

**GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY (G-4) FOR
GOLD, COPPER, GRAPHITE AND ASSOCIATED MINERALS IN
JAMTOLA-KHANDAPAR BLOCK (96.62 sq.km.)**

DISTRICT: BALAGHAT, STATE – MADHYA PRADESH
(Under NMEDT Programme)

(TEXT, ANNEXURES AND PLATES)



MINERAL EXPLORATION AND CONSULTANCY LTD.

(Formerly Mineral Exploration Corporation Ltd.)

मिनरल एक्सप्लोरेशन एंड कंसल्टेंसी लिमिटेड

(पूर्व में मिनरल एक्सप्लोरेशन कॉर्पोरेशन लिमिटेड)

खान मंत्रालय, भारत सरकार का उपक्रम मिनीरत्न-I सीपीएसई

Ministry of Mines, Govt of India Enterprise, MINIRATNA-I CPSE

An ISO 9001:2015, 14001:2015 & 45001:2018 Certified Company

October 2026

Cover page photo details:

Core drilling operation by MECL in dense forest in Khandapar sub block area.

**GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY FOR GOLD, COPPER,
GRAPHITE AND ASSOCIATED MINERALS IN JAMTOLA-KHANDAPAR BLOCK,
JAMTOLA-KHANDAPAR, DISTRICT: BALAGHAT,
STATE – MADHYA PRADESH**

LIST OF CONTENTS

अध्याय-1 ए	I
कार्यकारी सारांश	I
CHAPTER-1B	1
EXECUTIVE SUMMARY	1
1.1.0 INTRODUCTION	1
1.2.0 LOCATION AND ACCESSIBILITY OF THE BLOCK	1
1.3.0 GEOLOGY AND STRUCTURE OF THE BLOCK	1
1.4.0 MINERALISATION	5
1.5.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION	7
1.6.0 ESTIMATION OF RESOURCE AND EXPLORATION OUTCOME	12
1.7.0 RECOMMENDATIONS	14
CHAPTER-2	17
DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY	17
2.1.0 DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY	17
2.2.0 DETAILS OF PERSONS ASSOCIATED WITH VARIOUS ASPECTS OF EXPLORATION ASSESSMENT OF RESOURCES AND RESERVES	18
CHAPTER-3	19
TITLE AND OWNERSHIP	19
3.1.0 TITLE OF THE REPORT	19
3.2.0 DETAILS OF PERIOD OF PROSPECTING	19
CHAPTER-4	24
DETAILS OF THE AREA UNDER STUDY	24
4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK	24
4.2.0 ACCESSIBILITY TO THE BLOCK	25
4.3.0 DETAILS OF THE AREA WITH LAND USE	28
4.4.0 MINERAL(S) UNDER INVESTIGATION	28
CHAPTER-5	29
PHYSIOGRAPHY AND ENVIRONMENT	29
5.1.0 RELIEF OF THE AREA WITH MINIMUM AND MAXIMUM ELEVATION, DRAINAGE PATTERN, NATURAL WATER COURSES, RESERVOIRS, ETC.	29
5.2.0 ROADS, RAILWAY TRACK, ELECTRIC TRANSMISSION LINE, TELEPHONE LINE, ETC.	30
5.3.0 HOST POPULATION (LOCAL TRIBES), HUMAN SETTLEMENTS WITHIN AND NEARBY THE AREA	31
5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY	32
5.5.0 HISTORICAL SITES AND ARCHAEOLOGICAL MONUMENTS, PLACES OF WORSHIP, PUBLIC UTILITIES ETC.	33
5.6.0 FORESTS, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARIES ETC.	34
5.7.0 FLORA AND FAUNA WITHIN AND NEARBY	34
5.8.0 WATER BODIES SUCH AS RIVER, NALA, STREAM, RESERVOIR, ETC	35
5.9.0 CLIMATIC CONDITIONS	35
5.10.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR	36

CHAPTER-6	37
INFRASTRUCTURE	37
6.1.0 LOCAL INFRASTRUCTURE WITH ROADS, RAILWAYS, PORT FACILITIES, ELECTRICITY, WATER ETC. WITH DISTANCE FROM THE AREA. DETAILS OF NEAR BY INDUSTRIES IN THE AREA WHICH MAY USE THE MINERAL COMMODITY LIKELY TO BE MINED.	37
CHAPTER-7	39
GEOLOGY	39
7.1.0 REGIONAL GEOLOGY	39
7.2.0 REGIONAL STRUCTURE	41
7.3.0 REGIONAL METAMORPHISM	43
7.4.0 MINERALISATION IN THE REGION	43
7.5.0 GEOLOGY OF THE BLOCK	44
7.6.0 DESCRIPTION OF DIFFERENT LITHO UNITS	45
7.7.0 PETROGRAPHIC STUDY:	55
7.8.0 STRUCTURE	57
7.9.0 MINERALISATION IN THE BLOCK	58
7.10.0 MINERAGRAPHIC STUDIES OF MINERALISED SURFACE AND CORE SAMPLES	60
CHAPTER-8	65
PREVIOUS EXPLORATION	65
8.1.0 DETAILS OF PREVIOUS EXPLORATION CARRIED OUT BY OTHER AGENCIES	65
CHAPTER-9	70
AREAL OR GROUND GEOPHYSICAL OR GEOCHEMICAL DATA	70
9.1.0 AREAL OR GROUND GEOPHYSICAL OR GEOCHEMICAL DATA	70
9.2.0 GROUND GEOPHYSICAL SURVEY	70
9.3.0 INTRODUCTION	70
9.4.0 OBJECTIVE AND SCOPE OF THE WORK	71
9.5.0 SURVEY LAYOUT	71
9.6.0 DATA REDUCTION AND PROCESSING	75
9.7.0 FIELD DATA ACQUISITION:	76
9.8.0 DISCUSSION OF RESULTS	77
9.9.0 CONCLUSIONS AND RECOMMENDATIONS:	82
CHAPTER-10	85
EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION	85
10.1.0 BACKGROUND INFORMATION	85
10.2.0 EXPLORATION METHODOLOGY	86
10.3.0 DATA SPACING FOR REPORTING OF EXPLORATION RESULTS	99
10.4.0 PETROGRAPHIC STUDY	99
10.5.0 MINERAGRAPHIC STUDY	99
10.6.0 PREPARATION OF GEOLOGICAL REPORT:	99
CHAPTER-11	100
LOCATION OF DATA POINTS	100
11.1.0 ACCURACY AND QUALITY OF SURVEY TO LOCATE DRILL HOLES	100
11.2.0 ACCURACY AND QUALITY TO LOCATE BOREHOLES	101
CHAPTER-12	102
SAMPLING TECHNIQUES AND SAMPLE PREPARATION	102
12.1.0 SAMPLING	102

12.2.0 NATURE, QUALITY AND APPROPRIATENESS OF SAMPLE PREPARATION TECHNIQUE	102
12.3.0 QUALITY CONTROL PROCEDURES ADOPTED DURING SAMPLING	103
12.4.0 MEASURES TAKEN TO ENSURE THAT THE SAMPLING IS REPRESENTATIVE OF THE IN-SITU MATERIAL COLLECTED.	103
12.5.0 APPROPRIATENESS OF GRAIN SIZE	104
CHAPTER-13	105
DRILLING TECHNIQUE AND DRILL SAMPLING EMPLOYED	105
13.1.0 DRILLING TYPES AND DETAILS	105
13.2.0 WHETHER CORE AND CHIP SAMPLE RECOVERIES HAVE BEEN PROPERLY RECORDED AND RESULTS ASSAYED	108
13.3.0 MEASURES TAKEN TO MAXIMIZE SAMPLE RECOVERY AND ENSURE REPRESENTATIVE NATURE OF THE SAMPLES.	109
13.4.0 WHETHER THE RELATIONSHIP EXISTS BETWEEN SAMPLE RECOVERY AND GRADE	109
13.5.0 CORE LOGGING	109
13.6.0 ROCK QUALITY DESIGNATION (RQD %)	110
13.7.0 BOREHOLE GEOPHYSICAL LOGGING	111
CHAPTER-14	112
SUB-SAMPLING TECHNIQUES AND SAMPLE PREPARATION	112
14.1.0 WHETHER CUT OR DRAWN AND WHETHER QUARTER, HALF OR ALL CORE TAKEN	112
14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE	112
14.3.0 QUALITY CONTROL PROCEDURES ADOPTED	112
14.4.0 MEASURES TAKEN TO ENSURE THAT THE SAMPLES COLLECTED ARE REPRESENTATIVE OF THE IN-SITU MATERIAL COLLECTED	113
14.5.0 WHETHER SAMPLE SIZES ARE APPROPRIATE TO THE GRAIN	113
CHAPTER-15	114
QUALITY OF ASSAY DATA AND LABORATORY TESTS	114
15.1.0 THE NATURE, QUALITY AND APPROPRIATENESS OF THE ASSAYING AND LABORATORY PROCEDURES	114
15.2.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED	118
15.3.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORATORY	119
15.4.0 SECURITY AND CHAIN OF CONTROL OF SAMPLES SHOULD BE CLEARLY MENTIONED	122
CHAPTER-16	123
MOISTURE	123
16.1.0 METHOD OF DETERMINATION OF MOISTURE CONTENT	123
CHAPTER-17	124
BULK DENSITY	124
17.1.0 METHOD OF DETERMINATION AND RESULT	124
CHAPTER-18	125
BENEFICIATION STUDIES AS MAY BE REQUIRED	125
18.1.0 DETAILS OF BENEFICIATION STUDIES	125
CHAPTER-19	126
RESOURCE ESTIMATION TECHNIQUES	126
19.1.0 DISCUSSION ON DATA DENSITY TO ASSURE CONTINUITY OF MINERALISATION	126
19.2.0 WHETHER PREVIOUS EXPLORATION DATA HAS BEEN USED	126

