION OF THE REQUIRED DATABASE

To build a solid geological model and estimate resources using Leapfrog, several essential datasets are required:

- **Collar File** – Containing the coordinates and elevations of borehole collar positions.
- **Survey File** – Documenting the down-hole deviation data (azimuth and dip) for accurate spatial positioning of borehole traces.
- **Lithology File** – Describing the complete sequence of lithologies encountered in each borehole from surface to the closing depth, including all Graphite bands and inter-bedded partings.
- **Quality File** – Consisting of chemical properties of graphite samples (e.g. F.C %)
- **Block Boundary File** – Defining the block limits within which resource estimation must be confined.
- **Topographic Survey File** – Providing accurate ground surface elevation data.

These files form the foundation for constructing a reliable geological model and are carefully cross-verified before import.

2. BUILDING THE GEOLOGICAL FRAMEWORK IN LEAPFROG

After importing the data into Leapfrog:

- A topographic surface restricted to the block boundary is generated.
- A Geological Model is initiated, beginning with the topsoil layer, followed by arranging all lithologies in the Surface Chronology tab.
- The lithological order is assigned from oldest to youngest, ensuring that graphite bands are positioned correctly relative to the surrounding formations.
- Structural information, particularly dip and strike data, is incorporated. These values are derived from both outcrop measurements and borehole structural interpretations, helping in defining the orientation and continuity of mineralised horizons.

The software then constructs contact surfaces, representing the boundaries between different lithologies, enabling a realistic 3D geological interpretation of the deposit.

3. AREA OF INFLUENCE DETERMINATION

In resource estimation, defining the area of influence for each borehole is crucial. This is based on the spatial occurrence and continuity of the graphite bands:

- If a particular graphite band is consistently intersected in two or more consecutive boreholes, then 50% of the inter-borehole distance is considered as its zone of influence.
- If the same graphite band is absent or not intersected in the nearest boreholes, indicating reduced continuity or uncertainty, the influence distance is conservatively reduced to 25% of the inter-borehole spacing.

This methodology ensures that continuity of mineralization is neither overestimated nor underestimated.

4. VOLUME CALCULATION AND RESOURCE ESTIMATION

Once areas of influence are established:

- Leapfrog computes the band-wise volumes for each mineralised horizon within the block boundary.
- These volumes are then multiplied by the corresponding Specific Gravity values of graphite to derive the **Gross Reconnaissance Resource** for each band.
- The sum of all band-wise resources provides the total Gross Reconnaissance Resource for the block.

ZONE 1

Table 10.4 : Inferred Gross Reconnaissance Resource for Zone 1 by Leapfrog				
Zone	**Band**	**Volume (c.u.m)**	**Specific Gravity**	**Tonnage**
Zone 1	1A	322.71	2.62	845.5002
	1B	29761.00	2.62	77973.82
	1C	20851.00	2.62	54629.62
	1D	1636.40	2.62	4287.368
	1E	15238.00	2.62	39923.56
	1F	360.79	2.62	945.2698
	1G	1032.40	2.62	2704.888
	1H	96.415	2.62	252.6073
	1I	2082.10	2.62	5455.102
	1J	2391.50	2.62	6265.73
	1K	1922.20	2.62	5036.164
Total Resource for Zone 1 (in Tonnes)				**198319.6**
Total Resource for Zone 1 (in Million Tonnes)				**0.19832**

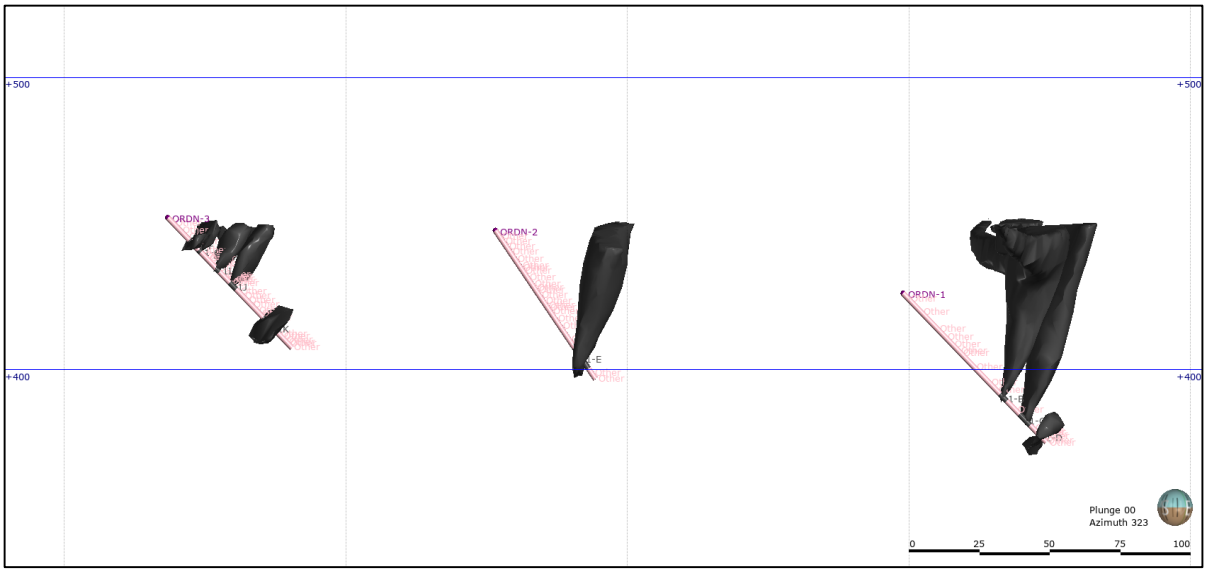


Fig 10.2: Sectional view for Zone 1

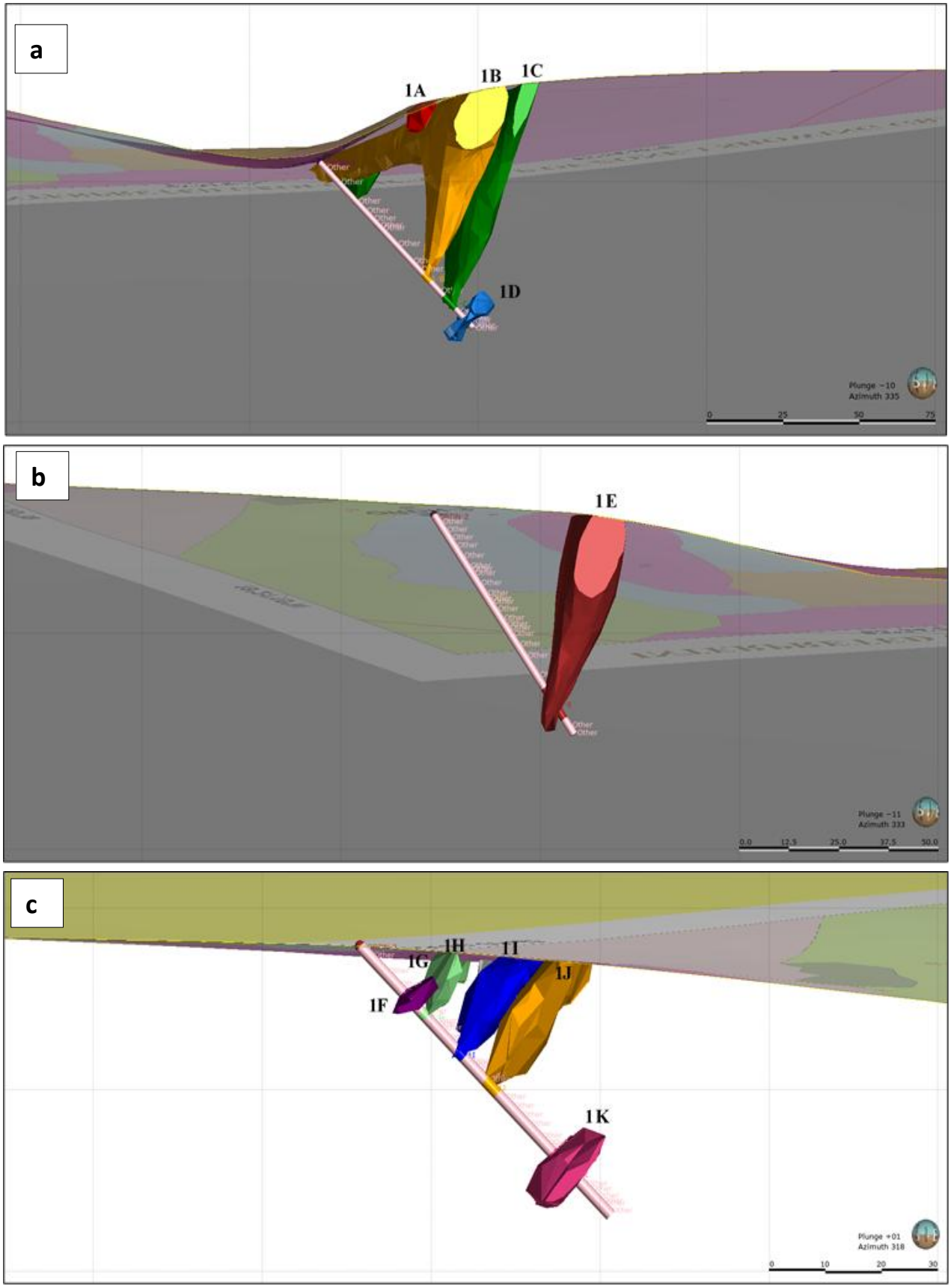


Fig 10.3: Sectional view for (a) ORDN-1, (b) ORDN-2 and (c) ORDN-3

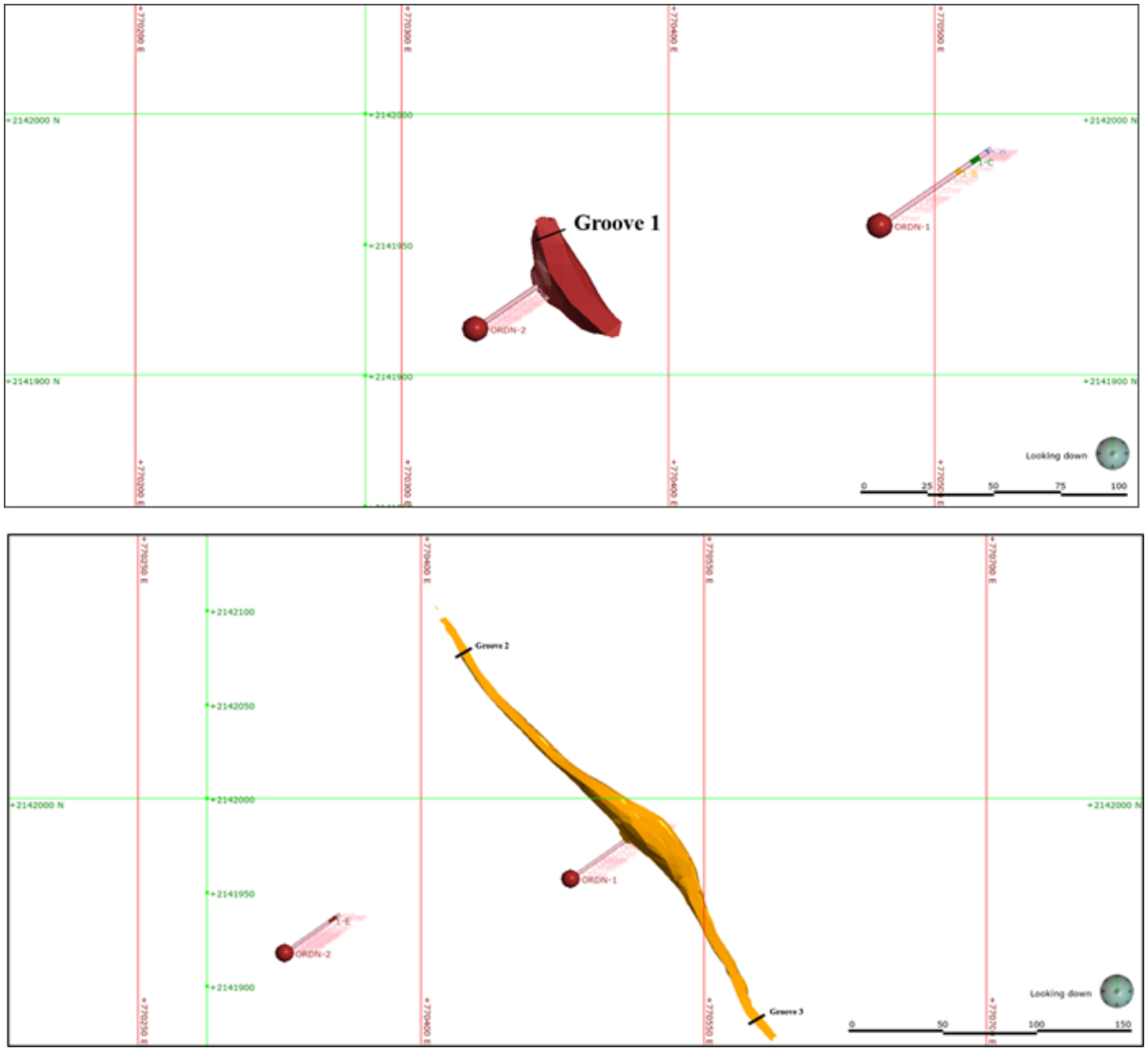


Fig 10.4: Disposition of grooves G1, G2 & G3 in Zone 1

ZONE 3

Table 10.5 : Inferred Gross Reconnaissance Resource for Zone 3 by Leapfrog				
Zone	**Band**	**Volume (c.u.m)**	**Specific Gravity**	**Tonnage**
Zone 3	3A	983.41	2.74	2694.5434
	3B	651.84	2.74	1786.0416
	3C	14647.00	2.74	40132.78
	3D	1633.10	2.74	4474.694
	3E	2658.20	2.74	7283.468
	3F	2142.30	2.74	5869.902
Total Resource for Zone 3 (in Tonnes)				**62241.429**
Total Resource for Zone 3 (in Million Tonnes)				**0.062**

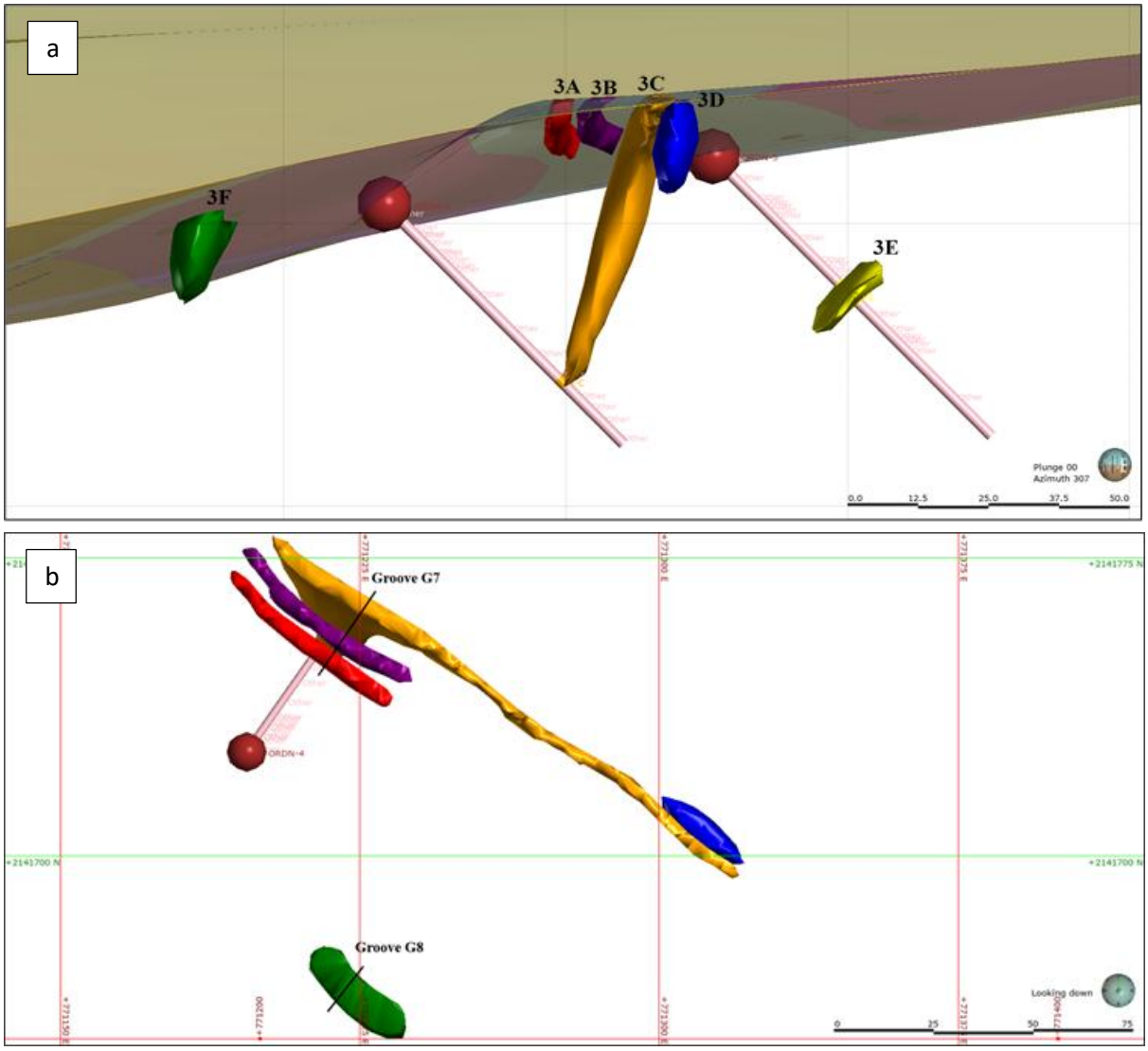


Fig 10.5: (a) Sectional view of ORDN-4 & ORDN-5 in Zone 3 (b) Disposition of groove G7 & G8 in Zone 3

ZONE 4

Table 10.6 : Inferred Gross Reconnaissance Resource for Zone 4 by Leapfrog				
Zone	**Band**	**Volume (c.u.m)**	**Specific Gravity**	**Tonnage**
Zone 4	4A	2325.10	2.61	6068.511
	4B	1330.80	2.61	3473.388
	4C	38002.00	2.61	99185.22
	4D	1401.70	2.61	3658.437
	4E	2783.10	2.61	7263.891
	4F	262.14	2.61	684.1854
	4G	1069.10	2.61	2790.351
	4H	7943.00	2.61	20731.23
Total Resource for Zone 4 (in Tonnes)				**120333.632**
Total Resource for Zone 4 (in Million Tonnes)				**0.120**

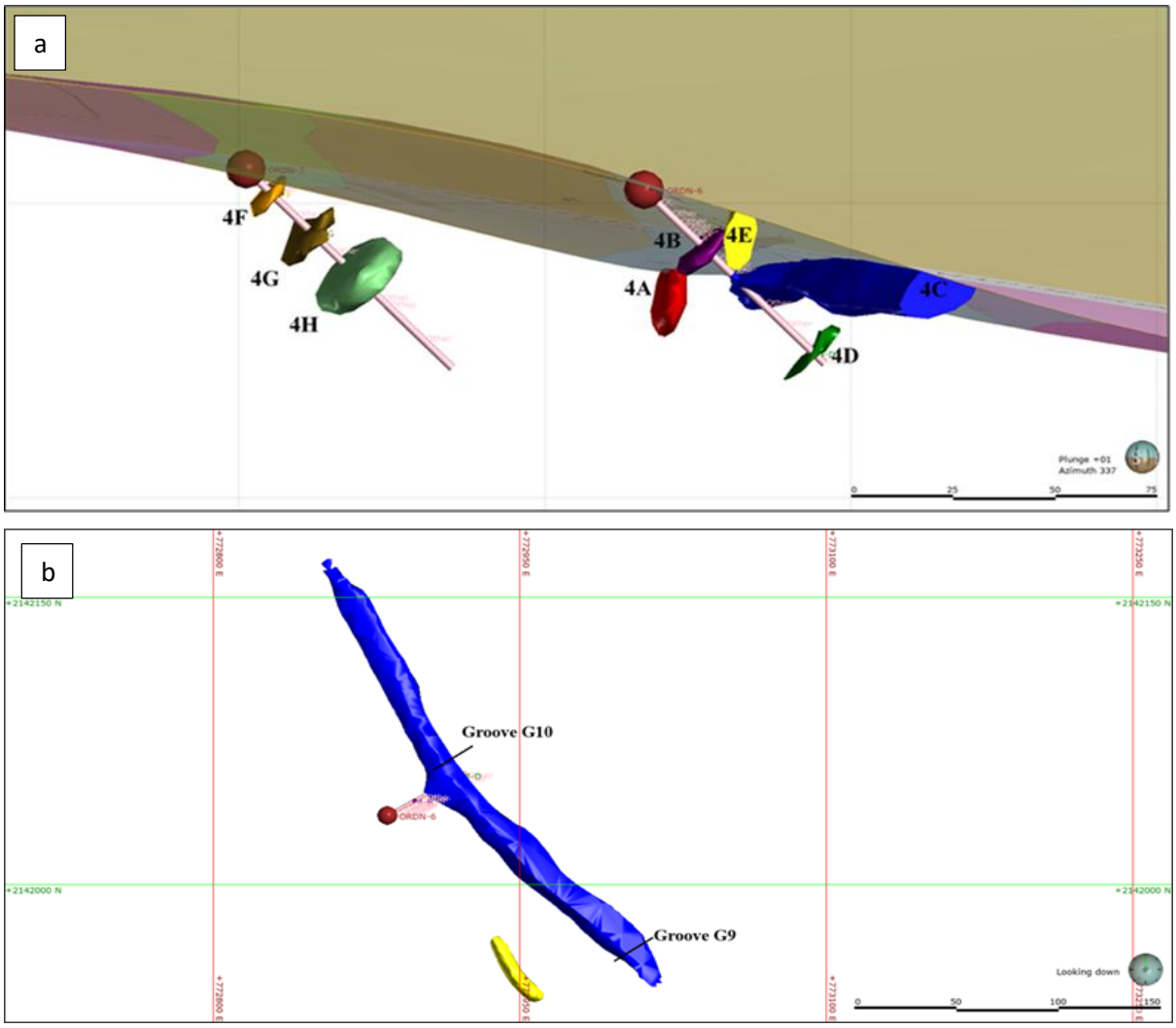


Fig 10.6: (a) Sectional view of ORDN-5 & ORDN-6 in Zone 4 (b) Disposition of groove G9 & G10 in Zone 4

CHAPTER 11:

CONCLUSION AND RECOMMENDATIONS

- Graphite bands are primarily hosted by the quartzo-feldspathic graphite gneisses, and a few occurrences are recorded within graphite bearing khondalites and associated graphite bearing gneisses.

