

**GEOLOGICAL REPORT**  
**ON**  
**PRELIMINARY EXPLORATION (G3) FOR GRAPHITE IN**  
**LAMER- PANGA BLOCK-A, KALAHANDI DISTRICT, ODISHA**

TOPOSHEET NOS: F44X8 (64P08) and F44X12 (64P12).

**Volume-I**



**ODISHA MINING CORPORATION LIMITED**

**(A Gold Category State PSU)**

**Bhubaneswar-751001, Odisha**

**May, 2025**

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**IN LAMER-PANGA BLOCK-A, KALAHANDI DISTRICT, ODISHA**

TOPOSHEET NOS: F44X8 (64P08) and F44X12 (64P12)

GOVERNMENT NOTIFICATION NO. - 4380/SM, BHUBANESWAR DTD. 07.05.2022

NMET APPROVED: 27<sup>th</sup> EC MEETING DTD.10<sup>th</sup> JANUARY 2023

BLOCK AREA:13.99 SQ. KM or 1399 HA.

MINERAL: GRAPHITE

FOREST DIVISION: KALAHANDI NORTH DIVISION

TALUK: MADANPUR RAMPUR AND NARLA

DISTRICT: KALAHANDI, STATE: ODISHA



**ODISHA MINING CORPORATION LIMITED**  
**(A Gold Category State PSU)**  
**Bhubaneswar-751001, Odisha**

**May, 2025**

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## CHAPTER 1

### EXECUTIVE SUMMARY

	Features	Details	
<b>1.</b>	<b>Location</b>	Eastern Ghat Mobile Belt	
	Mineral Block	Lamer-Panga Block-A, Kalahandi District	
	Latitude	20° 04' 30.91" N and 20° 06' 06.29" N	
	Longitude	83° 25' 50.30" E and 83° 30' 11.14" E	
	Villages	Lamer, Belagan, Tarkabahali, Sadalguchha, Dudalu, Terlo, Patangpadar, etc.	
	Tehsil/Taluka	Madanpur-Rampur and Narla	
	District	Kalahandi	
	State	Odisha	
<b>2.</b>	<b>Area (Hectares/square km)</b>	13.99 sq. km	
	Mineralised area (G3)	0.127 sq. km	
	Non-mineralised area	-	
<b>3.</b>	<b>Exploration</b>		
	Status	G3 Stage (Area: 13.99 sq. km)	
	Exploration Agency	Geological Survey of India (1972-73 and 1983-84) and Odisha Mining Corporation Limited (2023-24)	
	Total No. of BHs with meterage	Total 17 nos. of boreholes with cumulative 883 Meterage	
	Borehole spacing	About 200m	
<b>4.</b>	<b>Quantity of Minerals</b>		
	Mineral 1		
	Inferred Mineral Resource (333)	Total <b>3098039</b> tonnes or <b>3.098</b> million tonnes	<b>3098039</b> tonnes or <b>3.098</b> million tonnes ( $\geq 2\%$ FC) with an average of 6.76% FC.

<b>5.</b>	Total Thickness	385.68 m	Average 6.76% FC
<b>6.</b>	<b>Grade</b>		
	Mineral 1, mineral 2, Mineral 3...mineral n	Total <b>3098039 tonnes or 3.098 million tonnes</b> resource (UNFC- 333) has been estimated with an average of 6.67% FC at 2% cut off FC.	
<b>7.</b>	<b>Accessibility</b>		
	Nearest Rail head	Narla is the nearest railway station	
	Road	The State Highway 6A passes 4 km. away from NW direction of the block, which connects Madanpur-Rampur, Narla and Bhawanipatna.	
	Airport	Utkela airstrip (45 km) and VSS airport, Jharsuguda (245 km) are the nearest from block.	
<b>8.</b>	<b>Hydrography</b>		
	Local Surface Drainage Pattern (Channels)	The area has got dendritic pattern of drainage. Tel River flows outside the block along the north-west direction.	
<b>9.</b>	<b>Climate</b>		
	Mean Annual rainfall	1378.20 mm	
	Temperature (December)	Min 4°C	
	Temperature (May)	Max 45°C	
<b>10.</b>	<b>Topography</b>		
	Toposheet Numbers	F44X8 (64P08) and F44X12 (64P12)	
	Morphology of the area	The block area forms flat land along northern, north-eastern and western part of the block whereas the central, southern, south-eastern and some part of north-western comprises a hilly undulated terrain with some plane land in valley portion.	

Graphite is a naturally occurring form of crystalline carbon and is mostly consumed for refractory, lubricating, steel making, making lead pencils, brake linings, foundry facings etc. Graphite deposits of economic importance are reported from various states of India among which Odisha has a considerable share of graphite resources and is confined mainly to the Meso-Proterozoic rocks of Eastern Ghats Mobile Belt (EGMB).

The Ministry of Mines, Government of India has notified the Odisha Mineral Exploration Corporation Limited (OMECL) for undertaking prospecting operation in pursuance of the second provision to sub section (1) of section 4 of the Mines and Minerals (Development and Regulations) Act, 1957. The State Government in the department of Steel and Mines has allotted Lamer-Panga Graphite Block (88.838 sq. km) of Narla, Madanpur-Rampur and Lanjigarh Tehsil/Taluk of Kalahandi District to OMECL vide their Notification No. 4380/S&M, Bhubaneswar dated 07.05.2022 for exploration up to G2 level. A total 49.084 sq. km area has been carried out for reconnaissance survey (G4) for graphite mineral and Geological Report (GR) has been submitted to National Mineral Exploration Trust (NMET), Ministry of Mines as well as Directorate of Mining and Geology (DoMG), Steel and Mines Department, Odisha. Other two areas, i.e. Lamer-Panga Block-A (13.99 sq. km) and Lamer-Panga Block-B (12.994 sq. km) have been carried out on Preliminary Exploration (G3) for graphite within this allotted Lamer-Panga Graphite Block (88.838 sq. km). However, the Geological Report of Lamer-Panga Block-A (13.99 sq. km) on preliminary exploration (G3) for graphite has been prepared for submission. Now, Odisha Mineral Exploration Corporation Limited is amalgamated with Odisha Mining Corporation Limited vide letter no. 27/07/2022/CL-III dated 03.05.2023 of Ministry of Corporate Affairs, Government of India w.e.f. 08.06.2023 (Merger notification attached as ANNEXURE - IIA and ANNEXURE -IIB).

In accordance with the above, the Lamer-Panga block-A has carried out the detailed geological mapping (1:4000) over an area of 13.99 sq. km as well as 10-line km. of self-potential survey, 17 nos. of boreholes, 22 nos. of surface sample and 655 nos. of primary sample.

The exploration area lies in the western part of the Eastern Ghats Super Group of rocks and also known as Eastern Ghats Mobile Belt (EGMB). The area forms geologically a part of the Archaean complex of the peninsular shield comprising highly metamorphosed sedimentary and igneous rocks belonging to Khondalite and Charnockite Group of the Eastern Ghats Supergroup along with the ubiquitous granite-gneisses. Graphite occurs as small veins and disseminated flakes along the weak planes like foliation plane and micro fractures within the khondalite, granite gneiss and quartzite. Graphite also occurs at the contact of khondalite and granite gneiss as small veins being conformably along the foliation planes of host rock. They appear to be formed from the disseminated flakes of graphite, an essential constituent of khondalite by the process of remobilisation, controlled by shearing and subsequent migmatization by the granite- gneiss and their related pegmatites and quartz veins.

During Field Season (FS) 2022-23 and 2023-24, the detailed geological mapping (Scale 1:4000) over an area 13.99 sq. km has been carried out in toposheet no. F44X8(64P08) and F44X12(64P12) with collecting up Bed Rock Samples (BRS). The various lithological units observed during field mapping are granite gneiss, khondalite, charnockite, garnet bearing quartzite, leptynite, pegmatite and quartz veins. The detailed geological mapping is covered around the villages of Lamer, Belagan, Tarkabahali, Sadalguchha, Dudalu, Terlo and Patangpadar etc. of Narla and Madanpur-Rampur Tahasil of Kalahandi district of Odisha. Graphite mineralisation zones are found near the north-west and south-east part of Lamer village. In the south-eastern part of Lamer village, the graphite band is extended 1 km in NE-SW direction along the foliation and the average width of band is 62 m. which is dipping 50° towards SE direction. In the north-western part of Lamer village, 3 nos. of graphite bands are found. The length of graphite bands is 321m , 959 m and 160 m in NE-SW direction along the foliation and

the average width of the bands are 30m, 51m and 54m respectively which are dipping  $50^\circ$  towards SE direction. One number of pit has been discerned near Lamer village. The host rock for graphite mineralisation is high grade metamorphosed rocks of Khondalite Suite of EGMB.

During FS 2022-23, Self-Potential (SP) survey of total 10 line km was carried out in the study area across the foliation trend in where total 19 nos. of anomalies are found, where 2 numbers of prominent anomalous zones are delineated in this block area for further subsurface study. These areas are located near north-west and south-east part of Lamer village. Total 17 nos. of boreholes have been suggested based on anomaly value and the results of SP value varies from -306 mV to -607 mV in these anomalous zones.

A total of 17 nos. of inclined borehole were planned as well as drilled based on geological mapping and self-potential survey. Inclined boreholes at an angle varies from  $45^\circ$  to  $60^\circ$  were carried out with cumulative meterage of 883 m. The boreholes were drilled up to a minimum of 35.00 m to maximum of 115.00 m. Out of these, 13nos. boreholes have intersected graphite mineralisation having a total thickness of 392.5 m. However, four boreholes did not intersect mineralised zone (-Ve borehole). The graphite mineralisation covers an area of about 0.127 sq. km near Lamer within the entire block area.

Representative bed rock and drill core samples were analysed at Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC). The chemical analysis for 4 components (Moisture%, Volatile Matter%, Ash% and Fixed Carbon%) in 22 nos. surface sample, 655 nos. of primary sample and 65 nos. of check sample were carried out. A total 05 nos. of bulk density samples were analysed at Inspectorate Griffith private India Limited (IGI). FC% ranges of drill core samples vary from 2.004 % to 17.07% with an average of 6.76%.

The graphite resource in this block has been estimated using Cross Sectional (CS) Area method as well as Longitudinal Vertical (LV) Section method but the cross section area method is considered as the resource for this block. Flaky variety

of graphite mineralisation is observed in the study area; hence graphite resource has been estimated at cut off 2% FC. Bulk density of graphite bearing rock has been taken as 2.34 gm/cc. A total of 3098039 tonnes or 3.098 million tonnes Inferred Mineral Resource (UNFC- 333) for graphite has been estimated in Cross Sectional (CS) Area method with an average of 6.76 % FC in the Lamer-Panga block-A. In where, a total of 1987747 tonnes or 1.988 million tonnes above 5% FC has been estimated. However, a total of 3356828 tonnes or 3.356 million tonnes resource for graphite has been estimated in Longitudinal Vertical (LV) Section method in Lamer- Panga block-A.

In view of the potential zone for graphite mineralisation in this block, it is required to ascertain the lateral as well as depth continuity of the zone with a focus on mineralised area. As, the potential zones found for graphite mineralisation so it may be taken up into further stage of exploration.

## **CHAPTER 2**

### **INTRODUCTION**

#### **2.1 Details of project**

The Department of Steel and Mines, Government of Odisha has allotted Lamer-Panga Graphite Block (88.838 sq. km.) of Narla, Madanpur-Rampur and Lanjigarh Tehsil/Taluk of Kalahandi District to Odisha Mineral Exploration Corporation Limited vide their Notification No. 4380/S&M, Bhubaneswar dated 07.05.2022 for exploration up to G2 level. Consequent upon merging of Odisha Mineral Exploration Corporation Limited with Odisha Mining Corporation Limited the above block has been allocated to OMC Ltd. vide their Notification No. 7397/S&M, Bhubaneswar dated 20.07.2023 for carrying out the exploration work.

However, this Lame-Panga Block for graphite over an area of 88.838 sq. km has been approved to carry out for reconnaissance survey (G4 stage) over an area of 49.084 sq. km whereas another two blocks namely Lamer-Panga Block-A over an area of 13.99 sq. km and Lamer-Panga Block-B over an area of 12.994 sq. km for preliminary exploration (G3 stage) depending upon the potentiality of graphite mineralisation under the guidance of NMET. The Lamer-Panga Block-A (13.99 sq. km) for preliminary exploration was approved by NMET in 44<sup>th</sup> TCC meeting on 25<sup>th</sup> and 26<sup>th</sup> August, 2022 (ANNEXURE-III) and 27<sup>th</sup> EC meeting on 10<sup>th</sup> January, 2023(ANNEXURE - IIIA) and it was reviewed for work components in 73<sup>rd</sup> TCC meeting on 30<sup>th</sup> and 31<sup>th</sup> January, 2025 (ANNEXURE -IIIB).

In accordance, OMC Ltd. has done a detailed geological mapping of an area of 13.99 sq. km. on 1:4000, 10 line km of self-potential survey and 17 nos. of boreholes in this study area.



## 2.2 Investigating Agency

The Lamer-Panga graphite block was allotted to Odisha Mineral Exploration Corporation Ltd. by the Department of Steel & Mines, Government of Odisha vide their Notification No. 4380/SM, Bhubaneswar dated 07.05.2022 for the exploration of graphite mineral for a period of two years. However, Odisha Mineral Exploration Corporation Limited is amalgamated with Odisha Mining Corporation Limited henceforth the exploration has been carried out by OMC Ltd.

The details of Title and Ownership of the block is given in Table 2.1.

**Table 2.1:** Details of Title & Ownership

a	Name of the explorer/Mining or prospecting rights holder:	Odisha Mining Corporation Ltd.
b	Address:	OMC House, Bhubaneswar-751001, Odisha, India
c	Telephone No:	0674-2377400/2377401
d	E-Mail id:	omc.geology@odishamining.in

Details of period of prospecting/mineral right if any:

In case of license/lease:

(a) Date of grant: 07.05.2022

(b) Date of execution: 05.01.2023

(c) Period of license/lease: 02 years

## 2.3 Objectives of investigation

The main objective of the present investigation is to assess the mineral potentiality for graphite and to delineate the mineralised zone of the block area. The geological mapping combined with geophysical survey, systematic drilling, sampling and laboratory studies are carried out for assessing the disposition of the mineralised

zones and structural features of the block. The Inferred Mineral Resource of graphite mineral in the block is estimated as per UNFC norms and Minerals (Evidence of Mineral Contents) Rules-2015 & Amendment MEMC Rule-2021 at G3 stage.

## **2.4 Basis for taking up investigation**

Lamer-Panga block-A forms the part of western part of Eastern Ghats Mobile Belt. Geological investigation for graphite was carried out in the “Eastern Ghats” by Geological Survey of India (GSI) during 1968-69 and 1972-73 through geological mapping, pitting and trenching in the Titilagarh, Bolangir, and Patnagarh Sub-Division of Bolangir district. It was observed that graphite is found along certain zones, where concentration is higher. However, pitting and trenching have not been sufficient in the area to find the zone of maximum mineral concentration. Geophysical prospecting and drilling were also recommended in the report to study the exact nature of the deposits.

During the initial field visit to the study area by OMC geologists, the geological settings were assessed and grab samples of graphite have been collected from different locations. Graphite mineralisation was noticed within khondalite, granite gneiss and quartzite of this block. In order to delineate the graphite mineralised zone and to investigate the mineral potentiality of the area, a preliminary exploration in this block has been carried out. On the above observation it is proposed to take up detailed mapping on 1:4000, self-potential survey, drilling and sampling in Lamer-Panga block-A in Kalahandi district and falling Toposheet Nos: F44X8 (64P08) and F44X12 (64P12).

## 2.5 Nature and quantum of work and achievement

The details of the quantum of work approved by NMET and work accomplished by OMC are furnished in Table 2.2.

**Table 2.2:** Quantum of work approved by NMET vs. work accomplished by OMC:

Sl.no	Nature and quantum of work	Work proposed	Achievements
1.	<b>Mapping</b>		
	Detailed mapping on 1:4000	13.99 sq. km	13.99 sq. km
2.	<b>Geophysical Survey</b>		
	Self-Potential Survey (L Km.)	10 Line km (SP)	10 Line km (SP)
3.	<b>Technological</b>		
	a) Surface exploration-Pitting/trenching (Cum)	200 Cum. (Trenching)	NIL
	b) Sub Surface Exploration- Drilling (m)	1000m (Drilling)	17 Nos. BH (883mtr. Drilling)
4.	<b>Physical Analysis</b>		
	(a) XRD (Nos.)	10 Nos.	10 Nos.
	(b) ICP -MS studies	10 Nos.	NIL
	(c) Preparation of thin section (Nos.)	10 Nos.	10 Nos.
	(d) Petrographic studies (Nos.)	10 Nos.	10 Nos.
	(e) Preparation of polished section (Nos.)	10 Nos.	10 Nos.
	(f) Mineralographic studies (Nos.)	10 Nos.	10 Nos.
	(g) Bulk density (Nos.)	05 Nos.	05 Nos.
5.	<b>Chemical analysis</b>		
	<b>i) Primary samples</b>		
	a) Primary samples for 4 components (Ash, Moisture, V.M. &F.C.)	472 Nos.	Total <b>677</b> Nos. a) <b>22 Nos.</b> (Surface sample) b) <b>655 Nos.</b> (Core sample)

	b) Check samples for 4 components (Ash, Moisture, V.M.&F.C.)	50 Nos.	65 Nos.
	c) REE	10 Nos.	NIL
	<b>ii) Composite samples</b>		
	a) Composite samples for 4 components (Ash, Moisture, V.M.&F.C.)	20 Nos.	NIL
	b) Total Sulphur(S)	10 Nos.	NIL

## 2.6 Personal involved

**Table 2.3:** Person involved in supervision and guidance

a	Name and Designation:	Shri Bharat Chandra Sahoo, GM (Exploration)
b	Address:	OMC House, Bhubaneswar-751001, Odisha, India
c	E-Mail id:	bharat.sahoo@odishamining.in

**Table 2.4:** Personnel directly involved in exploration work

1	a	Name and Designation:	Dr. Lingaraj Sahoo, Sr. Manager (Geology)
	b	Address:	OMC House, Bhubaneswar-751001, Odisha, India
	c	Contact Mobile No:	9437603370
	d	E-Mail id:	lingaraj.sahoo@odishamining.in
	e	Affiliation to any organization/ company:	Odisha Mining Corporation Limited (OMC Ltd.)
2	a	Name and Designation:	Shri Bhupati Kumar Nayak, Dy. Manager (Geology)

### **Details of qualification & experience of personnel involved in exploration and report work**

1. Shri Bharat Chandra Sahoo, GM (Exploration), M.Sc. Tech (Applied Geology), more than 26 years of experience
2. Dr. Lingaraj Sahoo, Sr. Manager (Geology), M.Sc. and Ph.D. (Geology), more than 18 years of experience
3. Shri Bhupati Kumar Nayak, Dy. Manager (Geology), M.Sc. (Applied Geology), more than 02 years of experience

### **2.7 Different work components and associated agency**

The details of the quantum of work components and associated agency are furnished in Table 2.5.

**Table 2.5:** Work components and associated agency:

SL. NO.	WORK COMPONENTS	ASSOCIATED AGENCY
1	Geophysical survey (Self Potential)	M/s Steiger Geo-science and Engineering Pvt Ltd
2	Sample Analysis	M/s Jawaharlal Nehru Aluminium Research Development and Design Centre (JNARDDC) And M/s Inspectorate Griffith private India Limited (IGI).
3	Drilling	M/s Mining Associate Pvt. Ltd., Asansol, West Bengal.
4	Physical Analysis	Ravenshaw University, Cuttack, Odisha



## CHAPTER 3

### PROPERTY DESCRIPTION

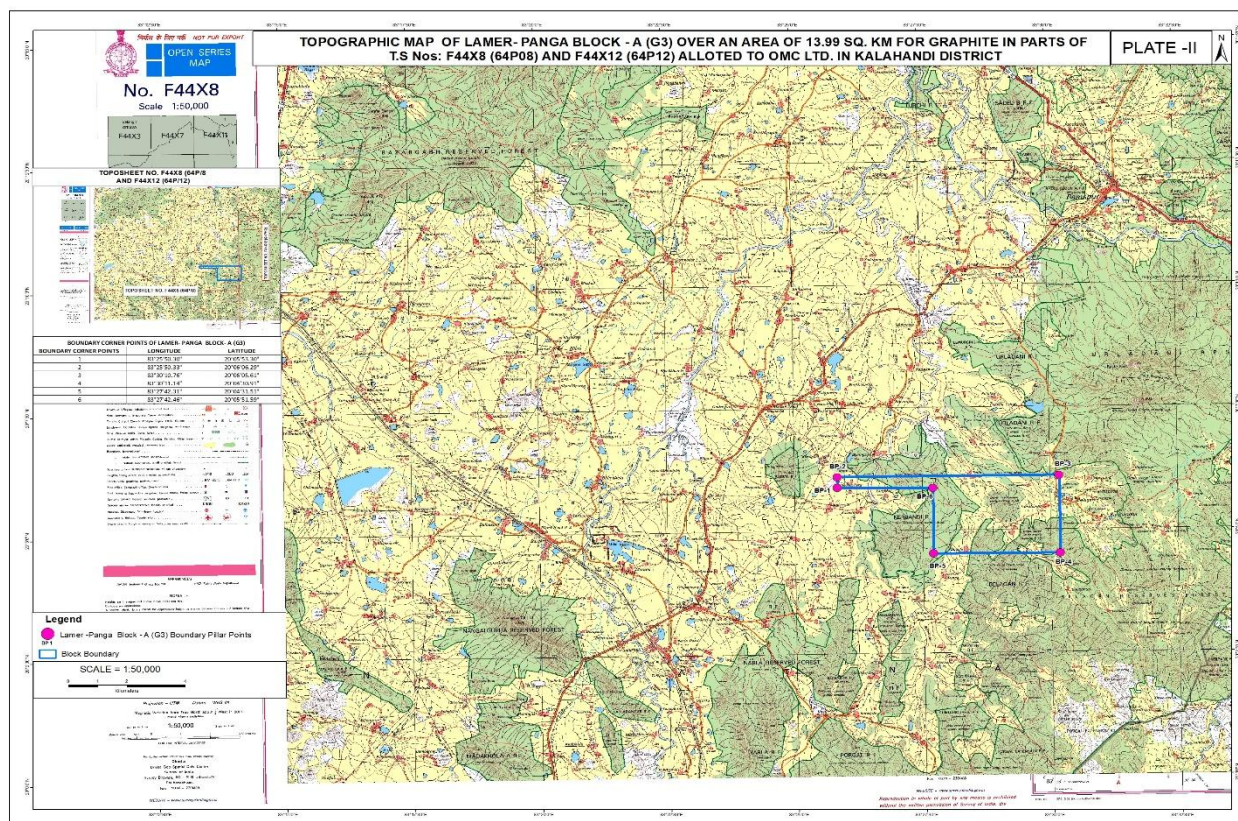
#### 3.1 Details of the area

**3.1A Village:** Lamer, Belagan, Tarkabahali, Sadalguchha, Dudalu, Terlo and Patangpadar etc.

**District:** Kalahandi

**State:** Odisha

**3.1B Survey of India Toposheet Nos.:** F44X8 (64P08) and F44X12 (64P12)



**Fig. 3.1:** Lamer-Panga block-A, Kalahandi district, Odisha shown on SOI F44X8 (64P08) and F44X12 (64P12)

### 3.1 C Geo-coordinate with the corner points of the investigated area:

The Lamer-Panga Block-A of Kalahandi district, Odisha is bounded by latitude 20° 04' 30.91"N & 20° 06' 06.29"N and longitude 83°25'50.30"E & 83° 30' 11.14"E. The block covers an area of 13.99 sq. km and is featured in Survey of India (SOI) Toposheet Nos. F44X8 (64P08) and F44X12 (64P12).

**Table 3.1:** Notified Coordinates of Boundary Corner Points of Lamer-Panga block-A, Kalahandi district.

Sl. No	Corner Points	Latitude	Longitude
1	1	20° 05' 53.30"	83° 25' 50.30"
2	2	20° 06' 06.29"	83° 25' 50.33"
3	3	20° 06' 05.61"	83° 30' 10.76"
4	4	20° 04' 30.91"	83° 30' 11.14"
5	5	20° 04' 31.51"	83° 27' 42.31"
6	6	20° 05' 51.59"	83° 27' 42.46"

The DGPS coordinates of all borehole points are presented in Table 3.2

**Table 3.2:** DGPS Coordinates of boreholes drilled in the Lamer-Panga block-A.

Sl. No	Borehole ID	Easting	Northing	Latitude	Longitude	RL(m)
1	LPA/G3/01	760179.783	2222212.535	20° 04' 45.988"	83° 29' 16.451"	270.607
2	LPA/G3/02	760261.048	2222398.892	20° 04' 52.006"	83° 29' 19.342"	268.186
3	LPA/G3/03	760678.149	2222823.987	20° 05' 5.619"	83° 29' 33.909"	288.246
4	LPA/G3/04	760557.89	2222671.887	20° 05' 0.734"	83° 29' 29.694"	320.371
5	LPA/G3/05	759895.501	2221882.62	20° 04' 35.31"	83° 29' 6.503"	306.985
6	LPA/G3/06	760028.242	2222084.14	20° 04' 41.889"	83° 29' 11.172"	279.961
7	LPA/G3/07	759645.181	2223639.686	20° 05' 32.538"	83° 28' 58.792"	305.257
8	LPA/G3/08	759498.14	2223475.84	20° 05' 27.376"	83° 28' 53.65"	284.657
9	LPA/G3/09	759758.98	2223484.82	20° 05' 37.292"	83° 29' 2.782"	323.254

10	LPA/G3/10	760359.86	2222472.96	20° 04' 54.364"	83° 29' 22.780"	316.993
11	LPA/G3/11	759902.25	2223663.88	20° 05' 33.292"	83° 29' 7.649"	369.934
12	LPA/G3/12	759722.45	2223573.24	20° 05' 30.433"	83° 29' 1.417"	353.179
13	LPA/G3/13	759592.88	2223414.3	20° 05' 25.33"	83° 28' 56.878"	333.327
14	LPA/G3/14	759460.37	2223267.25	20° 05' 20.615"	83° 28' 52.244"	264.486
15	LPA/G3/15	759851.64	2223724.36	20° 05' 35.282"	83° 29' 5.939"	338.832
16	LPA/G3/16	759329.2	2223110.23	20° 05' 15.575"	83° 28' 47.651"	245.134
17	LPA/G3/17	759976.68	2223876.96	20° 05' 40.181"	83° 29' 10.319"	274.989

The villages featuring inside the block is Lamer, Belagan, Tarkabahali, Sadalguchha, Dudalu, Terlo and Patangpadar etc. of Kalahandi district.

The Forest Clearance proposal seeking permission for using the forest area for drilling and other exploration activities in the Lamer-Panga block-A was submitted to the concerned Forest Department (Order attached in ANNEXURE IV).

The Lamer-Panga block-A for graphite has been approved to OMC (erstwhile OMECL) to carry out for G3 stage of exploration.

### **3.1 D Land use/cover:**

The block area forms flat land along northern, north-eastern and western parts of the block whereas the central, southern, south-eastern and some parts of north-western comprises a hilly undulated terrain with some plane land in valley portions.

### **3.1 E Forest with type of forest:**

The Belagan reserve forest presents in the north-eastern and southern part of the block.

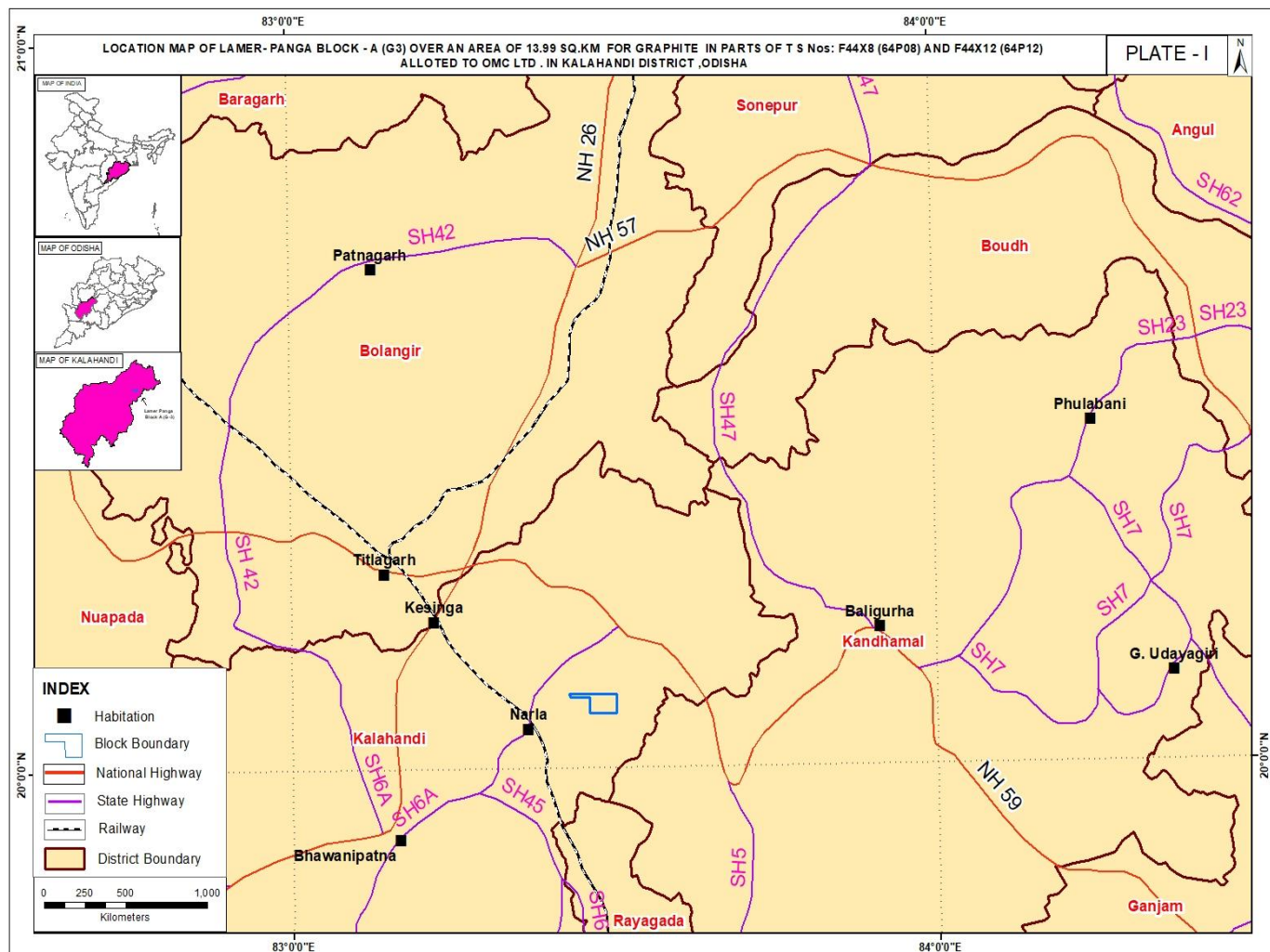
### **3.1 F Free hold/lease hold: Free hold area.**



### **3.1 G Location & accessibility:**

The study area is located about 370 km from the state capital Bhubaneswar falling in part of SOI toposheet no. F44X8 (64P08) and F44X12 (64P12), Kalahandi district, Odisha. The graphite block is 5 km away from State Highway (SH)-6A which is located on the western and northwestern side of the block. The main access road to the block connects SH-6A at Balipada and passes through the block to join at Patangpadar village at north-western part of the block. The Terlo village within the block is approached from Jampadar at SH-6A by a black top road. The block is also approached from Pujiladu and Sirpali at SH-6A up to village Lamer through Belagan and Tarkabahali at the north part of the block by a black top road. Narla is the nearest railway station from the block. The Utkela airstrip, Kesinga is the nearest of 45 km whereas the VSS airport, Jharsuguda is situated about 245 km from the block.

The map showing Lamer-Panga block-A along with major habitations, railway and road connections is presented in Fig. 3.2 and PLATE No. I. and the block falling on Toposheet presented in Fig 3.1 and PLATE No. II



**Fig.3.2:** Location map showing accessibility to Lamer-Panga block-A

### **3.1H Climate:**

- (a) Temperature (annual) min 4<sup>0</sup>c max 45<sup>0</sup>c Avg 25<sup>0</sup>c
- (b) Rain falls (annual) min 689.1 mm max 2067.3 mm Avg 1378.20 mm.
- (c) Humidity (annual) min 14% max 99% Avg 64.1%

The area experiences subtropical to tropical temperate monsoon climate and is characterized by a hot summer. The climate of the area is of extreme type. It is dry except during monsoon.

### **3.1I Flora & Fauna:**

The hilly tracts in the study area are very dense forest and plains of the area are covered by thick vegetation and sparsely distributed forest. The common flora found in the area are Kendu (*Diospyros melanoxylon*), Bija (*Peterrocarpus Marsupium*), Neem (*Azadirachta indica*), Chanhar (*Platanus orientalis*), Saptaparani (*Alstonia scholaris*), Sal (*Shorear obusta*), Mahul (*Bauhiniavahlia Wight & Arontt*), Bamboo (*Bambusa vulgaris*) etc.

The wild animals found in jungles are elephant (*Elephas maximus*), deer (*Odocoileus virginiana*), wild boar (*Sus scrofa*), jackal (*Canisaures indicus*) and fox (*Vulpes bengalensis*) etc. Poisonous snakes and reptiles are quite common and varieties of birds like crow, white and brown heron, peacock, parrot and pigeon in the study area. No rare/endangered/unique species of flora and fauna are found in the area.

### **3.1J Geomorphology:**

The area has dendritic pattern of drainage. There is no perennial nallah passing within the block area.

### 3.1K Local infrastructure:

The local infrastructure facilities like roads, railways, electricity and water etc. are available at the vicinity of the block. The State Highway (SH) 6A passing 7 km away from NW direction of the block, which connects Madanpur-Rampur, Narla and Bhawanipatna. Narla railway station is the nearest railway station from the block (25 km) and the nearest airport is Utkela (45 km).

### 3.1L Population:

The village featuring inside the block includes Lamer, Belagan, Tarkabahali, Sadalguchha, Dudalu, Terlo, Patangpadar etc. of Madanpur-Rampur and Narla Tehsils of Kalahandi district. As per the District Census Handbook, Kalahandi (Census of India 2011).

Socio Demographic profile of the area is mostly tribal-rural culture. The details of the villages are tabulated in Table 3.3.

**Table 3.3:** Village wise population details.

Village	Population	Literacy (%)	Sex Ratio
Lamer	284	66.13	1135
Belagan	316	65.19	1093
Tarkabahali	273	68.35	1068
Sadalguchha	59	60.38	966
Dudalu	121	62.00	1283
Terlo	599	59.18	926
Patangpadar	242	55.07	1033

### 3.1M Archaeological & historical sites:

No historical sites, archaeological monuments, places of worship, public utilities etc. are found within the block.

### **3.1N National parks:**

No national park, wildlife sanctuary, biosphere reserve, tiger reserve, elephant corridor, wildlife migration corridor etc. is located within the block boundary. The northern and eastern part of the study area is covered by Belagan reserve forest.

### **3.1O Physiography and environment**

Physiographically, the block area forms flat land along northern, north- eastern and western part of the block whereas the central, southern, south-eastern and some part of north-western comprises a hilly undulated terrain with some plane land in valley portions. The vegetation is around the northern, northeastern, southwestern and western part of the block. The western and northwestern parts of the area are mixed open shrubs. The minimum elevation of the block is about 220 MSL and maximum is about 440 MSL. The area has got a dendritic pattern of drainage.