19.3.0 THE NATURE AND APPROPRIATENESS OF THE ESTIMATION TECHNIQUE(S) APPLIED AND KEY ASSUMPTIONS	127
19.4.0 THE BASIS FOR CLASSIFICATION OF THE MINERAL RESOURCES	127
19.5.0 THE ASSUMPTIONS MADE REGARDING RECOVERY OF BY PRODUCTS	127
19.6.0 DETAILED DESCRIPTION OF THE METHOD USED AND THE ASSUMPTIONS MADE TO ESTIMATE TONNAGE AND GRADES	128
19.7.0 DESCRIPTION OF THE GEOLOGICAL INTERPRETATION USED TO CONTROL THE RESOURCE ESTIMATES	131
19.8.0 DESCRIPTION OF BASIS FOR USING OR NOT USING GRADE CUTTING OR CAPPING	131
19.9.0 GEOSTATISTICAL METHODS DETAIL	133
19.10.0 DATA VERIFICATION AND/OR VALIDATION PROCEDURES USED	133
CHAPTER-20	134
REPORTING OF RESOURCES	134
20.1.0 RESOURCE AND GRADE	134
20.2.0 COMPUTATION OF AVERAGE GRADE:	134
20.3.0 CATEGORY OF RESOURCE:	135
CHAPTER-21	136
SUMMARY AND RECOMMENDATIONS	136
21.1.0 DISCUSSION ON THE OUTCOME OF THE EXPLORATION WORK DETAILING THE NATURE OF THE DEPOSIT	136
21.2.0 RECOMMENDATIONS:	138
CHAPTER-22	140
PLATES AND MAPS	140
22.1.0 LIST OF PLATES	140
CHAPTER-23	141
ANNEXURE / ENCLOSURES TO THE REPORT	141
CHAPTER-24	142
ANY OTHER INFORMATION	142
24.1.0 GEO-TECHNICAL STUDIES	142
24.2.0 PEER-REVIEW	142
24.3.0 REFERENCES	142
CHAPTER-25	143
CERTIFICATION	143
LOCALITY INDEX	144
ABBREVIATIONS USED	144

LIST OF TEXT FIGURE

Text Figure 1 Location Map of Jamtola-Khandapar Block (G4), Balaghat, Madhya Pradesh.....	26
Text Figure 2 Location Map of Jamtola-Khandapar Block on Google satellite imagery	27
Text Figure 3 Regional Geological map of Jamtola-Khandapar Block.....	40
Text Figure 4 Magnetic Anomaly Map based on the NGPM Data.....	68
Text Figure 5 Gravity Anomaly Map based on the NGPM Data.....	69
Text Figure 6 Block boundary of Khandapar Sub Block-I of Jamtola-Khandapar Block along with Traverse Line.....	74
Text Figure 7 Block boundary of Karwahi Sub Block-II of Jamtola-Khandapar Block along with Traverse Line.....	74
Text Figure 8 Scatter Plot of Primary Vs External Check Samples of Gold (Au).....	120
Text Figure 9 Scatter Plot of Primary Vs External Check Samples of Silver (Ag)	121
Text Figure 10 Geological Cross section along section line S2-S2' of Jamtola Khandapar Block	130
Text Figure 11 Histogram.....	132

LIST OF TABLES

Table 1 Details of exploration agency involved during exploration work	17
Table 2 List of Person(s) associated with the Exploration Work.....	18
Table 3 Block Boundary Co-ordinates of Jamtola-Khandapar G-4 Block for Gold, Copper, Graphite and associated minerals, District-Balaghat, Madhya Pradesh	24
Table 4 Administrative Division and population (Census 2011) of Balaghat District, Madhya Pradesh....	32
Table 5 Regional Stratigraphic sequence of Litho units (After GSI).....	41
Table 6 Stratigraphic sequence of the Jamtola-Khandapar G4 Block for Gold, Copper, Graphite and associated minerals	44
Table 7 Physical Properties of different expected ores & host rocks	71
Table 8 Quantum of Ground geophysical work carried out in Block-I (Khandapar) and Block II (Karwahi) of Jamtola-Khandapar Block.....	72
Table 9 Instrument Details.....	75
Table 10 Details of Proposed Boreholes Locations for Block-I (Khandapar) of Jamtola-Khandapar Block.....	83
Table 11 Proposed tentative Borehole Locations for Block-II (Karwahi) of.....	84
Table 12 Quantum of Work vs. Achievement by MECL in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	87
Table 13 Summary of Bedrock sample analytical results showing Anomalous values for Au & Ag in Jamtola -Khandapar Block	91
Table 14 Summary of Bedrock sample analytical results showing Anomalous values for Graphite in Jamtola -Khandapar Block	92
Table 15 Details of scout boreholes drilled by MECL in Khandapar Sub Block and Karwahi sub block of Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	93
Table 16 Co-ordinates of the base station for DGPS survey of Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh.....	100
Table 17 Technical Specification Of DGPS	100
Table 18 The specifications of the Deviation Survey Instrument.....	106
Table 19 Summary of primary and external check assay data for Gold and Silver in Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh	119
Table 20 Comparision of Primary v/s Check sample analysis for Gold (Au) in PPM of primary and external check assay data of Jamtola Khandapar Block (G4),.....	120
Table 21 Comparision of Primary v/s Check sample analysis for Silver (Ag) in PPM of primary and external check assay data of Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh.....	121
Table 22 Summary of Silver lodes at 1000 ppb Ag cut-off and 1.00m minimum true thickness in Khandapar Sub Block of Jamtola Khandapar Block, District: Balaghat, M.P.....	129

Table 23 Statement showing Class Interval (Grade range) and Frequency	132
Table 24 Lode wise summary of Silver Ore Resource at 1000 ppb Ag cut-off grade and 2.00m minimum true thickness in Jamtola Khandapar Block, District: Balaghat, Madhya Pradesh	134
Table 25 Silver Ore Resource at 1000 ppb Ag cut-off grade and 2.00m minimum true thickness in Jamtola Khandapar Block, District: Balaghat, Madhya Pradesh.....	138

LIST OF PHOTOGRAPHS

Photo 1	Sheared Quartz reef exposed in Khandapar area, potential for hosting gold mineralisation.	48
Photo 2	Graphite boulder (Ex-situ) near borehole No. MJGR-02 in Karwahi area, potential for hosting graphite mineralisation.	48
Photo 3	Borehole Collar Fixation by DGPS in Karwahi Sub Block of Jamtola-Khandapar Block	49
Photo 4	Graphite band exposure near borehole no. MJGR-03 in Karwahi Sub Block area.....	49
Photo 5	Calibration of deviation camera	
Photo 6	Borehole deviation in progress.....	50
Photo 7	Paddy cultivation near MJGL-03 in Khandapar Sub block	50
Photo 8	Dense Teak plantation (Forest Nursery) near MJGL-01 in Khandapar Sub block	51
Photo 9	Quartz vein Intrusion in Migmatites near Barwahi village of Jamtola-Khandapar Block.....	51
Photo 10	Sulphide signatures (Pyrite, Bornite) near Katangi village in Jamtola-Khandapar Block.....	52
Photo 11	Full core photo from borehole No. MJGL-01 (Core Box No-09) from 42.5 to 47.5 m.....	52
Photo 12	Half Splitted core photo from borehole No. MJGL-01 (Core Box No-09) from 42.5 to 47.5 m.....	53
Photo 13	Full core photo from borehole No. MJGR-03 (Core Box No-10) from 45.0 to 50.0 m.....	53
Photo 14	Full core photo from borehole No. MJGR-04 (Core Box No-07) from 30.0 to 35.0 m.....	54
Photo 15	Full core photo from borehole No. MJGR-04 (Core Box No-08) from 35.0 to 40.0 m.....	54