- Nature of graphite bands are elongated, lensoidal and characterized by pinch-and-swell morphology, which is evident along strike and dip. The length of the lensoidal bodies range from 100 – 300 m while the width range from 20 – 60 m.

- Potential graphite bands are restricted in the southern part of the block.

- A reconnaissance resource (334) of 0.199 million tonnes at an average weighted F.C. of 6.00% for Zone 1, 0.062 million tonnes at an average weighted F.C of 4.33% for Zone 3, and 0.144 million tonnes at an average weighted F.C of 7.08% for Zone 4 has been estimated at the present G-4 stage of exploration using the cross-sectional area method. Considering the limited data density at the G-4 stage, the estimated resources require further exploration to establish the continuity, geometry and grade of the mineralised zones. Therefore, these graphite-bearing zones warrant up-gradation to G-3 stage through systematic drilling and additional surface exploration at closer spacing, in accordance with the MEMC guidelines.

- Zone 2, where drilling could not be undertaken, hosts graphite mineralization along the contact between khondalite and charnockite, marked by weathered quartzo-feldspathic graphite gneiss with a schistose appearance. The zone is interpreted to extend for about 100 - 150 m along strike with an average surface width of 60 m, comprising three inferred graphite bands of 5–16 m thickness. The inferred attitude of the graphite bands are 150°/60°, dipping south-westerly. Chemical analysis of 15 groove samples indicate a weighted average F.C content ranging from 4.00% to 12.64%. However, the economic potential of the zone can only be assessed after future drilling, supported by detailed surface sampling to establish the continuity, grade and nature of mineralization.

- In Zone 3, borehole ORDN-4 intersected only a 1.7 m thick graphite band between 43 – 46 m depth despite the encouraging surface results from Groove G7 (weighted average F.C of 5.01% over 20 m, for 13 samples) and the coincident strong negative SP anomaly (up to -350 mV). The limited subsurface intersection suggests a possible pinch-and-swell geometry and pinching of the mineralized zone at depth, or continuation of the graphite body at a greater depth. The continuity of the mineralization should be evaluated through systematic first and second-level drilling in accordance with MEMC guidelines.

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ANNEXURES

Annexure I: Analysis report of 84 graphite bearing bed rock samples (BRS)													
SL NO	GRAPHITE ZONE	LOCATION	BAND	SAMPLE ID	FROM	TO	LENGTH (m)	LITHOLOGY	MOISTURE (%)	VM (%)	ASH (%)	S (%)	FC (%)
1	ZONE 1 (South of Pichuligurha Village)	Along 240º from 770363 E 2141947 N)	1-E	DN/Z-1/G-1/1	0	1	1	Quartzofeldspathic Graphite gneiss	0.382	1.87	87.65	0.173	10.31
2				DN/Z-1/G-1/2	1	2	1	Quartzofeldspathic Graphite gneiss	0.324	1.42	88.02	0.036	10.52
3				DN/Z-1/G-1/3	2	3	1	Quartzofeldspathic Graphite gneiss	0.356	1.64	87.71	0.129	10.52
4				DN/Z-1/G-1/4	3	4	1	Quartzofeldspathic Graphite gneiss	0.302	1.49	88.97	0.014	9.53
5				DN/Z-1/G-1/5	4	5	1	Quartzofeldspathic Graphite gneiss	0.402	1.41	91.41	0.067	7.11
6				DN/Z-1/G-1/6	5	6	1	Quartzofeldspathic Graphite gneiss	0.48	1.64	91.91	0.179	6.27
7				DN/Z-1/G-1/7	6	7	1	Quartzofeldspathic Graphite gneiss	0.23	2.95	85.1	0.595	11.36
8				DN/Z-1/G-1/8	7	8	1	Quartzofeldspathic Graphite gneiss	0.272	3.3	84.14	0.783	11.78
9				DN/Z-1/G-1/9	8	9	1	Quartzofeldspathic Graphite gneiss	0.254	3.15	84.91	0.748	11.19
10				DN/Z-1/G-1/10	9	9.8	0.8	Quartzofeldspathic Graphite gneiss	0.332	4.2	82.62	0.972	12.21
11		Along 240º from 770434 E 2142075 N	1-C	DN/Z-1/G-2/1	0	1	1	Quartzofeldspathic Graphite gneiss	1.454	3.46	89.67	0.185	6.68
12				DN/Z-1/G-2/2	1	2	1	Quartzofeldspathic Graphite gneiss	1.247	3.05	90.72	0.27	5.96
13			1-B	DN/Z-1/G-2/3	3.5	4.5	1	Quartzofeldspathic Graphite gneiss	1.353	3.31	89.11	0.139	7.44
14				DN/Z-1/G-2/4	4.5	5.5	1	Quartzofeldspathic Graphite gneiss	1.262	2.58	91.05	0.155	6.21
15				DN/Z-1/G-2/5	5.5	6.5	1	Quartzofeldspathic Graphite gneiss	1.576	4.22	87.4	0.149	8.23
16				DN/Z-1/G-2/6	6.5	7.5	1	Quartzofeldspathic Graphite gneiss	1.49	2.82	90.39	0.216	6.57
17				DN/Z-1/G-2/7	7.5	8.5	1	Quartzofeldspathic Graphite gneiss	1.329	2.79	91.38	0.141	5.69
18		Along 230º from 770575 E 2141890 N	1-B	DN/Z-1/G-3/1	0	1	1	Quartzofeldspathic Graphite gneiss	0.794	2.53	94.99	0.386	2.09
19				DN/Z-1/G-3/2	1	2	1	Quartzofeldspathic Graphite gneiss	0.816	2.59	91.77	0.304	5.34
20				DN/Z-1/G-3/3	2	3	1	Quartzofeldspathic Graphite gneiss	0.776	2.68	93.62	0.378	3.32
21				DN/Z-1/G-3/4	3	4	1	Quartzofeldspathic Graphite gneiss	0.8	2.04	88.92	0.151	8.89
22				DN/Z-1/G-3/5	4	5	1	Quartzofeldspathic Graphite gneiss	0.852	2.09	89.4	0.101	8.41
23				DN/Z-1/G-3/6	5	6	1	Quartzofeldspathic Graphite gneiss	0.848	2.45	90.09	0.122	7.34
24				DN/Z-1/G-3/7	13	13.8	0.8	Quartzofeldspathic Graphite gneiss	0.85	2.2	92.33	0.338	5.13
25		Along 225º from		DN/Z-1/G-6/1	0	1	1	Quartzofeldspathic Graphite gneiss	4.362	2.17	94.86	0.035	2.94
26				DN/Z-1/G-6/2	1	2	1	Quartzofeldspathic Graphite gneiss	3.891	3.34	94.53	0.074	2.06

27		**770337 E 2141538 N**		DN/Z-1/G-6/3	2.3	3.3	1	Quartzofeldspathic Graphite gneiss	3.72	2.89	94.52	0.057	2.53
28				DN/Z-1/G-6/4	3.3	4.3	1	Quartzofeldspathic Graphite gneiss	3.558	3.16	94.34	0.068	2.43
29				DN/Z-1/G-6/5	4.3	5.2	0.9	Quartzofeldspathic Graphite gneiss	3.759	3.62	92.43	0.097	3.85
30	**ZONE-2** **(East of Lanji Village)**	**Along 240º from 772162 E 2143205 N**		DN/Z-2/G-4/1	0	1	1	Graphite bearing weathered gneiss	2.931	6.68	88.06	0.007	5.05
31				DN/Z-2/G-4/2	1	2	1	Graphite bearing weathered gneiss	2.808	6.94	87.59	0.027	5.24
32				DN/Z-2/G-4/3	3.5	4.5	1	Graphite bearing weathered gneiss	2.799	7.21	88.58	0.005	4
33				DN/Z-2/G-4/4	4.5	5.5	1	Graphite bearing weathered gneiss	2.804	7.23	87.59	0.007	4.96
34				DN/Z-2/G-4/5	7.5	8.5	1	Graphite bearing weathered gneiss	2.641	6.58	88.33	0.004	4.91
35				DN/Z-2/G-4/6	8.5	9.5	1	Graphite bearing weathered gneiss	2.69	7.55	87.44	0.007	4.79
36				DN/Z-2/G-4/7	9.5	10.5	1	Graphite bearing weathered gneiss	3.218	5.65	89.49	0.004	4.67
37				DN/Z-2/G-4/8	10.5	11.5	1	Graphite bearing weathered gneiss	2.523	5.44	87.32	0.008	7.09
38				DN/Z-2/G-4/9	11.5	12.5	1	Graphite bearing weathered gneiss	2.165	3.34	86.59	0.003	10
39				DN/Z-2/G-4/10	12.5	13.5	1	Graphite bearing weathered gneiss	1.878	2.19	85.13	0.004	12.64
40				DN/Z-2/G-4/11	13.5	14.2	0.7	Graphite bearing weathered gneiss	2.257	3.32	87.26	0.005	9.33
41		**Along 245º from 772131 E 2143177 N**		DN/Z-2/G-5/1	0	1.2	1.2	Graphite bearing weathered gneiss	1.356	3.65	86.27	0.011	10.07
42				DN/Z-2/G-5/2	4.2	5.5	1.3	Graphite bearing weathered gneiss	2.083	3.24	86.56	0.007	10.19
43		**Along 240º from 772203 E 2143206 N**		DN/Z-2/G-12/1	0	0.8	0.8	Graphite bearing weathered gneiss	5.346	1.91	91.37	0.066	6.65
44				DN/Z-2/G-12/2	3.5	4.2	0.7	Graphite bearing weathered gneiss	4.556	2.24	91.85	0.03	5.88
45	**ZONE-3** **(South of Bhaleri Village)**	**Along 215º from 771228 E 2141764 N**	**3-C**	DN/Z-3/G-7/1	0	1	1	Quartzofeldspathic Graphite gneiss	1.1	4.58	92.3	0.757	2.36
46				DN/Z-3/G-7/2	1	2	1	Quartzofeldspathic Graphite gneiss	1.117	4.67	92.47	0.864	2
47				DN/Z-3/G-7/3	2	2.8	0.8	Quartzofeldspathic Graphite gneiss	0.983	5.15	91.21	1.113	2.53
48				DN/Z-3/G-7/4	4.8	5.8	1	Quartzofeldspathic Graphite gneiss	1.106	4.73	91.01	0.791	3.47
49				DN/Z-3/G-7/5	5.8	6.8	1	Quartzofeldspathic Graphite gneiss	1.131	4.22	90.58	0.546	4.65
50				DN/Z-3/G-7/6	6.8	7.5	0.7	Quartzofeldspathic Graphite gneiss	1.05	5.16	90.78	0.846	3.21
51			**3-B**	DN/Z-3/G-7/7	12	13	1	Quartzofeldspathic Graphite gneiss	1.178	4.3	90.62	0.465	4.61
52				DN/Z-3/G-7/8	13	13.6	0.6	Quartzofeldspathic Graphite gneiss	0.841	4.36	88.95	0.761	5.93
53			**3-A**	DN/Z-3/G-7/9	16.2	16.9	0.7	Quartzofeldspathic Graphite gneiss	0.966	4.16	88.3	0.795	6.74

54			3-A	DN/Z-3/G-7/10	16.9	17.8	0.9	Quartzofeldspathic Graphite gneiss	0.978	3.5	86.98	0.408	9.11
55				DN/Z-3/G-7/11	17.8	18.5	0.7	Quartzofeldspathic Graphite gneiss	0.874	3.76	87.15	0.556	8.53
56				DN/Z-3/G-7/12	18.5	19.1	0.6	Quartzofeldspathic Graphite gneiss	1.07	3.92	87.41	0.577	8.09
57				DN/Z-3/G-7/13	21.5	22.2	0.7	Quartzofeldspathic Graphite gneiss	0.956	4.59	87.51	0.831	7.07
58		Along 208º from 771229 E 2141665 N	3-F	DN/Z-3/G-8/1	0	1	1	Quartzofeldspathic Graphite gneiss	1.136	5.79	90.61	1.03	2.57
59				DN/Z-3/G-8/2	2	3	1	Quartzofeldspathic Graphite gneiss	1.035	4.77	90.86	0.659	3.71
60				DN/Z-3/G-8/3	3	3.6	0.6	Quartzofeldspathic Graphite gneiss	1.1	4.28	87.61	0.659	7.45
61				DN/Z-3/G-8/4	5	6	1	Quartzofeldspathic Graphite gneiss	1.074	4.3	88.16	0.724	6.82
62				DN/Z-3/G-8/5	8	9.1	1.1	Quartzofeldspathic Graphite gneiss	0.926	4.24	86.99	0.668	8.1
63	ZONE-4 (South west of Dhuanbarhi Village)	Along 250º from 773014 E 2141967 N	4-C	DN/Z-4/G-9/1	0	1	1	Quartzofeldspathic Graphite gneiss	0.734	2.39	80.4	0.245	16.96
64				DN/Z-4/G-9/2	1	2	1	Quartzofeldspathic Graphite gneiss	0.728	1.9	81.53	0.143	16.43
65				DN/Z-4/G-9/3	2	3	1	Quartzofeldspathic Graphite gneiss	0.834	2.27	79.48	0.215	18.04
66				DN/Z-4/G-9/4	4	5	1	Quartzofeldspathic Graphite gneiss	0.716	1.91	80.88	0.112	17.1
67				DN/Z-4/G-9/5	5	6	1	Quartzofeldspathic Graphite gneiss	0.858	2.5	82.79	0.198	14.51
68				DN/Z-4/G-9/6	6	7	1	Quartzofeldspathic Graphite gneiss	0.646	3.2	81.68	0.418	14.7
69				DN/Z-4/G-9/7	7	8	1	Quartzofeldspathic Graphite gneiss	0.582	2.23	78.07	0.115	19.58
70				DN/Z-4/G-9/8	9	10	1	Quartzofeldspathic Graphite gneiss	0.51	2.05	77.53	0.116	20.3
71				DN/Z-4/G-9/9	10	11	1	Quartzofeldspathic Graphite gneiss	0.522	2.32	77.54	0.139	20
72				DN/Z-4/G-9/10	13	13.5	0.5	Quartzofeldspathic Graphite gneiss	0.678	2.68	77.19	0.238	19.89
73		Along 235º from 772924 E 2142064 N	4-C	DN/Z-4/G-10/1	0	1	1	Quartzofeldspathic Graphite gneiss	0.76	2.79	81.88	0.316	15.01
74				DN/Z-4/G-10/2	1	2	1	Quartzofeldspathic Graphite gneiss	0.792	2.71	84.4	0.297	12.59
75				DN/Z-4/G-10/3	2	3	1	Quartzofeldspathic Graphite gneiss	0.728	2.48	83.56	0.29	13.67
76				DN/Z-4/G-10/4	3	4	1	Quartzofeldspathic Graphite gneiss	0.59	2.63	82.07	0.093	15.21
77				DN/Z-4/G-10/5	5.5	6.5	1	Quartzofeldspathic Graphite gneiss	0.834	2.82	83.53	0.189	13.46
78				DN/Z-4/G-10/6	6.5	7.8	1.3	Quartzofeldspathic Graphite gneiss	0.626	3	81.87	0.149	14.98
79				DN/Z-4/G-10/7	7.8	8.5	0.7	Quartzofeldspathic Graphite gneiss	0.768	3.74	79.37	0.246	16.64
80				DN/Z-4/G-10/8	9.5	10.3	0.8	Quartzofeldspathic Graphite gneiss	0.686	2.74	82.66	0.153	14.45
81		Along 250º from 772950 E 2141955 N	4-E	DN/Z-4/G-11/1	0	1	1	Quartzofeldspathic Graphite gneiss	0.826	3.3	80.79	0.264	15.65
82				DN/Z-4/G-11/2	1	2	1	Quartzofeldspathic Graphite gneiss	0.608	3.14	83.57	0.17	13.12
83				DN/Z-4/G-11/3	2.6	3.2	0.6	Quartzofeldspathic Graphite gneiss	0.676	3.19	81.51	0.186	15.11
84				DN/Z-4/G-11/4	4	5	1	Quartzofeldspathic Graphite gneiss	0.66	2.2	80.54	0.219	17.04

Annexure II: Analysis report of 66 trench and pit samples (PTS)

SL NO	GRAPHITE ZONE	LOCATION	BAND	SAMPLE ID	FROM	TO	LENGTH (m)	LITHOLOGY	MOISTURE (%)	VM (%)	ASH (%)	S (%)	FC (%)
1	ZONE-1 (South of Pichuligurha Village)	Along 250° from 770295 E 2141825 N	1-J	DN/Z-1/T-1/1	0	1	1	Quartzofeldspathic graphite gneiss	1.722	3.57	86.71	0.007	9.71
2				DN/Z-1/T-1/2	1	2	1	Quartzofeldspathic graphite gneiss	1.701	3.36	86.68	0.004	9.96
3				DN/Z-1/T-1/3	2	3	1	Quartzofeldspathic graphite gneiss	1.74	3.31	86.74	0.01	9.94
4			1-I	DN/Z-1/T-1/4	4	5	1	Quartzofeldspathic graphite gneiss	1.71	3.38	86.66	0.004	9.96
5				DN/Z-1/T-1/5	5	6	1	Quartzofeldspathic graphite gneiss	1.704	3.25	86.63	0.005	10.12
6				DN/Z-1/T-1/6	6	7	1	Quartzofeldspathic graphite gneiss	1.707	3.26	86.72	0.007	10.01
7				DN/Z-1/T-1/7	7	8	1	Quartzofeldspathic graphite gneiss	1.669	3.49	86.67	0.008	9.83
8				DN/Z-1/T-1/8	8	9	1	Quartzofeldspathic graphite gneiss	1.696	3.2	86.66	0.007	10.13
9			1-H	DN/Z-1/T-1/9	13	14	1	Quartzofeldspathic graphite gneiss	1.654	3.43	86.64	0.007	9.92
10			1-G	DN/Z-1/T-1/10	17	18	1	Quartzofeldspathic graphite gneiss	1.686	3.26	86.7	0.007	10.03
11				DN/Z-1/T-1/11	18	19	1	Quartzofeldspathic graphite gneiss	1.648	3.6	86.61	0.007	9.78
12				DN/Z-1/T-1/12	19	20	1	Quartzofeldspathic graphite gneiss	1.664	3.29	86.65	0.005	10.06
13		Along 210° from 770510 E 2142006 N	1-C	DN/Z-1/T-3/1	2	3	1	Quartzofeldspathic graphite gneiss	2.705	4.73	89.37	0.144	5.76
14				DN/Z-1/T-3/2	3	4	1	Quartzofeldspathic graphite gneiss	2.438	4.44	89.24	0.113	6.21
15				DN/Z-1/T-3/3	4	5	1	Quartzofeldspathic graphite gneiss	2.103	3.63	88.95	0.076	7.34
16			1-B	DN/Z-1/T-3/4	6.5	7.5	1	Quartzofeldspathic graphite gneiss	1.296	2.44	87.74	0.012	9.81
17				DN/Z-1/T-3/5	7.5	8.5	1	Quartzofeldspathic graphite gneiss	1.185	2.42	86.95	0.01	10.62
18				DN/Z-1/T-3/6	9.5	10.5	1	Quartzofeldspathic graphite gneiss	1.114	2.32	86.15	0.005	11.52
19				DN/Z-1/T-3/7	10.5	11.2	0.7	Quartzofeldspathic graphite gneiss	1.557	2.92	87.26	0.261	9.56
20			1-A	DN/Z-1/T-3/8	14	15	1	Quartzofeldspathic graphite gneiss	1.463	3.02	87.26	0.023	9.7
21				DN/Z-1/T-3/9	15	16	1	Quartzofeldspathic graphite gneiss	1.473	2.9	87.38	0.049	9.67
22				DN/Z-1/T-3/10	16	17	1	Quartzofeldspathic graphite gneiss	1.718	3.37	87.85	0.079	8.7
23		Along 235° from 770651 E 2141826 N		DN/Z-1/T-6/1	5	6	1	Graphite bearing gneiss	1.755	3.86	93.17	0.008	2.96
24				DN/Z-1/T-6/2	6	7	1	Granitie Gneisss	1.754	3.67	95.74	0.005	0.59
25				DN/Z-1/T-6/3	7	8	1	Granitie Gneisss	1.85	3.98	95.94	0.008	0.07

