RECONNAISANCE SURVEY (G4 STAGE) FOR GRAPHITE AND ASSOCIATED MINERALS AROUND SONAGHATI, AMDOL, JHAREGAON & BHAYAWARI, DISTRICT: BETUL, MADHYA PRADESH

Name of the Block: AMDOL BLOCK
Explored block area: 7.34 SQ.KM
Toposheet No. 55G/13

Submitted to

खान मंत्रालय
MINISTRY OF
MINES
सत्यमेव जयते

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

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GEOLOGICAL REPORT ON

RECONNAISSANCE SURVEY (G4) FOR GRAPHITE AND ASSOCIATED MINERALS AROUND SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI, BETUL DISTRICT, MADHYA PRADESH

2. Officials Involved in the Exploration Project

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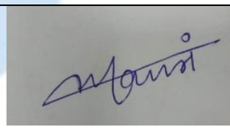
5	Ms Mansi Kesarwani	Junior Geologist	
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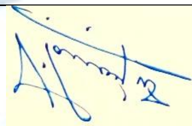
3	Mr. Manoj Kumar VP	Senior Geologist	
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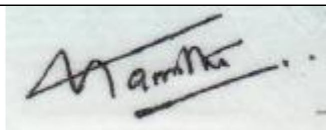
1	Mr. Sandeep Hamilton	Director Technical	

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Abbreviations	Description
GSI	Geological Survey of India
SOI	Survey of India
NMET	National Mineral Exploration Trust
MoM	Ministry or Mines
TCC	Technical – cum- Cost Committee
EC	Executive committee
DMG	Department of Mines and Geology
NQT	Nature, Quantum and Target
REE	Rare Earth Elements
DGPS	Differential Global Positioning System
PPM	Parts per Million
km2	Square Kilometre
ENE	East - North - East
WSW	West - South - West
NE	North-East
SW	South-west
NW	North-West
SE	South-East
ICP-MS	Inductively coupled plasma mass spectrometry
ICP-OES	Inductively coupled plasma optical emission spectroscopy
EPMA	Electron probe Microanalysis

CHAPTER – 1

1. SUMMARY

A reconnaissance survey (G4 Stage) titled ***"Reconnaissance Survey (G4-Stage) for Graphite and Associated Minerals around Sonaghati, Amdol, Jharegaon and Bhayawari, District Betul, Madhya Pradesh"*** was undertaken under the sanction letter F.No.23/448/2024-NMET/04 dated 2nd April 2024, issued by the National Mineral Exploration Trust (NMET), Ministry of Mines. The investigated region is situated in the western segment of the east-west trending Proterozoic Betul Belt and occupies the South-western margin of the Central Indian Tectonic Zone (CITZ), a prominent geological feature of Central India.

The selected block falls in the toposheet no 55G/13 and was taken adjacent to GSI's block which had proved and viable Graphite concentrations. Geological mapping of a 7.34 sq. km area at a 1:4000 scale was carried out in the selected region as part of the survey. This large-scale geological mapping helped in identifying a diverse lithological assemblage in the area, which is dominated by granitic gneiss, quartzite, phyllite, and migmatite, with prominent quartzite ridges and shear-controlled contacts.

Systematic sampling was executed on field, where a total of 50 BRS samples were collected during the investigation. Trenching activities involved excavating approximately 100 cubic meters from 5 trenches, from which 50 trench samples were obtained. From the total samples collected, selectively only 15 bedrock samples and 26 trench samples were analysed for proximate parameters (FC, VM, ash, moisture content) from certain ones to understand the presence of Graphite. 8 bedrock samples were analysed for base metal content using the ICP-MS method. Further 7 bedrock samples were submitted for

petrographic and mineralographic analysis to study their mineral composition and textures.

Lithology Type		FC%
Granite gneiss (7)	Min	0.12
	Max	0.26
	Avg	0.22
Quartzitic phyllite (4)	Min	0.05
	Max	0.62
	Avg	0.24
Ferruginous quartzite (1)		0.18
Phyllite (1)		0.19
Quartzite (2)	Min	0.13
	Max	0.26
	Avg	0.19

- The total of 7 granite gneiss samples shows that the minimum fixed carbon is 0.12%, the maximum is 0.26%, and the average is 0.22%.
- The total of 4 Quartzitic phyllite samples shows that the minimum fixed carbon is 0.5%, the maximum is 0.62%, and the average is 0.24%.

All Fixed Carbon (FC) values for BRS and trench samples were below the reconnaissance cut-off grade of 2% for graphite. Though a few trench samples such as sample no. MPAJ/T4-03/2023-24 recorded ~1.96% FC after acid digestion, reflecting near-cut-off values but still sub-threshold and only one sample yielded this level. These results show the presence of graphite in trace to low concentrations but not in economic abundance at shallow levels.

All eight samples analysed using the ICP-MS method exhibited very low base metal concentrations (Cu, Ta, Nb), except for one sample derived from a pegmatite body, which showed isolated tantalum enrichment (158 ppm) which is just above the economic reporting threshold (100 ppm).

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Geophysical coverage was restricted to 5 line-km of Self Potential (SP) profiling to understand the subsurface mineralization. The recorded anomalies ranged from –20 to –50 mV, which reflect a conductive body at depth. The interpretation of these anomalies also helped identify the lithological contact between quartzite, phyllite, and granite gneiss formations.

The Technical Coordination Committee (TCC) observed that the area lacks sufficient surface manifestations indicative of potential subsurface mineralized zones. Based on this assessment, the committee concluded that further investigation may not be warranted in the area and recommended to close further activities and submit the report.

Taken together, the geochemical and geophysical evidence suggests the absence of shallow, high-grade graphite mineralisation within the mapped area.

अध्याय – 1

सारांश

"ग्रेफाइट एवं संबंधित खनिजों के लिए रिकॉनसेंस सर्वे (G4 चरण), सोनाघाटी, अमडोल, झरेगांव एवं भायावरी गांव, जिला-बेतुल, मध्यप्रदेश" को राष्ट्रीय खनिज अन्वेषण न्यास (NMET), खनन मंत्रालय द्वारा 2 अप्रैल 2024 को जारी स्वीकृति पत्र क्रमांक F.No.23/448/2024-NMET/04 के अंतर्गत संचालित किया गया।

जांच किया गया क्षेत्र पूर्व–पश्चिम दिशा में फैली प्रोटेरोज़ोइक बेतुल बेल्ट के पश्चिमी खंड में स्थित है तथा यह मध्य भारत की एक प्रमुख भूवैज्ञानिक विशेषता सेंट्रल इंडियन टेक्टोनिक ज़ोन (CITZ) के दक्षिण–पश्चिमी भाग में आता है।

चयनित ब्लॉक टोपोशीट क्रमांक 55G/13 में आता है तथा यह GSI के उस ब्लॉक के समीप लिया गया, जहाँ ग्रेफाइट की सघन एवं व्यवहार्य सान्द्रता सिद्ध हुई थी। चयनित क्षेत्र में 7.34 वर्ग कि.मी. क्षेत्रफल का 1:4000 मापनी पर भूवैज्ञानिक मानचित्रण किया गया। इस विस्तृत मानचित्रण से क्षेत्र में विविध शैल-समूहों की पहचान हुई, जिसमें मुख्य रूप से ग्रेनाइटिक ग्नाइस, क्वार्ट्ज़ाइट, फिलाइट तथा मिगमैटाइट शामिल हैं। इनमे क्वार्ट्ज़ाइट की प्रमुख पहाड़ियाँ तथा शियर-नियंत्रित संपर्क देखे गए।

मैदान पर व्यवस्थित सैम्पलिंग की गई, जिसमें कुल 50 बेडरॉक सैम्पल (BRS) लिए गए। खाइयों (ट्रेंचिंग) की गतिविधियों में 5 खाइयों से लगभग 100 घन मीटर खुदाई कर 50 नमूने लिए गए। कुल नमूनों में से 15 बेडरॉक नमूनों एवं 26 खाई के नमूनों का विश्लेषण आसन्न मानकों (FC, VM, राख, नमी की मात्रा) हेतु किया गया। 8 बेडरॉक नमूनों का ICP-MS विधि द्वारा बेस मेटल तत्वों के लिए विश्लेषण किया गया। इसके अतिरिक्त 7 बेडरॉक नमूनों को पेट्रोग्राफिक एवं मिनरलोग्राफिक अध्ययन हेतु भेजा गया ताकि उनके खनिजीय संघटन एवं बनावट का पता लगाया जा सके।

शैलविज्ञान प्रकार		स्थिर कार्बन प्रतिशत
ग्रेनाइट ग्राइस (7)	न्यूनतम	0.12
	अधिकतम	0.26
	औसत	0.22
क्वार्टज़िटिक फिल्लाइट (4)	न्यूनतम	0.05
	अधिकतम	0.62
	औसत	0.24
फेरुजिनस क्वार्टज़ाइट (1)		0.18
फिल्लाइट (1)		0.19
क्वार्टज़ाइट (2)	न्यूनतम	0.13
	अधिकतम	0.26
	औसत	0.19

• कुल 7 **ग्रेनाइट ग्राइस** नमूनों से पता चलता है कि न्यूनतम स्थिर कार्बन 0.12%, अधिकतम 0.26%, और औसत 0.22% है।

• कुल 4 **क्वार्टज़िटिक फिल्लाइट** नमूनों से पता चलता है कि न्यूनतम स्थिर कार्बन 0.05%, अधिकतम 0.62%, और औसत 0.24% है।

बीआरएस और ट्रेंच नमूनों के लिए सभी स्थिर कार्बन (एफसी) मान ग्रेफाइट के लिए 2% की पुनरीक्षण कट-ऑफ श्रेणी से नीचे थे। हालांकि कुछ ट्रेंच नमूनों जैसे नमूना संख्या MPAJ/T4-03/2023-24 में अम्ल पाचन के बाद ~1.96% एफसी दर्ज किया गया, जो कट-ऑफ मानों के करीब था लेकिन फिर भी सीमा से नीचे था और केवल एक नमूने में यह स्तर प्राप्त हुआ। ये परिणाम अल्प से निम्न सांद्रता में ग्रेफाइट की उपस्थिति दर्शाते हैं लेकिन उथले स्तरों पर आर्थिक प्रचुरता में नहीं।

आईसीपी-एमएस विधि का उपयोग करके विश्लेषण किए गए सभी आठ नमूनों में बहुत कम आधार धातु सांद्रता (Cu, Ta, Nb) प्रदर्शित हुई, सिवाय एक नमूने के जो पेग्माटाइट निकाय से प्राप्त हुआ था, जिसमें पृथक टैंटलम संवर्धन (158 पीपीएम) दिखा जो आर्थिक रिपोर्टिंग सीमा (100 पीपीएम) से थोड़ा ऊपर है।

भूभौतिकीय अध्ययन 5 लाइन-किमी तक सेल्फ पोटेंशियल (SP) प्रोफाइलिंग द्वारा किया गया ताकि अधस्तलीय खनिजीकरण का पता लगाया जा सके। इसमें –20 से –50 mV तक की विसंगतियाँ दर्ज की गईं, जो गहराई पर एक चालक निकाय (कंडक्टिव बॉडी) की उपस्थिति को दर्शाती हैं। इन विसंगतियों की व्याख्या ने क्वार्ट्ज़ाइट, फिलाइट एवं ग्रेनाइट ग्राइस संरचनाओं के बीच लिथोलॉजिकल संपर्क की पहचान में भी मदद की।

तकनीकी समन्वय समिति (TCC) ने यह अवलोकन किया कि क्षेत्र में सतह पर पर्याप्त संकेत नहीं हैं जो संभावित अधस्तलीय खनिजीकृत क्षेत्रों की पुष्टि करें। इस मूल्यांकन के आधार पर समिति ने निष्कर्ष निकाला कि क्षेत्र में आगे की विस्तृत जांच आवश्यक नहीं है और शेष गतिविधियों को बंद कर रिपोर्ट प्रस्तुत करने की अनुशंसा की।

समग्र रूप से, भू-रासायनिक एवं भूभौतिकीय साक्ष्यों से यह स्पष्ट होता है कि मानचित्रित क्षेत्र में सतही उच्च-ग्रेड ग्रेफाइट खनिजीकरण अनुपस्थित है।

CHAPTER – 2

2. INTRODUCTION

2.1. Preamble

To enhance mineral exploration across the country, the Government of India introduced the National Mineral Exploration Policy (NMEP) in 2016, encouraging active involvement from the private sector. The policy is designed to tap into the private sector's strengths, such as advanced technology, specialized expertise, and greater financial capability, to uncover and develop the nation's untapped mineral potential. Additionally, NMEP provides risk-mitigation incentives to exploration agencies, reflecting the government's commitment to fostering a more collaborative and investment-friendly environment in the mineral exploration sector.

A major development supporting this initiative is the amendment of the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act) in 2021. These changes have enabled the Central Government to authorize Private Exploration Agencies (PEAs) to carry out mineral prospecting activities, with financial support from the National Mineral Exploration Trust (NMET). The participation of PEAs is anticipated to significantly accelerate exploration efforts across the country, helping to identify more mineral-rich blocks for future development. Once accredited by QCI-NABET, PEAs become eligible to apply for notification by the Ministry of Mines under the revised MMDR provisions. In alignment with these reforms, a dedicated scheme has been put in place to facilitate the involvement of Notified PEAs in major mineral exploration projects undertaken by State Governments.

The Indian graphite market is witnessing growing interest, driven by rising demand across multiple industrial sectors. Graphite, known for its excellent conductivity, lubricity, and thermal resistance, is a critical raw material in the manufacture of refractory products, foundry facings, crucibles, brake linings and Lithium-ion battery. Its expanding role in emerging technologies, particularly in the production of lithium-ion batteries, fuel cells, and advanced electronic devices has positioned graphite as a strategic mineral. The clean energy and electric vehicle (EV) revolution is further accelerating demand, as graphite is a key component in battery anodes. Additionally, the steel industry remains a major consumer of graphite electrodes used in electric arc furnaces. Despite having significant graphite deposits, India continues to rely on imports to meet growing domestic requirements, highlighting the urgent need for enhanced graphite exploration and development to support future industrial and energy needs.

Seeing this opportunity, GeoExpOre proposed exploration of graphite in Betul District, MP. Then, upon careful discussions and further recommendations of the Technical-cum-Cost Committee (TCC) of the National Mineral Exploration Trust (NMET), the Executive Committee (EC), in its 34th meeting held on 31st March 2023, approved the mineral exploration project titled ***"Reconnaissance Survey (G4-stage) for Graphite and Associated Minerals around Sonaghati, Amdol, Jharegaon, and Bhayawari, District: Betul, Madhya Pradesh."***. The project cost was estimated at 1.11Cr. However, the project cost has been curtailed to INR 27,01,216/- owing to a reduction in exploration activity due to absence of signatures of graphite.

2.2. Details of the Project

2.2.1. Title of the project

Reconnaissance Survey (G4-stage) for Graphite and Associated Minerals around Sonaghati, Amdol, Jharegaon, and Bhayawari, District: Betul, Madhya Pradesh.

2.2.2. Investigating agency

GeoExpOre Private Limited, Bangalore**,** is a notified private exploration agency accredited by QCI-NABET (Govt. of India) based in Bengaluru, Karnataka.

2.3. Objectives of Investigation

The exploration work for graphite and associated mineralization in graphite-bearing formations, primarily hosted within quartz mica schist, graphite schist gneissic lithologies, is being undertaken as part of a G4-stage reconnaissance survey. The programme consists of the following objectives.

1. Geological Mapping (1:4,000 scale): To delineate graphite-bearing formations, identify lithological contacts, structural features, and surface indications of graphite mineralization.
2. Surface Prospecting and Traverses: Conduct systematic field traverses to locate graphite-rich zones, visible flakes, and carbonaceous exposures in the target area and collect the samples from trenches.
3. Sample Collection (Bed rock and Trench Samples): Collect representative samples from outcrops, trenches to assess the presence and concentration of graphite.
4. Laboratory Analysis: Perform proximate analysis of samples for Fixed Carbon (FC), Volatile Matter (VM), Ash content, and Moisture to determine the quality and economic potential of the graphite.

5. Petrographic and Mineralographic Studies: Study selected samples to understand the mineralogical characteristics, flake size distribution, and texture of graphite within the host rock.
6. Geophysical Investigation: Undertake geophysical (resistivity, IP, Magnetic, and SP methods) survey to understand subsurface mineralized zones.
7. Subsurface Investigation through Borehole Drilling: Undertake limited scout drilling to intersect graphite-bearing zones at depth, validate surface observations, and assess vertical continuity and flake size distribution.
8. Reporting and Recommendations: Prepare and submit a detailed report in line with G4-stage requirements as per MEMC Rules 2021, including interpretations, conclusions, and recommendations for further exploration (G3 stage), if justified.

2.4. Basis for taking up the investigation

Initial investigations into graphite mineralization in the Betul belt, specifically around the Tikari–Gauthana and Chiklar areas, were first documented by J. Narayanmurthy in 1958. He identified a narrow zone of graphite schist hosted within muscovite-quartz schist, measuring approximately 3.2 km in length and 30–35 meters in width. Building upon this early work, the Geological Survey of India (GSI) conducted a G4-stage reconnaissance survey during the field season (FS) 2012–13, led by Lenka and Ahmad (2013). Detailed mapping at a scale of 1:12,500 was undertaken, which delineated graphite mineralization exposed intermittently across three lenticular bands arranged in an en echelon pattern. These bands collectively extend over a strike length of more than 3.5 km and trend from ENE–WSW to NNE–SSW. The three graphite-bearing zones were categorized as the southern (1,450 m), central (550 m), and northern (1,350 m) bands. In the following field season (FS: 2013–14), the same team undertook subsurface exploration, drilling seven boreholes across portions of the southern and central bands. This drilling confirmed graphite mineralization over a strike length of approximately 1.25 km and led to a resource estimation of 4.73 million tonnes at the 333 GNFC level.

Based on the positive results obtained from these explorations, GSI during FS:2015-16 took up a general exploration (G2), which included close-spaced drilling with deeper intersection (vertical depth – 135m) in the southern band and central band covering 670m and 530m respectively covering an area of 0.3 sq. km. The quantum of work included a detailed mapping on a scale of 1:2000, exploratory drilling approximately at 200 m intervals for 2nd level of intersection, and the infillings of boreholes wherever possible for the first level of intersection. GSI has also carried out a G4 reconnaissance investigation in the SW region of the investigated block, covering a total area of 100 sq.km. The work covered in this G4 study includes mapping on a scale of 1:12,500, collection of BRS samples, pitting and trenching, and geophysical study (resistivity, IP, Magnetic, and SP methods). The area was geochemically analyzed for graphite and associated mineralization.

Exploration activities undertaken by the Geological Survey of India (GSI) over different phases have revealed that metasedimentary units such as quartz-mica schist and quartzite appear as linear ridges of varying dimensions within the surrounding gneissic terrain in the Sonaghati and Golighat regions. The graphite mineralization in this area is hosted primarily within graphitic schist and phyllitic units of the Betul Belt, with quartz-mica schist identified as the principal host rock.

Structural analysis indicates that the area has undergone multiple phases of deformation, suggesting that the mineralization is largely structurally controlled. The majority of the grantic gneiss, quartzitic phyllite, quartzite, pegmatite veins are showing 70 to 80 dip direction with noticeable fabrics in the field, this establishes the fact that the mineralisation is structurally controlled. area indicates steep dip direction (greater than 70) which shows the area was disturbed earlier. The same has been depicted in the Plate III. Field evidence clearly demonstrates the remobilization and reorientation of graphite along major shear zones, which extend along the NE–SW strike direction across the block.

GeoExpOre has initiated an investigation in two blocks previously explored by the Geological Survey of India (GSI). The area is located in the northwestern part of the CITZ region within the Betul Belt and encompasses the villages of Sonaghati, Amdol, Jharegaon, and Bhayawari in Betul District, Madhya Pradesh. The investigation area falls under Survey of India Toposheet No. 55G/13. Further details about the block are provided in the following sections.

2.5. Details of Nature and Quantum of work Approved vs Achievement

2.5.1. Nature of work

The nature of the work and its flow pattern are shown in the chart below

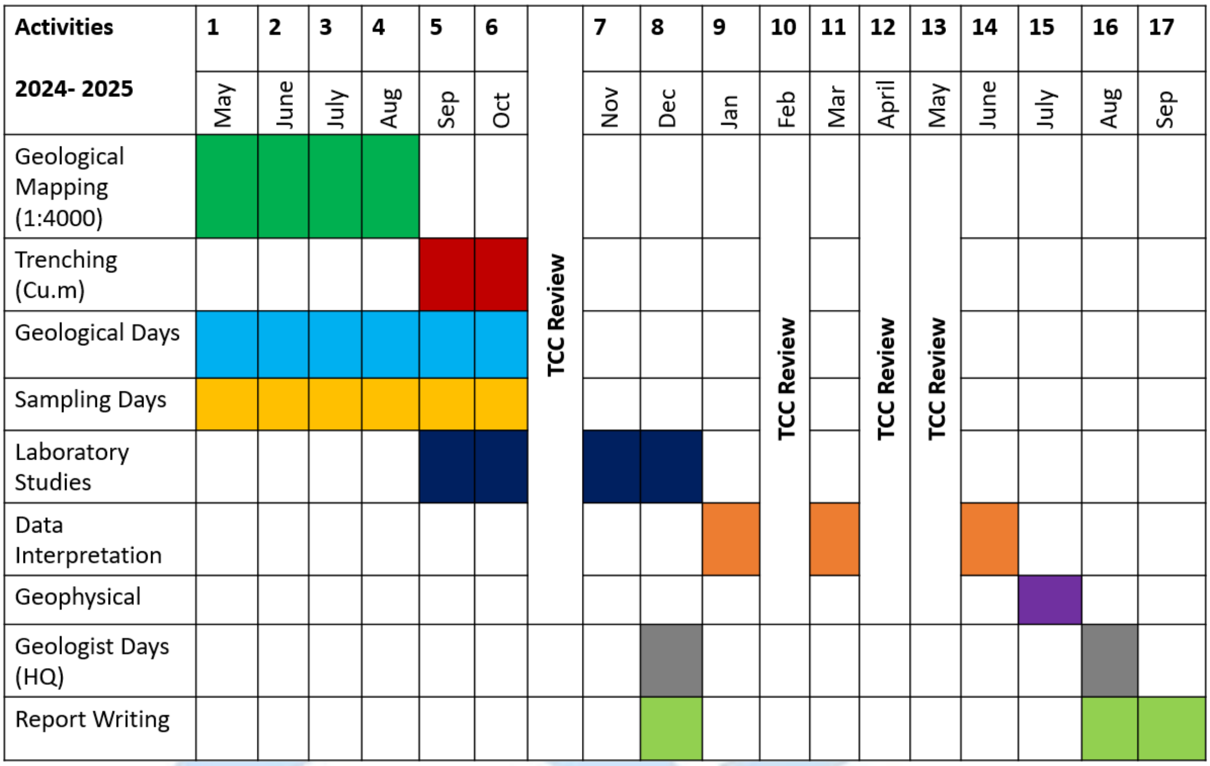

Fig 2.1 Time schedule / Action for the Reconnaissance Survey (G4-stage) for Graphite and Associated Minerals around Sonaghati, Amdol, Jharegaon, and Bhayawari, District: Betul, Madhya Pradesh.

Geophysics was conducted after sampling to demarcate the subsurface graphite zones present, if any. Significant low SP values were registered but concrete evidence of graphite zone can't be marked only based on SP survey, further IP survey or other geophysical methods are needed to completely assess the zone and draw a conclusion.

2.5.2. Quantum of work approved vs. achievement (Table 2.1)

The quantum of approved work and the achievements are shown in the following Table.

Table 2.1: Nature and Quantum of Work (Target v/s Achievement)

Sr. No	NATURE OF WORK	TARGET ASSIGNED	ACHIEVED

1	Geological mapping (LSM/DM) (Sq. km)	7.34Sq. Km (1:4000 scale)	7.34 Sq. Km
2	Geophysical Surveys – IP Cum Resistivity + Magnetic (8-10 line kms) package	8-10 line kms (modified to only SP – 05line kms)	5 Line km
3	**Technological**		
	a. Surface exploration: Trenching (1*2*10 mts) *5 no's trenches	100 cum	100 cum
	b. Sub surface exploration: Drilling 5 Boreholes (vertical depth 60m)	300 m	Later, not approval by TCC
4	**Geochemical survey**		
	a. Bed Rock Survey	40 Nos	50 Nos
	b. Trench Samples	40 Nos	50 Nos
	c. Core Sample (Nos)	100 Nos	*Not carried out
5	**Petrographic / Mineralographic/ Other Studies**		
	a. Preparation of thin section	10 Nos	7 Nos (thin polished Sections)
	b. Preparation of polished section	10 Nos	
	c. Complete petrographic/Ore microscopic study/Mineralographic study	20 Nos	7 Nos (07)
	d. ICP-MS Studies – Bse metal Analysis	15 Nos	8 Nos
	e. Petrographic Core (Nos)	5 Nos	*Not Carried out

	f. XRD	10 Nos	*Not Carried out
	g. Bulk Density	10 Nos	*Not carried out
6	Chemical Analysis		
	a. BRS chemical analysis	40 Nos	23 Nos
	b. Trench Samples	40 Nos	26 Nos
	c. Core	100 Nos	*Not carried out
	d. Internal Check Samples	5% - 4 Nos	*Not carried out
	e. External check samples	10% - 18 Nos	*Not carried out
	f. Whole Rock Analysis	10 Nos	*Not carried out

**Not Carried out -because of not finding encouraging values of graphite in BRS/Trench, and no drilling activity*

2.5.3. Achievement

As part of the reconnaissance survey in the area for graphite, significant progress has been made across various geological and exploration activities as per the targets assigned by NMET. The entire geological mapping target of 7.34 sq. km at a 1:4000 scale was successfully completed. Based on mapping, 100 cubic meters of surface trenching was fully achieved at potential locations. However, the planned 300 meters of sub-surface drilling approval was not given by the TCC, due to the lack of surface evidence of graphite mineralisation. In the geochemical survey, 100 targeted proximate analyses (comprising 50 BRS and 50 trench samples) were sampled and analysed a few selected samples, while the proximate analysis for drill core samples could not be conducted due to the absence of core samples from drilling. Based on geochemical analysis results, as per the approval from TCC, the ground geophysical survey was conducted and completed 5-line km of SP survey, which is partial against the targeted 8–10-line km under the IP-cum-Resistivity-SP-Magnetic survey package. The DGPS survey for borehole fixation (5 locations) was also not carried out for the same reason. In petrographic and mineralographic, 7 samples were analysed for petrography studies. Overall, the reconnaissance survey has resulted in an understanding of the entire area with surface geological mapping, trenching, and laboratory investigations.

2.6. Personnel involved

Based on the quantum of work assigned by NMET, GeoExpOre deployed a dedicated team to carry out the project activities. A Project Coordinator was appointed to oversee and manage the overall execution of the project, who was supervised and guided by the Director-Technical of the company. A Senior Geologist and a Geologist were engaged to conduct the geological mapping, sampling, and related fieldwork. Labourers were also employed to assist in sampling and trenching operations. Additionally, a Geophysicist was assigned to carry out the planned geophysical survey. This multidisciplinary team was mobilized to ensure the timely and efficient completion of the assigned tasks.

Table 2.2: List of personnel involved

Name of officers	Designation	No. of field Days
Mr. Manoj VP	Senior Geologist	90 days
Mr. Adoni Gopal	Geologist	90 days
Dr. R. Chandrasekaran	Project coordinator (PC)	20 days
Mr. Sandeep Hamilton	Director -Technical	10 days

2.7. Mode of operation of different work components and associated agency

Geological mapping on a 1:4,000 scale was conducted by GeoExpOre geologists as part of the reconnaissance survey. In addition to mapping, samples were systematically collected from outcrops and trenches for further analysis. The geophysical SP survey was carried out by GeoExpOre in-house geophysicist. Chemical analysis of bedrock and trench samples was outsourced, where a total of 23 bedrock samples and 26 trench samples were analysed. Petrography studies were undertaken by the Geological Survey of India (GSI), Bengaluru. As part of these studies, 7 thin sections were prepared and examined by GSI experts. And 8 samples were analysed for Base Metals using ICPMS.

2.8. Acknowledgement

Authors from GeoExpOre Private Limited sincerely thank the Ministry of Mines, Government of India, and the National Mineral Exploration Trust (NMET) and their whole team for their valuable support and funding for the project titled "Reconnaissance Survey (G4-stage) for Graphite and Associated Minerals around Sonaghati, Amdol, Jharegaon, and Bhayawari Villages, District: Betul, Madhya Pradesh.". Authors remains grateful to TCC Committee-NMET for giving us the opportunity and extending their commitment to support throughout the investigation. The authors would like to express their sincere gratitude to Dr. Subrasuchi Sarkar, former Deputy Director General of GSI, Retd., Bhopal, MP, for his invaluable guidance and support throughout the course of this project. The Authors heartfelt thanks also go to Shri Dileep Kumar, Director, GSI, Bhopal, MP, for his continued encouragement and assistance. The authors are grateful to Dr. Manish Paleewar, Director, Mining Department, Betul District, MP, for his insightful advice and support during this work.

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CHAPTER -3

3. PROPERTY DESCRIPTION

3.1. Details of the area

The proposed block is situated in the northwestern part of the CITZ region of the Betul Belt, within Sonaghati, Amdol, Jharegaon & Bhayawari villages, Betul District, Madhya Pradesh. It falls under the Survey of India Toposheet No. 55G/13. Land use in the area is diverse; approximately 60% of the land is utilized for cultivation, barren, or has been developed for infrastructure. It lies 6km away from Betul railway station. About 25% of the block is covered by reserve forest, indicating a significant presence of natural vegetation. The remaining 15% of the area consists of human settlements, including villages and small habitations.

3.2. Cadastral details, land use/cover, forest with type of forest

Table 3.1 Cardinal points of the proposed block

CARDINAL POINTS	WGS 84	
	LATITUDE	LONGITUDE
A	N21^{0} 53′ 30.2”	E77^{0} 49′ 49.4”
B	N21^{0} 54′ 18.0”	E77^{0} 49′ 44.6”
C	N21^{0} 54′ 21.3”	E77^{0} 49′ 49.6”
D	N21^{0} 55′ 15.7”	E77^{0} 49′ 40.4”

E	N21^{0} 55′ 28.7”	E77^{0} 50′ 00.3”
F	N21^{0} 55′ 10.7”	E77^{0} 51′ 16.3”
G	N21^{0} 55′ 26.5”	E77^{0} 51′ 49.0”
H	N21^{0} 54′ 59.5”	E77^{0} 52′ 05.7”
I	N21^{0} 54′ 30.7”	E77 ^{0} 50′ 56.9”
J	N21^{0} 54′ 07.7”	E77^{0} 50′ 28.3”
K	N21^{0} 53′ 35.6”	E77^{0} 50′ 15.5”
L	N21^{0} 53′ 34.8”	E77^{0} 49′ 55.2”

The proposed block, spanning an area of 7.34 sq. km, lies near Betul in the state of Madhya Pradesh and is mapped on Toposheet No. 55G/13. It enjoys convenient accessibility, with a well-developed network of both metalled and unmetalled roads. The nearest railway station, Betul, is located approximately 6 km from the block, while the closest airport is in Nagpur, about 190 km away. The land use pattern in the block is varied, roughly 25% of the area is covered by mixed subtropical forest, around 60% is used for agricultural purposes, and the remaining 15% comprises settlements, including villages and scattered habitations. The terrain is gently undulating, typical of the region’s physiography. The block receives moderate to high annual rainfall, ranging between 1200 and 1600 mm. It falls within the drainage basin of the Machna River, a tributary of the larger Narmada River system, and displays a semi-dendritic drainage pattern. The region experiences a subtropical climate, with temperatures fluctuating between 11°C during the cooler months and reaching up to 41°C in the summer. These conditions support a wide range of geological and mineral exploration activities. Based on the QGIS-OSM data, the location map of the Amdol block has been prepared and presented in Fig 3.1.

Fig.3.1: Location map of the Amdol block (Source: google earth)

The villages of Jharegaon, Sonaghati, and Amdol are located approximately 7 Km northwest of Betul town, the district headquarters. Betul lies about 198 Km south of Bhopal, which serves as the State (SU) headquarters, and is situated along the Bhopal Nagpur National Highway-7. The area is also accessible from Nagpur, a major regional centre and an important railway junction on the Delhi–Chennai main line of the Central Railway. While the main towns are connected by road and rail, the interior regions around these villages can only be reached through cart tracks and narrow footpaths, making them relatively remote.

3.3. Freehold/Leasehold

Most of the proposed block is dominated by agricultural land, which accounts for approximately 60% of the total area. Reserve forests cover around 25%, while settlements make up the remaining 15%. Notably, there is no freehold land within the proposed block, indicating that all land is either under cultivation, forest cover, or designated for habitation.

3.4. Location and accessibility

The villages of Jharegaon, Sonaghati, and Amdol are located approximately 7 kilometres northwest of Betul town, the district headquarters. Betul lies about 198 kilometres south of Bhopal, which serves as the State (SU) headquarters, and is situated along the Bhopal–Nagpur National Highway-7. The area is also accessible from Nagpur, a major regional centre and an important railway junction on the Delhi–Chennai main line of the Central Railway.