LIST OF PHOTOMICROGRAPHS

Pmg- 1 Photomicrograph depicts association of hornblende and plagioclase, where plagioclase is showing saussuritization and presence of corona of sphene around opaque as minor constituent as seen under crossed nicols.....	55
Pmg- 2 Photomicrograph showing association and parallel alignment of plagioclase, amphiboles and quartz in meta-quartz diorite as seen under crossed nicols.....	56
Pmg- 3 Photomicrograph showing dissemination of quartz and intrusion of calcite vein within micritic matrix as seen under crossed nicols.	56
Pmg- 4 Photomicrograph showing association and parallel alignment of very fine flaky aggregates of chlorite and sericite and associated very fine quartz grains as seen under reflected light.	57
Pmg- 5 Photomicrograph showing possible tiny speck of electrum as seen under reflected light.....	63
Pmg- 6 Photomicrograph showing presence of chalcopyrite speck in association with goethite and limonite patches as seen under reflected light.	63
Pmg- 7 Photomicrograph showing very fine relicts of ilmenite within sphene wedges as seen under reflected light.	64
Pmg- 8 Photomicrograph showing pyrite stringer as seen under reflected light.....	64

LIST OF ANNEXURES

SN	ANNEXURE NO.	DESCRIPTION	PAGE NO.
1	I-A	Details of Bedrock Sample Analysis for Gold and Silver in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1-8
2	I-B	Details of Bedrock Sample Analysis for Graphite in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1
3	I-C	Details of Whole Rock Analysis in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1
4	I-D	Details 34 elements IC-PMS sample Analysis for surface samples and boreholes samples in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
5	II-A	Details of Primary Sample Analysis Vs External Check sample Analysis for Gold and Silver pertaining to Surface samples in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
6	II-B	Details of Primary Sample Analysis Vs External Check sample Analysis for Graphite pertaining to surface samples in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
7	III-A	Particulars of Boreholes drilled by MECL (MJGL-01 to MJGL-04) & (MJGR-01 to MJGR-04) in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1
8	III-B	Particulars of base Stations used by MECL in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1
9	III-C	Details of Borehole Deviation Data (MJGL – Series) of the boreholes drilled by MECL in Khandapar Sub Block of Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1-2
10	IV-A	Detailed runwise Lithologs of Boreholes drilled by MECL in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1-13
11	IV-B	Summarised Lithologs of Boreholes Drilled by MECL in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1-2
12	V-A	Details of the Chemical Analysis for Gold and Silver of Primary Samples of the boreholes drilled by MECL in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1-5
13	V-B	Details of the Chemical Analysis for Graphite of Primary Samples of the boreholes drilled by MECL in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
14	VI-A	Details of Silver Lodes at 2000ppb Ag Cut-off grade (with 2m Minimum Stopping Width and 3m Maximum Non Ore Parting) intersected in boreholes drilled by MECL in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
15	VI-B	Details of Graphite Lodes at 2% FC Cut-off grade (with 2m Minimum Stopping Width and 3m Maximum Non Ore Parting) intersected in boreholes drilled by MECL in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1

SN	ANNEXURE NO.	DESCRIPTION	PAGE NO.
16	VII-A	Details of Primary Sample Analysis Vs External Check sample Analysis for Gold and Silver pertaining to boreholes drilled by MECL in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
17	VII-B	Details of Primary Sample Analysis Vs External Check sample Analysis for Graphite pertaining to boreholes drilled by MECL in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
18	VIII	Details 34 elements IC-PMS sample Analysis for boreholes drilled in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
19	IX	Details of Major Oxides and Trace elements Analysis for boreholes drilled in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
20	X	Details of Petrographic Study Results of Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1-7
21	XI-A	Details of Mineragraphic Study Results of Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1-3
22	XI-B	Details of Specific Gravity Determination of Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh	1
23	XII	Estimation of Silver (Ag) Ore Resources by Geological Cross Section Method at 2000 PPB Cu cut-off (with 2m minimum stoping width and 3m maximum non-ore parting) in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1
24	XIII	Report on Study of Geophysical studies conducted in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1-54
25	XIV	Sanction Letter from Executive Committee, NMEDT, Ministry of Mines, Govt. of India, for Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1-10
26	XV-A	Scanned copy of Peer Reviewers Comment	1-2
27	XV-B	Peer reviewer's comments and justifications on 'Geological Report on Reconnaissance Survey (G4) for Gold, Copper, Graphite and associated minerals in Jamtola-Khandapar Block, Balaghat District, Madhya Pradesh.	1

LIST OF PLATES

SN	PLATE NO.	DESCRIPTION	SCALE
1	I	Location map of Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	Not to Scale
2	II	Regional Geological map of Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1:50,000
3	III-A	Geological map with anomalous BRS values for gold and graphite in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1:12,500
4	III-B	Geological map with anomalous BRS values for silver in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1:12,500
5	IV-A	Geological cross section of boreholes drilled in Khandapar sub block of Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1:1000
6	IV-B	Geological cross section of boreholes drilled in Karwahi sub block of Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh	1:1000

जामटोला-खंडापार ब्लॉक (96.62 वर्ग किमी.) में स्वर्ण, ताम्र, ग्रेफाइट और संबद्ध खनिजों के लिए आवीक्षण सर्वेक्षण पर भूवैज्ञानिक रिपोर्ट, जिला: बालाघाट, राज्य – मध्य प्रदेश

अध्याय-1 ए कार्यकारी सारांश

1.1.0 प्रस्तावना

1.1.1 मध्य प्रदेश के बालाघाट ज़िले के जामटोला-खंडापार ब्लॉक (96.62 sq.km.) में सोना, ताम्र, ग्रेफाइट और संबद्ध खनिजों के लिए आवीक्षण सर्वेक्षण (G-4 स्टेज) वाली गवेषण की मौजूदा स्कीम, नेशनल मिनरल एक्सप्लोरेशन ट्रस्ट (NMET) प्रोग्राम के तहत मिनरल एक्सप्लोरेशन एंड कंसल्टेंसी लिमिटेड (MECL) ने इंटीग्रेटेड जियोलॉजिकल, जियोफिजिकल, जियोकेमिकल और स्काउट ड्रिलिंग इन्वेस्टिगेशन के ज़रिए ब्लॉक की मिनरल क्षमता का मूल्यांकन करने के लिए बनाई थी। प्रोग्राम का मुख्य मकसद खनिजीकरण के अनुकूल लिथोलॉजिकल और स्ट्रक्चरल कंट्रोल की पहचान करना, सिस्टमैटिक गवेषण के ज़रिए संभावित सोना और ग्रेफाइट वाले ज़ोन को पहचानना, और एक्सप्लोरेटरी ड्रिलिंग से उनकी सबसरफेस निरंतरता का आकलन करना था। गवेषण प्रोग्राम को मिनरल्स (एविडेंस ऑफ़ मिनरल कंटेंट्स) रूल्स, 2015 (MEMC रूल्स) के नियमों के अनुसार डिज़ाइन किया गया था ताकि यूएनएफसी (UNFC) क्लासिफिकेशन सिस्टम (कोड 334) के तहत आवीक्षण (G-4) लेवल के अनुरूप गवेषण डेटा तैयार किया जा सके। जियोलॉजिकल मैपिंग, ग्राउंड जियोफिजिकल सर्वे, जियोकेमिकल सैंपलिंग, स्काउट ड्रिलिंग, कोर लॉगिंग, लैबोरेटरी इन्वेस्टिगेशन, पेट्रोग्राफिक और मिनराग्राफिक स्टडीज़, और जियोलॉजिकल इंटरप्रीटेशन समेत सभी प्लान की गई गवेषण गतिविधियां एनएमईटी (NMET) फंडिंग के तहत पूरी की गई।