26				DN/Z-1/T-6/4	8	9	1	Granitie Gneisss	1.782	3.5	96.03	0.005	0.47
27				DN/Z-1/T-6/5	9	10	1	Granitie Gneisss	1.724	3.64	94.84	0.007	1.51
28				DN/Z-1/T-6/6	16	17	1	Granitie Gneisss	1.731	3.78	95.61	0.005	0.61
29				DN/Z-1/T-6/7	17	18	1	Graphite bearing gneiss	1.722	4	93.79	0.008	2.2
30	**ZONE-3 (South of Bhaleri Village)**	**Along 220º from 771141 E 2141817 N**		DN/Z-3/T-2/1	0	1	1	Migmatised Gneiss	1.816	3.84	95.16	0.005	1
31				DN/Z-3/T-2/2	1	2	1	Migmatised Gneiss	1.783	3.89	95.14	0.007	0.96
32				DN/Z-3/T-2/3	2	3	1	Migmatised Gneiss	1.814	4.03	95.21	0.007	0.75
33				DN/Z-3/T-2/4	3	4	1	Migmatised Gneiss	1.782	4.02	95.18	0.008	0.79
34				DN/Z-3/T-2/5	10	11	1	Migmatised Gneiss	1.779	3.94	95.11	0.007	0.94
35				DN/Z-3/T-2/6	11	12	1	Migmatised Gneiss	1.786	3.84	95.18	0.005	0.97
36		**Along 220º from 771313 E 2141699 N**		DN/Z-3/T-7/1	0	1	1	Granite Gneisss	1.695	3.69	94.37	0.012	1.93
37			**3-D**	DN/Z-3/T-7/2	1	2	1	Graphite bearing gneiss	1.712	3.88	93.57	0.01	2.54
38				DN/Z-3/T-7/3	2	3	1	Graphite bearing gneiss	1.774	3.77	93.81	0.005	2.42
39				DN/Z-3/T-7/4	3	4	1	Granite Gneisss	1.774	3.68	95.18	0.01	1.13
40			**3-C**	DN/Z-3/T-7/5	4	5	1	Graphite bearing gneiss	1.775	3.87	93.22	0.014	2.9
41				DN/Z-3/T-7/6	5	6	1	Graphite bearing gneiss	1.777	3.68	92.75	0.008	3.56
42				DN/Z-3/T-7/7	6	7	1	Graphite bearing gneiss	1.672	3.57	92.48	0.007	3.94
43				DN/Z-3/T-7/8	15	16	1	Migmatised Gneiss	2.844	3.49	96.34	0.01	0.16
44				DN/Z-3/T-7/9	16	17	1	Migmatised Gneiss	2.775	3.47	96.23	0.003	0.3
45				DN/Z-3/T-7/10	17	18	1	Migmatised Gneiss	2.891	3.43	95.51	0.012	1.05
46				DN/Z-3/T-7/11	18	19	1	Migmatised Gneiss	2.747	3.83	95.29	0.01	0.87
47	**ZONE-4 (South west of Dhuanbarhi Village)**	**Along 235º from 772873 E 2142152 N**	**4-C**	DN/Z-4/T-4/1	3	4	1	Quartzofeldspathic graphite gneiss	1.807	2.66	87.25	0.01	10.08
48				DN/Z-4/T-4/2	4	5	1	Graphite bearing gneiss	1.72	3.43	93.03	0.011	3.53
49				DN/Z-4/T-4/3	5	6	1	Graphite bearing gneiss	1.811	3.42	92.17	0.005	4.4
50				DN/Z-4/T-4/4	6	7	1	Graphite bearing gneiss	1.759	3.25	92.38	0.01	4.36
51			**4-A**	DN/Z-4/T-4/5	16	17	1	Graphite bearing gneiss	1.72	3.54	93.01	0.012	3.44
52				DN/Z-4/T-4/6	17	18	1	Graphite bearing gneiss	1.75	3.7	93.82	0.007	2.47
53				DN/Z-4/T-4/7	18	19	1	Graphite bearing gneiss	1.692	3.33	93.95	0.01	2.71
54				DN/Z-4/T-4/8	19	20	1	Granite Gneiss	1.794	3.67	96.17	0.005	0.16

55		**Along 245º from 772912 E 2142038 N**		DN/Z-4/T-5/1	4	5	1	Khondalite	1.636	3.86	95.8	0.007	0.33
56				DN/Z-4/T-5/2	5	6	1	Khondalite	1.672	4.1	94.96	0.008	0.93
57				DN/Z-4/T-5/3	8	9	1	Graphite bearing khondalite	1.642	4	93.5	0.023	2.48
58				DN/Z-4/T-5/4	9	10	1	Khondalite	1.668	3.99	94.88	0.004	1.13
59				DN/Z-4/T-5/5	10	11	1	Khondalite	1.689	3.96	95.78	0.005	0.26
60				DN/Z-4/T-5/6	11	12	1	Khondalite	1.686	3.73	94.89	0.01	1.37
61	**ZONE-1 (South of Pichuligurha Village)**	**At location 770546 E 2141937 N**	**1-B**	DN/Z-1/P-1/1	0	1	1	Graphite bearing gneiss	0.925	2.36	94.68	0.005	2.96
62				DN/Z-1/P-1/2	1	2	1	Graphite bearing gneiss	0.668	1.67	94.94	0.008	3.38
63	**ZONE-3 (South of Bhaleri Village)**	**At location 771235 E 2141743 N**	**3-B**	DN/Z-3/P-3/1	0	1	1	Quartzofeldspathic graphite gneiss	1.081	2.45	90.8	0.01	6.74
64				DN/Z-3/P-3/2	1	1.5	0.5	Quartzofeldspathic graphite gneiss	1.169	2.21	88.73	0.012	9.05
65	**ZONE-4 (South west of Dhuanbarhi Village)**	**At location 772944 E 2142027 N**	**4-C**	DN/Z-4/P-4/1	0	1	1	Quartzofeldspathic graphite gneiss	0.936	2.12	88.64	0.005	9.23
66				DN/Z-4/P-4/2	1	2	1	Quartzofeldspathic graphite gneiss	1.02	1.88	87.81	0.008	10.3

ANNEXURE III : Summarized litholog sheet of ORDN-1

BOREHOLE NO. - ORDN-1	DATE OF COMMENCEMENT : 22.01.2026
LATITUDE - 19°21' 12.605" N	DATE OF COMPLETION: 01.02.2026
LONGITUDE - 83°34' 28.858" E	COLLAR LEVEL - 426 m
INCLINATION - 45°	AZIMUTH - N55E

DEPTH FROM (m)	DEPTH TO (m)	TOTAL RUN LENGTH (m)	TOTAL CORE RECOVERY (m)	RECOVERY PERCENTAGE (%)	CORE RECOVERY OF LITHO-UNITS (m)	EXTRAPOLATED THICKNESS (m)	LITHOLOGY	CORE SIZE	DESCRIPTION	RQD %
0	1	1	1	100	1	1	Top Soil	HQ	Loose brownish yellow soil	0
1	2	1	1	100	1	1	Top Soil	HQ	Loose brownish yellow soil	0
2	3	1	1	100	1	1	Top Soil	HQ	Loose brownish yellow soil	0
3	4.5	1.5	1.15	77	1.15	1.5	Weathered mantle/mud	HQ	Brownish colour mud with fragments of granitic gneiss	0
4.5	6	1.5	1.07	71	1.07	1.5	Weathered mantle/mud	HQ	Brownish in colour with fragments of granite gneiss and minor flakes of graphite	0
6	7.5	1.5	0.82	55	0.82	1.5	Weathered mantle/mud	HQ	Brownish in colour with fragments of granite gneiss and minor flakes of graphite	0
7.5	9	1.5	0.92	61	0.92	1.5	Mud	HQ	Brownish colour mud	0
9	10.5	1.5	0.86	57	0.86	1.5	Weathered mantle	HQ	Greyish brown in colour with fragments of granite gneiss and minor flakes of graphite	0
10.5	12	1.5	1	67	1	1.5	Weathered mantle	HQ	Greyish brown in colour with fragments of quartz	0
12	13.5	1.5	1.5	100	1	1	Weathered mantle	HQ	Greyish brown in colour with fragments of granite gneiss	28.6
					0.5	0.5	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour	
13.5	15	1.5	1.47	98	1.47	1.5	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Broken and fragmented in nature.	50
15	16.5	1.5	1.41	94	1.41	1.5	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Less amount of fragmentation and broken pieces.	46

16.5	**18**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Less amount of fragmentation and broken pieces.	**62.7**
18	**19.5**	**1.5**	**1.32**	**88**	**1.32**	**1.5**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Less amount of fragmentation and broken pieces.	**46**
19.5	**21**	**1.5**	**0.65**	**43**	**0.65**	**1.5**	Highly Weathered mantle	HQ	Brownish colour mud with fragments of granitic gneiss and khondalite. Likely litho contact between Granite gneiss and Khondalite	**0**
21	**22.5**	**1.5**	**1.1**	**73**	**1.1**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured with trace of graphite in foliation planes	**34.6**
22.5	**24**	**1.5**	**1.35**	**90**	**1.35**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured with trace of graphite in foliation planes (minor quartz veins)	**45.3**
24	**25.5**	**1.5**	**1.39**	**93**	**1.39**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation planes (minor quartz veins)	**73.3**
25.5	**27**	**1.5**	**1.1**	**73**	**0.5**	**0.8**	Khondalite	HQ	Reddish white in colour having a fragmented appearance	**33.3**
					0.6	**0.7**	Weathered mantle	HQ	Highly weathered dusty friable loose materials	
27	**28.5**	**1.5**	**1.14**	**76**	**0.23**	**0.3**	Weathered mantle	HQ	Highly weathered dusty friable loose materials	**47.3**
					0.91	**1.2**	Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation planes	
28.5	**30**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (plenty of micaceous minerals present)	**92**
30	**31.5**	**1.5**	**1.47**	**98**	**1.47**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with one major fracture plane with mud filling	**95**
31.5	**33**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (plenty of micaceous minerals present)	**90**
33	**34.5**	**1.5**	**1.44**	**96**	**1.44**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour, highly fractured with minor trace of graphite in foliation planes	**58.6**
34.5	**36**	**1.5**	**1.46**	**97**	**1.46**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (plenty of micaceous minerals present)	**71.3**

36	**37.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Highly fractured rock with alteration along foliation plane (micaceous mineral present). At the end of the run minor traces of graphite observed. A major fractured plane filled with mud.	**33**
37.5	**39**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Highly fractured rock with carbonate alteration along fracture planes (minor traces of graphite)	**69**
39	**40.5**	**1.5**	**1.5**	**100**	**0.75**	**0.75**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation planes	**52**
					0.75	**0.75**	Migmatised Khondalite with graphite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (plenty of micaceous minerals present) along with presence of graphite.	
40.5	**43.5**	**3**	**2.9**	**97**	**0.72**	**0.72**	Migmatised Khondalite with graphite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (plenty of micaceous minerals present) along with presence of graphite.	**92.6**
					1.78	**1.8**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Broken and fragmented in nature. Carbonate veins present.	
					0.4	**0.48**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (plenty of micaceous minerals present)	
43.5	**46.5**	**3**	**2.98**	**99**	**2.98**	**3**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation plane. Sulphide mineralisation observed (pyrite/chalcopyrite). Greenish alteration along foliation plane	**92.3**
46.5	**49.5**	**3**	**2.95**	**98**	**2.1**	**2.15**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation planes with secondary carbonate veins along with greenish alteration	**85**
					0.85	**0.85**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	
49.5	**50**	**0.5**	**0.5**	**100**	**0.5**	**0.5**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers. Greenish alteration observed	**100**

50	**52.5**	**2.5**	**2.5**	**100**	**2**	**2**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers. Greenish alteration observed	**99**
					0.5	**0.5**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation plane. Sulphide mineralisation observed (pyrite/chalcopyrite). Greenish alteration along foliation plane	
52.5	**55**	**2.5**	**2.5**	**100**	**2.5**	**2.5**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with minor trace of graphite in foliation plane. Sulphide mineralisation observed (pyrite/chalcopyrite). Greenish alteration along foliation plane	**100**
55	**58**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with trace of graphite in foliation plane (slightly higher concentration of graphite flakes/graphite associated with garnet rich bands). Sulphide mineralisation observed (pyrite/chalcopyrite). Greenish alteration along foliation plane	**95.5**
58	**60**	**2**	**2**	**100**	**0.4**	**0.4**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with trace of graphite in foliation plane (slightly higher concentration of graphite flakes/graphite associated with garnet rich bands). Sulphide mineralisation observed (pyrite/chalcopyrite). Greenish alteration along foliation plane	**96**
					1.6	**1.6**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	
60	**63**	**3**	**2.9**	**97**	**2.9**	**3**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	**95**
63	**65**	**2**	**2**	**100**	**0.86**	**0.86**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	**100**
		0			**0.9**	**0.9**	Migmatised granite gneiss	HQ	Granite gneiss showing evidence of migmatization (minor trace of graphite)	

		0			**0.24**	**0.24**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with trace of graphite in foliation plane (slightly higher concentration of graphite flakes/graphite associated with garnet rich bands).	
65	**67**	**2**	**1.9**	**95**	**0.57**	**0.57**	Migmatised Khondalite	HQ	Reddish white in colour, fractured with trace of graphite in foliation plane (slightly higher concentration of graphite flakes/graphite associated with garnet rich bands).	**100**
					0.58	**0.58**	Quartzo feldspathic graphite gneiss	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	
					0.65	**0.75**	Migmatised granite gneiss	HQ	Granite gneiss showing evidence of migmatization(minor trace of graphite)	
					0.1	**0.1**	Quartzo feldspathic graphite gneiss	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	
67	**70**	**3**	**3**	**100**	**0.65**	**0.65**	Quartzo feldspathic graphite gneiss	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	**98**
					0.86	**0.86**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
					1.34	**1.34**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite associated with the graphite rich layers	
					0.15	**0.15**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
70	**72**	**2**	**2**	**100**	**0.8**	**0.8**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**
					1.2	**1.2**	Migmatised granite gneiss	HQ	Granite gneiss showing evidence of migmatization	**100**
THE BOREHOLE WAS CLOSED ON 01.02.2026 AT 72 M RUN IN MIGMATISED GRANITE GNEISS										

ANNEXURE IV : Summarized litholog sheet of ORDN-2

BOREHOLE NO. - ORDN-2							DATE OF COMMENCEMENT : 02.02.2026			
LATITUDE - 19°21' 11.396" N							DATE OF COMPLETION: 08.02.2026			
LONGITUDE - 83°34' 23.644" E							COLLAR LEVEL - 448 m			
INCLINATION - 55°							AZIMUTH - N55E			
DEPTH FROM (m)	**DEPTH TO (m)**	**TOTAL RUN LENGTH (m)**	**TOTAL CORE RECOVERY (m)**	**RECOVERY PERCENTAGE (%)**	**CORE RECOVERY OF LITHO-UNITS (m)**	**EXTRAPOLATED THICKNESS (m)**	**LITHOLOGY**	**CORE SIZE**	**DESCRIPTION**	**RQD %**
0	**1**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose greyish brown soil	**0**
1	**2**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose greyish brown soil	**0**
2	**3**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose greyish brown soil	**0**
3	**4**	**1**	**1**	**100**	**1**	**1**	Weathered mantle with top soil	HQ	Brownish in colour with broken fragments of granite gneiss and minor flakes of graphite	**0**
4	**5**	**1**	**1**	**100**	**0.28**	**0.28**	Weathered mantle	HQ	Brownish in colour with broken fragments of granite gneiss and minor flakes of graphite	**97**
					0.72	**0.72**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes). Numerous secondary vein networks present	
5	**6.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (trace of graphite flakes). Numerous secondary vein networks present	**45**
6.5	**8**	**1.5**	**1.35**	**90**	**1.06**	**1.1**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes). Numerous secondary vein networks present	**92**
					0.29	**0.4**	Weathered mantle	HQ	Brownish in colour with small broken fragments of khondalite and minor flakes of graphite	
8	**9.5**	**1.5**	**1.25**	**83**	**0.32**	**0.55**	Weathered mantle	HQ	Brownish in colour with small broken fragments of khondalite and minor flakes of graphite	**62**

					0.93	**0.95**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (trace of graphite flakes). Numerous secondary vein networks present	
9.5	**11**	**1.5**	**1.35**	**90**	**1.35**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes). Numerous secondary vein networks present. 15cm of highly weathered mantle/mud present	**77.3**
11	**14**	**3**	**2.95**	**98**	**2.25**	**2.3**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes). Numerous secondary vein networks present. Specks of pyrite at the end of run.	**100**
					0.7	**0.7**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	
14	**17**	**3**	**3**	**100**	**0.5**	**0.5**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	**100**
					0.5	**0.5**	Graphite bearing Khondalite	HQ	Reddish white in colour, fractured with graphite rich quartzo-feldspathic patch and graphite flakes in foliation plane.	
					1.8	**1.8**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	
					0.2	**0.2**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present.	
17	**20**	**3**	**3**	**100**	**3**	**3**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands associated with graphite rich bands (5 to 8 bands each approx. 2cm to 5cm wide). Pyrite mineralisation observed	**95.3**
20	**23**	**3**	**3**	**100**	**0.45**	**0.45**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich areas are graphite rich as well but not segregated into bands. Trace of graphite.	**97**
					2.25	**2.25**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane with micaceous minerals. Specks of pyrite observed	
					0.3	**0.3**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present.	

23	**26**	**3**	**3**	**100**	**0.57**	**0.57**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present. Specks of pyrite observed	**100**
					0.9	**0.9**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	
					1.53	**1.53**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present. Specks of pyrite observed	
26	**29**	**3**	**3**	**100**	**1.57**	**1.57**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present. Specks of pyrite observed	**100**
					1.43	**1.43**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Minor trace of graphite flakes. Specks of pyrite observed	
29	**32**	**3**	**3**	**100**	**0.8**	**0.8**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Large amount of pyrite is observed	**100**
					1.05	**1.05**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present. Large amount of pyrite is observed	
					1.15	**1.15**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals.	
32	**35**	**3**	**3**	**100**	**1.95**	**1.95**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present. Large amount of pyrite is observed	**100**
					1.05	**1.05**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with large amount of black coloured micaceous mineral possibly biotite forming a thick band. Large amount of pyrite is observed	
35	**38**	**3**	**2.98**	**99**	**2.98**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Large amount of pyrite is observed	**100**

38	**41**	**3**	**3**	**100**	**2.28**	**2.28**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet rich bands with micaceous minerals present. Minor trace of graphite present. Specks of pyrite observed	**100**
					0.72	**0.72**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Trace of graphite flakes associated with the garnet rich bands. Specks of pyrite observed	
41	**44**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Trace of graphite flakes associated with the garnet rich bands. Specks of pyrite observed. Greenish alteration observed	**100**
44	**47**	**3**	**2.97**	**99**	**2.97**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Trace of graphite flakes increasing. Specks of pyrite observed. Greenish alteration observed along the fractured and fragmented planes	**100**
47	**50**	**3**	**3**	**100**	**1.9**	**1.9**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with minor occurrence of micaceous minerals. Trace of graphite flakes associated with the garnet rich bands. Specks of pyrite increasing. Greenish alteration observed along the fractured and fragmented planes	**100**
					1.1	**1.1**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	
50	**53**	**3**	**3**	**100**	**3**	**3**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	**100**
53	**56**	**3**	**2.95**	**98**	**2.95**	**3**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	**100**
56	**59**	**3**	**2.95**	**98**	**0.65**	**0.65**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	**100**

					2.3	**2.35**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with trace of graphite in foliation planes (minor quartz veins). Graphite associated with garnet rich bands. Specks of pyrite present.	
59	**60**	**1**	**1**	**100**	**1**	**1**	Migmatised Khondalite	HQ	Reddish white in colour with garnet rich bands along with increasing occurrence of micaceous minerals. Trace of graphite flakes. Specks of pyrite observed	**100**
60	**62**	**2**	**2**	**100**	**2**	**2**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**100**
THE BOREHOLE WAS CLOSED ON 08.02.2026 AT 62 M RUN IN CHARNOCKITE										

ANNEXURE V : Summarized litholog sheet of ORDN-3

BOREHOLE NO. - ORDN-3	**DATE OF COMMENCEMENT : 10.02.2026**
LATITUDE - 19°21' 6.692" N	**DATE OF COMPLETION: 16.02.2026**
LONGITUDE - 83°34' 22.335" E	**COLLAR LEVEL - 452 m**
INCLINATION - 45°	**AZIMUTH - N45E**

DEPTH FROM (m)	DEPTH TO (m)	TOTAL RUN LENGTH (m)	TOTAL CORE RECOVERY (m)	RECOVERY PERCENTAGE (%)	CORE RECOVERY OF LITHO-UNITS (m)	EXTRAPOLATED THICKNESS (m)	LITHOLOGY	CORE SIZE	DESCRIPTION	RQD %
0	**1**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose brown soil	**0**
1	**2**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose brown soil	**0**
2	**3**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose brown soil	**0**
3	**4.5**	**1.5**	**1.2**	**80**	**0.35**	**0.5**	Top Soil	HQ	Loose brown soil	**0**
					0.85	**1**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Khondalite and minor flakes of graphite	