## **CHAPTER 4**

### **PREVIOUS WORK**

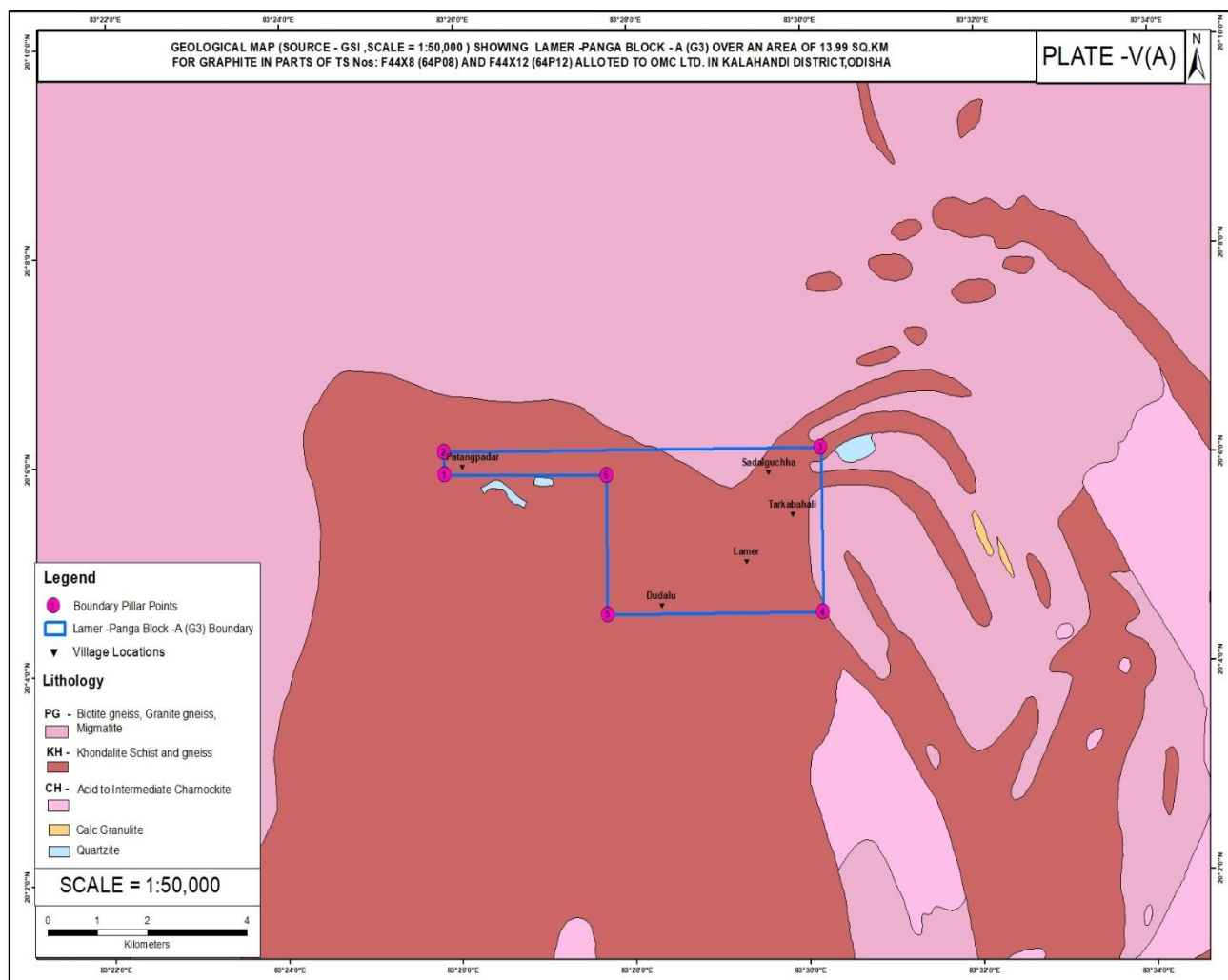
Investigation for graphite was carried out in the Eastern Ghats by Geological Survey of India during 1968-69 through geological mapping, pitting and trenching in the Titilagarh, Bolangir, and Patnagarh Sub-Division of Bolangir district. It was observed that graphite is found along certain zones, where concentration is higher. Pitting and trenching have not been sufficient to find the zone of maximum concentration. Geophysical prospecting and drilling were recommended to study the exact nature of the deposits.

Geological investigation, comprising geological mapping and pitting was undertaken in 1972-73 by Geological Survey of India, along the Titilagarh- Muribahal sector of the Titilagarh graphite Belt, Bolangir district, Orissa, for the detailed appraisal of the graphite resources and to study the controls of localization. The Titilagarh graphite belt is a vast, mineral bearing area (about 55 km long and 40 km wide) covering parts of Bolangir and Kalahandi districts of Orissa, in Survey of India's toposheet nos. 64 P/3, 4, 7, 8 & 11. As per the study, the area exposes highly metamorphosed khondalite and charnockite formations of Eastern Ghats Super Group and the granite-gneisses. The survey resulted in the finding of a number of small and scattered occurrences of graphite of which a few seem promising. Commercially exploitable graphite deposits of this sector are located at the sheared and migmatized contacts of khondalite and medium-fine grained gneiss with wide-spread feldspathisation. They are structurally controlled by the foliation of the host rock. Only lens and vein types of graphite deposits with sizeable dimensions are economically paying. Geophysical prospecting, Pitting, Drilling, Geochemical Sampling etc. were recommended over the area. A reconnaissance study covering an area of 321 sq km pitting and trenching of 95.6 cum and collection of 34 channel samples for chemical analysis from some of the quarries and prospecting trenches were undertaken in course of inventory of graphite quarries. Migmatized khondalite is the host rock in which

the workable concentration of graphite is noted. Structural control was found to be the major factor controlling graphite localization in the area in the form of bands, lenses and veins.

Graphite investigation for regional assessment of graphite resources was continued during 1983-84 Field Season covering an area of 302 sq.km in parts of Bolangir, Kalahandi and Phulbani districts of Odisha. The fieldwork carried out during the season covers large scale geological mapping on (1:12,500) over an area 302 sq. km, 212.65 cum Pitting/trenching, 452.20 m of test drilling in six boreholes, analysis of 46 nos. of channel & grab samples and analysis of 36 nos. of core samples. Among them a total of 5 nos. of trenches i.e. 2 nos. in 600 m southwest of Barabandha village and 3 nos. in 0.5 km west of Kankeri village have been carried out within this Lamer-Panga Block-B which is the adjacent from this block.

No pitting/trenching or drilling of boreholes were drilled in the currently explored Lamer-Panga block-A and no reserve estimation has been made by the previous exploration agency in this block for graphite.



**Fig.4.1:** Geological Map (1:50000) by GSI showing the Lamer-Panga block-A



## CHAPTER 5

### GEOLOGY OF THE AREA

#### 5.1 Regional Geology

The exploration area lies in the western part of the Eastern Ghats Supergroup of rocks and also known as Eastern Ghats Mobile Belt (EGMB) which extends from Brahmani River in Odisha to Ongole in Andhra Pradesh over a stretch of 900km with a width varying from 30 to 300km, the maximum width being in Odisha. The area forms geologically a part of the Archaean complex of the peninsular shield comprising highly metamorphosed sedimentary and igneous rocks belonging to Khondalite and Charnockite Group of the Eastern Ghats Supergroup along with the ubiquitous granite-gneisses. The Khondalite Group is represented by the quartz feldspathic garnetiferous sillimanite, graphite bearing schists and gneisses, calc-silicate granulites and garnetiferous quartzites. These occur intermittently inter-banded with each other suggesting inter-bedded nature of the pelitic, psammitic and calcareous sedimentary facies, although their relative position is obscure.

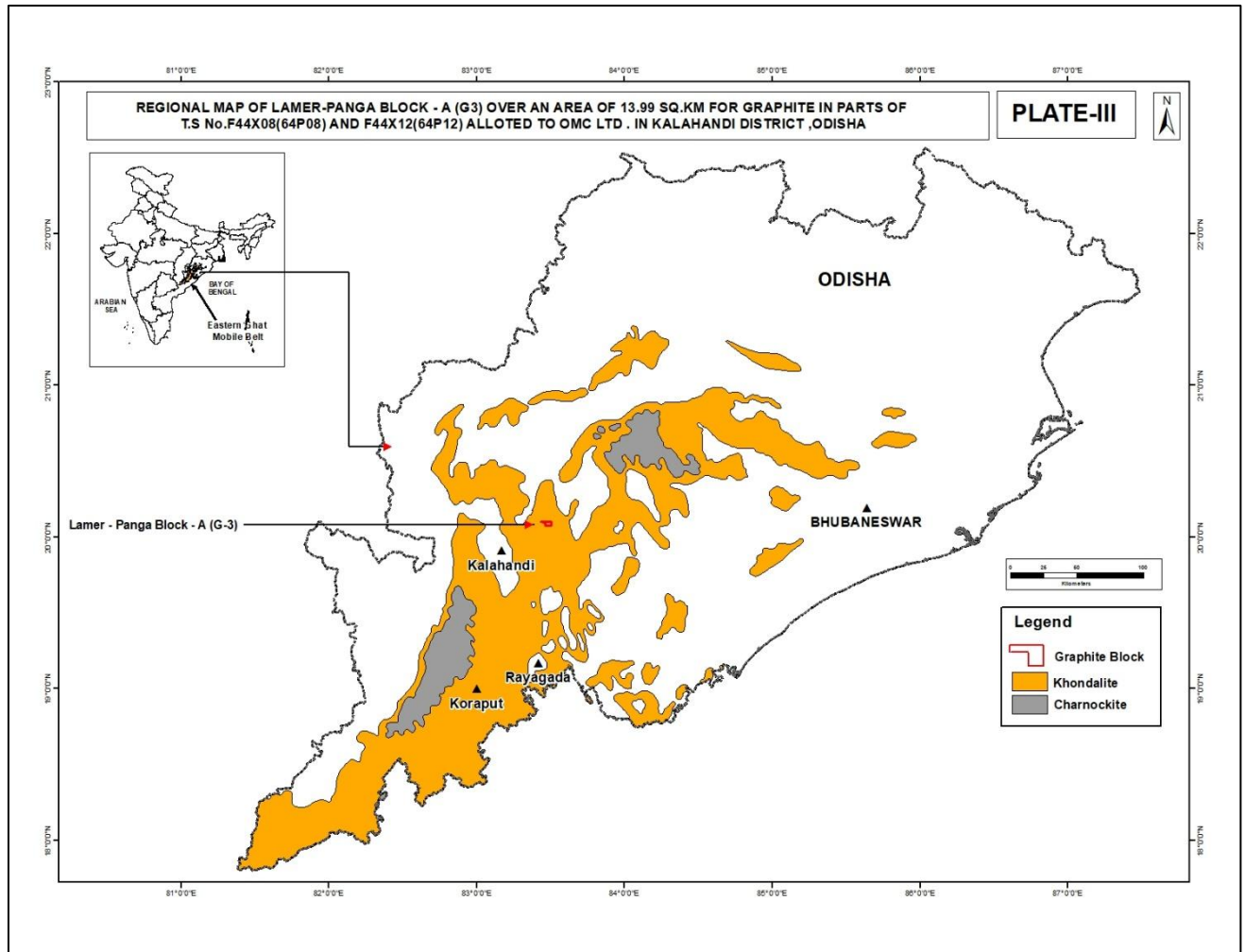
The well foliated rocks show marked variation in attitude due to poly-phase deformation. Metamorphism has affected almost all these rock types, sometimes obliterating their original lithology and field relationships. There are also folds and shear zones. The shear zones trend varies from NW-SE to WNW-ESE.

Based on their spatial distribution and mutual relationship enumerated above the rock types of the area can fit in the tentative geological succession presented in Table 5.1.

**Table 5.1:** Stratigraphic succession of the Area (after GSI)

Eastern Ghats Supergroup	Recent	Laterite Soil and Alluvium
	Intrusives	Pegmatite and Quartz vein. Porphyroblastic granite gneiss. Medium grained granite gneiss
	Charnockite Group	Pyroxene Granulite
	Khondalite Group	Calc granulite Quartz-garnet feldspar-biotite-sillimanite ± graphite gneiss/schist. Garnetiferous quartzites, Quartzites.

The regional geological map showing the Lamer-Panga block-A is presented in Fig. 5.1 and PLATE No. III. The Geological Map (1:50000) by GSI showing the Lamer-Panga block-A for graphite which is presented in Fig 4.1 and PLATE No. V (A).



**Fig.5.1:** Regional Geological Map showing the Lamer-Panga block-A.

## 5.2 Indication of mineralisation and nature of host rock

Graphite is invariably present in the khondalite group of rocks and their migmatites equivalents as one of the major mineral constituents. At places higher graphite proportions in the rock have made the rock graphite schist.

The graphite occurs as small veins and disseminates flakes along the weak planes like foliation plane and micro-fractures within migmatised khondalites. Graphite also occurs at the contact of khondalite and granite gneiss as small veins being conformably along the foliation planes of host rock. They appear to be formed from the disseminated flakes of graphite, an essential constituent of khondalite by the process of remobilisation, controlled by shearing and subsequent migmatisation by the granite- gneiss and their related pegmatites and quartz veins.

It is observed that the host rock for graphite localisation in all cases is migmatised khondalite, granite gneiss and quartzite. It is evident that the graphite zones within the host rock probably constitute originally carbonaceous sediments within the khondalite, granite gneiss and quartzite. It suggests that the localisation of graphite may be due to remobilization of graphite from the quartz-garnet-sillimanite-graphite schist to structurally weak zones during the period of migmatization.

## CHAPTER 6

### ACTIVITY DURING THE PERIOD (GEOSCIENTIFIC INVESTIGATION)

#### 6.1. Geological mapping

##### 6.1A. Detailed Geological Mapping on 1:4000 scale

The Lamer-Panga block-A for graphite in Kalahandi district spreads over an area of 13.99 sq. km in western part of Eastern Ghat Mobile Belt. The various lithological units in the block have been mapped in 1:4000 scale. The outcrop map, interpreted map and surface geological map showing the boreholes and mineralised zones of Lamer-panga block-A is presented in PLATE No. IV, V and VI respectively. The various lithounits observed during field mapping are Granite Gneiss, Khondalite, Charnockite and Garnetiferous Quartzite and Leptynite.

The central, southern and south-eastern part of the block comprises hillocks, which are generally consisting of garnetiferous quartzite, granite gneiss and charnockite rocks. Whereas the northwestern part of the block consists of a hillock which is comprising khondalite rock. Foliations have been observed in outcrops of country rocks, which have a general trend of NE-SW and the trend of foliation varies from N30°E-S30°W to N70°E-S70°W. and dipping 40° to 70° in SE direction. The graphite occurs as dissemination and flakes along schist sheet plane and along micro fractures within migmatised khondalites, granite gneiss and quartzite. Small scale folding is seen indicating the migmatisation at the contact zone of Granite gneiss and Khondalites. Migmatisation has been taken place at the contact of pegmatite-khondalite margins. Graphite also occurs at the contact of khondalite and granite gneiss as small veins being conformably along the foliation planes of host rock. They appear to be formed from the disseminated flakes of graphite, an essential constituent of khondalite by the process of remobilisation, controlled by shearing and subsequent migmatisation by the granite- gneiss and their related pegmatites and quartz veins.

The central, southern, north-western and south-eastern parts of the block are exposed with garnetiferous quartzite, granite gneiss, khondalite and charnockite which show the same trend of foliation. The northern and western part of the block is generally covered with soil/alluvium.

The geological succession of the study area was interpreted and presented in Table: 6.1

**Table 6.1:** Geological Succession of the study area

ARCHEAN	Eastern Ghats Supergroup	Recent	Soil/Alluvium
		Intrusives	Pegmatite and quartz veins
		Charnockite Group	Leptynite, Granite gneiss, Pyroxene granulites
		Khondalite Group	Khondalites, Calc-silicate rocks, Quartzite



30



## 6.1B Outcrop map on scale 1:4000

Outcrop map has been prepared on scale 1:4000 (PLATE No. IV) on the basis of field observations and exposure of the lithounits observed during mapping. The study area has limited output. Most of the outcrops of different lithounits i.e Granite Gneiss, Khondalite, Charnockite, Leptynite and Garnet bearing Quartzite are exposed in the mapped area. The cultivated areas in the northern and western part of the study area comprise a few rock exposures. The rocks of the area are highly metamorphosed and weathered. Areas without exposure are marked as soil cover. In the outcrop map, the outcrops of different lithounits were presented in the form of polygons. An outcrop map is prepared in Arc GIS platform and polygons are made where exposures are present in the field area. Structural data like foliation, joint etc. from the outcrop were plotted on the map.

### 6.1. C Description of rock type:

A brief description of the individual litho unit is as follows.

#### **Khondalite (quartz- feldspar- garnet- sillimanite + graphite schist/gneiss):**

It occurs typically in bouldery outcrops (highly weathered) on narrow, steep hill ranges and low-lying mounds and in valleys inter-banded with quartzite and calc-silicate rocks. This is coarse grained, brownish yellow to reddish grey, foliated and highly weathered rock. Due to varying degree of weathering its colour changes to pinkish/purplish at places, when highly kaolinised, it becomes very light. It is highly sheared and mylonitised at places. The rock is intimately associated with quartzite and both grade into each other along as well as across the foliation. They are highly migmatized and the quartzo-feldspathic leucosome bands that have traversed the rock along the regional foliation plane of the rocks.

In hand specimen, the rock is medium to coarse grained, varying in colour from grey to pink. It is mainly composed of quartz, feldspar, garnet, sillimanite with or without graphite. The garnets are mostly porphyroblastic and reddish in colour. The rock is hard, mesocratic showing well developed gneissosity with foliation and dissected by joints. The long axes of the platy and flaky minerals are oriented to define the foliation. Khondalite displays meso to mega scale variation of quartz content.



## **Granite Gneiss**

This is a medium to coarse grained rock occupying in low-lying areas with migmatite, consisting mainly of quartz, orthoclase, plagioclase, biotite, garnet and opaques. The whole sequence has been metamorphosed to granulite facies. The alkali-feldspar granite gneiss is fine to coarse grained.

## **Charnockite**

It is mainly orthopyroxene-bearing quartz-feldspar rock formed at high temperature and pressure, commonly found in granulite facies metamorphic terrain. This is a medium to coarse grained, massive porphyroblastic rock with large rounded to oval shaped porphyroblasts of potash feldspar. It is moderately foliated, gneissose and generally it has the typical greasy lustre and greenish black.

## **Leptynite**

It is a metamorphic rock made up of alkali-feldspar, quartz, mica, garnet and tourmaline with a planar gneissose structure.

## **Quartzite**

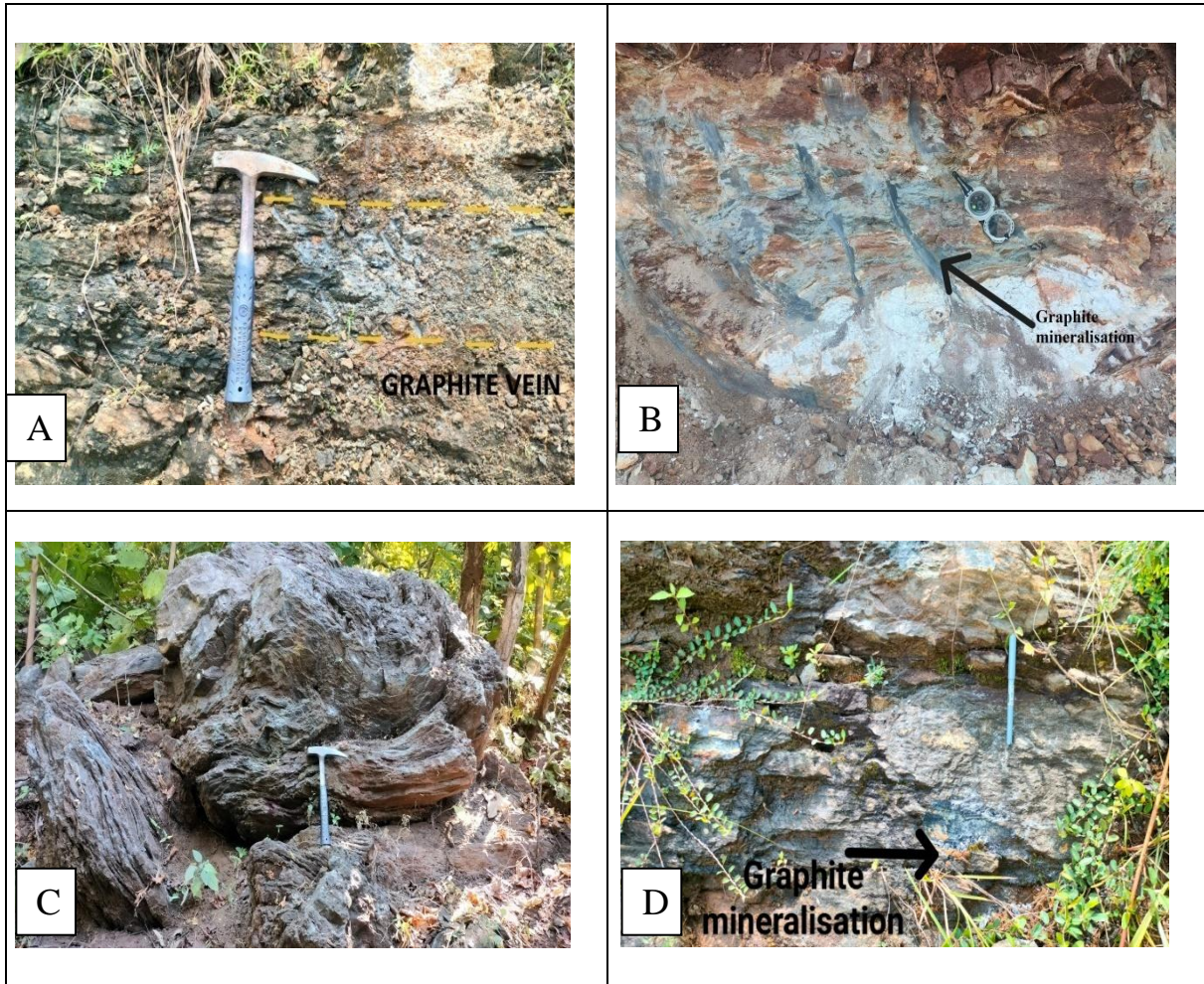
The quartzite is medium to coarse-grained, white to buff coloured, granular to faintly schistose in nature and is invariably garnetiferous.

## **Pegmatite and Quartz veins**

Pegmatite and quartz veins traverse the country rocks both along and across the foliation. At places pegmatite contains few crystals of beryl and tourmaline. Quartz veins with thickness varying from a few millimeters to centimeters traverse through the different rock types in this block. The quartz veins are milky white and grey/smoky. Most of the quartz veins are present at the contact of the two litho-units. These are observed as small outcrops on the top of the small mound. The trend of quartz vein varies widely. In hand specimen, the identified mineral assemblage consists of quartz, feldspar, mica and garnet with or without graphite specks at places. The rock is mostly fractured and jointed in nature.

## Soil/Alluvium

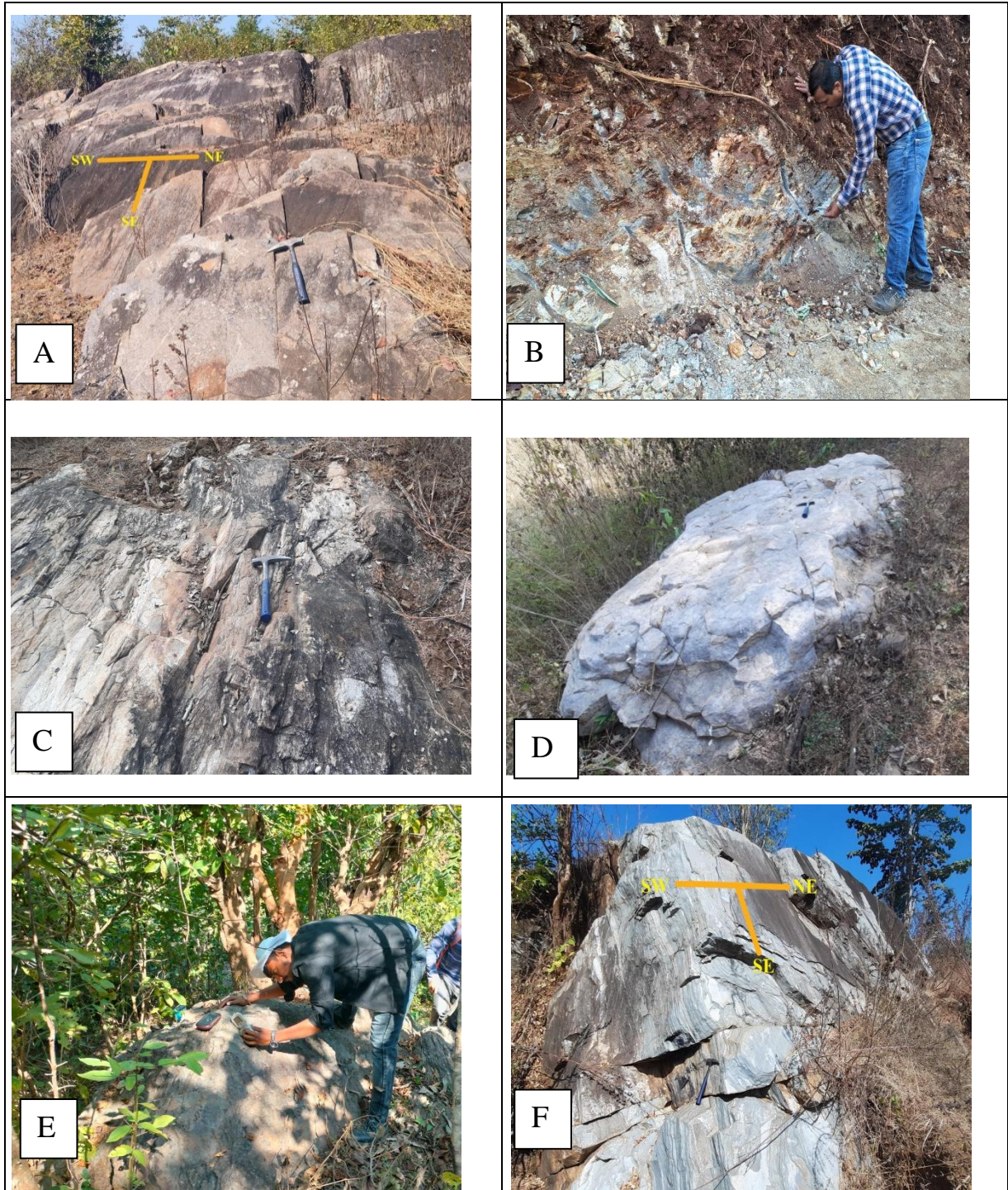
Soil is found over the granite gneiss, charnockite and quartzite which is very common in the study area.



**Fig.6.2:** Field photographs showing graphite outcrops in the Lamer-Panga block-A.

- A. Graphite vein exposed in granite gneiss in a pit in Lamer village.
- B. Graphite mineralisation found within granite gneiss in Lamer hill.
- C. Graphite mineralisation found within granite gneiss in Lamer hill.
- D. Graphite mineralisation in granite gneiss in a pit in Lamer village.





**Fig.6.3:** Field photographs showing different rock outcrops in the Lamer-Panga block-A.

- (A) Exposure of granite gneiss near Lamer village.
- (B) Outcrop of granite gneiss with graphite mineralisation in a hill near Lamer village.
- (C) Exposure of migmatised granite gneiss near Dudalu village.
- (D) Exposure of quartzite near Tarkabahali village.
- (E) Outcrop of granite gneiss near Lamer village.
- (F) Exposure of granite gneiss near Sadalguchha village.

#### 6.1.D Petrological & petrochemical study:

Representative samples were provided to Ravenshaw University for physical analysis for the following purposes:

- i) Physical and Morphological studies
- ii) Petrological, Mineralogical studies, using reflected & transmitted microscopy and XRD techniques.

#### Material details: -

Five representative samples as per details mentioned in Table 6.2, were taken up for detailed characterization.

Sl. No	Sample Code
1	LPA/ G3/GP/ 350
2	LPA/ G3/GP/ 644
3	LPA/ G3/GP/ 939A
4	LPA/ G3/GP/ 1107
5	LPA/ G3/GP/ 1216
6	LPA/ G3/GP/ 10A
7	LPA/ G3/GP/ 11A
8	LPA/ G3/GP/ 12A
9	LPA/ G3/GP/ 13A
10	LPA/ G3/GP/ 14A

## Methodologies: -

Mineralogical analysis has been carried out to infer the various mineral phases present in individual samples, textures and microstructures, and the altered products. The instruments used are optical microscopes (Reflected and Transmitted) and X-Ray Diffraction (XRD).

## Optical Microscopic Study: -

The rock samples were cut to the desired size by a diamond wheel saw (Carl Zeiss) / Iso-cut slow speed saw (Buehler make). For ore microscopic study, the samples were polished by conventional techniques and ultrasonically cleaned. Both polished and thin sections of representative samples were prepared for studies under reflected light and transmitted light microscope respectively. The following microscopes are used for the above study.

Name of the unit:	Leica DM2500P
	Olympus SZX16

## X-Ray Diffraction: -

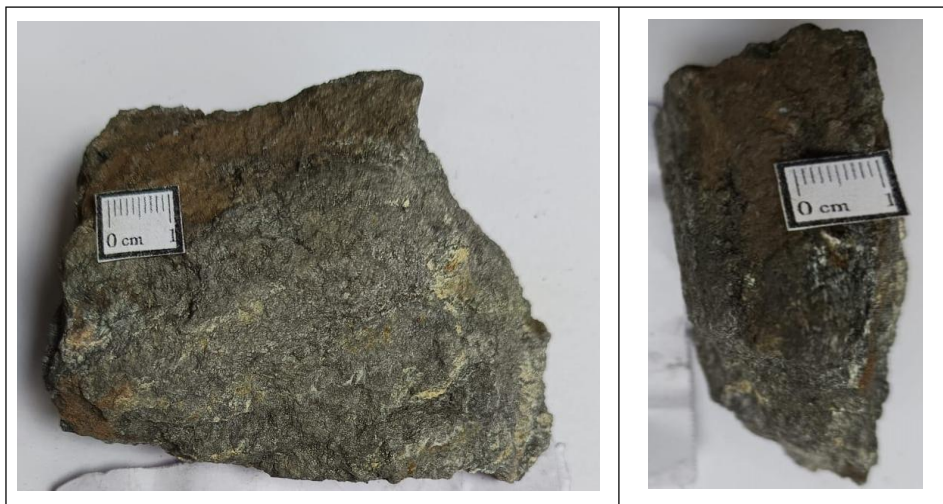
Typically, powdered X-ray diffraction (XRD) is an average of randomly oriented micro crystals that should equally represent all crystal orientations. X-rays are directed at the sample which produces a diffraction pattern that shows the intensity of X-rays collected at different angles. The X-rays on hitting the crystal lattice planes are separated by distance  $d$ . With the known wavelength ( $\lambda$ ) and diffraction angle ( $2\theta$ ), the corresponding values of „d“ were measured. The set of „d“ values obtained from the diffractogram was matched with the JCPDS data-book (1980), and minerals hence present were identified.

## Instrument details:

Name of the unit	Rigaku Ultima IV has an automatic slit and graphite monochromator.
Target used	Cu $K\alpha$
Scanning rate	$4^\circ/\text{min}$
Tube Voltage	40 kV
Current	40 mA
Range	$2 \times 10^3$ cps



## Mineral characteristic



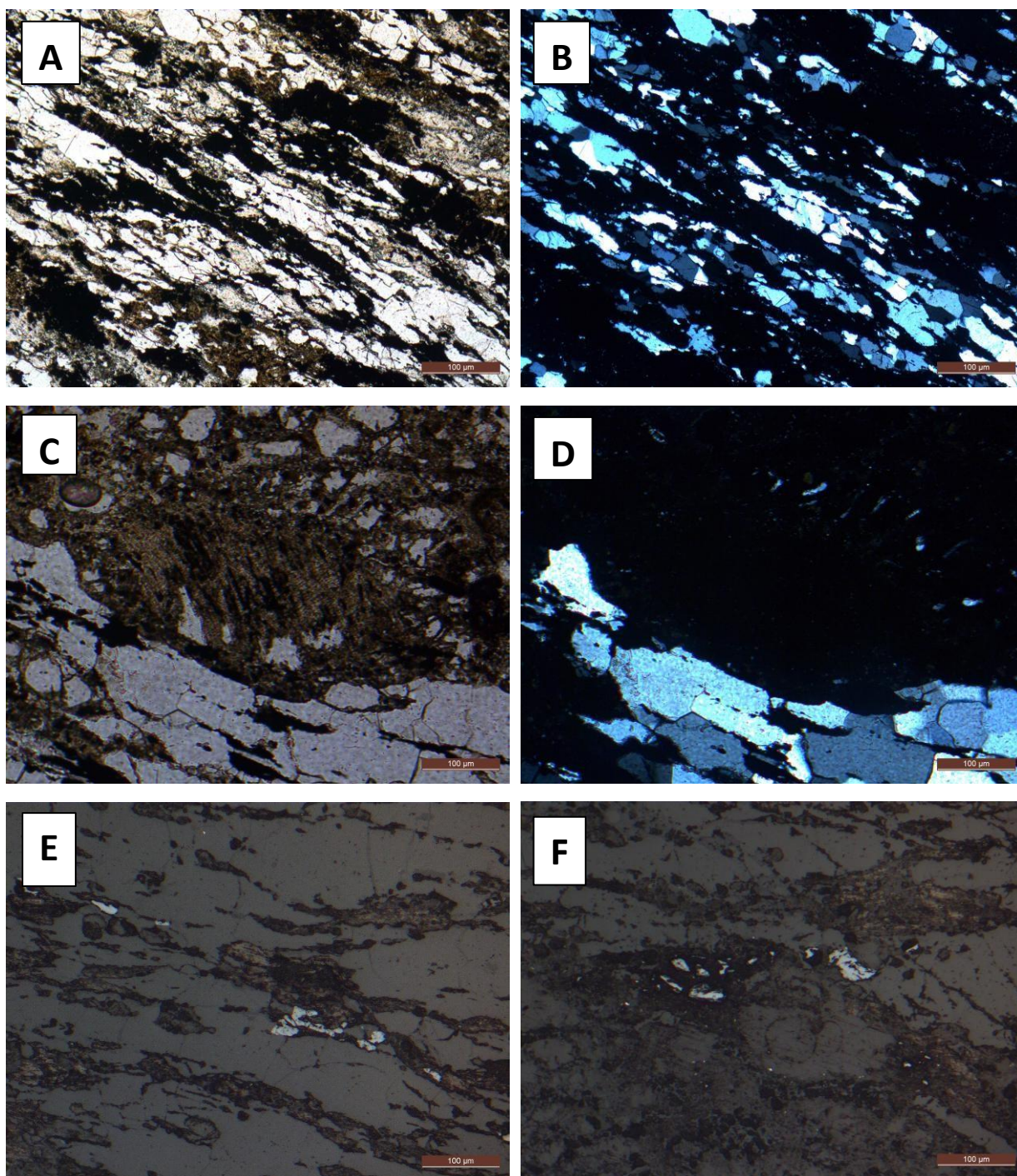
**Fig.6.4:** Megascopic image of sample no. **LPA/ G3/GP/ 350**

### **Physical-Morphological Characteristics**

The rock is compact with largely mesocratic with few leucocratic bands. The light coloured mineral is represented by quartz, while the dark minerals are usually graphite and altered ferromagnesian minerals. Graphite occurs as fine intercalations within the leucocratic bands. Tiny shiny flakes of muscovite are also observed.

### **Mineralogical-Petrological Characteristics**

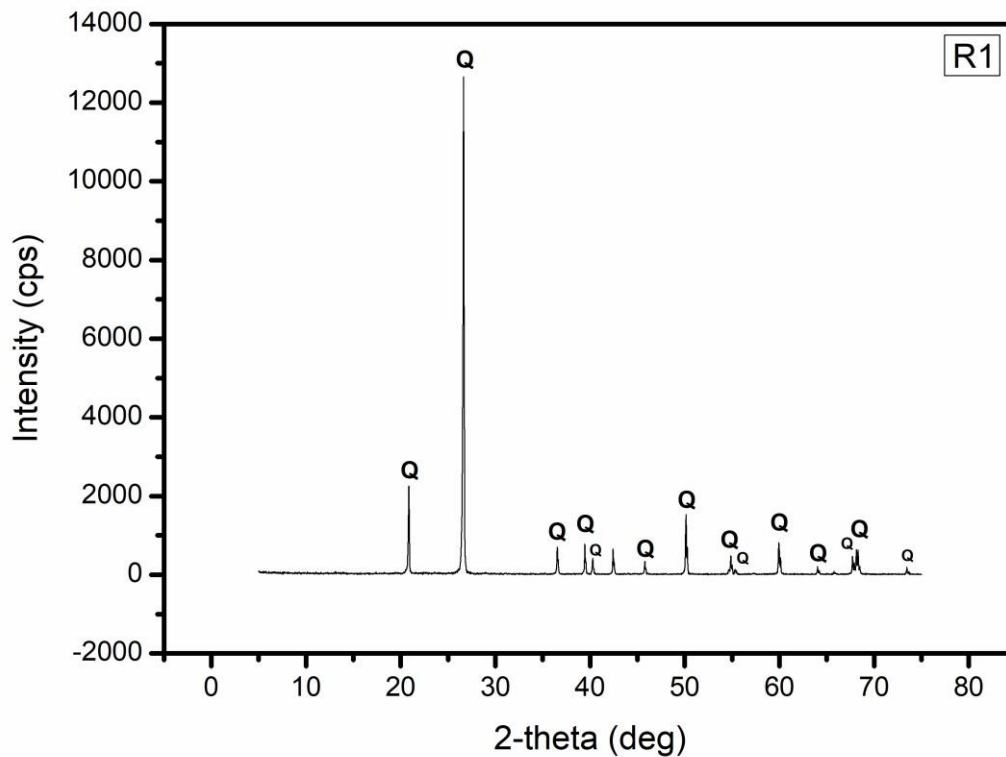
Elongated grains of quartz and graphite are oriented together to give rise to schistose structure (Fig.6.5 A&B). Graphite occurs as thin streaks or strands and often as clumps and clusters (Fig.6.5 C&D). Hematite occurs with graphite and with the silicates (Fig.6.5 E&F).