1.2.0 ब्लॉक स्थल और पहुंचने की सुविधा

1.2.1 जामटोला-खंडापार ब्लॉक, इंडियन टोपोशीट नंबर 64C/09 के सर्वे में आता है और 96.62 sq.km. के क्षेत्र में फैला है और यह बालाघाट जिले, मध्य प्रदेश में है। इस ब्लॉक में दो अलग-अलग भौगोलिक सब-ब्लॉक हैं, यानी खंडापार सब-ब्लॉक (ब्लॉक-I) और करवाही सब-ब्लॉक (ब्लॉक-II)। ब्लॉक के बाउंड्री कोऑर्डिनेट्स WGS-84 डेटाम पर DGPS सर्वे का इस्तेमाल करके बनाए गए हैं, और कॉर्नर कोऑर्डिनेट्स का विवरण इस रिपोर्ट के संबंधित अध्याय में दी गई हैं।

1.3.0 ब्लॉक का भूविज्ञान और संरचना

1.3.1 जामटोला-खंडापार ब्लॉक, सेंट्रल इंडियन टेक्टोनिक ज़ोन (CITZ) के अंदर भूवैज्ञानिकीय तौर पर उपयुक्त जगह पर है और बालाघाट-भंडारा ग्रैन्यूलाइट बेल्ट के दक्षिणी किनारे का हिस्सा है, जो मध्य भारत के ज़रूरी प्रीकैम्ब्रियन मेटलोजेनिक प्रोविंस में से एक है। इस प्रोविंस में लंबे समय तक भूवैज्ञानिकीय विकास हुआ है, जिसमें मैग्माटिज़्म, सेडिमेंटेशन, रीजनल मेटामॉर्फिज़्म, डिफॉर्मेशन और हाइड्रोथर्मल एक्टिविटी के कई फेज़ शामिल हैं। इन जियोलॉजिकल प्रोसेस ने ग्रेनाइटॉइड्स, हाई-ग्रेड मेटामॉर्फिक चट्टानों, नए मेटासेडिमेंट्री सीक्वेंस और अंतर्वेधित पिंडों का एक कॉम्प्लेक्स जमावड़ा बनाया है, जो मिलकर स्ट्रक्चरल रूप से कंट्रोल्ड स्वर्ण खनिजीकरण और ग्रेफाइट वाले हॉराइज़न के विकास के लिए अच्छी स्थिति प्रदान करते हैं। रीजनल स्टडीज़ से पता चलता है कि बालाघाट प्रोविंस में खनिजीकरण, बार-बार टेक्टोनिक रीएक्टिवेशन के दौरान बने बड़े शिपर सिस्टम, कार्टज़ रीफ़ और हाइड्रोथर्मल ऑल्टरेशन ज़ोन से करीब से जुड़ा हुआ है।

1.3.2 रीजनल जियोलॉजिकल सीक्वेंस में नंदगांव ग्रुप (ओल्डर मेटामॉर्फिक्स), मलंजखंड ग्रेनाइटॉइड्स, यंगर मेटामॉर्फिक्स, यंगर अंतर्वेधित रॉक्स और डेक्कन ट्रैप ज्वालामुखी सीक्वेंस शामिल हैं, जो स्थानीय तौर पर हाल के लैटेराइटिक निक्षेपों से ढका हुआ है। जामटोला-खंडापार ब्लॉक के अंदर सामने आए लिथोलॉजिकल सीक्वेंस में मिग्मैटिक वेरिफ़ंट्स के साथ ग्रीनिश-ग्रे ग्रेनाइट नाइस, एम्फीबोलाइट एन्क्लेव्स, ग्रैनोडायोराइट, बायोटाइट ग्रेनाइट, एप्लाइट, कार्टजाइट, क्रिस्टलाइन लाइमस्टोन, कॉन्लोमरेट, ग्रेफाइट-बेयरिंग फाइलाइट, कार्बोनेसियस फाइलाइट, कार्टज़ वेन्स, शिपर्ड कार्टज़ रीप्स, डोलराइट डाइक्स, बेसाल्टिक फ्लो और लैटेराइट्स शामिल हैं। यह स्ट्रेटीग्राफिक सीक्वेंस लेट आर्कियन से लेकर हाल के समय तक बार-बार होने वाले टेक्टो-मैग्मैटिक एपिसोड्स को दिखाता है और ब्लॉक के अंदर खनिजीकरण को कंट्रोल करने वाला जियोलॉजिकल फ्रेमवर्क बनाता है।

1.3.3 ब्लॉक की मुख्य बेसमेंट लिथोलॉजी को नंदगांव ग्रुप से जुड़े ग्रेनाइट नाइस और मिग्माटाइट नाइस दिखाते हैं। ये चट्टानें ब्लॉक के सेंट्रल और नॉर्दर्न सेक्टर के बड़े हिस्से पर हैं और सबसे पुरानी खुली लिथोलॉजिकल यूनिट बनाती हैं। मेगास्कोपिकली, ग्रेनाइट नाइस मीडियम से मोटे दाने वाला, ल्यूकोक्रेटिक से मेसोक्रेटिक होता है, और इसमें एक अच्छी तरह से विकसित नाइसिक फोलिएशन दिखता है जो बारी-बारी से फेल्सिक और मैफिक मिनरल बैंड से पहचाना जाता है। खनिज के हिसाब से, इसमें मुख्य रूप से कार्टज़, प्लेजियोक्लेज़, K-फेल्डस्पार और बायोटाइट के साथ सबऑर्डिनेट हॉर्नब्लेंड और एक्सेसरी एपेटाइट, ज़िरकोन, स्फीन और ओपेक

मिनरल होते हैं। मिग्माटाइटिक स्ट्रक्चर, ल्यूकोक्रेटिक सेग्रीगेशन और क्वार्ट्ज-फेल्डस्पार वेन्स आम हैं, जो रीजनल मेटामॉर्फिज्म के दौरान पार्श्वील मेल्टिंग और ग्रेनाइटॉइड एम्प्लेसमेंट के बार-बार होने वाले एपिसोड दिखाते हैं।

1.3.4 बेसमेंट की चट्टानों में मलंजखंड ग्रेनाइटॉइड सुइट से जुड़े ग्रेनाइटॉइड्स अंतर्वेधित हुए हैं, जिसमें मोटे दाने वाले हॉर्नब्लेंड ग्रेनाइटोडायोराइट, डायोराइट, बारीक दाने वाले बायोटाइट ग्रेनाइट और गुलाबी एप्लाइट शामिल हैं। ये ग्रेनाइटॉइड्स मुख्य रूप से ब्लॉक के पश्चिमी और दक्षिण-पश्चिमी सेक्टर में पाए जाते हैं और स्थानीय रूप से पुराने ग्रेनाइट नाइस और नई मेटासेडिमेंट्री चट्टानों के साथ अंतर्वेधन संपर्क दिखाते हैं। कई जगहों पर, ग्रेनाइटॉइड संपर्कों के साथ क्वार्ट्ज वेन्स और शियर्ड क्वार्ट्ज रीप्स पाए जाते हैं, जो यह दिखाता है कि अंतर्वेधित गतिविधि ने फ्रैक्चर सिस्टम बनाने में अहम भूमिका निभाई, जिसका इस्तेमाल बाद में स्वर्ण खनिजीकरण के लिए जिम्मेदार हाइड्रोथर्मल फ्लूइड्स द्वारा किया गया।

1.3.5 नए मेटासेडिमेंट्री सीक्वेंस में फ़िलाइट, कार्बोनेसियस फ़िलाइट, ग्रेफ़ाइट वाला फ़िलाइट, क्वार्ट्जाइट, क्रिस्टलाइन लाइमस्टोन और माइनर कॉन्ग्लोमरेट शामिल हैं, जो कम से मीडियम ग्रेड के मेटामॉर्फोज़्ड सेडिमेंट्री रॉक्स को दिखाते हैं। फ़िलाइट्स आम तौर पर ग्रे से गहरे ग्रे रंग के होते हैं, बारीक फ़ोलिएटेड होते हैं और क्वार्ट्ज, सेरीसाइट, क्लोराइट और माइका के साथ सबऑर्डिनेट ग्रेफ़ाइट, कार्बोनेसियस मैटर और डिसेमिनेटेड सल्फाइड से बने होते हैं। कार्बोनेसियस और ग्रेफ़ाइट वाले फ़िलाइट्स मुख्य रूप से करवाही सब-ब्लॉक में पाए जाते हैं, जहाँ ग्रेफ़ाइट पतले डिसेमिनेटेड फ़्लेक्स और फ़ोलिएशन के पैरेलल डिसकॉन्टिन्यूअस बैंड के रूप में डेवलप होता है। क्वार्ट्जाइट्स रेसिस्टेंट, कॉम्पैक्ट रिज के रूप में होते हैं जो मुख्य रूप से रीक्रिस्टलाइज़्ड क्वार्ट्ज से बने होते हैं, जबकि क्रिस्टलाइन लाइमस्टोन मेटासेडिमेंट्री हॉराइज़न से जुड़े पतले डिसकॉन्टिन्यूअस लेंस बनाते हैं। ये लिथोलॉजिकल यूनिट्स ग्रेफ़ाइट मिनरलाइज़ेशन के लिए फ़ेवरेबल होस्ट हैं और लोकल लेवल पर कॉम्पिटेंसी कंट्रास्ट देते हैं जो स्ट्रक्चरल डिफ़ॉर्मेशन पर असर डालते हैं।