4.5	**6**	**1.5**	**1.3**	**87**	**1.3**	**1.5**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Khondalite and minor flakes of graphite	**0**
6	**7.5**	**1.5**	**1.47**	**98**	**1.2**	**1.2**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Khondalite and minor flakes of graphite	**14.66**
					0.27	**0.3**	Khondalite	HQ	Reddish white in colour, fractured with presence of graphite in foliation planes. Numerous secondary vein networks present	
7.5	**9**	**1.5**	**1.43**	**95**	**1.43**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured with presence of graphite in foliation planes. Numerous secondary vein networks present	**30.66**
9	**10.5**	**1.5**	**1.05**	**70**	**0.86**	**0.9**	Khondalite	HQ	Reddish white in colour, fractured with presence of graphite in foliation planes. Numerous secondary vein networks present	**48.66**
					0.19	**0.6**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Khondalite and minor flakes of graphite	
10.5	**12**	**1.5**	**1.4**	**93**	**0.25**	**0.3**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Khondalite and minor flakes of graphite	**78**
					0.95	**1**	Khondalite	HQ	Reddish white in colour, fractured with graphite in foliation planes. Numerous secondary vein networks present	
					0.2	**0.2**	**Graphite bearing Gneiss**	HQ	Coarse grained, brownish in colour with graphite in foliation planes. Fractured appearance with specks of pyrite	
12	**13.5**	**1.5**	**1.38**	**92**	**1.38**	**1.5**	**Graphite bearing Gneiss**	HQ	Coarse grained, brownish in colour with graphite in foliation planes. Fractured appearance with specks of pyrite	**100**
13.5	**15**	**1.5**	**1.5**	**100**	**0.75**	**0.75**	**Graphite bearing Gneiss**	HQ	Coarse grained, brownish in colour with graphite in foliation planes. Fractured appearance with specks of pyrite	**47.33**
					0.75	**0.75**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Fractured appearance	
15	**16.5**	**1.5**	**1.48**	**99**	**0.48**	**0.5**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Fractured appearance	**83.33**
					1	**1**	**Graphite bearing Gneiss**	HQ	Coarse grained, brownish in colour with graphite in foliation planes. Fractured appearance with specks of pyrite	

16.5	**18**	**1.5**	**1.5**	**100**	**0.15**	**0.15**	**Graphite bearing Gneiss**	HQ	Coarse grained, brownish in colour with graphite in foliation planes. Fractured appearance with specks of pyrite	**88.66**
					1.2	**1.2**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Fractured appearance with minor flakes of graphite and calcite vein networks	
					0.15	**0.15**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Khondalite and appreciable amount of flakes of graphite	
18	**19.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Fractured appearance with specks of pyrite and disseminated flakes of graphite	**100**
19.5	**21**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Garnetiferous Quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	**100**
21	**22.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Garnetiferous Quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size) with minor flakes of graphite in the last 10cm	**100**
22.5	**24**	**1.5**	**1.45**	**97**	**1.47**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes). Specks of pyrite observed	**100**
24	**25.5**	**1.5**	**1.5**	**100**	**1.45**	**1.45**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes). Specks of pyrite observed	**100**
					0.05	**0.05**	**Graphite bearing Khondalite**	HQ	Reddish white in colour, fractured with graphite in foliation planes. Pyrite mineralisation observed	
25.5	**27**	**1.5**	**1.5**	**100**	**0.55**	**0.55**	**Graphite bearing Khondalite**	HQ	Reddish white in colour, fractured with graphite in foliation planes. Pyrite mineralisation observed	**100**
					0.95	**0.95**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	
27	**28.5**	**1.5**	**1.5**	**100**	**0.2**	**0.2**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane. Calcite veins present	**100**
					1.1	**1.1**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	

					0.2	**0.2**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour.	
28.5	**30**	**1.5**	**1.47**	**98**	**0.55**	**0.55**	Granite gneiss	HQ	Greyish colour, coarse grained with intermittent gneissic banding. Garnets present are pinkish in colour. Fractured with calcite veins	**100**
					0.92	**0.95**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals and calcite veins	
30	**31.5**	**1.5**	**1.48**	**99**	**0.2**	**0.2**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals and calcite veins	**100**
					1.15	**1.15**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	
					0.13	**0.15**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	
31.5	**34.5**	**3**	**3**	**100**	**3**	**3**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance.	**100**
34.5	**37.5**	**3**	**3**	**100**	**0.6**	**0.6**	Garnetiferous Quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	**100**
					2.4	**2.4**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	
37.5	**40.5**	**3**	**3**	**100**	**1.25**	**1.25**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	**100**
					0.6	**0.6**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	
					1.15	**1.15**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	
40.5	**43.5**	**3**	**3**	**100**	**2.5**	**2.5**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	**100**
					0.5	**0.5**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	
43.5	**46.5**	**3**	**3**	**100**	**1.5**	**1.5**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**100**

					1	**1**	Graphite bearing Khondalite	HQ	Reddish white in colour, fractured with graphite in foliation planes. Pyrite mineralisation observed	
					0.5	**0.5**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	
46.5	**49.5**	**3**	**3**	**100**	**0.28**	**0.28**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**100**
					1.42	**1.42**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	
					1.3	**1.3**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite specks observed	
49.5	**52.5**	**3**	**3**	**100**	**1.4**	**1.4**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite specks observed	**100**
					0.7	**0.7**	**Migmatised Khondalite with graphite**	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	
					0.9	**0.9**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite specks observed	
52.5	**55.5**	**3**	**3**	**100**	**2.3**	**2.3**	**Quartzo feldspathic graphite gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite specks observed	**100**
					0.7	**0.7**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	
55.5	**58.5**	**3**	**3**	**100**	**0.25**	**0.25**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**100**
					1.45	**1.45**	Garnetiferous Quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	
					1.3	**1.3**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	

58.5	**60**	**1.5**	**1.5**	**100**	**0.45**	**0.45**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**100**
					0.55	**0.55**	Garnetiferous Quartzite	HQ	Medium grained colourless rock containing pinkish garnet (larger in size)	
					0.5	**0.5**	Quartzo feldspathic graphite gneiss	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite specks observed	
60	**63**	**3**	**3**	**100**	**0.15**	**0.15**	Quartzo feldspathic graphite gneiss	HQ	Greyish white coloured rock where the gneissosity is defined by graphite rich layers alternating with quartz-feldspar rich layer. Overall the lithounit has a migmatised appearance. Pyrite specks observed	**100**
					2.85	**2.85**	Migmatised Khondalite	HQ	Reddish white in colour (minor trace of graphite flakes). Specks of pyrite observed	
THE BOREHOLE WAS CLOSED ON 16.02.2026 AT 63 M RUN IN MIGMATISED KHONDALITE										

ANNEXURE VI : Summarized litholog sheet of ORDN-4

BOREHOLE NO. - ORDN-4	**DATE OF COMMENCEMENT : 17.02.2026**
LATITUDE - 19°21' 4.743" N	**DATE OF COMPLETION: 21.02.2026**
LONGITUDE - 83°34' 53.307" E	**COLLAR LEVEL - 431 m**
INCLINATION - 45°	**AZIMUTH - N35E**

DEPTH FROM (m)	DEPTH TO (m)	TOTAL RUN LENGTH (m)	TOTAL CORE RECOVERY (m)	RECOVERY PERCENTAGE (%)	CORE RECOVERY OF LITHO-UNITS (m)	EXTRAPOLATED THICKNESS (m)	LITHOLOGY	CORE SIZE	DESCRIPTION	RQD %
0	**1**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose reddish brown soil	**0**
1	**2**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose reddish brown soil	**0**
2	**3**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose reddish brown soil	**0**

3	**4**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose reddish brown soil with few broken fragments of Granite gneiss having minor flakes of graphite	**0**
4	**5**	**1**	**1**	**100**	**1**	**1**	Weathered Mantle with mud	HQ	Greyish-brown in colour with broken fragments of Granite gneiss	**0**
5	**6**	**1**	**1**	**100**	**1**	**1**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of Granite gneiss	**0**
6	**7.2**	**1.2**	**1.18**	**98**	**0.75**	**0.75**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of weathered Khondalite	**21.33**
					0.43	**0.45**	Weathered Khondalite	HQ	Reddish brown in colour, weathered, fractured with graphite in foliation planes.	
7.2	**8.2**	**1**	**1**	**100**	**0.3**	**0.3**	Weathered Mantle	HQ	Greyish-brown in colour with broken fragments of weathered Khondalite	**44.66**
					0.7	**0.7**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes)	
8.2	**9.2**	**1**	**0.85**	**85**	**0.85**	**1**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (trace of graphite flakes)	
9.2	**10.7**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (trace of graphite flakes). Calcite veins are also observed	
10.7	**13.7**	**3**	**2.98**	**99**	**0.25**	**0.25**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes)	
					0.7	**0.7**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
					0.5	**0.5**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane with opaque minerals	
					1.53	**1.55**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
13.7	**16.7**	**3**	**2.95**	**98**	**0.75**	**0.75**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
					1.05	**1.05**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Calcite veins are observed, extensive greenish alteration and specks of pyrite	
					0.8	**0.8**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	

					0.35	**0.4**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
16.7	**19.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
19.7	**22.7**	**3**	**2.95**	**98**	**2.95**	**3**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Greenish alteration seen. Overall the lithounit has a migmatised appearance.	
22.7	**25.7**	**3**	**2.9**	**97**	**1.3**	**1.3**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Greenish alteration seen. Overall the lithounit has a migmatised appearance.	
					0.65	**0.65**	Migmatised Gneiss	HQ	Granite gneiss showing evidence of migmatization with trace of graphite concentration and garnet rich bands	
					0.4	**0.4**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
					0.55	**0.65**	Migmatised Gneiss	HQ	Granite gneiss showing evidence of migmatization with trace of graphite concentration and garnet rich bands	
25.7	**28.7**	**3**	**2.95**	**98**	**1.05**	**1.05**	Migmatised Gneiss	HQ	Granite gneiss showing evidence of migmatization with trace of graphite concentration, garnet rich bands and opaque rich bands	
					1.4	**1.4**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance and a reddish alteration	
					0.5	**0.55**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet and micaceous minerals present.	
28.7	**31.7**	**3**	**2.8**	**93**	**2.8**	**3**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet and micaceous minerals present.	**94.33**
31.7	**34.7**	**3**	**2.8**	**93**	**1.5**	**1.5**	Leptynite	HQ	Whitish in colour medium to coarse grained rock containing blebs of stretched quartz. Garnet and micaceous minerals present.	**82.66**

					1.3	**1.5**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
34.7	**37.7**	**3**	**2.9**	**97**	**2.9**	**3**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**
37.7	**40.7**	**3**	**2.85**	**95**	**2.85**	**3**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**
40.7	**43.7**	**3**	**2.85**	**95**	**0.8**	**0.9**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance alteration along the foliation plane (minor trace of graphite flakes)	**100**
					1.95	**2**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with minor quartz veins. Graphite rich layers are occurring as bands of 20 to 40 cm width. Quartz are larger in size with a smoky appearance. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
					0.1	**0.1**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Graphite rich layers are occurring as bands of 20 to 40 cm width. Quartz are larger in size with a smoky appearance. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
43.7	**46.7**	**3**	**2.88**	**96**	**1.57**	**1.6**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Graphite rich layers are occurring as bands of 20 to 40 cm width. Quartz are larger in size with a smoky appearance. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	**100**
					1.31	**1.4**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
46.7	**49.7**	**3**	**2.97**	**99**	**2.97**	**3**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**
49.7	**52.7**	**3**	**2.9**	**97**	**0.2**	**0.2**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**
					0.65	**0.65**	Migmatised Khondalite	HQ	Reddish white in colour with a fractured appearance micaceous alteration along the foliation plane	
					2.05	**2.15**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	
52.7	**55.7**	**3**	**3**	**100**	**3**	**3**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**
55.7	**58.7**	**3**	**3**	**100**	**0.7**	**0.7**	Garnetiferous quartzite	HQ	Medium grained colourless rock containing pinkish garnet	**100**

					2.3	2.3	Migmatised Khondalite	HQ	Reddish white in colour with micaceous alteration along the foliation plane along with a lot of pyrite mineralisation and few pyrite rich veins	
58.7	**60**	**1.3**	**1.3**	**100**	**1.3**	**1.3**	Migmatised Khondalite	HQ	Reddish white in colour with micaceous alteration along the foliation plane along with a lot of pyrite mineralisation and few pyrite rich veins	**100**
THE BOREHOLE WAS CLOSED ON 21.02.2026 AT 60 M RUN IN MIGMATISED KHONDALITE										

ANNEXURE VII : Summarized litholog sheet of ORDN-5

BOREHOLE NO. - ORDN-5	**DATE OF COMMENCEMENT : 22.02.2026**
LATITUDE - 19°21' 7.943" N	**DATE OF COMPLETION: 27.02.2026**
LONGITUDE - 83°34' 52.174" E	**COLLAR LEVEL - 439 m**
INCLINATION - 45°	**AZIMUTH - N35E**

DEPTH FROM (m)	DEPTH TO (m)	TOTAL RUN LENGTH (m)	TOTAL CORE RECOVERY (m)	RECOVERY PERCENTAGE (%)	CORE RECOVERY OF LITHO-UNITS (m)	EXTRAPOLATED THICKNESS (m)	LITHOLOGY	CORE SIZE	DESCRIPTION	RQD %
0	**0.5**	**0.5**	**0.5**	**100**	**0.5**	**0.5**	Top Soil	HQ	Loose reddish brown soil	**0**
0.5	**2**	**1.5**	**1.4**	**93**	**0.15**	**0.25**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite	**67.33**
					1.25	**1.25**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	
2	**3.2**	**1.2**	**1.2**	**100**	**1.2**	**1.2**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**100**
3.2	**4.7**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**95**

4.7	**6.2**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**97.33**
6.2	**7.7**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**100**
7.7	**10.7**	**3**	**3**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**77**
					1.5	**1.5**	Granite Gneiss with Graphite	HQ	Greyish colour, coarse grained with intermittent gneissic banding along with trace of graphite in foliation planes	
10.7	**13.7**	**3**	**2.8**	**93**	**0.8**	**0.8**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**96.66**
					0.95	**0.95**	Granite Gneiss with Graphite	HQ	Greyish colour, coarse grained with intermittent gneissic banding along with trace of graphite in foliation planes	
					1.05	**1.25**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	
13.7	**16.7**	**3**	**3**	**100**	**1.45**	**1.45**	Granite Gneiss with Graphite	HQ	Greyish colour, coarse grained with intermittent gneissic banding along with trace of graphite in foliation planes	**100**
					1.55	**1.55**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	
16.7	**19.7**	**3**	**2.97**	**99**	**2.97**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	**100**
19.7	**22.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	**100**
22.7	**25.7**	**3**	**3**	**100**	**2.3**	**2.3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	**100**
					0.7	**0.7**	Granite Gneiss with Graphite	HQ	Greyish colour, coarse grained with intermittent gneissic banding along with trace of graphite in foliation planes	
25.7	**28.7**	**3**	**2.95**	**98**	**0.25**	**0.25**	Granite Gneiss with Graphite	HQ	Greyish colour, coarse grained with intermittent gneissic banding along with trace of graphite in foliation planes	**100**
					0.85	**0.85**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	

					1.85	**1.9**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
28.7	**31.7**	**3**	**3**	**100**	**0.85**	**0.85**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	**100**
					0.95	**0.95**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite. Well-developed large crystals of feldspar and pinkish garnet present	
					1	**1**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Specks of greenish-blue hue minerals also observed. Overall the lithounit has a migmatised appearance.	
					0.2	**0.2**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
31.7	**34.7**	**3**	**3**	**100**	**0.8**	**0.8**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	**100**
					0.95	**0.95**	**Migmatised Khondalite with graphite**	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite. Well-developed large crystals of purple smoky quartz	
					1.25	**1.25**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
34.7	**37.7**	**3**	**3**	**100**	**2**	**2**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	**100**

					1	**1**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	
37.7	**40.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	**100**
40.7	**43.7**	**3**	**3**	**100**	**0.6**	**0.6**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with a lot of pyrite	**100**
					2.4	**2.4**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
43.7	**46.7**	**3**	**2.95**	**98**	**0.65**	**0.65**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	**100**
					0.4	**0.4**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with a lot of pyrite	
					1.55	**1.55**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance.	
					0.35	**0.4**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (trace of graphite flakes) with a lot of pyrite	
46.7	**49.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance with yellowish-white alteration having a greasy feel. Quartz having greenish hue	**100**
49.7	**52.7**	**3**	**3**	**100**	**0.1**	**0.1**	Migmatised Gneiss with Graphite	HQ	Greyish white in colour, fractured with trace of graphite in foliation planes. Garnets are also present along with pyrite specks. Overall the lithounit has a migmatised appearance with yellowish-white alteration having a greasy feel. Quartz having greenish hue	**100**
					2.9	**2.9**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (trace of graphite flakes) with a lot of pyrite. Patches of smoky purple quartz with large grain size	

52.7	**55.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with specks of pyrite	**100**
55.7	**58.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (trace of graphite flakes) with a lot of pyrite	**100**
58.7	**61.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane (trace of graphite flakes) with a lot of pyrite. Quartz having greenish hue	**100**
61.7	**64.7**	**3**	**2.95**	**98**	**2.95**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane with specks of pyrite. Few graphite rich patches present	**100**
64.7	**67.7**	**3**	**3**	**100**	**3**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with a lot of pyrite	**100**
67.7	**70**	**2.3**	**2.25**	**98**	**2.25**	**2.3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes) with a lot of pyrite	**100**
THE BOREHOLE WAS CLOSED ON 27.02.2026 AT 70 M RUN IN MIGMATISED KHONDALITE										

ANNEXURE VIII : Summarized litholog sheet of ORDN-6

BOREHOLE NO. - ORDN-6							DATE OF COMMENCEMENT : 03.03.2026			
LATITUDE - 19°21' 13.993" N							DATE OF COMPLETION: 07.03.2026			
LONGITUDE - 83°35' 51.28" E							COLLAR LEVEL - 472 m			
INCLINATION - 45°							AZIMUTH - N60E			
DEPTH FROM (m)	**DEPTH TO (m)**	**TOTAL RUN LENGTH (m)**	**TOTAL CORE RECOVERY (m)**	**RECOVERY PERCENTAGE (%)**	**CORE RECOVERY OF LITHO-UNITS (m)**	**EXTRAPOLATED THICKNESS (m)**	**LITHOLOGY**	**CORE SIZE**	**DESCRIPTION**	**RQD %**
0	**0.5**	**0.5**	**0.5**	**100**	**0.5**	**0.5**	Top Soil	HQ	Loose reddish brown soil	**0**
0.5	**1.5**	**1**	**0.92**	**92**	**0.92**	**1**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**0**
1.5	**3**	**1.5**	**1.45**	**97**	**0.43**	**0.45**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**15.33**
					1.02	**1.05**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with trace of graphite in foliation plane	
3	**4.5**	**1.5**	**1.4**	**93**	**1.4**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with trace of graphite in foliation plane	**66**
4.5	**6**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with trace of graphite in foliation plane	**88**
6	**7.5**	**1.5**	**1.4**	**93**	**1.4**	**1.5**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**0**
7.5	**9**	**1.5**	**1.43**	**95**	**1.43**	**1.5**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**0**
9	**10.5**	**1.5**	**1.5**	**100**	**0.9**	**0.9**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**33.33**
					0.6	**0.6**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with trace of graphite in foliation plane	
10.5	**12**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with trace of graphite in foliation plane	**93.33**
12	**13.5**	**1.5**	**1.15**	**77**	**1.15**	**1.5**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**0**
13.5	**15**	**1.5**	**1.25**	**83**	**1.25**	**1.5**	Highly weathered Khondalite	HQ	Dark-brownish, highly weathered, fractured with trace of graphite in foliation plane	**36.66**

15	**16.5**	**1.5**	**1.2**	**80**	**1.2**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with trace of graphite in foliation plane	**51.33**
16.5	**18**	**1.5**	**1.27**	**85**	**0.65**	**0.65**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**38.66**
					0.62	**0.85**	Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	
18	**19.5**	**1.5**	**1.2**	**80**	**0.5**	**0.65**	Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite flakes)	**64.66**
					0.7	**0.85**	Weathered Khondalite	HQ	Dark-brownish, weathered, fractured with trace of graphite in foliation plane	
19.5	**21**	**1.5**	**1.25**	**83**	**1.25**	**1.5**	**Graphite bearing Weathered Mantle**	HQ	Dark-brownish, highly weathered, loose, with good concentration of graphite flakes	**0**
21	**22.5**	**1.5**	**1.2**	**80**	**1.2**	**1.5**	**Graphite bearing Weathered Mantle**	HQ	Dark-brownish, highly weathered, loose, with broken pieces of graphite bearing khondalite	**14.66**
22.5	**24**	**1.5**	**1.4**	**93**	**1.4**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**0**
24	**25.5**	**1.5**	**1.25**	**83**	**1.25**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**0**
25.5	**27**	**1.5**	**1.15**	**77**	**0.65**	**0.7**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**20.66**
					0.5	**0.8**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	
27	**28.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**33.33**
28.5	**30**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane. A certain alteration mineral having a soapy feel	**72.66**
30	**31.5**	**1.5**	**1.2**	**80**	**0.7**	**0.7**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**0**
					0.5	**0.8**	**Graphite bearing Weathered Khondalite**	HQ	Dark-brownish, highly weathered, loose, with good concentration of graphite flakes	
31.5	**33**	**1.5**	**1.3**	**87**	**1.3**	**1.5**	**Graphite bearing Khondalite**	HQ	Reddish white in colour, fractured with large flakes of graphite in foliation planes	**79.33**