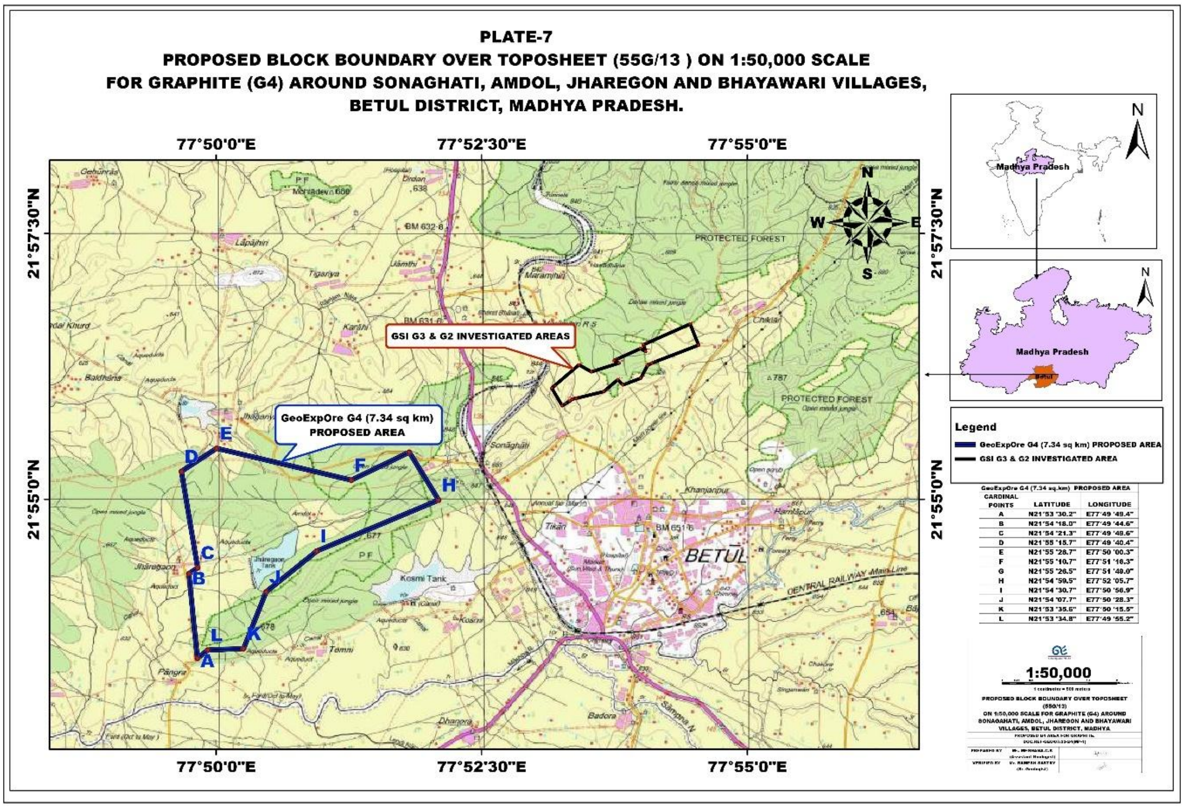


Fig.3.2: Location Map of the Amdol block superimposed on the SOI toposheet- 55G/13

3.5. Climate

The climate of Betul is generally pleasant, largely due to its elevation above the plains and the presence of extensive surrounding forests, which help moderate temperatures throughout most of the year. The region experiences a predominantly dry and temperate climate, except during the southwest monsoon season that begins in June and lasts until September. Summers extend from March to June, with temperatures peaking at around 41°C, particularly in May and June, the hottest months. Despite the daytime heat, nights during the summer remain relatively cool and comfortable. The area receives an average annual rainfall of approximately 1085 mm, with July and August being the wettest months. The monsoon season brings high humidity and, at times, chilly and damp conditions. Winters, lasting from November to February, are fairly cold, with maximum temperatures around 27°C and minimums dropping to 11°C. December and January are the coldest months, occasionally seeing night-time temperatures fall even lower than the average minimum.

3.6. Flora and Fauna

Betul district, located in the southern part of Madhya Pradesh, is richly endowed with diverse flora and fauna, thanks to its varied topography, moderate climate, and significant forest cover. The region forms part of the Satpura hill ranges, which support a mix of dry deciduous and moist deciduous forests. Dominant tree species include teak (*Tectona grandis*), sal (*Shorea robusta*), tendu (*Diospyros melanoxylon*), bamboo, mahua (*Madhuca indica*), and various types of medicinal and minor forest produce plants. The forests of Betul are home to a wide range of wildlife. Common fauna include species such as the Indian leopard, sloth bear, sambar, chital (spotted deer), wild boar, and langur. In some parts, one can also spot the Indian gaur (bison) and occasionally even tigers, especially near the Satpura Tiger Reserve, which lies adjacent to the district. The district is also rich in birdlife, with both resident and migratory species inhabiting the forests and wetlands. The biodiversity of Betul plays an important role in maintaining ecological balance and supports the livelihoods of local tribal communities who depend on forest resources.

3.7. Local Infrastructure and environment

The region is supported by moderate infrastructure. The Nagpur–Bhopal National Highway (NH-46) traverses through key locations including Shahpur, Padhar, and Betul, facilitating efficient road connectivity. Adjacent villages and towns are connected via fair-weather roads, ensuring basic access across the area. Betul, serving as the district headquarters, is well-developed and equipped with essential public services and facilities. Agriculture is the predominant occupation in the region, with a significant portion of the population also engaged in self-employment through trade and small-scale businesses. The area does not host any major industrial establishments, though a limited number of cottage industries are present. Fundamental amenities such as electricity, potable water, educational institutions, and a primary health centre are available across the region. Betul city maintains strong transportation links to major urban centres like Bhopal and Nagpur via both rail and road networks. It also offers a comprehensive range of infrastructure necessary for modern living, including healthcare services, educational facilities, and reliable utility services. The absence of large-scale industries, combined with the surrounding forest cover, contributes to a clean and unpolluted environment. The local community is known for its cooperative and welcoming nature, fostering a peaceful and supportive environment for ongoing activities and operations.

3.8. Population

Betul district has a population of around 1.5 to 1.6 million, with the majority living in rural areas. A significant portion belongs to tribal communities like the Gonds, Korkus, and Baigas. Most people depend on agriculture and forest resources for their livelihood. Urban centres such as Betul, Multai, and Sarni have growing populations engaged in services and trade. The district has a balanced sex ratio and an improving literacy rate, especially in tribal regions.

3.9. Historical sites

Betul district is rich in historical and cultural heritage. Multai is famous as the origin of the Tapti River and houses an ancient temple dedicated to Goddess Tapti. Kukru Khamla, a scenic hill station, is known for its association with Mahatma Gandhi, who once stayed there. The tribal region of Bhainsdehi preserves traditional tribal culture and historical remnants. Additionally, archaeological sites like Baranjhiri and Mokhed reveal prehistoric rock shelters and tools, indicating early human settlement in the area.

3.10. National Park

No national parks exist in the immediate proximity zone around the investigation area.

3.11. Topography

The area forms part of the Satpura Plateau, lying along the southwestern margin of the Satpura ranges, which gradually rise in elevation toward the adjoining northeastern region. Except for the north-central portion, the terrain is predominantly rugged, characterized by strike ridges and valleys trending in an ENE–WSW to E–W direction. The region around Betul town is relatively flat, interspersed with occasional granite hummocks. To the north, northeast, and northwest of Betul town, the landscape transitions into reserve forest areas. The highest elevation in the region, 787 meters above sea level, is recorded south of Chiklar village. One of the most striking physiographic features is the Sonaghati ridge, a steep, linear quartzite formation trending NE–SW, which dominates the surrounding landscape.

3.12. Drainage

The Machna River is the principal river draining the area under investigation. It serves as a tributary to the Narmada River and initially flows in an east–west direction through the gneissic terrain up to Kheri Saonligarh. Beyond this point, as it enters the Deccan Trap region, the river changes its course and flows from north to south. The drainage density is notably higher in the Deccan Trap areas compared to the gneissic regions. In the gneissic terrain, the drainage pattern appears to be influenced by factors such as joint systems, shear movement directions, and differences in rock strength or lithological resistance.

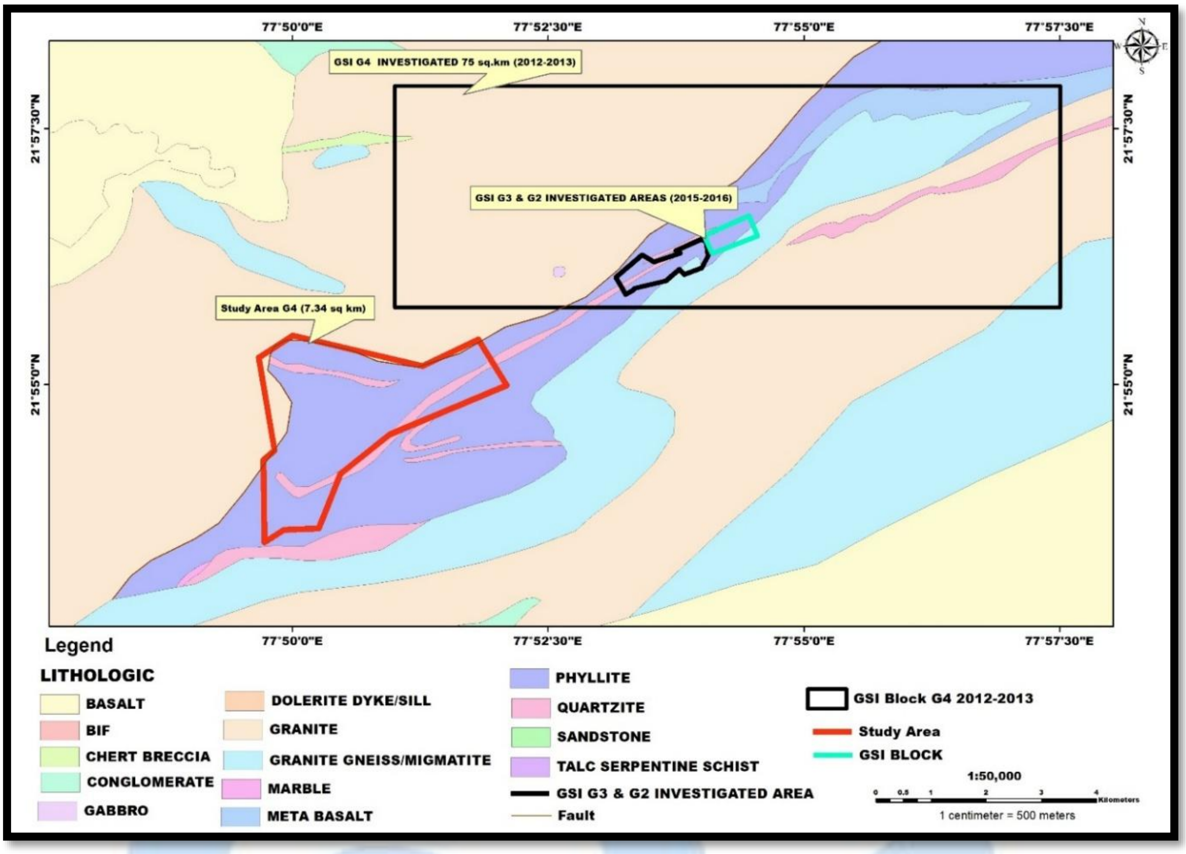


Fig 3.3 LSM Block marked on Geological map (1:50,000) of toposheet no.55G/13 in parts of Sonaghati, Amdol, Jharegaon and Bhayawari of Betul District, along with previous exploration blocks. (source : Bhukosh)

CHAPTER 4

4. PREVIOUS WORK

4.1. Previous work highlights

In 1936, Crookshank briefly mentioned that the metamorphic rocks underlie the Gondwana formations as their basement. Later, Narayanmurthy (1958) reported old graphite mining operations located north of Betul, specifically around Tikari, Gauthana, and Chiklar. These mining sites were mainly situated within graphite schist layers associated with muscovite-quartz schist, which appear as enclaves within the surrounding gneisses. The graphite-bearing schist belt extends roughly 3.2 kilometres (2 miles) long and about 30 to 35 meters (100 feet) wide, according to Narayanmurthy's findings. Pascoe (1964) described the crystalline rocks of the area as Dharwarian phyllites and schists, which are tightly folded with gneisses and show evidence of significant geological disturbances. In 1981, Tiwari and Sanyal carried out detailed geological mapping at a scale of 1:63,360, dividing the region's rock formations into five categories: Archean crystallines, lower to middle Proterozoic metasediments, younger Precambrian intrusives, Gondwana sediments, and Deccan trap basalts. Most of the crystalline rocks were classified as unclassified gneisses. A more focused study was done in 1990-91 by C.P.S. Parihar and Dr. S.K. Chellani, who mapped an area of 150 square kilometres within the B1 and C1 grid squares of toposheet 55G/13 at a finer scale of 1:25,000.

During the years 1992–93, Shrivastava and Patel conducted second-generation geological mapping across various sections of the A1, A2, B1, and B2 grid areas of toposheet no. 55G/13. Similar efforts were also undertaken in different parts of the Betul district by Raut and Mehrotra (1991), Shrivastava and Mehrotra (1992), and Ramteke and Patel (1992), all at a scale of 1:25,000. These studies focused on identifying different phases of granite, variations within granite gneiss, and the presence of metasedimentary enclaves. Additionally, their work included detailed differentiation of intrusive mafic suites. The primary objective of these investigations was to develop a comprehensive understanding of the Precambrian geological framework of the region, along with assessing its mineral resource potential.

Graphite mineralization in the Betul belt, particularly in the Tikari–Gauthana and Chiklar areas, was first reported by J. Narayanmurthy in 1958. He identified a narrow zone of graphite schist hosted within muscovite-quartz schist, extending approximately 3.2 km in length and 30–35 meters in width. Building upon this early work, the Geological Survey of India (GSI) undertook a G4 investigation during the field season (FS) 2012–13, led by Lenka and Ahmad (2013). The area was mapped at a large scale of 1:12,500, which led to the identification of discontinuous graphite mineralization occurring as three lenticular bands arranged in an echelon pattern. These bands stretch over a total strike length exceeding 3.5 km, trending from ENE–WSW to NNE–SSW. Based on their spatial orientation, the bands were classified into southern (1,450 m), central (550 m), and northern (1,350 m) segments. In the following field season (FS: 2013–14), the same team conducted subsurface exploration by drilling seven boreholes across the southern and central segments. This confirmed graphite mineralization over a 1.25 km strike length, with estimated resources of 4.73 million tonnes at the 333 GNFC level.

Following the encouraging outcomes of earlier exploration efforts, the Geological Survey of India (GSI) initiated a General Exploration (G2) program during the Field Season 2015–16. This phase involved close-spaced drilling and deeper intersections reaching vertical depths of up to 135 meters, focusing on the southern and central graphite bands. The exploration covered strike lengths of 670 meters and 530 meters, respectively, spanning an area of approximately 0.3 sq.

km. The work included detailed geological mapping at a 1:2,000 scale, exploratory drilling at intervals of about 200 meters to target second-level intersections, and infill drilling wherever feasible to refine first-level data.

In addition, GSI also carried out a G4 reconnaissance survey in the southwestern part of the proposed block, covering an area of 100 sq. km. This investigation included mapping at a scale of 1:12,500, collection of bedrock samples (BRS), pitting and trenching, along with a suite of geophysical studies employing resistivity, induced polarization (IP), magnetic, and self-potential (SP) methods. The area was also subjected to geochemical analysis to assess the presence of graphite and associated mineralization.

During FS: 2012-13, Lenka B.,et.al. (2013) carried out large scale mapping (1:12,500 scale) followed by detailed mapping in parts of Chiklar, Gauthana and Tikari areas in parts of Toposheet no. 55G/13. They delineated graphite bands over a cumulative strike length of 3.5 km and the bands were divided into three bands viz., the southern (1450 m strike length), the central (550 m strike length) and the northern band (1350 m strike length). Lenka B., (2014) carried out G-3 stage of exploration by drilling 07 boreholes covering parts of the southern and central graphite bands. They estimated an inferred resource (333) of 4.73 MT over the cumulative strike length of 1.25 km. The inferred graphite resources in the part of southern graphite band estimated by Longitudinal Vertical (LV) section method is 2.45 MT with an average of 9.0% FC, while the inferred resources in the central graphite band is 2.28 MT with an average of 11.68% FC (part). The inferred graphite resources by cross section method in the part of southern band is 2.33 MT with an average of 9.0% FC and in the Central graphite band it is 2.45 MT with an average of 11.68% FC. Later, Lenka B., et.al., (2016) carried out General exploration (G-2) for graphite in Tikari-Gauthana-Chiklar areas, covering parts of toposheet no. 55G/13 in Betul district of Madhya Pradesh. The total resources estimated for part of southern graphite band (670 m strike length) by L-V panel method are 6.24 million tonnes with an average grade of 8.79 % FC at 5 % cut off. The inferred resources (333) calculated is 1.25 MT and indicated resource (332) to be 4.99 MT. At 10 % FC cut off, a total of 4.67 million tonnes resources with an average grade of 10.55 % FC is estimated in the part of southern graphite band. In central graphite band, total inferred resources (333) estimated for part of 530 m strike length by L-V panel method are 4.69 million tonnes with an average grade of 11.13 % FC at 5% cut off. At 10 % cut off, the resources of 4.26 million tonnes is estimated with an average grade of 12.15 % FC in the central band.

4.2. Previous Aero geophysical and ground geophysical surveys:

National Geophysical Mapping (NGPM) on a 1:50,000 scale was conducted by Prasad, K.N. et al. (2013–14) in toposheet no. 55G/13. Bouguer gravity and magnetic anomaly maps for the area, obtained from the Geophysical Division, CR, Nagpur, The Bouguer gravity contour map reveals a moderate gravity zone extending from west of Jharegaon to Pangra in the central part of the area. This zone of relatively medium gravity is interpreted to result from the presence of metasedimentary rocks and felsic intrusives. Correspondingly, the magnetic anomaly map indicates a linear low magnetic zone trending E–W, coinciding with the central investigation area. This low magnetic anomaly zone is broadly associated with the contact zone between granite/granite gneiss and meta-sedimentary bands to the south, along with Deccan Trap basalt. In contrast, higher magnetic anomalies observed in the northern and southern parts of the area are likely attributed to the presence of Deccan Trap basalt.

CHAPTER 5

5. GEOLOGY OF THE AREA

5.1. Regional geology

The study area lies in the northern fringe (northwestern part) of Betul Belt, which forms a distinct part of the Central Indian Tectonic Zone (CITZ) bounded by the Son Narmada North Fault (SNNF) in the north and Central Indian Shear Zone (CIS) in the south. The CITZ marks traces of major suture zone in the central part of Indian Peninsula along which continental blocks were assembled during Precambrian (Fig-V.1). This zone is a prominent tectonic divide striking in ENE-WSW for more than 800km and is 400km in width and has dissected the Indian Peninsula into Northern (Archaean Bundelkhand Craton) and southern (Dharwar, Bhandara, Bastar and Singhbhum Craton) crustal blocks. Three major Proterozoic supracrustal belts are formed in the Central Indian Tectonic Zone and they are Mahakoshal, Betul and Sausar mobile belts from north to south respectively. Out of these three mobile belts, the regional geology of the Betul Belt discusses here with respect to the study area.

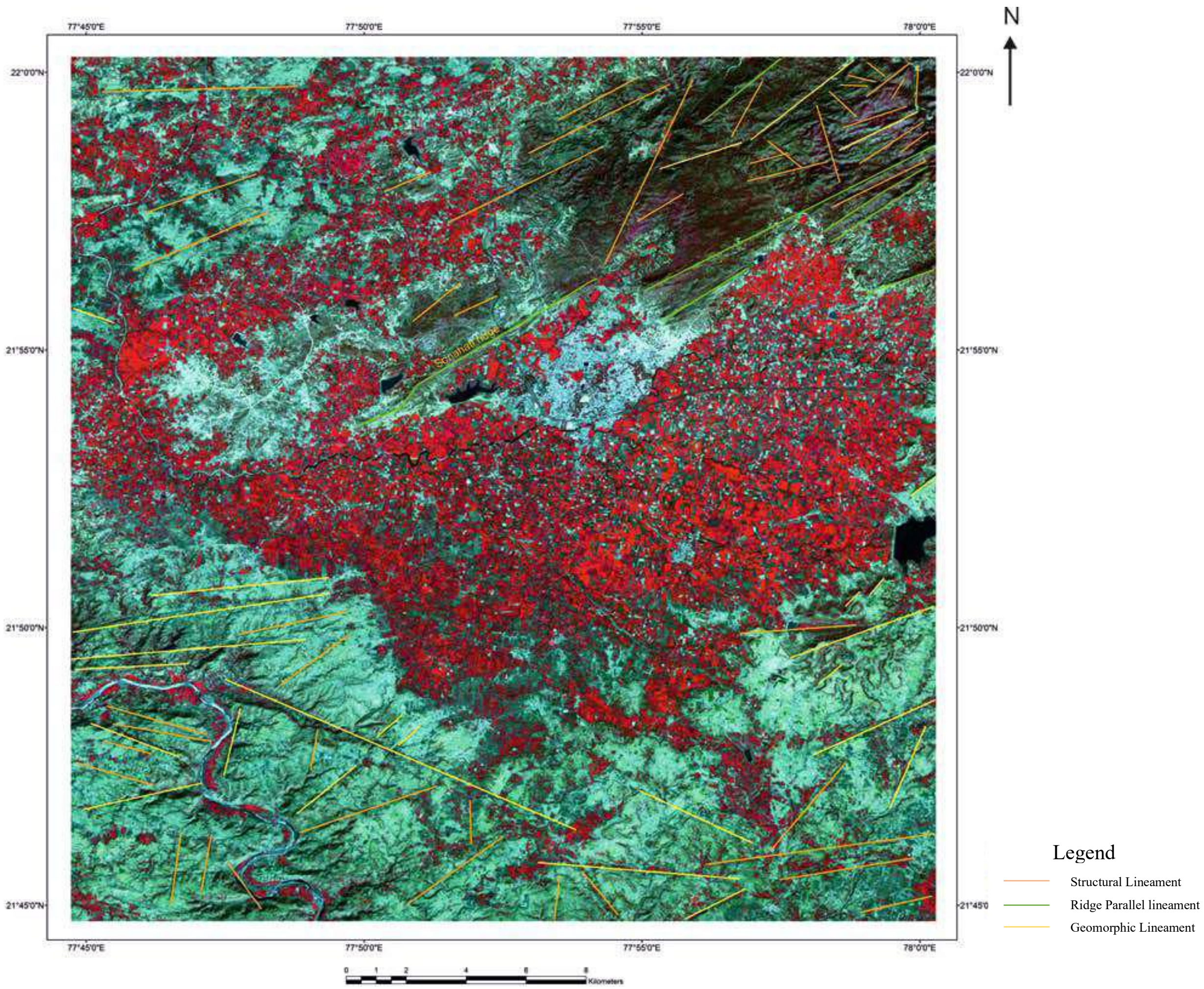


Fig 5.1 Lineament map interpreted from LISS-3 imagery within the area of SOI toposheet 55G/13, encompassing parts of Betul district, Madhya Pradesh. (Source : GSI Gauthana G3 Report)

5.1.1. Regional geology and regional stratigraphy

The ENE-WSW trending Betul supracrustal belt forms a conspicuous litho-tectonic unit lying between Mahakoshal belt in the north and Sausar supracrustal belt in the south, (Fig V.1). This belt extends for a length of about 135km with an average width of 15km from Chhindwara town in the east to Chicholi village in Betul district in the west and is composed of volcano-sedimentary rocks, intruded by mafic-ultramafic and granitic suite of rocks in that order (*Srivastava, S.K. et. al. 1995*). Lithologically, the belt is more similar to the Mahakoshal supracrustals having a large volume of volcanic rocks than to the volcanic free Sausar belt.

According to *Roy et.al. (2001)*, the litho-assemblage of the Betul belt (Fig V.2) comprises three distinct suites of rocks namely,1) supracrustal rocks, which include quartzites, metapelite, bimodal volcanics (basalt-rhyolite) metaexalhites, calc-silicates and BIF which show evidence for shallow water sedimentation 2) ultramafic-mafic suite, represented by pyroxenite-hornblendite, pyroxenite, gabbro-diorite- quartz diorite association and 3) syn to post tectonic granitic suites. The supracrustals are hosted within the gneissic complex, which is considered to be the basement. Due to shearing and copious granite magmatism, the supracrustal rocks are disposed as disturbed sequences. The metasedimentary/supracrustal litho association dominates the western and northwestern part of the belt around Sonaghati and Chicholi areas whereas the volcano-sedimentary sequence dominates the eastern and central parts.

The mafic-ultramafic complex crops out mainly in the western and northwestern parts of the belt around Padhar and in the eastern part of the belt around Mordongri where it occurs in association with bimodal volcanics. Apart from these mafic-ultramafic complexes, there are several other mappable units of gabbro, pyroxenite and hornblendite which also occur in association with bimodal volcanics. Granitoids show both intrusive and tectonic contact relationships with the supracrustals and mafic-ultramafics. The Betul belt presents a unique litho-package in CITZ containing bimodal volcanics in general and abundant felsic volcanics in particular. The belt is traversed by a number of ENE-WSW ductile shear zones having sub-vertical to steep dips towards the north and often served as avenues for the emplacement of granitic rocks. The belt shows low to medium-grade metamorphism. The different parts of the Betul Supracrustal belt were mapped on different scales by GSI officers in the past. However, *Chaturvedi (2001)* gave an overview of second-generation geological mapping on 1:25,000 scale by GSI workers in this belt from 1990 to 1995 and presented a detailed tectono-stratigraphic succession of Betul Belt, which is given as follows-

Table 5.1 Tectono-lithostratigraphy of the Betul belt (after Chaturvedi 2001)

DECCAN TRAPS	Basaltic lava flows and dolerite dykes
GONDWANA SUPERGROUP	Mainly sandstone, shale and conglomerates with coal seams in some areas.
Tectonic/Unconformable	
INTRUSIVE	Quartz veins, quartzo-felspathic veins, pegmatite veins, Aplitic veins, pink and grey granite
PADHAR MAFIC COMPLEX	Pyroxenite, gabbro, and metabasics
BHOPALI GROUP	Dolomite Limestone, Phyllitic /calc-phyllite Ferruginous quartzite
INTRUSIVES	Crudely foliated granite Prophyroblastic / augen gneiss
BARGAON GROUP	Pillowed lava. Basalt/apillitic/komatiite Chert rhyolite and associated volocano-clastics
GOLIGHAT GROUP	**Kosmi Formation**-quartz mica schist, actinolite tremolite-chlorite schist, garnetiferrous mica schist, and linear bands of graphite schist **Temni Formation**-Lenses of calcsilicate, marble and carbonates **Sonaghati Formation-** quartz calcareous quartzite, Micaceous quartzites
BETUL GNEISSIC COMPLEX	Amala gneiss with interbands of schist and amphibolites representing basement

Chaturvedi (2001) presumed that the metasedimentary rocks exposed in the Sonaghati area (i.e. north of Betul) as older remnants of the supracrustals and grouped them as “Golighat Group” forming an inseparable part of the Basement Betul Gneissic Complex. He further subdivided the “Golighat Group” into three formations viz Temni Formation, Kosmi Formation and Sonaghati Formation. The Kosmi Formation comprises quratz-mica schist, garnetiferous mica schist and interbands of actinolite-tremolite-chlorite dominated basic schist and amphibolites, with a regional spread. The Temni Formation includes impure marble and calc silicates which occur as small lensoidal bodies and the Sonaghati Formation represents linear ENE-WSW trending arenaceous rocks which pass through Sonaghati, 4km north of Betul. The rocks of the Golighat Group are seen only in the western and northern part of the Betul belt around Sonaghati and Chhicholi, forming high ridges. The Betul Gneissic Complex consists mainly of gneisses, migmatites, basic schists and amphibolite termed as “Amla Gneiss”.

The bimodal volcano-sedimentary litho-assemblage which hosts the Zn-Cu mineralization is exposed in the central and eastern part of the belt around Bargaon, Tarora and Kherlibazar has been grouped under the “Bargaon Group”. It comprises metabasalt, pillow lava, komatiite, acid volcanics, rare ultra-mafics, intercalated thin lenses of metasediments including garnet-staurolitefibrolite/sillimanite gahnite bearing schist and micro granite. In the northern part, adjoining the Gondwana sediments, low-grade metasedimentary sequence was termed as the “Bhopali Group”. This litho-assemblage was considered to be younger metasedimentary sequence as compared to the rocks of Betul Gneissic complex including the metasediments of Golighat Group and Bargaon Group. The rocks of the Bhopali Group are very well exposed in Bhopali, Ranipur and Khamalpur (*Raut and Mahakud, 2004*). He considered syntectonic intrusive of foliated and porphyroblastic granite as older granitoids to the metasediments of Bhopali Group. Large intrusive body of pyroxenite, gabbro, diorite and foliated mafic-ultramafics exposed around Padhar, Gajpur and at several other places within Betul Belt has been termed as "Padhar Mafic Complex". Post tectonic homophonous and undeformed granite is stated to be intrusive into all the litho-units of Betul Belt. However, *Chakraborty et.al., (2009)* provided a different view on tectono stratigraphic succession of Betul Belt based on their specialized thematic mapping carried out on 1:25,000 in parts of toposheet no. 55F/16, 55G/13 and 55J/0. They have proposed a four-fold lithostratigraphic subdivision of the Betul supracrustal rocks based mainly on the physical continuity of different litho-units and their broad lithological similarity.

According to *Chakraborty S.K., et.al. (2009)*, the basal sequence of calcarenite, marble, B.I.F. phyllite, metabasalt and carbonaceous phyllite is being best exposed in Ranipur and Bhopali areas and termed it as "Ranipur Formation". This litho-assemblage, earlier shown as "Bhopali Group" as younger metasediments (*Chaturvedi, 2001*), was in fact exposed continuously towards WSW in Sonaghati ridge area and forms the basal sequence. The southern margin of the basal supracrustal sequence (i.e. in the area south of Sonaghati ridge) is marked by the presence of calcareous, gritty, feldspathic quartzite (earlier termed as Temni Formation of Golighat Group by *Chaturvedi 2001*) which is highly tectonised and is in juxtaposition with the basement migmatitic gneiss, thereby indicating the tectonised unconformity. The migmatitic gneiss occurring as basement to the supracrustals of the Betul Group is termed as "Amla gneiss". The contact between Ranipur Formation and the basement gneiss is unconformable at places and faulted at other. In rest of the area, basement migmatitic gneiss i.e. Amla gneiss is having tectonic contact with different litho-units of Betul supracrustal sequence. Due to intense tectonism and profuse granitic activity along the prominent shear zones, it is difficult to work out the original lithostratigraphic succession of the Betul belt. The litho-units of the basal "Ranipur Formation" are folded and conformably overlain by the interbanded sequence of micaceous ferruginous quartzite (± magnetite) and quartz-mica schist/ phyllite and graphitic schist and are being termed as “Sonaghati Formation”. The Sonaghati Formation extends as a linear ridge in NE-SW direction from SW of Pangra via Sonaghati towards Ranipur. Another major outcrop of the formation extends in a NNE direction from east of Padhar through the south of Arjongondi. Isolated outcrops are also seen as patches resting over the basement Amla gneiss. In the central part of the Betul Belt around Bargaon, Muariya and Kherlibazar, the Zn-Cu-Pb mineralization bearing bimodal volcano-sedimentary litho-assemblage of meta-rhyollite and meta-basalt with minor intercalations of meta tuff and metapelite are exposed and termed as “Bargaon Formation”.

The litho-assemblage of Bargaon Formation is not in contact with the litho-units of Ranipur Formation and Sonaghati Formation but are separated from each other by syn to post kinematic intrusive granites along prominent ductile shear zones. They have tentatively kept the stratigraphic position of Bargaon Formaton in between the Ranipur Formation and Sonaghati Formation. Large intrusive bodies of pyroxenite, gabbro, diorite and foliated mafic-ultramafics exposed around Padhar, Gajpur and at several places in the northern part have been termed as Padhar Mafic Ultramafic suite. Several small exposures of gabbro, pyroxenite and hornblendite are also seen within the bimodal litho-assemblage of Bargaon Formation in eastern part of the Betull belt towards the south of Mordongri ridge. Granitoid rocks in the area show both intrusive as well as tectonic contact rrelationships with the basement gneiss, supracrustal rocks and mafic-ultramafic rocks. Syn-to post tectonic, prophyritic to homophonous granites were emplaced along several ENE-WSW trending ductile shear zones. Due to intense shearing and copious granitic magmatism, the supracrustal lithoassemblage of Betul belt occur as dismembered sequences within the granitic host. Two major varieties of granitoid rocks are recognized viz coarsely crystalline porphyritic granite which is mostly porphyroclastic, strongly foliated and mylonitic along the shear zones and homophanous amphibole mica granite (± garnet ± allanite). Apart from these granitoids, tourmaline mica pegmatite, quartz veins and dolerites of different generations intrude almost all the rock types of Betul belt. The tectono stratigraphic succession of Betul belt proposed by *Chakraborthy et. al. (2009)* is as follows:

Table 5.2 Tectonostratigraphic succession of Betul belt (modified after *Chakraborty et al., 2009):*

<table>
<tr><td>DECCAN TRAPS</td><td colspan="2">Basaltic flows and dolerite dykes</td></tr>
<tr><td colspan="3">Intrusive contact/ Disconformity</td></tr>
<tr><td>GONDWANA SUPER GROUP</td><td colspan="2">Conglomerate, sandstone, and shales</td></tr>
<tr><td colspan="3">Unconformable/ Tectonic contact</td></tr>
<tr><td rowspan="7">BETUL GROUP</td><td>INTRUSIVES</td><td>Basic dykes, pegmatite, quartz veins, homophonous amphibole-mica granite, porphyritic granite</td></tr>
<tr><td colspan="2">Intrusive/Tectonic contact</td></tr>
<tr><td>PADHAR MAFIC-ULTRAMAFIC SUITE</td><td>Diorite, epidiorite, gabbro, norite, pyroxenite
Hornblende, websterite, harzburgite, anorthosite, diorite, talc-serpentinite rock, quartz – epidote rock</td></tr>
<tr><td colspan="2">Intrusive / Tectonic contact</td></tr>
<tr><td>SONGAHATI FORMATION</td><td>Intercalated sequence of quartzite, quartz-mica schist and graphite schist</td></tr>
<tr><td colspan="2">Conformable/ Tectonic contact</td></tr>
</table>

	BARGAON FORMATION	Meta-sediments (mica schist), meta-rhyolite and felsic metatuff, metabasalt and amphibole- chlorite schist
	Conformable/ Tectonic contact	
	RANIPUR FORMATION	Phyllite, banded hematite/ magnetite quartzite, BIF, granulite, meta-basalt, amphibolites, carbonaceous phyllites, calcareous quartzite, calc-silicates, marble
Un-conformable / Tectonic contact		
AMLA GNEISS	BASEMENT ROCK	Banded migmatite gneiss, Quartzofeldspathic mica schist/gneiss

5.1.2. Regional structure

The Betul belt in Central India, a Paleoproterozoic to Neoproterozoic meta-volcano sedimentary sequence, is situated between the Son-Narmada and Tapti lineaments, which generally trend in an ENE–WSW direction.