**Fig.6.5: Optical photomicrographs of sample no. LPA/ G3/GP/ 350**

- A. Oriented grains of quartz and graphite showing schistose structure, 4X PPL
- B. Same as A, 4X CN
- C. Elongated crystals of quartz oriented along with graphite flakes, 10X PPL
- D. Same as C, 10X CN
- E. Elongated grains of graphite in proximity to hematite inclusion within graphite RL 10X
- F. Blebs of hematite within silicate backdrop and graphite RL 10X

B



**Fig. 6.6: XRD pattern of sample no. LPA/ G3/GP/ 350**

### Interpretation:

The rock is made up of quartz accompanied by graphite. Petrographic study shows that the rock is made up majorly of quartz and some graphite. Broad Lithology: The sample represents a part of **Quartz Graphite Schist**.





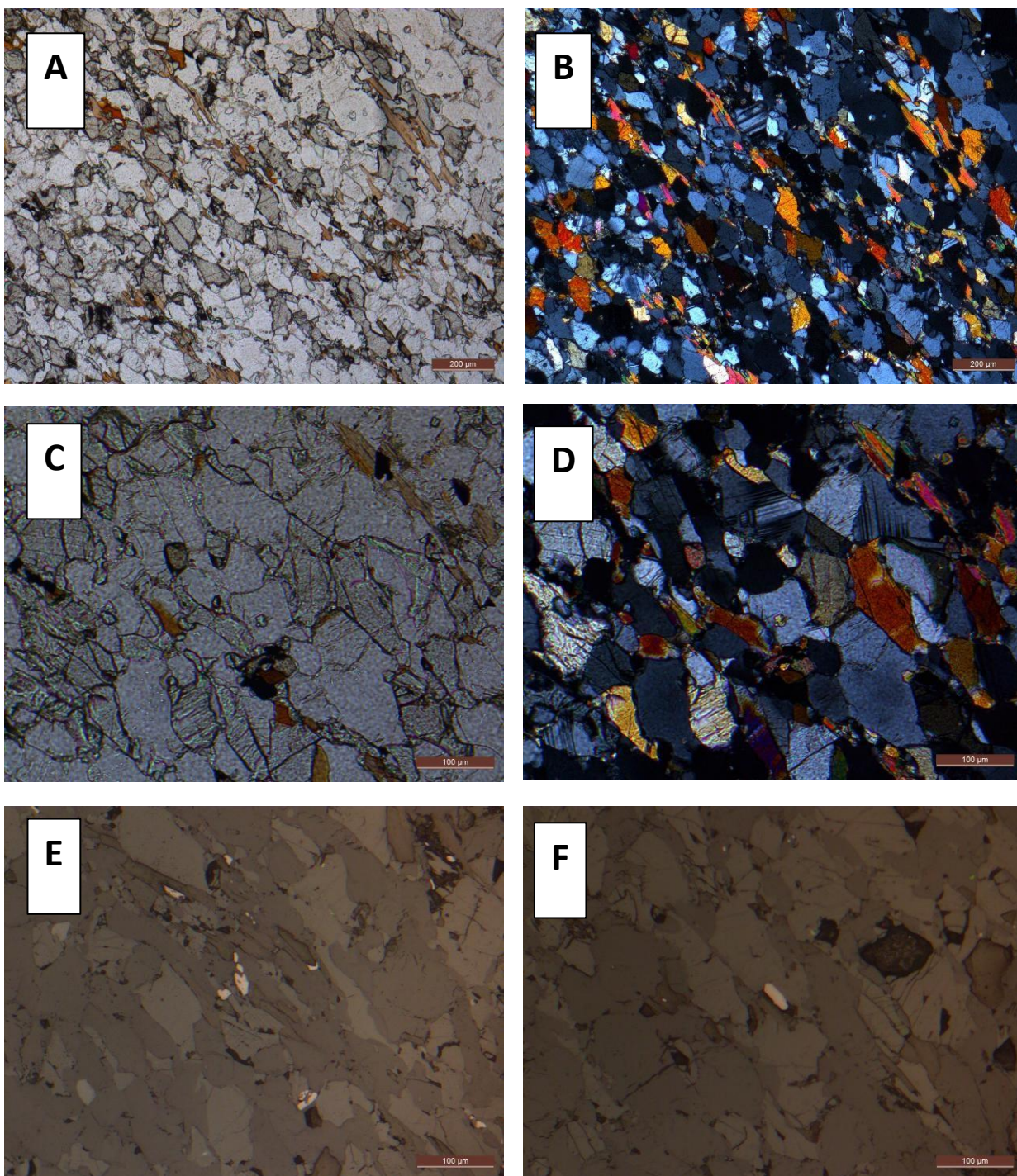
**Fig.6.7: Megascopic image of sample no. LPA/ G3/GP/ 644**

### **Physical-Morphological Characteristics**

The sample is hard, with alternate bands of light and greyish white and dark grey minerals. It is chiefly constituted of quartz with few feldspars and mica. A few ferromagnesian minerals along with garnet are present. Graphite mineralisation is not evident.

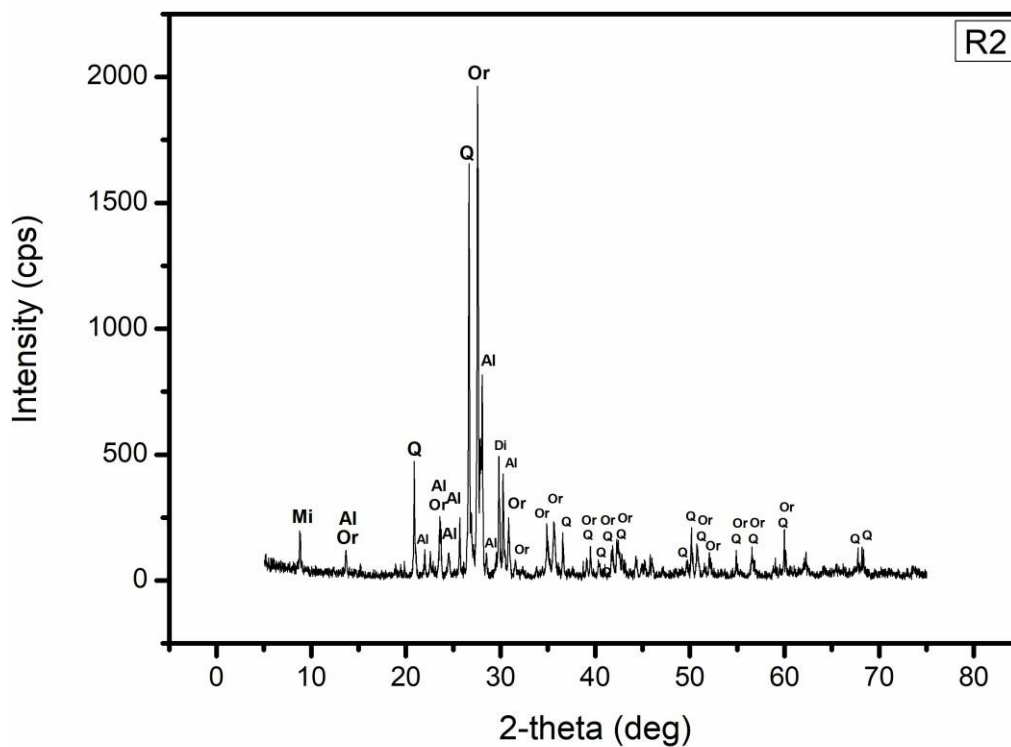
### **Mineralogical-Petrological Characteristics**

The rock is made up of quartz, altered feldspar, hypersthene and biotite along with garnet (Fig.6.8 A&B). However, no incidence of graphite is reported (Fig.6.8 C&D). The ore minerals found in the rock are hematite and euhedral grains of ilmenite (Fig.6.8 E&F).



**Fig.6.8: Optical photomicrographs of sample no. LPA/ G3/GP/ 644**

- A. General microstructure showing quartz, feldspar, biotite and hypersthene, 4X PPL
- B. Same as A, 4X CN
- C. Quartz, feldspar, biotite and hypersthene but no graphite, 10X PPL
- D. Same as C, 10X CN
- E. Grains of hematite within silicates RL 10X PPL
- F. Euhedral grain of ilmenite within silicates RL 10X PPL



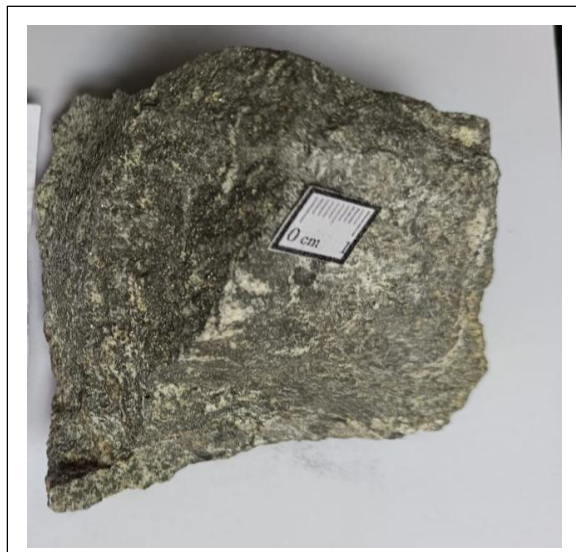
**Fig.6.9:** XRD pattern of sample no. **LPA/ G3/GP/ 644**

**Or: Orthoclase; Mi: Mica; Al: Albite; Q: Quartz; Di: Diopside**

### **Interpretation:**

The sample is made up quartz, hypersthene, biotite, plagioclase and orthoclase. A few grains of garnet may be present. No incidence of graphite is reported in the sample. The rock sample may be identified as **Charnockite**.





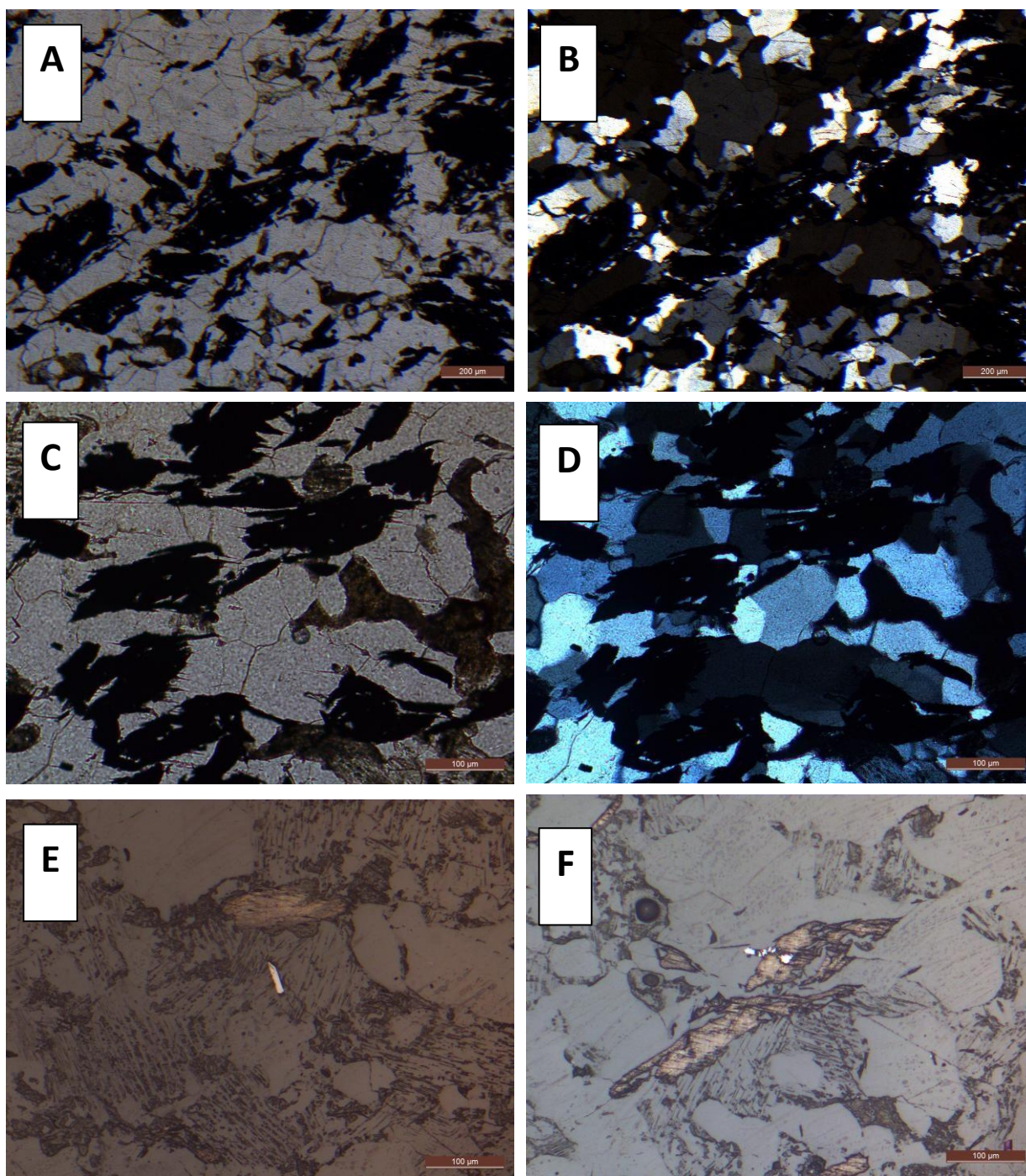
**Fig.6.10:** Megascopic image of sample no. **LPA/ G3/GP/ 939A**

### **Physical-Morphological Characteristics**

The rock is made up of light and dark coloured minerals usually coarse grained demonstrating granulose structure. It is constituted of quartz, feldspar, garnet, hypersthene and often graphite.

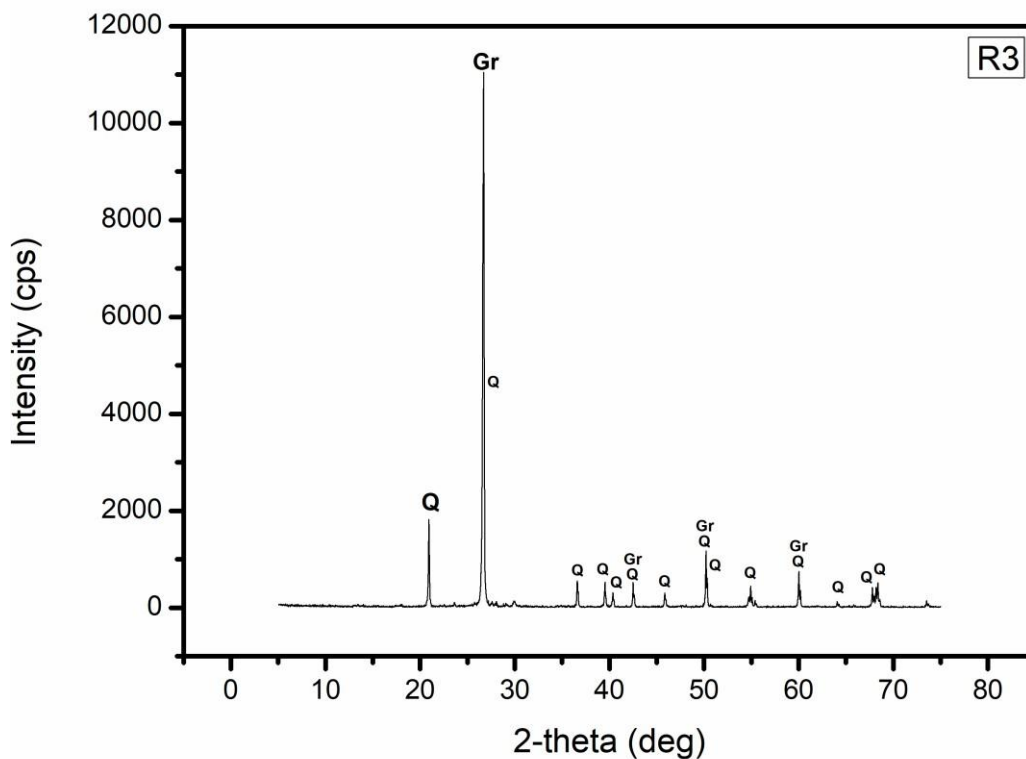
### **Mineralogical-Petrological Characteristics**

The rock sample is constituted of quartz along with tufts of graphite (Fig. 6.11A&B). Short graphite strands occur with quartz and hypersthene (Fig. 6.11C&D). The ore minerals are usually ilmenite and hematite (Fig. 6.11E&F).



**Fig.6.11: Optical photomicrographs of sample no. G3 LPA/ G3/GP/ 939A**

- A. Quartz along with tufts of graphite, 4X PPL
- B. Same as A, 4X CN
- C. Graphite strands with quartz and hypersthene, 10X PPL
- D. Same as C, 10X CN
- E. A grain of ilmenite in proximity to graphite inclusion within quartz RL 10X
- F. Few grains of hematite embedded within graphite as fracture fillings RL 10X

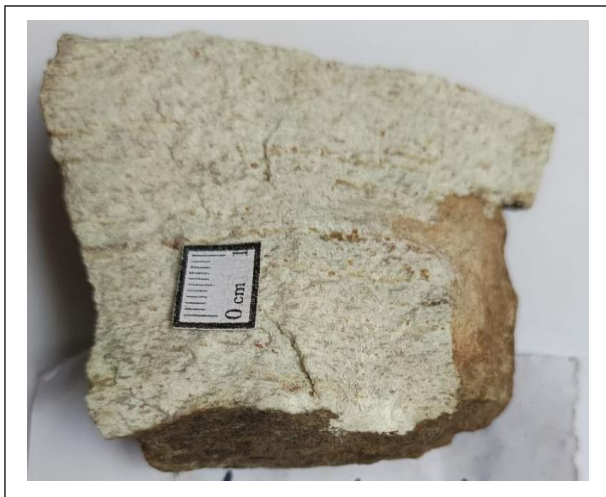


**Fig. 6.12:** XRD pattern of sample no. **G3 LPA/ G3/GP/939A**

**Q: Quartz; Gr: Graphite**

#### **Interpretation:**

The rock is made up of quartz and hypersthene with copious amount of graphite. Petrographic study shows that the ore minerals are ilmenite and hematite. Broad Lithology: The rock sample may be identified as **Quartz Graphite Schist**.



**Fig.6.13:** Megascopic image of sample no. **LPA/ G3/GP/ 1107**

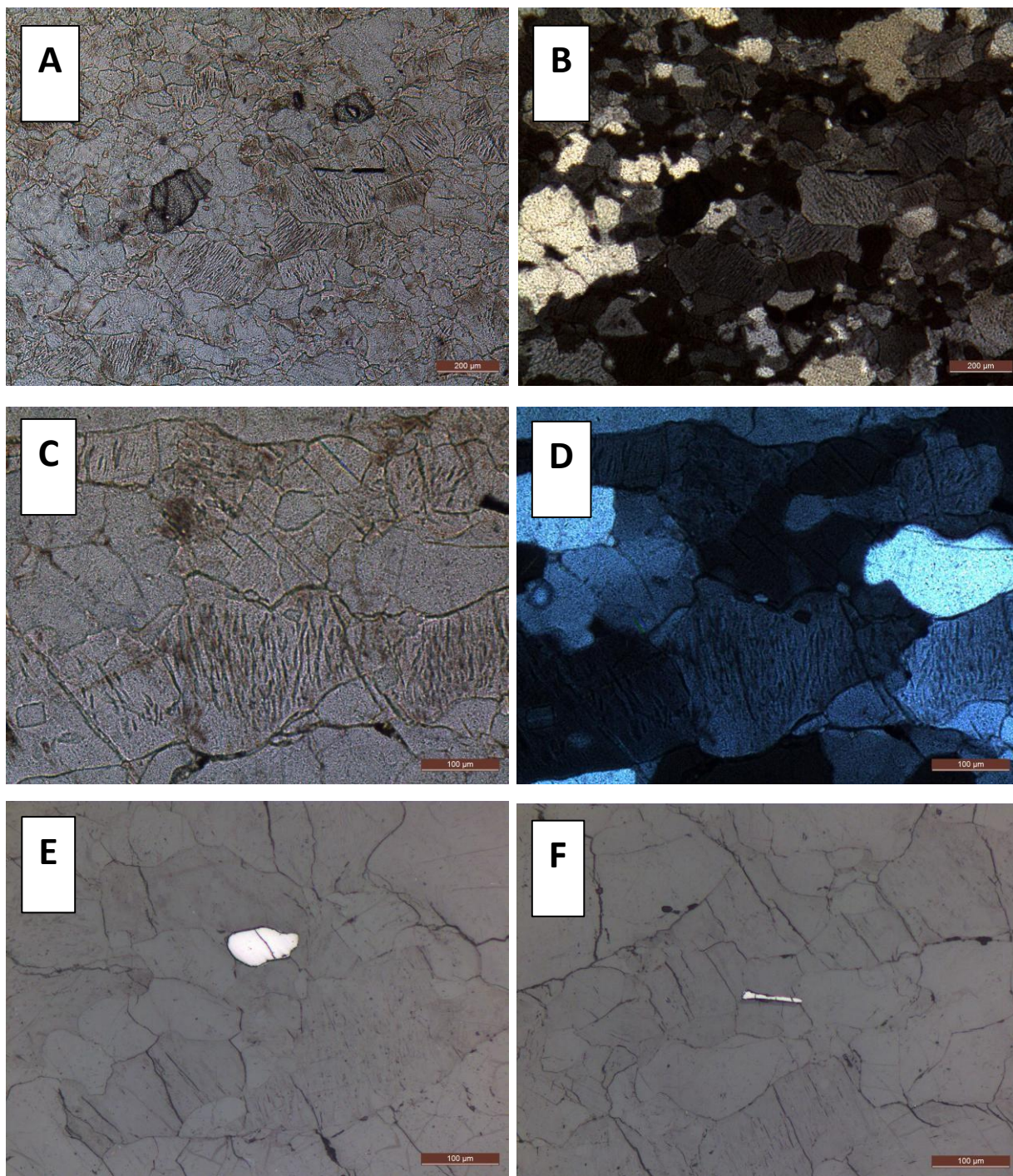
### **Physical-Morphological Characteristics**

The rock is white and is hard and compact. The minerals identified are quartz, feldspar, sillimanite and garnet. Muscovite appears as shiny flakes. Evidence of graphite is not observed.

### **Mineralogical-Petrological Characteristics**

The sample shows interlocked grains of hypersthene, quartz, feldspar and garnet (Fig. 6.14 A&B). Quartz, altered feldspar along with hypersthene somewhat altered are held together in a close fit (Fig. 6.14 C&D). The rock sample contains hematite within silicates (Fig. 6.14 E). Needle shaped crystal of ilmenite are also reported (Fig. 6.14 F).

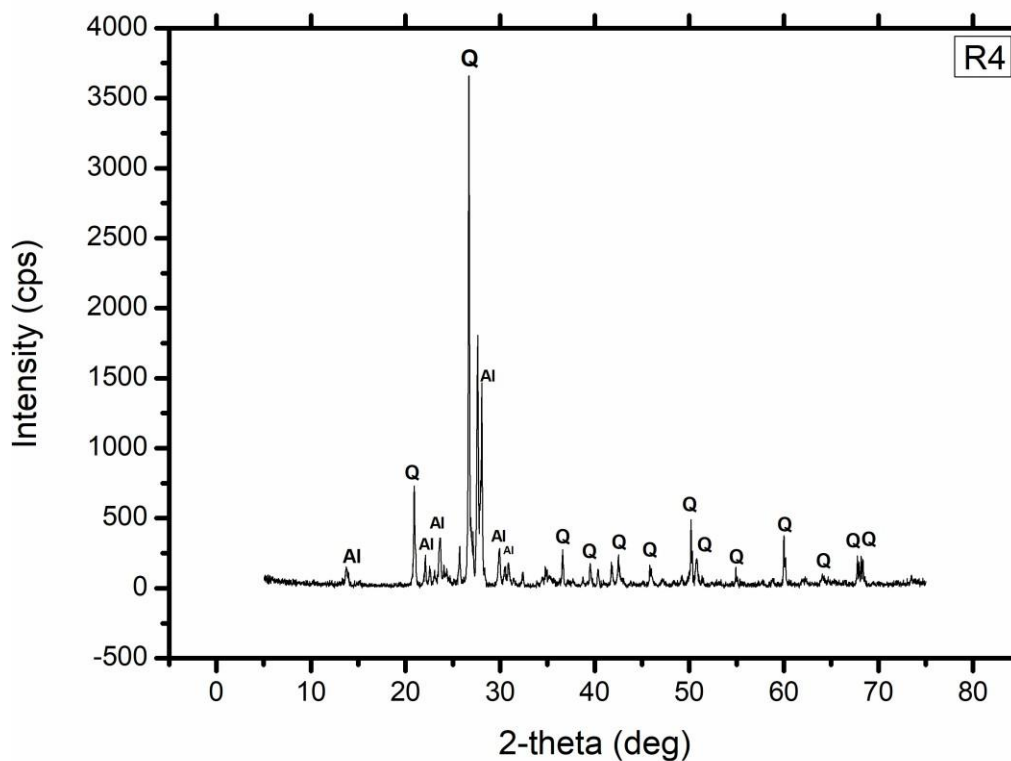




**Fig.6.14: Optical photomicrographs of sample no. LPA/ G3/GP/ 1107**

- A. Interlocked grains of hypersthene, quartz, feldspar and garnet, 4X CN
- B. Same as A, 4X CN
- C. Quartz, altered feldspar along with altered hypersthene, 10X PPL
- D. Same as C, 10X CN
- E. A fractured grain of hematite within silicates RL 10X
- F. A needle shaped crystal of ilmenite within silicates RL 10X





**Fig. 6.15:** XRD pattern of sample no. **LPA/ G3/GP/ 1107**

**Q: Quartz; Al: Albite**

### **Interpretation:**

Petrographic study of the sample and substantiated by XRD studies show that the rock sample is constituted of quartz, feldspar, hypersthene and quartz. The sample represents a part of **Leptynite**.



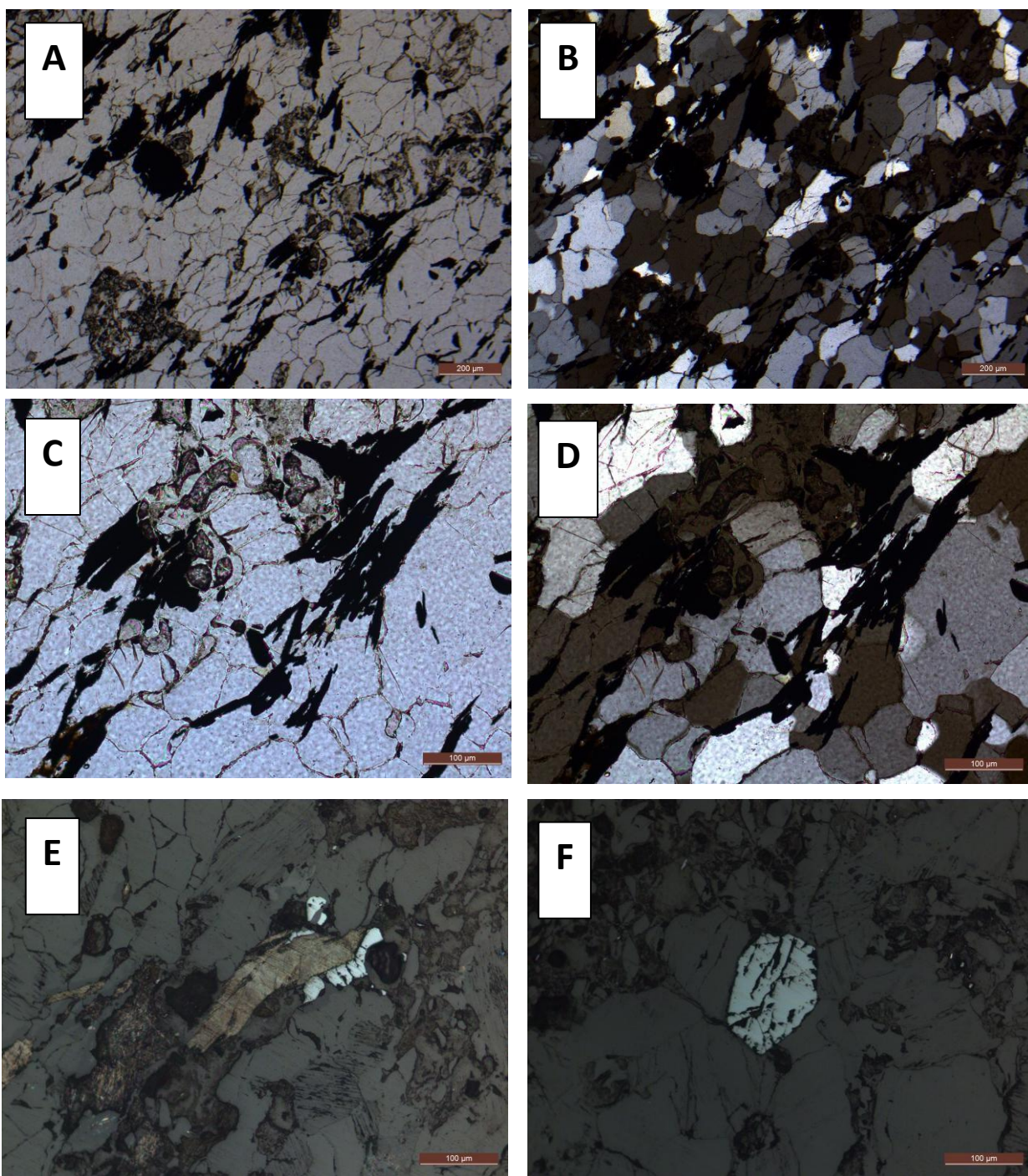
**Fig.6.16:** Megascopic image of sample no. **LPA/ G3/GP/ 1216**

### **Physical-Morphological Characteristics**

The sample is made up of alternate dark and light coloured bands, often the bands assume brown colour due to limonite solution. Streaks of graphite are observed within quartz and feldspar. The dark coloured minerals are ferromagnesian minerals. Garnet and graphite are evident.

### **Mineralogical-Petrological Characteristics**

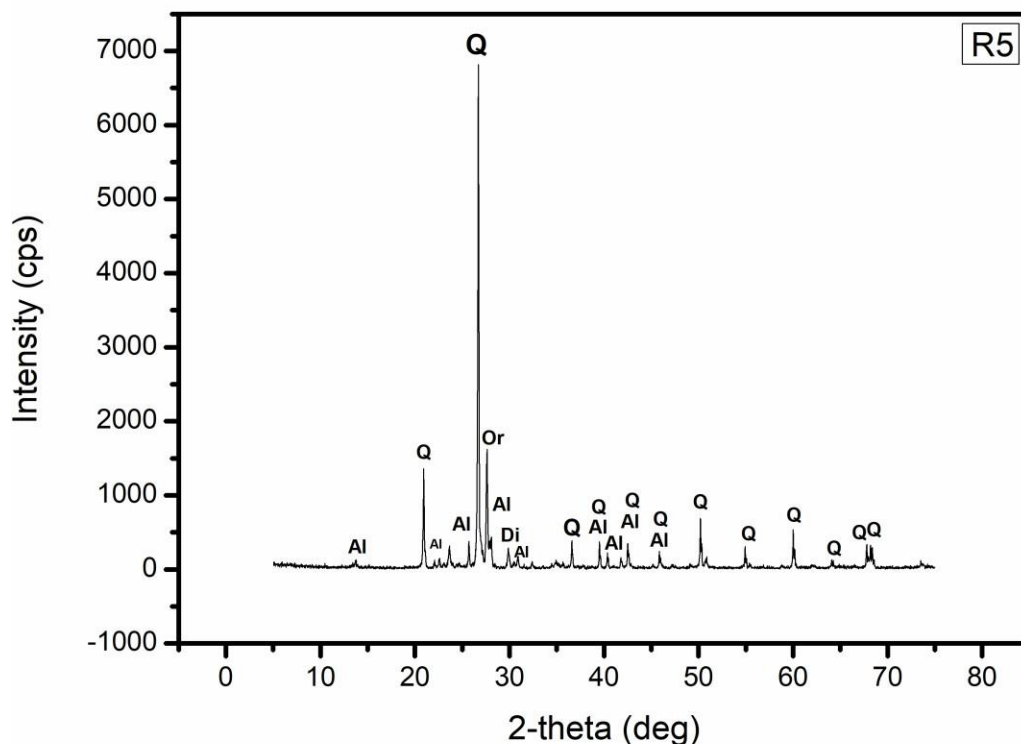
Intimately interlocked grains of quartz, garnet and graphite form the petrography of the rock specimen (Fig.6.17 A&B). Stretched and elongated sheafs of graphite along with quartz is observed (Fig.6.17 C&D). Hematite occurs as crystals partially encircling sheafs of graphite or as independent euhedra (Fig.6.17 E&F).



**Fig.6.17 Optical photomicrographs of sample no. LPA/ G3/GP/ 1216**

- A. Interlocked grains of quartz, graphite and garnet, 4X PPL
- B. Same as A, 4X CN
- C. Graphite fibres emebded within quartz, 10X PPL
- D. Same as C, 10X CN
- E. Hematite grains in contact with graphite sheafs RL 10X
- F. Large pitted euhedra of hematite with graphite inclusion RL10X





**Fig.6.18:** XRD pattern of sample no. **LPA/ G3/GP/ 1216**

**Q: Quartz; Al: Albite; Di: Diopside**

#### **Interpretation:**

Graphite occurs as bundle of fibers and as sheafs along with quartz, plagioclase and garnet in the rock. The feldspar is few and wide part. Feldspars have occasionally altered to kaolinite. The rock is basically made up of quartz, feldspar, garnet and graphite. Broad Lithology: The sample represents graphite in **Granite Gneiss**.



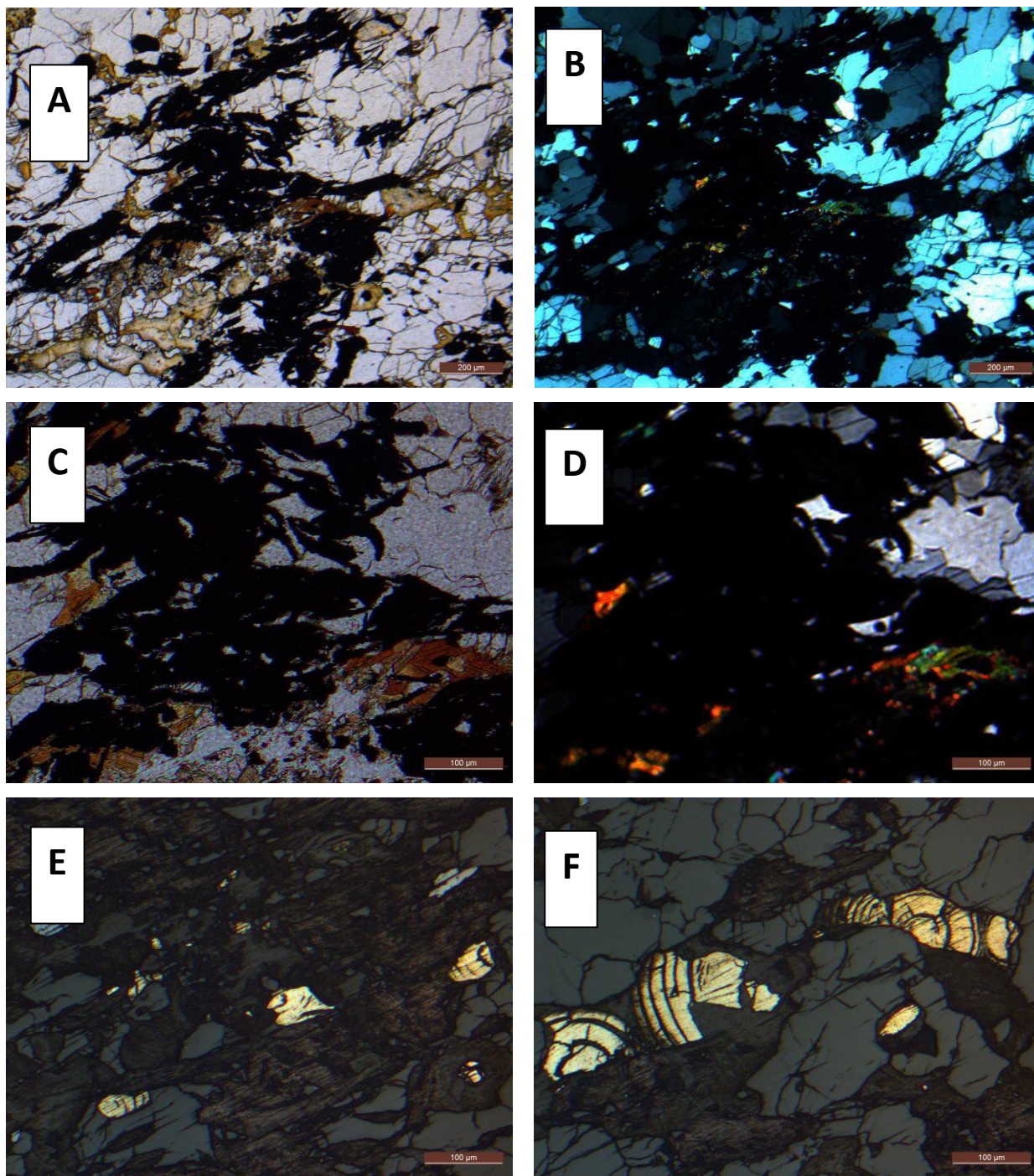
**Fig.6.19:** Megascopic image of sample no. **LPA/ G3/GP/ 10A**

### **Physical-Morphological Characteristics**

The rock is hard and massive and shows gneissose structure. The sample is made up of dark grey to dark grains of pyroxene (hypersthene), quartz, feldspar and flakes of mica. Pyroxene occurs along with copious amount of graphite.