33	**34.5**	**1.5**	**1.25**	**83**	**1.25**	**1.5**	**Graphite bearing Khondalite**	HQ	Reddish white in colour, fractured with large flakes of graphite in foliation planes (last 60cm highly broken and fractured)	**34.66**
34.5	**36**	**1.5**	**1.25**	**83**	**0.2**	**0.2**	**Graphite bearing Khondalite**	HQ	Reddish white in colour, fractured with graphite in foliation planes	**0**
					1.05	**1.3**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane and presence of secondary carbonate veins	
36	**37.5**	**1.5**	**1.45**	**97**	**0.8**	**0.8**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane and presence of secondary carbonate veins	**56.66**
					0.5	**0.5**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	
					0.15	**0.2**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane and presence of secondary carbonate veins	
37.5	**39**	**1.5**	**1.4**	**93**	**1.05**	**1.05**	Weathered Khondalite	HQ	Reddish-brown, weathered, highly fractured with minor trace of graphite in foliation plane and presence of secondary carbonate veins	**46.66**
					0.35	**0.45**	Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane (minor trace of graphite flakes)	
39	**40.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane (minor trace of graphite flakes)	**100**
40.5	**43.5**	**3**	**2.9**	**97**	**2.9**	**3**	Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane (minor trace of graphite flakes)	**100**
43.5	**46.5**	**3**	**2.9**	**97**	**2.9**	**3**	Migmatised Gneiss	HQ	Granite gneiss showing evidence of migmatization (minor trace of graphite)	**100**
46.5	**49.5**	**3**	**2.85**	**95**	**2.85**	**3**	Migmatised Gneiss	HQ	Granite gneiss showing evidence of migmatization (minor trace of graphite)	**100**
49.5	**52.5**	**3**	**3**	**100**	**3**	**3**	Migmatised Gneiss	HQ	Granite gneiss showing evidence of migmatization (minor trace of graphite)	**100**
52.5	**55.5**	**3**	**2.95**	**98**	**2.95**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane	**100**
55.5	**58.5**	**3**	**2.9**	**97**	**2.9**	**3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane	**100**
58.5	**61.5**	**3**	**3**	**100**	**1.2**	**1.2**	**Graphite bearing Khondalite**	HQ	Reddish white in colour, fractured with graphite in foliation planes	**100**

					1.8	**1.8**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane	**100**
61.5	**63**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
THE BOREHOLE WAS CLOSED ON 07.03.2026 AT 63 M RUN IN MIGMATISED KHONDALITE										

ANNEXURE IX : Summarized litholog sheet of ORDN-7

BOREHOLE NO. - ORDN-7							**DATE OF COMMENCEMENT : 08.03.2026**			
LATITUDE - 19°21' 19.377" N							**DATE OF COMPLETION: 12.03.2026**			
LONGITUDE - 83°35' 45.32" E							**COLLAR LEVEL - 473 m**			
INCLINATION - 45°							**AZIMUTH - N60E**			
DEPTH FROM (m)	**DEPTH TO (m)**	**TOTAL RUN LENGTH (m)**	**TOTAL CORE RECOVERY (m)**	**RECOVERY PERCENTAGE (%)**	**CORE RECOVERY OF LITHO-UNITS (m)**	**EXTRAPOLATED THICKNESS (m)**	**LITHOLOGY**	**CORE SIZE**	**DESCRIPTION**	**RQD %**
0	**1**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose reddish brown soil	**0**
1	**2**	**1**	**1**	**100**	**1**	**1**	Top Soil	HQ	Loose reddish brown soil	**0**
2	**3.5**	**1.5**	**1.42**	**95**	**1.42**	**1.5**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**0**
3.5	**5**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**45**
5	**6**	**1**	**1**	**100**	**1**	**1**	Weathered Mantle	HQ	Reddish-brown in colour with broken fragments of Khondalite with minor trace of graphite	**65**
6	**7.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**86.66**

7.5	**9**	**1.5**	**1.43**	**95**	**0.2**	**0.2**	**Weathered Khondalite with graphite**	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**80**
					1	**1**	**Graphite bearing weathered Khondalite**	HQ	Reddish white in colour, weathered, fractured with graphite in foliation planes	
					0.23	**0.3**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	
9	**10.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane	**81.33**
10.5	**12**	**1.5**	**1.48**	**99**	**1.48**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane along with greenish alteration and reddish streaks	**67.33**
12	**13.5**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**70.66**
13.5	**15**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**83.33**
15	**16.5**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**73.33**
16.5	**18**	**1.5**	**1.46**	**97**	**1.46**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**90**
18	**19.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**76.66**
19.5	**21**	**1.5**	**1.4**	**93**	**1.4**	**1.5**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane along with greenish alteration and reddish streaks	**50**
21	**22.5**	**1.5**	**1.42**	**95**	**0.55**	**0.6**	Weathered Khondalite	HQ	Reddish-brown, weathered, fractured with minor trace of graphite in foliation plane along with greenish alteration and reddish streaks	**30**
					0.87	**0.9**	**Graphite bearing weathered Mantle**	HQ	Dark-brownish, highly weathered, loose, with good concentration of graphite flakes	
22.5	**24**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	**Graphite bearing weathered Khondalite**	HQ	Reddish white in colour, weathered, fractured with graphite in foliation planes along with greenish alteration	**90**
24	**25.5**	**1.5**	**1.47**	**98**	**0.3**	**0.3**	**Graphite bearing weathered Khondalite**	HQ	Reddish white in colour, weathered, fractured with graphite in foliation planes along with greenish alteration	**100**
					1.17	**1.2**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane (minor trace of graphite flakes)	

25.5	**27**	**1.5**	**1.48**	**99**	**1.48**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane	**100**
27	**28.5**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane	**100**
28.5	**30**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane	**100**
30	**31.5**	**1.5**	**1.48**	**99**	**1.48**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane	**100**
31.5	**33**	**1.5**	**1.47**	**98**	**1.47**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane	**100**
33	**34.5**	**1.5**	**1.42**	**95**	**0.7**	**0.7**	Migmatised Khondalite	HQ	Reddish white in colour with greenish alteration along the foliation plane	**80.66**
					0.72	**0.8**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	
34.5	**36**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**100**
36	**37.5**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**73.33**
37.5	**39**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**100**
39	**40.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**100**
40.5	**42**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**100**

42	**43.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**83.33**
43.5	**45**	**1.5**	**1.5**	**100**	**1.15**	**1.15**	**Graphite bearing Gneiss**	HQ	Greyish white coloured rock where the gneissosity is defined by graphite + biotite rich layers alternating with quartz-feldspar rich layer. Garnets are also present giving a pinkish hue. Overall the lithounit has a migmatised appearance.	**86.66**
					0.35	**0.35**	Migmatised Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	
45	**46.5**	**1.5**	**1.4**	**93**	**1.4**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**56.66**
46.5	**48**	**1.5**	**1.4**	**93**	**0.8**	**0.8**	Migmatised Khondalite	HQ	Reddish white in colour, fractured, broken with minor trace of graphite in foliation planes	**70**
					0.6	**0.7**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals. Highly broken and fractured	
48	**49.5**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**73.33**
49.5	**51**	**1.5**	**1.5**	**100**	**0.4**	**0.4**	Charnockite	HQ	Overall a dark greenish colour appearance with greenish alteration and high amount of micaceous minerals	**100**
					1.1	**1.1**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	
51	**52.5**	**1.5**	**1.5**	**100**	**1.2**	**1.2**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	**100**
					0.3	**0.3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	
52.5	**54**	**1.5**	**1.45**	**97**	**1.45**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
54	**55.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**80**
55.5	**57**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
57	**58.5**	**1.5**	**1.5**	**100**	**1.2**	**1.2**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**86.66**
					0.3	**0.3**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	

58.5	**60**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	**100**
60	**61.5**	**1.5**	**1.5**	**100**	**0.9**	**0.9**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	**100**
					0.6	**0.6**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	
61.5	**63**	**1.5**	**1.45**	**97**	**1.05**	**1.05**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
					0.4	**0.45**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	
63	**64.5**	**1.5**	**1.5**	**100**	**1.2**	**1.2**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	**100**
					0.3	**0.3**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	
64.5	**66**	**1.5**	**1.45**	**97**	**1.35**	**1.35**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
					0.1	**0.15**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	
66	**67.5**	**1.5**	**1.5**	**100**	**1.5**	**1.5**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	**100**
67.5	**69**	**1.5**	**1.5**	**100**	**0.4**	**0.4**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
					1.1	**1.1**	Migmatised Khondalite with Graphite	HQ	Reddish white in colour, fractured with flakes of graphite in foliation planes	
69	**70**	**1**	**1**	**100**	**1**	**1**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
70	**71**	**1**	**1**	**100**	**1**	**1**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
71	**72**	**1**	**0.9**	**90**	**0.9**	**1**	Migmatised Khondalite	HQ	Reddish white in colour with alteration along the foliation plane (minor trace of graphite)	**100**
THE BOREHOLE WAS CLOSED ON 12.03.2026 AT 72 M RUN IN MIGMATISED KHONDALITE										

Annexure X : Analysis report of 225 Borehole Core samples

SL NO	BORE HOLE NO	SAMPLE ID	FROM	TO	LENGTH (m)	MOISTURE (%)	VM (%)	ASH (%)	S (%)	FC (%)	Lihology	Interpreted Band
1	ORDN-1	ORDN-1/CS-1	20	21	1	4.89	5.87	93.49	0.12	0.52	Highly Weathered mantle	
2		ORDN-1/CS-2	21	22	1	2.11	3.01	96.06	0.15	0.78	Khondalite	
3		ORDN-1/CS-3	22	23	1	1.31	2.44	96.88	0.13	0.55	Khondalite	
4		ORDN-1/CS-4	23	24	1	1.06	2.38	96.96	0.16	0.50	Khondalite	
5		ORDN-1/CS-5	24	25	1	0.24	0.77	98.75	0.04	0.44	Khondalite	
6		ORDN-1/CS-6	38.75	39.75	1	0.93	0.81	98.88	0.06	0.25	Migmatised Khondalite	
7		ORDN-1/CS-7	39.75	41.22	1.47	0.47	1.09	98.52	0.04	0.35	Migmatised Khondalite	
8		ORDN-1/CS-8	41.22	42.22	1	0.64	0.65	98.64	0.08	0.63	Granite gneiss	
9		ORDN-1/CS-9	47.65	48.65	1	0.26	0.90	98.72	0.04	0.34	Migmatised Khondalite	
10		**ORDN-1/CS-10**	**48.65**	**49.65**	**1**	**0.67**	**4.60**	**90.48**	**0.26**	**4.66**	**Quartzo-feldspathic graphite gneiss**	**1-B**
11		**ORDN-1/CS-11**	**49.65**	**50.65**	**1**	**0.97**	**4.98**	**89.85**	**0.26**	**4.91**		
12		**ORDN-1/CS-12**	**50.65**	**52**	**1.35**	**0.41**	**1.90**	**94.32**	**0.27**	**3.51**		
13		ORDN-1/CS-13	52	53	1	0.16	0.99	98.63	0.06	0.32	Migmatised Khondalite	
14		ORDN-1/CS-14	57.4	58.4	1	0.09	0.76	98.79	0.03	0.42	Migmatised Khondalite	
15		**ORDN-1/CS-15**	**58.4**	**59.4**	**1**	**0.38**	**1.99**	**94.53**	**0.20**	**3.28**	**Quartzo-feldspathic graphite gneiss**	**1-C**
16		**ORDN-1/CS-16**	**59.4**	**60.4**	**1**	**0.65**	**2.44**	**92.56**	**0.16**	**4.84**		
17		**ORDN-1/CS-17**	**60.4**	**61.4**	**1**	**0.91**	**3.43**	**91.45**	**0.25**	**4.87**		
18		**ORDN-1/CS-18**	**61.4**	**62.4**	**1**	**0.43**	**1.40**	**96.77**	**0.12**	**1.71**		
19		**ORDN-1/CS-19**	**62.4**	**63.86**	**1.46**	**0.50**	**1.62**	**94.28**	**0.24**	**3.86**		
20		ORDN-1/CS-20	63.86	64.86	1	0.22	0.56	98.77	0.08	0.59	Migmatised granite gneiss	
21		ORDN-1/CS-21	64.86	65.57	0.71	0.13	0.70	98.24	0.14	0.93	Migmatised Khondalite	
22		ORDN-1/CS-22	65.57	66.15	0.58	0.17	0.74	96.24	0.22	2.81	Quartzo-feldspathic graphite gneiss	
23		ORDN-1/CS-23	66.15	66.9	0.75	0.14	0.52	99.04	0.08	0.36	Migmatised granite gneiss	

24		ORDN-1/CS-24	66.9	67.65	0.75	0.22	1.23	95.67	0.24	2.86	Quartzo-feldspathic graphite gneiss	
25		ORDN-1/CS-25	67.65	68.51	0.86	0.11	0.43	99.05	0.06	0.46	Garnetiferous quartzite	
26		**ORDN-1/CS-26**	**68.51**	**69.85**	**1.34**	**0.29**	**1.44**	**96.14**	**0.22**	**2.20**	**Quartzo-feldspathic graphite gneiss**	**1-D**
27		ORDN-1/CS-27	69.85	70.85	1	0.10	0.55	99.03	0.08	0.34	Garnetiferous quartzite	
28	**ORDN-2**	ORDN-2/CS-1	7.32	8.32	1	1.26	2.45	96.91	0.06	0.58	Weathered mantle	
29		ORDN-2/CS-2	8.32	9.5	0.95	0.87	1.90	97.54	0.06	0.50	Migmatised Khondalite	
30		ORDN-2/CS-3	9.5	10.5	1	0.87	2.54	97.07	0.04	0.35	Migmatised Khondalite	
31		ORDN-2/CS-4	10.95	11.95	1	1.06	2.05	97.32	0.08	0.55	Migmatised Khondalite	
32		ORDN-2/CS-5	11.95	12.55	0.6	0.67	2.27	97.26	0.08	0.39	Migmatised Khondalite	
33		ORDN-2/CS-6	12.55	13.55	1	0.28	0.98	98.58	0.13	0.31	Migmatised Khondalite	
34		ORDN-2/CS-7	13.55	14.5	1	0.33	0.87	98.82	0.06	0.25	Garnetiferous quartzite	
35		ORDN-2/CS-8	14.5	15	0.5	0.45	2.20	95.15	0.06	2.59	Graphite bearing Khondalite	
36		ORDN-2/CS-9	15	16	1	0.30	0.67	98.90	0.04	0.39	Garnetiferous quartzite	
37		ORDN-2/CS-10	16	17	1	0.23	0.59	99.08	0.03	0.31	Garnetiferous quartzite & Leptynite	
38		ORDN-2/CS-11	17	18	1	0.99	2.26	96.21	0.18	1.34	Leptynite	
39		ORDN-2/CS-12	18	18.65	0.65	0.35	1.09	98.40	0.16	0.35	Leptynite	
40		ORDN-2/CS-13	18.65	19.45	0.8	0.15	0.20	99.32	0.18	0.30	Leptynite	
41		ORDN-2/CS-14	19.45	20	0.55	0.24	0.50	99.02	0.20	0.28	Leptynite	
42		ORDN-2/CS-15	20	21	1	0.65	1.01	98.52	0.06	0.41	Leptynite & Migmatised khondalite	
43		ORDN-2/CS-16	47.9	48.9	1	0.21	0.93	98.74	0.08	0.25	Migmatised khondalite	
44		**ORDN-2/CS-17**	**48.9**	**49.9**	**1**	**0.81**	**4.29**	**90.37**	**0.11**	**5.23**	**Quartzo-feldspathic graphite gneiss**	**1-E**
45		**ORDN-2/CS-18**	**49.9**	**50.9**	**1**	**0.85**	**5.12**	**89.29**	**0.26**	**5.33**		
46		**ORDN-2/CS-19**	**50.9**	**51.9**	**1**	**0.95**	**4.78**	**89.68**	**0.04**	**5.50**		
47		**ORDN-2/CS-20**	**51.9**	**52.9**	**1**	**1.15**	**4.41**	**89.45**	**0.12**	**6.02**		

48		**ORDN-2/CS-21**	**52.9**	**53.9**	**1**	**1.05**	**3.95**	**89.73**	**0.14**	**6.18**		
49		**ORDN-2/CS-22**	**53.9**	**54.9**	**1**	**1.12**	**3.64**	**90.03**	**0.24**	**6.09**		
50		**ORDN-2/CS-23**	**54.9**	**55.9**	**1**	**1.15**	**3.20**	**90.34**	**0.26**	**6.20**		
51		**ORDN-2/CS-24**	**55.9**	**56.65**	**0.75**	**0.89**	**3.04**	**92.36**	**0.21**	**4.39**		
52		**ORDN-2/CS-25**	**56.65**	**57.65**	**1**	**0.18**	**1.32**	**97.00**	**0.12**	**1.56**		
53		ORDN-2/CS-26	57.65	58.65	1	0.27	1.30	97.73	0.14	0.82	Migmatised khondalite	
54		ORDN-2/CS-27	58.65	59.65	1	0.94	1.52	98.07	0.06	0.35	Migmatised khondalite	
55		ORDN-2/CS-28	59.65	60.65	1	0.28	0.82	98.68	0.05	0.45	Migmatised khondalite & Charnockite	
56		ORDN-3/CS-1	6.2	7.2	1	1.56	3.47	94.98	0.04	1.51	Weathered mantle	
57		ORDN-3/CS-2	7.2	8.2	1	1.50	2.65	95.40	0.16	1.78	Khondalite	
58		ORDN-3/CS-3	8.2	9.2	1	2.75	3.63	94.83	0.06	1.48	Khondalite	
59		ORDN-3/CS-4	9.2	9.9	0.7	3.71	5.14	92.99	0.14	1.72	Khondalite	
60		ORDN-3/CS-5	9.9	10.8	0.9	6.36	5.43	92.89	0.08	1.60	Weathered mantle	
61		**ORDN-3/CS-6**	**10.8**	**11.8**	**1**	**2.93**	**3.63**	**94.57**	**0.12**	**1.68**	**Graphite bearing Khondalite**	**1-F**
62		**ORDN-3/CS-7**	**11.8**	**12.8**	**1**	**2.32**	**3.94**	**93.29**	**0.24**	**2.53**		
63		**ORDN-3/CS-8**	**12.8**	**14.25**	**1.45**	**2.55**	**4.56**	**92.73**	**0.26**	**2.44**	**Graphite bearing Gneiss**	
64		ORDN-3/CS-9	14.25	15.5	1.25	1.21	1.89	97.19	0.09	0.83	Granite gneiss	
65	**ORDN-3**	**ORDN-3/CS-10**	**15.5**	**16.65**	**1.15**	**0.97**	**2.46**	**95.08**	**0.26**	**2.21**	**Graphite bearing Gneiss**	**1-G**
66		ORDN-3/CS-11	16.65	17.65	1	0.58	1.56	98.00	0.02	0.42	Granite gneiss	
67		**ORDN-3/CS-12**	**24.45**	**25.45**	**1**	**0.31**	**1.89**	**96.06**	**0.28**	**1.77**	**Graphite bearing Khondalite**	**1-I**
68		**ORDN-3/CS-13**	**25.45**	**26.05**	**0.6**	**0.19**	**2.88**	**92.56**	**0.28**	**4.28**		
69		ORDN-3/CS-14	26.05	27.05	1	0.11	0.82	98.57	0.08	0.53	Charnockite	
70		ORDN-3/CS-15	30.35	31.35	1	0.12	1.09	98.33	0.12	0.45	Migmatised Khondalite	
71		**ORDN-3/CS-16**	**31.35**	**32.35**	**1**	**0.92**	**4.05**	**93.23**	**0.16**	**2.57**	**Quartzo-feldspathic graphite gneiss**	**1-J**
72		**ORDN-3/CS-17**	**32.35**	**33.35**	**1**	**0.76**	**4.38**	**93.21**	**0.20**	**2.21**		
73		**ORDN-3/CS-18**	**33.35**	**34.5**	**1.15**	**0.74**	**3.86**	**94.03**	**0.18**	**1.94**		
74		ORDN-3/CS-19	34.5	35.5	1	0.15	1.14	98.29	0.12	0.45	Garnetiferous quartzite	

75		ORDN-3/CS-20	42.8	43.8	1	0.16	0.66	98.98	0.06	0.30	Charnockite	
76		ORDN-3/CS-21	43.8	45	1.2	0.26	1.60	96.83	0.12	1.45	Charnockite	
77		ORDN-3/CS-22	45	46	1	0.12	1.49	96.07	0.24	2.21	Graphite bearing Khondalite	
78		ORDN-3/CS-23	47.2	48.2	1	0.10	1.09	98.53	0.02	0.36	Migmatised khondalite	
79		**ORDN-3/CS-24**	**48.2**	**49.2**	**1**	**0.18**	**2.26**	**93.74**	**0.22**	**3.78**	**Quartzo-feldspathic graphite gneiss**	**1-K**
80		**ORDN-3/CS-25**	**49.2**	**50.2**	**1**	**0.22**	**1.65**	**93.01**	**0.28**	**5.06**		
81		**ORDN-3/CS-26**	**50.2**	**50.9**	**0.7**	**0.33**	**1.55**	**94.23**	**0.24**	**3.98**		
82		**ORDN-3/CS-27**	**50.9**	**51.6**	**0.7**	**0.12**	**0.87**	**98.71**	**0.04**	**0.38**		
83		**ORDN-3/CS-28**	**51.6**	**52.6**	**1**	**1.35**	**4.26**	**90.39**	**0.18**	**5.17**		
84		**ORDN-3/CS-29**	**52.6**	**53.6**	**1**	**0.61**	**3.01**	**91.06**	**0.20**	**5.73**		
85		**ORDN-3/CS-30**	**53.6**	**54.8**	**1.2**	**0.42**	**2.17**	**93.03**	**0.18**	**4.62**		
86		ORDN-3/CS-31	54.8	55.8	1	0.34	1.20	97.69	0.15	0.97	Charnockite	
87		ORDN-3/CS-32	58.5	59.5	1	0.18	1.33	98.20	0.08	0.39	Charnockite	
88		ORDN-3/CS-33	59.5	60.15	0.65	0.72	3.56	93.93	0.18	2.32	Quartzo-feldspathic graphite gneiss	
89		ORDN-3/CS-34	60.15	61.15	1	0.13	0.95	98.74	0.06	0.25	Migmatised khondalite	
90	**ORDN-4**	ORDN-4/CS-1	5.75	6.75	1	1.45	2.65	96.94	0.14	0.27	Weathered mantle	
91		ORDN-4/CS-2	6.75	7.2	0.45	1.22	2.47	96.03	0.12	1.38	Weathered Khondalite	
92		ORDN-4/CS-3	7.2	8.3	1.1	0.68	1.09	98.51	0.11	0.29	Weathered mantle	
93		ORDN-4/CS-4	8.3	9.2	0.9	0.8	1.95	96.23	0.14	1.68	Migmatised Khondalite	
94		ORDN-4/CS-5	9.2	9.5	0.3	0.38	0.27	99.49	0.13	0.11	Migmatised Khondalite	
95		ORDN-4/CS-6	9.5	10.2	0.7	0.68	1.81	96.08	0.18	1.93	Migmatised Khondalite	
96		ORDN-4/CS-7	10.2	11.2	1	0.36	0.63	98.97	0.13	0.27	Migmatised Khondalite	
97		ORDN-4/CS-8	13.45	14.45	1	0.21	0.40	99.28	0.11	0.21	Garnetiferous quartzite	
98		ORDN-4/CS-9	14.45	15.5	1.05	0.94	2.06	96.5	0.17	1.27	Migmatised Gneiss	
99		ORDN-4/CS-10	15.5	16.3	0.8	0.30	0.52	99.01	0.17	0.30	Garnetiferous quartzite	
100		ORDN-4/CS-11	16.3	17.3	1	0.84	2.56	95.64	0.17	1.63	Migmatised Gneiss	
101		ORDN-4/CS-12	17.3	18.3	1	0.54	1.99	96.21	0.16	1.64	Migmatised Gneiss	
102		ORDN-4/CS-13	18.3	19.3	1	0.47	1.92	97.07	0.16	0.85	Migmatised Gneiss	