In this region, quartzites have preserved the primary geological structures quite well, displaying distinct color banding with alternating pink, grey, and off-white layers, as well as compositional banding marked by alternating siliceous and iron-rich bands. These bedding patterns run parallel to the regional foliation observed in the surrounding granite gneiss. The complex geology results in varied orientations of rock layers. Overall, the rock formations strike in an NNE–SSW direction, dipping towards the WNW in the northern area and towards the ESE in the southern part. The prevalent dip direction is northward, except in the south, where a regional antiformal fold appears to influence the structure. (Chaturvedi 2001)

The area has experienced at least three phases of folding accompanied by simultaneous shearing, with each phase showing a decrease in intensity and a shift in the compressive stress direction from ENE–WSW to N–S. The earliest folds

(F1) are tight to isoclinal, ranging from large to medium scale, and tend to be inclined or reclined with moderate to steep plunges northeast and southwest. These folds are classified as moderately plunging to vertical and steeply inclined upright folds (Parihar et al., 1991). At a large scale, the Sonaghati ridge represents two joined limbs of an upright synformal fold from this first folding event. On a smaller scale, F1 folds are visible within the quartz-mica schist on either limb of this large fold. While bedding is preserved only in a few spots, schistosity (S1) is clearly developed in these schists, characterized by mica flakes aligned parallel due to tight folding. (Chakraborty et. al 2009)

The second folding event (F2) is less widespread and mostly observed locally at the mesoscopic scale. These folds are tight, isoclinal, and often chevron-shaped, with axial planes trending between NE–SW and NW–SE. They are also categorized as moderately plunging to vertical and steeply inclined upright folds (Parihar et al., 1991).

The third phase of folding (F3) produced broad, open bends and minor kink folds trending roughly NNE–SSW to NNW–SSE. These folds are steep, upright, and asymmetric, cutting across the earlier folds (F1 and F2). This phase is reflected by numerous uplifts and depressions across the folded Sonaghati ridge, giving the area a characteristic undulating topography.

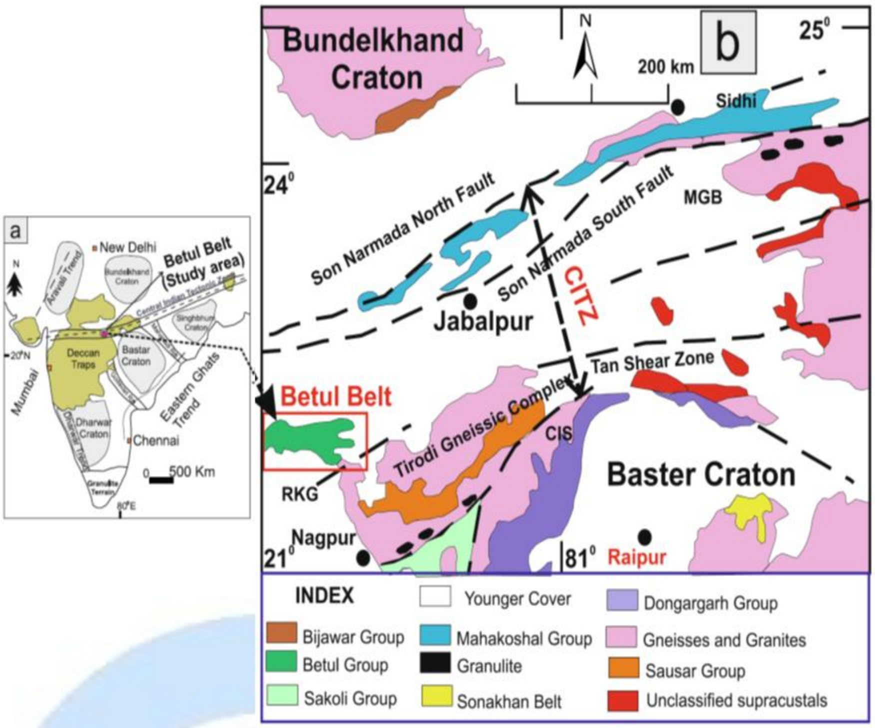


Fig 5.2 Regional Geological map showing different components of CITZ. Bundelkhand and Bastar Craton and geological setup within and near CITZ (after Dora et al. 2023).

5.1.3. Regional Metamorphism

Polyphase deformation in the Betul supracrustal rocks has been accompanied by corresponding metamorphism to make adjustment of mineral assemblages with changed temperature and pressure conditions. Metasedimentary rocks in the western part of the Betul inlier, which are highly deformed and regionally metamorphosed. Presence of various mineral assemblages suggest that the rocks have experienced regional metamorphism which is syntectonic to F1 deformation and is confined to upper greenschist facies except in marginal areas, where calcareous metasediments close to granitoid /shear zones are thermally metamorphosed to calc-silicate hornfels. Widespread occurrence of quartz + orthoclase + microcline + muscovite + biotite + plagioclase + perthite + apatite + zircon in the basement banded migmatite gneisses, quartz + plagioclase + muscovite +sericites + chlorite + feldspar + calcite + diopside + epidote + garnet + sphene + apatite + tremolite + wollastonite + opaques and carbonate in the metasedimentary units of the Ranipur Formation and quartz + muscovite +

sericite + opaques + feldspar + garnet+ calcite + graphite in the metasedimentary units of the Sonaghati Formations is an indicative of a regional metamorphism of upper greenschist facies to amphibolite facies. The rocks of the Padhar Mafic-ultramafic Suite are virtually unmetamorphosed. Various volcano-sedimentary lithounits along with tuffaceous lithounits of Betul Group exhibit low-grade mineral assemblages of greenschist facies to lower amphibolite facies metamorphism (*Chore, 2010*).

5.1.4. Regional Mineralisation

The Betul Belt has long been recognized by the geological community for its potential in hosting volcanic-hosted massive sulphide (VHMS) mineralization. The volcano-sedimentary sequences in the eastern part of the belt host all the proven base metal deposits, including zinc, lead, and copper. Exploration efforts by various researchers have confirmed the presence of massive sulphide mineralization characterized by a sulphide assemblage comprising sphalerite, pyrite, galena, chalcopyrite, and pyrrhotite (Praveen et al., 2007). This mineralization bears strong similarities to VHMS deposits found globally. The complex tectono-lithostratigraphic and structural setting of the region also suggests potential for mineralization associated with acid magmatism, with reported occurrences of tungsten, molybdenum, niobium, and tantalum in the western parts of the belt. Additionally, the Padhar mafic-ultramafic rocks in the north and the Mordongri ultramafic complex in the east have shown promise for PGE, Ni, Co, Cr, and Cu mineralization.

Graphite occurrences were first reported in the Betul Belt by Narayanmurthy in 1958, but it was not until the work of Lenka et al. (2013) that systematic exploration resumed, particularly in the Chiklar-Gauthana-Tikari region of Betul district. Subsequent G3 and G2 stage explorations (Lenka, 2014; Lenka et al., 2016) established a significant graphite deposit confined to Proterozoic supracrustal rocks. Based on earlier reports by Shrivastava et al. (1988) and Raut et al. (1991), further G4 stage investigations by Agnihotri and Khan (2017–2018) identified graphite-mica schist bands in the Golighat, southeast of Makra, west of Junawani (Block-I), and Bhopali area (Block-II), the graphite potential of the Betul Belt within its supracrustal sequences.

CHAPTER 6

6. PRESENT GEOSCIENCE INVESTIGATION

6.1. Geological Mapping

6.1.1. Large Scale Mapping (LSM)

6.1.1.1. Large scale geological mapping on 1:4000 scale

During the 2024–2025 field season, large-scale geological mapping at a 1:4000 scale was conducted over an area of approximately 7.34 sq. km in and around Sonaghati, Amdol, Jharegaon, and Bhayawari in Betul District, Madhya Pradesh. The study area geographically coordinates:

A (21°53′27.4″N, 77°49′43.5″E), B (21°54′15.6″N, 77°49′43.1″E),

C (21°54′21.3″N, 77°49′49.6″E), D (21°55′15.7″N, 77°49′40.4″E),

E (21°55′28.7″N, 77°50′00.3″E), F (21°55′10.7″N, 77°51′16.3″E),

G (21°55′26.5″N, 77°51′49.0″E), H (21°54′59.5″N, 77°52′05.7″E),

I (21°54′30.7″N, 77°50′56.9″E), J (21°54′07.7″N, 77°50′28.3″E),

K (21°53′35.6″N, 77°50′15.5″E), and L (21°53′34.8″N, 77°49′55.2″E).

This region falls within Survey of India toposheet no. 55G/13. The mapped area lies along the northwestern margin of the ENE–WSW trending Proterozoic Betul Belt. Lithologically, the area comprises older metasedimentary sequences and granite gneiss belonging to the Betul (Amla) Gneissic Complex. These basement rocks are intruded by a variety of granitic and mafic-ultramafic bodies, along with pegmatite, aplite, and quartz veins, representing post-magmatic intrusive phases of varying dimensions. In the northern and eastern parts of the area, these crystalline rocks are unconformably overlain by Gondwana sediments.

6.1.1.2. Outcrop Mapping on 1:4000 scale:

During large-scale mapping (LSM), outcrop mapping was conducted of the study area. In the northern part of the study area, which is primarily a protected forest, the terrain exhibits high relief, characterized by closely spaced contours. In the field, steep cliffs are prominent in this area. In contrast, the northern and northwestern parts of the study area are predominantly agricultural land, with limited outcrop exposure. Out crop map of the investigated area is given in Plate-1. A geological map of the investigated area is shown in Plate-2.

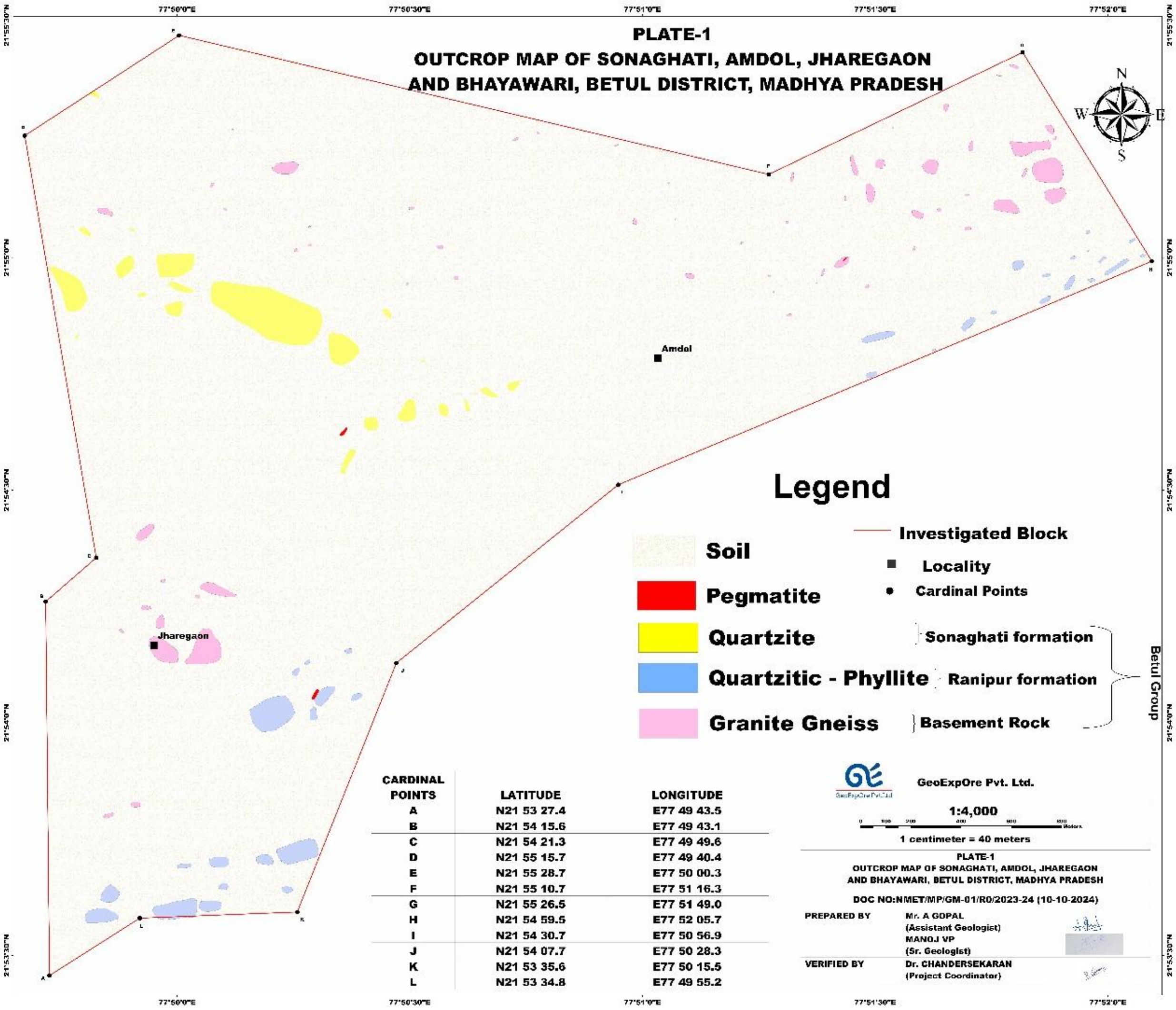
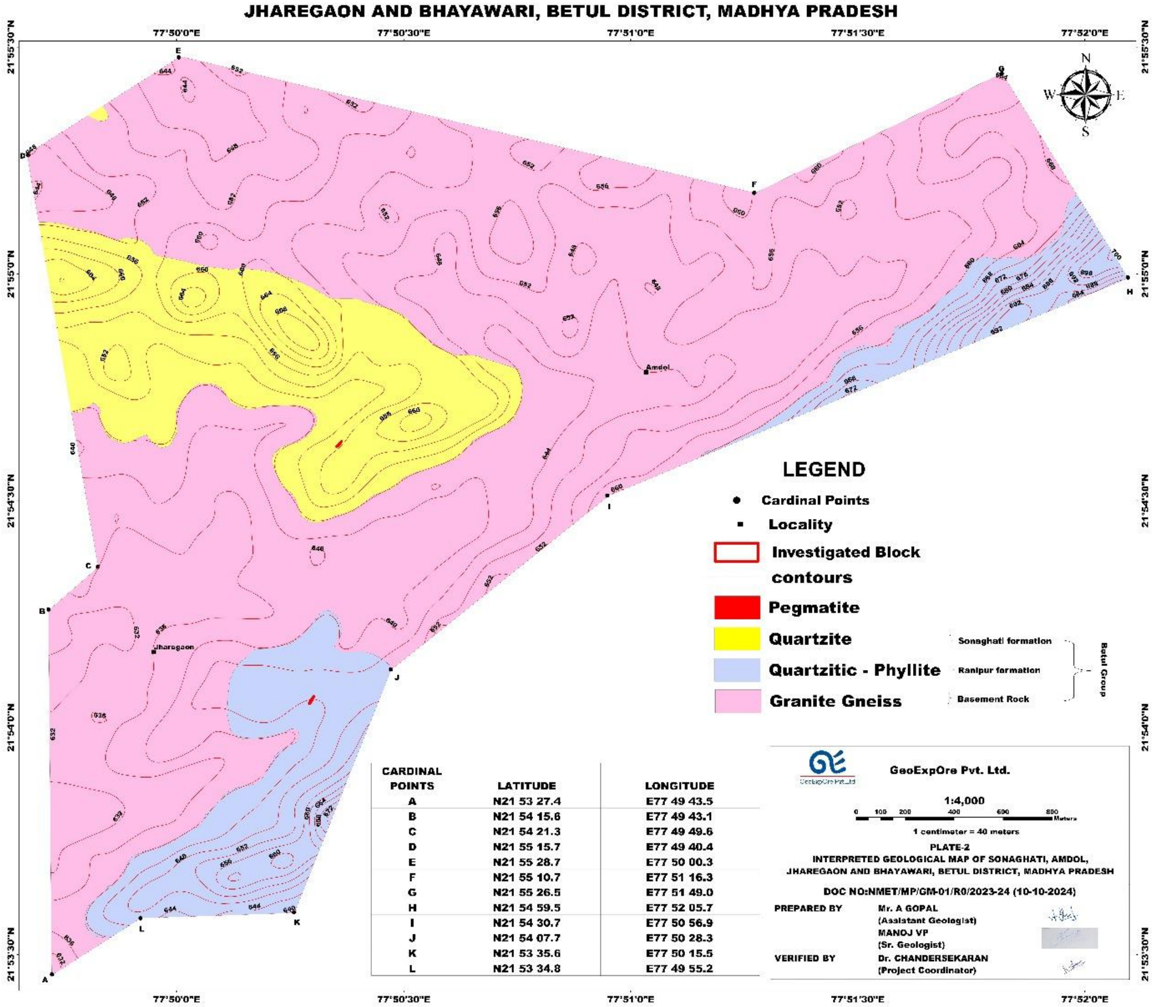


PLATE-2
INTERPRETED GEOLOGICAL MAP OF SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI, BETUL DISTRICT, MADHYA PRADESH



CARDINAL POINTS	LATITUDE	LONGITUDE
A	N21 53 27.4	E77 49 43.5
B	N21 54 15.6	E77 49 43.1
C	N21 54 21.3	E77 49 49.6
D	N21 55 15.7	E77 49 40.4
E	N21 55 28.7	E77 50 00.3
F	N21 55 10.7	E77 51 16.3
G	N21 55 26.5	E77 51 49.0
H	N21 54 59.5	E77 52 05.7
I	N21 54 30.7	E77 50 56.9
J	N21 54 07.7	E77 50 28.3
K	N21 53 35.6	E77 50 15.5
L	N21 53 34.8	E77 49 55.2

6.1.1.3. Description of rock types

To identify potential new graphite deposits and assess the mineralization prospects of the region, a detailed large-scale geological mapping was conducted over an area of 7.34 sq. km at a 1:4000 scale around Sonaghati, Jharegaon, and Amdol, falling within toposheet no. 55G/13. The mapped formations include the Sonaghati Formation, comprising predominantly quartzite; the Ranipur Formation, consisting of quartzite, phyllite, and quartzitic phyllite; and the Granitic Complex, represented by granite gneiss. The mapping revealed that the regional strike of the rock formations generally trends ENE–WSW, with dips varying across the area towards the northwest in the northern sector and southeast in the southern sector. The area is predominantly underlain by gneissic rocks, which include both older gneisses and younger porphyroblastic or remelted varieties. Additionally, metasedimentary rocks are present and are occasionally cut by quartz veins and pegmatite intrusions, indicating multiple phases of deformation and intrusion.

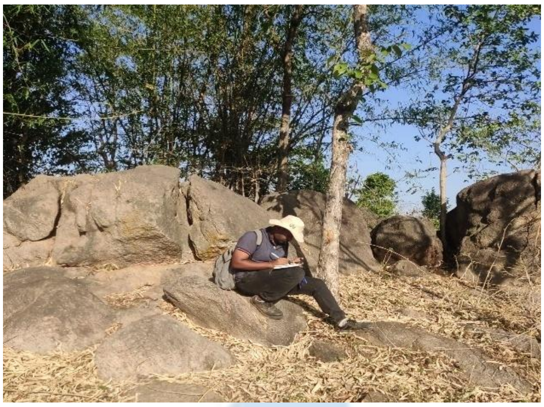
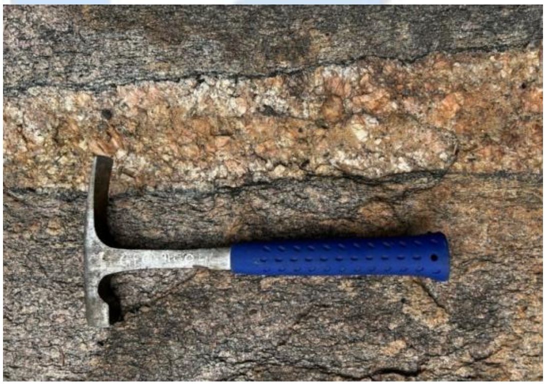
Table-6.1: Stratigraphy of the mapped area based on present work

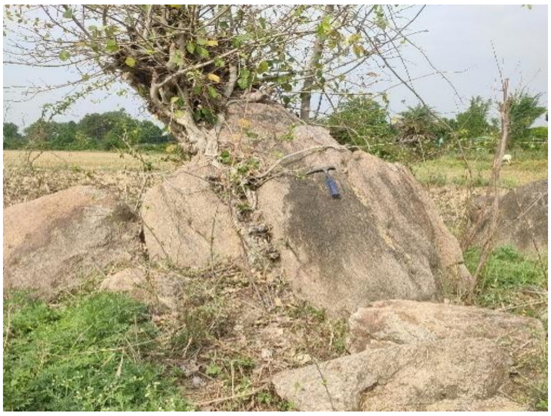
GROUP	FORMATION	LITHOLOGY
Betul Group	Sonaghati Formation	Quartzite
	Ranipur Formation	Quartzitic phyllite
	Granitoid Complex	Granite Gneiss

6.1.1.3.1. Granite Gneiss

Gneissic rocks occupy nearly 75% of the area, forming an extensive spread across the region and contributing to the predominantly low-lying, undulating terrain. The gneissic rocks in the area are the result of high-grade metamorphism, characterized by distinctive banding. These rocks primarily consist of quartz, feldspar, biotite, and hornblende, and are a crucial component of the Central Indian Gneissic Complex. These gneissic formations are commonly found alongside other Proterozoic units in the region, such as Betul Gneiss and Quartzite in Jharegaon. The gneissosity is clear in the rocks, with minerals being segregated into alternating light and dark bands. The foliated texture is pronounced in many outcrops, where minerals like biotite, muscovite, and hornblende show a distinct alignment along the foliation planes. The general trend of the foliation in the Gneiss is oriented from ENE to SWS. This alternation of light and dark bands in the Gneiss occurs because of differential recrystallization of the minerals during the metamorphic process.

Fig 6.1 Field photograph showing exposure of Granite Gneiss

 Field Photograph (i)- Sheared granite gneiss, East of Jharegaon. Lat/Long: 21.90469, 77.83491	 Field Photograph (ii)- Sheared granite gneiss East of Jharegaon. Lat/Long: 21.90339, 77.83418
 Field photograph (iii) -Porphyritic granite gneiss howing a sinistral sense of shearing of k-feldspar grains. East of Sonaghati.	 Field Photograph (iv)- Intrusive contact between 11granite gneiss of pegmatite vein. south of Sonaghati.

 Field photograph (v) - Granite gneiss, west of Jharegaon. Lat/Long: 21.90666, 77.83208	 Field photograph (vi) - Granite gneiss, west of Jharegaon Lat/Long: 21.91650, 77.8572

 Field Photograph (vii)- Quartz vein within granite gneiss, East of Sonaghati. Lat/Long: 21.91636,77.85695.	 Field Photograph (viii) Quartz vein within granite gneiss, west of Sonaghati. Lat/Long: 21.92057,77.86329.

Intrusive:

Quartz vein:

Numerous quartz vein occurs as intrusive within the granites in the area, having widths from a few centimetres to more than 50 m in multiple orientations.

6.1.1.3.2. Quartzite

Quartzite is a minor lithounit within the region, with most of its exposures occurring in the central part of the proposed block. These quartzite bands trend in an E-W direction and are characterized by extensive fracturing and jointing, which give them a highly disrupted structure. The average thickness of the quartzite bands is typically between 100 to 150 meters, and they are predominantly found at the uppermost portion of the Sonaghati Ridge, where they form prominent geological features. The colour of the quartzite ranges from white to light grey, with some sections displaying reddish zones that indicate a ferruginous composition, suggesting the presence of iron-bearing minerals. Due to their well-developed jointing, the quartzite tends to break into large blocks during weathering and frost action, further contributing to the rock's discontinuous nature. The structural integrity of these quartzite bands is also affected by the jointing and fracturing, making them prone to significant erosion and breakdown over time.

Fig 6.2 Field photograph showing exposure of Quartzite

<table>
<tr><td>
Field Photograph- Fractured quartzite in Jharegaon. Lat/Long: 21.90041,77.83604</td><td>
Field Photograph- Quartzite outcrop. in Jharegaon. Lat/Long: 21.96639, 77.83472</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Field photograph: Two joints set, J1 trending N64E and J2 trending N45W, are common in the area of investigation, north of Jharegaon village (21.91518,77.83473).

6.1.1.3.3. Quartzitic Phyllites

The quartzitic phyllites in the Amdol and Jharegaon areas form an integral part of the meta-sedimentary sequence of the region, and they are a distinctive feature of the Proterozoic metamorphism that has shaped the area's geology. The Quartzitic phyllite ranges from few feet to up to 5m. These rocks were formed during a period of intense tectonic and metamorphic activity, marking their Proterozoic age and indicating the significant geological forces at play during their formation. These phyllites have undergone high-grade regional metamorphism, which has substantially altered their original sedimentary composition. As a result, the sedimentary layers have undergone recrystallization and alignment, leading to the formation of their foliated structure—a key characteristic of phyllite. The rock's primary component is quartz, which accounts for a significant portion of its composition. Additionally, the mica content, especially muscovite and biotite, imparts a shiny or glossy appearance, further enhancing its characteristic phyllitic texture. In some areas, the phyllite also contains minor amounts of feldspar and chlorite, though these are less prevalent. The presence of quartz gives these phyllites a more durable and resistant character when compared to typical phyllites, making them better able to withstand weathering processes. The fine-grained texture of the phyllite, combined with its well-developed foliation, reveals an aligned arrangement of minerals, particularly mica, which is responsible for its characteristic shiny finish. The foliation direction in these quartzitic phyllites typically strikes in an NE-SW to E-W orientation, consistent with the regional tectonic forces that have influenced the area's geological history. This alignment of minerals reflects the compressive forces that led to their metamorphic transformation.

Fig 6.3 Field photograph showing exposure of Quartzitic Phyllite

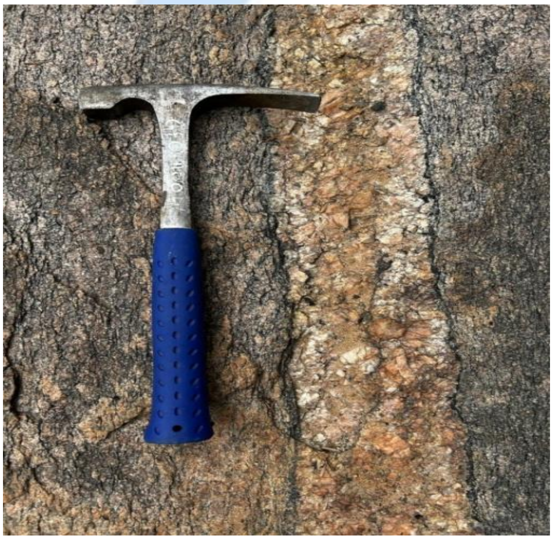
 Field Photograph: Gradational nature of quartzitic-phyllite, south of Jharegaon area. Lat/Long: 21.89306,77.83274	 Field Photograph- Displays a satiny foliation with minor crenulation in places. North of Sonaghati.
 Field Photograph: Quartzitic phyllite outcrop. in Sonaghati. Lat/Long: 21.89330,77.83069	 Field Photograph- Quartzitic phyllite outcrop. In Jharegaon. Lat/Long: 21.89047,77.83282

 Field Photograph - Phyllite outcrops (21.91595 / 77.84048)	 Field Photograph - Phyllite outcrops (21.91595 / 77.83491)

6.1.1.3.4. Pegmatites

Few small pegmatite bodies are present in the southwestern part of the mapped area, primarily emplaced within mica schists and granite gneisses, where they exhibit sharp contacts with the surrounding rocks. These pegmatite bodies typically display a characteristic composition, which includes quartz, feldspar, muscovite, biotite books, and occasional garnet. The presence of pink garnets has also been reported in the pegmatite near the Sonaghati area, highlighting the mineral diversity within these bodies. It is well-known that pegmatite bodies found within the schists are often rich in commercial-grade mica, making them a significant source of valuable minerals. The high concentration of muscovite and the presence of other minerals like biotite in these pegmatites make them economically important for extraction, particularly for mica production, which is widely used in various industrial applications.

Fig 6.4 Field photograph showing exposure of Pegmatites

 Field photograph of Pegmatite intruded within granite gneiss near Northeast of Jharegaon (Lat/Long 21.91704,77.84270)	 Field photograph -Pegmatite intruded within granite gneiss exposed near Jharegaon area. (Lat/Long: 21.910136,77.83944)
 Field Photograph: Pegmatite body found in the Jharegaon area(Lat /Long:21.91595/77.83891)	 Field Photograph-: Tourmaline-bearing pegmatite body found in the south Jharegaon area. (Lat / Long: 21.90090,77.83848)

6.1.1.4. Petrological Studies

Though 20 samples of thin and polished sections were sanctioned by TCC-NMET in the beginning, due to non-encouraging results and absence of drilling, only 07 sections (including both thin and polished sections) were prepared from the representative rock samples of all the lithounits for the investigation. The details of samples prepared for the thin/polished section study are given in Table No. 6.2. The objective of the petrographic study was to establish i) the percentage and size of phenocrysts, ii) the Nature of the different mineral constituents, iii) the mineral assemblages, overall composition, and their texture and structure.

Table 6.2 Details of samples subjected for petrographic study:

Sl.no	Latitude /Longitude	Locality	Sample No	Rock type
1	21.89305 / 77.83286	Jharegaon	MPAJ/BRS-01/2024-25	Ferruginous quartzite
2	21.90411 / 77.83241	Jharegaon	MPAJ/BRS-3/2024-25	Biotite gneiss
3	21.90086 / 77.83841	Jharegaon	MPAJ/BRS-9/2024-25	Aplitic Granite
4	21.90100 / 77.83986	Jharegaon	MPAJ/BRS-10/2024-25	Quartzite
5	21.91641 / 77.83475	Jharegaon	MPAJ/BRS-17/2024-25	Alkali feldspar granite
6	21.91994 / 77.83675	Amdol	MPAJ/BRS-18/2024-25	Biotite gneiss
7	21.91020 / 77.83940	Amdol	MPAJ/BRS-41/2024-25	Quartz vein

6.1.1.4.1. Ferruginous quartzite:

In hand specimen, the rock is a medium- to coarse-grained rock. The rock shows light pink in color. It consists mainly of quartz and ferruginous material (Fig. 1a). Petrographically, the sample is characterized by an iron oxide laminae/layer interlayered with quartz bands, which is known as ferruginous quartzite (Fig. 1b). It is chiefly made up of quartz, with zircon, tourmaline, and opaques as the accessory minerals. The quartz grains are extensively strained with the development of a highly irregular, finger-like pattern where the grain edges interlock significantly, creating a complex suture-like appearance (Fig. 1c). In addition, undulose extinction and sub-grain formations of quartz grains are profusely formed. These features are typically formed under high-pressure and temperature conditions during deformation. Ferruginous layers consist of magnetite in the form of independent crystals associated with the oxidized oxy-iron oxides as seen under reflected light (Fig. 1d). Some of the euhedral to subhedral magnetite grains are embedded within the quartz matrix. Tourmaline is a crystalline ranging from stubby columnar crystals in association with the quartz matrix, especially at the contact zone (Fig. 1e). It shows yellowish green in color with two specific absorption colors (dichroism). The presence of tourmaline in quartzite typically originates from the weathering and erosion of pre-existing igneous and metamorphic rocks, where the tourmaline crystals formed primarily within the granite pegmatite. This study suggests that the tourmaline minerals may be confirmed in an SEM or EPMA study to provide information about the source of the sediments**.**

Fig 6.5 Chip samples of Ferruginous quartzite

Fig. 1a. Chip sample of ferruginous quartzite (Sample no. MPAJ/BRS-1/24-25).

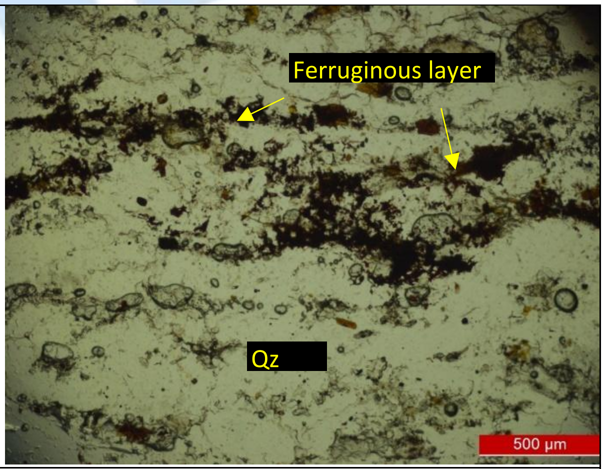
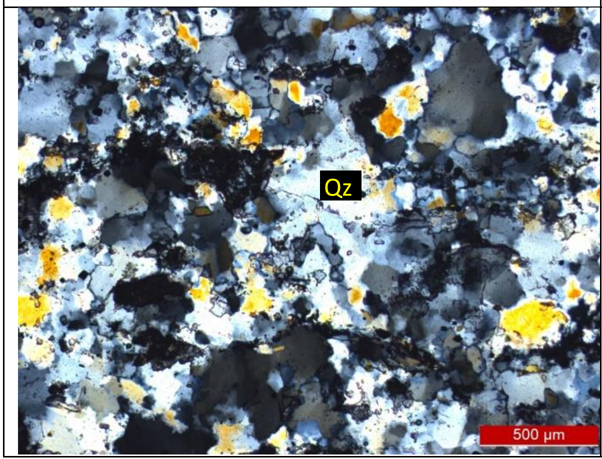


Fig. 1b. Photomicrograph showing ferruginous layer interlayered within the ferruginous quartzite under PPL (sample no. MPAJ/BRS-1/2024-25).