### **Mineralogical-Petrological Characteristics**

The rock sample is made up of grains of quartz, biotite and graphite flakes arranged in enechelon pattern (Fig.6.20 A&B). Tuffts of graphite occur as clusters and sheafs in association with biotite and quartz (Fig.6.20 C&D). Pyrite is found embedded within graphite (Fig.6.20E) and usually shows zoning and colloform banding (Fig.6.20F).

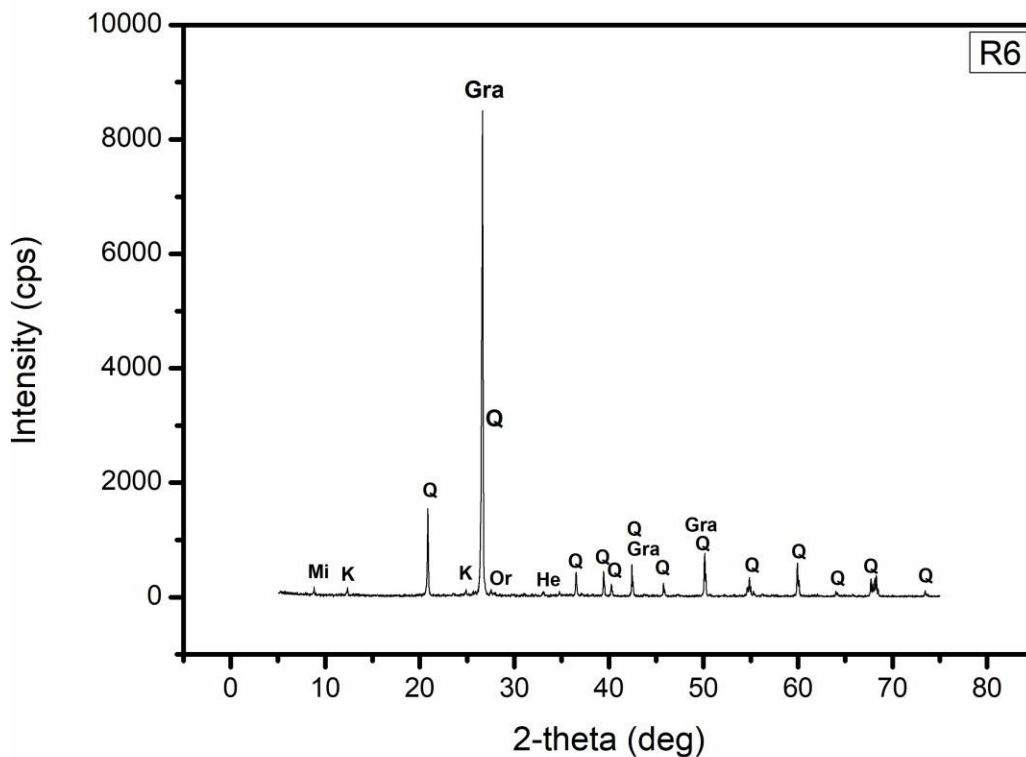


**Fig.6.20 Optical photomicrographs of sample no. LPA/ G3/GP/ 10A**

- A. Enechelon patterns of graphite and biotite along with quartz, 4X PPL
- B. Same as A, 4X CN
- C. Tufts of graphite in association with biotite and quartz, 10X PPL
- D. Same as C, 10X CN



- E. Pyrite grains in association with graphite strands RL 10X
- F. Pyrite showing zoning and colloform banding RL10X

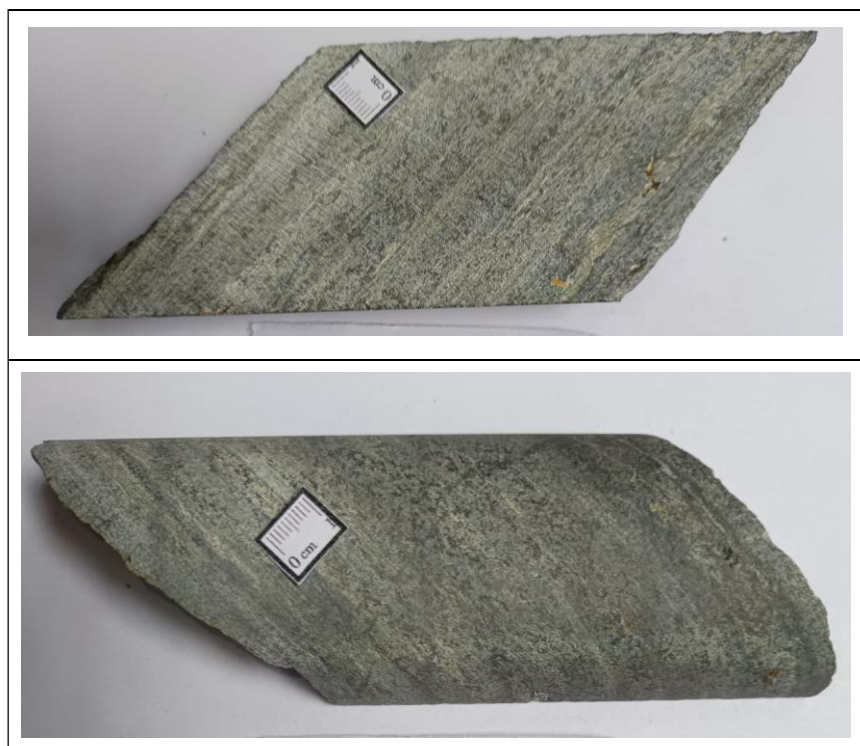


**Fig. 6.21:** XRD pattern of sample no. **LPA/ G3/GP/ 10A**

**He: Hematite; Q: Quartz; Mi: Mica; K: Kaolinite; Gra: Graphite**

### **Interpretation:**

The rock sample is made of up of quartz, biotite, kaolinite i.e., altered from felspar and abundant sheafs of graphite. The petrographical study supplemented by XRD analysis suggests the presence of hematite and mica. The rock from its mineral assemblage and texture may broadly be best described as alternate schistose bands of graphite and granulose bands of quartz and feldspar in **Graphite Gneiss**.



**Fig.6.22:** Megascopic image of sample no. **LPA/G3/GP/11A**

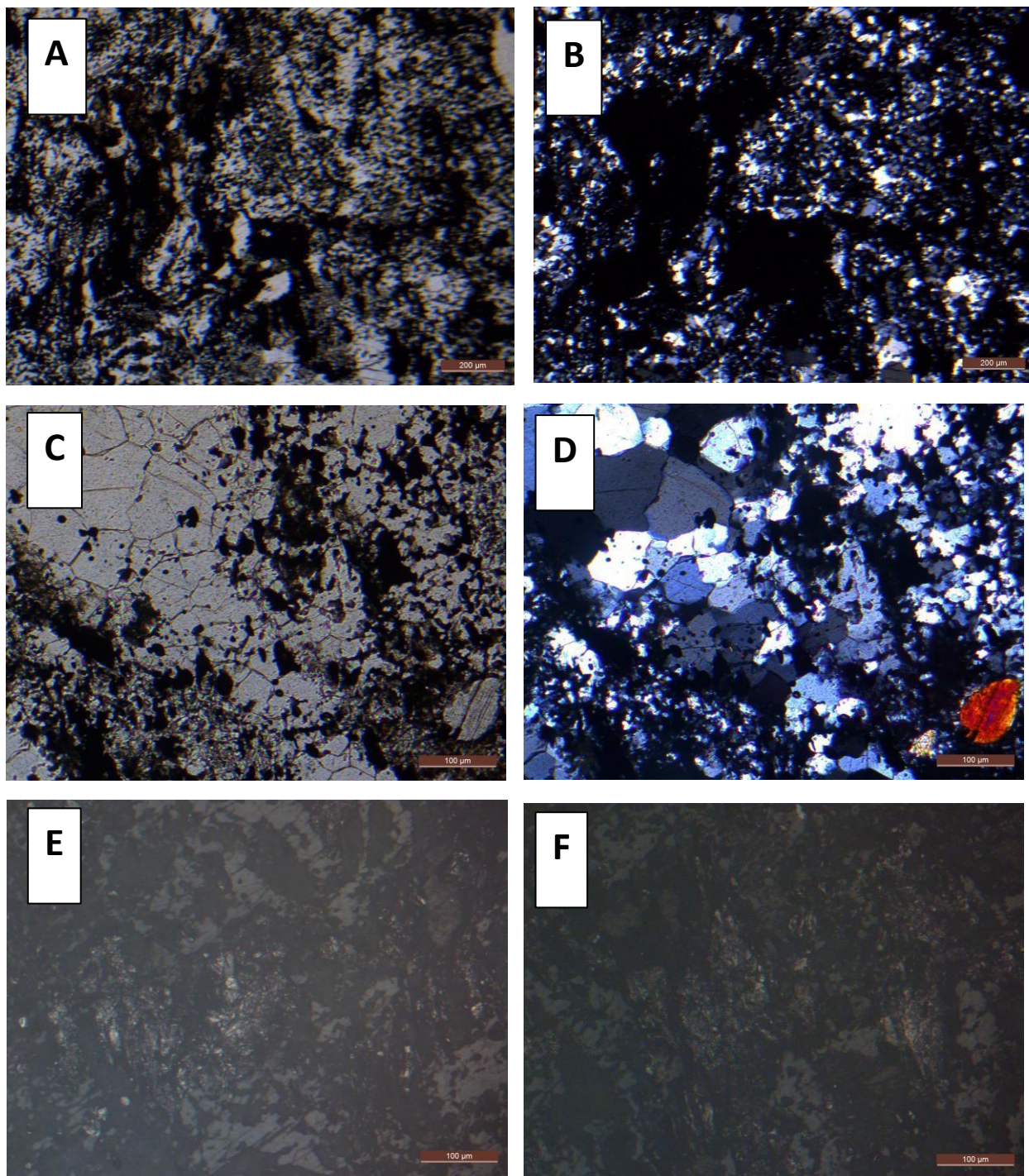
### **Physical-Morphological Characteristics**

The rock is hard and massive and is fine grained. It is greyish green. A few talc veins are observed. The sample is made up of dark grey to dark grains of pyroxene (hypersthene), quartz, feldspar and flakes of mica. Chlorite might have formed after hypersthene.

### **Mineralogical-Petrological Characteristics**

The rock sample is made up of tiny grains of quartz embedded within clays (Fig.6.23 A&B). Also some flakes of biotite is found embedded within clays (Fig.6.23 C&D). Pyrite occurs as fine dust and specks within the silicates but presence of graphite is not evident (Fig.6.23 E & F).

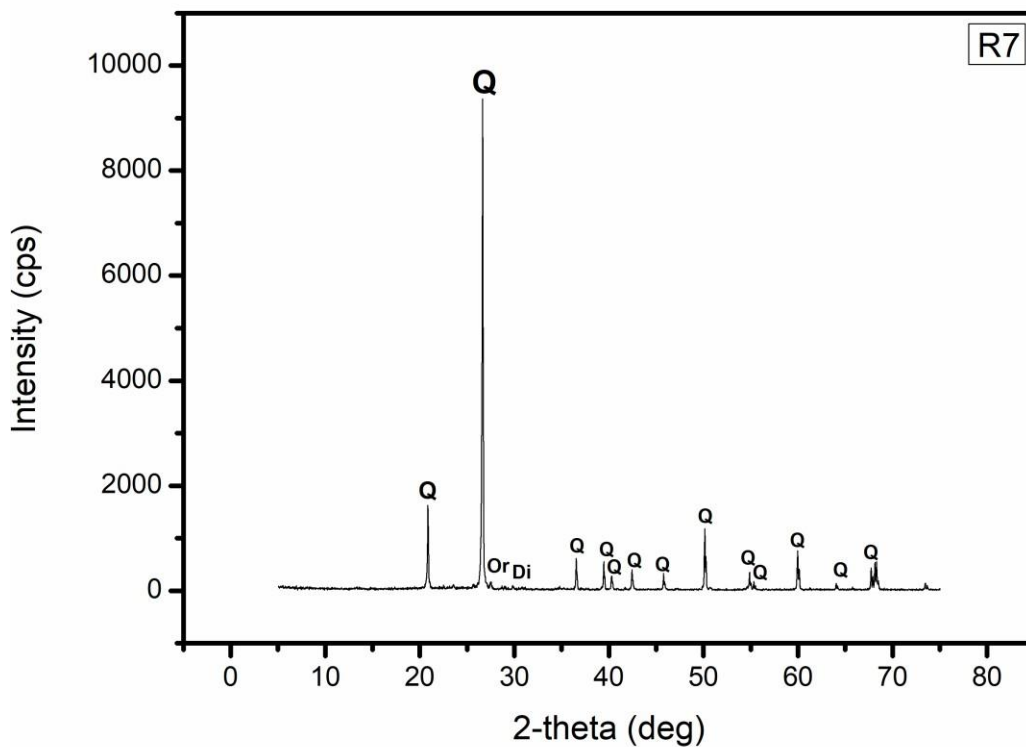




**Fig.6.23** Optical photomicrographs of sample no. LPA/ G3/GP/ 11A

- A. Tiny grains of quartz embedded within clay, 4X PPL
- B. Same as A, 4X CN
- C. Quartz and biotite within clay, 10X PPL
- D. Same as C, 10X CN

- E. Pyrite occurs as fine dust within a silicate backdrop, RL 10X
- F. Pyrite occurs as fine dust, RL10X

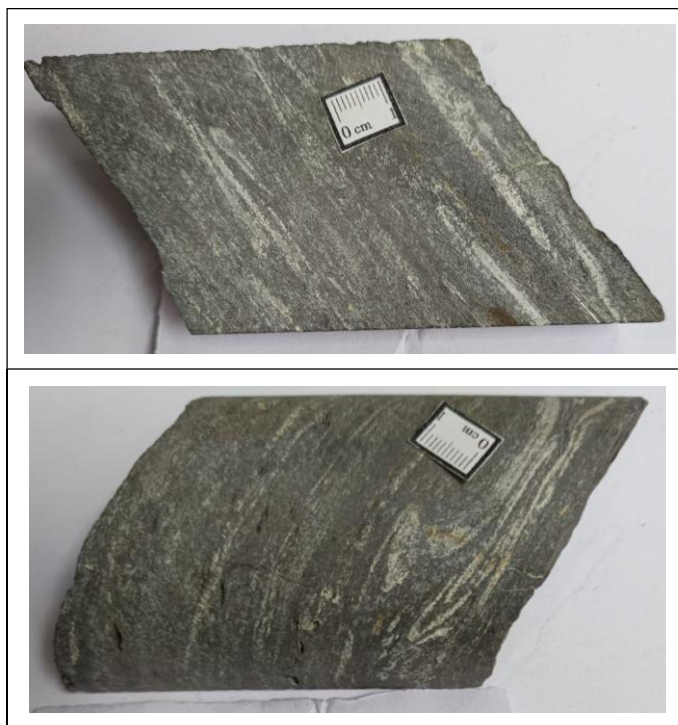


**Fig. 6.24:** XRD pattern of sample no. **LPA/ G3/GP/ 11A**

**Q: Quartz; Di: Diopside; Or: Orthoclase**

### **Interpretation:**

The rock sample is constituted of very fine grains of quartz, within a clayey groundmass. Pyrite also occurs as dusts and specks. Presence of graphite is not evident. The rock from its texture and mineral assemblage may broadly be best described as **Granite Gneiss**.



**Fig.6.25:** Megascopic image of sample no. **LPA/ G3/GP/12A**

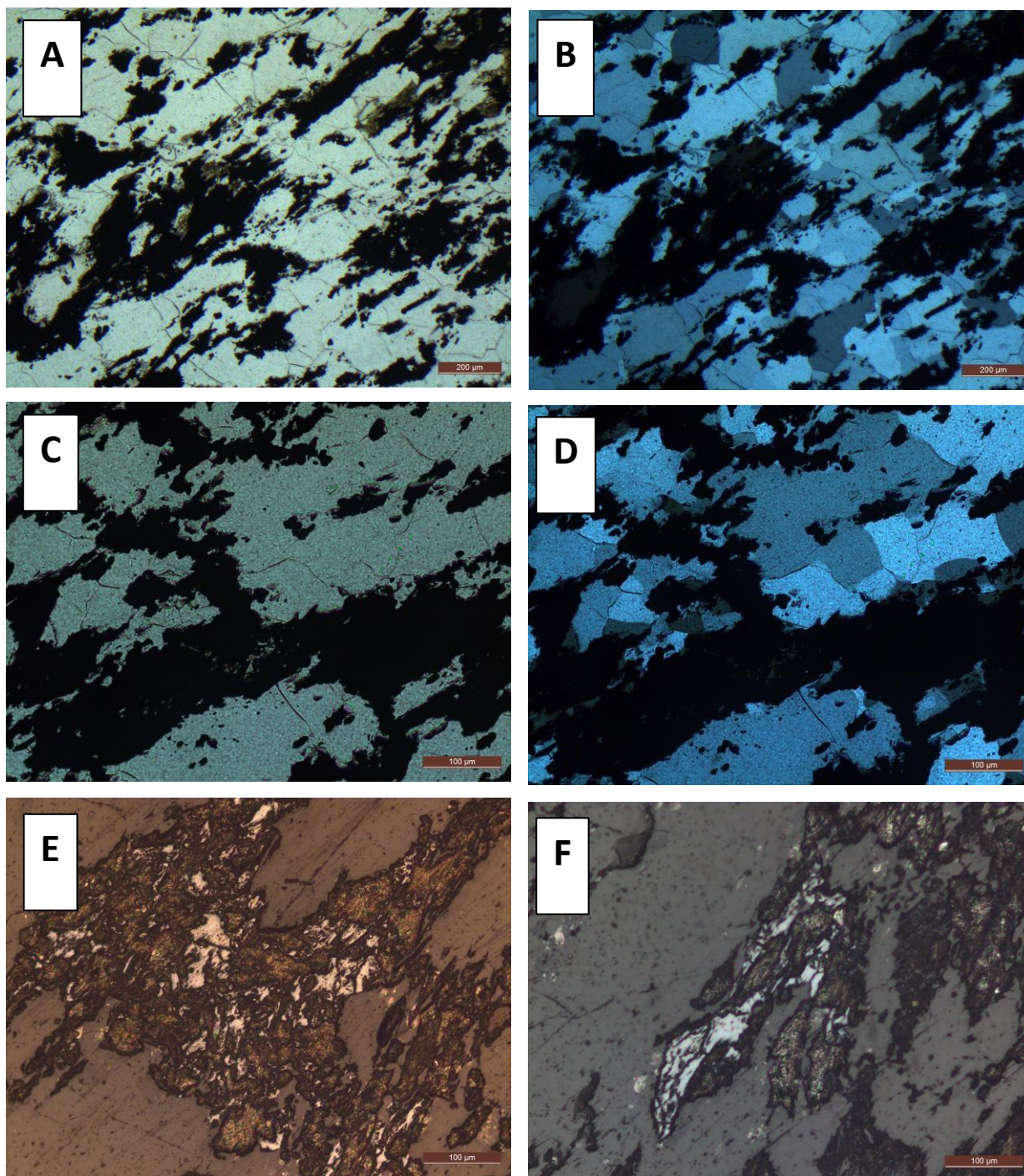
### **Physical-Morphological Characteristics**

The rock is hard and massive and is very fine grained. The sample is made up of dark grey to black grains of pyroxene (hypersthene), feldspar and copious amount of graphite. Talc and chlorite are present as altered derivatives of ferromagnesian minerals.

### **Mineralogical-Petrological Characteristics**

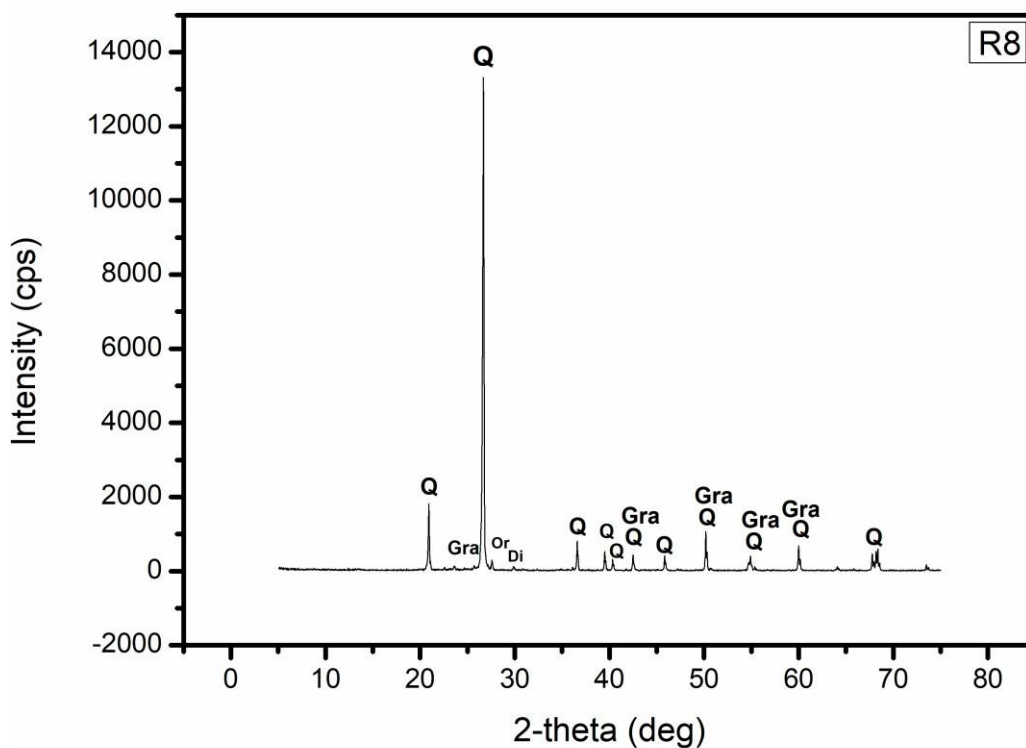
The rock sample shows that graphite in copious proportion intertwined with quartz (Fig.6.26 A&B). Thick bands of graphite as strands are also observed filling the intergranular space between quartz (Fig.6.26 C&D). Fine disseminations of hematite and pyrite within graphite are ubiquitous (Fig.6.26 E & F).





**Fig.6.26 Optical photomicrographs of sample no. LPA/ G3/GP/12A**

- A. Graphite intertwined with quartz inclusions, 4X PPL
- B. Same as A, 4X CN
- C. Thick tufts of graphite filling the intergranular space between quartz, 10X PPL
- D. Same as C, 10X CN
- E. Disseminations of hematite within graphite RL 10X
- F. Pyrite replacing graphite, RL10X



**Fig. 6.27:** XRD pattern of sample no. **LPA/ G3/GP/12A**

**Q: Quartz; Or: Orthoclase; Gra: Graphite; Di: Diopside**

### **Interpretation:**

The rock sample is made up of elongated grains of quartz, and feldspar with copious amount of graphite strands. The rock from its texture and structure and mineral assemblage may broadly be best described as **Quartz Graphite Schist**.



**Fig.6.28:** Megascopic image of sample no. **LPA/ G3/GP/ 13A**

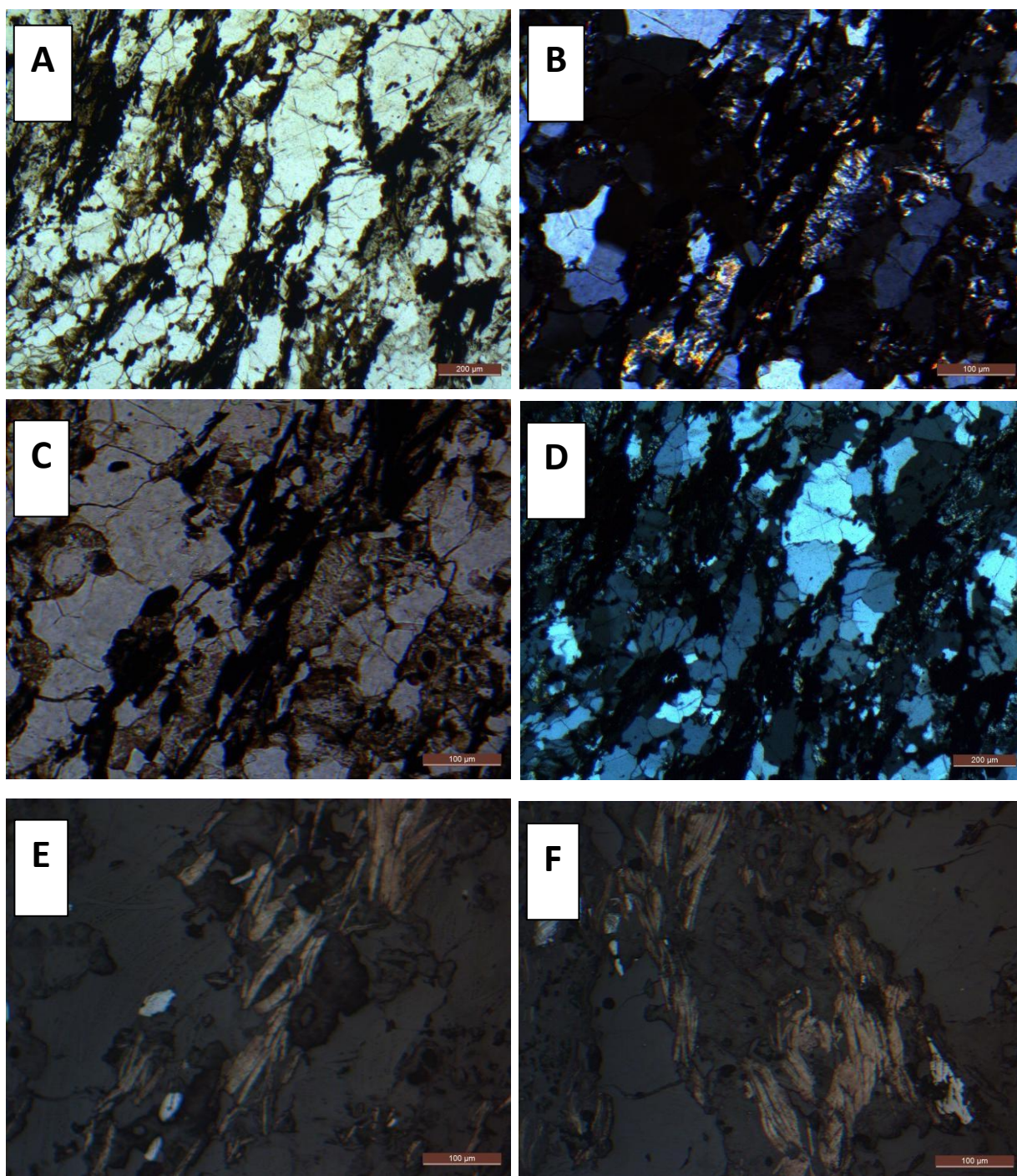
### **Physical-Morphological Characteristics**

The rock is hard and massive and shows orbs of quartz boudins within a fine grained matrix of ferromagnesian minerals. The minerals identified are plagioclase, quartz, hypersthene and chlorite. Pyrite and graphite occur as fine streaks.

### **Mineralogical-Petrological Characteristics**

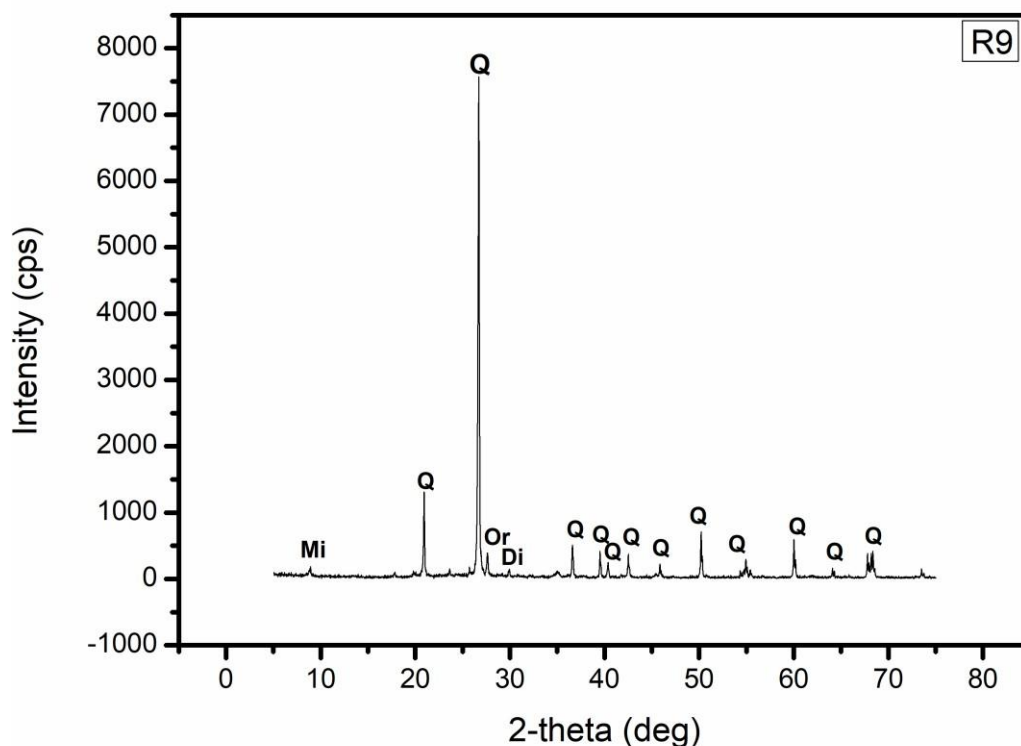
The petrography is made up of graphite in the intergranular space in quartz with occasional biotite, (Fig.6.29 A&B). Graphite occurs as strands and clusters amidst quartz crystals (Fig.6.29 C&D). Few grains of hematite crystals are embedded within graphite fibres (Fig.6.29 E & F).





**Fig.6.29 Optical photomicrographs of sample no. LPA/ G3/GP/ 13A**

- A. Graphite filling up the intergranular space in quartz with occasional biotite, 4X PPL
- B. Same as A, 4X CN
- C. Quartz with graphite fibres, 10X PPL
- D. Same as C, 10X CN
- E. Hematite crystals within graphite strands RL 10X
- F. Strings of hematite crystals within graphite, RL 10X



**Fig. 6.30:** XRD pattern of sample no. **LPA/ G3/GP/ 13A**

**Q: Quartz; Mi: Mica; Or: Orthoclase; Di: Diopside**

### **Interpretation:**

The rock sample is made of quartz, orthoclase, pyroxene and graphite. Graphite occur as thick and stout strands or as thin emaciated fibres. The ore mineral present is hematite. The rock from its texture and structure and mineral assemblage may broadly be best described as **Quartz graphite schist**.





**Fig.6.31:** Megascopic image of sample no. **LPA/ G3/GP/ 14A**

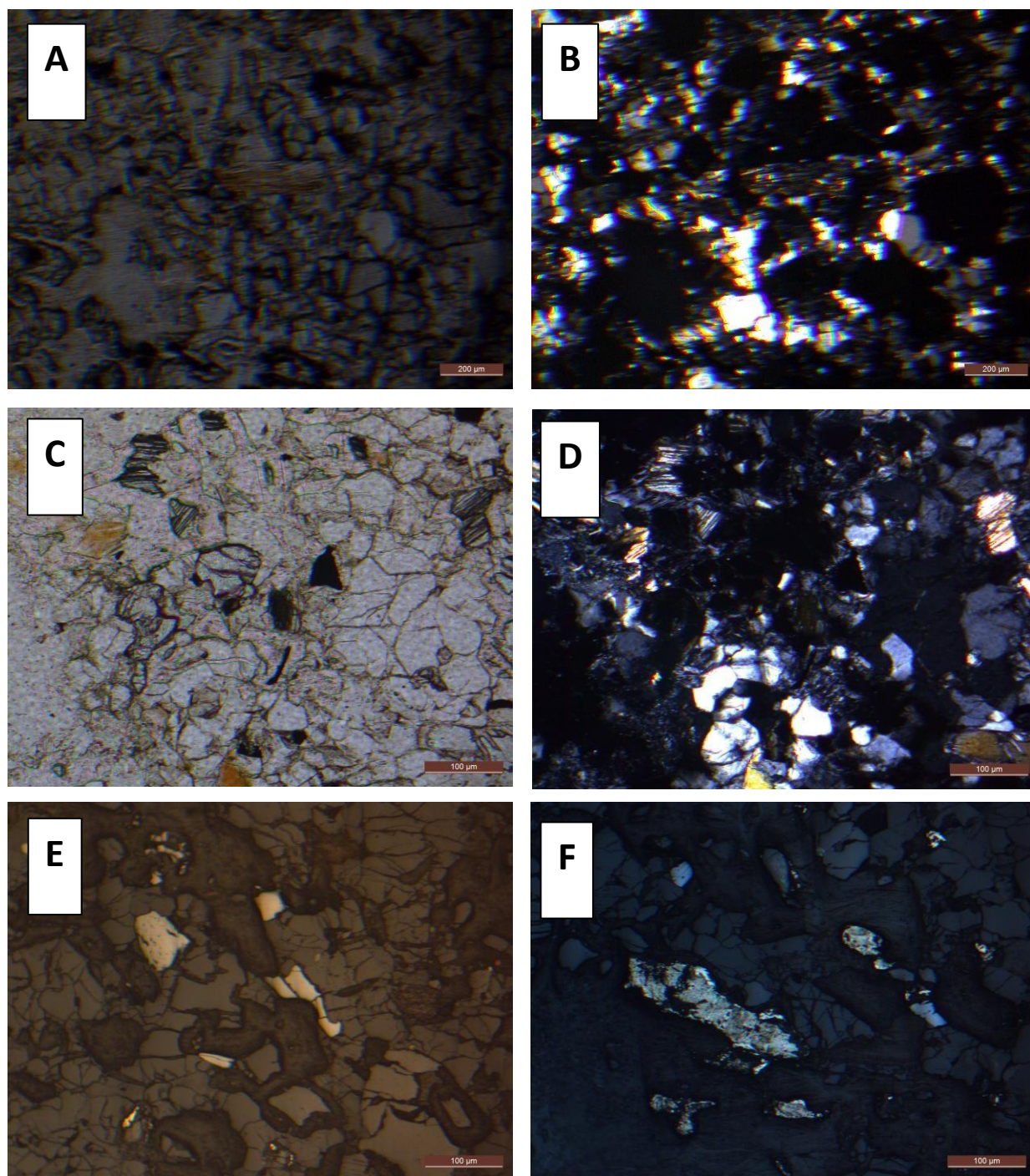
### **Physical-Morphological Characteristics**

The rock is fine grained, hard and massive and shows ferromagnesian minerals along foliation. The minerals identified are plagioclase, quartz, hypersthene and chlorite. Graphite is not discernible in the sample.