103		ORDN-4/CS-14	19.3	20.3	1	0.5	1.82	96.72	0.18	1.28	Migmatised Gneiss	
104		ORDN-4/CS-15	20.3	21.3	1	0.58	1.86	96.72	0.18	1.24	Migmatised Gneiss	
105		ORDN-4/CS-16	21.3	22.3	1	0.4	1.64	97.65	0.2	0.51	Migmatised Gneiss	
106		ORDN-4/CS-17	22.3	23.3	1	0.48	1.86	97.61	0.21	0.32	Migmatised Gneiss	
107		ORDN-4/CS-18	23.3	24	0.7	0.38	1.57	97.57	0.22	0.64	Migmatised Gneiss	
108		ORDN-4/CS-19	24	24.65	0.65	0.27	0.35	99.22	0.15	0.28	Migmatised Gneiss	
109		ORDN-4/CS-20	24.65	25.05	0.4	0.28	1.2	98.37	0.23	0.2	Migmatised Gneiss	
110		ORDN-4/CS-21	25.05	26.05	1	0.34	0.63	98.95	0.12	0.30	Migmatised Gneiss	
111		ORDN-4/CS-22	26.05	26.75	0.7	0.26	0.78	98.73	0.11	0.38	Migmatised Gneiss	
112		ORDN-4/CS-23	26.75	28.15	1.4	0.46	1.56	97.04	0.2	1.2	Migmatised Gneiss	
113		ORDN-4/CS-24	28.15	29.15	1	0.20	0.31	99.29	0.11	0.29	Leptynite	
114		ORDN-4/CS-25	40.6	41.6	1	0.28	1.26	98.14	0.16	0.44	Migmatised Khondalite	
115		ORDN-4/CS-26	41.6	42.6	1	0.38	1.66	96.85	0.19	1.3	Migmatised Khondalite	
116		ORDN-4/CS-27	42.6	43.6	1	0.3	1.27	97.24	0.19	1.3	Migmatised Gneiss	
117		**ORDN-4/CS-28**	**43.6**	**44.6**	**1**	**0.39**	**1.65**	**94.22**	**0.1**	**4.03**	**Graphite bearing Gneiss**	**3-C**
118		**ORDN-4/CS-29**	**44.6**	**45.3**	**0.7**	**0.22**	**1.81**	**94.94**	**0.11**	**3.14**		
119		ORDN-4/CS-30	45.3	46.3	1	0.18	0.09	99.58	0.10	0.23	Garnetiferous quartzite	
120	**ORDN-5**	ORDN-5/CS-1	8.2	9.2	1	0.37	1.01	98.40	0.16	0.43	Migmatised Khondalite	
121		ORDN-5/CS-2	9.2	10.2	1	0.43	1.41	98.1	0.13	0.36	Granite gneiss	
122		ORDN-5/CS-3	10.2	10.7	0.5	0.27	1.48	98.07	0.06	0.39	Granite gneiss	
123		ORDN-5/CS-4	10.7	11.5	0.8	0.32	1.09	98.36	0.22	0.33	Migmatised Khondalite	
124		ORDN-5/CS-5	11.5	12.45	0.95	0.31	1.4	98.16	0.08	0.36	Granite gneiss	
125		ORDN-5/CS-6	12.45	13.7	1.25	0.29	1.10	98.30	0.14	0.46	Migmatised Khondalite	
126		ORDN-5/CS-7	13.7	15.15	1.45	0.29	1.51	98.06	0.09	0.34	Granite gneiss	
127		ORDN-5/CS-8	15.15	16.15	1	0.28	0.77	98.57	0.27	0.39	Migmatised Khondalite	
128		ORDN-5/CS-9	24	25	1	0.26	1.03	98.36	0.21	0.40	Migmatised Khondalite	
129		ORDN-5/CS-10	25	25.95	0.95	0.53	2.75	95.95	0.12	1.18	Granite gneiss	
130		ORDN-5/CS-11	25.95	26.8	0.85	0.26	1.09	98.41	0.18	0.32	Garnetiferous quartzite	

131		ORDN-5/CS-12	26.8	27.8	1	0.64	2.59	95.43	0.11	1.87	Migmatised Gneiss	
132		ORDN-5/CS-13	27.8	28.8	1	0.81	3.98	94.06	0.1	1.86	Migmatised Gneiss	
133		ORDN-5/CS-14	28.8	29.55	0.75	0.39	2.4	96.25	0.11	1.24	Migmatised Gneiss	
134		ORDN-5/CS-15	29.55	30.5	0.95	0.19	0.48	99.05	0.11	0.36	Migmatised Khondalite	
135		ORDN-5/CS-16	30.5	31.5	1	0.24	1.18	97.59	0.09	1.14	Migmatised Gneiss	
136		**ORDN-5/CS-17**	**31.5**	**32.5**	**1**	**0.35**	**2.1**	**94.27**	**0.13**	**3.5**	**Graphite bearing Gneiss**	**3-F**
137		**ORDN-5/CS-18**	**32.5**	**33.45**	**0.95**	**0.24**	**0.78**	**98.45**	**0.34**	**0.43**		
138		**ORDN-5/CS-19**	**33.45**	**34.45**	**1**	**0.89**	**4.18**	**91.39**	**0.11**	**4.32**		
139		**ORDN-5/CS-20**	**34.45**	**35.45**	**1**	**0.61**	**3.06**	**93.93**	**0.1**	**2.91**		
140		**ORDN-5/CS-21**	**35.45**	**36.7**	**1.25**	**0.57**	**3.49**	**92.48**	**0.1**	**3.93**		
141		ORDN-5/CS-22	36.7	37.7	1	0.18	0.31	99.22	0.10	0.37	Migmatised Khondalite	
142		ORDN-5/CS-23	40.3	41.3	1	0.18	0.65	98.82	0.09	0.44	Migmatised Khondalite	
143		ORDN-5/CS-24	41.3	42.3	1	0.53	3.02	95.73	0.11	1.14	Migmatised Gneiss	
144		ORDN-5/CS-25	42.3	43.3	1	0.63	2.54	96.43	0.18	0.85	Migmatised Gneiss	
145		ORDN-5/CS-26	43.3	44.35	1.05	0.53	2.59	95.29	0.16	1.96	Migmatised Gneiss	
146		ORDN-5/CS-27	44.35	44.75	0.4	0.36	1.62	97.53	0.21	0.64	Migmatised Khondalite	
147		ORDN-5/CS-28	44.75	45.75	1	0.49	2.38	96.9	0.17	0.55	Migmatised Gneiss	
148		ORDN-5/CS-29	45.75	46.3	0.55	0.56	2.37	96.63	0.21	0.79	Migmatised Gneiss	
149		ORDN-5/CS-30	46.3	46.7	0.4	0.23	0.86	98.65	0.19	0.30	Migmatised Khondalite	
150		ORDN-5/CS-31	46.7	47.7	1	1.09	4.29	93.85	0.2	1.66	Migmatised Gneiss	
151		ORDN-5/CS-32	47.7	48.7	1	1.08	4.18	94.13	0.21	1.48	Migmatised Gneiss	
152		ORDN-5/CS-33	48.7	49.8	1.1	0.71	2.76	96.71	0.14	0.39	Migmatised Gneiss	
153		ORDN-5/CS-34	49.8	50.8	1	0.21	0.78	98.78	0.11	0.33	Migmatised Khondalite	
154	**ORDN-6**	ORDN-6/CS-1	18.5	19.5	1	4.9	4.17	95.08	0.17	0.58	Weathered Khondalite	
155		**ORDN-6/CS-2**	**19.5**	**20.5**	**1**	**6.44**	**7.54**	**89.01**	**0.13**	**3.32**	**Graphite bearing Weathered Mantle**	**4-B**
156		**ORDN-6/CS-3**	**20.5**	**21.5**	**1**	**4.64**	**7.03**	**85.64**	**0.15**	**7.18**		
157		**ORDN-6/CS-4**	**21.5**	**22.5**	**1**	**2.2**	**2.72**	**93.32**	**0.16**	**3.8**		
158		ORDN-6/CS-5	22.5	23.5	1	1.54	1.17	98.5	0.23	0.1	Weathered Khondalite	
159		ORDN-6/CS-6	27.3	28.3	1	2.1	1.51	97.69	0.21	0.59	Weathered Khondalite	

160		ORDN-6/CS-7	28.3	29.2	0.9	5.81	5.59	93.13	0.24	1.04	Weathered Khondalite	
161		ORDN-6/CS-8	29.2	29.7	0.5	2.95	2.39	97.01	0.16	0.44	Weathered Khondalite	
162		ORDN-6/CS-9	29.7	30.7	1	7.66	5.97	92.66	0.19	1.18	Weathered Khondalite	
163		**ORDN-6/CS-10**	**30.7**	**31.7**	**1**	**4.6**	**5.93**	**91.82**	**0.13**	**2.12**	**Graphite bearing Khondalite + Weathered Mantle**	**4-C**
164		**ORDN-6/CS-11**	**31.7**	**32.7**	**1**	**3.91**	**4.82**	**92**	**0.11**	**3.07**		
165		**ORDN-6/CS-12**	**32.7**	**33.7**	**1**	**2.68**	**3.28**	**92.8**	**0.17**	**3.75**		
166		**ORDN-6/CS-13**	**33.7**	**34.7**	**1**	**7.42**	**5.19**	**91.57**	**0.13**	**3.11**		
167		ORDN-6/CS-14	34.7	36	1.3	7.95	4.24	95.18	0.16	0.42	Weathered Khondalite	
168		ORDN-6/CS-15	36	37	1	6.29	2.84	96.37	0.14	0.65	Migmatised Khondalite	
169		ORDN-6/CS-16	39.9	40.9	1	0.49	0.55	98.58	0.19	0.68	Migmatised Khondalite	
170		ORDN-6/CS-17	40.9	41.4	0.5	2.25	2.32	97.09	0.16	0.43	Migmatised Khondalite	
171		ORDN-6/CS-18	41.4	42.4	1	0.44	0.55	97.28	0.21	1.96	Migmatised Khondalite	
172		ORDN-6/CS-19	47	48	1	0.5	0.76	98.59	0.19	0.46	Migmatised Khondalite	
173		ORDN-6/CS-20	48	49	1	3.19	3.38	96.02	0.14	0.46	Migmatised Khondalite	
174		ORDN-6/CS-21	49	49.5	0.5	2.37	2.24	97.27	0.13	0.36	Migmatised Gneiss	
175		ORDN-6/CS-22	49.5	50.5	1	1.93	1.89	97.54	0.11	0.46	Migmatised Gneiss	
176		ORDN-6/CS-23	50.5	51.1	0.6	1.77	1.96	97.47	0.14	0.43	Migmatised Khondalite	
177		ORDN-6/CS-24	51.1	52.5	1.4	3.57	4.25	95.13	0.16	0.46	Migmatised Khondalite	
178		ORDN-6/CS-25	52.5	53.5	1	0.65	0.79	98.76	0.13	0.32	Migmatised Khondalite	
179		ORDN-6/CS-26	57.5	58.5	1	0.43	0.84	98.55	0.17	0.44	Migmatised Khondalite	
180		**ORDN-6/CS-27**	**58.5**	**59.7**	**1.2**	**2.52**	**4.98**	**90.63**	**0.17**	**4.22**	**Graphite bearing Khondalite**	**4-D**
181		ORDN-6/CS-28	59.7	60.7	1	0.44	0.89	98.51	0.21	0.39	Migmatised Khondalite	
182	**ORDN-7**	ORDN-7/CS-1	4.7	5.7	1	3.21	5.53	93.62	0.24	0.61	Weathered Mantle	
183		ORDN-7/CS-2	5.7	6.3	0.6	5.29	7.9	91.33	0.26	0.51	Weathered Khondalite	
184		ORDN-7/CS-3	6.3	6.7	0.4	3.75	8.95	90.39	0.23	0.43	Weathered Khondalite	
185		ORDN-7/CS-4	6.7	7.7	1	2.41	6.83	91.91	0.2	1.06	Weathered Khondalite	
186		**ORDN-7/CS-5**	**7.7**	**8.7**	**1**	**2.79**	**6.26**	**90.86**	**0.19**	**2.69**	**Graphite bearing Weathered Khondalite**	**4-F**
187		**ORDN-7/CS-6**	**8.7**	**9.8**	**1.1**	**2.68**	**7.45**	**90.71**	**0.18**	**1.66**		
188		ORDN-7/CS-7	9.8	10.8	1	2.76	6.06	93.19	0.21	0.54	Weathered Khondalite	

189		ORDN-7/CS-8	20.6	21.6	1	5.4	9.58	89.87	0.15	0.4	Weathered Khondalite	
190		**ORDN-7/CS-9**	**21.6**	**22.6**	**1**	**5.05**	**7.96**	**89.24**	**0.16**	**2.64**	**Graphite bearing Weathered Khondalite**	**4-G**
191		**ORDN-7/CS-10**	**22.6**	**23.6**	**1**	**4.4**	**6.57**	**89.48**	**0.14**	**3.81**		
192		**ORDN-7/CS-11**	**23.6**	**24.3**	**0.7**	**3.17**	**6.25**	**90.66**	**0.19**	**2.9**		
193		ORDN-7/CS-12	24.3	25.3	1	0.64	1.1	98.28	0.17	0.45	Migmatised Khondalite	
194		ORDN-7/CS-13	32.7	33.7	1	1.96	3.7	95.74	0.16	0.4	Migmatised Khondalite	
195		**ORDN-7/CS-14**	**33.7**	**34.7**	**1**	**4.25**	**7.79**	**88.15**	**0.11**	**3.95**	**Graphite bearing Gneiss**	**4-H**
196		**ORDN-7/CS-15**	**34.7**	**35.7**	**1**	**4.55**	**5.93**	**90.04**	**0.13**	**3.9**		
197		**ORDN-7/CS-16**	**35.7**	**36.7**	**1**	**4.15**	**6.99**	**86.99**	**0.17**	**5.85**		
198		**ORDN-7/CS-17**	**36.7**	**37.7**	**1**	**4.07**	**7.51**	**86.86**	**0.19**	**5.44**		
199		**ORDN-7/CS-18**	**37.7**	**38.7**	**1**	**4.95**	**6.25**	**89.26**	**0.14**	**4.35**		
200		**ORDN-7/CS-19**	**38.7**	**39.7**	**1**	**3.92**	**7.34**	**89.4**	**0.13**	**3.13**		
201		**ORDN-7/CS-20**	**39.7**	**40.7**	**1**	**3.92**	**8.75**	**85.25**	**0.16**	**5.84**		
202		**ORDN-7/CS-21**	**40.7**	**41.7**	**1**	**2.48**	**8.72**	**84.25**	**0.17**	**6.86**		
203		**ORDN-7/CS-22**	**41.7**	**42.7**	**1**	**1.76**	**7.28**	**85.61**	**0.16**	**6.95**		
204		**ORDN-7/CS-23**	**42.7**	**43.7**	**1**	**5.2**	**6.92**	**90.29**	**0.21**	**2.58**		
205		**ORDN-7/CS-24**	**43.7**	**44.65**	**0.95**	**3.71**	**5.67**	**88.95**	**0.2**	**5.18**		
206		ORDN-7/CS-25	44.65	45.65	1	3.43	4.31	95.09	0.19	0.41	Khondalite	
207		ORDN-7/CS-26	48.9	49.9	1	1.46	0.72	98.56	0.22	0.5	Charnockite	
208		ORDN-7/CS-27	49.9	50.9	1	3.19	5.63	93.24	0.24	0.89	Migmatised Khondalite	
209		ORDN-7/CS-28	50.9	52.2	1.3	3.8	4.52	94.52	0.17	0.79	Migmatised Khondalite	
210		ORDN-7/CS-29	52.2	53.2	1	0.7	1.38	98.1	0.18	0.34	Migmatised Khondalite	
211		ORDN-7/CS-30	57.2	58.2	1	1.81	2.16	97.27	0.13	0.44	Migmatised Khondalite	
212		ORDN-7/CS-31	58.2	59.2	1	0.63	2.5	96.88	0.16	0.46	Migmatised Khondalite	
213		ORDN-7/CS-32	59.2	60.2	1	1.31	4.56	94.96	0.08	0.4	Migmatised Khondalite	
214		ORDN-7/CS-33	60.2	60.9	0.7	0.29	1.22	98.13	0.11	0.54	Migmatised Khondalite	
215		ORDN-7/CS-34	60.9	61.9	1	0.61	1.21	98.36	0.12	0.31	Migmatised Khondalite	
216		ORDN-7/CS-35	61.9	62.55	0.65	0.41	0.77	98.65	0.09	0.49	Migmatised Khondalite	
217		ORDN-7/CS-36	62.55	63.55	1	0.31	0.82	98.69	0.08	0.41	Migmatised Khondalite	

218		ORDN-7/CS-37	63.55	64.2	0.65	0.28	1.08	98.41	0.13	0.38	Migmatised Khondalite	
219		ORDN-7/CS-38	64.2	65.2	1	0.58	1.4	98.06	0.13	0.41	Migmatised Khondalite	
220		ORDN-7/CS-39	65.2	65.85	0.65	0.3	0.68	98.79	0.14	0.39	Migmatised Khondalite	
221		ORDN-7/CS-40	65.85	66.85	1	0.21	0.98	98.48	0.11	0.43	Migmatised Khondalite	
222		ORDN-7/CS-41	66.85	67.5	0.65	0.28	0.7	98.67	0.14	0.49	Migmatised Khondalite	
223		ORDN-7/CS-42	67.5	67.9	0.4	0.33	0.78	98.57	0.16	0.49	Migmatised Khondalite	
224		ORDN-7/CS-43	67.9	69	1.1	0.24	1.82	97.57	0.13	0.48	Migmatised Khondalite	
225		ORDN-7/CS-44	69	70	1	0.16	0.81	98.67	0.12	0.4	Migmatised Khondalite	

Annexure XI: Analysis report of Check samples

SL NO	SAMPLE TYPE	SAMPLE ID	CHECK LAB	MOISTURE (%)	VM (%)	ASH (%)	S (%)	F.C (%) OF CHECK LAB	F.C (%) OF PRIMARY LAB	F.C (%) DIFFERENCE	PRIMARY LAB
1	Groove Samples	DN/Z-1/G-1/10	NMCI	0.31	4.52	82.54	0.19	12.75	12.21	0.54	IGI
2		DN/Z-3/G-7/10		0.94	3.53	86.74	0.18	9.55	9.11	0.44	
3		DN/Z-2/G-4/10		2	3.99	84.34	0.18	11.49	12.64	-1.15	
4		DN/Z-2/G-5/02		1.99	3.56	84.56	0.11	11.77	10.19	1.58	
5		DN/Z-4/G-9/08		0.42	2.03	77.47	0.15	20.35	20.3	0.05	
6		DN/Z-4/G-9/10		0.59	2.69	77.31	0.12	19.88	19.89	-0.01	
7		DN/Z-4/G-10/07		0.72	3.12	80.03	0.14	16.71	16.64	0.07	
8		DN/Z-4/G-11/04		0.52	2.67	80.53	0.13	16.67	17.04	-0.37	
9	Trench Samples	DN/Z-1/T-1/05		1.52	3.59	86.53	0.16	9.72	10.12	-0.4	
10		DN/Z-1/T-1/08		1.49	3.48	86.51	0.21	9.8	10.13	-0.33	
11		DN/Z-1/T-3/05		1.08	2.2	86.62	0.18	11	10.62	0.38	
12		DN/Z-1/T-3/06		1.21	2.76	86.27	0.17	10.8	11.52	-0.72	
13		DN/Z-4/T-4/01		1.72	3.61	88.42	0.14	7.83	10.08	-2.25	
14	Pit Samples	DN/Z-3/P-3/02		1.13	2.62	89.54	0.12	7.72	9.05	-1.33	
15		DN/Z-4/P-4/02		0.95	3.15	89.46	0.11	7.28	10.3	-3.02	
16	Core Samples	ORDN-2/CS-21	IGI	1.137	2.8	88.82	3.711	4.67	6.18	-1.51	NMCI
17		ORDN-3/CS-25		0.34	0.92	92.88	2.92	3.28	5.06	-1.78	
18		ORDN-6/CS-3		4.517	5.44	85.04	0.371	9.15	7.18	1.97	
19		ORDN-6/CS-12		2.467	3.22	92.68	0.177	3.92	3.75	0.17	
20		ORDN-7/CS-16		4.06	7.07	86.38	0.582	5.97	5.85	0.12	
21		ORDN-1/CS-10	SHIVA	0.9	0.9	88.85	nil	5.21	4.66	0.55	
22		ORDN-1/CS-16		0.83	0.83	90.97	nil	5.98	4.84	1.14	
23		ORDN-2/CS-20		1.04	1.04	87.11	nil	8.27	6.02	2.25	
24		ORDN-3/CS-28		1.38	1.38	88.06	nil	6.6	5.17	1.43	
25		ORDN-7/CS-20		2.89	2.89	81.87	nil	6.29	5.84	0.45	