1.3.6 क्वार्ट्ज वेन्स और शियर्ड क्वार्ट्ज रीप्स, जांच वाले एरिया में स्वर्ण खनिजीकरण से जुड़ी सबसे ज़रूरी लिथोलॉजिकल खासियत हैं। ये बॉडीज़ शियर ज़ोन, फ्रैक्चर और फ़िलाइट्स के अंदर फ़ोलिएशन प्लेन के साथ और मलंजखंड ग्रेनाइटॉइड्स के पास मौजूद सब-कॉन्कॉर्डेंट वेन्स के तौर पर डिऑर्डर के तौर पर होती हैं। क्वार्ट्ज रीप्स आम तौर पर दूधिया सफ़ेद, बड़े से लेकर ब्रेकिएटेड होते हैं, और मिनरलाइज़्ड ज़ोन में तेज़ सिलिकिफ़िकेशन, फ़ेरुगिनाइज़ेशन और सल्फाइड इंप्रेगेशन दिखाते हैं। शियरिंग, फ्रैक्चरिंग और बार-बार क्वार्ट्ज वेनिंग ने हाइड्रोथर्मल

फ्लूइड सर्कुलेशन के लिए अच्छे स्ट्रक्चरल ट्रैप बनाए हैं, जिससे लोकलाइज़्ड गोल्ड एनरिचमेंट हुआ है। सरफ़ेस मैपिंग से पता चलता है कि सबसे अच्छी तरह से डेवलप शिप्ट कार्डज़ रीफ़्स खंडापार सब-ब्लॉक में होती हैं, जहाँ वे इस जांच के दौरान रिकॉर्ड की गई सबसे ज़्यादा सरफ़ेस गोल्ड एनोमलीज़ से मैच करती हैं।

1.3.7 बेसिक अंतर्वेधित चट्टानें बेसाल्टिक/डोलराइट डाइक से दिखाई देती हैं, जो ब्लॉक के अंदर सबसे नया अंतर्वेधित फेज़ बनाती हैं। ये डाइक मीडियम-ग्रेन वाले, गहरे ग्रे से हरे-काले रंग के, सख्त और बड़े होते हैं, और ग्रेनाइट नाइस, मिग्माटाइट्स, फाइलाइट्स और कार्डज़ रीफ़ में तेज बेमेल कॉन्टैक्ट्स के साथ अंतर्वेधित होते हैं। पेट्रोग्राफिकली, डोलराइट्स में प्लेजियोक्लेज़, क्लिनोपाइरोक्सीन, सबऑर्डिनेट हॉर्नब्लेंड और ओपेक मिनरल्स होते हैं, जो खास ओफिटिक से सब-ओफिटिक टेक्सचर दिखाते हैं। फ़ैक्चर के साथ लोकल क्लोराइट्स, एपिडोटाइजेशन और कार्बोनेट में बदलाव देखा जाता है, जो कम तापमान वाले हाइड्रोथर्मल ओवरप्रिंटिंग को दिखाता है। हालांकि ये डाइक सीधे मिनरलाइज़्ड नहीं होते हैं, लेकिन उन्होंने लोकल तौर पर ब्रिटल डिफॉर्मेशन को कंट्रोल किया है और बाद में कार्डज़ वेन एम्प्लेसमेंट के लिए उपयुक्त स्थिति प्रदान किए हैं।

1.3.8 सबसे नई लिथोलॉजिकल यूनिट्स में डेक्कन ट्रैप बेसाल्टिक फ़्लो शामिल हैं, जो लंबे समय तक ट्रॉपिकल अपक्षय से बनी लैटेराइटिक कैपिंग से ढके होते हैं। बेसाल्ट ज़्यादातर अलग-अलग पैच में होते हैं, जबकि लैटेराइट ऊँची ज़मीन पर अलग-अलग तरह की परतें बनाते हैं। इन अपक्षय उत्पादों के कारण खंड के बड़े भागों में शैल-आवरण (बेडरॉक) का प्रकटीकरण अस्पष्ट हो जाता है और लोकल तौर पर जियोलॉजिकल कॉन्टैक्ट्स को छिपा देते हैं, जिससे गवेषण के दौरान सरफ़ेस सैंपलिंग लोकेशन्स के डिस्ट्रीब्यूशन पर असर पड़ता है। इस कवर के बावजूद, स्ट्रीम सेक्शन, पहाड़ी ढलानों और खदानों के किनारों पर प्रोविंस के जियोलॉजिकल फ्रेमवर्क को बनाने के लिए काफी बेडरॉक एक्सपोज़र मौजूद थे।

1.3.9 पेट्रोग्राफी: गवेषण के दौरान मिली मुख्य लिथोलॉजिकल यूनिट्स की पहचान करने के लिए, सरफ़ेस एक्सपोज़र और बोरहोल कोर दोनों से इकट्ठा किए गए 10 रिप्रेजेंटेटिव रॉक सैंपल्स पर पेट्रोग्राफिक जांच की गई। पेट्रोग्राफिक स्टडीज़ ने ग्रेनाइट नाइस, मिग्माटाइट, फाइलाइट, कार्डज़ रीफ़, डोलराइट, एम्फीबोलाइट, फेल्डस्पैथिक क्लोराइट-बायोटाइट कार्डज़ शिस्ट, ग्रेफाइट-बेयरिंग फाइलाइट और कार्बोनेसियस फाइलाइट की फील्ड पहचान की पुष्टि की। माइक्रोस्कोपिक जांच से पता चलता है कि चट्टानों में अलग-अलग लेवल पर डिफॉर्मेशन, रीक्रिस्टलाइजेशन और हाइड्रोथर्मल बदलाव हुआ है। कार्डज़ में आमतौर पर अनडुलोज़

एक्सटिक्शन और डायनामिक रीक्रिस्टलाइजेशन दिखता है, फेल्डस्पार में सेरिसाइटिस और बदलाव दिखता है, जबकि मैफिक मिनरल्स में क्लोरिटाइजेशन और सेकेंडरी मिनरल्स से थोड़ा बदलाव दिखता है, जो इस प्रोविंस पर असर डालने वाली कई टेक्टोनो-मेटामॉर्फिक उपस्थिति को दिखाता है।

1.3.10 स्ट्रक्चर: जामटोला-खंडापार ब्लॉक में एक कॉम्प्लेक्स स्ट्रक्चरल आर्किटेक्चर दिखता है जो बार-बार होने वाले डिफॉर्मेशन से बनता है। मुख्य स्ट्रक्चरल एलिमेंट्स में गनीस फोलिएशन, शिस्टोसिटी, शियर ज़ोन, जॉइंट्स, फ्रैक्चर, कार्टज वेन्स और फॉल्ट-कंट्रोल लाइनमेंट्स शामिल हैं। रीजनल फोलिएशन आम तौर पर NW-SE से NNW-SSE की ओर होता है, जिसमें मीडियम से तीखे पूर्वी डिप्स होते हैं, हालांकि फोल्डिंग और शियरिंग के कारण लोकल डेविेशन होते हैं। शियर ज़ोन बहुत ज़्यादा फ्रैक्चर्ड और सिलिसिफाइड कार्टज रीप्स से दिखाए जाते हैं जो ब्रेकिंग, फेरुजिनाइजेशन और तेज़ डिफॉर्मेशन दिखाते हैं। ये शियर कॉरिडोर हाइड्रोथर्मल फ्लूइड माइग्रेशन और उसके बाद स्वर्ण खनिजीकरण पर मुख्य स्ट्रक्चरल कंट्रोल बनाते हैं। शियर ज़ोन के सही लिथोलॉजिकल कॉन्टेक्ट्स के साथ इंटरसेक्शन, खासकर ग्रेनाइटॉइड-फ़िलाइट बाउंड्रीज़ के साथ, खनिज निक्षेप के लिए उपयुक्त जगहें बनी हैं।