### **Mineralogical-Petrological Characteristics**

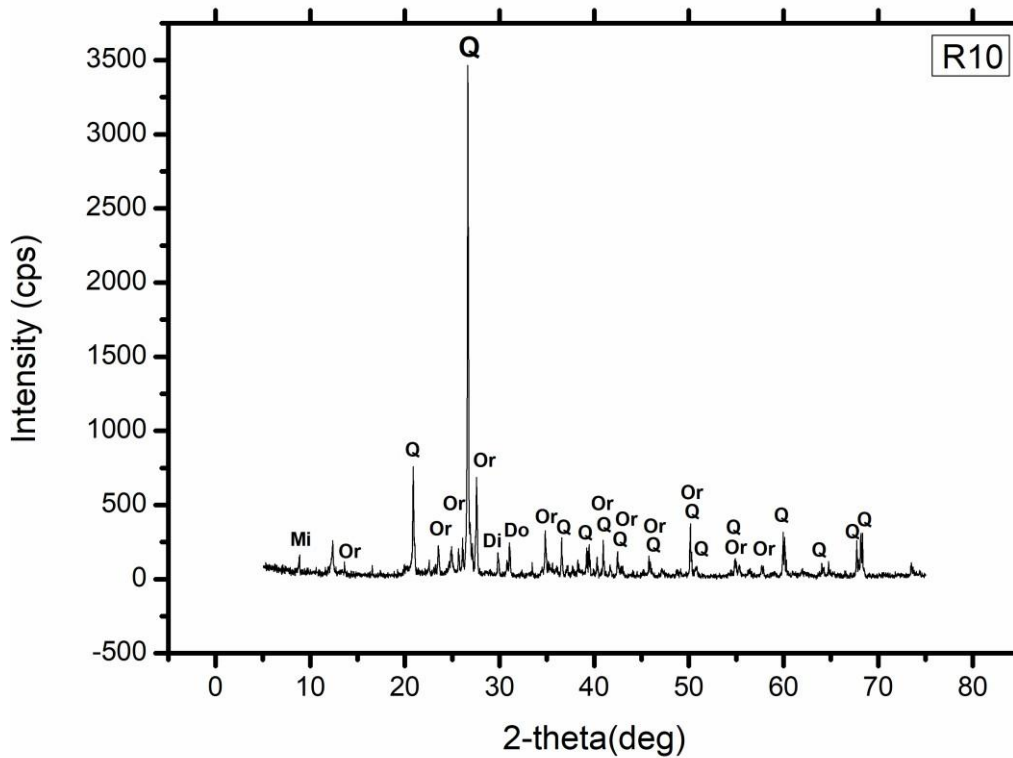
Graphite strands are only a few and emaciated present with quartz (Fig.6.32 A&B). Few strands of graphite with granular quartz, felspar and biotite (Fig.6.32 C&D). Hematite and chalcopyrite occur within a granular mosaic of silicates (Fig. 6.32 E&F).

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**Fig.6.32 Optical photomicrographs of sample no. LPA/ G3/GP/ 14A**

- A. Few fragmentary strands of graphite along with quartz, 10X PPL
- B. Same as C, 10X CN
- C. Few strands of graphite with quartz and feldspar RL 10X
- D. As in E, RL10X, CN
- E. Grains of hematite and chalcopyrite in silicates, RL10X
- F. A few grains of chalcopyrite within silicates RL 10X



**Fig. 6.33:** XRD pattern of sample no. **LPA/ G3/GP/ 14A**

**Q: Quartz; Mi: Mica; Or: Orthoclase; Di: Diopside; Do: Dolomite**

### Interpretation:

The rock sample is made of equant grains of quartz, feldspar, biotite and emaciated strands of graphite giving rise to granulose structure. Hematite and chalcopyrite occur within a granular matrix of silicates. The rock from its texture and structure and mineral assemblage may broadly be best described as **Quartz Schist**.

## 6.1. E Structure

Structure plays a significant role in the graphite location in this terrain. The most common structural features acting as controls are (a) foliation of host rock (b) shear zones, joints, folds and faults (c) lithological contacts and (d) regional lineation direction. Foliation is the most important structural feature controlling the graphite occurrences in EGMB. Graphite schist or lode occurs along with foliation and axial plane of folds. The effects of different fold phases resulting in an interference pattern are distinct at places. In such areas, the graphite ore body appears to be most deceptive. But the graphite is concentrated at fold hinges following the plunge directions and the limb may be thinner and leaner.

The metasedimentaries display well-developed foliation due to preferred orientation of sillimanite, biotite and other platy/flaky minerals. It is also very well developed in garnetiferous granite gneiss, filled up by pegmatite/quartz veins. Foliations have been observed in outcrops of country rocks, which have a general trend of NE-SW direction. But the average dipping amount is  $40^{\circ}$  to  $70^{\circ}$  towards SE direction. Small scale folding is seen indicating the migmatisation at the contact zone of Granite gneiss and Khondalites. This migmatisation has taken place at the contact of granite gneiss-khondalite margins. Graphite occurs as small veins and disseminates flakes along the weak planes like foliation plane and micro fractures within migmatised gneiss.

Shearing parallel of foliation has developed at many places. However, they cannot be traced for long due to a vast stretch of soil-covered tract. Though, shearing evidenced by mylonitisation and silicification are noticed as well as sulphide mineralisation is observed in graphite schist.



### **Foliation/Gneissosity:**

The most important structural element noted in the area is the foliation which is best displayed in the granite gneiss. Gneissosity is marked by darker bands having more mafic minerals like biotite and hornblende and lighter bands containing felsic minerals like quartz and feldspar. Granite gneiss shows gneissosity in the study area which follows the trend varies from NE-SW and the dipping is  $75^\circ$  in SE direction of the block (Fig. 6.19 B).

### **Joints:**

Two sets of joints are observed in granite gneiss of the study area (Fig. 6.19 A). The trend of one set of joints (J1) is NE-SW, vertical dipping and the trend of other one (J2) is NW-SE, dipping  $60^\circ$  in NE direction near Lamer village of the block.

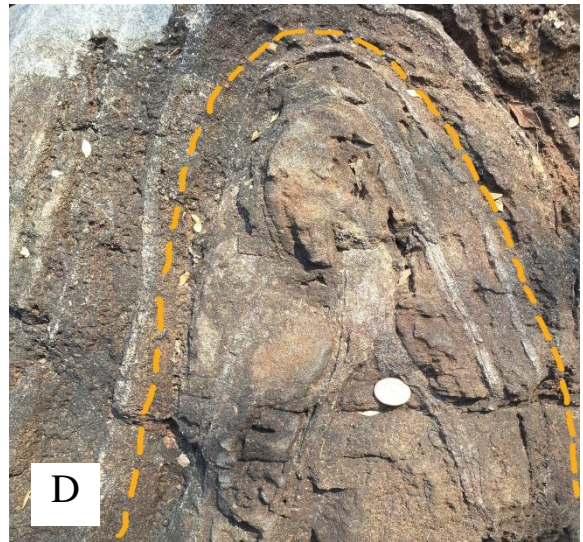
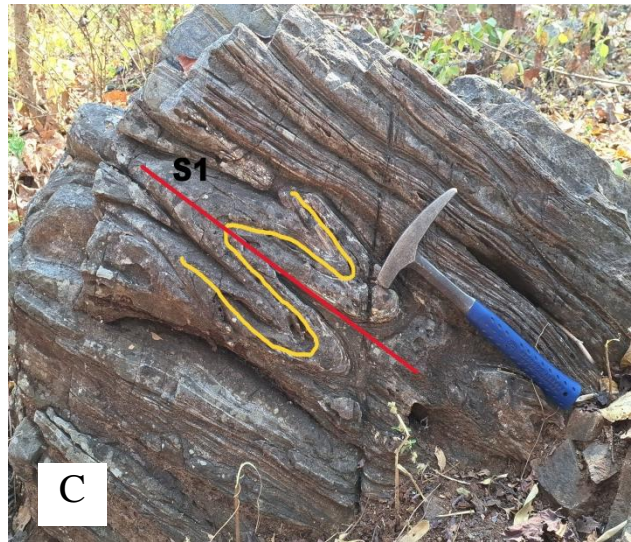
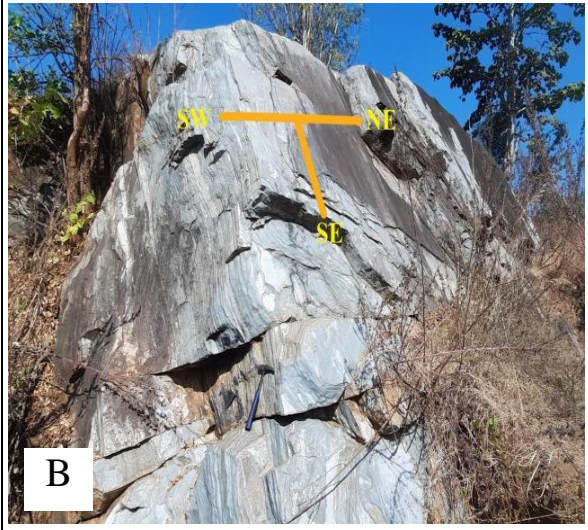
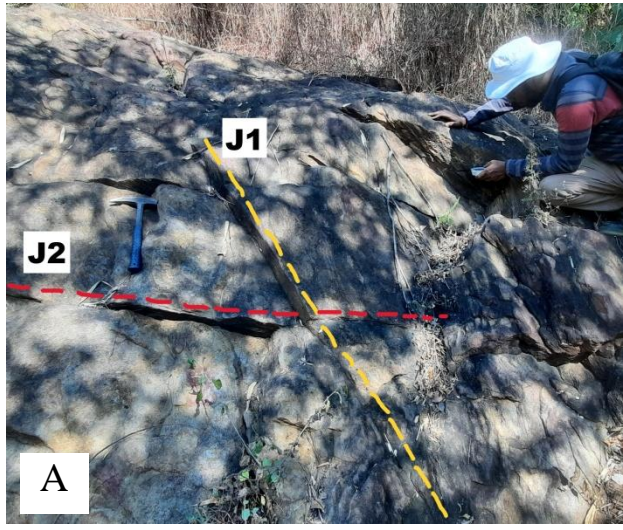
### **Shear Structures:**

Shear structures were observed in granite gneiss near Jamguda village. The asymmetrical porphyroblasts of feldspar display shear senses, which is mostly sinistral (Fig. 6.19 F).

### **Fold:**

The block area experienced two phases of deformation leading to the development of two distinct foliation planes. The first phase of deformation has produced F1. F1 folds are of tight to isoclinal type. The second phase of deformation has produced an F2 fold which is a gently plunging upright fold. Upright folds are also observed near the north-eastern part of the study area (Fig. 6.19 D).







**Fig. 6.19** Field photographs of Lamer-Panga block-A

- (A) 2 sets of joints found in granite gneiss rock in Lamer village
- (B) Gneisosity in gneiss trending N40°E-S40°W and dipping 70° in SE direction near Sadalguchha village.
- (C) First generation of foliation (S1) is observed in outcrop of granite gneiss.
- (D) Upright fold is observed in granite gneiss
- (E) Congruent fold developed in granite gneiss
- (F) Feldspar showing shear sense

### 6.1. F Metamorphism

The rocks of the area have been affected by regional metamorphism. The rocks of the area appear to have undergone hypo grade metamorphism of granulite facies. The anhydrous metamorphic mineral assemblages like quartz, garnet, sillimanite, graphite, diopside, plagioclase, calcite, quartz, garnet etc. are characteristic of pyroxene granulite sub-facies of granulite facies. Retrogression, shown by the litho units of granulite facies, manifested in the hydrous minerals like biotite and hornblende and the anomalous association of granites gneiss, migmatites on the one hand and the khondalite and charnockite on the other, thus contrasted metamorphic facies are the common feature of Eastern ghats terrain. The admixture of two facies is thought to be due to two episodes of metamorphism, probably connected with the periods of deformation. Murthy of al (1971) opine that the presence of migmatites gneisses and granulites were the products of the same orogenic movement, the granulites forming at the lower levels whereas the rocks of the lower facies at higher levels. Their present disposition and juxtaposition are attributed, first to folding to then upliftment followed by peneplanation.

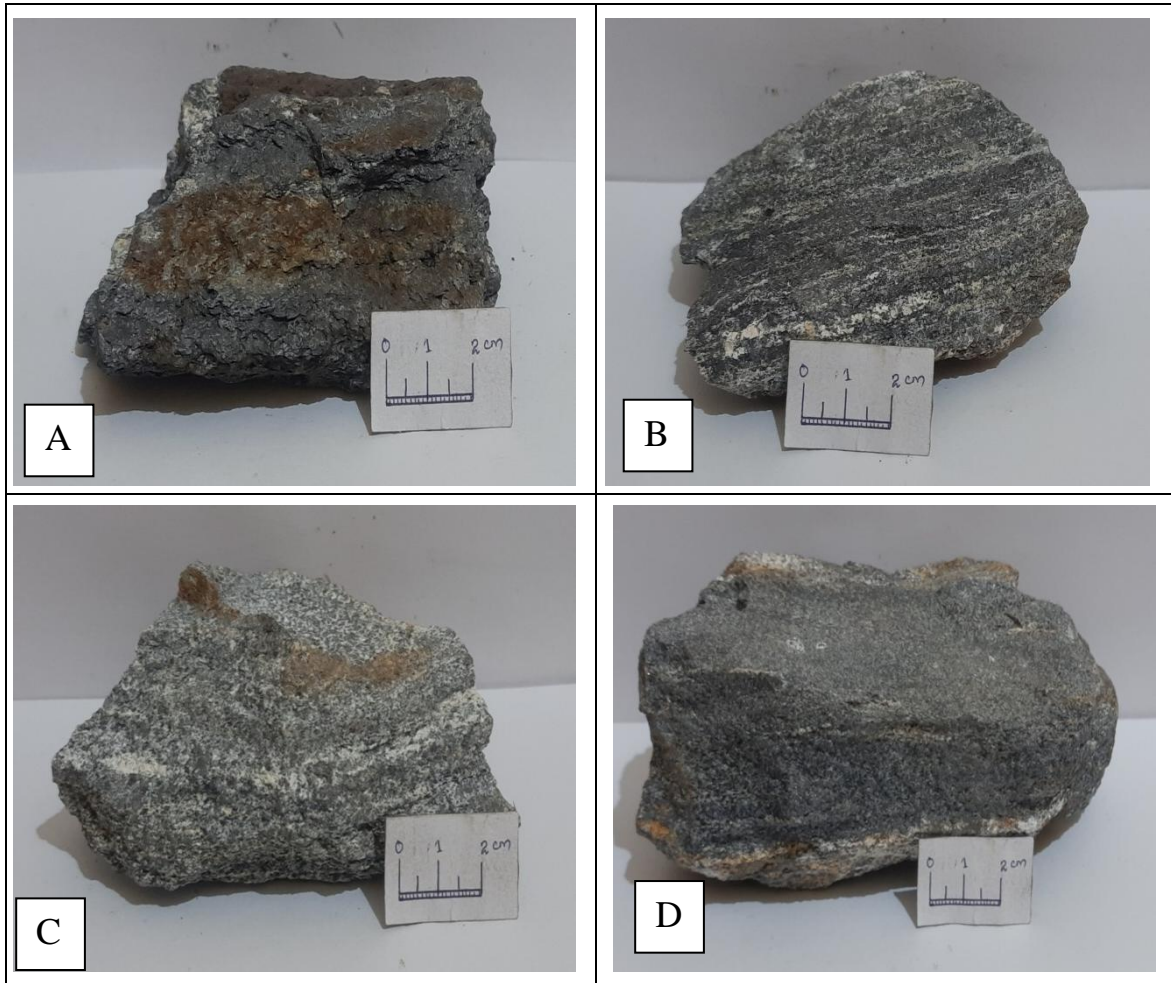


Fig. 6.35: Megascopic Photographs of Graphite occurrences in the Lamer-Panga block-A

- (A) Graphite mineralisation within granite gneiss.
- (B) Graphite mineralisation within granite gneiss.
- (C) Dissemination of graphite inclusion within granite gneiss.
- (D) Graphite mineralisation within granite gneiss.

### **6.1.G Mineralogy of the ore zones and ore textures**

Graphite is the main mineral phase present in the ore zone. It is naturally occurring in crystalline form of carbon. It is a native element mineral found in metamorphic and igneous rocks. Graphite is a mineral of extremes. It is extremely soft, cleaved with very light pressure and has a very low specific gravity. In the study area it has been observed that the main graphite schist band also encompasses impurities of quartz, feldspar, sillimanite, calcite, biotite and muscovite minerals.

The graphite in schists occurs in two forms, somewhere it flaky, silver grey and somewhere it is amorphous and black. Generally, the amorphous graphite schist gives less fixed carbon content compared to flaky variety of graphite schist. The host rocks of graphite mineralisation in the area are granite gneiss, khondalite and quartzite. Graphite schist shows well developed schistosity and flaky appearance is due to the presence of mica and other platy minerals.

### **6.1. H Pitting and Trenching**

All graphite mineralisations are exposed within the reserve forest areas of this block. Hence, no trench has been done due to lack of forest clearance.

### **6.1.I Sampling**

Sampling in preliminary exploration (G3) aims at identifying the potential zones of the target commodity in the assigned area. Initially thorough mapping of the area is required to target the commodity and to infer the control of mineralisation (lithological, structural, stratigraphic). After the inference of the control of mineralisation a systematic approach is adopted to collect the samples which represent the overall extension of the commodity in the area. Different sampling media for varied uses are as follows.

#### **Bedrock Sampling (BRS)**

A total of 22 nos. of bedrock samples (BRS) collected from the graphite bearing granite gneiss and quartzite in a systematic manner. BRS were collected for Proximate analysis which gives values of Fixed carbon, moisture content, ash content and volatile matter content in percentage format. Spacing between the two samples is reduced where graphite mineralisation outcrop is observed while mapping.

Approximately 300gm. of each sample was crushed by jaw crusher to reduce the size into 2mm then powder through Pulverizer and sieving it to -200 mesh sizes. Two sets of samples (original and duplicate) were prepared by means of coning and quartering. Packet of 100 gm. was sent to Chemical Laboratory, JNARDDC, Nagpur for chemical analysis and the rest 100 gm. was kept as duplicate for future reference at exploration camp and sent for preservation at head office of OMC Ltd. Bhubaneswar. The Analytical result of entire 22 nos. of BRS samples have been received and given in Table 6.3.

## **6.1 J Discussion of result of chemical analysis of sample**

The analysis results of 22 bed rock samples show 3.95% to 44.57% FC, all 22 nos. samples show more than 2% FC value and 02 nos. of BRS samples show more than 20% fixed carbon. LPA/G3/GP/98A has the highest value of 44.57% FC. The values of Moisture % in all BRS samples range from 0.10% to 1.37%, volatile matter content from 0.74% to 5.49% and ash content from 49.38% to 93.78%.

## **6.1K Details of interpreted ore zones on the basis of geological investigation**

A total of 13.99 sq. km area has been covered by detailed geological mapping on 1:4000, out of which about 0.127 sq. km area is covered by graphite mineralisation. The host rock for graphite mineralisation in the area is granite gneiss and quartzite. Based on surface and subsurface geological investigations about four number of graphite bands were delineated in the assigned area.

In the south-eastern part of Lamer village, the graphite band is extended for a strike distance of 1 km in NE-SW parallel to the foliation and the average width of band is 62 m. which is dipping 50° towards SE. In the north-western part of Lamer village, 3 nos. of graphite bands are found. The length of graphite bands is 321m. (0.3 km), 959m (0.9 km) and 160 m (0.1 km) in NE-SW direction along the foliation and the average width of the bands are 30m, 51m and 54m respectively which are dipping 50° towards SE direction. The graphite mineralised zones are shown in interpreted map (Fig. 7.1).

Table 6.3: Analysis results of spot samples from Lamer-Panga block-A

SL. NO	SAMPLE ID	LATITUDE	LONGITUDE	RL (In meter)	LITHOLOGY	Fixed Carbon % (db)	Moisture % (ar)	Volatile Matter % (db)	Ash % (db)
1	LPA/G3/GP/98A	20° 5' 53.85"	83° 26' 1.975"	240	Graphite mineralisation found within quartzite	44.57	1.32	4.73	49.38
2	LPA/G3/GP/348	20° 5' 30.24"	83° 28' 55.35"	280	Graphite mineralisation found within granite gneiss	9.36	1.01	3.12	86.51
3	LPA/G3/GP/350	20° 5' 29.71"	83° 28' 56.56"	297	Graphite mineralisation found in granite gneiss	13.88	0.27	2.10	83.75
4	LPA/G3/GP/363	20° 5' 38.78"	83° 29' 12.24"	267	Graphite mineralisation found in granite gneiss	13.52	1.10	4.47	80.91



SL. NO	SAMPLE ID	LATITUDE	LONGITUDE	RL (In meter)	LITHOLOGY	Fixed Carbon %(db)	Moisture%(ar )	Volatile Matter%(db)	Ash%(d b)
5	LPA/G3/GP/379	20° 5' 41.22"	83° 28' 51.28"	269	Graphite occurrence in floats of granite gneiss	9.36	0.74	4.28	85.62
6	LPA/G3/GP/382	20° 5' 41.20"	83° 28' 49.76"	256	Graphite mineralisation found in granite gneiss	18.75	1.32	3.46	76.46
7	LPA/G3/GP/400	20° 5' 6.741"	83° 29' 27.59"	312	Graphite occurrence in granite gneiss	4.51	1.36	3.72	90.41
8	LPA/G3/GP/461	20° 4' 40.85"	83° 29' 6.464"	267	Graphite occurrence within granite gneiss	15.02	0.38	1.24	83.35
9	LPA/G3/GP/573A	20° 5' 12.95"	83° 28' 46.30"	249	Graphite occurrence within granite gneiss	11.92	0.31	0.74	87.03

SL. NO	SAMPLE ID	LATITUDE	LONGITUDE	RL (In meter)	LITHOLOGY	Fixed Carbon %(db)	Moisture%(ar )	Volatile Matter%(db)	Ash%(d b)
10	LPA/G3/GP/593	20° 4' 46.94"	83° 29' 15.90"	266	Graphite occurrence within granite gneiss	18.40	0.24	0.75	80.61
11	LPA/G3/GP/865	20° 4' 53.43"	83° 29' 26.02"	341	Graphite occurrence within the granite gneiss	10.46	0.46	3.59	85.48
12	LPA/G3/GP/866	20° 4' 54.86"	83° 29' 27.56"	329	Graphite occurrence within the granite gneiss	5.85	0.72	3.43	90.00
13	LPA/G3/GP/874	20° 5' 9.171"	83° 29' 31.25"	293	Graphite occurrence within the granite gneiss	8.54	0.50	1.45	89.51
14	LPA/G3/GP/939	20° 5' 12.00"	83° 30' 7.610"	301	Graphite mineralisation within garnetiferous quartzite	18.07	0.23	1.88	79.83
15	LPA/G3/GP/939A	20° 5' 12.00"	83° 30' 7.610"	301	Graphite mineralisation within garnetiferous quartzite	12.70	0.34	2.55	84.41

SL. NO	SAMPLE ID	LATITUDE	LONGITUDE	RL (In meter)	LITHOLOGY	Fixed Carbon %(db)	Moisture%(ar )	Volatile Matter%(db)	Ash%(d b)
16	LPA/G3/GP/1177	20° 4' 35.59"	83° 29' 8.365"	312	Inclusion of graphite in granite gneiss	3.95	0.71	1.56	93.78
17	LPA/G3/GP/1179	20° 4' 33.88"	83° 29' 5.053"	297	Occurrence of graphite within the granite gneiss	8.63	0.65	2.64	88.08
18	LPA/G3/GP/1180	20° 4' 34.59"	83° 29' 4.491"	294	Occurrence of graphite within the granite gneiss	14.77	0.10	1.01	84.12
19	LPA/G3/GP/1206	20° 5' 0.445"	83° 28' 56.46"	262	Occurrence of graphite within the granite gneiss	6.20	0.33	5.49	87.97

SL. NO	SAMPLE ID	LATITUDE	LONGITUDE	RL (In meter)	LITHOLOGY	Fixed Carbon % (db)	Moisture % (ar)	Volatile Matter % (db)	Ash % (db)
20	LPA/G3/GP/1213	20° 4' 39.16"	83° 29' 8.498"	296	Graphite mineralisation within granite gneiss	13.31	0.26	2.84	83.59
21	LPA/G3/GP/1222	20° 4' 44.01"	83° 29' 2.731"	298	Graphite occurrence within granite gneiss	4.19	0.28	2.74	92.78
22	LPA/G3/GP/1507	20° 6' 3.027"	83° 26' 49.36"	232	Graphite mineralisation found within quartzite	38.90	1.23	2.87	56.99

## 6.2. Geophysical exploration

A total of ten (10) line kilometers of Self-Potential (SP) survey was conducted in Lamer-Panga block-A of Kalahandi District, Odisha maintaining the traverse interval of 100 metres and 10 metres of station interval for preliminary exploration. The SP survey was executed by Steiger Geoscience and Engineering Pvt. Ltd., Hyderabad, Telangana. Coverage of SP surveys in different target areas is tabulated below in Table 6.4 and shown in Fig 6.36 (PLATE No. VII).

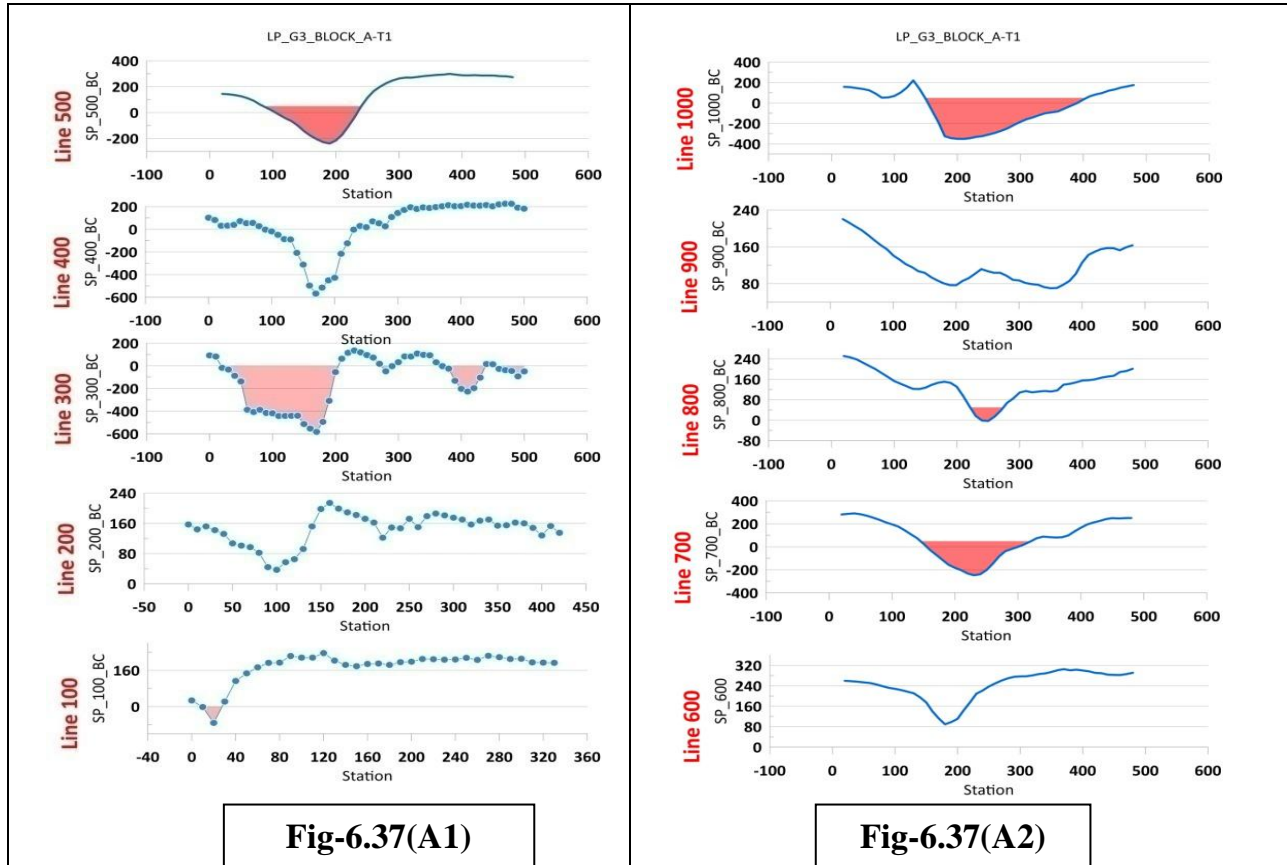
**Table 6.4** SP survey coverage of Lamer-Panga block-A

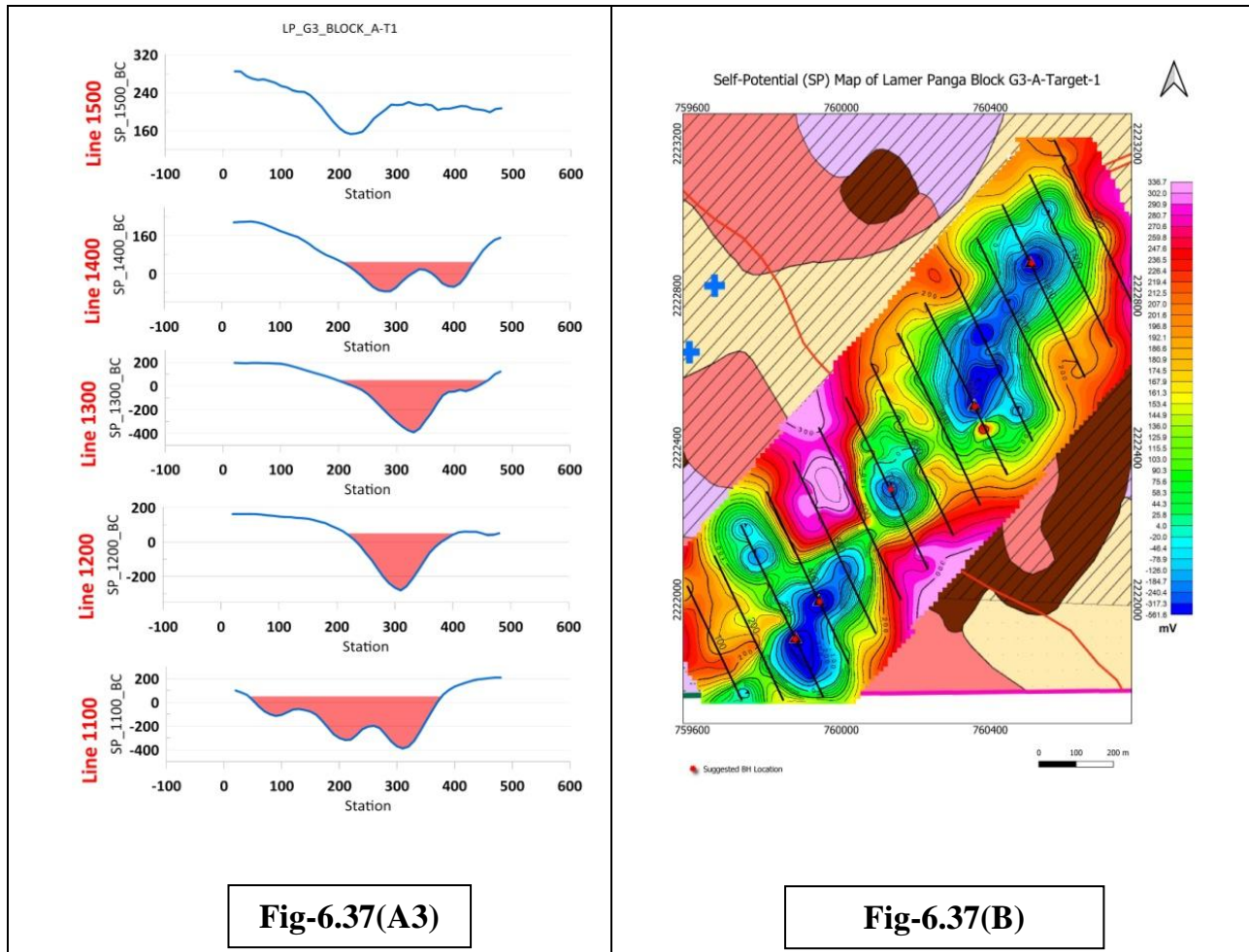
Sl. Nos.	Block Name	SP Survey Target Area	Lines covered	Total Coverage (L. km)	Remarks
1	Lamer-Panga Block-A	Target 1	15	7.3 lkm	5 anomalies found
2		Target 2	9	2.7 lkm	3 anomalies found





already explained in the above paragraph. It is to be noted that the low anomalies in the Fig.6.37 (B) over the traverses 100 and 200 are associated with positive values of SP and fall over uphill regions and are not suggested for further follow up





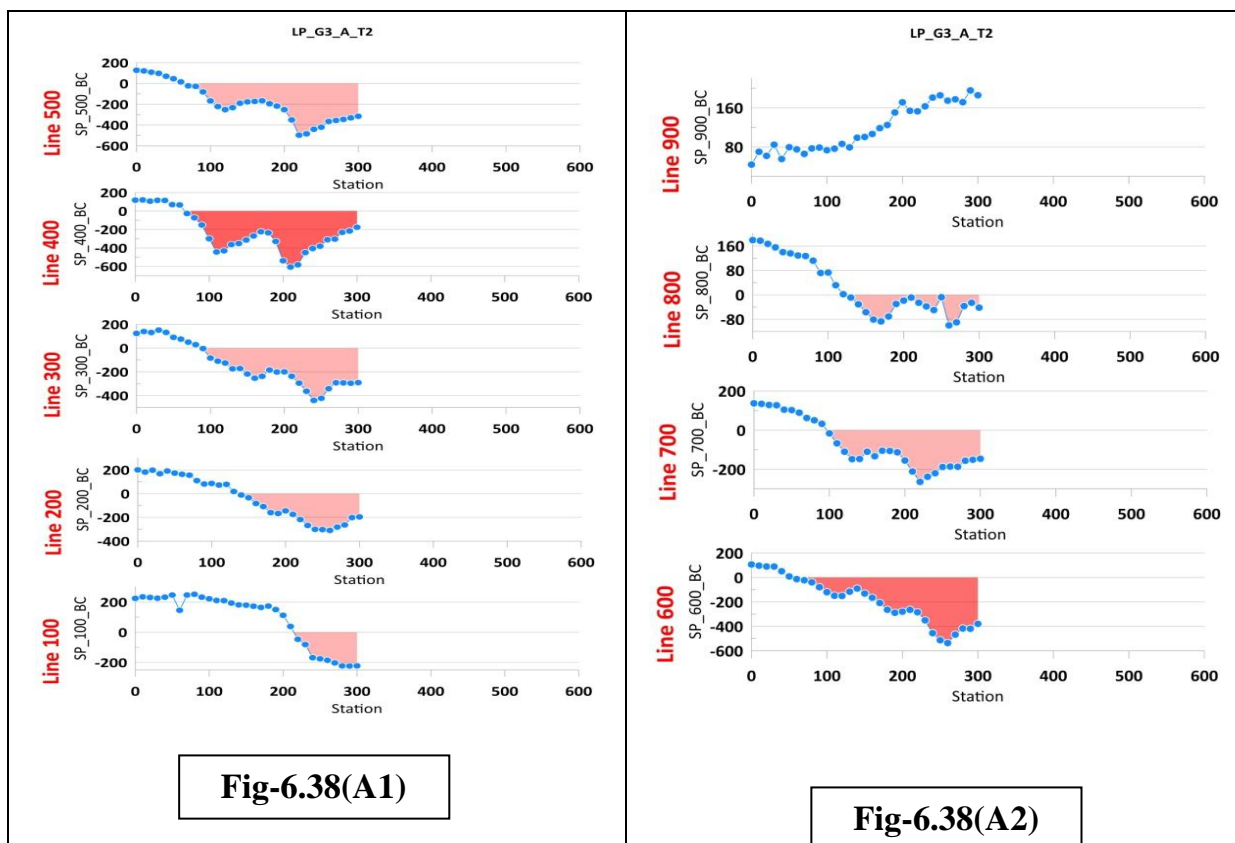
**Fig. 6.37 (A1 to A3)** Prominent SP lows observed along profiles of South-East part of Lamer Village (Target 1)  
**(B)** SP grid image map of South-East part of Lamer Village (Target 1)

**Table 6.5** SP survey coverage details of South-East part of Lamer Village (Target 1)

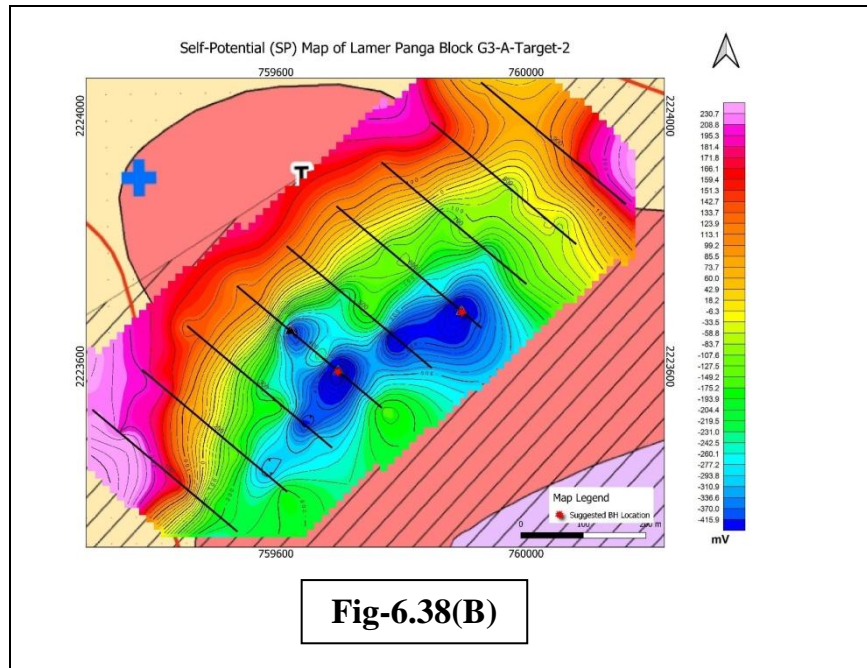
Target	Line	Station	Easting	Northing	Longitude	Latitude	Field SP value (mV)
Target-	300	170	759876.5	2221897.6	20° 4' 35.901"	89° 29' 5.857"	-583
	400	180	759940.1	2221995.4	20° 4' 39.048"	89° 29' 8.095"	-508
	700	-568	760126.5	2222297.7	20° 4' 48.783"	89° 29' 14.662"	-306

1(A)	1000	200	760356.6	2222510.1	20° 4' 55.575"	89° 29'22.686"	-390
	1300	330	760507.9	2222884.2	20° 5' 7.66"	89° 29'28.084"	-429

**2. Target 2:** In target-2, SP survey was carried out over 9 traverses and the data was processed and SP grid image map is shown in Fig.6.38 (B). and SP profiles are plotted as shown in Fig.6.38 (A1) and Fig.6.38 (A2). The image map depicts a prominent SP low anomaly associated with intermittent breaks, between the traverses 300 to 700. The SP low zone with relief of nearly -200 mV from the back-ground value of -300 mv over the traverse 600, aligned in NE-SW direction is very promising and hold potential for hosting rich concentrations of graphite. Another low closure over the traverse 400 associated with NE-SW trend and a relief of -200 mV over the same background value of -300, also hold potential for graphite mineralisation. In the SP profiles Fig.6.38 (A1) and Fig.6.38 (A2), the order of the SP lows can be better visualized. It is to be noted that the SP profiles are displayed in the figures from south to north. On the basis of above observation, two boreholes can be suggested for the confirmation of presence of graphite mineralisation.