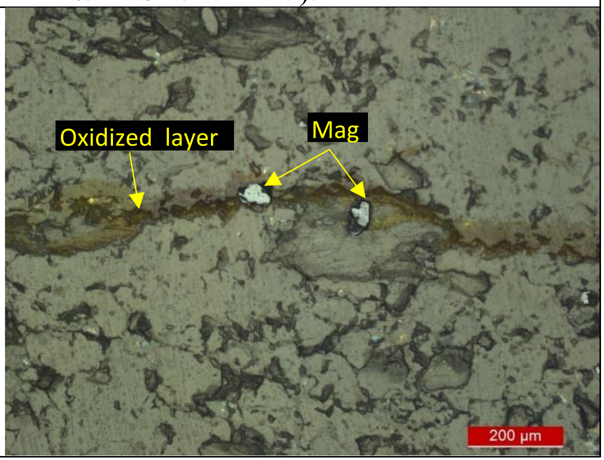


Fig. 1c. Photomicrograph showing zircon under CPL (sample no. MPAJ/BRS-1/2024-25).	Fig. 1d. Photomicrograph showing tourmaline under reflected light (sample no. MPAJ/BRS-1/2024-25).

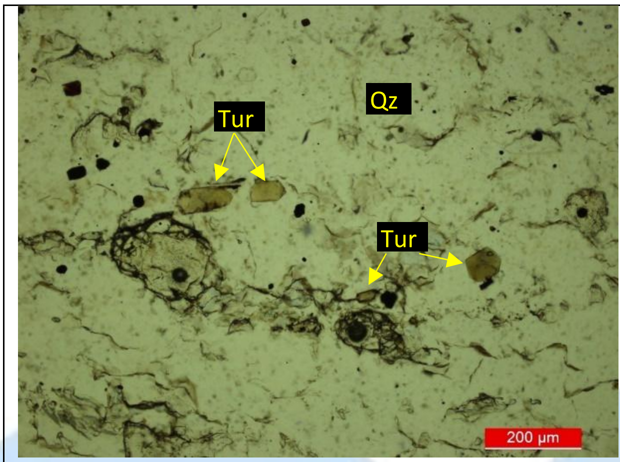


Fig. 1e. Photomicrograph showing stubby tourmaline (Tur) grains in the ferruginous quartzite under PPL (sample no. MPAJ/BRS-1/2024-25)

6.1.1.4.2. Biotite gneiss:

A fragile, moderately weathered, medium-grained rock, composed predominantly of quartz, alkali feldspar, plagioclase, and biotite (Fig. 2a). In thin section, the rock is classified as a biotite gneiss. Its mineralogical composition is dominated by quartz and alkali feldspar, with plagioclase and biotite present as accessory phases (Fig. 2b). The alkali feldspar component includes both orthoclase and microcline, distinguishable by their characteristic twinning. Plagioclase grains, commonly enclosed within biotite, exhibit well-defined lamellar twinning in several instances. Alkali feldspar crystals are typically sub-equant and exhibit indented grain boundaries in contact with adjacent quartz grains. Rounded to sub-rounded inclusions of quartz and plagioclase are observed within alkali feldspar, while a few plagioclase grains are also enclosed within biotite (Fig. 2c). These textural relationships suggest that the larger alkali feldspar and biotite grains crystallized later than the included minerals. The biotite occurs as brown, platy grains with a preferred orientation, imparting a well-defined foliation to the rock (Fig. 2d). In certain areas, elongated or stretched quartz grains are present, indicative of ductile deformation or shear.

Fig 6.6 Biotite gneiss

Fig. 2a. Hand sample of biotite gneiss showing highly fragile and weathered (Sample no. MPAJ/BRS-3/2024-25).

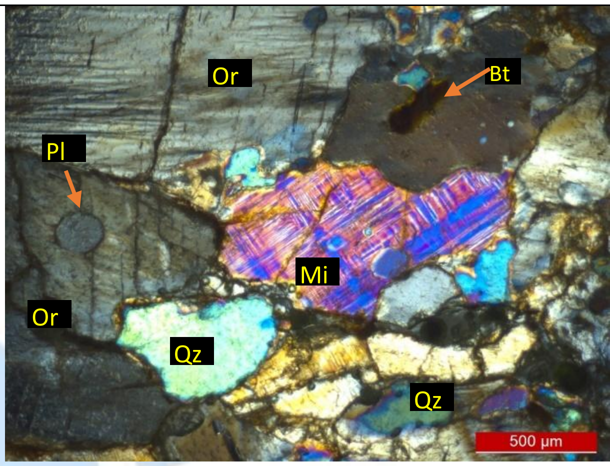


Fig. 2b. Photomicrograph showing microcline, orthoclase, plagioclase, quartz and biotite in the biotite gneiss under XPL (Sample no MPAJ/BRS-3/2024-25).

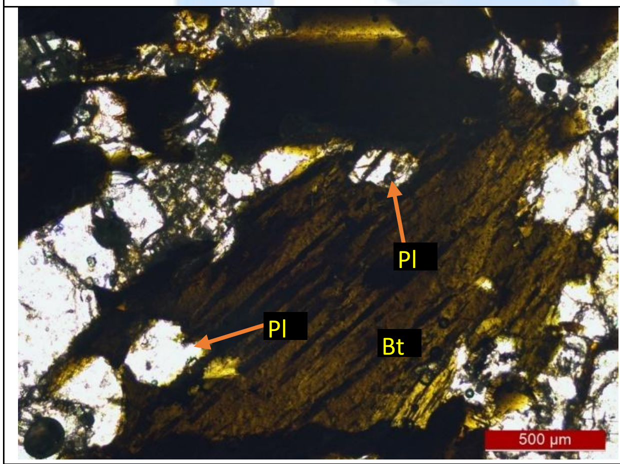


Fig.2c. Photomicrograph showing plagioclase included in the biotite under XPL (Sample no. MPAJ/BRS-3/2024-25).

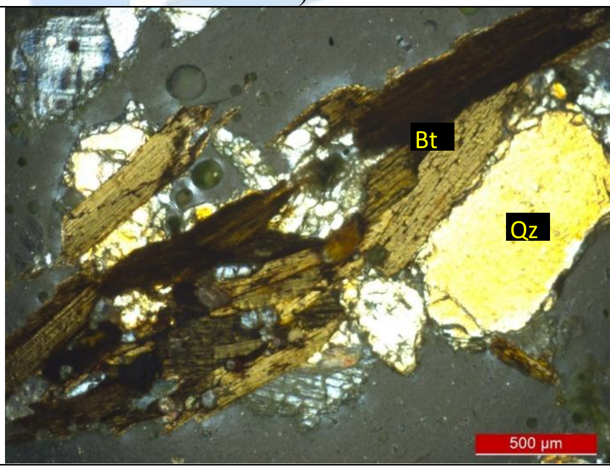
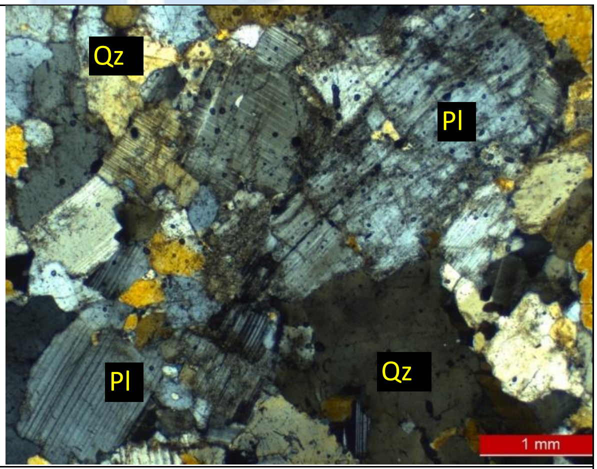


Fig.2c. Photomicrograph of biotite gneiss showing foliation defined by biotite under PPL (Sample no. MPAJ/BRS-3/2024-25).

6.1.1.4.3. Aplitic Granite:

Aplitic granite is a coarse-grained, leucocratic rock predominantly composed of quartz and plagioclase, with garnet occurring as an accessory mineral (Fig. 3a). In thin section, the rock is primarily composed of quartz and plagioclase, with minor amounts of garnet. Based on its mineral assemblage and texture, the rock is classified as an *aplitic granite*. The texture is predominantly sub-hypidiomorphic to granulose. The sub-hypidiomorphic texture is marked by the presence of plagioclase laths (Fig. 3b). Plagioclase crystals vary in size from large to small and commonly display well-developed lamellar twinning. In several areas, plagioclase is partially to completely altered to fine-grained sericite, indicating sericitization (Fig. 3c). Myrmekitic texture is evident in the form of vermicular quartz intergrowths within plagioclase (Fig. 3d). Quartz grains exhibit undulose extinction and sub-grain development, both indicative of strain-related deformation. Quartz inclusions within plagioclase are also observed. Garnet appears as rounded, cracked crystals in association with plagioclase, suggesting a xenomorphic texture (Fig. 3e).

Fig 6.7 Aplitic granite

<table>
<tr><td></td><td>
</td></tr>
<tr><td>Fig. 3a. Hand sample of Aplitic Granite (Sample no. MPAJ/ BRS 9/24-25).</td><td>Fig. 3b. Photomicrograph showing laths of plagioclase defines sub-hypidiomorphic texture in the aplitic granite under the cross-polar view (Sample no. RJBO/BRS-9/24-25) .</td></tr>
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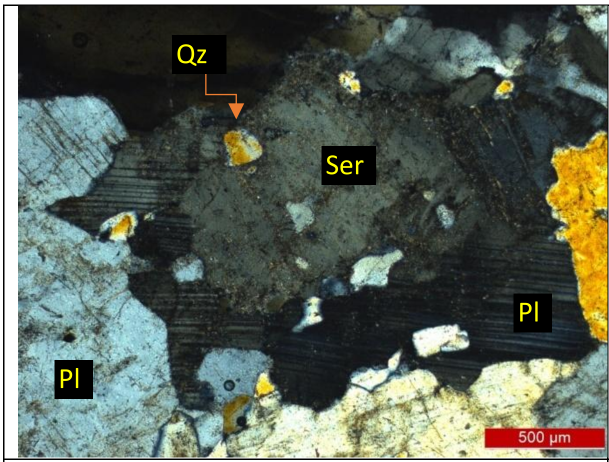


Fig. 3c. Photomicrograph showing partial alteration of plagioclase by sericite under the cross-polar view (Sample no.MPAJ/BRS-9/24-25).

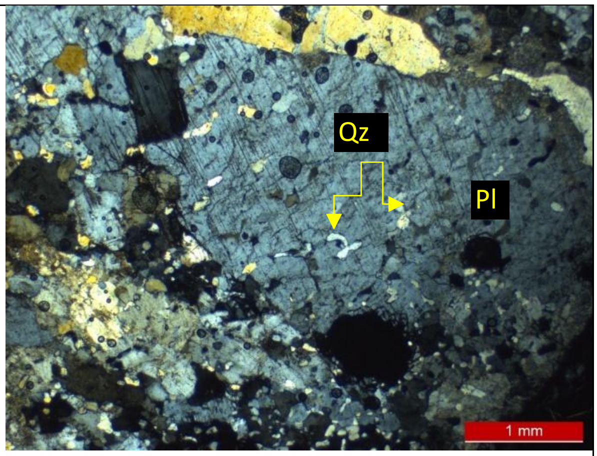


Fig. 3d. Photomicrograph of aplitic granite showing myrmekite texture defined by intergrowth of quartz in the plagioclase under the cross-polar view (Sample no. MPAJ/BRS-9/24-25).

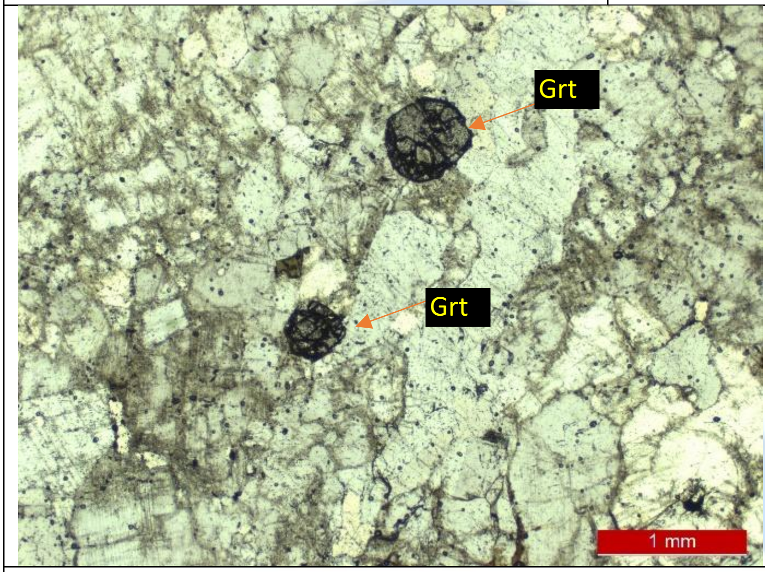
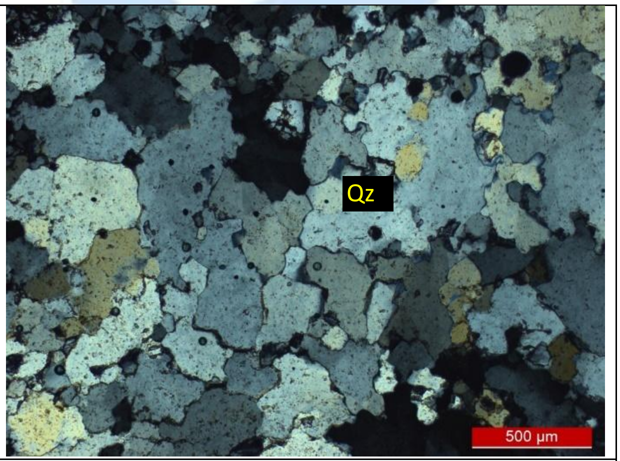


Fig. 3e. Photomicrograph showing a xenomorphic garnets associated with the plagioclase and quartz under plane-polar view (Sample no. MPAJ/BRS-9/24-25).

6.1.1.4.4. Quartzite:

The sample appears as a light-colored, medium-grained rock, predominantly composed of quartz (Fig. 4a). No foliation is apparent in the hand specimen, and the rock shows a uniform texture throughout. Under the polarizing microscope, the rock is composed almost entirely of quartz, with zircon and opaque minerals (iron oxides and pyrite) as minor accessories. Quartz grains exhibit strong evidence of deformation, including highly irregular, interlocking grain boundaries that form a distinctive suture-like or fingered texture (Fig. 4b). This pattern is characteristic of high-pressure and high-temperature deformation regimes. In other areas, the quartz grains exhibit a polygonal mosaic arrangement with well-defined triple junctions, representing a classic *granulose texture* indicative of recrystallization under static metamorphic conditions (Fig. 4c). Additionally, quartz grains display undulose extinction, sub-grain development, and elongation—features consistent with strain-induced deformation and dynamic recrystallization (Fig. 4d). A single, small zircon grain was also observed, indicating the presence of high-temperature resistant accessory phases. Reflected Light Microscopy Opaques in the sample are identified as goethite (iron oxide) and pyrite. Goethite commonly fills fractures and occurs along grain boundaries, suggesting secondary alteration (Fig. 4e). Pyrite is the only sulphide mineral identified and appears as round to sub-rounded grains, occurring independently within the quartz matrix. The morphology and distribution of pyrite grains are consistent with precipitation from hydrothermal fluids circulating through the rock's fracture system.

Fig 6.8 Quartzite

<table>
<tr><td></td><td>
</td></tr>
<tr><td>Fig. 4a. Chip sample of quartzite (Sample no. MPAJ/ BRS-10/24-25).</td><td>Fig. 4b. Photomicrograph of extensively strained quartzite display suture grain boundary between the quartz grains under XPL (Sample no. MPAJ/ BRS-10/24-25).</td></tr>
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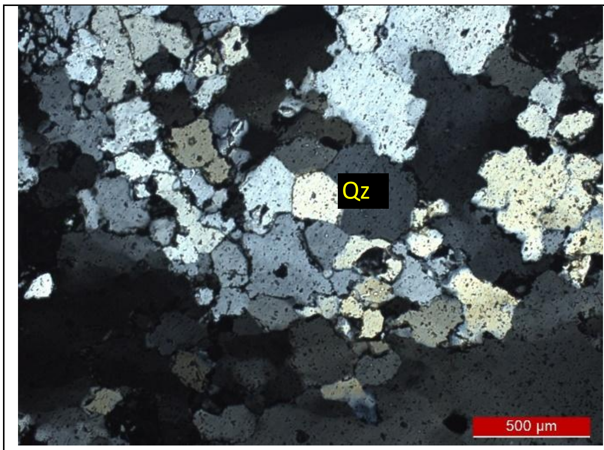


Fig. 4c. Photomicrograph of quartzite showing granulose texture under XPL (sample no. MPAJ/ BRS-10/24-25).

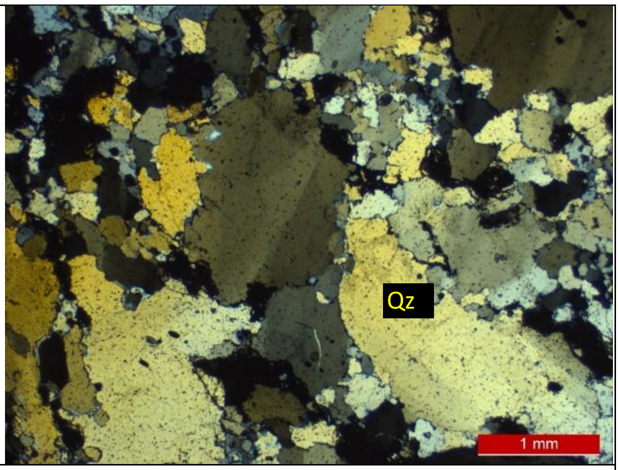


Fig. 4d. Photomicrograph of quartzite showing undulose extinction, elongation and subgrain formation in the quartz grains under XPL (Sample no. MPAJ/BRS-10/24-25).

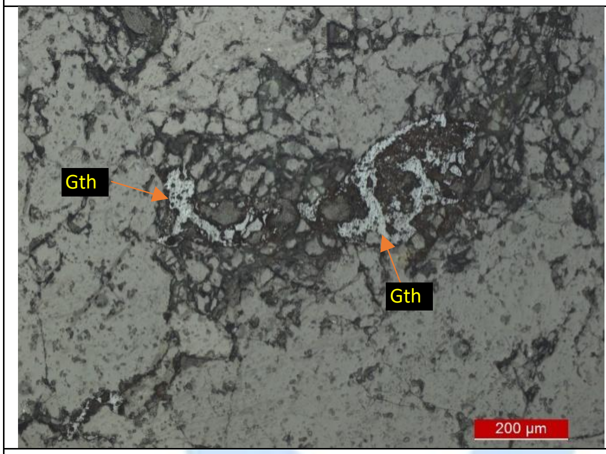


Fig. 4e. Photomicrograph showing the fracture filling goethite under reflected light (Sample no. MPAJ/BRS-10/24-25).

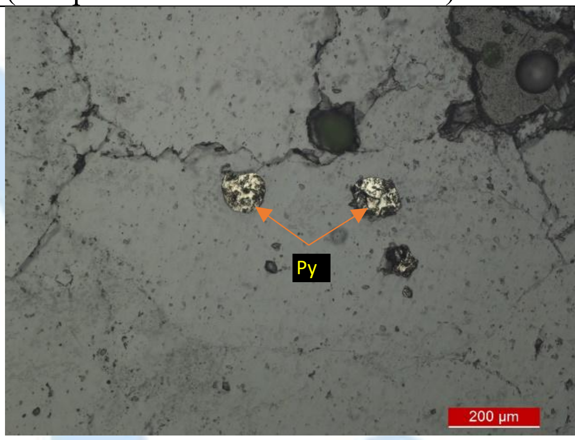


Fig. 4f. Photomicrograph of quartzite showing rounded pyrite grains associated with quartz under reflected light (Sample no. MPAJ/ BRS-10/24-25).

6.1.1.4.5. Biotite gneiss:

The sample is a fragile and moderately weathered, medium-grained rock. It is typically composed of quartz, alkali feldspar, plagioclase, and biotite (Fig. 5a). The foliation is discernible and defined by aligned biotite grains, giving the rock a layered appearance. Under the microscope, the rock is identified as a biotite gneiss, composed primarily of quartz, alkali feldspar, and plagioclase, with biotite and plagioclase acting as accessory minerals (Fig. 5b). The alkali feldspar is represented by both orthoclase and microcline, which are distinguishable by their characteristic twin lamellae. Plagioclase grains commonly occur as inclusions within biotite and display distinct lamellar twinning. Alkali feldspars are typically sub-equant and exhibit indented grain boundaries shared with quartz, indicative of dynamic recrystallization. Inclusions of rounded to sub-rounded quartz and plagioclase within alkali feldspar, along with plagioclase enclosed in biotite (Fig. 5c), suggest that the larger K-feldspar and biotite grains crystallized later than the included minerals. Biotite is present as brown, platy grains with a preferred orientation that defines the rock's foliation (Fig. 5d). Elongated or stretched quartz grains are also observed, suggesting the influence of shear deformation. The rock is devoid of mineralization.

Fig 6.9 Biotite gneiss

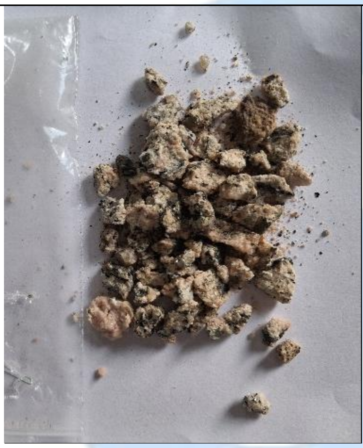


Fig. 5a. Chip sample of biotite gneiss showing highly fragile and weathered (Sample no. MPAJ/BRS-3/2024-25).

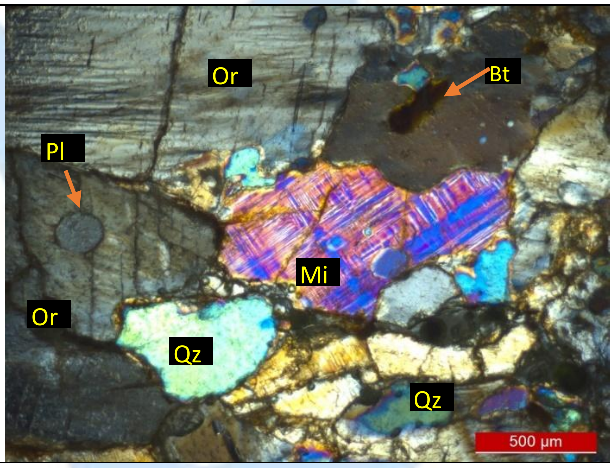


Fig. 5b. Photomicrograph showing microcline, orthoclase, plagioclase, quartz and biotite in the biotite gneiss under XPL (Sample no MPAJ/BRS-3/2024-25).

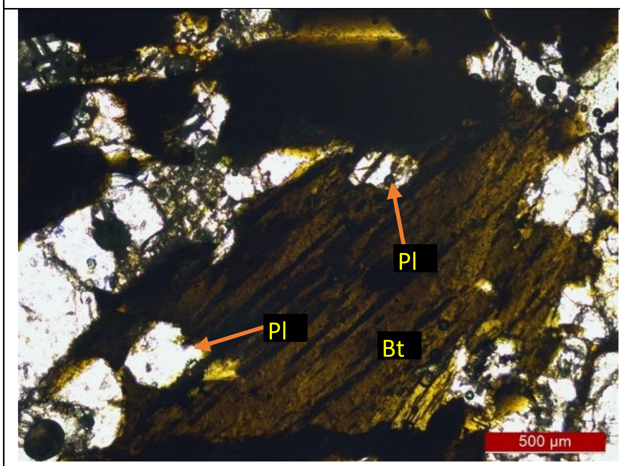


Fig.5c. Photomicrograph showing plagioclase included in the biotite under XPL (Sample no. MPAJ/BRS-3/2024-25).

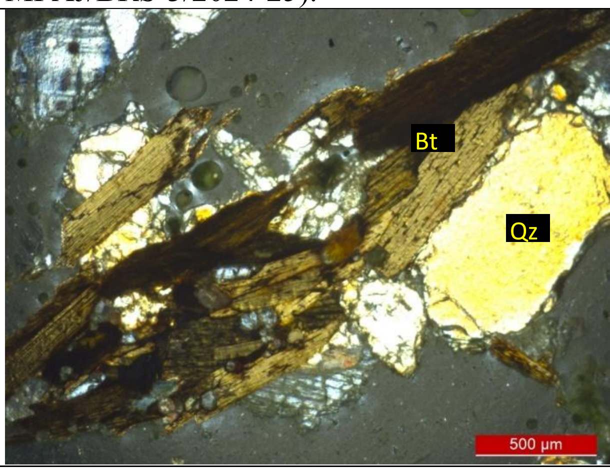


Fig.5c. Photomicrograph of biotite gneiss showing foliation defined by biotite under PPL (Sample no. MPAJ/BRS-3/2024-25).

6.1.1.4.6. Quartz Vein

In hand specimen, the sample shows pinkish white in colour quartz vein, with muscovite flakes (Fig. 7a).

Under microscope, the rock mainly consists of quartz, with muscovite as accessory. The quartz is showing undulose extinction. Muscovite is in platy form having 1st order interference colour (Fig. 7b). None of the mineralization is found in this sample after thorough examinations under the microscope.

Fig. 7a. Hand sample of quartz vein (Sample no. MPAJ/BRS-41/24-25).

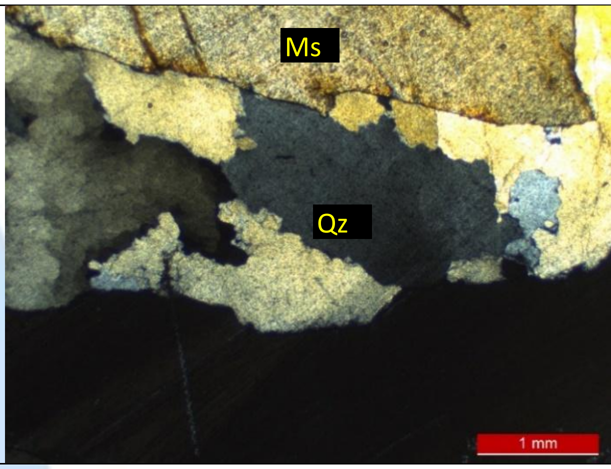


Fig. 7b. Photomicrograph quartz and muscovite in the quartz vein under CPL (sample no. MPAJ/BRS-41/24-25).

6.1.2. Structure of the area

The region under investigation lies between the Son-Narmada and Tapti lineaments, which predominantly trend in an east-northeast to west-southwest (ENE-WSW) orientation. The regional foliation of the rocks and prominent shear zones within this area align with these structural trends, influencing the overall geological fabric.

Various primary and secondary structures have been preserved within quartzite and other lithological units across the area. Notably, the primary structural features identified in these rocks are as follows

6.1.2.1. Primary structures

The bedding planes in the Sonaghati generally display sub-horizontal or low-angle dips, indicative of a relatively undisturbed depositional environment in the region. In some areas, slight tilting or folding may be observed due to later tectonic forces, but in most cases, the bedding remains close to horizontal. In the Jharegaon area, the quartzite beds exhibit a vertically dipping orientation, which is a marked deviation from the sub-horizontal or low-angle dips seen in other parts of the formation, and indicate the presence of a fault. This vertical dip enhances the visibility of the bedding nature and provides a clearer view of the underlying stratigraphy.

6.1.2.2. Deformational structures

The rocks in the region have experienced at least four distinct phases of deformation, which are characterized by the formation of three different sets of schistosity and fracture cleavage. The overall strike of the rock formations is oriented ENE-WSW, with varying dip directions: the northern part dips toward the WNW, while the southern part dips ESE. The outcrop patterns in the area are primarily controlled by the F2 and F3 deformation phases, with the F3 phase being the most significant. This phase led to the folding of the entire lithological sequence.

6.1.2.3. Planar structures

6.1.2.3.1. Foliation/ Schistosity

The foliated texture is pronounced in many outcrops, where minerals like biotite, muscovite, and hornblende show a distinct alignment along the foliation planes. In the study area, four distinct sets of foliations are clear. The S0 foliation is mostly parallel to S1, with S1 typically trending in a NE-SW direction and exhibiting steep to sub-vertical dips towards the southeast. Changes in the dip direction and magnitude are observed, likely because of folding. The S2 foliation forms an acute interfolial angle of approximately 15° to 20° with S1 and dips steeply, undergoing variations in both amount and direction due to folding. The S3 foliation manifests as crenulation cleavage, primarily observed in quartz-mica schists. Finally, the S4 foliation appears as a fracture cleavage oriented in the N37°W-S37°E direction, with a dip of 70° to the north. Two additional sets of foliations are apparent in the amphibolite units, with strikes that are oriented both in the NE direction and in an E-W orientation, displaying varying dips towards the NW and SE.

6.1.2.3.2. Joints

Joints are primarily observed in gneiss and quartzite formations. In the study area, two distinct sets of joints are prevalent. The first set, which is most widespread, trends N55°E-S55°W and has a vertical dip, aligning parallel to the regional foliation. The second set trends N30°W-S30°E, also with a vertical dip.

6.1.3. Metamorphism

The Sonaghati-Jharegaon area in Betul, Madhya Pradesh, lies within a geologically active region that has undergone substantial metamorphism, largely driven by tectonic forces and the broader geodynamic evolution of the area.. The metamorphism in the area is generally classified as medium to high grade, as evidenced by the presence of schists, gneisses. These rock types typically form under conditions of moderate to high pressure and temperature. This regional metamorphism most likely occurred during episodes of tectonic compression, which resulted in significant deformation of the lithological layers. The development of schistosity and gneissic foliation is widespread throughout the area, indicating that the region underwent intense shearing and folding during the deformation process. The multiple sets of foliations (S1, S2, S3, and S4) that can be observed are a direct result of progressive deformation under escalating metamorphic conditions. These foliation sets reveal the region's complex tectonic history. Quartzites and mica schists are also present in the region, and these rocks likely represent those that have undergone significant recrystallization under medium to high-grade metamorphic conditions. These lithologies are indicative of the intensity of the regional metamorphism.

The rock units exposed in the study area constitute the southeastern extension of the Aravalli Supergroup, which is regionally metamorphosed and exhibits complex structural deformation. The intensity of metamorphism is closely linked to the degree of deformation, with the earliest deformation phase (F1) playing a dominant role in controlling the metamorphic imprint of the region. Petrographic and field evidence indicate that the rocks have undergone regional, syntectonic metamorphism associated with the F1 deformation phase. The observed mineral assemblages are characteristic of the upper greenschist facies, indicating moderate-grade metamorphic conditions. The presence of sheared K-feldspar porphyry further supports evidence of significant ductile shearing. In the peripheral parts of the area, where calcareous metasedimentary rocks are present, shear zones have been subjected to localized thermal metamorphism, resulting in the development of calc-silicate hornfelses. These contact metamorphic effects are attributed to heat generated along shear zones, possibly related to syntectonic intrusion or deep-seated tectonic activity.

Based on petrographic investigations, the metamorphic rocks of the area can be broadly categorized into the following mineral assemblages:

Metasedimentaries of Ranipur Formation: Quartz + plagioclase + muscovite + sericite +chlorite + feldspar ± calcite ± diopside ± epidote ± garnet ± sphene ± apatite ± tremolite ±wollastonite ± opaques + carbonate.

Metasedimentaries of Sonaghati Formation: Quartz + muscovite + sericite + opaques ±feldspar ± garnet ± calcite± graphite.

Meta basics / ultra basics

1) Hornblende + tremolite + actinolite + plagioclase + quartz ± pyroxene ±garnet ± sphene ± epidote + iron oxides.

2) Olivine + tremolite ± spinel ± ilmenite ± garnet

3) Pyroxene + amphibole ± talc ± magnetite.

Migmatite gneiss/ Granite gneisses – Quartz + orthoclase + microcline + muscovite + biotite + plagioclase + perthite + apatite + zircon ± hornblende ± sphene +iron oxides

The above-mentioned assemblages are suggestive of a regional metamorphism of upper green schist facies to amphibolite facies.

6.1.4. Mineralogy of the Graphite zones and ore textures

Upon traversing the block no Graphite zone was identified at the surficial scale, but there is a probability of subsurface graphite beds due to presence of graphite in adjacent blocks, which come under GSI.

6.1.5. Trenching

As the traces of graphite schists are mostly covered with soils in the area, subsurface exploration, trenching was carried out to understand the nature and continuity of the graphite mineralized zones and to delineate their extension in such an area. A total of 100 cu m of trenching has been carried out in the study area to expose the bedrock in Jharegaon and the Amdol area. To check the strike continuity of the possible host for graphite and associated mineralisation in the study area, the trenches were excavated across the general trend, maximum depth of 2m by removing the topsoil cover and the oxidized/weathered part of the bedrock horizon. Samples were collected at regular intervals of 1m. Out of the 50 samples collected, 15 representative samples were selected based on physical properties (black to grey colour) and submitted for chemical analysis for the determination of fixed carbon, moisture content, volatile matter, and ash content. The other half was preserved as a duplicate.

6.1.5.1. Trenching Methodology

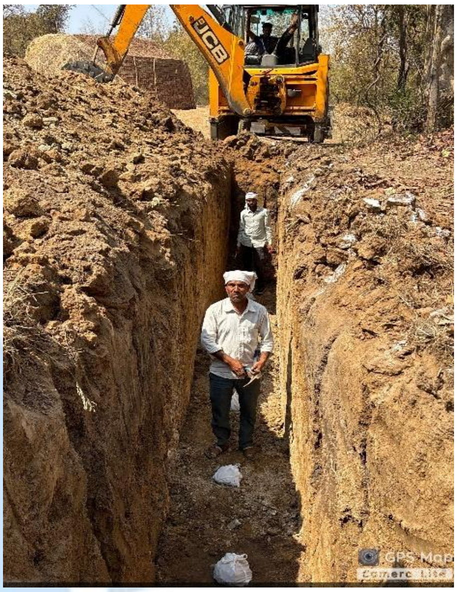
As part of the geological investigation, a total of 50 trench samples were collected from five systematically excavated trenches across the study area. The trenching activities involved the excavation of approximately 100 cubic meters of material. Each trench measured roughly 10 meters in length and 2 meters in depth, 1m width, providing adequate exposure of the subsurface geological profile for detailed sampling and analysis. Samples were carefully collected at regular 2-meter intervals along both the walls and floors of each trench, ensuring comprehensive coverage and representative sampling of the exposed lithologies. Out of the 50 collected trench samples, 26 were selected (again based on physical properties which had higher chances of yielding graphite) and submitted for proximate analysis to evaluate their graphite content. The proximate analysis focused on key parameters relevant to graphite characterization, including Volatile Matter (VM), Fixed Carbon (FC), and Ash Content. These parameters are critical in determining the quality and economic potential of the graphite present.