1.3.11 हाइड्रोथर्मल बदलाव: ब्लॉक के मिनरल वाले हिस्सों में हाइड्रोथर्मल बदलाव अच्छी तरह से विकसित है और यह कार्टज वेनिंग और सल्फाइड मिनरलाइजेशन से करीब से जुड़ा हुआ है। मुख्य बदलाव के ग्रुप में सिलिकिफिकेशन, फेरुजिनाइजेशन, क्लोराइटिसाइजेशन, सेरिसाइटिसाइजेशन, कार्बोनेटाइजेशन और लोकल एपिडोटाइजेशन शामिल हैं। सिलिकिफिकेशन सबसे ज़्यादा शियर्ड कार्टज रीफ़ में होता है, जबकि फेरुजिनाइजेशन फ्रैक्चर सतहों और वेदर वाले सल्फाइड ज़ोन में बड़े पैमाने पर होता है। क्लोराइटिसाइजेशन और सेरिसाइटिसाइजेशन मिनरल वाली संरचनाओं के पास की फ़िलाइट्स और मैफिक चट्टानों दोनों को प्रभावित करते हैं, जो बड़े पैमाने पर हाइड्रोथर्मल फ्लूइड इंटरैक्शन का संकेत देते हैं। सल्फाइड वाले ज़ोन के ऑक्सीडेशन के कारण सतह पर लिमोनाइटिक और लेटराइटिक कैप्स का विकास हुआ है, जो जियोलॉजिकल मैपिंग और जियोकेमिकल सैंपलिंग के दौरान उपयोगी एक्सप्लोरेशन गाइड देते हैं।

1.3.12 मिनरलाइजेशन पर जियोलॉजिकल कंट्रोल: मौजूदा जांच से पता चलता है कि जामटोला-खंडापार ब्लॉक के अंदर मिनरलाइजेशन लिथोलॉजी, स्ट्रक्चर और हाइड्रोथर्मल बदलाव के मिले-जुले असर से कंट्रोल होता है। स्वर्ण खनिजीकरण मुख्य रूप से फाइलाइट्स के अंदर और मलंजखंड ग्रेनाइटॉइड्स के संपर्क में बनी शियर्ड कार्टज रीफ़ तक ही सीमित है, जो एक

स्ट्रक्चरल रूप से कंट्रोल्ड हाइड्रोथर्मल लोड सिस्टम को दिखाता है। इसके उलट, ग्रेफाइट मिनरलाइजेशन लिथोलॉजिकल रूप से कंट्रोल होता है और करवाही सब-ब्लॉक के ग्रेफाइट वाले कार्बन वाले फाइलाइट्स के अंदर फैले हुए फ्लेक्स और अलग-अलग बैंड के रूप में होता है। कार्टज़ वेनिंग, शियर डिफॉर्मेशन, सल्फाइड डिसेमिनेशन और हाइड्रोथर्मल बदलाव का मेल मौजूदा G-4 जांच के दौरान पहचाने गए सबसे संभावित गवेषण टारगेट को बताता है और भविष्य में विस्तृत गवेषण के लिए आधार देता है।

1.4.0 खनिजीकरण

1.4.1 मौजूदा आवीक्षण सर्वेक्षण (G-4) ने जामटोला-खंडापार ब्लॉक के अंदर सोने और ग्रेफाइट खनिजीकरण की मौजूदगी का पता लगाया है, साथ ही पाइराइट, पाइरोटाइट, चाल्कोपीराइट और मैग्नेटाइट जैसे मामूली सल्फाइड खनिजीकरण भी हैं। खनिजीकरण दो विशिष्ट भूवैज्ञानिक परिवेशों से स्थानिक रूप से संबद्ध है। सोने का खनिजीकरण मुख्य रूप से फिलाइट्स के अंदर और खंडापार सब-ब्लॉक में मलांजखंड ग्रेनाइटॉइड्स के संपर्क में बने स्ट्रक्चरल रूप से कंट्रोल किए गए शियर्ड कार्टज़ रीफ तक ही सीमित है, जबकि ग्रेफाइट खनिजीकरण मुख्य रूप से करवाही सब-ब्लॉक के अंदर पाए जाने वाले ग्रेफाइट वाले कार्बन वाले फिलाइट्स में होता है। दोनों खनिजीकरण स्टाइल जेनेटिक रूप से अलग हैं और अलग-अलग लिथोलॉजिकल डोमेन में पाए जाते हैं, हालांकि दोनों पर स्ट्रक्चरल रूप से रीजनल डिफॉर्मेशन और फ्रैक्चर सिस्टम का असर होता है।

1.4.2 स्वर्ण खनिजीकरण : जामटोला-खंडापार ब्लॉक में स्वर्ण खनिजीकरण खास तौर पर हाइड्रोथर्मल लोड टाइप का है, जो बड़े शियर ज़ोन और फ्रैक्चर सिस्टम के साथ बने सिलिसिफाइड और शियर्ड कार्टज़ रीफ के अंदर होता है। कार्टज़ रीफ सामान्यतः दूधिया श्वेत से धूमिल धूसर रंग के, ठोस से लेकर ब्रेशियायुक्त रूप में पाए जाते हैं तथा तीव्र विकृति प्रदर्शित करते हैं, जो शियरिंग, फ्रैक्चरिंग एवं स्थानीय माइलोनिटाइजेशन द्वारा अभिव्यक्त होती है। खनिजीकरण का संबंध प्रसारित सल्फाइड्स, फेरूजिनाइजेशन एवं सिलिसीकरण से है, जो बार-बार हुई हाइड्रोथर्मल गतिविधि को इंगित करता है।

1.4.3 सरफेस जियोकेमिकल जांच से पता चलता है कि सोने की सबसे ज़्यादा वैल्यू खंडापार सब-ब्लॉक के दक्षिण-पश्चिमी हिस्से तक ही सीमित हैं, जहाँ अच्छी तरह से विकसित शियर्ड कार्टज़ रीफ काफ़ी नतिलंब लेंथ पर दिखाई देते हैं। बेडरॉक और चैनल सैंपल के एनालिटिकल नतीजों से पता चलता है कि सोने की वैल्यू बिलो डिटेक्शन लिमिट (BDL) से 4.89 ppm तक है, जबकि

चांदी की वैल्यू BDL से 6.21 ppm तक है। सोने की सबसे ज़्यादा वैल्यू 4.89 ppm है, जो मज़बूती से सिलिकाइफ़ाइड और फेरुजिनाइज़्ड शियर्ड कार्बोनाट रीफ़ से जुड़ी है, जबकि आस-पास के दक्षिणी और दक्षिण-मध्य सेक्टर में कई और मध्यम सोने की गड़बड़ियाँ होती हैं। ये नतीजे साफ़ तौर पर बताते हैं कि सोने का मिनरलाइज़ेशन स्ट्रक्चरल रूप से तैयार ज़ोन के अंदर ही होता है और पूरे ब्लॉक में एक जैसा नहीं होता है।

1.4.4 मिनरलाइज़्ड कार्बोनाट रीफ़ की सबसरफ़ेस निरंतरता की जांच के लिए की गई स्काउट ड्रिलिंग से गहराई पर शियर्ड कार्बोनाट वेन्स के साथ-साथ हाइड्रोथर्मल बदलाव और सल्फ़ाइड वाले ज़ोन की मौजूदगी की पुष्टि होती है। हालांकि, बोरहोल कोर सैंपल के एनालिटिकल नतीजे आम तौर पर कम और अलग-अलग गोल्ड वैल्यू दिखाते हैं, जिससे पता चलता है कि सरफ़ेस मिनरलाइज़ेशन लोकलाइज़्ड स्ट्रक्चरल ज़ोन तक ही सीमित है और जांची गई गहराई रेंज में इसकी गहराई बनी रहने की कोई खास कमी है। इसलिए, मौजूदा जांच से पता चलता है कि सोने का सिस्टम स्ट्रक्चरल रूप से कंट्रोल्ड और अलग-अलग है, जिससे सही स्ट्रक्चरल इंटरसेक्शन और गहरे ओर शूट की पहचान करने के लिए और गवेषणबीन की ज़रूरत है।