**Fig. 6.38 (A1 to A2)** Prominent SP lows observed along profiles of North-West part of Lamer Village (Target 2)

(G) SP grid image map of North-West part of Lamer village (Target 2)

**Table 6.6** SP survey coverage details of North-West part of Lamer village (Target 2)

Target	Line	Station	Easting	Northing	Longitude	Latitude	Field SP value (mV)
Target-2(A)	400	110	759622.8	2223656.8	20° 5' 33.199"	89° 28' 58.031"	-444
	400	210	759699.5	2223592.5	20° 5' 31.072"	89° 29' 0.637"	-607
	600	260	759897	2223687.9	20° 5' 34.077"	89° 29' 7.48"	-536



### **6.3 Geochemical exploration**

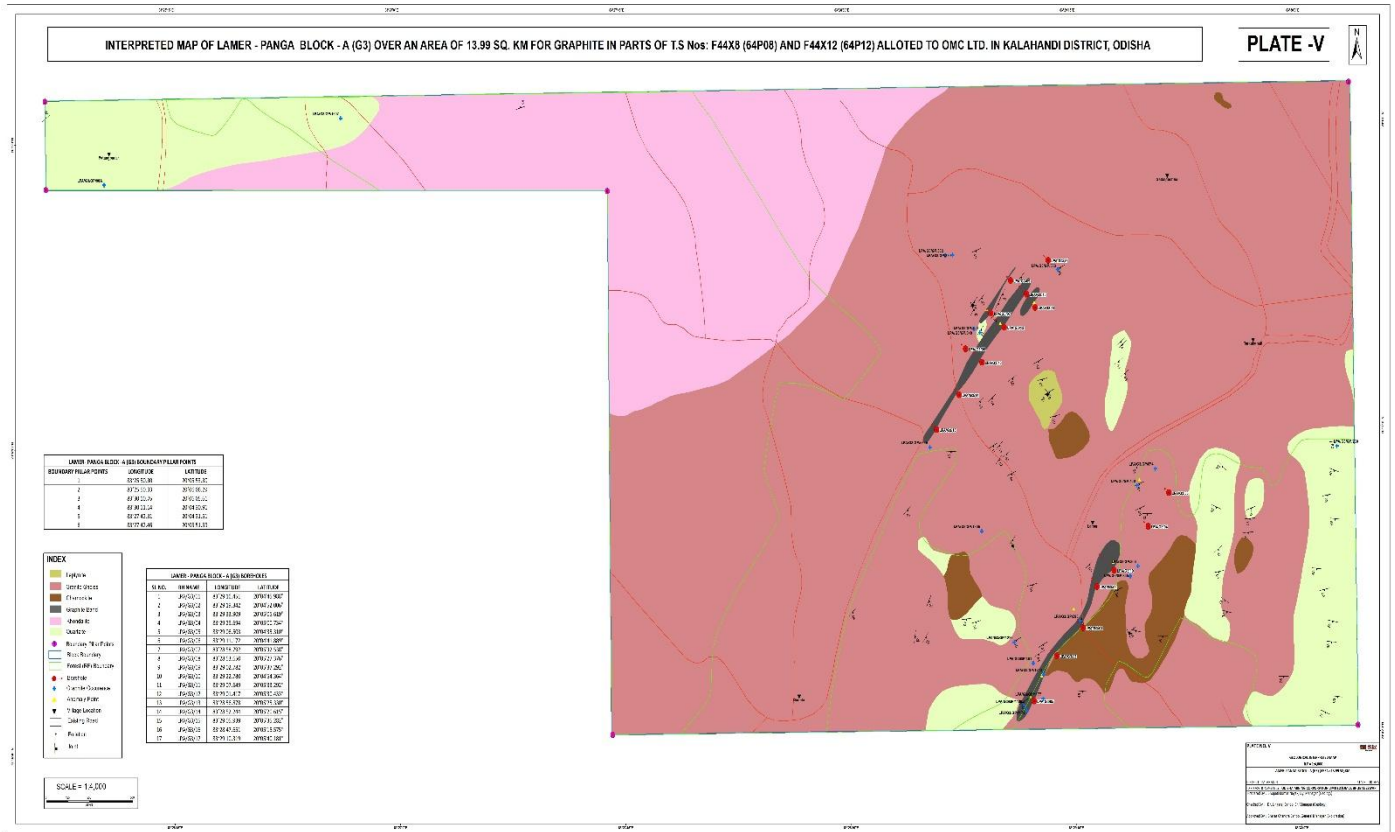
Since no geochemical exploration proposed in nature and quantum of work and achievements so, there are no details of regarding this context.

## **CHAPTER 7**

### **INTEGRATION OF GEOLOGICAL AND GEOPHYSICAL EXPLORATION DATA AND INTERPRETATIONS**

To understand the behavior of the graphite mineralised zone in Lamer-Panga Block-A, the different thematic maps and data viz. detailed geological map and geophysical map (Self-Potential) (PLATE No. VII) were overlain in Arc GIS platform and following results are obtained.

1. In the geophysical SP anomaly map, a total of 2 nos. of self-potential anomaly have been delineated and both zones are promising for the graphite.
2. The trend of the SP anomaly matches well along with the foliation trend of the mineralised zone, which indicates that the graphite may occur at depth under soil cover.



**Fig. 7.1** Interpreted Geological Map of Lamer-Panga block-A

## CHAPTER 8

### MINERAL PROSPECTING

#### 8.1 Surface indication

The surface indications of mineralisation in the area are represented by the presence of flakes, specks and stringers of graphite along the foliation plane of the granite gneiss, khondalite and quartzite.

Surface manifestations of graphite mineralisation in the area are found in a few graphite outcrops. Mostly the trend of graphite band varies from NE-SW along the foliation and dipping towards SE direction.

#### 8.2 Mode of occurrence

The graphite bodies/deposits are located within the highly migmatised metaigneous and metasedimentary rocks. Their mode of occurrence and controls of localisations are dealt with separately.

**Dissemination:** The dissemination graphite scales and flakes are generally found in khondalite, less commonly in garnetiferous granite gneiss, quartzite and calc-granulite. In some cases, graphite is partially enclosed by sillimanite, garnet, biotite, feldspar and quartz in the khondalite suite of rocks. The size of the graphite flakes increases in the migmatised portions of the host rock. The graphite bodies in general show parallelism, to the foliation trend of the host rock, which are also sheared. Association of pegmatite and quartz vein is common in the mineralised zone.

**Graphite schists:** The schistose occurrence of graphite has been noticed in khondalite, calcsilicate granulite, biotite schist and acid gneiss which are mostly confined to the margin of foliation controlled as lodes, small veins and pockets. Graphite schists with or without biotite, associated with pegmatite are also observed at the contact of migmatised khondalite and calc-silicate granulite. The contact between graphite schist and host rocks is generally sharp but are gradational at places. The host rocks are invariably migmatised. Migmatised granite gneiss contain disseminated graphite.

**Graphite lodes or veins:** The lodes or veins essentially consist of graphite and have more or less distinct boundaries against the country rocks and are observed in khondalite, granite gneiss, quartzite and calc-silicate granulite. The graphite lodes show pinch and swell structures are along and across the foliation and taper towards both ends forming lensoid bodies. Thin irregular graphite veins associated with quartz-feldspar-biotite intrude the fracture of migmatized khondalite. Pocket deposits are very small and occur as detached bodies in khondalite, granite gneiss and calc-silicate granulite.

The Lamer-Panga block-A is in the western part of the Eastern Ghat Mobile Belt of Kalahandi district, Odisha. The previous exploration in the area confirms the presence of graphite in Kalahandi district associated with khondalite and granite gneiss. The objective of the current investigation was to carry out preliminary exploration of the Lamer-Panga block-A involving detailed geological mapping, geophysical survey (Self Potential), systematic drilling, core sampling, analysis and resource estimation for preparation of geological report as per the guidelines of the Minerals (Evidence of Mineral Contents) Rules 2015 and Amendment Rules 2021.

The graphite mineralisation covers an area of about 0.127 sq. km in Lamer-Panga block-A. Graphite encountered in 13 nos. of borehole out of 17 nos. of borehole and the thickness of the graphite bands varies from 1.00 m. to 37.50 m.

### **8.3 Strike length and width of anomalies identified on the basis of geology, geochemical, geophysical exploration.**

On the basis of anomalous zone of SP survey data, 17 nos. of boreholes have been done out of which 13 boreholes are intersected the graphite mineralisation.

### **8.4 Alteration zone**

Alteration with respect to graphite mineralisation could not be observed in the area.

## 8.5 Genesis of mineralisation

In the Eastern Ghat Mobile Belt (EGMB) neither there is any graphite deposit nor there is any identifiable relic of carbonaceous sediments in the country rock, but the host rocks of graphite are sediment metamorphous under granulite facies condition. Precambrian sediments are known to contain microorganisms mostly in the form of bacteria (Schidlowski, 1995). Hence the biogenic origin of some graphite cannot be ruled out. The metamorphism of carbonaceous material producing graphite is well known. The calc-silicate granulites are also probable sources of carbon in the EGMB. Methanation of carbonate mineral by hydrogen takes place at low hydrogen pressure, under 2000C -6000C, provided the gaseous produced (particularly H<sub>2</sub>O) leave the system or enter solid phase. Subsequent pyrolysis of methane results in the formation of graphite by the reaction  $\text{CH}_4 \rightarrow \text{C} + 2\text{H}_2$ . Once carbon is formed it would have a catalytic effect on subsequent methane dissociation (Salotti et al; 1971; Acharya and Dash, 1984).

Graphite occurs as schist and dissemination in khondalite, granite gneiss and calc-silicate granulite. It is cleared that the source of carbon to be organic which has been converted to graphite during metamorphism.



## **CHAPTER 9**

### **EXPLORATION BY SYSTEMATIC DRILLING**

#### **9.1 Stage of exploration as per mineral content rule**

The exploration in Lamer-Panga Block-A, Kalahandi district, Odisha has been carried out under Preliminary exploration (G-3 stage) for graphite as per the Minerals (Evidence of Mineral Contents) Rules, 2015 and Minerals (Evidence of Mineral Contents) Amendment Rules, 2021.

#### **9.2 Methodology of drilling with the details of type of drilling**

The core drilling in the block was executed by M/s. Mining Associates Private Ltd., Asansol, West Bengal. The wet drilling with triple tube has been carried out using DYNA-35-01, DYNA-35-02, DYNA-50-H-01, DYNA-50-CR-01 and DYNA-50-CR-07 drilling rigs with HQ/NQ size diameter. A maximum of 1.50 m run was deployed in a single run of drilling.

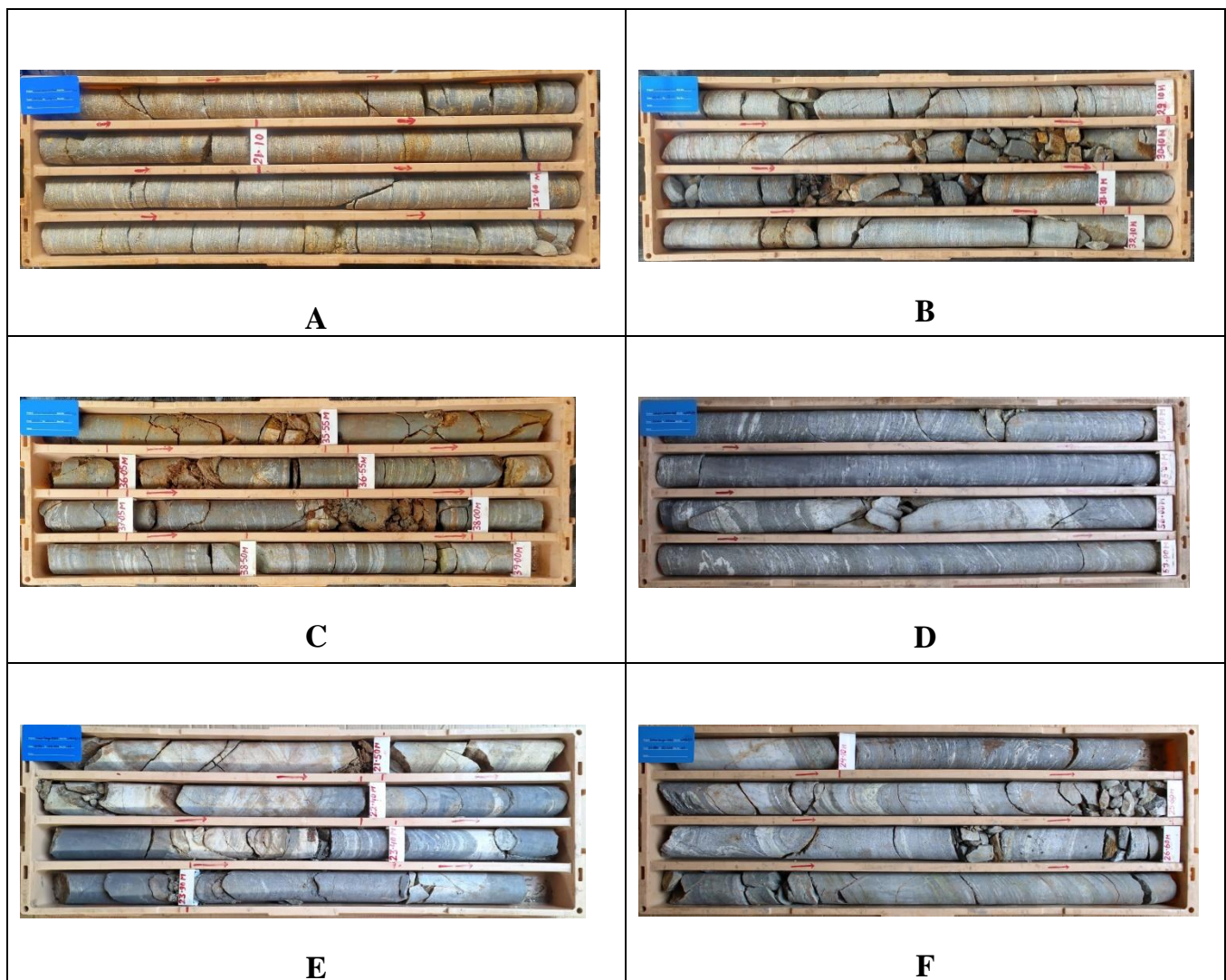
The drill cores are preserved in Polypropylene (PVC) boxes and labelled with relevant details like borehole number, box number, run interval from top to bottom etc. and these core boxes are transported to core shed at Regional Office, Rayagada of OMC Ltd. for preservation of cores. At the core facility, the required drill cores were sun dried and all the core boxes were photographed. The recovery details including total recovered length and recovery percentage for each run is recorded in the borehole logs. The borehole details with average recovery percentage and total depth are presented in Table 9.2.

The sample recoveries were maximised by using triple tube barrels and appropriate drilling fluids. Core lifters were inspected frequently and changed whenever required to improve the recovery. The depth wise drill core was sequentially preserved in the core box.

As per the drill log data, no correlation was observed between sample recovery and grade. Also, no sample bias has occurred due to preferential loss or gain of fine or course material. Average core recovery of 17 boreholes is 88.76%.

The drill cores were logged to determine the run details, recovery factors, mineralisation details and lithology. The lithological domains were initially defined based on the visual inspection of the features and later reconciled based on the chemical analysis results. Logging was qualitative in nature, i.e., based on lithology. The different grades of graphite have been identified within the litho units of granite gneiss and quartzite.

The core box photographs showing various litho units are presented in the Fig. 9.1. The detailed litho logs and summarized litho logs of all the boreholes are presented in ANNEXURE-V and ANNEXURE-VI respectively. Graphical litho logs of all the boreholes are presented in PLATE No. VIII.



**Fig. 9.1:** Photograph showing drill core boxes with appropriate labelling.

- A. Borehole LPA/G3/02 with graphite in granite gneiss from 19.75 m to 23.65 m
- B. Borehole LPA/G3/05 with graphite in granite gneiss from 28.10 m to 32.15 m
- C. Borehole LPA/G3/06 with graphite in granite gneiss from 35.00 m to 39.00 m
- D. Borehole LPA/G3/10 with graphite in granite gneiss from 53.00 m to 57.00 m
- E. Borehole LPA/G3/11 with dissemination graphite in granite gneiss from 22.30 m to 24.40 m
- F. Borehole LPA/G3/12 with graphite in granite gneiss from 24.00 m to 27.55 m

### **9.3 Planning of the boreholes**

During FS 2023-24, drilling was carried to evaluate the potential zone of graphite in Lamer-Panga Block-A. A total of 17 boreholes were drilled involving a total of 883 meters of drilling. All the boreholes (LPA/G3/01 to LPA/G3/17) are inclined, out of which 13 nos. (LPA/G3/01, LPA/G3/02, LPA/G3/05, LPA/G3/06, LPA/G3/07, LPA/G3/09, LPA/G3/10, LPA/G3/11, LPA/G3/12, LPA/G3/13, LPA/G3/14, LPA/G3/15, LPA/G3/16) have intersected sporadic graphite mineralisation at different depths along the boreholes. Minor sulphides are also present in the form of specks. The boreholes are planned based on detailed geological mapping in 1: 4,000 along with geophysical anomaly. Systematic drilling has been carried out and spacing between two boreholes is about 200m along the foliation. The azimuth of borehole LPA /G3/01 and LPA /G3/02 is 320° with inclination angle of 45°. Whereas the azimuth of other fifteen nos. of boreholes is 310°. Borehole no LPA/G3/04, LPA/G3/07, LPA/G3/08, LPA/G3/09, LPA/G3/14, LPA/G3/16 and LPA/G3/17 is drilled with an inclination angle of 45°. Whereas in LPA/G3/03, LPA/G3/05, LPA/G3/06, LPA/G3/10 and LPA/G3/15 with an inclination angle of 50°. In bore hole LPA/G3/05, LPA/G3/06 inclination angle of 55° and in LPA/G3/12 is 60°.

**Table 9.1 Details of the drilled boreholes are given below**

Sl. No	Borehole ID	DGPS Coordinate		RL at collar (m)	Azimuth	Angle from horizon tal	Depth (m)	RL at close (m)
		Latitude	Longitude					
1	LPA/G3/01	20° 04' 45.988"	83° 29' 16.451"	270.607	320°	45°	50.00	232.830
2	LPA/G3/02	20° 04' 52.006"	83° 29' 19.342"	268.186	320°	45°	50.00	235.074
3	LPA/G3/03	20° 05' 5.619"	83° 29' 33.909"	288.246	310°	50°	35.00	260.614
4	LPA/G3/04	20° 05' 0.734"	83° 29' 29.694"	320.371	310°	45°	35.00	295.622
5	LPA/G3/05	20° 04' 35.31"	83° 29' 6.503"	306.985	310°	50°	60.00	260.122
6	LPA/G3/06	20° 04' 41.889"	83° 29' 11.172"	279.961	310°	50°	45.00	245.491
7	LPA/G3/07	20° 05' 32.538"	83° 28' 58.792"	305.257	310°	45°	35.00	280.501
8	LPA/G3/08	20° 05' 27.376"	83° 28' 53.65"	284.657	310°	45°	35.00	260.015

9	LPA/G3/09	20° 05' 37.292"	83° 29' 2.782"	323.254	310°	45°	35.00	298.369
10	LPA/G3/10	20° 04' 54.364"	83° 29' 22.780"	316.993	310°	50°	115.00	228.880
11	LPA/G3/11	20° 05' 33.292"	83° 29' 7.649"	369.934	310°	55°	77.00	306.894
12	LPA/G3/12	20° 05' 30.433"	83° 29' 1.417"	353.179	310°	60°	62.00	299.481
13	LPA/G3/13	20° 05' 25.33"	83° 28' 56.878"	333.327	310°	55°	71.00	273.762
14	LPA/G3/14	20° 05' 20.615"	83° 28' 52.244"	264.486	310°	45°	42.00	234.714
15	LPA/G3/15	20° 05' 35.282"	83° 29' 5.939"	338.832	310°	50°	59.00	292.674
16	LPA/G3/16	20° 05' 15.575"	83° 28' 47.651"	245.134	310°	45°	42.00	215.140
17	LPA/G3/17	20° 05' 40.181"	83° 29' 10.319"	274.989	310°	45°	35.00	250.236



**Table 9.2 The borehole details with average recovery percentage in mineralized and non-mineralized zone:**

<b>Borehole ID</b>	<b>Total drilled depth (m)</b>	<b>Mineralized zone depth (m)</b>	<b>Avg. core recovery (%) in mineralized zone</b>	<b>Non mineralized zone depth (m)</b>	<b>Avg. core recovery (%) in non-mineralized zone</b>	<b>Avg. core recovery (%)</b>
LPA/G3/01	50.00	25.83	95.93	24.17	83.37	89.94
LPA/G3/02	50.00	38.20	89.66	11.8	54.32	81.34
LPA/G3/03	35.00	0.00	0.00	35.00	93.97	93.97
LPA/G3/04	35.00	0.00	0.00	35.00	91.31	91.31
LPA/G3/05	60.00	50.29	87.63	9.71	80.23	86.48
LPA/G3/06	45.00	24.81	85.49	20.19	81.28	83.64
LPA/G3/07	35.00	3.10	81.94	31.9	77.90	78.25
LPA/G3/08	35.00	0.00	0.00	35.00	80.89	80.89
LPA/G3/09	35.00	4.00	94.25	31	91.42	91.77
LPA/G3/10	115.00	94.95	96.47	20.05	94.01	96.04
LPA/G3/11	77.00	23.30	93.86	53.7	88.51	90.25

LPA/G3/12	62.00	28.10	94.16	33.9	88.38	91.26
LPA/G3/13	71.00	23.00	89.22	48	89.63	91.00
LPA/G3/14	42.00	17.60	91.25	24.4	87.21	88.93
LPA/G3/15	59.00	39.50	89.49	19.5	72.67	83.93
LPA/G3/16	42.00	13.00	94.46	29	87.90	89.90
LPA/G3/17	35.00	0.00	0.00	35.00	86.20	86.20

### **Borehole No. LPA/G3/01:**

The borehole no. LPA/G3/01 was planned in the south-eastern part of Lamer village near a pit which is located in the south-eastern part of the Lamer-Panga block-A, where graphite is well exposed along the foliation strike of N50°E-S50°W with a southeasterly dip of 50°. The self-potential value of anomalous zone is -306mv. The analysis result of spot sample of that area is 18.4% FC. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 320°. The borehole is planned at 30m horizontal distance from anomalous point to intersect mineralised zone at 25m vertical depth. The borehole was drilled to a depth of 50m.

### **Borehole No. LPA/G3/02:**

The borehole no. LPA/G3/02 was planned in the south-eastern part of Lamer village which is located in the south-eastern part of the Lamer-Panga block-A. The borehole is planned about 200 m interval along strike of the foliation to know the extension of the graphite body. It is decided to drill at 20m horizontal distance from the target point to intersect the ore body at 20m vertical depth from the surface. The foliation strike of the area is N50°E-S50°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 320°. The borehole was drilled to a depth of 50 m.

### **Borehole No. LPA/G3/03:**

The borehole no. LPA/G3/03 is planned in the south-eastern part of Lamer village which is located in the south-eastern part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the strike of foliation direction to know the extension of the graphite body. It is decided to drill at 20m horizontal distance from the target point to intersect at 27m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 50° and azimuth is bearing 310°. The borehole was drilled to a depth of 35m, but no graphite mineralisation is found so it is observed that the graphite band is not extending along the foliation.

#### **Borehole No. LPA/G3/04:**

The borehole no. LPA/G3/04 is planned in the south-eastern part of Lamer village which is located in the south-eastern part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the foliation to know the extension of the graphite body. It is decided to drill at 25m horizontal distance from the target point to intersect at 28m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 35m, but no graphite mineralisation is found so it is observed that the graphite band is not extending along the foliation direction.

#### **Borehole No. LPA/G3/05:**

The borehole no LPA/G3/05 was planned in the south-eastern part of Lamer village which is located in the south-eastern part of the Lamer-Panga block-A, where self-potential value of an anomalous zone is -583mv. The analytical results of surface samples of that area ranges from 8.63 to 14.77 % of FC. The borehole is planned about 200m interval along the foliation to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the SP survey anomalous zone to intersect at 23m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 50° depending upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 60m.

#### **Borehole No. LPA/G3/06:**

The borehole no LPA/G3/06 was planned in the south-eastern part of the Lamer village which is located in the south-eastern part of the Lamer-Panga block-A, where self-potential value of anomalous zone is -508mv. The borehole is planned about 200m interval along the foliation to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the SP survey anomalous zone to intersect at 23m vertical depth. The strike foliation of the area is N40°E S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 50° depending

upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 45m.

**Borehole No. LPA/G3/07:**

The borehole no. LPA/G3/07 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga Block-A, where self-potential value of an anomalous zone is -444mv. The borehole is planned at 30 m horizontal distance from the SP survey anomalous zone to intersect at 30m vertical depth. The strike of the foliation is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 35m.

**Borehole No. LPA/G3/08:**

The borehole no. LPA/G3/08 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga Block-A. The borehole is planned about 200m interval along the foliation to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the target point to intersect at 25m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 35m, but no graphite mineralisation is found so it is observed that the graphite band is not extending along the foliation.

**Borehole No. LPA/G3/09:**

The borehole no. LPA/G3/09 is planned near the Lamer (NW) village which is located central part of the Lamer-Panga Block-A. The borehole is planned about 200m interval along the foliation to know the extension of the graphite body. It is decided to drill 25m horizontal distance from the target point to intersect at 27m vertical depth. The foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 35m.



### **Borehole No. LPA/G3/10:**

The borehole no LPA/G3/10 was planned in the south-eastern part of Lamer village which is located in the central part of the Lamer-Panga block-A, where self-potential value of anomalous zone is -390mv. The analysis result of surface sample of that area is 10.46 % of FC. The borehole is planned about 200m intervals along the strike of foliation to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the SP survey anomalous zone to intersect at 25m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 50° depending upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 115m.

### **Borehole No. LPA/G3/11:**

The borehole no. LPA/G3/11 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga block-A, where self-potential value of anomalous zone is -536mv. The borehole is planned at 25m horizontal distance from the SP survey to intersect at 28m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 55° depending upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 77m.

### **Borehole No. LPA/G3/12:**

The borehole no. LPA/G3/12 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga block-A, where self-potential value of anomalous zone is -607mv. The borehole is planned at 30m horizontal distance from the SP survey anomalous zone to intersect at 32m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 60° depending upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 62m.

**Borehole No. LPA/G3/13:**

The borehole no. LPA/G3/13 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the foliation to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the target point to intersect at 25m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 55° depending upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 71m.

**Borehole No. LPA/G3/14:**

The borehole no. LPA/G3/14 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the foliation strike to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the target point to intersect at 26m vertical depth. The strike of foliation of the area is N40°E -S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 42m.

**Borehole No. LPA/G3/15:**

The borehole no. LPA/G3/15 is planned near Lamer (NW) village which is located in the central part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the foliation strike to know the extension of the graphite body. It is decided to drill at 30m horizontal distance from the target point to intersect at 24m vertical depth. The foliation of the area strikes N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 50° depending upon the topographic elevation of the borehole location and azimuth is bearing 310°. The borehole was drilled to a depth of 59m.

**Borehole No. LPA/G3/16:**

The borehole no. LPA/G3/16 is planned near Lamer (NW) village which is

located in the central part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the foliation strike to know the extension of the graphite body. It is decided to drill at 25m horizontal distance from the target point to intersect at 25m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 42m.

### **Borehole No. LPA/G3/17:**

The borehole no. LPA/G3/17 is planned near the Lamer (NW) village which is located in the central part of the Lamer-Panga block-A. The borehole is planned about 200m interval along the foliation strike to know the extension of the graphite body. It is decided to drill at 25m horizontal distance from the target point to intersect at 24m vertical depth. The strike of foliation of the area is N40°E-S40°W with a southeasterly dip of 50°. Hence, the borehole is drilled at an angle of 45° and azimuth is bearing 310°. The borehole was drilled to a depth of 35m, but no graphite mineralisation is found so it is observed that the graphite band is not extending along the foliation direction.

The summarized litholog and assay value of core samples are given in ANNEXURE-VI and ANNEXURE -VII respectively. The borehole cross section is given in PLATE No. IX.

## **9.4 Borehole logging**

The cores of boreholes were logged incorporating all the details about lithology, mineralisation, core angle, core recovery, and structural features. All these details are recorded in the borehole log register and detailed lithologies; mineralisation and core recovery % along the boreholes are given in ANNEXURE -V.

## **9.5 Core recovery percentage**

The average core recovery is 88.76 % in drilled boreholes. However, the recovery of core is more than 90% in maximum meterage of boreholes whereas some boreholes have been obtained more losses of core due to the weathered zone. The details of core recovery are given in the summarized lithologs (ANNEXURE-VI).

## **9.6 Geophysical logging**

Geophysical logging has not been carried out in boreholes LPA/G3/01 to LPA/G3/17.

## **9.7 Mineralogy of the ore zone**

The ore zone comprises graphite mineralisation. The gangue minerals present within the ore zones are mainly quartz, feldspar, pyroxene and garnet.

## **9.8 Borehole deviation test and methodology**

The zenithal deviations of the boreholes are determined by using Reflex EZ Trac, which is a magnetic multi-shot survey tool. This is a wireless device which is controlled by android system connected by Bluetooth. The maximum range of bluetooth connectivity is upto 2000 m. It contains sensor, power supply unit, data processing system and other controlling unit altogether and it can independently determine the inclination angle of the borehole, azimuth and magnetic field influence. Each shot has been taken at every 6 metres regular interval. Generally, the boreholes show upward deviation up to 1°. It was seen that from the surface up to 30 m there was practically no deviation in the borehole where it is increased gradually towards the depth. The deviation in azimuth of the boreholes varied from 0° to 3°. (Deviation test result attached as ANNEXURE-IX).

## **9.9 Methodology of ore zone sampling and sample preparation:**

The drill core was vertically split into two equal halves. One half was retained in the core box for future reference and the other half was crushed for further sample preparation. The sample intervals are identified on the basis of mineralisation/formation during logging. The samples were mostly collected at one meter intervals in mineralised zones as well as hang wall and foot wall. In the case of larger length of non-ore lithology core sampling has been taken for sampling from appropriate intervals or were subjected to composite sampling. Samples are also taken where lithological changes occur across the length of the boreholes. The minimum sampling interval is 30 cm and the maximum is 4.00 m. The

final sample of -200 mesh (75 micron) size was packed in 4 packets of 50g each. Out of these, 2-3 packets of samples were utilized for different chemical and physical analysis.

The splitted core was crushed to a size of about 10mm size and the sample was coned & quartered using Riffle splitter to divide the quantity of the sample. One half of the representative sample from 10 mm was stored as coarse reject and other half was further passed through a Roller crusher to produce 2 mm size sample. The entire 2mm size sample was pulverised to pass through - 200 mesh (75 micron) size. The splitter/crusher was air dried after each sample to avoid contamination. A total of 240 primary core samples were sampled and after receiving the analytical results from the laboratory the mineralized domains anticipated. Proper coning & quartering of crushed drill core samples were executed to ensure the homogeneity and representativity for further sub sampling and despatch to the laboratory for analysis. The drill core samples were mostly collected at one meter intervals in mineralised zones, except in places where lithology change occurs. The samples were further reduced to the desired size of -200 mesh (75 micron) size and despatched to the laboratory.

### **9.10 Chemical analysis and laboratory procedures:**

The samples after submission to Chemical Lab are analysed for their fixed carbon content. Generally proximate analysis is carried out for determination of FC% of graphite. The standard for chemical procedure followed for determination of FC is IS 14852:2000 of Bureau of Indian standard. The process of proximate analysis starts with the freeing of moisture content and determination of volatile matter and ash content. After determination of these 02 parameters, the sum of these two is deducted from 100. The result thus obtained from this is the Fixed carbon.



### **Determination of moisture:**

About 5 gm of the sample is weighed in a tared porcelain dish and covered with a watch glass. Then the dish is placed in an air oven maintained at a temperature  $150 \pm 10^\circ\text{C}$  and removes the watch glass from it. Then the sample is heated for 02 hours in the oven and the dish is covered with the watch glass before it is taken out of the oven. Then the dish is cooled in a desiccator and weighed. The following formulae is used for calculation of moisture content.

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

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

and B= weight in g of the material taken.

### **Determination of volatile matter:**

Nearly 1 g of the moisture free sample is introduced in a weighted volatile matter crucible with tightly fitted lid. Then the crucible is heated in a muffle furnace maintained at temperature of  $925 \pm 250^\circ\text{C}$  for 7 minutes. The bottom of the crucible shall not rest on the floor of the muffle furnace. Then remove the crucible from the muffle furnace after 7 minutes and cool it in a desiccators and weigh. The following formula is used for calculation of volatile matter content.

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

Where, A= loss in weight in g of the moisture free sample after heating up to  $925 \pm 250^\circ\text{C}$

B= weight in g of the moisture free sample taken.

### **Determination of ash:**

Nearly 1 gm of the moisture free sample is taken in a silica crucible, keep the crucible in a muffle furnace and heat to  $500 \pm 100^\circ\text{C}$  within one hour and  $775 \pm 100^\circ\text{C}$  in two hours. A slow stream of air is maintained through the muffle furnace. The temperature is further increased to  $925 \pm 250^\circ\text{C}$  and kept for one hour. Cool it in a

desiccator and weigh the sample. The procedure is repeated till the residue in the crucible is constant in weight. The following formula is used for calculation of ash content.

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

Where, A= Weight of ash in g

and B= weight in of the sample taken.