Annexure XII : Analysis report of minor and trace elements (in ppm) of 20 samples

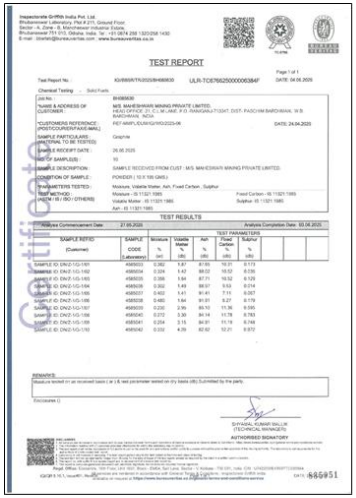
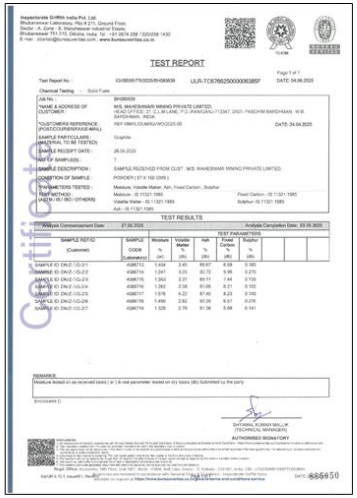
Sl No	Sample ID	Li	Be	B	Sc	Co	Ga	Ge	Se	Rb	Y	Nb	Mo	Cd	In	Sn	Sb	Te	Cs	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Tl	Bi	Th	U	Cu	Ni	Pb	Sr	Zn	Zr
1	DN/Z1/NGB/S1	<0.5	<0.5	<5	10.8	25.7	12.3	<0.5	1.1	130.4	19.9	20.9	<0.5	<0.5	<0.5	3.8	<0.5	<0.5	0.5	75.6	150.8	16.4	61.8	8.8	2.2	7.6	0.9	4.2	0.8	2.3	<0.5	2.2	<0.5	1.8	1.5	<0.5	<0.5	<0.5	25.4	0.9	38	26	29	114	124	21
2	DN/Z3/NGB/S2	12.8	0.6	<5	<0.5	3.2	19.3	<0.5	1.5	134.9	4.6	4.5	<0.5	<0.5	<0.5	7.9	<0.5	0.5	<0.5	23.2	48.8	5.1	17.3	3.0	0.8	2.6	<0.5	0.8	<0.5	<0.5	<0.5	<0.5	<0.5	2.8	0.7	0.9	<0.5	<0.5	2.2	<0.5	28	<5	43	70	51	22
3	DN/Z4/NGB/S3	<0.5	<0.5	<5	8.2	31.3	15.3	<0.5	1.0	191.4	26.2	10.2	<0.5	1.0	<0.5	1.3	<0.5	<0.5	<0.5	122.1	251.1	25.1	88.9	14.0	2.2	11.6	1.1	4.6	0.9	2.9	<0.5	2.8	<0.5	1.0	0.6	<0.5	<0.5	<0.5	40.0	1.5	35	6	30	146	162	34
4	DN/Z4/NGB/S4	18.5	1.0	<5	<0.5	5.7	23.0	<0.5	0.7	118.6	15.0	12.3	<0.5	<0.5	<0.5	6.0	<0.5	<0.5	<0.5	82.7	164.6	17.1	58.7	9.4	1.2	7.7	0.7	2.8	0.5	1.7	<0.5	1.5	<0.5	6.3	0.8	5.6	<0.5	<0.5	41.8	1.1	25	<5	40	147	107	48
5	DN/Z2/NGB/S5	<0.5	<0.5	<5	10.3	20.9	14.1	<0.5	1.0	186.0	19.8	16.4	<0.5	0.7	<0.5	2.0	<0.5	<0.5	<0.5	84.9	167.3	16.4	59.8	9.9	2.4	7.7	0.8	3.9	0.8	2.4	<0.5	2.2	<0.5	1.6	1.0	<0.5	<0.5	<0.5	30.1	1.0	50	14	45	139	76	41
6	DN/Z1/T3/GBS1	<0.5	1.5	<5	7.5	21.8	11.9	<0.5	5.8	57.2	18.3	1.7	8.4	<0.5	<0.5	4.0	0.6	<0.5	<0.5	90.3	168.4	18.9	69.5	12.2	1.6	11.5	1.1	3.9	0.6	1.9	<0.5	1.8	<0.5	0.7	<0.5	<0.5	<0.5	0.5	27.2	2.0	207	63	27	119	149	29
7	DN/Z1/T3/GBS2	<0.5	<0.5	<5	7.2	32.5	9.5	<0.5	7.1	42.2	18.9	2.6	16.8	<0.5	<0.5	1.3	<0.5	0.6	<0.5	58.9	120.3	12.9	49.5	8.8	1.1	8.5	0.9	3.4	0.7	1.9	<0.5	2.0	<0.5	0.7	<0.5	<0.5	<0.5	<0.5	22.2	1.3	330	80	20	55	166	27
8	DN/Z4/T4/GBS3	<0.5	<0.5	<5	5.1	18.4	12.4	<0.5	3.2	63.9	19.8	6.3	3.7	<0.5	<0.5	4.6	<0.5	0.8	<0.5	58.4	122.8	14.4	55.1	8.7	1.6	8.0	0.9	3.6	0.6	1.9	<0.5	1.7	<0.5	3.2	<0.5	0.7	<0.5	<0.5	24.3	3.8	61	46	39	194	98	107
9	DN/Z4/T4/GBS4	<0.5	<0.5	<5	5.2	15.7	11.6	<0.5	2.4	119.7	15.5	8.7	1.0	<0.5	<0.5	5.6	<0.5	<0.5	<0.5	70.3	140.9	15.3	57.2	8.9	2.2	7.7	0.7	3.1	0.6	1.7	<0.5	1.5	<0.5	3.1	<0.5	0.9	<0.5	<0.5	25.2	3.8	50	24	50	159	115	116
10	DN/Z1/T1/GBS5	1.5	1.2	<5	13.9	20.7	14.5	<0.5	2.2	53.2	21.0	6.7	<0.5	<0.5	<0.5	2.5	0.6	<0.5	0.5	54.5	119.3	12.8	47.3	8.8	1.1	7.8	0.9	4.2	0.8	2.4	<0.5	2.0	<0.5	1.6	<0.5	<0.5	<0.5	<0.5	25.8	2.0	72	62	316	57	142	64
11	ORDN-1/IC-1	2.31	<0.5	<5	5.7	52.8	18.4	<0.5	2.2	110.0	27.4	<0.5	6.8	<0.5	<0.5	<0.5	<0.5	0.7	<0.5	80.6	202.9	18.2	71.1	13.2	1.7	16.2	1.5	6.2	1.1	2.9	<0.5	2.3	<0.5	0.8	<0.5	1.4	<0.5	0.8	33.0	1.8	356	189	19	68	106	17
12	ORDN-1/IC-2	6.5	1.6	<5	10.2	23.4	18.2	<0.5	2.3	125.1	35.2	8.7	1.9	<0.5	<0.5	2.0	<0.5	<0.5	2.9	37.7	91.0	9.0	36.6	7.2	1.6	8.7	1.1	6.2	1.3	3.8	<0.5	3.4	0.5	1.7	0.9	<0.5	<0.5	<0.5	13.7	2.3	35	39	8	191	155	48
13	ORDN-2/IC-1	9.5	1.1	<5	6.2	19.6	12.6	<0.5	5.1	104.1	24.5	0.7	33.8	3.8	<0.5	<0.5	<0.5	1.1	1.1	37.8	72.5	8.6	34.4	6.7	1.3	7.6	0.9	4.7	0.9	2.3	<0.5	1.6	<0.5	1.9	<0.5	<0.5	<0.5	<0.5	15.0	3.3	320	223	9	43	357	65
14	ORDN-2/IC-2	11.2	1.7	<5	24.9	42.1	22.8	<0.5	1.9	93.3	24.6	11.5	8.7	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	46.3	107.0	12.6	52.1	10.6	2.2	10.7	1.1	5.3	1.0	2.6	<0.5	2.1	<0.5	1.6	0.6	<0.5	<0.5	<0.5	8.4	0.8	44	75	6	284	179	53
15	ORDN-3/IC-1	6.3	<0.5	<5	8.4	38.2	14.7	<0.5	4.5	153.4	44.6	4.4	39.4	1.6	<0.5	<0.5	<0.5	<0.5	0.8	63.9	124.4	14.0	54.1	10.3	1.6	12.5	1.5	8.1	1.6	4.3	0.5	3.5	0.5	1.8	<0.5	<0.5	<0.5	<0.5	26.4	3.8	201	198	11	92	320	58
16	ORDN-4/IC-1	12.3	<0.5	<5	8.7	26.6	14.7	<0.5	1.1	123.9	21.8	1.6	9.1	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	76.4	140.9	14.6	51.4	7.9	1.5	9.8	0.9	4.5	0.9	2.6	<0.5	2.2	<0.5	2.7	<0.5	<0.5	<0.5	<0.5	35.7	1.6	76	49	16	150	71	90
17	ORDN-5/IC-1	11.0	<0.5	<5	10.6	25.4	16.6	<0.5	1.4	161.3	26.0	1.0	4.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7	91.6	178.4	18.0	63.6	10.2	1.8	13.0	1.1	5.3	1.0	2.8	<0.5	2.5	<0.5	2.4	<0.5	<0.5	<0.5	<0.5	42.7	2.1	67	56	18	104	78	84
18	ORDN-6/IC-1	1.9	0.8	<5	10.3	18.2	26.8	<0.5	7.1	70.1	17.8	2.0	23.8	<0.5	<0.5	2.7	<0.5	<0.5	<0.5	81.8	171.8	17.1	64.3	9.9	1.3	12.4	1.0	4.1	0.7	2.1	<0.5	1.6	<0.5	1.0	<0.5	<0.5	<0.5	0.7	35.5	1.8	180	55	12	67	87	30
19	ORDN-7/IC-1	5.0	0.8	<5	6.3	10.8	24.2	<0.5	8.4	89.8	18.2	2.8	40.1	0.9	<0.5	<0.5	<0.5	<0.5	0.6	77.1	160.0	17.1	64.5	10.7	1.5	12.5	1.1	4.5	0.7	1.9	<0.5	1.2	<0.5	1.6	0.5	<0.5	<0.5	1.1	42.7	2.6	335	101	13	101	78	48
20	ORDN-7/IC-2	7.4	<0.5	<5	8.0	21.8	27.6	<0.5	1.2	161.8	16.5	11.5	3.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	72.9	141.7	13.2	48.6	8.4	2.0	9.2	0.8	3.7	0.7	2.1	<0.5	1.7	<0.5	1.2	0.8	<0.5	<0.5	<0.5	30.3	0.7	180	42	21	118	77	33

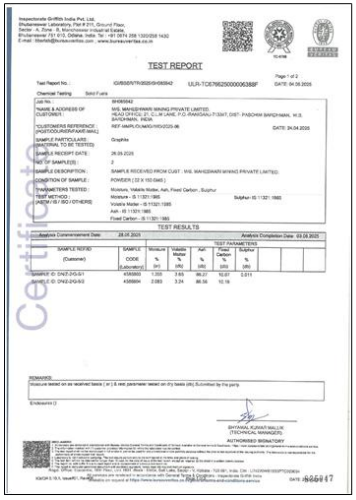
Annexure XIII: Analysis report of PCS Samples (in %)																		
Sl No	**Sample ID**	**Al2O3**	**BaO**	**CaO**	**Cr2O3**	**Fe (T)**	**Fe2O3**	**K2O**	**MgO**	**MnO**	**Na2O**	**P2O5**	**SO3**	**TiO2**	**SiO2**	**SrO**	**V2O5**	**LOI**
1	DS 86	17.78	<0.05	<0.05	0.06	7.34	10.5	<0.05	0.12	<0.05	<0.08	<0.05	<0.05	1.14	65.35	<0.05	<0.05	4.81
2	DS 632	16.48	0.07	5.03	0.05	4.02	5.75	1.73	1.71	<0.05	2.82	0.12	<0.05	0.55	65.4	<0.05	<0.05	0.18
3	DS 1112	17.22	<0.05	10.55	<0.05	8.23	11.77	0.31	8.95	0.13	1.89	0.08	0.2	1.05	47.07	<0.05	<0.05	0.66
4	DS 1204	11.38	<0.05	0.8	<0.05	4.96	7.09	4.93	0.27	<0.05	1.85	0.07	<0.05	0.22	73.21	<0.05	<0.05	<0.1
5	DS 1362	1.08	<0.05	0.32	0.07	1.64	2.35	1.21	<0.05	<0.05	<0.08	<0.05	<0.05	0.31	85.39	<0.05	<0.05	8.4
6	ORDN-3/CS-17	9.54	<0.05	0.66	0.09	6.71	9.59	3.62	0.49	<0.05	1.08	0.08	4.51	0.32	63.32	<0.05	<0.05	6.49
7	ORDN-2/CS-20	6.3	<0.05	0.42	0.07	4.01	5.73	1.95	0.75	<0.05	0.08	0.3	2.59	0.35	69.99	<0.05	<0.05	11.26
8	ORDN-7/CS-21	9.22	<0.05	0.06	0.08	1.74	2.48	4.36	0.15	<0.05	0.27	0.13	1.17	0.37	73.47	<0.05	<0.05	8.12
9	ORDN-5/CS-16	13.28	0.05	0.83	0.07	8.07	11.53	3.06	1.59	<0.05	0.86	0.08	4.54	0.68	58.06	<0.05	<0.05	5.27
10	ORDN-3 CR	14.21	0.13	6.04	0.07	5.36	7.66	1.33	4.36	0.07	1.29	0.32	0.34	0.62	63.16	<0.05	<0.05	0.35

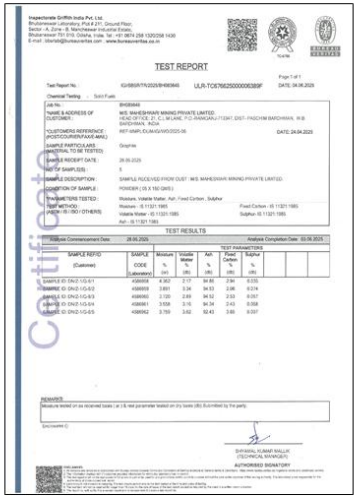
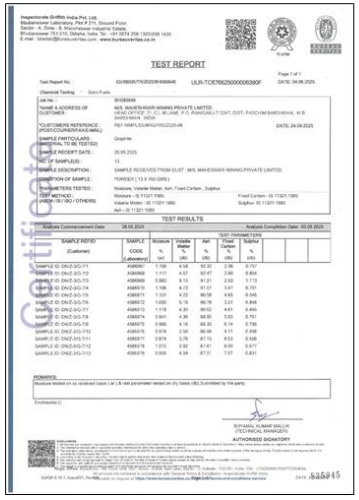
Annexure XIV : Locality Index				
Name of village	**Latitude**	**Longitude**	**Latitude**	**Longitude**
Balipadar	19°21' 15.679" N	83°35' 12.841" E	19.3544	83.5869
Bandugurha	19°21' 23.602" N	83°35' 20.364" E	19.3566	83.5890
Bhaleri	19°21' 16.068" N	83°34' 45.447" E	19.3545	83.5793
Chengli	19°22' 1.275" N	83°36' 56.044" E	19.3670	83.6156
Dharmagurha	19°21' 56.375" N	83°36' 7.876" E	19.3657	83.6022
Dhuanbari	19°21' 25.127" N	83°35' 59.331" E	19.3570	83.5998
Dubagurha	19°22' 44.525" N	83°35' 21.917" E	19.3790	83.5894
Dumburuneli	19°22' 35.076" N	83°37' 3.332" E	19.3764	83.6176
Gauragurha	19°22' 11.636" N	83°36' 27.266" E	19.3699	83.6076
Hikiriguma	19°24' 2.439" N	83°36' 57.774" E	19.4007	83.6160
Icchapai	19°24' 2.997" N	83°35' 51.697" E	19.4008	83.5977
Juani	19°24' 33.886" N	83°35' 21.695" E	19.4094	83.5894
Kalapai	19°20' 28.025" N	83°34' 10.615" E	19.3411	83.5696
Kalipadar	19°21' 38.331" N	83°36' 28.448" E	19.3606	83.6079
Katalipadar	19°23' 28.377" N	83°36' 57.367" E	19.3912	83.6159
Kumbhar dhamuni	19°23' 19.704" N	83°33' 10.582" E	19.3888	83.5529
Kundingipadar	19°20' 36.786" N	83°34' 39.384" E	19.3436	83.5776
Lakshmipur	19°21' 33.521" N	83°34' 50.311" E	19.3593	83.5806
Lanji	19°21' 51.62" N	83°35' 11.456" E	19.3643	83.5865
Minahala	19°24' 6.347" N	83°33' 20.354" E	19.4018	83.5557
Muratili	19°22' 51.235" N	83°34' 19.129" E	19.3809	83.5720
Nuagan	19°27' 46.916" N	83°33' 43.549" E	19.4630	83.5621
Padabai	19°24' 52.435" N	83°36' 53.367" E	19.4146	83.6148
Panugurha	19°22' 9.084" N	83°35' 17.829" E	19.3692	83.5883
Papatambu	19°22' 12.394" N	83°33' 25.666" E	19.3701	83.5571
Papikhal	19°24' 27.934" N	83°36' 25.532" E	19.4078	83.6071
Pathargarh	19°24' 56.633" N	83°33' 11.478" E	19.4157	83.5532
Penugonda	19°22' 36.214" N	83°34' 37.7" E	19.3767	83.5771
Pichuligurha	19°21' 27.125" N	83°34' 19.899" E	19.3575	83.5722
Rachuli	19°23' 36.952" N	83°33' 46.206" E	19.3936	83.5628
Rengabai	19°21' 46.265" N	83°35' 54.22" E	19.3629	83.5984
Rengalpaharu	19°21' 20.631" N	83°34' 0.925" E	19.3557	83.5669
Retili	19°21' 51.732" N	83°32' 49.892" E	19.3644	83.5472
Sindupanga	19°21' 55.046" N	83°34' 4.067" E	19.3653	83.5678
Terhiligurha	19°23' 51.546" N	83°32' 36.99" E	19.3977	83.5436

APPENDIX

Certificates from primary lab IGI for proximate analysis of groove samples of groove G1 to G8

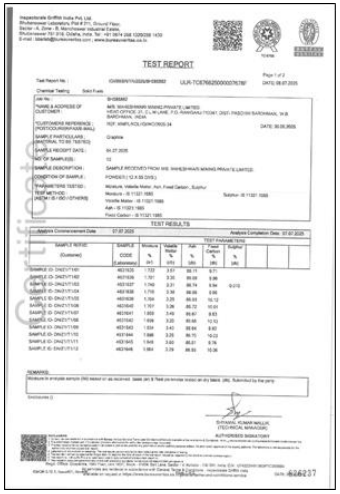
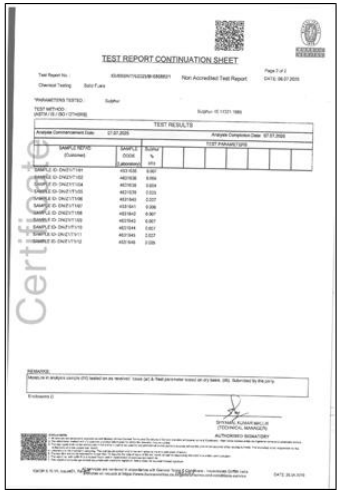



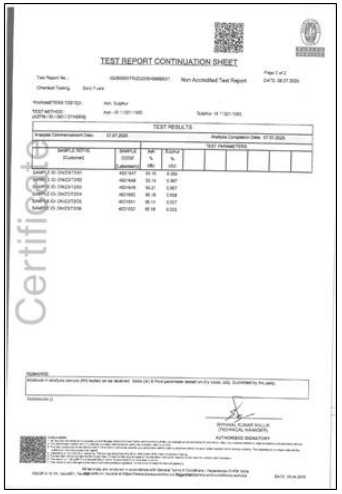


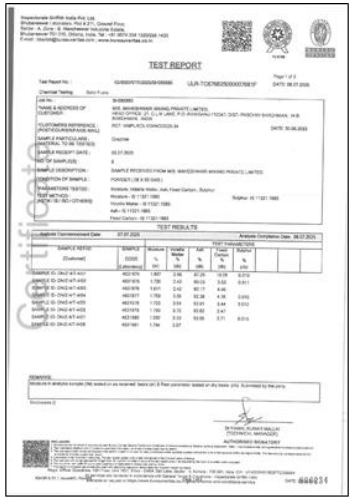
Certificates from primary lab IGI for proximate analysis of groove samples of groove G9 to G12