1.4.5 ग्रेफ़ाइट खनिजीकरण: ब्लॉक के अंदर ग्रेफ़ाइट खनिजीकरण ज़्यादातर करवाही सब-ब्लॉक में होता है, जहाँ यह यंगर मेटामॉर्फ़िक सीक्वेंस से जुड़े ग्रेफ़ाइट वाले कार्बन वाले फाइलाइट्स में होता है। ग्रेफ़ाइट बहुत ज़्यादा कार्बन वाले फाइलाइट्स के अंदर बारीक फैले हुए प्लेक्स, पतले फोलिएशन-पैरेलल बैंड और लोकल रूप से कंसन्ट्रेटेड स्ट्रीक्स के रूप में होता है। खनिजीकरण लिथोलॉजिकली कंट्रोल होता है और होस्ट रॉक के रीजनल फोलिएशन को फॉलो करता है। गोल्ड खनिजीकरण के उलट, ग्रेफ़ाइट में कार्बोनाट वेनिंग या हाइड्रोथर्मल बदलाव के साथ कोई साफ़ जुड़ाव नहीं दिखता है, लेकिन यह कार्बन वाले सेडिमेंट्स के मेटामॉर्फ़िक कंसन्ट्रेशन को दिखाता है।

1.4.6 सतह से मिले कुल 19 खास ग्रेफ़ाइट सैंपल का, ग्रेफ़ाइट मिनरलाइज़ेशन की क्वालिटी का पता लगाने के लिए, पास से एनालिसिस किया गया। एनालिटिकल नतीजों से पता चलता है कि राख की मात्रा ज़्यादा है, वोलाटाइल मैटर ठीक-ठाक है, और कार्बन की फिक्स्ड वैल्यू आम तौर पर कम है, जो खराब से कम ग्रेड के ग्रेफ़ाइट कंसन्ट्रेशन का इशारा है। एनालिटिकल डेटा से पता चलता है कि हालांकि ग्रेफ़ाइट कार्बन वाले फाइलाइट्स में बड़े पैमाने पर फैला हुआ है, लेकिन ग्रेफ़ाइट की क्वालिटी और कंसन्ट्रेशन, गवेषण के मौजूदा स्टेज में आर्थिक रूप से ज़रूरी ग्रेफ़ाइट रिसोर्स बनाने के लिए काफ़ी नहीं हैं। इसलिए, ग्रेफ़ाइट का मिलना लगातार हाई-ग्रेड ग्रेफ़ाइट जमा होने के बजाय, लोकल मेटामॉर्फ़िक एनरिचमेंट को दिखाता है।

1.5.0 मौजूदा जांच के दौरान की गई गवेषण

1.5.1 जामटोला-खंडापार ब्लॉक को आवीक्षण सर्वेक्षण (G-4 स्टेज) के लिए इसलिए चुना गया था क्योंकि जियोलॉजिकल कंडीशन अच्छी थीं, खंडापार प्रोविंस में सोने जैसी शियर्ड कार्टज रीफ्स थीं, करवाही प्रोविंस में ग्रेफाइट वाले कार्बोनेसियस फाइलाइट्स थे, पहले की जांच से मिली क्षेत्रीय जियोलॉजिकल जानकारी अच्छी थी और सेंट्रल इंडियन टेक्टोनिक ज़ोन (CITZ) के अंदर ब्लॉक की स्ट्रेटेजिक लोकेशन भी अच्छी थी। पूर्ववर्ती भूवैज्ञानिक गवेषणों से यह स्पष्ट हुआ कि क्षेत्र में हाइड्रोथर्मल स्वर्ण खनिजीकरण हेतु अनुकूल शैलविज्ञानिक एवं संरचनात्मक परिस्थितियाँ विद्यमान हैं, विशेषकर शियर-नियंत्रित कार्टज रीफ प्रणालियों के साथ। साथ ही, कार्बनयुक्त फ़िलाइट्स में पाए जाने वाले ग्राफ़ाइटिक क्षितियों ने ग्राफ़ाइट की संभाव्यता के व्यवस्थित मूल्यांकन की आवश्यकता को रेखांकित किया। इस परिप्रेक्ष्य में, राष्ट्रीय खनिज गवेषण न्यास (NMET) के अंतर्गत MECL द्वारा एक समन्वित गवेषण कार्यक्रम तैयार किया गया, जिसमें भूवैज्ञानिक मानचित्रण, भूभौतिकीय सर्वेक्षण, भू-रासायनिक जाँच, स्काउट ड्रिलिंग तथा प्रयोगशाला अध्ययन सम्मिलित किए गए, ताकि G-4 चरण की गवेषण दिशानिर्देशों के अनुरूप ब्लॉक की खनिज संभाव्यता का सम्यक् मूल्यांकन किया जा सके।

1.5.2 मौजूदा गवेषण प्रोग्राम को ब्लॉक का जियोलॉजिकल फ्रेमवर्क बनाने, मिनरलाइज़ेशन के फ़ायदेमंद लिथोलॉजिकल और स्ट्रक्चरल कंट्रोल तय करने, जियोकेमिकल और जियोफिजिकल गड़बड़ियों की पहचान करने, एक्सप्लोरेटरी ड्रिलिंग के ज़रिए मिनरलाइज़्ड ज़ोन की सबसरफ़ेस निरंतरता का मूल्यांकन करने और गवेषण के आगे के स्टेज की सिफारिश करने के लिए काफ़ी जियोलॉजिकल सबूत जुटाने के लिए डिज़ाइन किया गया था। सभी गवेषण एक्टिविटीज़ मिनरल्स (एविडेंस ऑफ़ मिनरल कंटेंट्स) रूल्स, 2015 के नियमों के अनुसार की गईं, जिसमें जियोलॉजिकल मैपिंग, सैंपलिंग, ड्रिलिंग, लैबोरेटरी एनालिसिस और डेटा वैलिडेशन के लिए स्टैंडर्ड प्रोसेस अपनाए गए। गवेषण प्रोग्राम काम के मंज़ूर दायरे में पूरा किया गया, और जांच के दौरान मिली सभी जियोलॉजिकल, जियोफिजिकल, जियोकेमिकल और ड्रिलिंग जानकारी को मिलाकर जियोलॉजिकल रिपोर्ट तैयार की गई है।

1.5.3 जियोलॉजिकल मैपिंग : पूरे 96.62 sq.km. ब्लॉक में 1:12,500 स्केल पर बड़े पैमाने पर जियोलॉजिकल मैपिंग की गई ताकि मिनरलाइज़्ड ज़ोन के लिथोलॉजिकल सक्सेशन, स्ट्रक्चरल फ्रेमवर्क और सरफ़ेस डिस्ट्रीब्यूशन का पता लगाया जा सके। मैपिंग के नतीजे में मिग्माटाइट, मलंजखंड ग्रेनाइटॉइड्स, फाइलाइट्स, ग्रेफाइट वाले कार्बोनेसियस फाइलाइट्स, कार्टजाइट्स, क्रिस्टलाइन लाइमस्टोन, कार्टज वेन्स, शियर्ड कार्टज रीफ्स, डोलराइट डाइक्स, बेसाल्टिक फ्लो

और लैटेराइट कवर के साथ ग्रेनाइट नाइस का पता चला। शियर ज़ोन, कार्टज रीफ्स, फ्रैक्चर सिस्टम, लिथोलॉजिकल कॉन्टैक्ट्स और हाइड्रोथर्मल ऑल्टरेशन ज़ोन की पहचान करने पर खास ज़ोर दिया गया, जो स्वर्ण खनिजीकरण के लिए अच्छे कंट्रोल हैं। जांच के दौरान तैयार किया गया इंटरप्रेटेड जियोलॉजिकल मैप बाद के जियोफिजिकल सर्वे, जियोकेमिकल सैंपलिंग और स्काउट ड्रिलिंग का आधार बनता है।