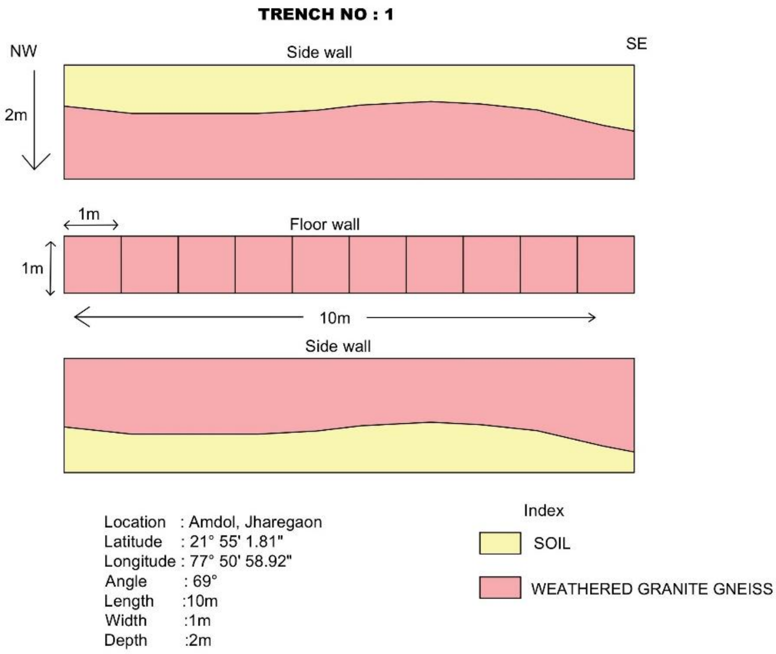
Details of all the trenches excavated in the area are shown in table here:

Table 6.3: Details of collected trenching samples in the area

Sl .no	Trench	Locations	Latitude	Longitude	Dimension of trench (LxWxD) m	No of samples collected
1	T-1	Amdol	21°55,01.81”	77°50,58.92”	10×1×2	10
2	T-2	Jharegaon	21°54,42.22”	77°50,24.59”	10×1×2	10
3	T-3	Jharegaon	21°53,42.34”	77°49,47.60”	10×1×2	10
4	T-4	Jharegaon	21°54,00.42”	77°50,17.20”	10×1×2	10
5	T-5	Jharegaon	21°54,58.26”	77°49,55.04”	10×1×2	10

Fig 6.11 Trench 1

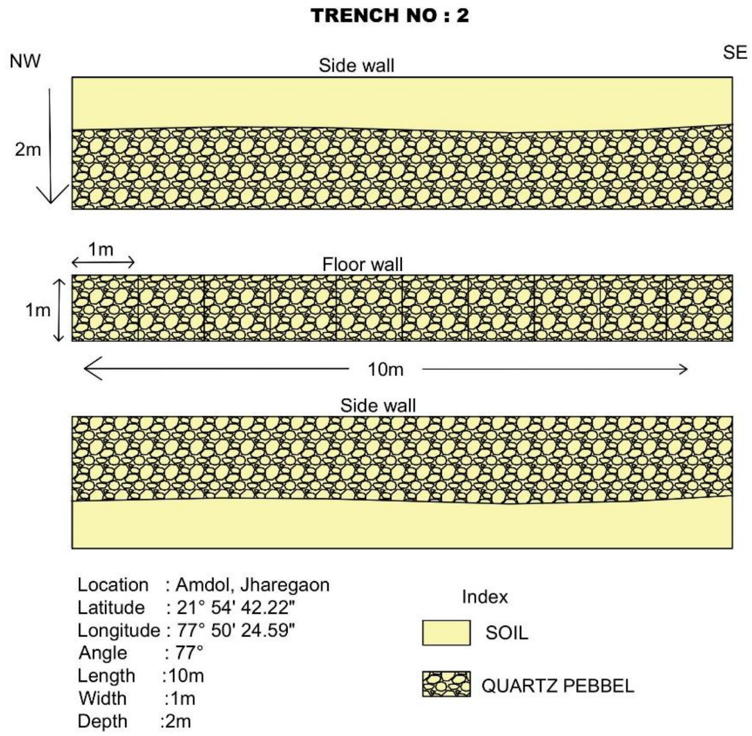
	
Field Photograph- Excavated trench in N60W-S60E direction across the granite body located at the Amdol village. Lat/Long:21.9112,77.84997	



Geological section of T-01, Sonaghati, Amdol, Jharegaon, and Bhayawari

Fig 6.12 Trench 2

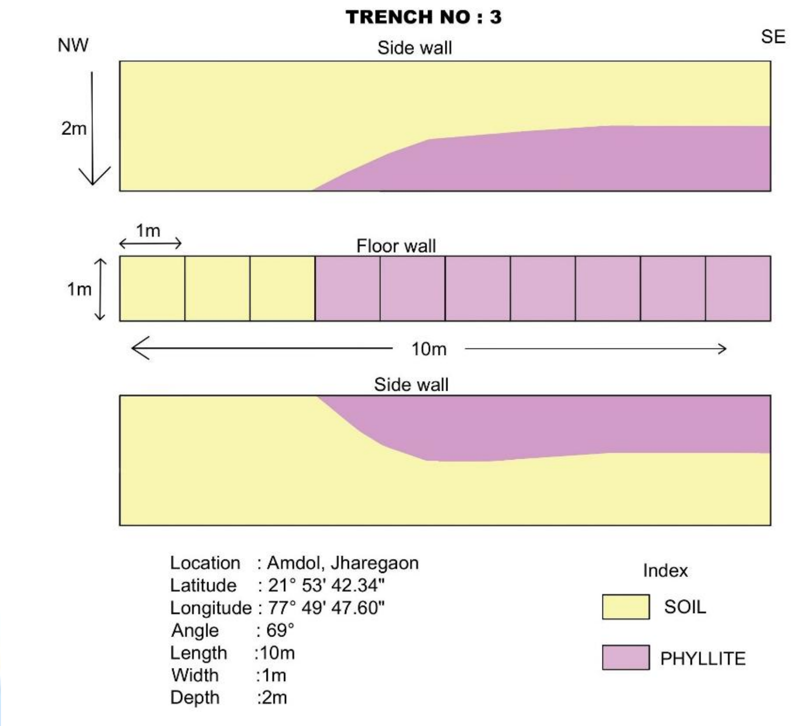
Field Photograph- showing excavated trench in N77W-S77E direction across the contact between granite gneiss and Quartzite body located to the Jharegaon village. Lat/Long: 21.91172,77.84028.



Geological section of T-02, Sonaghati, Amdol, Jharegaon, and Bhayawari

Fig 6.13 Trench 3

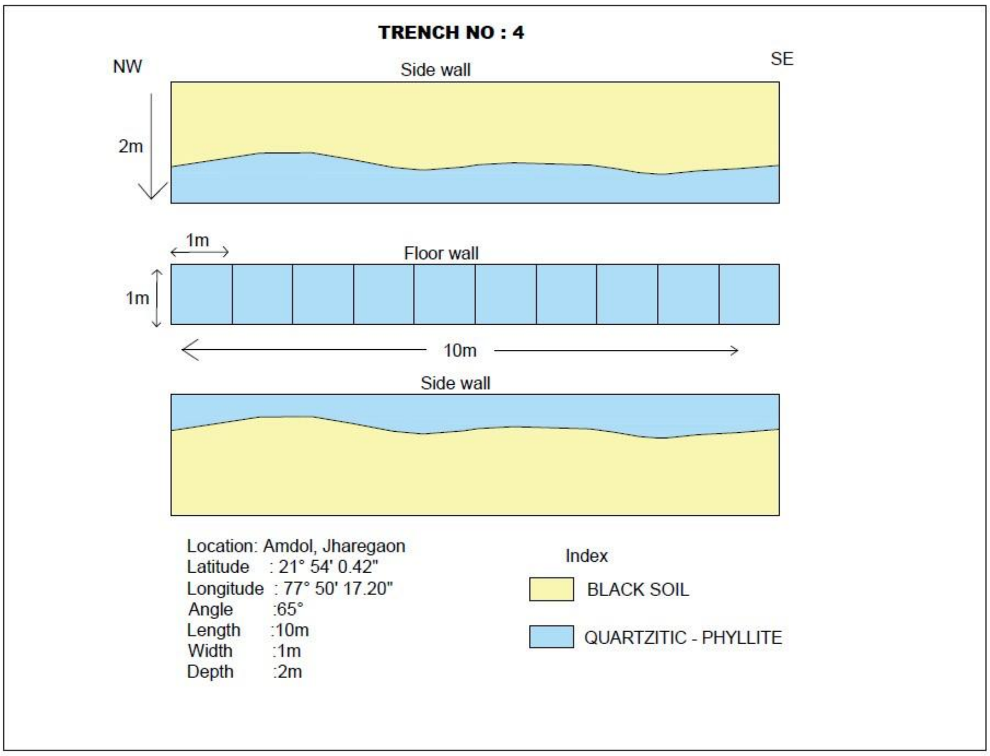
Field Photograph- showing excavated trench in N69W-S69E direction across the Phyllite body located to the Jharegaon village. Lat/Long: 21.89559,77.83052.



Geological section of T-03, Sonaghati, Amdol, Jharegaon, and Bhayawari

Fig 6.14 Trench 4

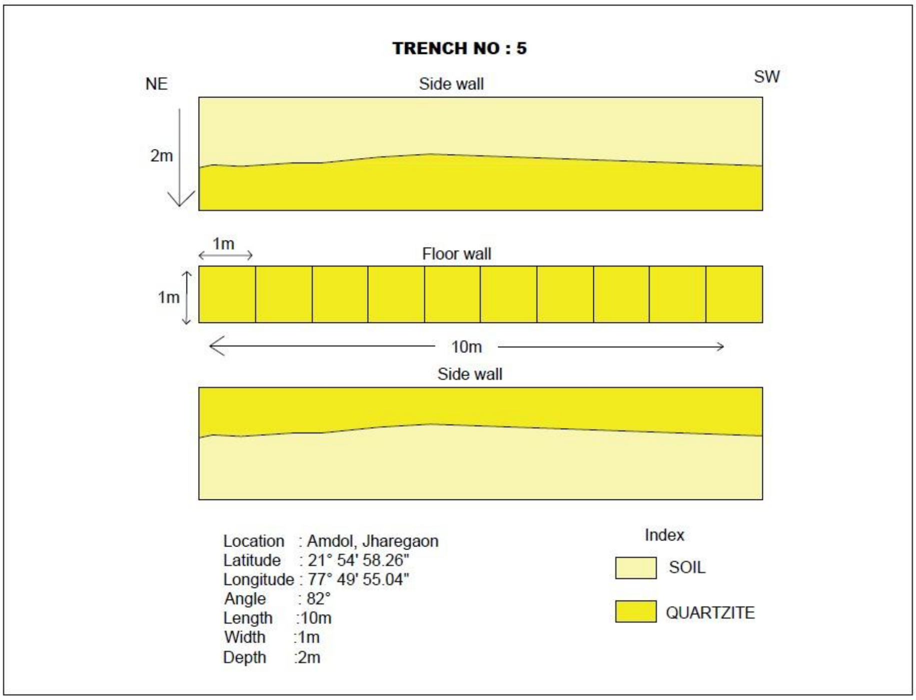
Field Photograph- showing excavated trench in N69W-S69E direction across the Quarzitic-Phyllite body located to the Jharegaon village. Lat/Long: 21.90014,77.83739.



Geological section of T-04, Sonaghati, Amdol, Jharegaon, and Bhayawari

Fig 6.15 Trench 5

Field Photograph- showing excavated trench in N82E-S82W direction across the Quartzite body located to the Jharegaon village. Lat/Long: 21.91692,77.83255.

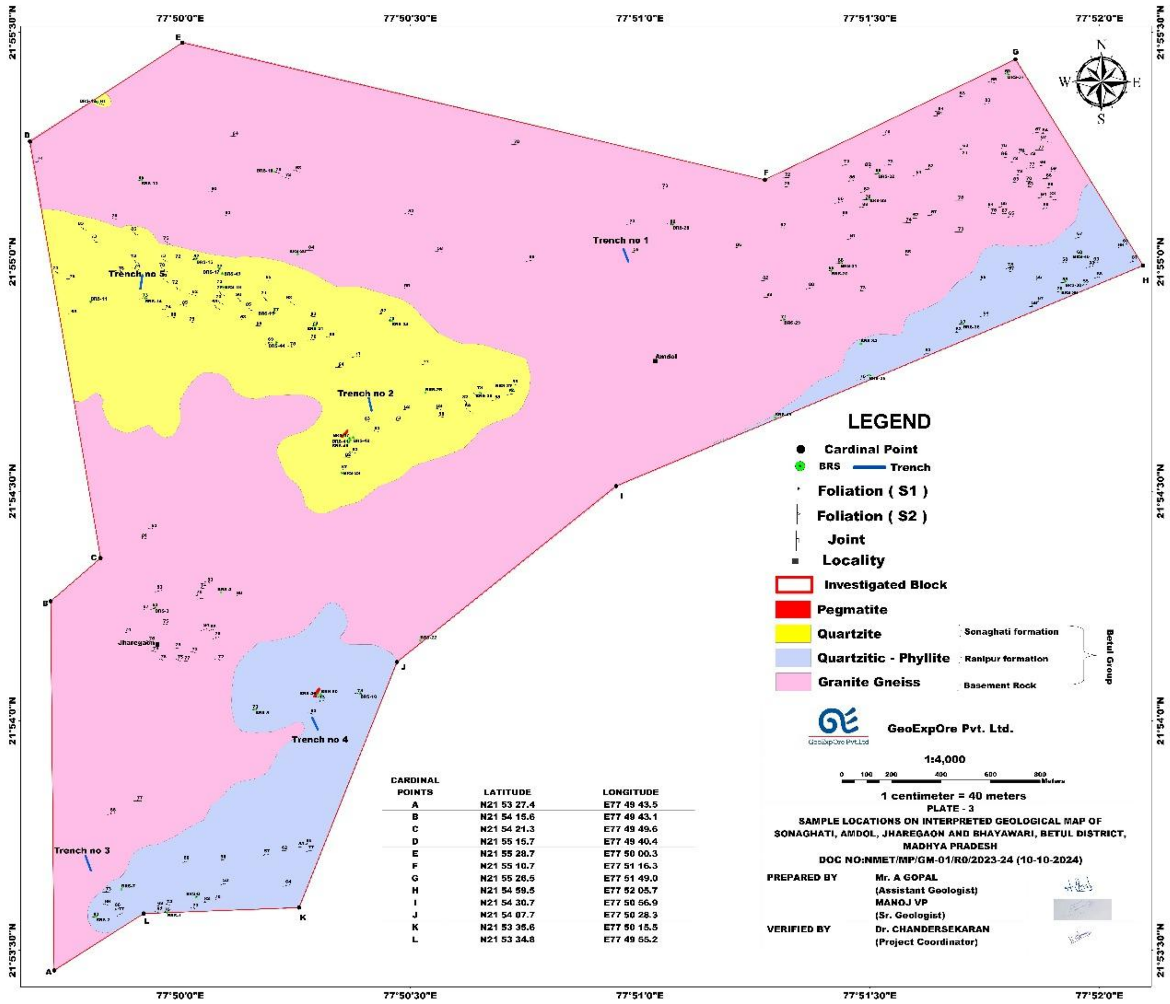


Geological section of T-05, Sonaghati, Amdol, Jharegaon, and Bhayawari

6.1.6. Sampling

To check the potentiality of graphite and associated mineralisation in Sonaghati, Amdol, Jharegaon, and bhayawari areas, Betul District, Madhya Pradesh, various types of samples such as bedrock samples, petrochemical samples, trenching samples etc., were collected from the study area. Samples were obtained from the schists, phyllites and granite gneiss based on the GSI's explored area where graphite was reported. Also sampling was done from pegmatites, quartz vein, alkali feldspar granite to check for other associated minerals if any. The details of these samples are as follows:

PLATE - 3
SAMPLE LOCATIONS ON INTERPRETED GEOLOGICAL MAP OF SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI, BETUL DISTRICT, MADHYA PRADESH



6.1.6.1. Bedrock sampling (BRS):

A total of 50 nos. of bedrock samples were collected randomly from all possible host rocks for graphite and associated mineralisation in the area. The details of their location, rock type, etc. are given in Annexure I, chemical analysis is given in Annexure III (Fixed Carbon) and Annexure IV (Trace element) and marked in Plate-III.

Bedrock samples were collected as small chips from fresh rock surfaces within a 1 meter radius. Before sampling, the surfaces were thoroughly cleaned to minimize contamination. Approximately 2 kg of sample was obtained and subsequently ground to a 200 mesh size using a laboratory grinder. Standard sampling procedure, one portion was reserved for chemical analysis. 15 samples were analysed for proximate analysis, 8 samples were submitted for Trace element analysis to the laboratory, and remaining were preserved as duplicate**.**

6.1.6.2. Trench Samples

A total of 50 samples were collected from 5 trenches (10 samples from each trench). Across the strike trenches were made, and systematic composite samples were obtained from the walls and floor of the trench with a spacing of 1 m between samples in a trench. 26 samples were selected based on physical properties and then sent for analysis in laboratory.

6.1.6.3. Samples for Petrography:

A total of 07 samples were collected for petrographic studies from representative bed rocks in the mapped area. The rock samples were collected in the form of small chips from fresh bedrock by thoroughly cleaning the sample. Thin polished sections (TPD) studies were prepared outsourced.

6.1.7. Interpretation of analytical results:

During the investigation, 50 BRS samples were collected and 15 were analysed for fixed carbon. BRS samples have been chemically analysed. Out of 50 nos. 12 nos. BRS are Quartzite, 08 BRS are Quartzitic -Phyllite, 01 BRS Ferruginous Quartzite, 15 BRS are Granite Gneiss, 09 BRS are pegmatites, 01 nos. BRS is quartz veins, 01 BRS is Smoky quartz, 01 BRS is Alkali feldspar granite, 01 BRS is Aplitic Granite and 01 BRS is Phyllite.

6.1.7.1. Interpretation on BRS Samples:

A total of eight BRS samples were collected and analyzed for trace metal content. Among these, two samples (BRS Nos. 46 and 49) are identified as pegmatite. BRS No. 46 recorded tantalum (Ta) values of up to 157.85 ppm. BRS No. 49 exhibited niobium (Nb) concentrations reaching 70 ppm, tungsten (W) up to 56.39 ppm, and tantalum (Ta) up to 90.61 ppm. These geochemical results are encouraging, pointing to hybrid nature of pegmatite in the area.

6.1.7.2. Trenching Samples:

A total of 50 trench samples were collected. The two samples of graphite schist from the Jharegaon area. Of the 26 analysed PTS samples, three were collected from phyllite, with one sample showing a fixed carbon (FC) content of 1.90%, while the remaining samples reported FC values of less than 1%. Four trench samples were obtained from quartzitic phyllite; among these, two samples recorded FC values of 1.94% and 1.96%, respectively, while the other samples showed FC content below 1%. These results indicate the presence of graphitic carbon in both phyllite and quartzitic phyllite lithologies.

6.1.8. Graphite Zones

Though a few encouraging values of graphite were recorded in the Quartzitic phyllite, however, no relatable graphite zones could be identified on the surface. In view of the above, efforts were made to probe the subsurface by geophysical investigation. However post geophysical survey the area the graphite presence could not be verified as only SP survey was conducted in limited area.

6.2. Geophysical exploration

In pursuance of the NMET-scheduled work programme under this project, a Self-Potential (SP) geophysical survey was carried out with the primary objective of identifying subsurface anomalies associated with graphite mineralization. The self-potential survey was carried out by GeoExpOre Pvt limited from 16th to 22nd in Sonaghati, Amdol, Jharegaon and Bhayawari. The objective of this survey is to identify probable favourable zones for graphite mineral. This non-invasive, passive survey method is well-suited for graphite exploration, as graphite-rich zones often exhibit distinct electrical properties due to their good electrical conductivity. The SP survey involved systematic measurements of natural electrical potential differences at the surface, which arise from electrochemical processes occurring within the subsurface. These measurements help in delineating electrically conductive zones, which may correspond to graphitic schist or graphite-bearing formations. The survey was strategically conducted across geologically favourable areas identified during earlier stages of the investigation, such as remote sensing, geological mapping, and trenching. Further details regarding the SP survey methodology, instrumentation, survey layout, data acquisition, and interpretation are provided below.

6.2.1. Methodology

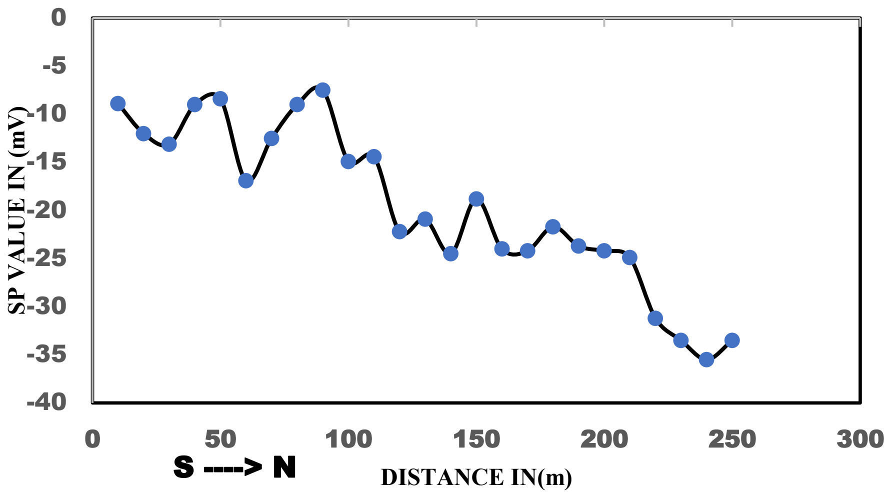
The Self-Potential (SP) data were acquired along 17 traverses, with individual traverse lengths ranging from approximately 150 meters to 300 meters, resulting in the collection of data from over 400 measurement points. Most of these traverses were strategically positioned in proximity to the trenches excavated within the designated exploration block, thereby enhancing the correlation between geophysical responses and known geological exposures. The SP method detects natural electrical potential differences that develop due to naturally flowing electrochemical currents in the shallow subsurface. These currents are primarily generated by the movement of ions within groundwater, especially where the water is in contact with conductive materials such as graphite-bearing formations. The resulting self-potential anomalies can serve as indicators of subsurface mineralization. Porous pots filled with electrolytic solution were employed as non-polarizable electrodes to measure these potential differences accurately. A fixed-base reference technique was used throughout the survey to maintain consistency in data acquisition. All collected SP data was systematically processed and interpreted, and the results have been presented in the form of potential profile plots, which help in visualizing subsurface conductive zones and guiding further exploration efforts.

6.2.2. SP Profiles and interpretation

All the self-potential (SP) profiles generated from the survey data were interpreted qualitatively, focusing on identifying anomalous zones that could be indicative of graphite mineralization. The qualitative interpretation involved analysing the shape, amplitude, and continuity of the self-potential curves along each traverse to infer subsurface conditions and possible zones of interest. Self-potential anomalies are typically expressed as negative or positive deviations from a baseline potential, and in the context of graphite exploration, negative anomalies are particularly significant. This is since graphite, being a good conductor of electricity, can create electrochemical cells when in contact with groundwater, leading to the movement of ions and the generation of measurable potential differences at the surface. Here we will be discussing in detail on the traverses which yielded significant SP Low anomaly.

6.2.2.1. Jharegaon SP Anomalies (Near trench no:3, Traverse no:2)

Fig 6.16 Traverse 2

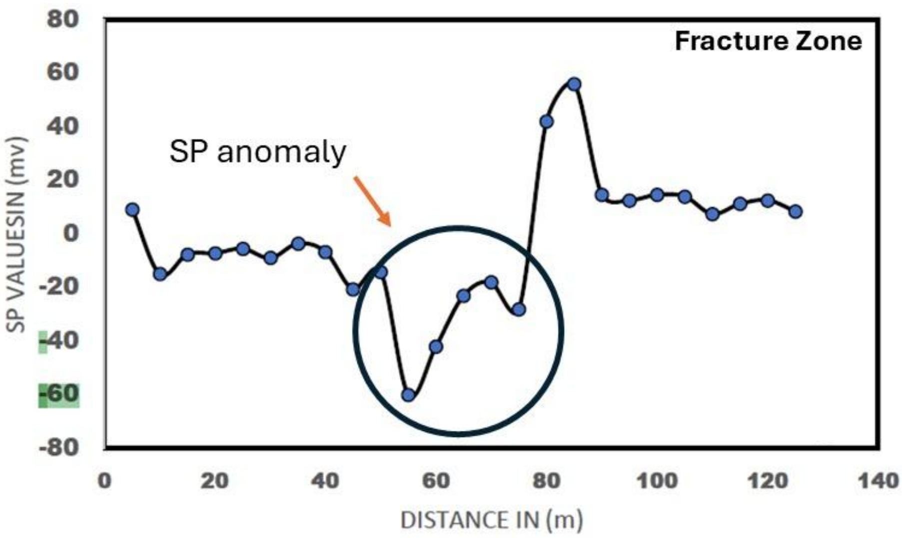


Negative SP anomalies (~ –25 mV) were observed near phyllite-quartzite contacts. These readings are modest but indicate conductive material at shallow depth. The coordinates for this profile are as follows:

- Base station (0 position): Latitude 21° 53' 39.30" N, Longitude 77° 49' 52.78" E
- End of the profile: Latitude 21° 53' 35.27" N, Longitude 77° 49' 52.027" E

6.2.2.2. Jharegaon SP Anomalies (Near trench no:2, Traverse no:9)

Fig 6.17 Traverse 9

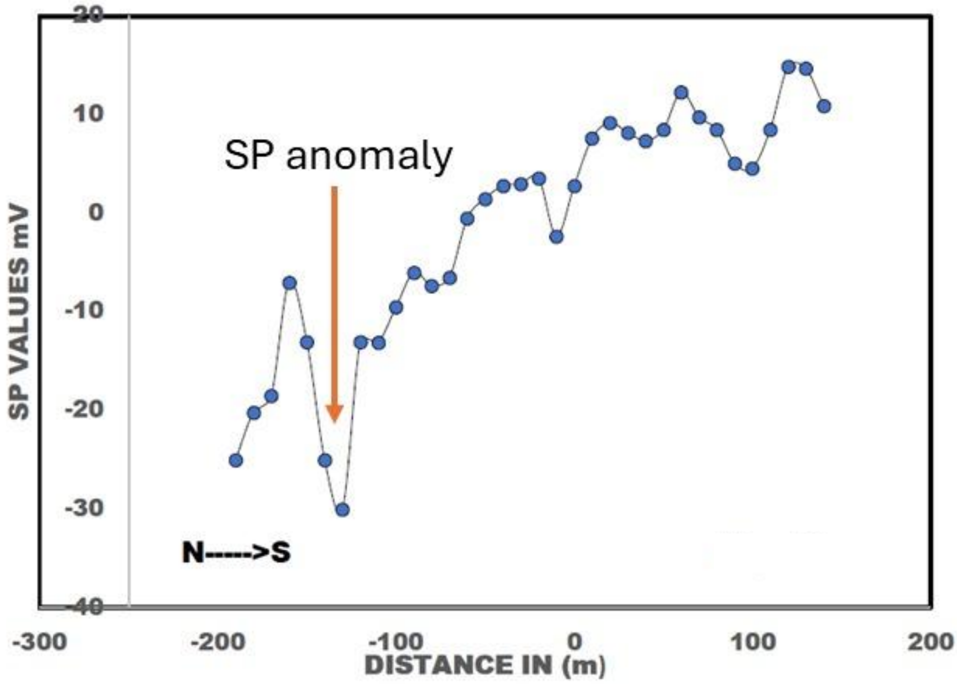


This traverse shows stronger lows, with values extending below –30 mV. Such anomalies are significant as they may correspond to zones enriched in conductive minerals. The coordinates for this profile are as follows:

- Base station (0 position): Latitude 21° 54′ 33.00″ N, Longitude 77° 50′ 20.76″ E
- End of profile: Latitude 21° 54′ 36.45″ N, Longitude 77° 50′ 23.19″ E

6.2.2.3. Jharegaon SP Anomalies (Near trench no:2, Traverse no:12)

Fig 6.18 Traverse 10



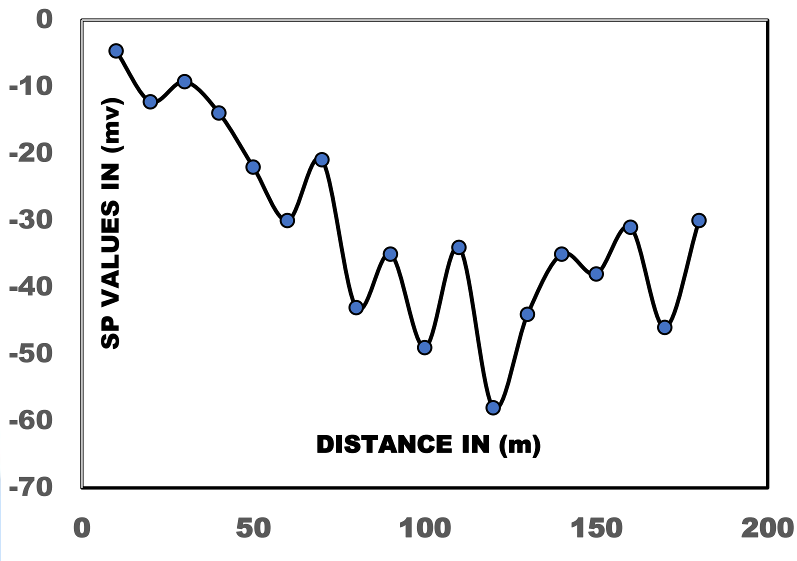
SP lows of –20 to –25 mV are seen at lithological boundaries. The anomalies are narrower compared to Traverse 9, suggesting more localized features. The coordinates for this profile are as follows:

-Base station (0 position): Latitude 21° 54′ 42.14″ N, Longitude 77° 50′ 22.65″ E

-End of profile: Latitude 21° 54′ 46.14″ N, Longitude 77° 50′ 20.74″ E

6.2.2.4. Amdol SP Anomalies (Near trench no:1, Traverse no:15)

Fig 6.19 Traverse 15



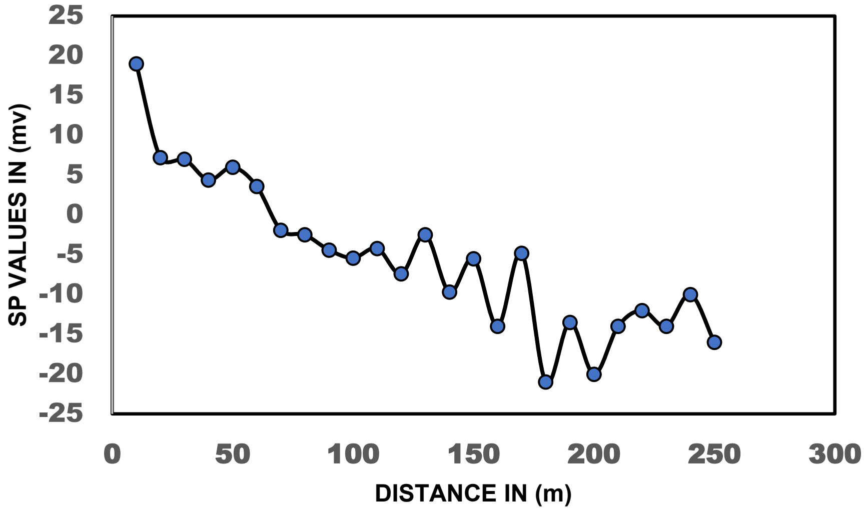
A pronounced negative SP anomaly of approximately -58 mV is attributed to a fracture zone characterized by a conductive environment. This suggests the presence of fluids or conductive minerals within the fracture, which influence the SP response. To gain more detailed information on the subsurface structure and depth extent of this conductive zone, it is recommended to conduct an electric resistivity survey. This method will provide complementary data on resistivity distribution and help better delineate the fracture zone.

The coordinates for this profile are as follows:

- Base station (0 position): Latitude 21° 54′ 50.56″ N, Longitude 77° 51′ 2.81″ E
- End of profile: Latitude 21° 55′ 13.35″ N, Longitude 77° 50′ 48.80″ E

6.2.2.5. Amdol SP Anomalies (Near trench no:1, Traverse no:16)

Fig 6.20 Traverse 16



At the contact between phyllite and gneiss, a negative anomaly of ~ –20 mV was recorded. This likely reflects alteration or fluid movement along the contact. The coordinates for this profile are as follows:

- Base station (0 position): Latitude 21° 54′ 43.47″ N, Longitude 77° 51′ 6.91″ E
- End of profile: Latitude 21° 54′ 36.17″ N, Longitude 77° 51′ 8.85″ E

6.2.3. Geophysical survey summary & conclusion

Across the surveyed area, SP lows ranged between –20 mV and –50 mV. Profiles recording –30 mV and below are most significant and should be highlighted, as they point to stronger conductive body. These anomalies coincide with lithological contacts, especially phyllite–quartzite and phyllite–gneiss junctions. While SP alone cannot confirm graphite, the results justify further work such as resistivity and Induced Polarization (IP) surveys for depth-specific information.

6.3. Geochemical Exploration for graphite mineralisation:

6.3.1. Selection of Geochemical exploration type:

For Geochemical exploration, bedrock samples, petrochemical samples, and trenching samples were systematically collected, analysed, and interpreted to identify the Graphite and other mineralized zones.

6.3.2. Methodology of geochemical exploration:

6.3.2.1. Bed Rock Samples (BRS): Observations, Anomalies & Interpretation

6.3.2.1.1. Observations

The BRS data (reports added in the appendix) showcase proximate analytical results primarily for moisture (IM), ash, volatile matter (VM), and fixed carbon (FC) content. The samples broadly represent the underlying basement geology in areas of graphite exploration.