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

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

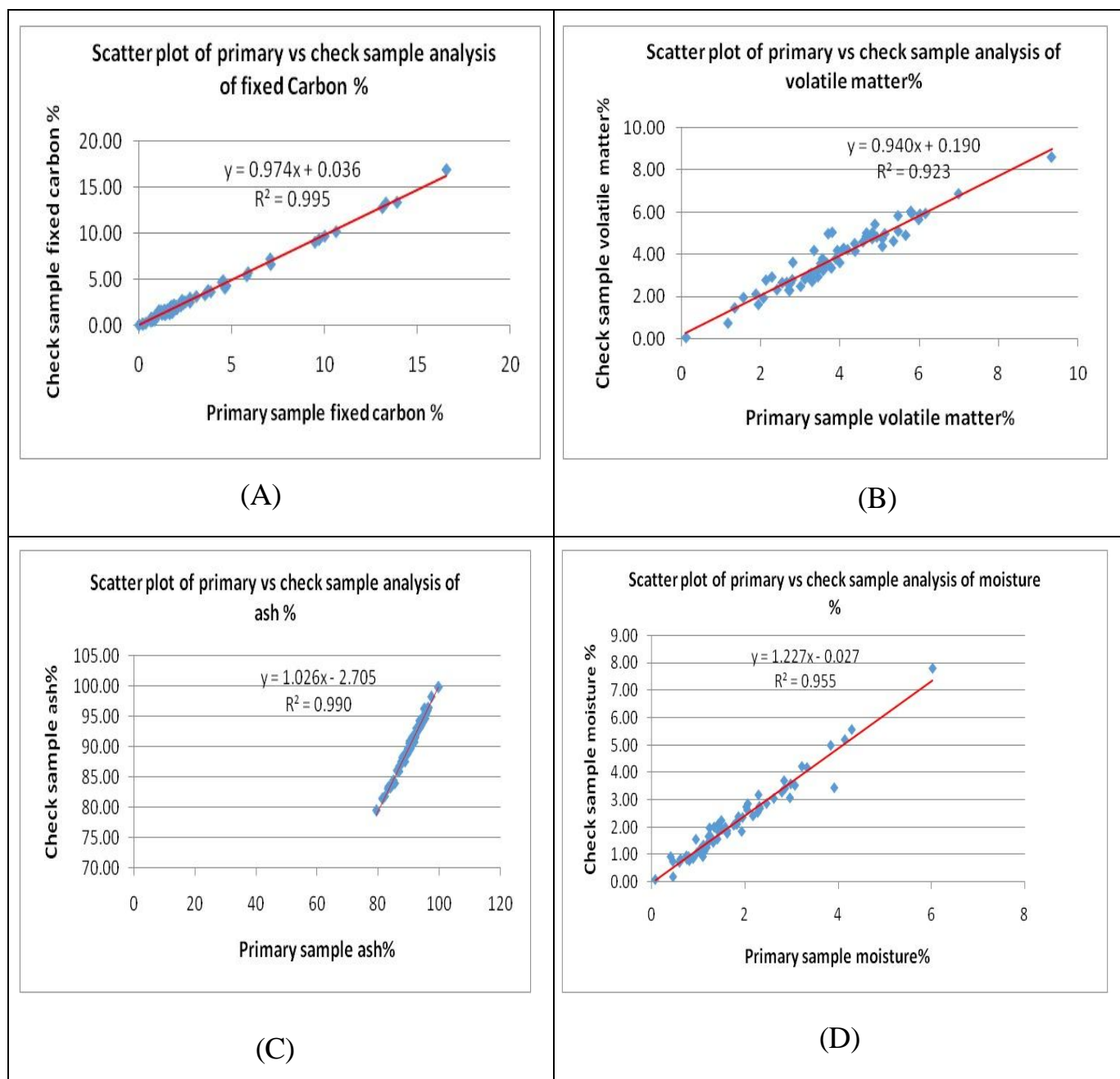
Where, FC= Fixed carbon

VM= Volatile matter

Ash= Ash content.

### 9.11 Check samples

In order to ensure the accuracy of analysis results, the pulp duplicate of core samples were introduced as check samples of at least 10% of total samples. A total of 655 samples comprising all the litho units encountered in the drill core were analysed for 4 components (Moisture%, Volatile Matter%, Ash% and Fixed Carbon %). A total of 65 samples were analysed as check samples with duplicate sample id. The check sample analysis was carried out at JNARDDC, Nagpur. The analysis showed very good correlation with the primary samples. The analysis results of primary and check samples show negligible variability and the laboratory results can be considered as valid and acceptable. The analysis results of the primary samples are presented in ANNEXURE-VII. The scatter plots generated by plotting the primary and check sample data sets are presented in Fig. 9.2.



**Fig. 9.2:** Scatter plots of Primary Vs Check Samples for

(A) Fixed Carbon (FC) % (B) Volatile Matter % (C) Ash % (D) Moisture %

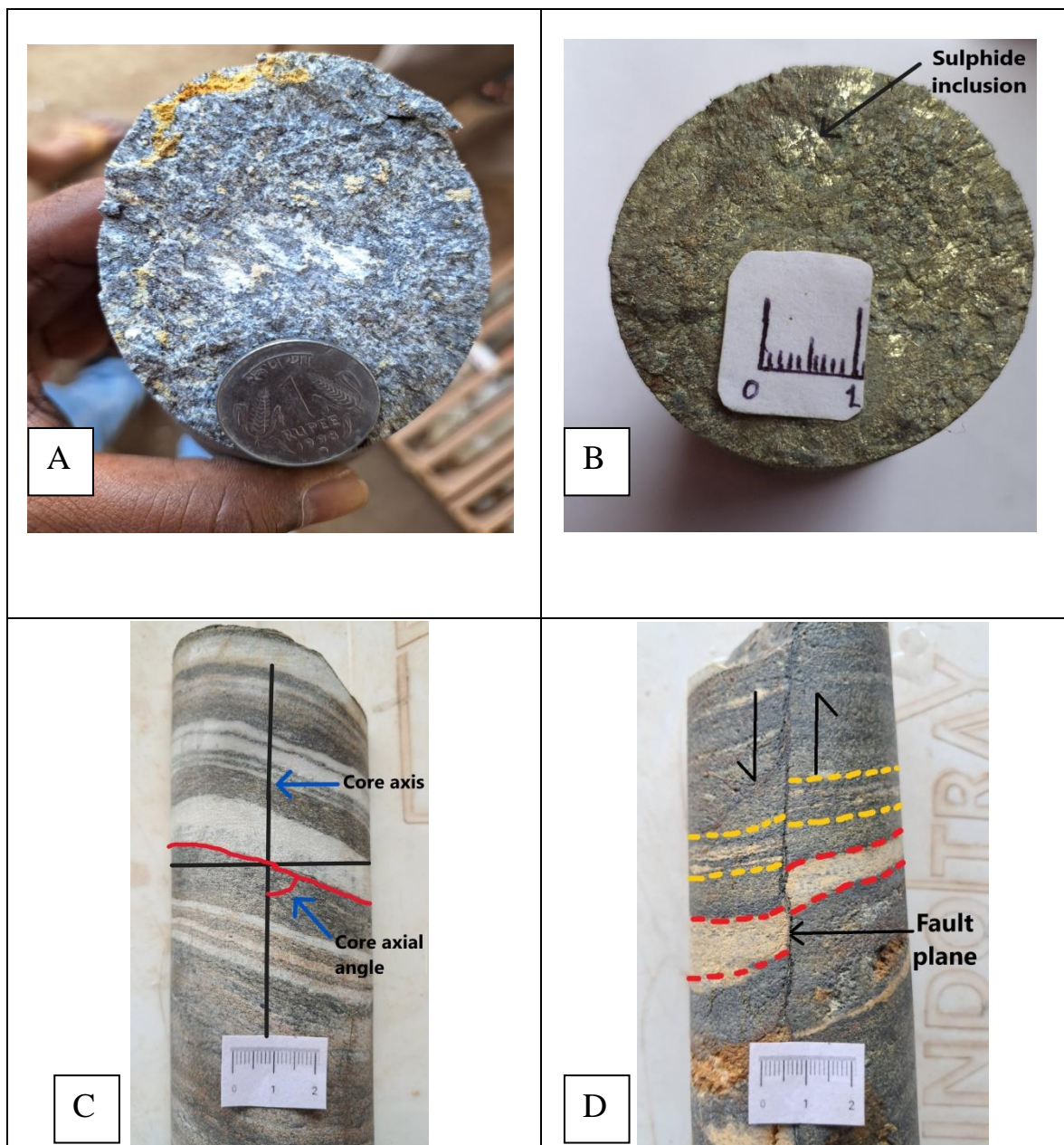
The descriptive statistics of the analytical results is tabulated in Table 9.3.

Table 9.3: descriptive statistics of the analytical results

	<b>Fixed Carbon %(db)</b>	<b>Volatile Matter %(db)</b>	<b>Ash%(db)</b>	<b>Moisture%(ar)</b>
<b>Mean</b>	3.64	3.68	91.02	1.66
<b>Minimum</b>	0.01	0.02	78.00	0.01
<b>Maximum</b>	17.07	9.35	99.91	7.98

## 9.12 Details of intersected ore zones of the boreholes drilled and their correlation

The assay value of drilled core samples shows fixed carbon values between 2.02% and 17.07%. The thickness of the graphite zone varies from 1.0 m to 37.5 m. Eighty-Nine numbers (89 nos.) of graphite lodes are intersected in 13nos. boreholes out of all 17 nos. boreholes. Seven graphite bands are found in borehole LPA/G3/01 which are comprising the FC from 2.16% to 11.58%. Six graphite bands are found in Borehole-LPA/G3/02 having 2.97% to 8.62% of FC. In borehole LPA/G3/05, six graphite bands are obtaining 2.42% to 12.58% of FC. Five graphite bands are found in Borehole-LPA/G3/06 having 3.16% to 5.63% of FC. One graphite loads are found in Borehole-LPA/G3/07 having 6.83% FC. One graphite bands are found in Borehole-LPA/G3/09 having 2.43% FC. In Borehole-LPA/G3/10, twelve graphite bands are obtaining 2.31% to 7.74% of FC. Twelve graphite bands are found in Borehole- LPA/G3/11 having 2.09% to 6.77% of FC. Nine graphite bands are found in Borehole-LPA/G3/12 having 2.67% to 14.32% of FC. Eleven graphite bands are found in Borehole-LPA/G3/13 having 2.02% to 7.16% FC. In Borehole-LPA/G3/14, two graphite bands are obtaining 2.54% to 3.05% of FC. Thirteen graphite bands are found in Borehole- LPA/G3/15 having 2.15% to 7.07% of FC. Four graphite bands are found in Borehole-LPA/G3/16 having 2.81% to 4.21% of FC.



**Fig.9.3:** Core photographs showing different types of graphite mineralisation in the Lamer-Panga block-A.

- A. Core showing graphite bearing granite gneiss in BH No.- LPA/G3/10
- B. Core showing graphite bearing granite gneiss with sulphide minerals in BH No- LPA/G3/11
- C. Core of granite gneiss showing core axis along with axial angle around  $75^\circ$  in BH No.- LPA/G3/13
- D. Core showing fault plane in graphite bearing granite gneiss in BH No.- LPA/G3/15



## CHAPTER 10

### GEOTECHNICAL STUDIES ON BOREHOLE CORE SAMPLES OF MINERALISED ZONE, HANGING WALL AND FOOTWALL SIDE

#### 10.1 Bulk Density

The bulk density of the ore body was determined by the selection of the best representative samples from drill cores. The measurement of the core samples was carried out by water displacement method using the digital weight measuring scale.

- i) Air dry the core sample
- ii) Weight the sample to determine the dry mass (ms).
- iii) Weigh it suspended from a balance in water (ms in water).

$$\text{Bulk Density} = \frac{\text{ms}}{\text{ms} - \text{ms in water}}$$

A total of 05 nos. of representative core samples were submitted to the M/s Inspectorate Griffith India Pvt. Ltd., Bhubaneswar for the analysis bulk density. The bulk density measured for all 05 nos. of the core sample is given in Table 10.1.

**Table 10.1:** Bulk density of various lithological units

Sl. No	Borehole ID	Sample ID	From (m)	To (m)	Thickness (m)	Lithology	Bulk Density (gm/cm <sup>3</sup> )
1	LPA/G3/06	LPA/BD/06-01	38.3	38.4	0.1	Graphite bearing granite gneiss	2.19
2	LPA/G3/10	LPA/BD/10-02	53.3	53.4	0.1	Graphite bearing granite gneiss	2.31
3	LPA/G3/11	LPA/BD/11-03	67	67.1	0.1	Graphite bearing granite gneiss	2.54
4	LPA/G3/12	LPA/BD/12-04	11.7	11.8	0.1	Graphite bearing granite gneiss	2.33
5	LPA/G3/14	LPA/BD/14-05	31.1	31.2	0.1	Graphite bearing granite gneiss	2.34

## 10.2 Rock quality designation (RQD)

Rock Quality Designation (RQD) depends upon the frequency of weak discontinuity in the rock mass—an increase in the frequency grades the rock into low RQD. While drilling, the core is supposed to break along the weak discontinuity planes, and the broken length indicates the planes' frequency. This principle is used to determine the RQD from the drill cores and the following formula has been applied to calculate the RQD of different lithounits.

$$\text{RQD (\%)} = \frac{\text{Cumulative length of core pieces more than 10cm in a run}}{\text{Run length}} \times 100$$

RQD can be graded as Excellent (90-100%), Good (75-90%), Fair (50-75%), Poor (25- 50%) and very poor (<25% RQD).

The RQD of cores of all boreholes drilled in the G3 stage exploration in the Lamer-Panga Block-A area is ranked excellent too good.

## CHAPTER 11

### RESOURCE ESTIMATION

#### 11.1 Detailed description of ore zones

The mineralisation as evidenced on the surface has been discussed earlier. However, the evidence and characteristics as observed from the study of drill core, the following inferences can be drawn regarding the nature and control of graphite mineralisation and behaviour of the ore body.

The graphite mineralisation is mostly associated with graphitic schist as the host rock accompanied by granite gneiss and quartzite as the major gangue. Graphite occurs in the form of dissemination thin flakes within associated rocks. Sulphide mineral veins are observed in some graphite schists. Based on subsurface geological investigation by systematic drilling the graphite bands of all boreholes are interbanded with granite gneiss and the granite gneiss is the material in between economic bands. The description of graphite bands are delineated and analysed which are given below.

1. Seven graphite bands are found in borehole- LPA/G3/01 having 25.83 m thickness with 2.16% to 11.58% of FC.
2. Six graphite bands are found in borehole- LPA/G3/02 having 38.20 m thickness with 2.97% to 8.62% of FC.
3. In borehole LPA/G3/05, six graphite bands are found having 50.29 m thickness with 2.42% to 12.58% of FC.
4. Five graphite bands are found in borehole- LPA/G3/06 having 24.81 m thickness with 3.16% to 5.63% of FC.
5. One graphite band is found in borehole LPA/G3/07 having 3.10 m thickness with 6.83% of FC.
6. One graphite band is found in borehole LPA/G3/09 having 4.00 m thickness with 2.43% of FC.
7. Twelve graphite bands are found in borehole- LPA/G3/10 having 94.95 m thickness with 2.31% to 7.74% of FC.

8. Twelve graphite bands are found in borehole- LPA/G3/11 having 23.30 m thickness with 2.09% to 6.77% of FC.

9. In borehole LPA/G3/12, nine graphite bands are found having 28.10 m thickness with 2.67% to 14.32% of FC.

10. Eleven graphite bands are found in borehole- LPA/G3/13 having 23.00 m thickness with 2.02% to 7.16% of FC.

11. Two graphite bands are found in borehole LPA/G3/14 having 17.60 m thickness with 2.54% to 3.05% of FC.

12. Thirteen graphite bands are found in borehole LPA/G3/15 having 39.50 m thickness with 2.15% to 7.07% of FC.

13. Four graphite bands are found in borehole LPA/G3/16 having 13.00 m thickness with 2.81% to 4.21% of FC.

## **11.2 Cut-off grade consideration**

The nature of graphite occurrence is flaky type in the block area hence, the threshold value of graphite was taken into consideration at 2% FC. The present cut off value is 2 % FC for flaky graphite and 10 % FC for amorphous graphite as per the Gazette of India Notification-REGD. No.D.L.-33004/99 and IBM Notification No. C-284/3/CMG/2017 dated 25.04.2018 (Table 11.1).

## **11.3 Minimum stoping width**

Attempts were made to keep the stoping width at 1m as per mining parameters. However, it could not strictly be adhered to in view of the pinching and swelling nature of mineralisation, besides graphite occurring as enechelon lenses both on the surface and down the dip.

## **11.4 Description and correlation of lodes**

### **Correlation of ore lodes**

The correlation of ore lodes is determined for graphite mineralisation as evidenced by analysis data of surface and core samples. Based on the detailed mapping, 04 nos. of graphite bands have been delineated and the foliation strike is NE- SW direction. The graphite band near the SE part of Lamer is corelated considering the FC% of five borehole nos. LPA/G3/01, LPA/G3/02, LPA/G3/05, LPA/G3/06 and LPA/G3/10. Whereas another three bands in the NW part of Lamer village are correlated considering the FC% of eight borehole nos. LPA/G3/07, LPA/G3/09, LPA/G3/11, LPA/G3/12, LPA/G3/13, LPA/G3/14, LPA/G3/15 and LPA/G3/16. The mineralised zones were intersected in 13nos. of boreholes, though the average values of 6.76% FC. Graphite mineralisations having less than stoping width are not correlated.



## **Description of lodes**

The ore zones were first projected and correlated in sections based on the parameters enumerated below: (1) Projection angle of ore lodes as seen or inferred during the course of core logging. (2) Nature and grade of graphite mineralisation, such as the range FC% is considered i.e. (2-5) % FC and above 5% FC of the intersection of ore lodes from the collar of boreholes and their vertical depth.

### **11.5 Preparation of LV section**

Longitudinal- Vertical sections were prepared and the ore zones were correlated (PLATE No. X).

The following principles have been applied while calculating the resources in LV Section.

1. Considering the cut-off grade of 2% FC for graphite ore resource has been estimated.
2. The core axis vs. foliation (core angle) of the host lithology was considered for calculating the dip of the lodes by assessing the angle of inclination of the borehole and thickness of the zone along the borehole.
4. To avoid overestimation of the resource, only true thickness of individual lode was considered during resource estimation. The true thickness of individual lodes in each borehole was calculated trigonometrically considering by multiplying the apparent thickness (width of the lode along the borehole) and sine of the core axial angle (angle of lode with core axis).
5. The assay content of individual sample by chemical analysis has been combined and weighted average to represent the assay of individual lode of the borehole. Similarly, the average assays of the lodes in a borehole were combined and weighted average to calculate average assay of the borehole. The average assay of different boreholes was combined to calculate weighted average grade of the block.
6. The mineralised zone intersected in individual borehole is projected up to the soil cover, where it is correlated with the lithounit and surface sampling values, if any.

7. The strike influence of the borehole was taken midway between the positive boreholes. However, if there is no borehole on one side yet there is enough exposure to infer the physical continuity of the ore body, the influence on that side was taken 100 m from the positive boreholes, whereas in case if there is no intersection of ore body/ no bore hole, it was taken 1/4th of the interval between two bore holes.

8. The dip influence was calculated by adding the up-dip and the down-dip influences. The up dip length was determined from the borehole's cross-section by projecting the ore zone towards the surface. Due to control over outcrops having bed rock sample, the up dip influence has been considered to extend up to the soil cover. The down-dip lode was taken at 50% of the up-dip length of graphite lodes.

9. The bulk density has been considered as 2.34 gm/cc at NW and SE part of Lamer village based on the results received from the M/s Inspectorate Griffith India (P) Ltd., Bhubaneswar for the resource estimation (Table 10.1).

10. An allowance of loss of 25% has been accounted for considering the sampling as well as recovery error, structural control, mining and geological parameters etc.

### **11.6 Specific gravity/bulk density calculation**

The bulk density was initially determined in graphite mineralisation. Five representative samples were analysed at NABL accredited M/s Inspectorate Griffith India Pvt. Ltd., Bhubaneswar. The tests are performed against the Test Method Specification – IS: 5842/1986, R.A – 2019. The corresponding average bulk density of graphite was taken into consideration for resource estimation. The details of bulk density samples along with the corresponding test results are tabulated Table 10.1 and the laboratory certified results are presented in ANNEXURE-IX.

## 11.7 Assumption for resource estimation

A total of 17 inclined boreholes with a total meterage of 883 m of systematic drilling were drilled at an interval of about 200m over the block area. The collar data of all the boreholes were surveyed by DGPS. Altogether, 655 nos. of drill core samples were analysed. The Quality check of the laboratory analysis has been verified by inserting 65 nos. of check samples along with the primary samples. The results are found to be valid.

The data from previous exploration by GSI has been referred for the current investigation and this study area has been mapped on large scale mapping (Scale 1:12,500). There was no drilling carried out by GSI and no resource was estimated in this block. So, it is not integrated with the current exploration data for assessment of the resources. The strike influence on either side of the borehole, generally 100 m length on both directions was considered for calculation of the volume of the ore body.

The threshold value of graphite is defined with 2% FC minimum for flaky ores. So 2% grade of FC content is considered for the estimation of resources in this block. It is noticed that the dissemination of flaky graphite less than 2% FC occurs within granite gneiss and quartzite in this study area. However, these very low-grade ore below 2% FC are not considered for resource estimation.

As per The Gazette of India Notification-REGD. No.D.L.-33004/99 and IBM Notification No. C-284/3/CMG/2017 dated 25.04.2018, the threshold value of flake graphite is 2% FC and 10% for amorphous graphite. Flaky varieties of graphite mineralisation are observed in the study area; hence graphite resource has been estimated at cut off 2% FC however, the resource estimation is calculated at cut off 2% FC.

As per the IBM notification, different grades of graphite and corresponding threshold values is tabulated in Table 11.1.

**Table 11.1:** Grades of graphite and corresponding threshold values

Sl. No	Graphite	Threshold values
1	For flaky variety	2% Fixed Carbon (FC) (Minimum)
2	For amorphous variety	10% Fixed Carbon (FC) (Minimum)

No by-products are assumed at this stage of investigation. The estimation of resources in Lamer-Panga block-A has been carried out in both Cross Sectional Area Method and Longitudinal Vertical Section Method.

### 11.8 Resource estimation by cross sectional area method

The geological and ore body intersection data derived from the geology map of scale 1:4000 and the assay results from the 17 boreholes of systematic drilling were correlated to prepare the two-dimensional slice of the subsurface data. In order to calculate the cross sectional area of the graphite bands, the cross sections were drawn across the foliation in N40°W direction in 200 m interval for the entire block. Seventeen (17) nos. of Cross section viz. A-A'' to Q-Q'' comprising all the boreholes have been prepared considering the foliation of the terrain. An appropriate scale of 1:1000 was maintained for both the horizontal and vertical scale of the cross sections.

The data obtained from geological mapping, surface sampling, core logging and chemical analysis are used to estimate the resource. The ore intersection zones and geological information between all the boreholes in each section lines were transformed into the profile to prepare the two-dimensional slice of the subsurface data and further, the volume is calculated. The tonnage of graphite in each section is calculated by multiplying volume with its bulk density.

The cross sections were prepared by using AutoCAD (Autodesk Civil 3D) software. The geological map was prepared by ArcGIS 10.7. The resource estimation of the Lamer-Panga block-A has been carried out using the conventional Cross Sectional Area method.

The lithological units identified in geological mapping of the block has been validated using the chemical analysis of the surface samples collected during the mapping programme. The litho-units of the drill core have been initially interpreted based on the visual inspection and the same has been updated after the chemical analysis. The quality of the analysis has been validated by inserting 10% of check samples.

The following processes have been applied for calculating the resources in Cross Sectional Area method.

1. The range wise FC% of graphite bands for sectional area were calculated using AutoCAD Software.
2. The dip influence was calculated by adding the up-dip and the down-dip influences. The up dip length was determined from the borehole's cross-section by projecting the ore zone towards the surface. Due to control over outcrops having bed rock sample, the up-dip influence has been considered to extend up to the surface. The down-dip lode was taken at 50% of the up-dip length of graphite lodes.
3. The volume of graphite band is calculated by multiplying the area and the foliation influence of graphite band.
4. However, the tonnage of the ore (resource) in each section is calculated by multiplying volume with tonnage factor (bulk density).
5. Bulk density of dissemination of flakes of graphite bearing rock has been taken as 2.34 gm/cc.
6. An allowance of loss of 25% has been accounted for considering the sampling as well as recovery error, structural control, mining and geological parameters etc.



## Reporting of resource by cross-section

Among all the 17 number of sections, the section A-A'' to Q-Q'' is elongated along NW-SE direction. The average core recovery of all the boreholes comprises 88.76% in where the core recovery 91.98% in mineralized zone. The grade of recovery length is taken as the grade of run with the assumption that the uncovered portion also contains the same assay value. However, an allowance of loss of 25% has been accounted for considering the sampling as well as recovery error, structural control, mining and geological parameters etc.

A total of 0.127 sq. km graphite mineralisation area has been demarcated from the entire Lamer-Panga Block-A (G3). Geological cross-sections (A-A'' to Q-Q'') is presented on PLATE No. IX.

**Table 11.2:** Section-wise Resource calculation chart by Cross Sectional Area Method at cut off 2% FC in Lamer-Panga Block-A (G3)

RESOURCE ESTIMATION AT CUT OFF 2% FC IN LAMER-PANGA BLOCK-A							
Name of the Section	Band No.	Area of ore body (in sq. m)	Influence length (in m)	Volume (in Cum)	Bulk Density (gm/cum)	Grade (FC%)	Tonnage
Section-AA`	Band No. 1	69.4002	200.94	13945.276	2.34	2.70	32631.946
Section-AA`	Band No. 2	82.1969	200.94	16516.645	2.34	6.84	38648.950
Section-AA`	Band No. 3	31.6619	200.94	6362.142	2.34	8.70	14887.413
Section-AA`	Band No. 4	36.4794	200.94	7330.171	2.34	2.16	17152.599
Section-AA`	Band No. 5	112.0986	200.94	22525.093	2.34	11.58	52708.717
Section-AA`	Band No. 6	56.4214	200.94	11337.316	2.34	2.51	26529.320
Section-AA`	Band No. 7	150.1657	200.94	30174.296	2.34	7.13	70607.852
Section-BB`	Band No. 1	4.5661	163.39	746.055	2.34	3.03	1745.769
Section-BB`	Band No. 2	21.4368	163.39	3502.559	2.34	4.41	8195.987
Section-BB`	Band No. 3	138.2274	163.39	22584.975	2.34	8.62	52848.841
Section-BB`	Band No. 4	57.8513	163.39	9452.324	2.34	2.97	22118.438
Section-BB`	Band No. 5	603.1016	163.39	98540.770	2.34	5.84	230585.403
Section-BB`	Band No. 6	246.1315	163.39	40215.426	2.34	3.62	94104.096
Section-EE`	Band No. 1	16.9224	220.65	3733.928	2.34	10.56	8737.390
Section-EE`	Band No. 2	14.1244	220.65	3116.549	2.34	2.42	7292.724
Section-EE`	Band No. 3	9.8486	220.65	2173.094	2.34	11.78	5085.039
Section-EE`	Band No. 4	38.4167	220.65	8476.645	2.34	9.54	19835.349

Section-EE`	Band No. 5	306.8566	220.65	67707.909	2.34	13.58	158436.507
Section-EE`	Band No. 6	580.4468	220.65	128075.586	2.34	10.62	299696.872
Section-FF`	Band No. 1	2.7084	219.96	595.740	2.34	3.34	1394.031
Section-FF`	Band No. 2	71.2655	219.96	15675.559	2.34	3.22	36680.809
Section-FF`	Band No. 3	16.6512	219.96	3662.598	2.34	3.45	8570.479
Section-FF`	Band No. 4	369.2656	219.96	81223.661	2.34	3.16	190063.368
Section-FF`	Band No. 5	56.0696	219.96	12333.069	2.34	5.63	28859.382
Section-GG`	Band No. 1	34.1633	146.09	4990.916	2.34	6.83	11678.745
Section-II`	Band No. 1	109.659	146.09	16020.083	2.34	2.43	37486.995
Section-JJ`	Band No. 1	1.0231	111.76	114.342	2.34	3.77	267.559
Section-JJ`	Band No. 2	1.8068	111.76	201.928	2.34	3.15	472.511
Section-JJ`	Band No. 3	9.0169	111.76	1007.729	2.34	6.49	2358.085
Section-JJ`	Band No. 4	54.5441	111.76	6095.849	2.34	2.92	14264.286
Section-JJ`	Band No. 5	58.4829	111.76	6536.049	2.34	3.34	15294.354
Section-JJ`	Band No. 6	40.16	111.76	4488.282	2.34	6.47	10502.579
Section-JJ`	Band No. 7	151.6192	111.76	16944.962	2.34	2.91	39651.211
Section-JJ`	Band No. 8	46.3049	111.76	5175.036	2.34	5.59	12109.583
Section-JJ`	Band No. 9	1426.1403	111.76	159385.440	2.34	6.68	372961.929
Section-JJ`	Band No. 10	95.0592	111.76	10623.816	2.34	4.79	24859.730
Section-JJ`	Band No. 11	3423.1235	111.76	382568.282	2.34	7.74	895209.781
Section-JJ`	Band No. 12	252.9891	106	26816.845	2.34	2.31	62751.416
Section-KK`	Band No. 1	5.4331	100	543.310	2.34	2.31	1271.345
Section-KK`	Band No. 2	30.8448	100	3084.480	2.34	5.93	7217.683
Section-KK`	Band No. 3	31.4082	100	3140.820	2.34	5.26	7349.519
Section-KK`	Band No. 4	60.6139	100	6061.390	2.34	3.21	14183.653
Section-KK`	Band No. 5	26.4094	100	2640.940	2.34	2.09	6179.800
Section-KK`	Band No. 6	56.7787	100	5677.870	2.34	2.11	13286.216
Section-KK`	Band No. 7	30.5722	100	3057.220	2.34	6.77	7153.895
Section-KK`	Band No. 8	27.4257	100	2742.570	2.34	4.04	6417.614
Section-KK`	Band No. 9	91.5615	100	9156.150	2.34	5.39	21425.391
Section-KK`	Band No. 10	118.221	100	11822.100	2.34	3.48	27663.714
Section-KK`	Band No. 11	101.9335	100	10193.350	2.34	2.98	23852.439
Section-KK`	Band No. 12	88.3832	100	8838.320	2.34	2.40	20681.669
Section-LL`	Band No. 1	17.3655	201.91	3506.268	2.34	8.32	8204.667
Section-LL`	Band No. 2	19.4931	201.91	3935.852	2.34	2.67	9209.893
Section-LL`	Band No. 3	9.297	201.91	1877.157	2.34	5.01	4392.548
Section-LL`	Band No. 4	12.4313	201.91	2510.004	2.34	4.60	5873.409
Section-LL`	Band No. 5	95.4853	201.91	19279.437	2.34	6.26	45113.882
Section-LL`	Band No. 6	41.2826	201.91	8335.370	2.34	3.65	19504.765
Section-LL`	Band No. 7	33.2493	201.91	6713.366	2.34	14.32	15709.277
Section-LL`	Band No. 8	28.3261	201.91	5719.323	2.34	2.73	13383.215
Section-LL`	Band No. 9	255.1513	201.91	51517.599	2.34	2.86	120551.182
Section-MM`	Band No. 1	9.0669	202.52	1836.229	2.34	3.56	4296.775
Section-MM`	Band No. 2	19.3248	202.52	3913.658	2.34	5.08	9157.961

Section-MM`	Band No. 3	21.916	202.52	4438.428	2.34	3.48	10385.922
Section-MM`	Band No. 4	18.6141	202.52	3769.728	2.34	2.02	8821.162
Section-MM`	Band No. 5	39.7163	202.52	8043.345	2.34	2.85	18821.427
Section-MM`	Band No. 6	74.0183	202.52	14990.186	2.34	2.05	35077.036
Section-MM`	Band No. 7	121.8139	202.52	24669.751	2.34	7.16	57727.217
Section-MM`	Band No. 8	101.5147	202.52	20558.757	2.34	5.65	48107.491
Section-MM`	Band No. 9	40.6461	202.52	8231.648	2.34	2.31	19262.057
Section-MM`	Band No. 10	48.7849	202.52	9879.918	2.34	5.54	23119.008
Section-MM`	Band No. 11	132.1643	202.52	26765.914	2.34	2.35	62632.239
Section-NN`	Band No. 1	19.4381	200.03	3888.203	2.34	3.05	9098.395
Section-NN`	Band No.2	279.3336	200.03	55875.100	2.34	2.54	130747.734
Section-OO`	Band No.1	160.829	149.39	24026.244	2.34	2.45	56221.412
Section-OO`	Band No. 2	15.9611	149.39	2384.429	2.34	2.53	5579.563
Section-OO`	Band No. 3	16.5792	149.39	2476.767	2.34	5.50	5795.634
Section-OO`	Band No. 4	16.1167	149.39	2407.674	2.34	4.47	5633.957
Section-OO`	Band No. 5	18.6972	149.39	2793.175	2.34	2.15	6536.029
Section-OO`	Band No. 6	21.2894	149.39	3180.423	2.34	6.18	7442.191
Section-OO`	Band No.7	143.0913	149.39	21376.409	2.34	3.22	50020.798
Section-OO`	Band No. 8	67.4604	149.39	10077.909	2.34	6.83	23582.307
Section-OO`	Band No. 9	47.4306	149.39	7085.657	2.34	3.26	16580.438
Section-OO`	Band No. 10	168.7233	149.39	25205.574	2.34	6.25	58981.043
Section-OO`	Band No. 11	47.9517	149.39	7163.504	2.34	2.25	16762.600
Section-OO`	Band No. 12	40.3092	149.39	6021.791	2.34	7.07	14090.992
Section-OO`	Band No. 13	22.3967	149.39	3345.843	2.34	2.26	7829.273
Section-PP`	Band No. 1	36.9269	152.29	5623.598	2.34	2.81	13159.218
Section-PP`	Band No. 2	68.5579	152.29	10440.683	2.34	3.51	24431.197
Section-PP`	Band No. 3	35.7738	152.29	5447.992	2.34	3.98	12748.301
Section-PP`	Band No. 4	118.3	152.29	18015.907	2.34	4.21	42157.222
<b>TOTAL</b>		<b>11950.820</b>	<b>-</b>	<b>1765264.283</b>	<b>2.34</b>	<b>-</b>	<b>4130718.423</b>
<b>Reduction of 25% towards accuracy in recovery, sampling, structural control and other variables</b>							<b>1032679.606</b>
<b>Preliminary resource of graphite (in tonnes)</b>							<b>3098038.817</b>
<b>Resource (in million tonnes)</b>							<b>3.098038817</b>

**Table 11.3:** Resource estimation at cut off 2% FC in northwest of Lamer Village (NW Zone)

RESOURCE ESTIMATION AT CUT OFF 2% FC IN NORTH -WEST OF LAMER VILLAGE (NW ZONE)							
Name of the Section	Band No.	Area of ore body (in sq. m)	Influence length (in m)	Volume (in Cum)	Bulk Density (gm/cum)	Grade (FC%)	Tonnage
Section-GG`	Band No. 1	34.1633	146.09	4990.916	2.34	6.83	11678.745
Section-II`	Band No. 1	109.659	146.09	16020.083	2.34	2.43	37486.995
Section-KK`	Band No. 1	5.4331	100	543.310	2.34	2.31	1271.345
Section-KK`	Band No. 2	30.8448	100	3084.480	2.34	5.93	7217.683
Section-KK`	Band No. 3	31.4082	100	3140.820	2.34	5.26	7349.519
Section-KK`	Band No. 4	60.6139	100	6061.390	2.34	3.21	14183.653
Section-KK`	Band No. 5	26.4094	100	2640.940	2.34	2.09	6179.800
Section-KK`	Band No. 6	56.7787	100	5677.870	2.34	2.11	13286.216
Section-KK`	Band No. 7	30.5722	100	3057.220	2.34	6.77	7153.895
Section-KK`	Band No. 8	27.4257	100	2742.570	2.34	4.04	6417.614
Section-KK`	Band No. 9	91.5615	100	9156.150	2.34	5.39	21425.391
Section-KK`	Band No. 10	118.221	100	11822.100	2.34	3.48	27663.714
Section-KK`	Band No. 11	101.9335	100	10193.350	2.34	2.98	23852.439
Section-KK`	Band No. 12	88.3832	100	8838.320	2.34	2.40	20681.669
Section-LL`	Band No. 1	17.3655	201.91	3506.268	2.34	8.32	8204.667
Section-LL`	Band No. 2	19.4931	201.91	3935.852	2.34	2.67	9209.893
Section-LL`	Band No. 3	9.297	201.91	1877.157	2.34	5.01	4392.548
Section-LL`	Band No. 4	12.4313	201.91	2510.004	2.34	4.60	5873.409
Section-LL`	Band No. 5	95.4853	201.91	19279.437	2.34	6.26	45113.882
Section-LL`	Band No. 6	41.2826	201.91	8335.370	2.34	3.65	19504.765
Section-LL`	Band No. 7	33.2493	201.91	6713.366	2.34	14.32	15709.277
Section-LL`	Band No. 8	28.3261	201.91	5719.323	2.34	2.73	13383.215
Section-LL`	Band No. 9	255.1513	201.91	51517.599	2.34	2.86	120551.182
Section-MM`	Band No. 1	9.0669	202.52	1836.229	2.34	3.56	4296.775
Section-MM`	Band No. 2	19.3248	202.52	3913.658	2.34	5.08	9157.961
Section-MM`	Band No. 3	21.916	202.52	4438.428	2.34	3.48	10385.922
Section-MM`	Band No. 4	18.6141	202.52	3769.728	2.34	2.02	8821.162
Section-MM`	Band No. 5	39.7163	202.52	8043.345	2.34	2.85	18821.427
Section-MM`	Band No. 6	74.0183	202.52	14990.186	2.34	2.05	35077.036
Section-MM`	Band No. 7	121.8139	202.52	24669.751	2.34	7.16	57727.217
Section-MM`	Band No. 8	101.5147	202.52	20558.757	2.34	5.65	48107.491
Section-MM`	Band No. 9	40.6461	202.52	8231.648	2.34	2.31	19262.057
Section-MM`	Band No. 10	48.7849	202.52	9879.918	2.34	5.54	23119.008
Section-MM`	Band No. 11	132.1643	202.52	26765.914	2.34	2.35	62632.239
Section-NN`	Band No. 1	19.4381	200.03	3888.203	2.34	3.05	9098.395