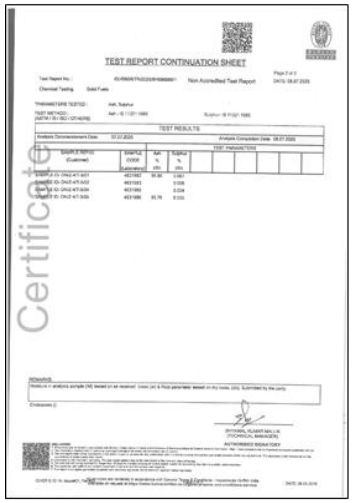
Certificates from primary lab IGI for proximate analysis of trench samples of trench T1 & T2

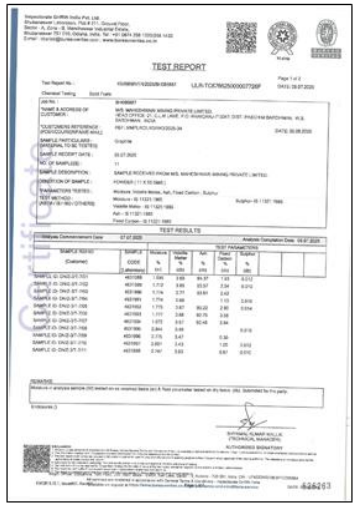





Certificates from primary lab IGI for proximate analysis of trench samples of trench T3 to T7

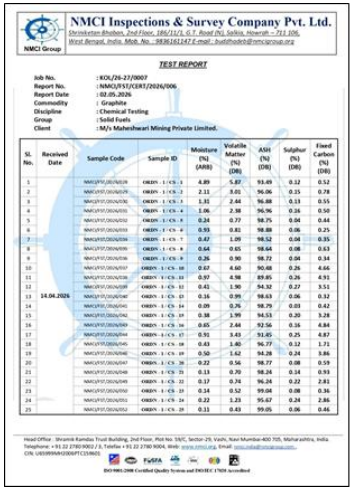
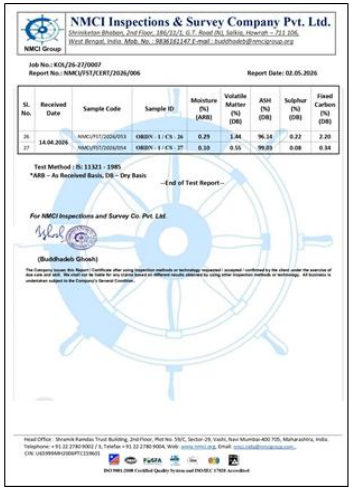
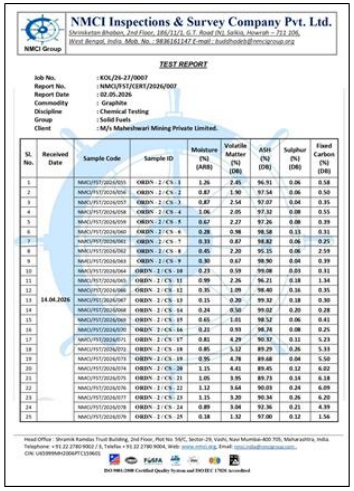
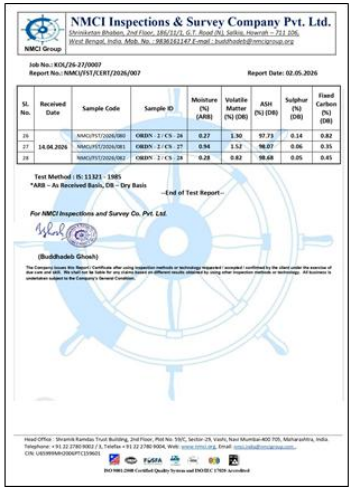
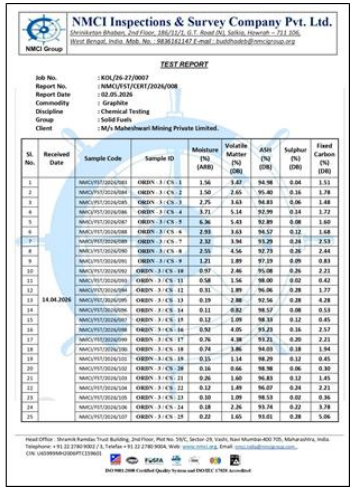




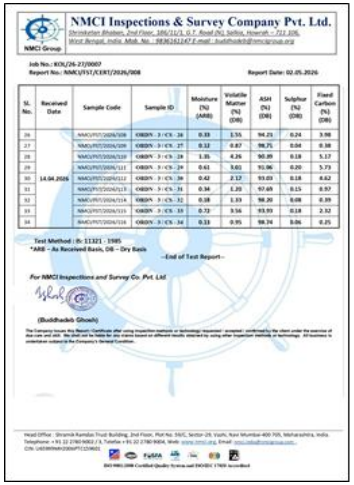
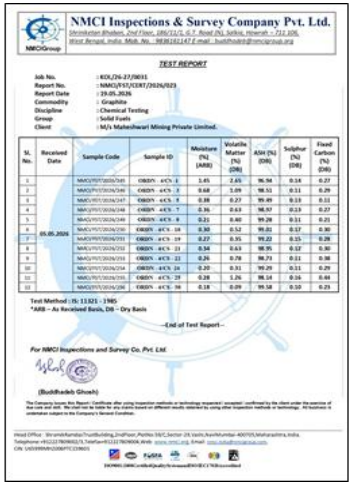
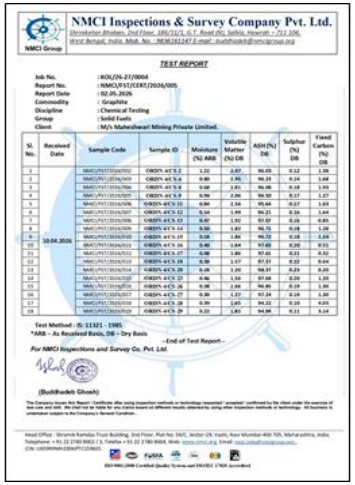
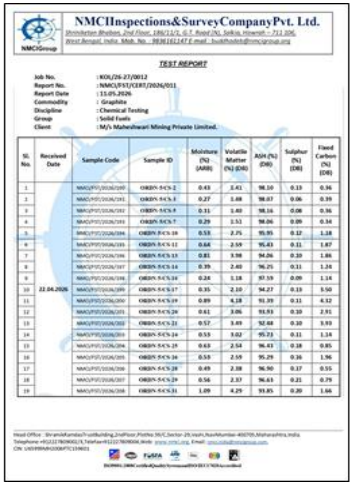
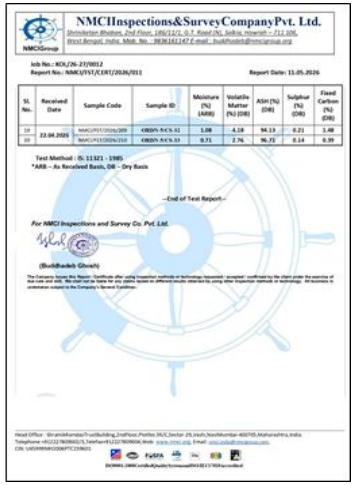


Certificates from primary lab IGI for proximate analysis of pit samples of pit P1 to P6

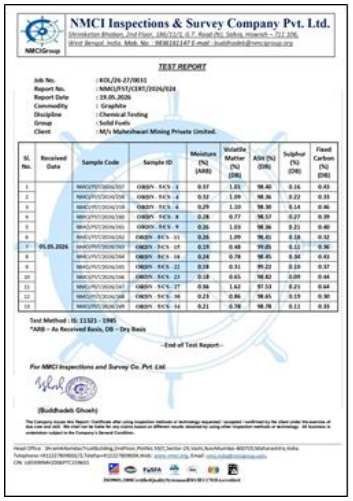
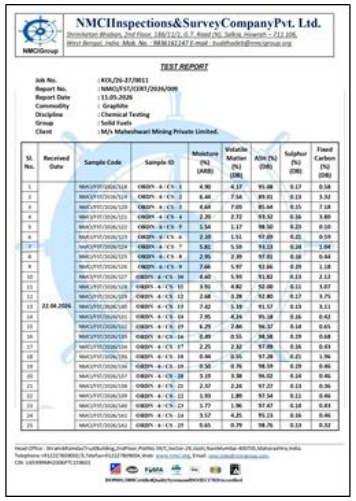
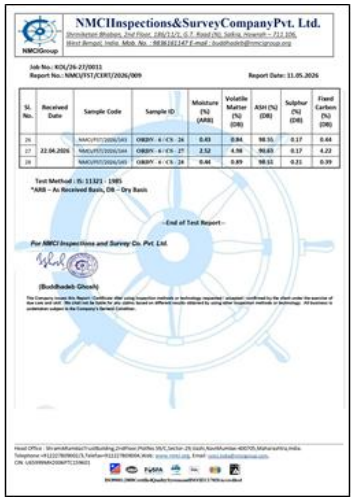
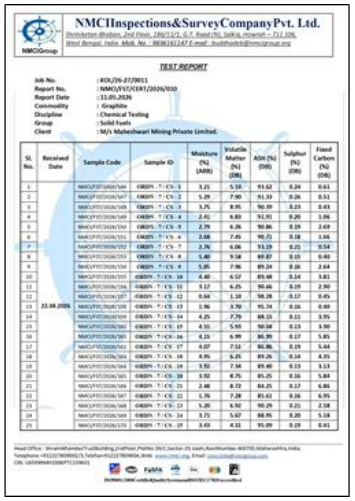
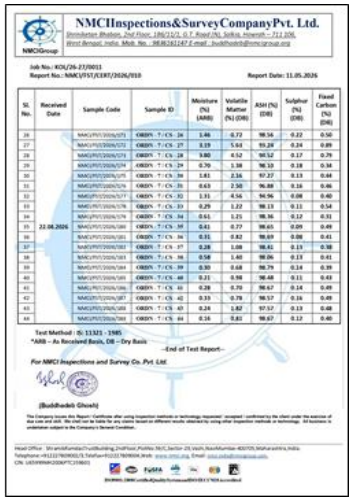
Certificates from primary lab NMCI for proximate analysis of core samples of ORDN-1 to ORDN-3

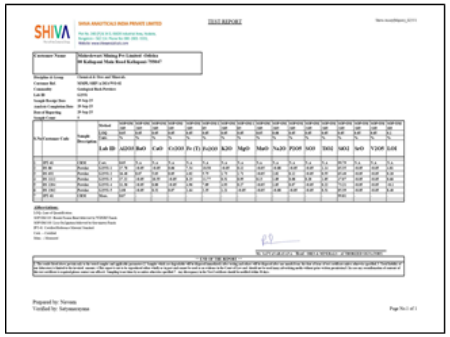
Certificates from primary lab NMCI for proximate analysis of core samples of ORDN-3 to ORDN-5

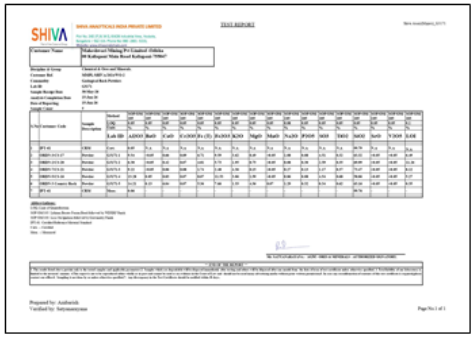






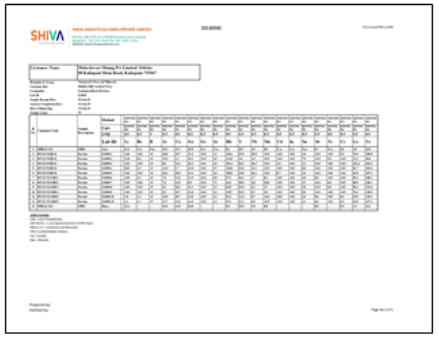
Certificates from primary lab NMCI for proximate analysis of core samples of ORDN-5 to ORDN-7

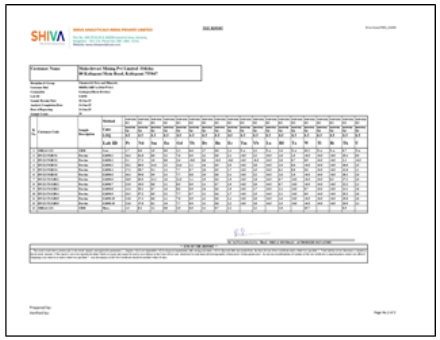






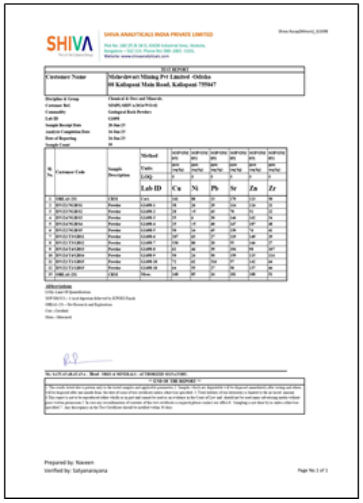
Certificates from primary lab SHIVA for PCS & ICPMS analysis of selected bed rock & core samples

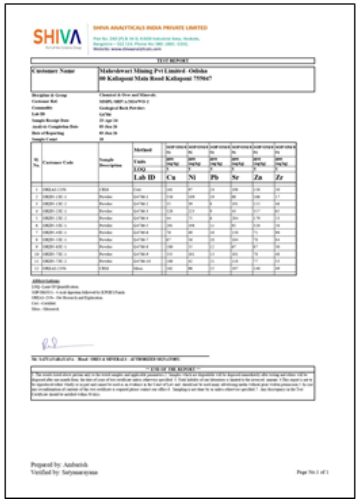


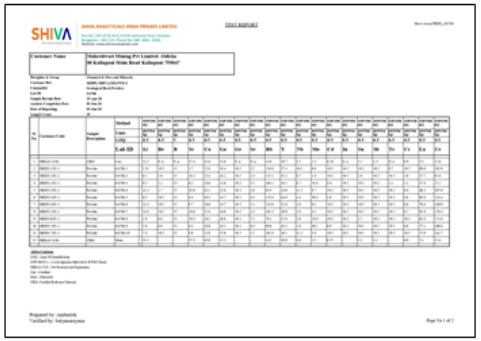


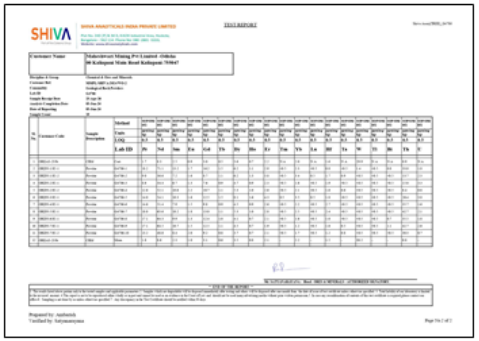








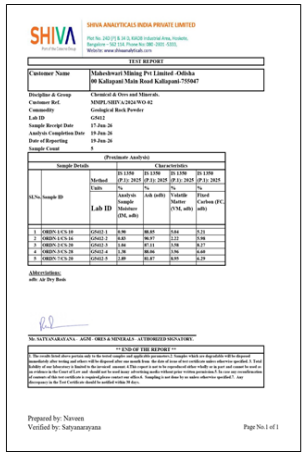




Certificates from SHIVA, IGI & NMCI lab for check sample of proximate analysis of BRS, PTS & core samples

TEST REPORT

Certificate



SHIVA ANALYTICALS INDIA PRIVATE LIMITED

TEST REPORT

Customer Name	Maheshwari Mining Pvt Limited -Odisha 00 Kaliapani Main Road Kaliapani-755047

Discipline & Group : Chemical & Ores and Minerals.
Customer Ref. : MNPL/SHIVA/2024/WO-02
Commodity : Geological Rock Powder
Lab ID : G5612
Sample Receipt Date : 17-Jun-26
Analysis Completion Date : 19-Jun-26
Date of Reporting : 19-Jun-26
Sample Count : 5

(Proximate Analysis)

Sl.No	Sample ID	Lab ID	Analysis Sample Moisture (OL adb)	Ash (adb)	Volatile Matter (VM, adb)	Fixed Carbon (FC adb)
1	ORDN 1CS 19	G5612-1	0.90	00.55	3.64	5.31
2	ORDN 1CS 16	G5612-2	0.83	00.97	2.12	3.98
3	ORDN 2CS 18	G5612-3	3.94	97.11	3.98	8.17
4	ORDN 3CS 28	G5612-4	1.38	00.06	3.96	6.60
5	ORDN 7CS 28	G5612-5	2.00	00.87	0.95	6.28

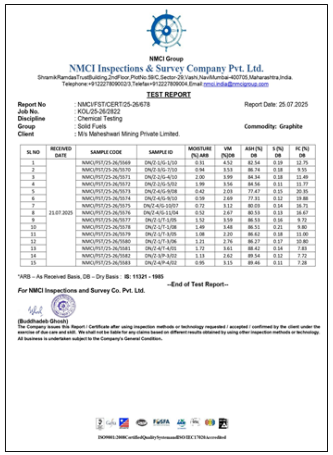
Abbreviations:
adb: Air Dry Basis

Mr. SATYANARAYANA - AGM - ORES & MINERALS - AUTHORIZED SIGNATORY.

** END OF THE REPORT **

Prepared by: Naveen
Verified by: Satyanarayana

Page No.1 of 1



NMCI Group

NMCI Inspections & Survey Company Pvt. Ltd.

TEST REPORT

Report No : NMCI/FST/CERT/25-26/678
Job No. : KOL/25-26/2822
Discipline : Chemical Testing
Group : Solid Fuels
Client : M/s Maheshwari Mining Private Limited.

Report Date: 25.07.2025
Commodity: Graphite

SL NO	RECEIVED DATE	SAMPLE CODE	SAMPLE ID	MOISTURE [%] ARB	VM [%]DB	ASH [%] DB	S [%] DB	FC [%] DB
1		NMCI/FST/25-26/5569	DN/2-1/L-1/10	0.93	4.52	82.54	0.18	12.75
2		NMCI/FST/25-26/5570	DN/2-3/L-7/10	0.94	3.53	88.74	0.18	9.55
3		NMCI/FST/25-26/5571	DN/2-2/L-6/10	2.00	3.99	84.34	0.18	13.49
4		NMCI/FST/25-26/5572	DN/2-1/L-5/02	1.99	3.56	84.56	0.11	11.77
5		NMCI/FST/25-26/5573	DN/2-4/L-9/08	0.42	2.05	77.47	0.15	20.35
6		NMCI/FST/25-26/5574	DN/2-4/L-9/10	0.58	2.68	77.31	0.12	19.88
7		NMCI/FST/25-26/5575	DN/2-4/L-10/07	0.72	3.12	80.05	0.14	16.71
8	21.07.2025	NMCI/FST/25-26/5576	DN/2-4/L-11/04	0.52	2.67	80.53	0.13	16.47
9		NMCI/FST/25-26/5577	DN/2-1/T-1/05	1.52	3.58	86.53	0.18	9.72
10		NMCI/FST/25-26/5578	DN/2-1/T-1/08	1.49	3.48	86.51	0.21	9.80
11		NMCI/FST/25-26/5579	DN/2-1/T-3/05	1.08	2.20	86.62	0.18	10.00
12		NMCI/FST/25-26/5580	DN/2-1/T-3/06	1.21	2.76	86.27	0.17	10.80
13		NMCI/FST/25-26/5581	DN/2-4/T-4/01	1.72	3.61	88.42	0.14	7.83
14		NMCI/FST/25-26/5582	DN/2-4/P-9/03	1.13	2.62	89.54	0.12	7.72
15		NMCI/FST/25-26/5583	DN/2-4/P-4/02	0.95	3.13	89.46	0.11	7.28

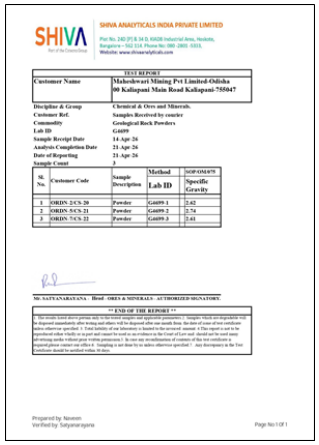
*ARB – As Received Basis, DB – Dry Basis : IS: 11329 : 1985

For NMCI Inspections and Survey Co. Pvt. Ltd.

--End of Test Report--

(Buddhadeb Ghosh)

Certificate from SHIVA lab for bulk density analysis of core samples



SHIVA ANALYTICALS INDIA PRIVATE LIMITED

TEST REPORT

Customer Name	Maheshwari Mining Pvt Limited-Odisha 00 Kaliapani Main Road Kaliapani-755047

Discipline & Group : Chemical & Ores and Minerals.
Customer Ref. : Samples Received by courier
Commodity : Geological Rock Powders
Lab ID : G6899
Sample Receipt Date : 14-Apr-26
Analysis Completion Date : 21-Apr-26
Date of Reporting : 21-Apr-26
Sample Count : 3

Sl. No.	Customer Code	Sample Description	Lab ID	Method SOP-OM-070 Specific Gravity
1	ORDN 2-CS-20	Powder	G6899-1	2.42
2	ORDN 5CS-21	Powder	G6899-2	2.74
3	ORDN 7CS-21	Powder	G6899-3	2.41

Mr. SATYANARAYANA - Head - ORES & MINERALS - AUTHORIZED SIGNATORY.

** END OF THE REPORT **

Prepared by: Naveen
Verified by: Satyanarayana

Page No.1 Of 1