- Moisture (IM): All BRS samples display extremely low moisture (0.01–0.09%), reflecting the dry nature of the rocks.
- Ash Content: Ash values are exceptionally high (0.01–3.96%), indicating a dominant mineral matrix with little or no combustible matter.
- Fixed Carbon (FC): Across all samples, FC values are low, ranging from as little as 0.02% to a maximum of just 0.62%. Occasional peaks near 0.62% may point to a trace presence of graphite or organic carbon, but none of these reach the cutoff values for graphite.
- Volatile Matter: VM is ranges between 97.86% to 99.81%. This is consistent with rocks that are highly metamorphosed and lack significant volatiles.

The multielement data highlights typical major oxide patterns: aluminium (Al) and silicon (Si) dominate, while iron (Fe) and trace elements like Nb, Ta, Th, and U occasionally spike, corresponding to accessory minerals like zircon or tourmaline.

6.3.2.1.2. Anomalies

- Ash Value Deviations: One or two samples in each report show slightly lower ash values (as low as 0.01%), paired with slightly elevated FC (up to 0.23%).

- Trace Elements: Certain bedrock samples show enhancement values of elements like Ta, Nb, Th, U, suggesting minor enrichment processes. The host rocks for elevated Ta values are Granite gneiss and pegmatite veins. The host rock for elevated Nb values are Pegmatite, Quartzite, Granite gneiss and quartzite veins.

6.3.2.1.3. Interpretation

The BRS data clearly reflects by high volatile % and low fixed carbon. While graphite presence is minor and sporadic, the elevated FC values in specific samples give cause for optimism. Such results hint at geological environments where graphite could have precipitated under favourable metamorphic conditions, meriting follow-up detailed mapping and sampling in those zones. The anomalies in FC and trace elements suggest pockets of geochemical concentration—important focal points for further exploratory work.

6.3.2.2. Trench Samples: Observations, Anomalies & Interpretation

6.3.2.2.1. Observations

Multiple trench samples from various field programs have been investigated and discussed in detail here on:

- ❖ Moisture & Ash: Trench samples show a broader range in moisture (up to 4.26%) and lower ash (down to 0.26%) compared to BRS, reflecting a more heterogeneous sample population including weathering profiles and possible enrichment zones.

- Fixed Carbon (FC): Notably, several trench samples demonstrate significantly elevated FC values, ranging up to 3.38% and even after acid washing (removing carbonate interference), some samples still maintain 1.96% FC and above.
- Volatile Matter (VM): VM is higher in trench samples (up to 98.66%), possibly due to greater organic or clay minerals associated with shallow depth and supergene enrichments.
- Graphitic Carbon Validation: Acid washing and repeat tests on some samples consistently demonstrate that the FC observed is indeed graphitic, not merely carbonate or organic carbon. This is crucial for confidently inferring graphite mineralization.

6.3.2.2.2. Anomalies

- High Fixed Carbon in Trench Samples: The most remarkable anomaly lies in trench sample like MPAJ/T4-3/2024-25 where FC values peak substantially above background (up to 3.38%). Acid-washed repeats confirm substantial graphitic content rather than spurious carbonate. Such anomalies are not seen in typical BRS samples and clearly signal local enrichment.

- Highly Variable Ash & Volatile Contents: Ash content drops as low as 0.26%, especially in samples with high FC (0.86%), suggesting graphite could be present in significant quantities, reducing total mineral matrix proportion. VM rises in similar areas, possibly due to organic matter or fine graphitic particles.

6.3.2.2.3. Interpretation

The trench sample analyses give moderate signals of graphite mineralization at shallow depths within the tested area. FC values, especially those confirmed by acid washing, support the conclusion that these zones are genuinely graphitic and not simply a result of interference from carbonate minerals. The variability in ash and VM correlated to FC spikes further supports the presence of discrete graphite-rich bodies or layers. But the values still never cross the cut-off grade for feasible mining.

6.3.3. Summary of the Geochemical analysis

Air-dry proximate data from the batch of bedrock and trench samples indicate that ash contents are dominantly high (typically in the range ~3.96 % ash for the analysed samples) with correspondingly low measured fixed carbon (FC) on an air-dry basis for most specimens. One sample initially returned an anomalously higher FC (reported 13.55 % FC) prior to re-analysis and acid washing, after which the FC decreased markedly (re-run value 3.38 % and acid-washed adjusted FC 1.96 %). The proximate data and the laboratory note together indicate that carbonate (inorganic) carbon can interfere with fixed-carbon determinations and that acid washing is required to remove CO2-releasing carbonate prior to accurate graphitic-carbon (graphite) estimation. These proximate observations are reported in the laboratory certificates.

A consistent petrological explanation for the high ash / low FC signature is provided by the petrography. Thin-section studies of seven representative rock-chip samples show that graphite, where present, occurs as fine flakes intimately intergrown with muscovite, quartz, and carbonate-bearing phases; in other cases graphite was not observed and the host lithologies were dominated by quartz, feldspar and iron oxides (magnetite/goethite). Ferruginous quartzite horizons with magnetite laminae and tourmaline, strained quartzites with fracture-filling goethite and minor pyrite, and variably foliated biotite gneisses and granitoids were documented; none of the granitic and most gneissic samples displayed visible mineralization. The petrographic evidence therefore points to a textural and mineralogical control on analytical grade: graphitic material is locally present but is commonly disseminated, interlayered with high-silica and carbonate gangue, and is commonly fine-grained and intergrown with mica and quartz (micro-lamellar texture). These petrographic observations are documented in the petrography report.

From the combined datasets the following patterns and correlations were inferred:

- An inverse correlation between ash content and measured fixed carbon is present and is mechanistically consistent with dilution of graphitic carbon by quartz-carbonate-iron oxides in the sampled material. High ash fractions were dominantly carried by quartz and carbonate gangue as observed petrographically; consequently, bulk FG (fixed graphitic) values are depressed in whole-rock samples.
- Apparent high FC in at least one sample was explained as a methodological artefact attributable to carbonate interference; after acid washing (CO2 removal) the FC value fell substantially. This demonstrates that sample pre-treatment is essential for accurate graphitic-carbon assessment in carbonate-bearing metasediments.

Fig 6.21 (Boxplot: Fixed Carbon by Sample Type) compares fixed carbon content between bedrock and trench samples. Both groups show low median values, but a few high outliers reach around 14%, suggesting localized enrichment in organic or graphitic material. This plot highlights the variability and central tendency of carbon content, helping to identify differences in carbon-bearing phases or depositional conditions between sample types.

- **Silica-dominant field:** Most samples (BRS-30, BRS-31, BRS-42, BRS-47, BRS-48) cluster near the SiO_2–Al_2O_3 edge → quartz–muscovite schist or quartzite host.

- **Calcareous influence:** BRS-46 shows elevated CaO (~10%), consistent with pegmatitic carbonate or calc-silicate gangue — this will affect beneficiation (acid wash required before FC estimation).
- **Aluminous variant:** BRS-49 is distinctly Al_2O_3-rich (~40%), indicating clay/mica-rich lithology possibly representing altered schist zones favorable for graphite enrichment.
- **Silica-extreme:** BRS-43 (99.5% SiO_2_norm) corresponds to pure quartzite — likely barren.

6.3.4. Concluding interpretation

The analytical and petrographic data together indicate that carbon rich horizons are present even though but are commonly masked by high gangue (quartz/carbonate/iron oxide) content. The data were therefore interpreted as cautiously encouraging mineralization, which is demonstrated at sample scale, but commercial potential will depend on metallurgical upgrade and continuity of higher-grade lenses.

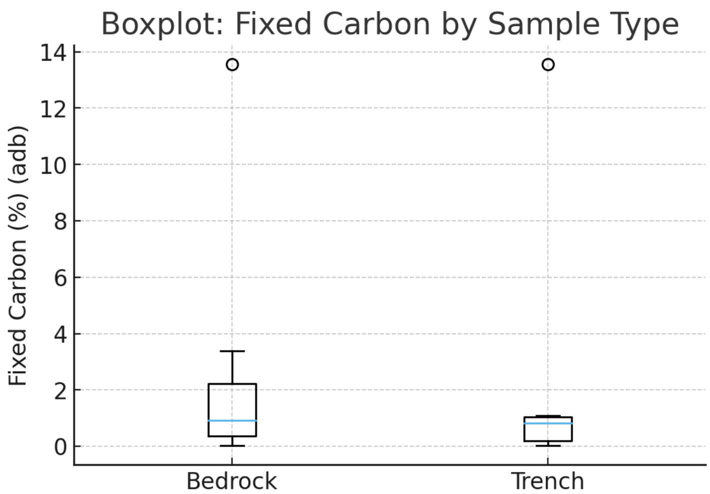


Fig. 6.21 Variability and central tendency of FC in bedrock vs trench samples

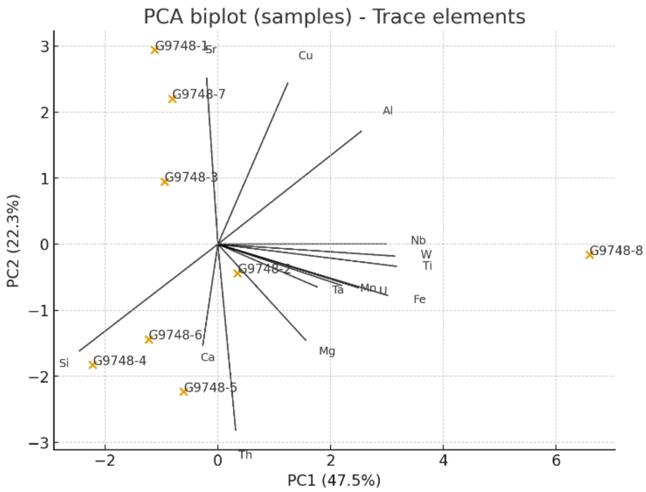


Fig. 6.22 PCA biplot (trace elements): Principal Component Analysis of trace-element data. PC1 separates Fe–W–Nb–Ti enriched samples (e.g. G9748-8) from Si-rich samples.

Table 6.4 Ternary Oxide Table

Sample	SiO_2 (wt%)	Al_2O_3 (wt%)	CaO (wt%)	SiO_2_norm (%)	Al_2O_3_norm (%)	CaO_norm (%)
BRS-30	70.67	16.84	0.20	80.57	19.20	0.23
BRS-31	77.43	16.17	0.76	82.06	17.13	0.81
BRS-42	64.02	19.62	0.03	76.51	23.45	0.04
BRS-43	94.93	0.42	0.07	99.49	0.44	0.07
BRS-46	76.45	9.67	9.60	79.87	10.10	10.03
BRS-47	89.31	4.17	0.14	95.40	4.45	0.15
BRS-48	66.43	19.98	0.19	76.71	23.07	0.22
BRS-49	47.73	32.66	0.14	59.27	40.55	0.18

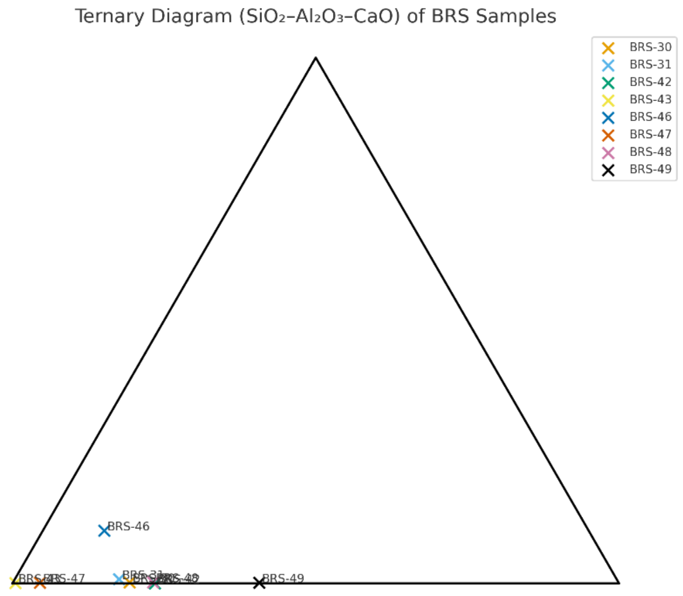


Fig. 6.23 Ternary diagram (SiO2–CaO–Al2O3) : Gangue composition plotted in oxide ternary. Most samples are SiO2–Al2O3 dominated; G9748-5 is Ca-rich.

CHAPTER 7

7. CONCLUSION AND RECOMMENDATION

7.1. Conclusion

All-out efforts have been made by geological mapping, geophysical surveys, trenching to identify the Graphite mineralisation in the Amdol block. The following conclusions are made based on the interpretation of the data.

1. The host rock for the graphite mineralisation has been identified as the Quartzitic Phyllite belonging to Sonaghati formation of Amdol Group.

2. There is no significant graphite occurrence has been recorded on the surface. The large amount of area covered by a thick pile of soil and cultivated land was a constraint.

3. The FC values up to 1.96% have been recorded in Trench no.4, indicating the possible occurrence of a graphite horizon at depth.

4. Several pegmatites have been recorded in the area that have analysed significant values of Ta 158 ppm, Nb 70 ppm, and W 56, pointing to the possibility of a hybrid pegmatite deposit.

7.2. Recommendations:

1. The area did not indicate adequate surface signatures and same with trench results except one or two results. Further exploration may not be required in this area before having strong geophysical evidence.
2. Based on the interpretation of the trace elemental data of pegmatite, further additional sampling campaign and analysis is required to classify the presence of hybrid (LCT/NYF) type pegmatite if any.

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8. EXPENDITURE

Expenditure of Reconnaissance Survey (G4 Stage) for Graphite and associated Minerals around Sonaghati, Amdol, Jharegaon and Bhayawari, District Betul, Madhya Pradesh						
Sl No.	**Item of work**	**Unit**	**NMET SoC Item Sl No**	**NMET Rates (2020)**	**Qty**	**Amount INR**
A	**GEOLOGICAL WORK**					
i	Geologist Party Days (HQ)	Days	1.3	9000	26	2,34,000
ii	Geological Mapping (1:400) & Trenching and Drilling -Geologist Party days (1) - Field	Days	1.3	11000	75	8,25,000
iii	Labour	Days	5.7	504	140	70,560
iv	Sampler Party Days	Days	1.5.2	5100	19	96,900
v	Labour for Sampling	Days	5.7	504	80	40,320
	Sub Total A					**12,66,780**
B	**GROUND GEOPHYSICAL STUDIES**					
i	IP Cum resistivity S.P magnetic (8-10 line km) - Package	Line Km	3.4b	1448693	1	1,48,000
ii	Geophysicist (HQ)	Per Day	3.18	9000	6	54,000
	Sub Total B					**2,02,000**
C	**PITTING AND TRENCHING**					
i	Trenching (1m x 2m x 10m) (5 Nos)	Per Cu.M	2.1.2	3330	100	3,33,000
	Sub Total C					**3,33,000**
D	*** LABORATORY STUDIES**					
i	**Chemical Analysis**					
a	Proximate Analyses of BRS	Per Sample	4.1.16	3000	15	47,788
b	Proximate Analyses of Trench	Per Sample	4.1.16	3000	20	35,200

ii	**Petrography Studies**					
	Preparation of thin sections	Per Sample	4.3.1	2353	7	28,745
	Complete petrographic / ore microscopic study/ Mineragraphic studies	Per Sample	4.3.4	4232	7	
	Preparation of polished sections	Per Sample	4.3.2	1549	7	
iii	ICP-MS studies (34 trace elements)	Per Sample	4.1.14	7731	8	19,688
	Sub Total D					**1,31,421**
E	**Total [A+B+C+D]**					**19,33,201**
F	**PREPARATION OF EXPLORATION PROPOSAL**	Per Project	5.1	2% of approved Project cost subject to maximum of 5 lakh which ever is lower		**1,76,016**
G	**PEER REVIEW**	As per EC				**30,000**
H	**GEOLOGICAL REPORT PREPARATION**	Per Project	5.2	For Projects up to Rs 50 Lakhs a minimum of Rs. 1.5 lakhs or 5% of the work whichever is more	5 nos Hard copies along with soft copy	**1,50,000**
I	**Total Estimated cost without GST [E+F+G+H]**					**22,89,217**
J	**Provision for GST @18%**					**4,12,059**
K	**Total Estimated Cost with GST**					**27,01,276**
					or Say Rs. In Lakhs	**27.01**

9. REFERENCES

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10. LOCALITY INDEX

LOCALITY INDEX			
Sl.No	**Villages**	**LATITUDE**	**LONGITUDE**
1	Amdol	21.91306	77.85056
2	Baldhana	21.93278	77.81361
3	Bhadus	21.87139	77.85139
4	Bhayawari	21.88472	77.80972
5	Chiklar	21.94472	77.91639
6	Dhanora	21.87972	77.875
7	Gauthana	21.92917	77.90528
8	Jhagariya	21.93056	77.83333
9	Jharegaon	21.90278	77.8325
10	Kosmi	21.89583	77.87361
11	Mahadgaon	21.87056	77.84694
12	Maramjhiri	21.94583	77.8825
13	Pangra	21.8875	77.83194
14	Tikari	21.91333	77.88222

11. REVIEWER'S COMMENTS

Comment's by Dr. Shyamal Kumar Biswas (Retd. Director), GSI

S. No.	NMET's Norms	Reviewer Dr. S. K. Biswas's comments	GeoExpOre's Action
1	Whether the aim and objective of the proposal have been fulfilled/ achieved and properly reflected in the report	Yes, the aim and objective of the proposal have been achieved and properly reflected in the report. Due to poor analytical results the decision to close the investigation was logical.	
2	Collection of data relevant to the objective of the work	Data collections were relevant to the objective of the work. Geophysical survey was proper to get idea of graphite band, if any, in soil covered area. Quartzitic phyllite and phyllite are the rocks in which marginal graphite values were recorded. As the finding was not encouraging, the investigation was rightly closed.	
3	Required laboratory studies, petrology/petrography etc. and its interpretation	Chemical analysis was sufficient. Graphitic band, if any, in the area would have shown physical indication as well as enhanced chemical grade. Petrological study was sufficient.	
4	Whether the analytical data have been logically incorporated and properly interpreted	Analytical data logically incorporated, interpretation requires modification.	
5	The desired outcome and logical framing of the conclusions and recommendation.	Conclusion is logical. Recommendation requires rethinking. The area is negative, and results are not promising, recommendation for further survey is not logical. Data on pegmatite are too scanty to draw any conclusion.	
6	**General comments and scope for improvement**		
6a.		Name of the village may be checked, Jhadegaon or Jharegaon.	Verified and found that "Jharegaon" is the correct

			name and corrected accordingly
6b.		In summary discuss Avg. F.C values and range in different lithologies. The logic for opinion "Mineralisation could be occurring at depth "is not clear. Without proper data prediction of concealed deposit has no meaning. Expected base metal names may be shown in bracket. Without supportive evidence last sentence of the summary may be deleted.	As per the suggestions changes were made in the geological report.
6c.		Para 2.4--Basis for taking up the investigation clearly shows mineralisation is hosted by graphite schist, muscovite quartz schist and phyllite, hence sampling emphasis could have been within metasediments. The area has undergone multiple phases of deformation does not mean the mineralisation is structurally controlled. It must be established. Please give reference of remobilisation and reorientation of mineralisation in the shear zone. ICTZ may be changed to CITZ.	Explained and justifies the basis for sampling in the text. 50 samples had been collected but majority of the samples analyzed were those within metasediments. As per the suggestions justifications were given in the geological report.

		Para 3.1---It is CITZ; Distance from Betul Rly. station? Fig..3.3-- Source of 1:50000 scale map may be given.; Para 4.1 (previous work highlights) mention grade of graphite established by GSI after initial investigation and also grade and tonnage after G 2 stage investigation .Mention the finding of GSI for G-4 survey in adjacent area(100 sq. km);	Incorporated in the geological report.
6d.		Para 5.1.2, give references of later workers like Chaturvedi 2001 , Chakraborty et.al 2009 while discussing regional structure ; In para 5.1.3 give references of workers under heading " regional metamorphism"; Para 6.1.1.2 statement the rocks are well exposed does not match with Plate-1; Plate-2 title may be written as " Interpreted Geological map--; In all the plates spelling of gneiss may be corrected.;. Basement Gneiss is shown under Betul Group--Pl. check.; Para.6.1.1.3. Map legend of Ranipur formation may include phyllite and quartzite. Map legend must match with Table- 6.1. Betul Gneiss and Sonaghati Gneiss are confusing without any separation. or proper description.	Reference were alphabetically ordered Plate 1 and statements were corrected Plate 2- Changed accordingly Corrected the spelling Ranipur formation has been included All the modifications were made as per the suggestions Mica schist not found 6.1.3.3.

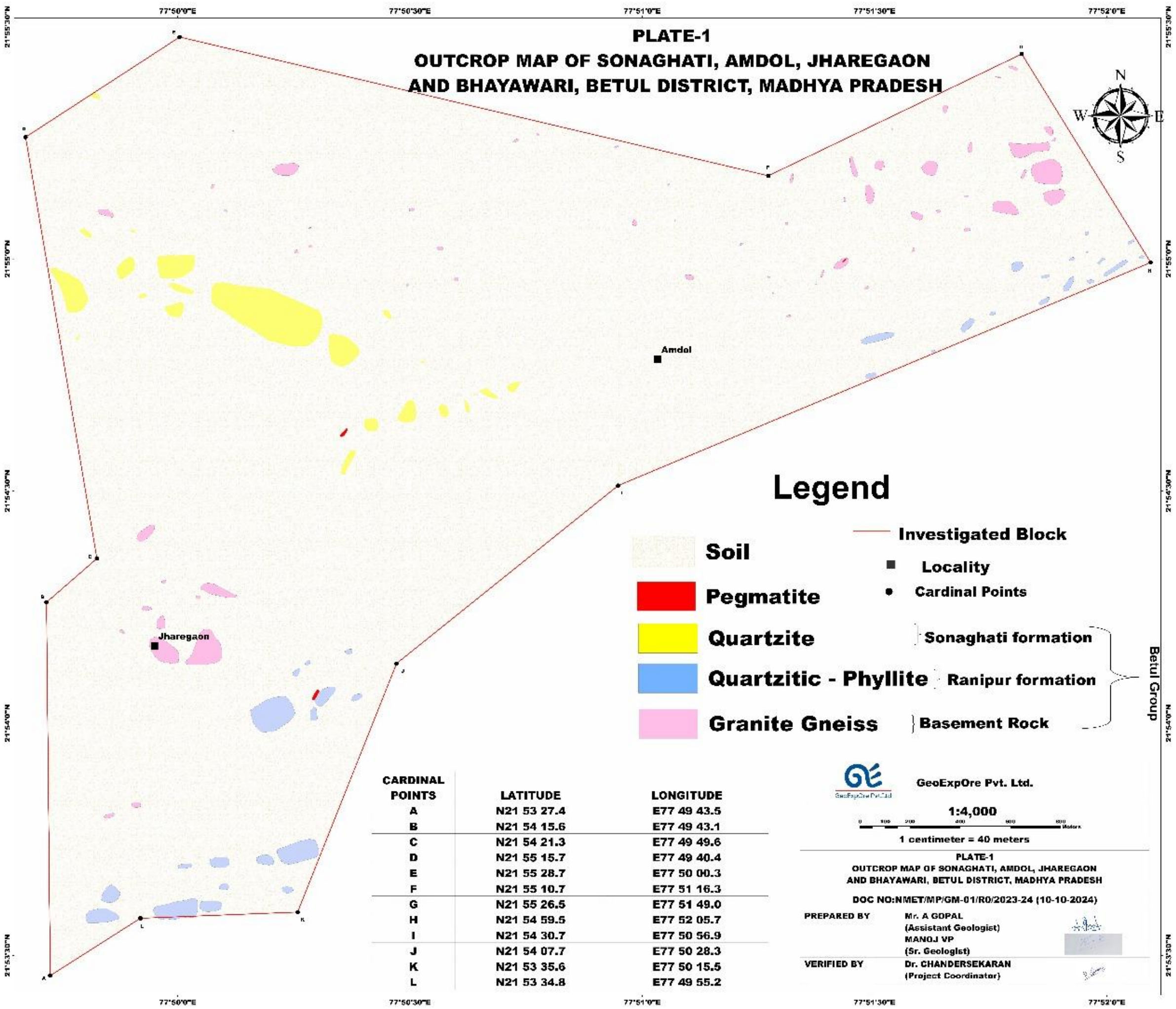
		In 6.1.1.3.1 all the variants must be mentioned.; Para 6.1.7- 50 samples were collected and analysed is a wrong statement, only 15 samples were analysed. Under the heading granite gneiss, photographs show porphyritic granite/. sheared granite etc. (Fig 6.1) for which there is no description in the report. Rock name should be same in photographs, petrographic description (aplitic granite, alkali feldspar granite) and write up, the variants to be discussed mentioning all the units are not mappable ; Describe the gradational contact from quartzite to phyllite through a stage of quartzitic phyllite. This gradation is due to variation in composition of original sedimentary package. Initially discuss field variation supported by petrographic study. Mica schist (6.1.1.3.4) may be mentioned in 6.1.1.3.3 ;. Para.6.1.8 it is mentioned that effort was made to probe subsurface by geophysical survey, so without success any further work recommendation is not justified in the area	
6e.		Deeper level trench is not clear. Sweeping remarks to be avoided.	Corrected in the geological report.

6f.		Para 6.1.5- Out of 50 bedrock samples collected,15 representative samples were analysed. How were samples reduced? 6.1.5.1 shows 40 samples from trenches were collected and 26 samples were analysed. How samples were collected at 2m interval? Was it a channel sample from floor and wall of the trench? From annexure, it appears two samples were collected from trench nos. 1,2 and 5 and ten samples from trench nos.3 and.4. Sampling strategy may be discussed in the text.	Properly explained the sampling procedure under 6.1.5.1 But only selected samples were analysed basing physical parameters of the samples
6g.		Logic behind sampling for graphite from pegmatites, quartz vein, alkali feldspar granite, granite gneiss is not clear. Which are the host rocks for graphite mineralisation in the area explored by GSI? Graphite bearing host rocks are defined in the stratigraphic table also.	Justifications were made accordingly
6h.		Avoid classification of pegmatite (LCT/NYF type) based on analysis of a few elements only in two samples.	Incorporated in the geological report.
6i.		F.C values are low varying from 0.02% to 0.62%, so sweeping remarks in para 6.3.2.1.2 may be avoided.	Incorporated in the geological report.

6j.		Sweeping concluding interpretation may be avoided in para 6.3.4	Incorporated in the geological report.
6k.		Para 2.5.1 (nature of work) shows sampling was earlier to geophysical survey. How geophysics helped the exploration?	Incorporated in the geological report.
6l.		Para 6.3.2.1.2 -. Evidence for assuming graphite concentration due to tectonic activity or localised hydrothermal events may be furnished. Mention rock name showing enhanced values of Ta, Nb etc. Para 6.3.2.2.3 - The results obtained do not suggest follow up detailed exploration. Please modify; Para. 6.3.4 -Please try to interpret based on available data on graphite content and F.C values.	Incorporated in the geological report.
6m.		Please recast structure part of the block. Show structural elements on the map also. Different S planes will help understanding of deformational history. Evidence of shearing may be mentioned.	Incorporated in the geological report.
6n.		Para 7.1- Sl.no 7 in conclusion does not corroborate with F.C values	Incorporated in the geological report.

6o.		Reference list is incomplete. Write in alphabetical order. Annexure ii has been discussed in the text. The name Betul block may be changed. Where is Annexure i? Is it between Plate 2 and Annexure ii, Title to be given?	Incorporated in the geological report.

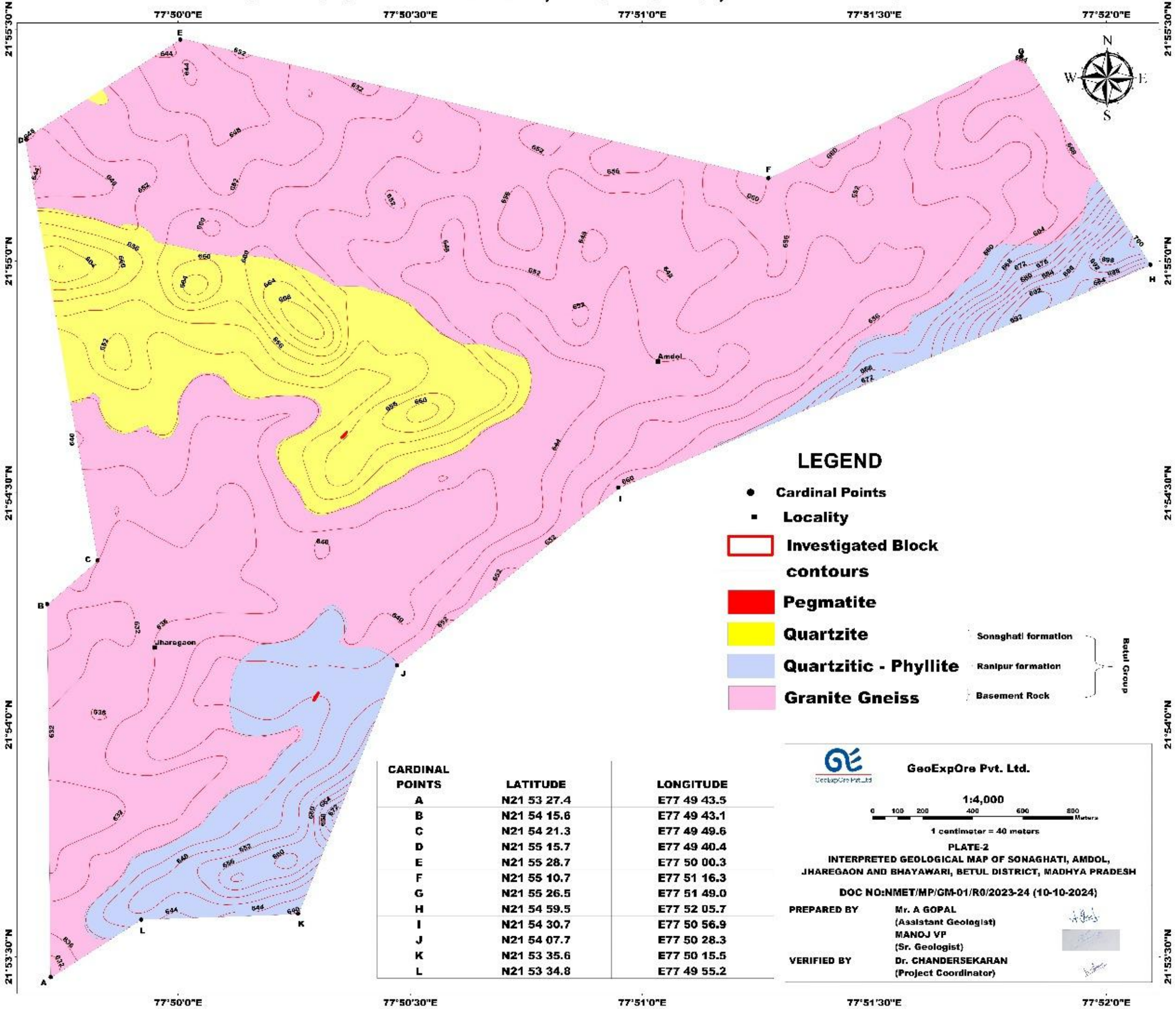
12. PLATES



CARDINAL POINTS	LATITUDE	LONGITUDE
A	N21 53 27.4	E77 49 43.5
B	N21 54 15.6	E77 49 43.1
C	N21 54 21.3	E77 49 49.6
D	N21 55 15.7	E77 49 40.4
E	N21 55 28.7	E77 50 00.3
F	N21 55 10.7	E77 51 16.3
G	N21 55 26.5	E77 51 49.0
H	N21 54 59.5	E77 52 05.7
I	N21 54 30.7	E77 50 56.9
J	N21 54 07.7	E77 50 28.3
K	N21 53 35.6	E77 50 15.5
L	N21 53 34.8	E77 49 55.2

PLATE-2

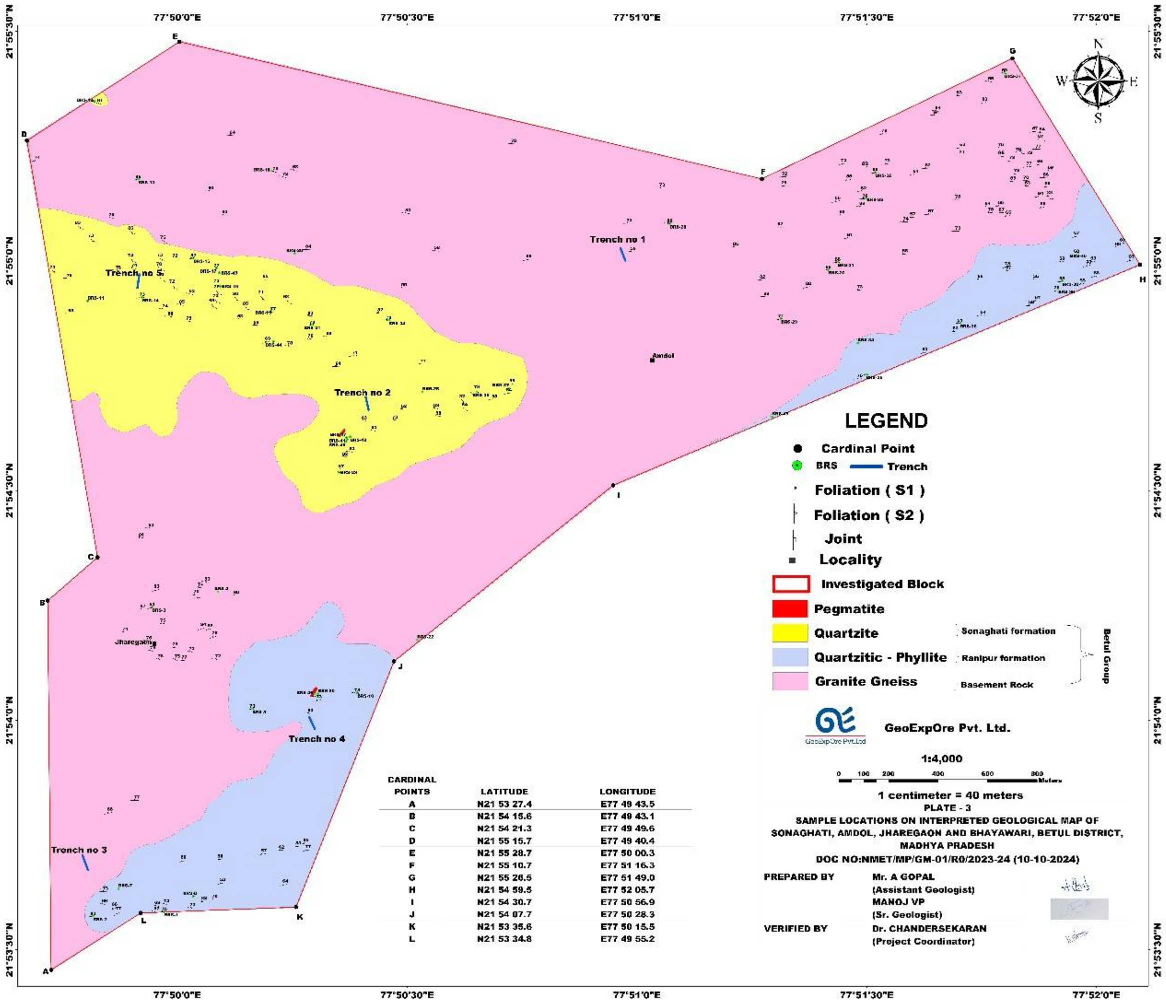
INTERPRETED GEOLOGICAL MAP OF SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI, BETUL DISTRICT, MADHYA PRADESH



CARDINAL POINTS	LATITUDE	LONGITUDE
A	N21 53 27.4	E77 49 43.5
B	N21 54 15.6	E77 49 43.1
C	N21 54 21.3	E77 49 49.6
D	N21 55 15.7	E77 49 40.4
E	N21 55 28.7	E77 50 00.3
F	N21 55 10.7	E77 51 16.3
G	N21 55 26.5	E77 51 49.0
H	N21 54 59.5	E77 52 05.7
I	N21 54 30.7	E77 50 56.9
J	N21 54 07.7	E77 50 28.3
K	N21 53 35.6	E77 50 15.5
L	N21 53 34.8	E77 49 55.2

PLATE - 3

SAMPLE LOCATIONS ON INTERPRETED GEOLOGICAL MAP OF SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI, BETUL DISTRICT, MADHYA PRADESH



13. ANNEXURES

ANNEXURE I SAMPLE DESCRIPTION

SI.No	Sample Number	Latitude	Longitude	Elevation (m)	Sample Type	Lithology	Geology/ Formation	Description
1	MPAJ/BRS-1/2024-25	21.89306	77.832861	640 m	BRS	Ferruginous quartzite	Betul Group	Ferruginous quartzite is a hard & metamorphic rock, Massive part is harder than foliated part. Protolith - shaly sand , Rock colour - Pinkish
2	MPAJ/BRS-2/2024-25	21.89289	77.830278	643 m	BRS	Phyllite	Betul Group	Ferruginous quartzite is a hard & metamorphic rock, Massive part is harder than foliated part. Protolith - shaly sand , Rock colour - Pinkish
3	MPAJ/BRS-3/2024-25	21.90411	77.832417	638 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
4	MPAJ/BRS-4/2024-25	21.90467	77.834806	638 m	BRS	Granite gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
5	MPAJ/BRS-5/2024-25	21.90042	77.836056	650 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Pinkish silvery
6	MPAJ/BRS-6/2024-25	21.901306	78.004528	652 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.