Section-NN`	Band No.2	279.3336	200.03	55875.100	2.34	2.54	130747.734
Section-OO`	Band No.1	160.829	149.39	24026.244	2.34	2.45	56221.412
Section-OO`	Band No. 2	15.9611	149.39	2384.429	2.34	2.53	5579.563
Section-OO`	Band No. 3	16.5792	149.39	2476.767	2.34	5.50	5795.634
Section-OO`	Band No. 4	16.1167	149.39	2407.674	2.34	4.47	5633.957
Section-OO`	Band No. 5	18.6972	149.39	2793.175	2.34	2.15	6536.029
Section-OO`	Band No. 6	21.2894	149.39	3180.423	2.34	6.18	7442.191
Section-OO`	Band No.7	143.0913	149.39	21376.409	2.34	3.22	50020.798
Section-OO`	Band No. 8	67.4604	149.39	10077.909	2.34	6.83	23582.307
Section-OO`	Band No. 9	47.4306	149.39	7085.657	2.34	3.26	16580.438
Section-OO`	Band No. 10	168.7233	149.39	25205.574	2.34	6.25	58981.043
Section-OO`	Band No. 11	47.9517	149.39	7163.504	2.34	2.25	16762.600
Section-OO`	Band No. 12	40.3092	149.39	6021.791	2.34	7.07	14090.992
Section-OO`	Band No. 13	22.3967	149.39	3345.843	2.34	2.26	7829.273
Section-PP`	Band No. 1	36.9269	152.29	5623.598	2.34	2.81	13159.218
Section-PP`	Band No. 2	68.5579	152.29	10440.683	2.34	3.51	24431.197
Section-PP`	Band No. 3	35.7738	152.29	5447.992	2.34	3.98	12748.301
Section-PP`	Band No. 4	118.3	152.29	18015.907	2.34	4.21	42157.222
<b>TOTAL</b>		<b>3298.235</b>	<b>-</b>	<b>535298.340</b>	<b>2.34</b>	<b>-</b>	<b>1252598.116</b>
<b>Reduction of 25% towards accuracy in recovery, sampling, structural control and other variables</b>							<b>313149.529</b>
<b>Preliminary resource of graphite (in tonnes)</b>							<b>939448.587</b>
<b>Resource (in million tonnes)</b>							<b>0.939</b>

**Table 11.4:** Resource estimation at cut off 2% FC in southeast of Lamer Village (SE Zone)

<b>RESOURCE ESTIMATION AT CUT OFF 2% FC IN SOUTH -EAST OF LAMER VILLAGE (SE ZONE)</b>							
<b>Name of the Section</b>	<b>Band No.</b>	<b>Area of ore body (in sq. m)</b>	<b>Influence length (in m)</b>	<b>Volume (in Cum)</b>	<b>Bulk Density (gm/cum)</b>	<b>Grade (FC%)</b>	<b>Tonnage</b>
Section-AA`	Band No. 1	69.400	200.94	13945.276	2.34	2.70	32631.946
Section-AA`	Band No. 2	82.197	200.94	16516.645	2.34	6.84	38648.950
Section-AA`	Band No. 3	31.662	200.94	6362.142	2.34	8.70	14887.413
Section-AA`	Band No. 4	36.479	200.94	7330.171	2.34	2.16	17152.599
Section-AA`	Band No. 5	112.099	200.94	22525.093	2.34	11.58	52708.717
Section-AA`	Band No. 6	56.421	200.94	11337.316	2.34	2.51	26529.320
Section-AA`	Band No. 7	150.166	200.94	30174.296	2.34	7.13	70607.852
Section-BB`	Band No. 1	4.566	163.39	746.055	2.34	3.03	1745.769
Section-BB`	Band No. 2	21.437	163.39	3502.559	2.34	4.41	8195.987
Section-BB`	Band No. 3	138.227	163.39	22584.975	2.34	8.62	52848.841



Section-BB`	Band No. 4	57.851	163.39	9452.324	2.34	2.97	22118.438
Section-BB`	Band No. 5	603.102	163.39	98540.770	2.34	5.84	230585.403
Section-BB`	Band No. 6	246.132	163.39	40215.426	2.34	3.62	94104.096
Section-EE`	Band No. 1	16.922	220.65	3733.928	2.34	10.56	8737.390
Section-EE`	Band No. 2	14.124	220.65	3116.549	2.34	2.42	7292.724
Section-EE`	Band No. 3	9.849	220.65	2173.094	2.34	11.78	5085.039
Section-EE`	Band No. 4	38.417	220.65	8476.645	2.34	9.54	19835.349
Section-EE`	Band No. 5	306.857	220.65	67707.909	2.34	13.58	158436.507
Section-EE`	Band No. 6	580.447	220.65	128075.586	2.34	10.62	299696.872
Section-FF`	Band No. 1	2.708	219.96	595.740	2.34	3.34	1394.031
Section-FF`	Band No. 2	71.266	219.96	15675.559	2.34	3.22	36680.809
Section-FF`	Band No. 3	16.651	219.96	3662.598	2.34	3.45	8570.479
Section-FF`	Band No. 4	369.266	219.96	81223.661	2.34	3.16	190063.368
Section-FF`	Band No. 5	56.070	219.96	12333.069	2.34	5.63	28859.382
Section-JJ`	Band No. 1	1.023	111.76	114.342	2.34	3.77	267.559
Section-JJ`	Band No. 2	1.807	111.76	201.928	2.34	3.15	472.511
Section-JJ`	Band No. 3	9.017	111.76	1007.729	2.34	6.49	2358.085
Section-JJ`	Band No. 4	54.544	111.76	6095.849	2.34	2.92	14264.286
Section-JJ`	Band No. 5	58.483	111.76	6536.049	2.34	3.34	15294.354
Section-JJ`	Band No. 6	40.160	111.76	4488.282	2.34	6.47	10502.579
Section-JJ`	Band No. 7	151.619	111.76	16944.962	2.34	2.91	39651.211
Section-JJ`	Band No. 8	46.305	111.76	5175.036	2.34	5.59	12109.583
Section-JJ`	Band No. 9	1426.140	111.76	159385.440	2.34	6.68	372961.929
Section-JJ`	Band No. 10	95.059	111.76	10623.816	2.34	4.79	24859.730
Section-JJ`	Band No. 11	3423.124	111.76	382568.282	2.34	7.74	895209.781
Section-JJ`	Band No. 12	252.989	106	26816.845	2.34	2.31	62751.416
<b>TOTAL</b>		<b>8652.585</b>		<b>1229965.943</b>	<b>2.34</b>		<b>2878120.307</b>
<b>Reduction of 25% towards accuracy in recovery, sampling, structural control and other variables</b>							<b>719530.077</b>
<b>Preliminary resource of graphite (in tonnes)</b>							<b>2158590.230</b>
<b>Resource (in million tonnes)</b>							<b>2.159</b>

In this context, above 5% FC has been estimated to know the better quality of grade of the total resource ( cut off 2% FC) and also separately estimated the two zones i.e north-west of Lamer village (NW zone) and south-east of Lamer village (SE zone) in the Lamer-Panga Block-A for graphite. The following tables are showing the resource above 5% FC (Table 11.5) in two zones (Table 11.6 and Table 11.7).

**Table 11.5:** Section-wise Resource calculation chart by Cross Sectional Area Method  
above 5 % FC of Lamer-Panga Block-A (G3)

RESOURCE ESTIMATION > 5% FC IN LAMER-PANGA BLOCK-A							
Name of the Section	Band No.	Area of ore body (in sq. m)	Influence length (in m)	Volume (in Cum)	Bulk Density (gm/cum)	Grade (FC%)	Tonnage
Section-AA`	Band No. 2	82.1969	200.94	16516.645	2.34	6.84	38648.950
Section-AA`	Band No. 3	31.6619	200.94	6362.142	2.34	8.70	14887.413
Section-AA`	Band No. 5	112.0986	200.94	22525.093	2.34	11.58	52708.717
Section-AA`	Band No. 7	150.1657	200.94	30174.296	2.34	7.13	70607.852
Section-BB`	Band No. 3	138.2274	163.39	22584.975	2.34	8.62	52848.841
Section-BB`	Band No. 5	603.1016	163.39	98540.770	2.34	5.84	230585.403
Section-EE`	Band No. 1	16.9224	220.65	3733.928	2.34	10.56	8737.390
Section-EE`	Band No. 3	9.8486	220.65	2173.094	2.34	11.78	5085.039
Section-EE`	Band No. 4	38.4167	220.65	8476.645	2.34	9.54	19835.349
Section-EE`	Band No. 5	306.8566	220.65	67707.909	2.34	13.58	158436.507
Section-EE`	Band No. 6	580.4468	220.65	128075.586	2.34	10.62	299696.872
Section-FF`	Band No. 5	56.0696	219.96	12333.069	2.34	5.63	28859.382
Section-GG`	Band No. 1	34.1633	146.09	4990.916	2.34	6.83	11678.745
Section-JJ`	Band No. 3	9.0169	111.76	1007.729	2.34	6.49	2358.085
Section-JJ`	Band No. 6	40.16	111.76	4488.282	2.34	6.47	10502.579
Section-JJ`	Band No. 8	46.3049	111.76	5175.036	2.34	5.59	12109.583
Section-JJ`	Band No. 9	1426.1403	111.76	159385.440	2.34	6.68	372961.929
Section-JJ`	Band No. 11	3423.1235	111.76	382568.282	2.34	7.74	895209.781
Section-KK`	Band No. 2	30.8448	100	3084.480	2.34	5.93	7217.683
Section-KK`	Band No. 3	31.4082	100	3140.820	2.34	5.26	7349.519
Section-KK`	Band No. 7	30.5722	100	3057.220	2.34	6.77	7153.895
Section-KK`	Band No. 9	91.5615	100	9156.150	2.34	5.39	21425.391
Section-LL`	Band No. 1	17.3655	201.91	3506.268	2.34	8.32	8204.667
Section-LL`	Band No. 3	9.297	201.91	1877.157	2.34	5.01	4392.548
Section-LL`	Band No. 5	95.4853	201.91	19279.437	2.34	6.26	45113.882
Section-LL`	Band No. 7	33.2493	201.91	6713.366	2.34	14.32	15709.277
Section-MM`	Band No. 2	19.3248	202.52	3913.658	2.34	5.08	9157.961
Section-MM`	Band No. 7	121.8139	202.52	24669.751	2.34	7.16	57727.217
Section-MM`	Band No. 8	101.5147	202.52	20558.757	2.34	5.65	48107.491
Section-MM`	Band No. 10	48.7849	202.52	9879.918	2.34	5.54	23119.008
Section-OO`	Band No. 3	16.5792	149.39	2476.767	2.34	5.50	5795.634
Section-OO`	Band No. 6	21.2894	149.39	3180.423	2.34	6.18	7442.191
Section-OO`	Band No. 8	67.4604	149.39	10077.909	2.34	6.83	23582.307
Section-OO`	Band No. 10	168.7233	149.39	25205.574	2.34	6.25	58981.043

Section-OO`	Band No. 12	40.3092	149.39	6021.791	2.34	7.07	14090.992
<b>TOTAL</b>		<b>8050.505</b>	<b>-</b>	<b>1132619.284</b>	<b>2.34</b>	<b>-</b>	<b>2650329.124</b>
<b>Reduction of 25% towards accuracy in recovery, sampling, structural control and other variables</b>							<b>662582.281</b>
<b>Preliminary resource of graphite (in tonnes)</b>							<b>1987746.843</b>
<b>Resource (in million tonnes)</b>							<b>1.988</b>

**Table 11.6:** Resource estimation above 5% FC in northwest of Lamer Village (NW Zone)

<b>RESOURCE ESTIMATION &gt; 5% FC IN NORTH -WEST OF LAMER VILLAGE (NW ZONE)</b>							
<b>Name of the Section</b>	<b>Band No.</b>	<b>Area of ore body (in sq. m)</b>	<b>Influence length (in m)</b>	<b>Volume (in Cum)</b>	<b>Bulk Density (gm/cum)</b>	<b>Grade (FC%)</b>	<b>Tonnage</b>
Section-GG`	Band No. 1	34.1633	146.09	4990.916	2.34	6.83	11678.745
Section-KK`	Band No. 2	30.8448	100	3084.480	2.34	5.93	7217.683
Section-KK`	Band No. 3	31.4082	100	3140.820	2.34	5.26	7349.519
Section-KK`	Band No. 7	30.5722	100	3057.220	2.34	6.77	7153.895
Section-KK`	Band No. 9	91.5615	100	9156.150	2.34	5.39	21425.391
Section-LL`	Band No. 1	17.3655	201.91	3506.268	2.34	8.32	8204.667
Section-LL`	Band No. 3	9.297	201.91	1877.157	2.34	5.01	4392.548
Section-LL`	Band No. 5	95.4853	201.91	19279.437	2.34	6.26	45113.882
Section-LL`	Band No. 7	33.2493	201.91	6713.366	2.34	14.32	15709.277
Section-MM`	Band No. 2	19.3248	202.52	3913.658	2.34	5.08	9157.961
Section-MM`	Band No. 7	121.8139	202.52	24669.751	2.34	7.16	57727.217
Section-MM`	Band No. 8	101.5147	202.52	20558.757	2.34	5.65	48107.491
Section-MM`	Band No. 10	48.7849	202.52	9879.918	2.34	5.54	23119.008
Section-OO`	Band No. 3	16.5792	149.39	2476.767	2.34	5.50	5795.634
Section-OO`	Band No. 6	21.2894	149.39	3180.423	2.34	6.18	7442.191
Section-OO`	Band No. 8	67.4604	149.39	10077.909	2.34	6.83	23582.307
Section-OO`	Band No. 10	168.7233	149.39	25205.574	2.34	6.25	58981.043
Section-OO`	Band No. 12	40.3092	149.39	6021.791	2.34	7.07	14090.992
<b>TOTAL</b>		<b>979.747</b>	<b>-</b>	<b>160790.364</b>	<b>2.34</b>	<b>-</b>	<b>376249.452</b>
<b>Reduction of 25% towards accuracy in recovery, sampling, structural control and other variables</b>							<b>94062.363</b>
<b>Preliminary resource of graphite (in tonnes)</b>							<b>282187.089</b>
<b>Resource (in million tonnes)</b>							<b>0.282</b>

**Table 11.7:** Resource estimation above 5% FC in southeast of Lamer Village (SE Zone)

<b>RESOURCE ESTIMATION &gt; 5% FC IN SOUTH -EAST OF LAMER VILLAGE (SE ZONE)</b>							
<b>Name of the Section</b>	<b>Band No.</b>	<b>Area of ore body (in sq. m)</b>	<b>Influence length (in m)</b>	<b>Volume (in Cum)</b>	<b>Bulk Density (gm/cum)</b>	<b>Grade (FC%)</b>	<b>Tonnage</b>
Section-AA`	Band No. 2	82.1969	200.94	16516.645	2.34	6.84	38648.950
Section-AA`	Band No. 3	31.6619	200.94	6362.142	2.34	8.70	14887.413
Section-AA`	Band No. 5	112.0986	200.94	22525.093	2.34	11.58	52708.717
Section-AA`	Band No. 7	150.1657	200.94	30174.296	2.34	7.13	70607.852
Section-BB`	Band No. 3	138.2274	163.39	22584.975	2.34	8.62	52848.841
Section-BB`	Band No. 5	603.1016	163.39	98540.770	2.34	5.84	230585.403
Section-EE`	Band No. 1	16.9224	220.65	3733.928	2.34	10.56	8737.390
Section-EE`	Band No. 3	9.8486	220.65	2173.094	2.34	11.78	5085.039
Section-EE`	Band No. 4	38.4167	220.65	8476.645	2.34	9.54	19835.349
Section-EE`	Band No. 5	306.8566	220.65	67707.909	2.34	13.58	158436.507
Section-EE`	Band No. 6	580.4468	220.65	128075.586	2.34	10.62	299696.872
Section-FF`	Band No. 5	56.0696	219.96	12333.069	2.34	5.63	28859.382
Section-JJ`	Band No. 3	9.0169	111.76	1007.729	2.34	6.49	2358.085
Section-JJ`	Band No. 6	40.16	111.76	4488.282	2.34	6.47	10502.579
Section-JJ`	Band No. 8	46.3049	111.76	5175.036	2.34	5.59	12109.583
Section-JJ`	Band No. 9	1426.1403	111.76	159385.440	2.34	6.68	372961.929
Section-JJ`	Band No. 11	3423.1235	111.76	382568.282	2.34	7.74	895209.781
<b>TOTAL</b>		<b>7070.758</b>	<b>-</b>	<b>971828.920</b>	<b>2.34</b>	<b>-</b>	<b>2274079.672</b>
<b>Reduction of 25% towards accuracy in recovery, sampling, structural control and other variables</b>							<b>568519.918</b>
<b>Preliminary resource of graphite (in tonnes)</b>							<b>1705559.754</b>
<b>Resource (in million tonnes)</b>							<b>1.706</b>

**Table 11.8:** Total Inferred Mineral Resource (333) by Cross sectional area method for graphite in Lamer-Panga block-A.

<b>Grade</b>	<b>Resource by Cross Sectional Area Method (tonnes)</b>	<b>Thickness (m)</b>	<b>Average FC%</b>
<b>2%- 5% FC</b>	<b>1110291.974</b>	<b>176.11</b>	<b>3.30</b>
<b>Above 5% FC</b>	<b>1987746.843</b>	<b>209.57</b>	<b>8.48</b>
<b>Above 2% FC</b>	<b>3098038.817</b>	<b>385.68 m</b>	<b>6.76</b>
<b>Total Inferred Mineral Resource (333)</b>	<b>3098039 tonnes or 3.098 million tonnes</b>		

## **11.9 Resource estimation by Longitudinal Vertical section method**

Four numbers of LVS sections i.e. A-A'' to D-D'' are elongated in NE-SW direction. The average recovery of all the boreholes comprises 88.76%. The grade of recovery length is taken as the grade of run with the assumption that the uncovered portion also contains the same assay value. However, an allowance of loss of 25% has been accounted for considering the sampling as well as recovery error, structural control, mining and geological parameters etc.

A total of 0.127 sq. km graphite mineralisation area has been demarcated from the entire Lamer-Panga Block-A. Longitudinal Vertical Section (A-A'' to D-D'') is presented on PLATE No. X.



**Table 11.9 Resource estimation by Longitudinal-Vertical (LV) section method of Lamer-Panga Block-A.**

Section Name	BH No.	Lode No.	Depth of lode. (m)		Width of the lode along the BH (m)	Borehole angle (degree)	Angle of lode with core axis (degree)	SIN (Φ)	True thickness (m)	Dip of the lode	Sin (Ψ)	Horizontal thickness (m)	Dip length of lode in RL (m)		Difference in dip length	Strike length (m)	Tonnage factor	Grade (FC %)	Tonnage
			From	To	W	θ	Φ	B	TW= W x B	Ψ	B	HW=T W/B	Up	Down	DDL	C	D	G	T= HW*DDL* C*D
A-A'	LPA/ G3/10	Lode No. 1	2.30	3.20	0.90	50	80	0.985	0.89	50	0.77	1.16	315.00	314.00	1.00	111.76	2.34	3.77	302.58
		Lode No. 2	5.55	6.30	0.75	50	80	0.985	0.74	50	0.77	0.96	314.00	311.00	3.00	111.76	2.34	3.15	756.45
		Lode No. 3	7.20	16.80	9.60	50	80	0.985	9.45	50	0.77	12.34	313.00	304.00	9.00	111.76	2.34	3.66	29047.82
		Lode No. 4	22.80	33.50	10.70	50	80	0.985	10.54	50	0.77	13.76	307.00	290.00	17.00	111.76	2.34	3.59	61155.07
		Lode No. 5	35.50	37.10	1.60	50	80	0.985	1.58	50	0.77	2.06	308.00	280.00	28.00	111.76	2.34	5.59	15061.83
		Lode No. 6	39.10	69.20	30.10	50	80	0.985	29.64	50	0.77	38.70	305.00	258.00	47.00	111.76	2.34	6.68	475624.37
		Lode No. 7	70.50	109.00	38.50	50	80	0.985	37.92	50	0.77	49.49	294.00	225.00	69.00	111.76	2.34	7.66	893119.48
		Lode No. 8	112.20	115.00	2.80	50	80	0.985	2.76	50	0.77	3.60	296.00	198.00	98.00	106.00	2.34	2.31	87499.05

LPA/ G3/0 2	Lode No. 1	2.00	3.00	1.00	45	85	0.996	1.00	50	0.77	1.30	270.00	267.00	3.00	163.39	2.34	3.03	1491.60
	Lode No. 2	5.20	9.70	4.50	45	85	0.996	4.48	50	0.77	5.85	267.00	262.00	5.00	163.39	2.34	4.41	11187.01
	Lode No. 3	16.30	44.60	28.30	45	85	0.996	28.19	50	0.77	36.80	265.00	234.00	31.00	163.39	2.34	6.33	436194.03
	Lode No. 4	45.60	50.00	4.40	45	85	0.996	4.38	50	0.77	5.72	263.00	222.00	41.00	163.39	2.34	3.62	89694.98
LPA/ G3/0 1	Lode No. 1	15.10	27.80	12.70	45	85	0.996	12.65	50	0.77	16.52	260.00	249.00	11.00	200.94	2.34	4.72	85421.84
	Lode No. 2	29.10	30.73	1.63	45	85	0.996	1.62	50	0.77	2.12	258.00	241.00	17.00	200.94	2.34	8.70	16943.73
	Lode No. 3	31.50	37.30	5.80	45	85	0.996	5.78	50	0.77	7.54	258.00	236.00	22.00	200.94	2.34	9.14	78023.10
	Lode No. 4	44.30	50.00	5.70	45	85	0.996	5.68	50	0.77	7.41	255.00	226.00	29.00	200.94	2.34	6.00	101075.38
LPA/ G3/0 6	Lode No. 1	2.20	3.60	1.40	50	80	0.985	1.38	50	0.77	1.80	278.00	276.00	2.00	219.96	2.34	3.34	1852.74
	Lode No. 2	18.79	24.10	5.31	50	80	0.985	5.23	50	0.77	6.83	271.00	260.00	11.00	219.96	2.34	3.32	38649.53
	Lode No. 3	25.10	26.05	0.95	50	80	0.985	0.94	50	0.77	1.22	269.00	256.00	13.00	219.96	2.34	3.45	8171.92
	Lode No. 4	27.85	45.00	17.15	50	80	0.985	16.89	50	0.77	22.05	265.00	244.00	21.00	219.96	2.34	3.47	238309.02
LPA/ G3/0 5	Lode No. 1	1.10	10.60	9.50	50	80	0.985	9.36	50	0.77	12.21	304.00	298.00	6.00	220.65	2.34	7.13	37834.86
	Lode No. 2	12.10	13.60	1.50	50	80	0.985	1.48	50	0.77	1.93	300.00	294.00	6.00	220.65	2.34	11.78	5973.93
	Lode No. 3	16.86	20.45	3.59	50	80	0.985	3.54	50	0.77	4.62	297.00	289.00	8.00	220.65	2.34	9.54	19063.46
	Lode No. 4	22.60	39.30	16.70	50	80	0.985	16.45	50	0.77	21.47	293.00	273.00	20.00	220.65	2.34	13.58	221699.01

		Lode No. 5	41.00	60.00	19.00	50	80	0.985	18.71	50	0.77	24.43	282.00	261.00	21.00	220.65	2.34	10.62	264844.02
B-B'	LPA/G3/15	Lode No. 1	7.80	23.80	16.00	50	80	0.985	15.76	50	0.77	20.57	331.00	319.00	12.00	149.39	2.34	2.45	86285.16
		Lode No. 2	29.00	32.00	3.00	50	80	0.985	2.95	50	0.77	3.86	322.00	312.00	10.00	149.39	2.34	4.17	13482.06
		Lode No. 3	33.50	54.00	20.50	50	80	0.985	20.19	50	0.77	26.35	316.00	293.00	23.00	149.39	2.34	4.68	211892.98
	LPA/G3/12	Lode No. 1	11.50	17.10	5.60	60	70	0.940	5.26	50	0.77	6.87	344.00	339.00	5.00	201.91	2.34	5.70	16227.95
		Lode No. 2	18.60	19.60	1.00	60	70	0.940	0.94	50	0.77	1.23	341.00	334.00	7.00	201.91	2.34	5.01	4056.99
		Lode No. 3	22.20	23.30	1.10	60	70	0.940	1.03	50	0.77	1.35	339.00	330.00	9.00	201.91	2.34	4.60	5737.74
		Lode No. 4	24.00	30.60	6.60	60	70	0.940	6.20	50	0.77	8.10	338.00	325.00	13.00	201.91	2.34	6.26	49727.06
		Lode No. 5	33.00	37.60	4.60	60	70	0.940	4.32	50	0.77	5.64	333.00	317.00	16.00	201.91	2.34	6.91	42656.32
		Lode No. 6	41.80	51.00	9.20	60	70	0.940	8.65	50	0.77	11.29	327.00	305.00	22.00	201.91	2.34	2.86	117304.87
	LPA/G3/13	Lode No. 1	17.80	20.80	3.00	55	75	0.966	2.90	50	0.77	3.78	321.00	313.00	8.00	202.52	2.34	4.57	14341.18
		Lode No. 2	29.80	31.10	1.30	55	75	0.966	1.26	50	0.77	1.64	315.00	303.00	12.00	202.52	2.34	3.48	9321.77
		Lode No. 3	34.00	35.00	1.00	55	75	0.966	0.97	50	0.77	1.26	313.00	299.00	14.00	202.52	2.34	2.02	8365.69
		Lode No. 4	36.00	38.00	2.00	55	75	0.966	1.93	50	0.77	2.52	312.00	297.00	15.00	202.52	2.34	2.85	17926.47
		Lode No. 5	44.60	47.50	2.90	55	75	0.966	2.80	50	0.77	3.66	308.00	288.00	20.00	202.52	2.34	2.05	34657.85
		Lode No. 6	49.40	53.80	4.40	55	75	0.966	4.25	50	0.77	5.55	305.00	283.00	22.00	202.52	2.34	7.16	57842.75

		Lode No. 7	55.00	58.00	3.00	55	75	0.966	2.90	50	0.77	3.78	303.00	277.00	26.00	202.52	2.34	5.65	46608.83	
		Lode No. 8	59.60	62.00	2.40	55	75	0.966	2.32	50	0.77	3.03	301.00	273.00	28.00	202.52	2.34	4.20	40155.30	
		Lode No. 9	68.00	71.00	3.00	55	75	0.966	2.90	50	0.77	3.78	297.00	264.00	33.00	202.52	2.34	2.35	59157.36	
	LPA/ G3/1 4	Lode No. 1	17.80	19.80	2.00	45	85	0.996	1.99	50	0.77	2.60	255.00	248.00	7.00	200.03	2.34	3.05	8521.76	
		Lode No. 2	21.30	36.90	15.60	45	85	0.996	15.54	50	0.77	20.29	252.00	239.00	13.00	200.03	2.34	2.54	123443.78	
	LPA/ G3/1 6	Lode No. 1	4.40	10.40	6.00	45	85	0.996	5.98	50	0.77	7.80	242.00	236.00	6.00	152.29	2.34	2.81	16683.22	
		Lode No. 2	22.60	25.60	3.00	45	85	0.996	2.99	50	0.77	3.90	240.00	222.00	18.00	152.29	2.34	3.51	25024.84	
		Lode No. 3	31.00	32.00	1.00	45	85	0.996	1.00	50	0.77	1.30	240.00	214.00	26.00	152.29	2.34	3.98	12049.00	
		Lode No. 4	34.00	37.00	3.00	45	85	0.996	2.99	50	0.77	3.90	240.00	210.00	30.00	152.29	2.34	4.21	41708.06	
	c-c'	LPA/ G3/0 9	Lode No. 1	18.40	22.40	4.00	45	85	0.996	3.98	50	0.77	5.20	323.00	302.00	21.00	146.09	2.34	2.43	37342.72
		LPA/ G3/0 7	Lode No. 1	12.10	15.20	3.10	45	85	0.996	3.09	50	0.77	4.03	301.00	293.00	8.00	146.09	2.34	6.38	11024.99
D-D'	LPA/ G3/1 1	Lode No. 1	19.90	20.50	0.60	55	75	0.966	0.58	50	0.77	0.76	358.00	350.00	8.00	100.00	2.34	2.31	1416.27	
		Lode No. 2	22.30	25.50	3.20	55	75	0.966	3.09	50	0.77	4.03	355.00	348.00	7.00	100.00	2.34	5.93	6609.27	
		Lode No. 3	30.50	32.50	2.00	55	75	0.966	1.93	50	0.77	2.52	352.00	340.00	12.00	100.00	2.34	5.26	7081.36	
		Lode No. 4	43.10	45.60	2.50	55	75	0.966	2.41	50	0.77	3.15	346.00	328.00	18.00	100.00	2.34	2.21	13277.56	

Lode No. 5	47.80	48.80	1.00	55	75	0.966	0.97	50	0.77	1.26	343.00	323.00	20.00	100.00	2.34	2.09	5901.14
Lode No. 6	49.80	52.80	3.00	55	75	0.966	2.90	50	0.77	3.78	342.00	321.00	21.00	100.00	2.34	3.66	18588.58
Lode No. 7	54.50	55.30	0.80	55	75	0.966	0.77	50	0.77	1.01	340.00	317.00	23.00	100.00	2.34	4.04	5429.05
Lode No. 8	56.40	59.40	3.00	55	75	0.966	2.90	50	0.77	3.78	338.00	314.00	24.00	100.00	2.34	5.39	21244.09
Lode No. 9	64.40	67.40	3.00	55	75	0.966	2.90	50	0.77	3.78	335.00	307.00	28.00	100.00	2.34	3.48	24784.77
Lode No. 10	71.70	73.90	2.20	55	75	0.966	2.13	50	0.77	2.77	332.00	299.00	33.00	100.00	2.34	2.98	21421.13
Lode No. 11	75.00	77.00	2.00	55	75	0.966	1.93	50	0.77	2.52	330.00	297.00	33.00	100.00	2.34	2.40	19473.75
Total																	<b>4475770.45</b>
Reduction of 25% towards accuracy in sampling, recovery, structural control, mining and geological parameters etc.																	<b>1118942.612</b>
Inferred mineral resource for graphite (tonnes)																	<b>3356827.84</b>
Inferred mineral resource for graphite (million tonnes)																	<b>3.356</b>



### 11.10 Comparison of Resources calculated by Cross Section (CS) method and Longitudinal Vertical (LV) Section method

The resources for graphite calculated by Cross-Section and LV Section method are given in Table 11.7. The variation of resources depends on factors like dip of the ore body, core axis to foliation, horizontal thickness, true thickness etc. Resource calculated for graphite lode is 3098039 tonnes (3.098 million tonnes) with an average grade of 6.76 %FC by CS method and 3356828 tonnes (3.356 million tonnes) with an average grade of 6.76 %FC by LVS projection method.

**Table 11.10** Resource calculation by different methods for graphite at cut-off 2% FC

Cut-off	CS Method		LVS Projected method	
	Tonnage (million tonnes)	Average Grade	Tonnage (million tonnes)	Average Grade
Graphite at 2% FC	3.098	6.76 %.	3.356	6.76 %.

### **11.11 Categorization of Resources as per MEMC, 2015 along with UNFC section methods: -**

The resource has been estimated as per MEMC Rules, 2015 and Amendment Rules, 2021.

#### **Economic axis (E)**

The quantity of the graphite in tonnes with average grade has been estimated in reconnaissance exploration. The resource identified is of Intrinsically Economic (E3) interest and economic viability of the resources is to further be ascertained through a prefeasibility or feasibility study by application of appropriate modifying factors.

#### **Feasibility Axis (F)**

A preliminary and general geological study involving delineation of lithological units, attaining mineralogical and chemical data and its interpretation and assessment of mineral resources with quantity and grade has been undertaken during the exploration. The data related to topographical setting, nature of land and infrastructure have been acquired. The mineralisation was defined based on IBM's threshold value of graphite. The local infrastructure facilities like roads, electricity and water etc. are available nearby villages of the block. Therefore, the feasibility stage can be of Geological Study (F3) category.

#### **Geological axis (G)**

The Preliminary exploration (G3) comprising surface geological mapping Scale 1:4000, geophysical survey, systematic drilling, core sampling, and chemical analysis etc. have been carried out to decipher extent of mineralisation and evaluate mineral quantity and quality.

Hence, the estimated mineral resource may be assigned as **“Inferred Mineral Resource (333)”** of Minerals (Evidence of Mineral Contents) Rules, 2015 and Amendment Rules, 2021.

## CHAPTER 12

### CORE PRESERVATION

The drill cores are preserved in Polypropylene (PVC) boxes in book pattern and labelled with relevant details like borehole co-ordinate, borehole number, box number, RL of collar, run interval from top to bottom etc. These core boxes are transported to the core shed at the Regional Office, Rayagada of OMC Ltd. for preservation of cores. At the core facility, the required drill cores were sun dried and all the core boxes were photographed. The recovery details including total recovered length and recovery percentage for each run is recorded in the borehole logs. The borehole details with average recovery percentage and total depth are presented in Table 9.2. and Photograph showing drill core boxes with appropriate labelling are present in Fig No. 9.1.



**Fig.12 (A & B):** Core boxes preserved at Core Shed of Regional Office, Rayagada of OMC Ltd.

## CHAPTER 13

### CONCLUSION AND RECOMMENDATION

1. The preliminary exploration (G3 stage) was carried out with the objective to assess the resource for graphite in the Lamer-Panga block-A over an area of 13.99 sq.km in Kalahandi district. The sub-surface persistence of graphite-bearing mainly in the granite gneiss and quartzite has been established.
2. The detailed mapping (Scale 1:4000) has been carried out with work components of geophysical survey, systematic drilling, drill core sampling, analysis of samples and resource estimation.
3. The graphite mineralisation in Lamer-Panga block-A is associated with granite gneiss and quartzite along the foliation plane as dissemination of flakes and scales as bands and veins.
4. A total of 17 nos. of borehole with a total meterage of 883 m. have been drilled in this block.
5. The depth of the borehole varies from 35 m to 115 m. and the graphite is encountered in 13 nos. of borehole out of 17 nos. of borehole. The thickness of graphite mineralisation is 351.88 m, in which FC% ranges of drill core samples vary from 2% and 17.07%. with an average of 6.76 % FC.
6. The threshold value for resource estimation has been defined as per the IBM Notification in which the graphite flake is 2% FC and 10% for amorphous graphite. Flaky varieties of graphite mineralisation are observed in the study area and resource of the same has also been estimated.
7. The resource has been estimated for considering in both Cross Sectional Area method. A total of 3098039 tonnes or 3.098 million tonnes Inferred mineral resource (333) for graphite has been estimated in Cross Sectional Area method with an average of 6.76 % FC at 2% cut off FC in the Lamer-Panga block-A. In where, a total of 1987747 tonnes or 1.988 million tonnes above 5% FC and 1110291 tonnes or 1.11 million tonnes 2% to 5 % FC have been estimated. However, a total of 3356828 tonnes or 3.356 million tonnes resource for graphite has been estimated in Longitudinal Vertical (LV) Section method in this block. A total of 25% resource has been reduced towards accuracy in

sampling, recovery, structural control, mining and geological parameters etc. for consideration of resource estimation.

8. A total 0.127 sq. km graphite mineralisation area has been demarcated from this entire block near Lamer village.
9. The resource has been categorised as “Inferred Mineral Resource (333)” of Minerals (Evidence of Mineral Contents) Rules, 2015 and Amendment Rules, 2021.
10. As per the mineral resource estimation of Lamer-Panga block-A on preliminary exploration, total 2 nos. of potential zone near the Lamer villages have been delineated.
11. In view of the potential zone for graphite mineralisation in this block, it is required to ascertain the lateral as well as depth continuity of the zone with a focus on the mineralised area. As the potential zones found for graphite mineralisation so it may be taken up into further stage of exploration.



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## 15. LOCALITY INDEX

**Table No. 15.1: -**

Sl. No	Locality Name	Co-ordinates		Toposheet No.
		Latitude	Longitude	
1	Lamer	N20° 4' 54.91"	E83° 29' 17.59"	F44X08 (64P08) and F44X12 (64P12)
2	Patangpadar	N 20° 5' 56.35"	E 83° 26' 9.578"	F44X08 (64P08) and F44X12 (64P12)
3	Dudalu	N 20° 4' 35.13"	E 83° 28' 18.01"	F44X08 (64P08) and F44X12 (64P12)
4	Tarkabahali	N 20° 5' 33.18"	E 83° 29' 55.92"	F44X08 (64P08) and F44X12 (64P12)
5	Sadalguchha	N 20° 5' 54.14"	E 83° 29' 29.96"	F44X08 (64P08) and F44X12 (64P12)