7	MPAJ/BRS-7/2024-25	21.89389	77.831194	647 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Gray, silvery
8	MPAJ/BRS-8/2024-25	21.89361	77.833917	654 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Gray, silvery
9	MPAJ/BRS-9/2024-25	21.90086	77.838417	643 m	BRS	Aplitic Granite	Betul Group	Aplitic granite is a fine-grained variety of granite characterized by a uniform, sugary texture.
10	MPAJ/BRS-10/2024-25	21.901	77.839861	651 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
11	MPAJ/BRS-11/2024-25	21.91522	77.830083	656 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
12	MPAJ/BRS-12/2024-25	21.92247	77.830333	654 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
13	MPAJ/BRS-13/2024-25	21.91964	77.831917	648 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
14	MPAJ/BRS-14/2024-25	21.91536	77.832056	658 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
15	MPAJ/BRS-15/2024-25	21.91678	77.833917	661 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular

16	MPAJ/BRS-16/2024-25	21.91575	77.834889	670 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
17	MPAJ/BRS-17/2024-25	21.91642	77.83475	665 m	BRS	Alkali feldspar granite	Betul Group	Alkali feldspar granite is a coarse-grained intrusive igneous rock dominated by alkali feldspar. Minerals-Quartz, Mica, K-feldspar
18	MPAJ/BRS-18/2024-25	21.91994	77.83675	654 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
19	MPAJ/BRS-19/2024-25	21.91492	77.83675	673 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
20	MPAJ/BRS-20/2024-25	21.91694	77.837583	657 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
21	MPAJ/BRS-21/2024-25	21.91436	77.838222	681 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
22	MPAJ/BRS-22/2024-25	21.90292	77.842028	654 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
23	MPAJ/BRS-23/2024-25	21.909	77.839194	673 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
24	MPAJ/BRS-24/2024-25	21.91453	77.841	664 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular

25	MPAJ/BRS-25/2024-25	21.91192	77.842222	659 m	BRS	Granite Gneiss	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
26	MPAJ/BRS-26/2024-25	21.91192	77.844194	658 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
27	MPAJ/BRS-27/2024-25	21.91206	77.845361	656 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
28	MPAJ/BRS-28/2024-25	21.91803	77.851194	658 m	BRS	Granite gnesis	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
29	MPAJ/BRS-29/2024-25	21.91458	77.855222	648 m	BRS	Granite gnesis	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
30	MPAJ/BRS-30/2024-25	21.91636	77.856944	653 m	BRS	Granite gnesis and quartz vein	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture & intrusion Quartz vein. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
31	MPAJ/BRS-31/2024-25	21.91664	77.857278	652 m	BRS	Granite gnesis and pegmatite vein	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture & intrusion Pegmatite. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
32	MPAJ/BRS-32/2024-25	21.91989	77.858639	674 m	BRS	Granite gnesis	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.

33	MPAJ/BRS-33/2024-25	21.91894	77.858278	663 m	BRS	Granite gnesis	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
34	MPAJ/BRS-34/2024-25	21.91369	77.858	664 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Pinkish, silvery
35	MPAJ/BRS-35/2024-25	21.91256	77.858306	676 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Pinkish, silvery
36	MPAJ/BRS-36/2024-25	21.91442	77.861722	686 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Pinkish, silvery
37	MPAJ/BRS-37/2024-25	21.9235	77.863333	661 m	BRS	Granite gnesis and quartz vein	Betul Group	Granite gneiss is a high-grade metamorphic rock & banded or foliated texture & intrusion Quartz vein. Medium coarse grained .Minerals- Quartz, k-feldspar & Biotite.
38	MPAJ/BRS-38/2024-25	21.91594	77.865417	695 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Pinkish
39	MPAJ/BRS-39/2024-25	21.91567	77.865278	699 m	BRS	Quartzitic-Phyllite	Betul Group	Quartzitic- Phyllite, typically representing a transitional rock & fine-grained mica Slightly foliated or wavy layers (phyllitic sheen) Color: Pinkish
40	MPAJ/BRS-40/2024-25	21.91697	77.866	697 m	BRS	Smooky Quartz	Betul Group	Smoky quartz is a transparent to translucent variety of quartz & Conchoidal fracture.

41	MPAJ/BRS-41/2023-24	21.9102	77.83949	661 m	BRS	Quartz vein	Betul Group	Pegmatite is a very coarse-grained and dominated by quartz, plagioclase feldspar , and mica.
42	MPAJ/BRS-42/2023-24	21.91029	77.8396	659 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
43	MPAJ/BRS-43/2023-24	21.91624	77.83486	668 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
44	MPAJ/BRS-44/2023-24	21.91374	77.83682	658 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
45	MPAJ/BRS-45/2023-24	21.91058	77.85515	634 m	BRS	Quartzite	Betul Group	More than 90 % Quartz grains, Breaks with a conchoidal or irregular fracture Color: White to grey,Texture: Non-foliated and granular
46	MPAJ/BRS-46/2023-24	21.90096	77.83831	663 m	BRS	Pegmatite	Betul Group	Pegmatite is a very coarse-grained and dominated by quartz, plagioclase feldspar , and mica.
47	MPAJ/BRS-47/2023-24	21.91026	77.83946	663 m	BRS	Pegmatite	Betul Group	Pegmatite is a very coarse-grained and dominated by quartz, plagioclase feldspar , and mica.
48	MPAJ/BRS-48/2023-24	21.91011	77.83943	664 m	BRS	Mica schist	Betul Group	mica schist is a medium- to coarse-grained metamorphic rock, characterized by well-developed schistosity due to the parallel alignment of micaceous minerals. mainly of muscovite and biotite, with amounts of quartz and feldspar.
49	MPAJ/BRS-49/2023-24	21.91035	77.8393	663 m	BRS	Pegmatite	Betul Group	Pegmatite is a very coarse-grained and dominated by quartz, plagioclase feldspar , and mica.

50	MPAJ/BRS-50/2023-24	21.90096	77.83844	665 m	BRS	Pegmatite	Betul Group	Pegmatite is a very coarse-grained and dominated by quartz, plagioclase feldspar , and mica, and also seen tourmaline in pegmatite.

ANNEXURE II

Report on Petrography/Mineragraphy studies of granitoids and metasedimentary rocks of the Betul block in Madhya Pradesh

1. Introduction

On a payment basis, Dr. R. Chandrasekaran, Project Coordinator, M/s GeoExpOre Pvt. Ltd., Bangalore, has submitted 7 rock chip samples for the preparation of thin polished sections followed by complete petrography/mineragraphy studies of granitoids and their associated metasedimentary rocks intruded by quartz vein from the Betul block, Madhya Pradesh at the Petrology laboratory, NCEGR, RSAS, GSI, and Bangalore. The rock chip samples have obliterated the original banding and textures. A petrological microscope (Model: Leica DM2700P) was used to look at all the thin polished sections for mineral content, textures, and other optical properties. The sections were thoroughly examined under both transmitted and reflected light. Numerous digital photomicrographs of the thin sections were taken using an attached digital camera. The detailed descriptions of thin polished sections of different rock types are elucidated below:

2. Sample Preparation

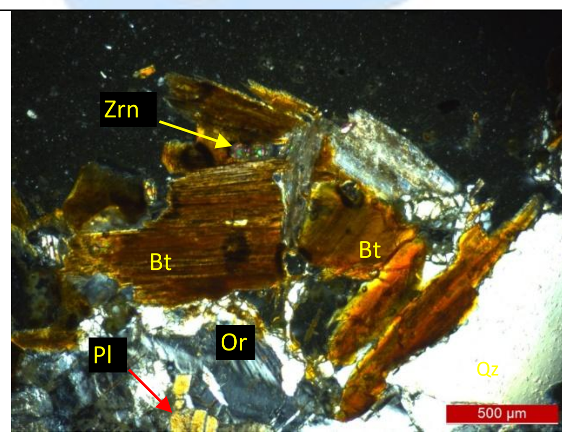
Selection and isolation have been done for the granitoids, quartzite, and quartz vein. Using a mixture of epoxy and hardener, these samples were mounted on thin-section slides measuring 46 x 25 mm, and the sections were left overnight. After that, the mounted sections were ground using several carborundum grinding media fractions until the specimen fractions were visible. This is followed by polishing using diamond and chrome paste.

3. Petrography/mineragraphy description of rocks

i. **Sample no. MPAJ/BRS-18/2024-25 (Biotite gneiss)**

In hand specimen, the sample (MPAJ/BRS-18/2024-25) has a banded with alternation of mesocratic (mesosomes) and leucocratic (leucosomes) bands/layers of different minerals. It can be medium foliated, as the layers are sub-parallel to each other. The most common minerals in this rock are plagioclase, quartz, and biotite. (Fig. 1a).

Petrographically, the light-colored layers are usually composed of quartz, plagioclase, and K-feldspar, while the dark layer consists of biotite (fig. 1b). Muscovite and zircon are accessory minerals. K-feldspar is compositionally classified as microcline and orthoclase. All such types of feldspars occur as sub-equant grains, while anhedral quartz grains with variable sizes are seen. Numerous quartz and some plagioclase inclusions embedded within the larger plagioclase and K-feldspar crystals. These inclusions would appear as smaller and rounded to wormy or vermicular in nature. The intergrowth of wormy-like quartz grains in a larger plagioclase exhibits myrmekite texture (Fig. 1c). The presence of such types of inclusions suggests that the plagioclase started growing before the quartz and smaller plagioclase crystals, indicating the cooling and crystallization process of the magma. Polysynthetic lamellar twinning in the plagioclases and cross-hatched twinning in the microcline are distinctly preserved (Fig. 1d). Bended lamellar twinning in plagioclase (Fig. 1d) and undulatory extinction in the quartz are noticed, which are indicative of the strain-induced deformation. Biotite occurs as platy, showing brown to dark brown in color. A few biotite flakes are also found in association with plagioclase. None of the alterations of the minerals and opaques are seen in the biotite gneiss. This rock is devoid of any mineralization.

	
Fig. 1a. Hand sample showing chip form of Biotite Gneiss (Sample no. MPAJ/BRS-18/2024-25).	Fig. 1b. Photomicrograph of biotite gneiss showing mineral assemblages under CPL (sample no. MPAJ/BRS-18/2024-25).

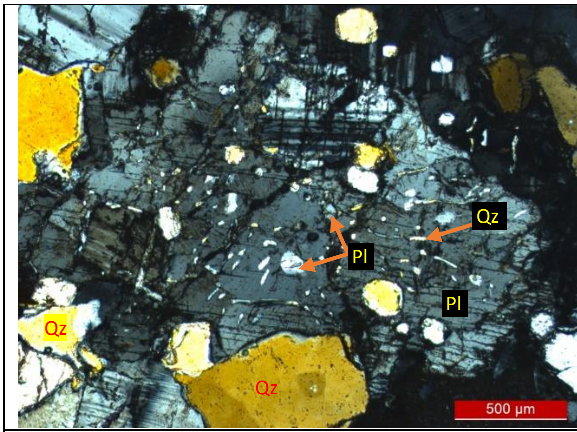


Fig 1c. Photomicrograph showing numerous plagioclase and quartz inclusions, and vermicular intergrowth of quartz in the plagioclase exhibits myrmekite texture under CPL (sample no. MPAJ/BRS-18/2024-25).

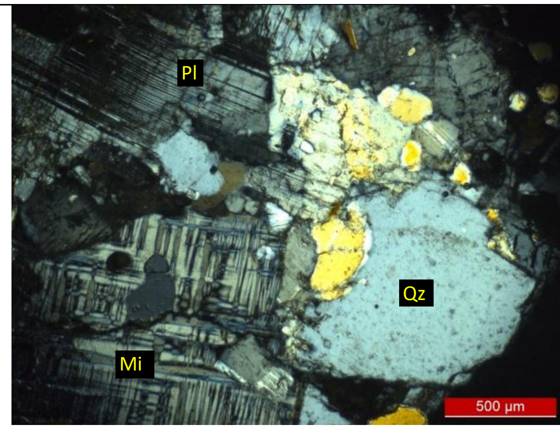


Fig 1d. Photomicrograph showing bended lamellar twinning and cross-hatched microcline in the biotite gneiss under CPL (sample no. MPAJ/BRS-18/2024-25).

ii) Sample no. MPAJ/BRS-3/2024-25 (Biotite gneiss)

In hand specimen, the rock chip sample (MPAJ/BRS-3/2024-25) is a fragile and moderately weathered, medium-grained rock. It is usually composed of quartz, alkali feldspar, plagioclase, and biotite (Fig. 2a).

In thin section, the biotite gneiss is composed predominantly of quartz and alkali feldspar plagioclase. Plagioclase and biotite are the accessory minerals (Fig. 2b). K-feldspar consists of orthoclase and microcline. Their twin planes are clearly distinguished. Plagioclase occurs as inclusions embedded within the biotite. They show lamellar twinning distinctly at places. K-feldspars occur as sub-equant forms with indenting grain boundary shares with quartz. Round to sub-rounded plagioclase and quartz inclusions embedded in the alkali feldspar and a few plagioclases in the biotite (Fig. 2c), it suggests that the larger K-feldspars and biotite appear to be crystallized later than the included grains. The platy of brown biotite shows preferred orientation that defines foliation (Fig. 2d). Stretched or elongated quartz grains are also noticed at places indicative of the shear. The rock is devoid of mineralization.

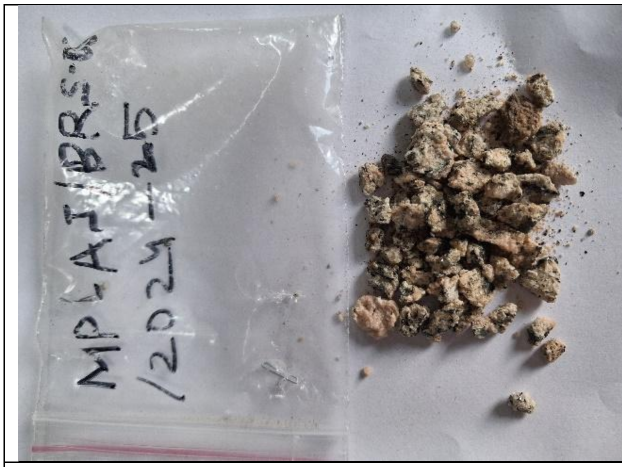


Fig. 2a. Hand sample of biotite gneiss showing highly fragile and weathered (Sample no. MPAJ/BRS-3/2024-25).

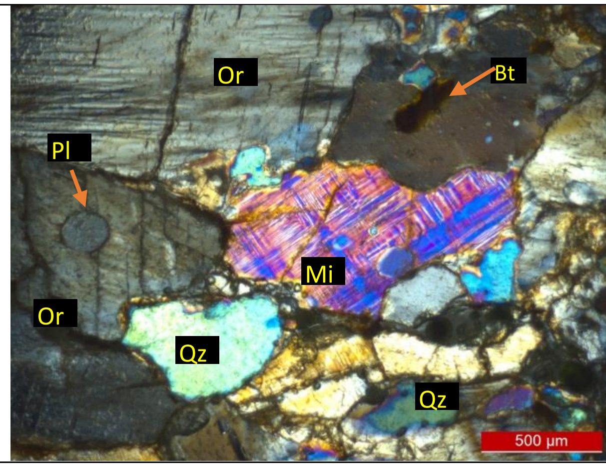


Fig. 2b. Photomicrograph showing microcline, orthoclase, plagioclase, quartz and biotite in the biotite gneiss under XPL (Sample no MPAJ/BRS-3/2024-25).

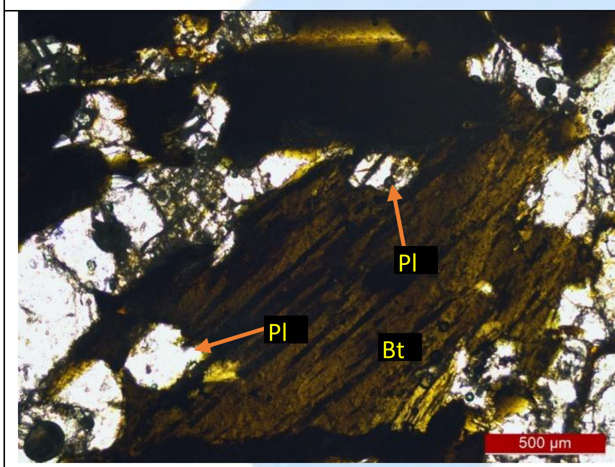


Fig.2c. Photomicrograph showing plagioclase included in the biotite under XPL (Sample no. MPAJ/BRS-3/2024-25).

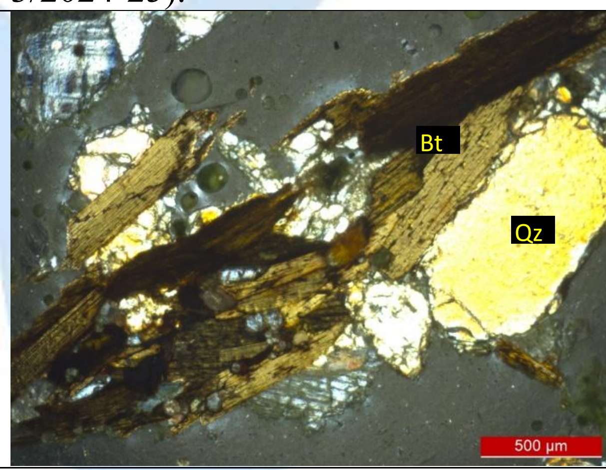
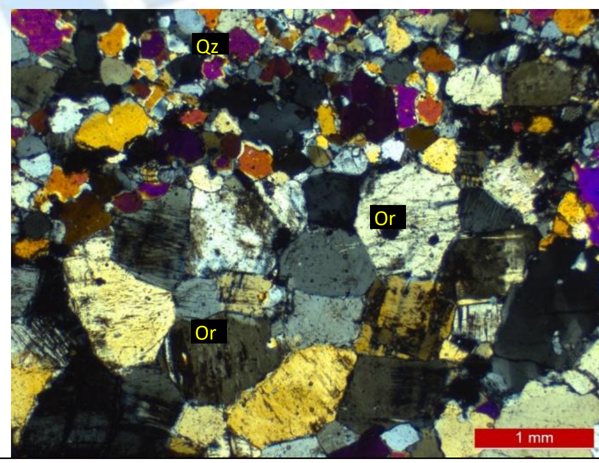


Fig.2c. Photomicrograph of biotite gneiss showing foliation defined by biotite under PPL (Sample no. MPAJ/BRS-3/2024-25).

iii) Sample no. MPAJ/BRS-17/2024-25 (Alkali feldspar granite)

In hand specimen, the sample (MPAJ/BRS-17/24-25) is a light color with medium to fine-grained rock and composed of quartz and alkali feldspar (Fig. 3a).

Under the microscope, the sample is composed predominantly of quartz and K-feldspar. Sillimanite (?), muscovite, zircon, and apatite are accessory minerals. No mafic minerals are present in this sample. According to the mineral assemblages, the rock may thus be classified as alkali feldspar granite. The rock shows a granulose texture defined by polygonal orthoclase and shares a sharp contact with triple junctions (Fig. 3b). Larger K-feldspar consists of microcline and orthoclase, which are easily distinguished by cross-hatched twinning and Carlsbad twinning, respectively. Smaller microcline grains are associated with the quartz matrix. The granular quartz grains are more preserved in this rock. Some of the quartz grains are stretched at places indicative of shearing (Fig. 3c). At places, the sub-grain formation of quartz grains has taken place, which clearly indicates the deformation and metamorphism. The euhedral zircon grains are occurring within the quartz and along the grain contact. The suspected sillimanite occurs as needle occupying at the contact to the quartz (Fig. 3d). It is colorless in plane-polarized light, whereas 1st-order yellow interference color and straight extinction are observed under cross-polarized light. It is suggested that the suspected sillimanite may be confirmed in SEM or EPMA. The sample is devoid of mineralization.

<table>
<tr><td></td><td>
</td></tr>
<tr><td>Fig. 3a. Hand sample showing chip of alkali granite (MPAJ/BRS-17/24-25)</td><td>Fig. 3b. Photomicrograph showing granulose texture defined by orthoclase in the alkali granite under XPL (MPAJ/BRS-17/24-25.</td></tr>
</table>

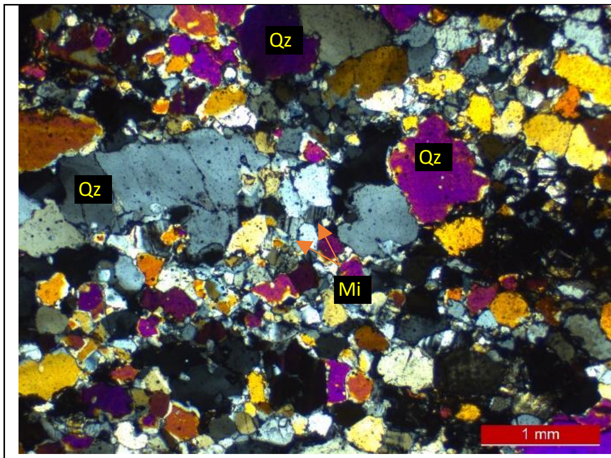


Fig. 3c. Photomicrograph showing granular and stretched quartz grains in the alkali granite under XPL (Sample no. APMJ/BRS-17/24-25).

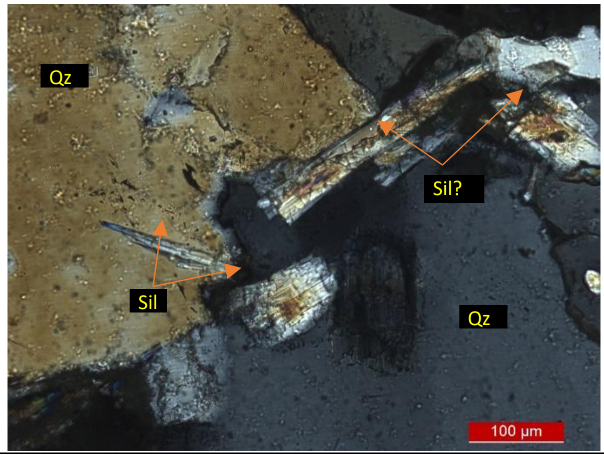


Fig. 3d. Photomicrograph showing suspected sillimanite needles in the alkali granite under XPL (Sample no. APMJ/BRS-17/24-25).

iv) Sample no. MPAJ/BRS-9/2024-25 (Aplitic Granite)

In hand specimen, the sample (MPAJ/BRS-9/2024-25) is a coarse-grained, leucocratic colored rock usually composed of quartz and plagioclase. It may also contain garnet as an accessory mineral (Fig. 4a).

In thin section, the rock is made up of quartz and plagioclase, with accessory garnet. According to the mineral assemblages, the rock may therefore be categorized as aplitic granite. The rock exhibits sub-hypidiomorphic and granulose textures. Sub-hypidiomorphic texture is defined by plagioclase laths (Fig. 4b). Larger to smaller plagioclases are characterized by lamellar twinning distinctly developed in this rock. At places, the plagioclases are partially to completely altered to sericite by the process of sericitization (Fig. 4c). Vermicular quartz grains intergrown in the plagioclase exhibit myrmekite texture (Fig. 4d). The quartz clearly exhibits undulose extinction and sub-grain development, which are signs of strain-induced deformation. Quartz inclusion within plagioclase is observed. Rounded garnets with the development of cracks are observed in association with plagioclase, which is also called a xenomorphic nature (Fig. 4e). This rock is devoid of mineralization.

Fig. 4a. Hand sample of Aplitic Granite (Sample no. MPAJ/ BRS 9/24-25).

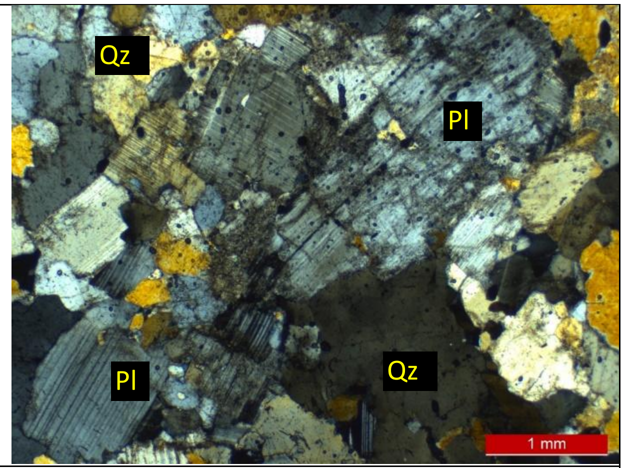


Fig. 4b. Photomicrograph showing laths of plagioclase defines sub-hypidiomorphic texture in the aplitic granite under the cross-polar view (Sample no. RJBO/BRS-9/24-25) .

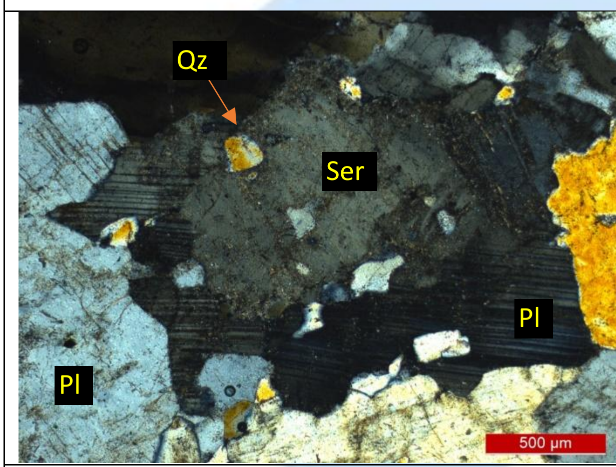


Fig. 4c. Photomicrograph showing partial alteration of plagioclase by sericite under the cross-polar view (Sample no.MPAJ/BRS-9/24-25).

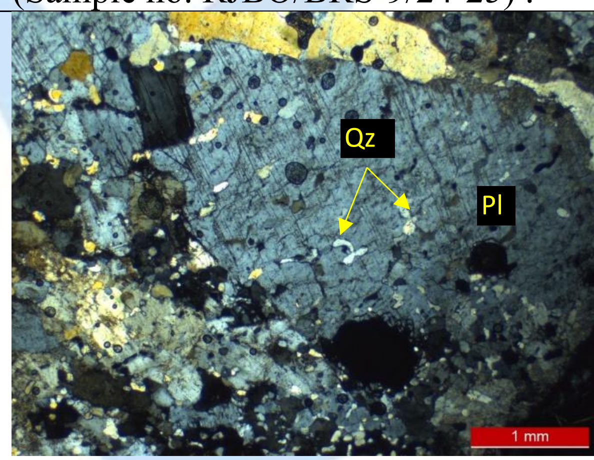


Fig. 4d. Photomicrograph of aplitic granite showing myrmekite texture defined by intergrowth of quartz in the plagioclase under the cross-polar view (Sample no. MPAJ/BRS-9/24-25).

#(45) S, 2nd A Main, 2nd Cross, Chandra Layout, Bengaluru-560040, www.geoexpore.com

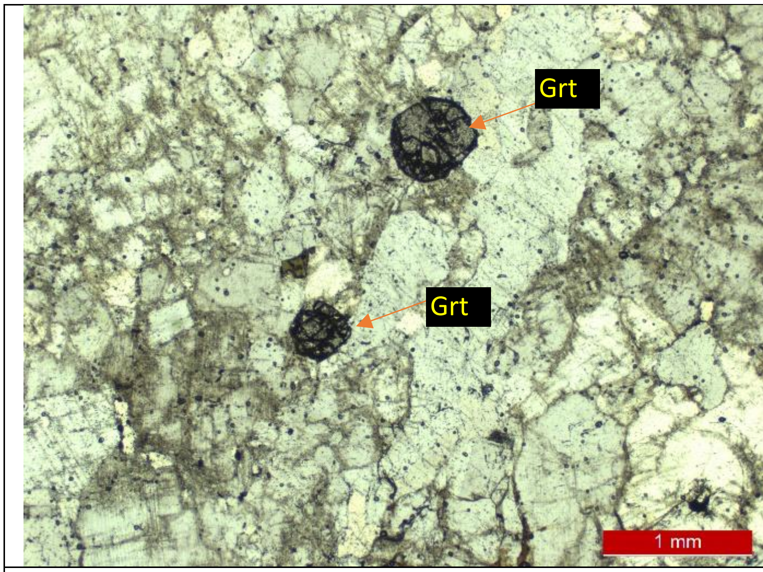


Fig. 4e. Photomicrograph showing a xenomorphic garnets associated with the plagioclase and quartz under plane-polar view (Sample no. MPAJ/BRS-9/24-25).

v) Sample no. MPAJ/BRS-10/2024-25 (Quartzite)

In hand specimen, the sample (MPAJ/BRS-10/2024-25) appears as a light-colored, medium-grained rock. It is made up of quartz (Fig. 5a).

In thin section, the rock mainly consists of quartz. Opaque and zircon are accessory minerals. The rock is extensively strained quartz grains. These boundaries display a highly irregular, finger-like pattern where the grain edges interlock significantly, creating a complex suture-like appearance (Fig. 5b). This feature is typically formed under high pressure and temperature conditions during deformation. Whereas. polygonal mosaic quartz shares sharp contact with triple junctions, which are also present at places. This feature is called a granulose texture (Fig. 5c). Undulose extinction, sub-grain formations, and elongations are well preserved in the quartz grains, indicating the strain-induced deformation and metamorphism (Fig. 5d). A tiny zircon is found in this rock.

In reflected light, the opaques are classified as iron oxide and pyrite. The iron oxide comprises mainly goethite which occur as fracture filling at the grain contacts (Fig. 5e). Pyrite is the only sulphide present in this rock. Pyrite grains display round to sub-rounded shapes and are occurring as independently associated with the quartz (Fig. 5e). The rounded pyrite can form from hydrothermal fluids, which are hot, mineral-rich fluids that circulate through fractures in rocks.

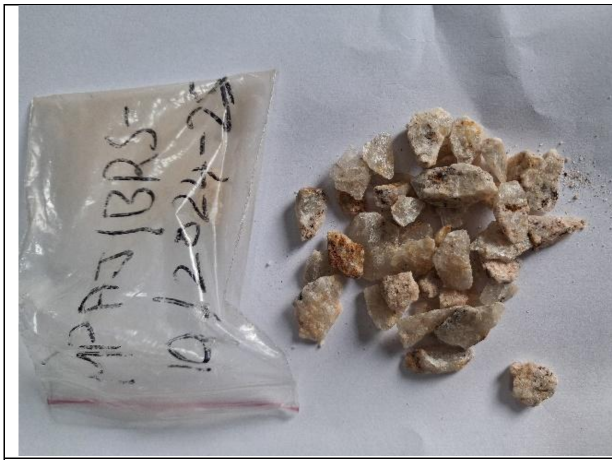


Fig. 5a. Hand chip sample of quartzite (Sample no. MPAJ/ BRS-10/24-25).

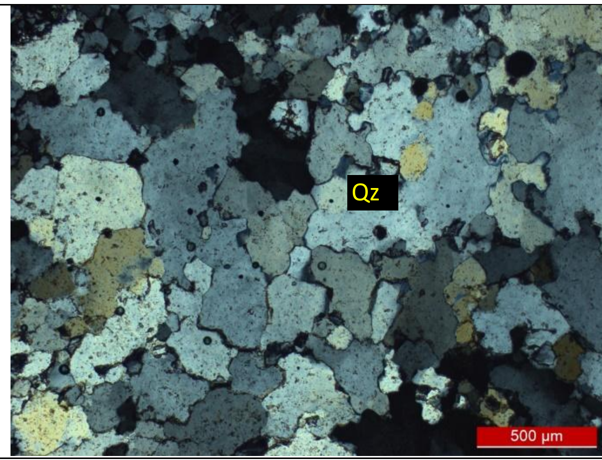


Fig. 5b. Photomicrograph of extensively strained quartzite display suture grain boundary between the quartz grains under XPL (Sample no. MPAJ/ BRS-10/24-25).

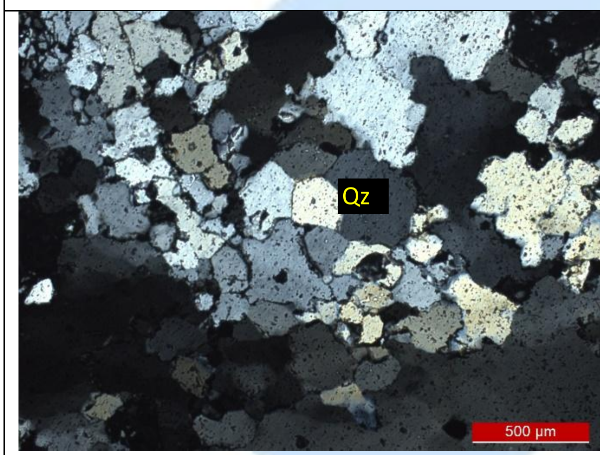


Fig. 5c. Photomicrograph of quartzite showing granulose texture under XPL (sample no. MPAJ/ BRS-10/24-25).

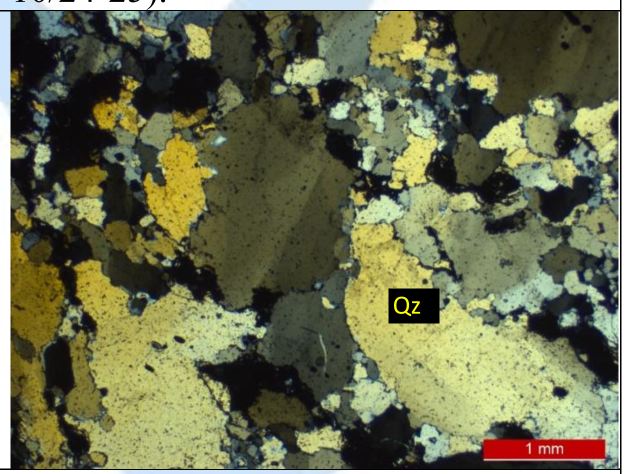
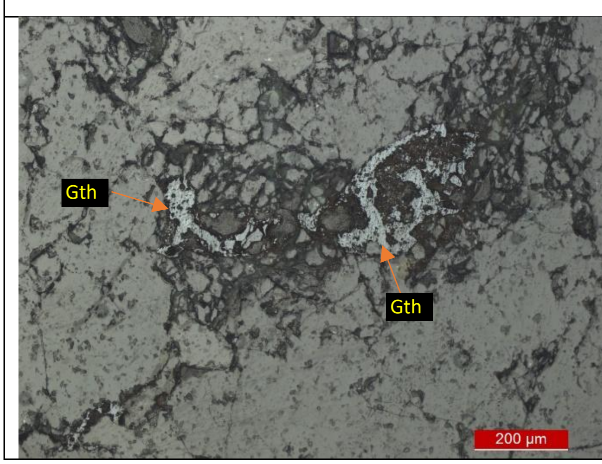


Fig. 5d. Photomicrograph of quartzite showing undulose extinction, elongation and subgrain formation in the quartz grains under XPL (Sample no. MPAJ/BRS-10/24-25).



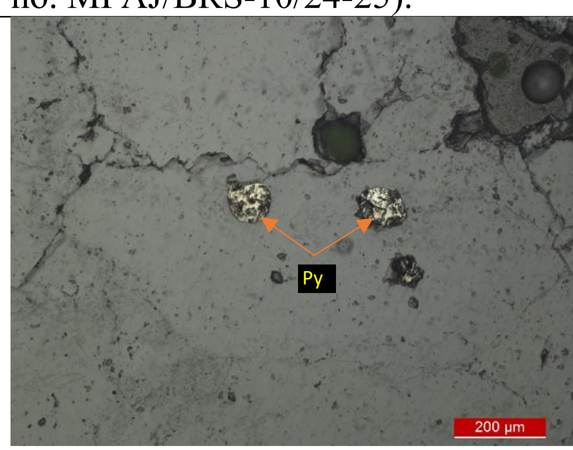


Fig. 5e. Photomicrograph showing the fracture filling goethite under reflected light (Sample no. MPAJ/BRS-10/24-25).	Fig. 5f. Photomicrograph of quartzite showing rounded pyrite grains associated with quartz under reflected light (Sample no. MPAJ/ BRS-10/24-25).

vi) Sample no. MPAJ/BRS-01/2024-25 (Ferruginous quartzite)

In hand specimen, the rock is a medium- to coarse-grained rock. The rock shows light pink in color. It consists mainly of quartz and ferruginous material (Fig. 6a).

Petrographically, the sample is characterized by an iron oxide laminae/layer interlayered with quartz bands, which is known as ferruginous quartzite (Fig. 6b). It is chiefly made up of quartz, with zircon, tourmaline, and opaques as the accessory minerals. The quartz grains are extensively strained with the development of a highly irregular, finger-like pattern where the grain edges interlock significantly, creating a complex suture-like appearance (Fig. 6c). In addition, undulose extinction and sub-grain formations of quartz grains are profusely formed. These features are typically formed under high-pressure and temperature conditions during deformation. Ferruginous layers consist of magnetite in the form of independent crystals associated with the oxidized oxy-iron oxides as seen under reflected light (Fig. 6d). Some of the euhedral to subhedral magnetite grains are embedded within the quartz matrix. Tourmaline is a crystalline ranging from stubby columnar crystals in association with the quartz matrix, especially at the contact zone (Fig. 6e). It shows yellowish green in color with two specific absorption colors (dichroism). The presence of tourmaline in quartzite typically originates from the weathering and erosion of pre-existing igneous and metamorphic rocks, where the tourmaline crystals formed primarily within the granite pegmatite. This study suggests that the tourmaline minerals may be confirmed in an SEM or EPMA study to provide information about the source of the sediments.

Fig. 6a. Hand chip sample of ferruginous quartzite (Sample no. MPAJ/BRS-1/24-25).

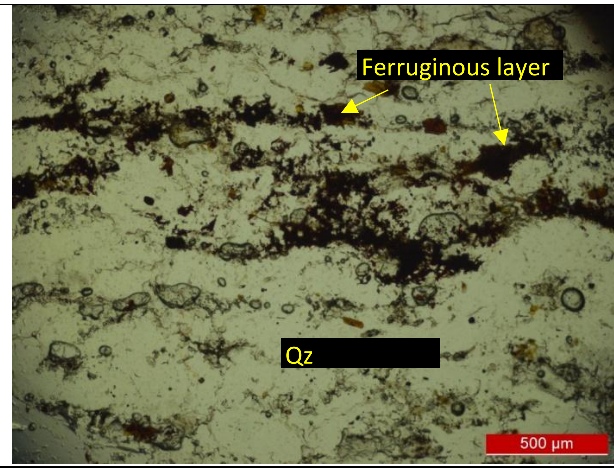


Fig. 6b. Photomicrograph showing ferruginous layer interlayered within the ferruginous quartzite under PPL (sample no. MPAJ/BRS-1/2024-25).

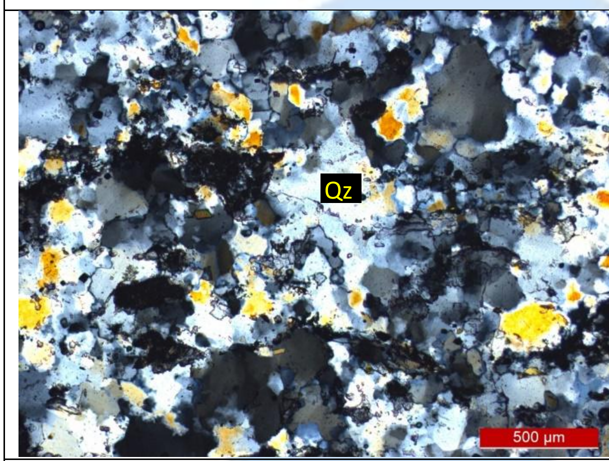


Fig. 6c. Photomicrograph showing zircon under CPL (sample no. MPAJ/BRS-1/2024-25).

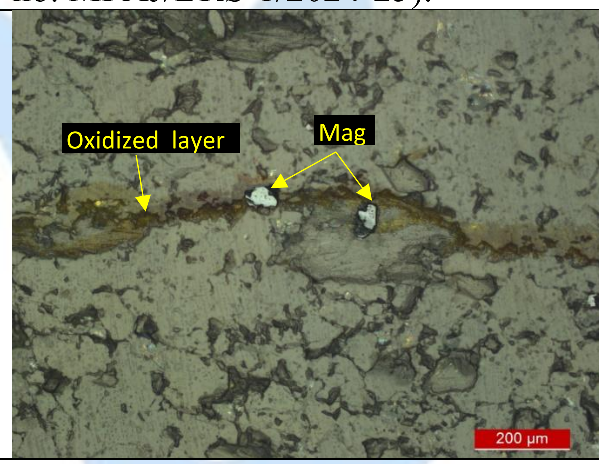


Fig. 6d. Photomicrograph showing tourmaline under reflected light (sample no. MPAJ/BRS-1/2024-25).

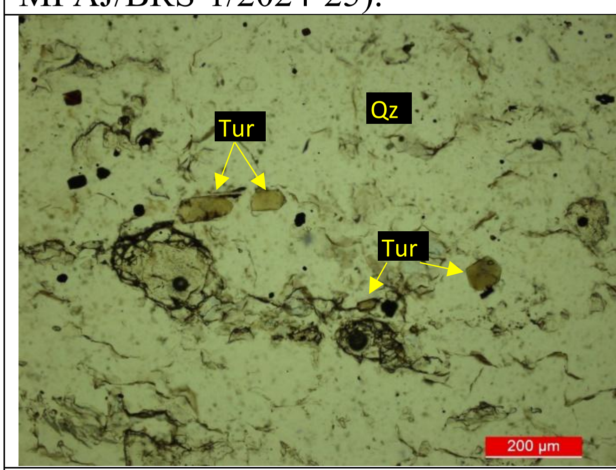


Fig. 6e. Photomicrograph showing stubby tourmaline (Tur) grains in the

ferruginous quartzite under PPL (sample no. MPAJ/BRS-1/2024-25)

vii) Sample no. MPAJ/BRS-41/2024-25 (Quart vein)

In hand specimen, the sample shows pinkish white in colour quartz vein, with muscovite flakes (Fig. 7a).

Under microscope, the rock mainly consists of quartz, with muscovite as accessory. The quartz is showing undulose extinction. Muscovite is in platy form having 1st order interference colour (Fig. 7b). None of the mineralization is found in this sample after thorough examinations under the microscope.

Fig. 7a. Hand sample of quartz vein (Sample no. MPAJ/BRS-41/24-25).

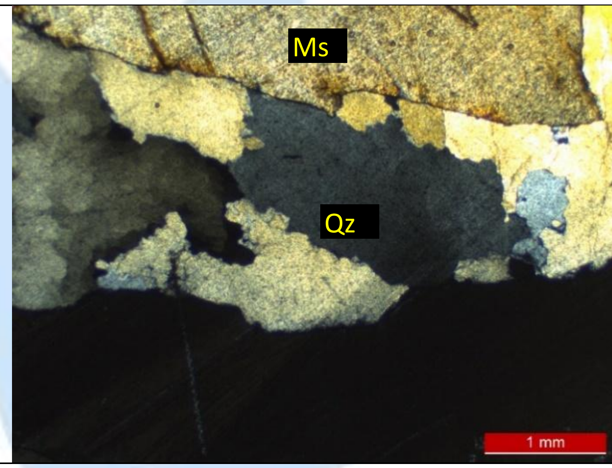


Fig. 7b. Photomicrograph quartz and muscovite in the quartz vein under CPL (sample no. MPAJ/BRS-41/24-25).

Abbreviations: Bi-Biotite; Grt-Garnet; Gth-Goethite; Mag-Magnetite; Mi-Microcline; Or-Orthoclase; Pl-Plagioclase; Py-Pyrite; Qz-Quartz; Ser-Sericite; Sil-Sillimanite; Tur-Turmaline; Zrn-Zircon.

ANNEXURE III

Details of analytical result of Fixed carbon of BRS samples, Amdol, Jharegaon area, Betul district, Madhya Pradesh									
Sl.no	Sample no.	Latitude (DD)	Longitude (DD)	Lithology	Location	Moisture %	Volatile %	Ash %	Fixed Carbon %
1	MPAJ/BRS-1/2024-25	21.8931	77.8329	Ferruginous quartzite	Jharegaon	0.04	99.07	0.77	0.18
2	MPAJ/BRS-2/2024-25	21.8929	77.8303	Phyllite	Jharegaon	0.04	97.86	2.02	0.19
3	MPAJ/BRS-3/2024-25	21.9041	77.8324	Granite Gneiss	Jharegaon	0.03	99.21	0.5	0.26
4	MPAJ/BRS-4/2024-25	21.9047	77.8348	Granite Gneiss	Jharegaon	0.04	99.34	0.45	0.17
5	MPAJ/BRS-7/2024-25	21.8939	77.8312	Quartzitic - Phyllite	Jharegaon	0.09	95.33	3.96	0.62
6	MPAJ/BRS-15/2024-25	21.9168	77.8339	Quartzite	Jharegaon	0.06	99.62	0.06	0.26
7	MPAJ/BRS-17/2024-25	21.9164	77.8348	Alkali feldspar Granite	Jharegaon	0.06	99.81	0.01	0.12
8	MPAJ/BRS-18/2024-25	21.9199	77.8368	Granite Gneiss	Jharegaon	0.01	99.02	0.74	0.23
9	MPAJ/BRS-24/2024-25	21.9145	77.8410	Quartzite	Amdol	0.06	99.66	0.15	0.13
10	MPAJ/BRS-28/2024-25	21.9180	77.8512	Granite Gneiss	Amdol	0.02	98.87	0.85	0.26
11	MPAJ/BRS-32/2024-25	21.9199	77.8586	Granite Gneiss	Amdol	0.01	99.18	0.58	0.23
12	MPAJ/BRS-34/2024-25	21.9137	77.8580	Quartzitic - Phyllite	Amdol	0.01	98.37	1.55	0.07
13	MPAJ/BRS-35/2024-25	21.9126	77.8583	Quartzitic - Phyllite	Amdol	0.01	99.17	0.77	0.05
14	MPAJ/BRS-37/2024-25	21.9235	77.8633	Granite Gneiss and quartz vein	Amdol	0.02	99.19	0.61	0.18
15	MPAJ/BRS-39/2024-25	21.9157	77.8653	Quartzitic - Phyllite	Amdol	0.01	98.62	1.14	0.23

ANNEXURE IV

Details of analytical result of Trace elements (ICPMS, values in ppm) of BRS samples, Amdol, Jharegaon area, Betul district, Madhya Pradesh

Sl.no	Sample no.	Latitude (DD)	Longitude (DD)	Lithology	Al	Ca	Cd	Co	Cu	Fe	Mg	Mn	Nb	Si	Sn	Sr	Ta	Ti	V	W	Th	U
1	MPAJ/BRS-30/2024-25	21.9164	77.8569	Granite Gneiss and quartz vein	89197	1454	<5	8	12	1947	<100	<100	13	330407	<50	57	<0.5	<100	<5	<0.5	<0.5	<0.5
2	MPAJ/BRS-31/2024-25	21.9166	77.8573	Granite Gneiss and pegmatite vein	85630	5452	<5	8	<5	7728	405	519	<5	361970	<50	19	157.85	205	<5	4.06	1.19	<0.5
3	MPAJ/BRS-42/2024-25	21.9103	77.8396	Quartzite	103900	242	<5	9	<5	2438	<100	<100	18	299283	<50	10	5.17	<100	<5	1.99	<0.5	<0.5
4	MPAJ/BRS-43/2024-25	21.9162	77.8349	Quartzite	2221	485	<5	9	<5	5257	<100	<100	<5	443801	<50	<5	1.39	<100	<5	1.55	3.58	<0.5
5	MPAJ/BRS-46/2024-25	21.9010	77.8383	Pegmatite	51220	68620	<5	12	<5	3885	4727	152	18	357416	<50	9	22.07	131	<5	2.4	2.59	<0.5
6	MPAJ/BRS-47/2024-25	21.9103	77.8395	Pegmatite	22090	1004	<5	11	<5	5666	<100	<100	<5	417546	117	13	18.54	148	<5	3.05	3.23	1.91
7	MPAJ/BRS-48/2024-25	21.9101	77.8394	Mica schist	105801	1359	<5	11	13	2765	180	<100	<5	310563	<50	23	1.45	105	<5	2.95	<0.5	<0.5
8	MPAJ/BRS-49/2024-25	21.9104	77.8393	Pegmatite	172971	1032	<5	12	11	19984	3032	416	70	223151	119	14	90.61	927	<5	56.39	2.91	<0.5

ANNEXURE V

Details of analytical result of Fixed carbon of Trench samples, Amdol, Jharegaon area, Betul district, Madhya Pradesh									
Sl.no	Sample no.	Latitude (DD)	Longitude (DD)	Lithology	Location	Moisture %	Volatile %	Ash %	Fixed Carbon %
1	MPAJ/T1-5/2024-25	21.9172	77.8497	weathered Granite Gneiss	Amdol	0.66	97.19	1.69	0.47
2	MPAJ/T1-9/2024-25			weathered Granite Gneiss	Amdol	0.88	96	2.67	0.45
3	MPAJ/T2-1/2024-25	21.9117	77.8402	soil with Quartz pebbles	Jharegaon	0.99	96.16	2.71	0.14
4	MPAJ/T2-10/2024-25			soil with Quartz pebbles	Jharegaon	0.8	96.69	2.39	0.12
5	MPAJ/T3-1/2024-25	21.8951	77.8299	soil	Jharegaon	0.64	96.31	2.65	0.4
6	MPAJ/T3-2/2024-25			soil	Jharegaon	1.04	94.54	4.37	0.06
7	MPAJ/T3-3/2024-25			soil	Jharegaon	0.69	95.96	3.28	0.06
8	MPAJ/T3-4/2024-25			Phyllite	Jharegaon	0.28	97.91	1.77	0.04
9	MPAJ/T3-5/2024-25			Phyllite	Jharegaon	0.66	95.74	2.66	0.93
10	MPAJ/T3-06/2024-25			Phyllite	Jharegaon	0.66	95.23	4.07	0.04
11	MPAJ/T3-7/2024-25			Phyllite	Jharegaon	0.58	95.17	3.94	0.32
12	MPAJ/T3-8/2024-25			Phyllite	Jharegaon	0.56	96.19	2.58	0.67

13	MPAJ/T3-09/2024-25			Phyllite	Jharegaon	0.75	95.73	2.43	1.09
14	MPAJ/T3-10/2024-25			Phyllite	Jharegaon	0.45	96.22	2.88	0.45
15	MPAJ/T4-1/2024-25	21.9001	77.8381	Quartzitic - Phyllite	Jharegaon	2.78	89.43	7.7	0.08
16	MPAJ/T4-2/2024-25			Quartzitic - Phyllite	Jharegaon	2.95	91.74	4.6	0.71
17	MPAJ/T4-3/2024-25			Quartzitic - Phyllite	Jharegaon	3.96	88.48	4.18	1.96
18	MPAJ/T4-4/2024-25			Quartzitic - Phyllite	Jharegaon	0.55	97.27	2.14	0.04
19	MPAJ/T4-5/2024-25			Quartzitic - Phyllite	Jharegaon	2.5	86.83	8.73	1.94
20	MPAJ/T4-6/2024-25			Quartzitic - Phyllite	Jharegaon	1.42	93.73	4.82	0.02
21	MPAJ/T4-7/2024-25			Quartzitic - Phyllite	Jharegaon	1.06	95.52	3.39	0.03
22	MPAJ/T4-8/2024-25			Quartzitic - Phyllite	Jharegaon	1.51	92.28	6.15	0.06
23	MPAJ/T4-9/2024-25			Quartzitic - Phyllite	Jharegaon	0.67	97.71	0.67	0.95
24	MPAJ/T4-10/2024-25			Quartzitic - Phyllite	Jharegaon	0.26	98.66	0.26	0.82
25	MPAJ/T5-06/2024-25	21.9162	77.8320	Quartzite	Jharegaon	3.36	89.3	7.31	0.03
26	MPAJ/T5-10/2024-25			Quartzite	Jharegaon	4.26	89.26	6.47	0.02

Government of India
Ministry of Mines
National Mineral Exploration Trust
Technical cum Cost Committee [TCC]

F. No.: 6/4/2015-NMET/ **New Delhi, 12th March, 2024**

Corrigendum

With reference to the minutes of 62nd TCC Meeting held on 28th, 29th February and 1st March , 2024 the following modifications may be noted:

1. In Agenda 62.1.16. Reconnaissance Survey (G4 Stage) For Graphite and Associated Minerals Around Sonaghati, Amdol, Jharegaon & Bhayawari District: Betul, M.P, the recommendation of TCC may be read as **"The committee recommends the proposal for approval of EC for "Reconnaissance Survey (G4 Stage) For Graphite and associated Minerals around Sonaghati, Amdol, Jharegaon & Bhayawari, District: Betul, M.P. with an estimated cost of Rs. 111.47 lakh (including GST) within time schedule of 12 months and submission of report as per annexure-12A & 12B. The item will be reviewed after 06 months"** instead of "*The committee recommends the proposal for approval of EC for "Reconnaissance Survey (G4 Stage) For Graphite and associated Minerals around Sonaghati, Amdol, Jharegaon & Bhayawari, District: Betul, M.P. with an estimated cost of Rs.105.04 lakh (including GST) within time schedule of 12 months and submission of report as per annexure-12A & 12B. The item will be reviewed after 06 months.*"

The other text of the minutes will remain unchanged.

Parthi 12/3/24

[C. Parthasarathi]
Director, GSI & Member Secretary,TCC- NMET

To

1. Dr. S. Ravi, Dy. Director General, Su: Karnataka & Goa, GSI, Bangalore.
2. Sh. I.R. Kirmani, ADG (Retd.), GSI.
3. Shri Hemraj Suryavanshi, Additional Director General (Retd.), GSI.

4. Sh. K. Koteshwar Rao, Dy.D.G. (Retd.), GSI.
5. Shri S. K. Adhikari, Chief Mining Geologist, IBM, Nagpur.
6. Sh. SK Kulshrestha , DOG-RMH-III, NER, GSI, Shillong.
7. Dr. EV.S.SK Babu, Scientist (G), NGRI.
8. Sh. K.L. Mundra, Head-RMRE, AMD, Hyderabad.
9. Sh. A.R. Sengupta, Director (IFD), Ministry of Mines.
10. Sh. Vivek Kumar Sharma, Director & In-charge of NMET, Ministry of Mines.
11. Shri Ravi Kumar Gupta, GM (Finance) Hindustan Copper Limited, Kolkata.
12. Sh. P. K. Maharana, AGM (Finance), NALCO, Bhubaneswar.
13. Smt. Vandana, Cost Accounts Officer, RSAS, Bangalore, GSI.

Annexure 12A

Estimate Cost for Reconnaissance Survey (G-4 STAGE) for Graphite and associated Minerals Around Sonnaghati, Amdol, Jharegaon &Bhayawari District: Betul, Madhya Pradesh.

Total Area 7.34.00 Sq.Km -Mapping 1:4000 Scale, No of Boreholes: 5 , Depth: 60 m (Vertical) , Total Depth: 300 meters , Timeline :12 months, Review 6 months

Sl.No	Item of work	Unit	NMETSo C-Item - Sl No.	NMET Rates (2020)	Qty	Amount INR	Remarks
A	**GEOLOGICAL MAPPING OTHER GEOLOGICAL WORK & SURVEYING**						
i	Geologist Party days H Q	Days	1.3	9000	30	270000	
ii	Geological Mapping (1:4000)& Trenching and Drilling - Geologist Party days (1) - Field	Days	1.3	11000	90	990000	
iii	Labour	Days	5.7	504	180	90720	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher.
iv	Sampler Party days (1party)	Days	1.5.2	5100	29	147900	
v	Labour for Sampling (4 Nos.)	Days	5.7	504	116	58464	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
B	**GROUND GEOPHYSICAL SURVEY**						
1	IP Cum resistivity S.P magnetic (8-10 line km) - Package	Line Km	3.4b	1448693	1	1448693	
	Geophysicist (HQ)	Per Day	3.18	9000	10	90000	To be checked by Finance committee
3	Labourers (Rs 477/day/labour) Geophysical Survey(2Nos)	Days	5.7	477	0	0	
	Geophysicist (Field)	Per Day	3.18	11000	0	0	

C	**SURVEY WORK**						
i	Survey Party Days (1 party)	Days	1.6.1a	8300	30	249000	
	DGPS Survey- BH fixation, boundary, RL determination	Per point	1.6.2	19200	5	96000	
ii	Labourers (4 Nos)	Days	5.7	504	120	60480	Amount will be reimburse as per the notified rates by the Central Labour Commissioner or respective State Govt. whichever is higher
	SubTotal A+ B + C					**3501257**	
D	**PITTING & TRENCHING**						
1	**Trenching(1m x 2mx 10 m) (5 Nos)**	Per Cu.M	2.1.1	3330	100	333000	
	SubTotal D					**333000**	
E	**DRILLING (after Review)**						
1	Drilling (30 m vertical depth) 5 bhs	mts.	2.2.1.3a	10100	300	3030000	
3	Approach Road making for Flat terrain	per Km.	2.2.10a	22020	5	110100	Road Making will be considered as per the requirement and Road Making Charges will be reimbursed later
4	Land Compensation	Per Borehole	5.6	20000	5	100000	Amount will be reimburse as per actuals or max. Rs. 20000 per BH with certification from local authorities
5	Construction of concrete Pillar (12" x12"x30")	Per Borehole	2.2.7a	2000	5	10000	
6	Drill Core Preservation	per m	5.3	1590	160	254400	This amount will be reimbursed after successful delivery of the cores to concerned libraries/authorities

7	Drilling camp setting cost	Per Project	2.2.9a	250000	1	250000	
8	Drilling Camp Winding cost	per project	2.2.9b	250000	1	250000	
7	**SubTotal E**					**4004500**	
F	**LABORATORY STUDIES**						
	a.Chemical analyses (Geochemicals Sampling(Bedrock/Channel/Stream sediments)						
1	Proximate Anlalyses of Trench/Pit for graphite-VM,FC, Moisture & Ash	Per sample	4.1.16	3000	80	240000	
2	Whole Rock Analyses-Major Oxides by XRF technique	Per sample	4.1.15a	4200	10	42000	
3	REE analysis of 14 elements ICPMS	per sample	4.1.13	5380	15	80700	
4	ii) Check Samples (Bed rock/ soil/ stream) (10%) External	Per sample	4.1.16	3000	8	24000	
	b)Trench & Check Samples from Trench						
5	Proximate Anlalyses of Trench/Pit for graphite-VM,FC, Moisture & Ash	per sample	4.1.16	3000	0	0	
	Check Samples (10%) External	per sample	4.1.16	3000	0	0	
6	**Borehole Core samples**						
7	a)Proximate Analysis (Ash, Moisture, V.M. and F.C.)	Per sample	4.1.16	3000	100	300000	
8	(b)Check Samples-(Ash, Moisture, V.M. and F.C.) 10%	Per sample	4.1.16	3000	10	30000	
9	c) Total Sulphur (S)	Per sample	4.2.14	1900	0	0	

10	(d) REE analyses of 14 elements/radicals by ICPMS (10%)	Per sample	4.1.13	5380	0	0	
11	ICP -MS studies (34 trace elements)	Per sample	4.1.14	7731	15	115965	
	Check Samples (10%) External				0		
	b.Petrography studies						
1	X-RD Studies	Per sample	4.5.1	4000	10	40000	
2	c) Preparation of thin sections	Per sample	4.3.1	2353	10	23530	
3	c)Complete petrographic /ore microscopic study/Mineragraphic studies	Per sample	4.3.4	4232	10	42320	
4	d)Preparation of Polished Sections	Per sample	4.3.2	1549	10	15490	
	SubTotal F					**954005**	
G	**GEOTECHNICAL STUDIES**						
	a)Specific Gravity Determination	Per Sample	4.8.1	1605	5	8025	
	b)Bulk density	Per Sample	'4.10	3540	0	0	
	SubTotal G					**8025**	
	Total A+B+C+D+E+F+G					**8800787**	
H	**PREPARATION OF EXPLORATION PROPOSAL (5+1 Softcopy)**	Per Project	5.1		1	**176016**	
I	**PEER REVIEW**	As per EC committee			30,000	**30000**	

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J	**GEOLOGICAL REPORT PREPARATION 5+5 HARD COPIES + 2 SOFTCOPY (@3%)**	Per Porject	5.2	ii	1	**440039**	
	TOTAL A to J					**9446842**	
	GST 18%					**1700432**	
	Total with GST 18%					**11147274**	
	Rs. In lacs					**111.47**	
Note:							
1	**Strict adherence to the Ministry of Finance's and GFR guidelines is mandatory. Every transaction must adhere to GFR rule 21.**						
2	**In case of delay/non- performance, the appropriate action will be taken by competent authority against delinquent agency as per prevailing govt. of India rules/guidelines on procurement.**						
3	**If any part of the project is outsourced, the amount will be reimbursed as per the Paragraph 3 of NMETSoC and Item no. 6 of NMETSoC. In case of execusion of the project by NEA on its own, a Certificate regarding non outsourcing of any component/project is required.**						
4	**Necessary efforts should be made to minimize any adverse impact on the environment during exploration activities.**						

Annexure 12B

Time Schedule / Action Plan for Reconnaissance Survey (G-4 STAGE) for Graphite and associated Minerals Around Sonnaghati, Amdol, Jharegaon & Bhayawari District: Betul Madhya Pradesh

Item of Work	1	2	3	4	5	6		7	8	9	10	11	12
Camp Setting & Ground Geophysical studies													
Geologist (1 Party) for Geological Mapping, Pitting/Trenching/Drilling & Sampling -(1:4000 scale mapping)													
Bed rock / channel. Stream													
Pitting/Trenching -Bed Rock													
Sample Preparation(1Party)- includes crushing, powdering, packing & Labeling													
Analyses of Pit/Trench, BRS & Geochemical Samples							Review						
Survey work- boundary survey, surface features Contouring & BH fixation, determination of coordinates and Reduced level													
Drilling (Drill Operation)(300 Mtrs.)													
Core Sampling - core splitting, crussing, powdering, coning and quartering													
Analysis of Drilling Core Samples(Nos.)													
Camp Winding													
Geological Report Writing with Peer Review and submission													

ANNEXURE VII

GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G4) FOR GRAPHITE AND ASSOCIATED MINERALS AROUND SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI, BETUL DISTRICT, MADHYA PRADESH

PROJECT REVIEWED AT VARIOUS STAGES

1. Mr Shubra Suchi Sarkar, Deputy Director General, and Mr Dilip Kumar Yadav, Director, GSI, Bhopal, MP, interacted with the GeoExpOre team during geological mapping on 23rd May 2024.

2. The committee deferred the proposal to the next TCC-II meeting, scheduled for January 2025.

3. The Geologists & Mr Shubra Suchi Sarkar, Deputy Director General, and Mr Dilip Kumar Yadav, Director, GSI, Bhopal, MP of GSI, inspected the trenching activity at the site on 15th March 2025.

4. The committee agreed to conduct an SP survey along a 5-line km stretch on 1st Apr 2025.

5. TCC-II recommended trenching in the area and approved a 3-month extension up to 11th June 2025 for completion of the Project.

6. After reviewing the Geological Map, Deputy Director Manish Palewar, DMG Madhya Pradesh, interacted with the GeoExpOre team.

7. The committee agreed on Geophysical Exploration – SP Survey in 5 L km & timeline extension of 2 months up to 11th Aug.2025.

9. TCC-II opined that no further work is needed in this project since the analytical results are not encouraging. The committee advised to close the project and submitting the GR. Timeline extension up to 10th October 2025 was agreed by the committee.

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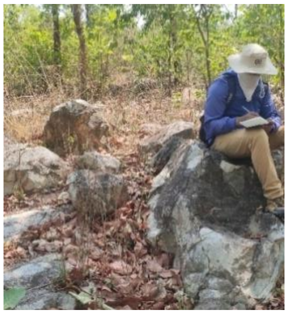
ANNEXURE VIII
GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G4) FOR GRAPHITE AND ASSOCIATED MINERALS AROUND SONAGHATI, AMDOL, JHAREGAON AND BHAYAWARI BLOCK, BETUL DISTRICT, MADHYA PRADESH

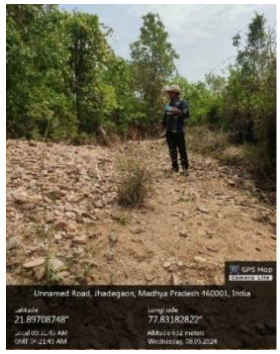
FIELD INSPECTION PHOTOGRAPHS





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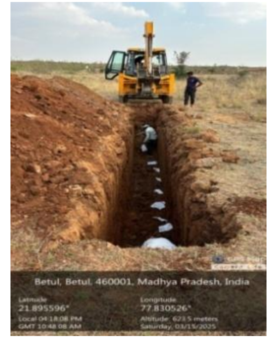
77.83182822°
Wednesday, 08.05.2024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