- 1.5.4 विस्तृत स्ट्रक्चरल मैपिंग से पता चला कि मिनरलाइज़्ड कार्टज रीफ़ खास तौर पर खंडापार सब-ब्लॉक में बने खास शियर कॉरिडोर में मौजूद हैं। करवाही सब-ब्लॉक में ग्रेफाइट वाले हॉराइज़न की मैपिंग की गई, जहाँ कार्बोनेसियस फ़िलाइट्स मुख्य होस्ट रॉक हैं। भूवैज्ञानिक मानचित्रण में संरचनात्मक रूप से विक्षुब्ध क्षेत्रों से संबद्ध व्यापक सिलिसीकरण, फेरूजिनाइजेशन तथा कार्टज वेंसों की पहचान भी हुई, जिसने हाइड्रोथर्मल गतिविधि के लिए महत्वपूर्ण क्षेत्रीय साक्ष्य प्रदान किए तथा विस्तृत गवेषण हेतु लक्ष्यों को प्राथमिकता देने में सहायक सिद्ध हुआ।
- 1.5.5 जियोकेमिकल जांच: सरफेस जियोकेमिकल जांच गवेषण प्रोग्राम के मुख्य हिस्सों में से एक थी। सोने, चांदी और उससे जुड़े एलिमेंट्स के एनालिसिस के लिए, शियर्ड कार्टज रीफ़, मिग्माटाइट्स, ग्रेनाइट नाइस, फाइलाइट्स, कार्टज वेन्स, लेटराइट्स और डोलराइट डाइक्स समेत खास लिथोलॉजिकल यूनिट्स से कुल 213 बेडरॉक और चैनल सैंपल सिस्टमैटिक तरीके से इकट्ठा किए गए। सैंपलिंग की जगहों को जियोलॉजिकल फेवरेबिलिटी, स्ट्रक्चरल सेटिंग, हाइड्रोथर्मल बदलाव और ताज़ी चट्टानों की मौजूदगी के आधार पर चुना गया था।
- 1.5.6 एनालिटिकल नतीजों से पता चलता है कि सोने की वैल्यू बिलो डिटेक्शन लिमिट (BDL) से 4.89 ppm तक है, जबकि चांदी की वैल्यू BDL से 6.21 ppm तक है। सोने में बड़ी गड़बड़ियां खंडापार सब-ब्लॉक के दक्षिण-पश्चिमी हिस्से में हैं, जहां शियर्ड कार्टज रीफ़ में बहुत ज़्यादा सिलिकिफिकेशन और फेरूजिनाइजेशन होता है। आस-पास के दक्षिणी सेक्टर में कई और मामूली गड़बड़ियां होती हैं, जबकि ब्लॉक के बाकी हिस्सों में सोने की वैल्यू कभी-कभी और अलग-अलग दिखती हैं। ये एनालिटिकल नतीजे दिखाते हैं कि सोने का मिनरलाइजेशन स्थानीय और स्ट्रक्चरल रूप से कंट्रोल में है, न कि क्षेत्रीय रूप से फैला हुआ।
- 1.5.7 कीमती मेटल की जांच के अलावा, ग्रेफाइट वाले कार्बन वाले फाइलाइट से इकट्ठा किए गए 19 खास सैंपल का ग्रेफाइट की क्वालिटी का पता लगाने के लिए करीबी एनालिसिस किया गया। एनालिसिस के नतीजों से पता चलता है कि आम तौर पर राख की मात्रा ज़्यादा होती है, वोलाटाइल मैटर ठीक-ठाक होता है और फिक्स्ड कार्बन वैल्यू कम होती है, जिससे पता चलता

है कि ग्रेफाइट का कंसंट्रेशन खराब से कम ग्रेड का है। नतीजों से पता चलता है कि हालांकि करवाही सब-ब्लॉक में ग्रेफाइट बहुत ज़्यादा है, लेकिन ग्रेफाइट की क्वालिटी अभी इतनी काफ़ी नहीं है कि यह दिखाया जा सके कि ग्रेफाइट मिनरलाइज़ेशन सस्ता है।

1.5.8 स्काउट ड्रिलिंग: जियोलॉजिकल मैपिंग, जियोफिजिकल गड़बड़ियों और सरफेस जियोकेमिकल नतीजों की मिली-जुली व्याख्या के आधार पर, सही जियोलॉजिकल स्ट्रक्चर और मिनरल वाले ज़ोन की सबसरफेस निरंतरता की जांच करने के लिए आठ स्काउट बोरहोल ड्रिल किए गए। बोरहोल को खास तौर पर इस तरह से बनाया गया था कि वे खंडापार सब-ब्लॉक में मुख्य शियर-कंट्रोल्ड कार्टेज रीफ और करवाही सब-ब्लॉक में ग्रेफाइट वाले हॉराइजन को काट सकें। ड्रिलिंग की गहराई आम तौर पर लगभग 44 m और 100 m के बीच थी, जो G-4 स्टेज की टोही गवेषण के मकसद के मुताबिक थी।

1.5.9 ड्रिल कोर की जियोलॉजिकल लॉगिंग से पता चलता है कि जिन मुख्य लिथोलॉजी को इंटरसेक्ट किया गया, उनमें कार्टेज रीफ़, फ़िलाइट्स, फ़ेल्डस्पैथिक क्लोराइट-बायोटाइट कार्टेज शिस्ट, एम्फीबोलाइट्स, ग्रेफाइट बैंड और कार्बोनेशियस फ़िलाइट्स शामिल हैं। बोरहोल ने सतह के नीचे मैप किए गए जियोलॉजिकल सीक्वेंस के जारी रहने की पुष्टि की और कई स्ट्रक्चरल रूप से कंट्रोल किए गए कार्टेज वेन्स, सल्फाइड-बेयरिंग ज़ोन और ग्रेफाइटिक हॉराइजन को इंटरसेक्ट किया। कई बोरहोल में, खासकर मिनरलाइज़्ड शियर ज़ोन के अंदर, हाइड्रोथर्मल बदलाव, जो सिलिकिफ़िकेशन, क्लोराइटिसेशन, फ़ेरुगिनाइज़ेशन और कार्बोनेटाइज़ेशन से दिखाई देता है, रिकॉर्ड किया गया।

1.5.10 स्काउट ड्रिलिंग प्रोग्राम ने मुख्य लिथोलॉजिकल यूनिट्स की जियोलॉजिकल निरंतरता को सफलतापूर्वक स्थापित किया और यह कन्फर्म किया कि गोल्ड-बेयरिंग कार्टेज रीफ सतह के नीचे तक फैली हुई हैं। हालांकि, प्राइमरी कोर सैंपल्स के ऐसे रिजल्ट्स से पता चलता है कि आर्थिक रूप से महत्वपूर्ण गोल्ड खनिजीकरण असंतत है और लोकल इंटरवल तक ही सीमित है। इसी तरह, करवाही सब-ब्लॉक में इंटरसेक्ट हुए ग्रेफाइट बैंड्स सीमित मोटाई और तुलनात्मक रूप से कम फिक्स्ड कार्बन वैल्यू दिखाते हैं। इसलिए ड्रिलिंग प्रोग्राम ने खनिजीकरण के डिस्ट्रीब्यूशन और कैरेक्टर के बारे में कीमती जानकारी देते हुए सबसरफेस जियोलॉजिकल निरंतरता को टेस्ट करने का मुख्य मकसद पूरा किया।

1.5.11 फायर एसे एनालिसिस: स्काउट बोरहोल से मिले प्राइमरी कोर सैंपल को सिस्टमैटिक तरीके से सैंपल किया गया और फायर एसे से सोने के लिए एनालाइज़ किया गया। एनालिटिकल नतीजों से

पता चलता है कि ज़्यादातर बोरहोल सैंपल में सोने की वैल्यू कम है, और कुछ ही सैंपल में बैकग्राउंड कंसंट्रेशन से ज़्यादा असामान्य वैल्यू मिली हैं। हालांकि कई बोरहोल में सल्फाइड वाले कार्टज़ रीफ़ और बदले हुए शियर ज़ोन मिले थे, फिर भी सोने की वैल्यू कभी-कभी और रुक-रुक कर मिलती है, जिससे पता चलता है कि मिनरलाइज़ेशन लोकल है और खोजी गई गहराई के अंदर इसमें लैटरल और वर्टिकल निरंतरता की कमी है। इसलिए, मौजूदा ड्रिलिंग से पता चलता है कि सतह पर सोने की अच्छी असामान्यताएं मुख्य रूप से उथले, स्ट्रक्चरल रूप से कंट्रोल किए गए हाइड्रोथर्मल ज़ोन तक ही सीमित हैं।

1.5.12 सिल्वर मिनरलाइज़ेशन: हाइड्रोथर्मल सिस्टम में कीमती मेटल के जुड़ाव का पता लगाने के लिए, सभी रिप्रेजेंटेटिव सरफेस और बोरहोल सैंपल में सिल्वर का गोल्ड के साथ एक साथ एनालिसिस किया गया। सरफेस एनालिटिकल रिज़ल्ट बताते हैं कि सिल्वर की वैल्यू बिलो डिटेक्शन लिमिट (BDL) से लेकर 6.21 ppm तक है, जिसमें सबसे ज़्यादा वैल्यू खंडापार सब-ब्लॉक में सामने आए सोने के कतरे हुए कार्टज़ रीफ़ से जुड़ी हैं। सबसरफेस जांच से पता चलता है कि सिल्वर मिनरलाइज़ेशन मोटे तौर पर गोल्ड जैसा ही पैटर्न फॉलो करता है और लगातार ओर-ग्रेड ज़ोन बनाए बिना अलग-अलग मिनरलाइज़्ड इंटरवल तक ही सीमित है। पर्यवेक्षित स्वर्ण-रजत संबद्धता खनिजीकरण की हाइड्रोथर्मल उत्पत्ति का समर्थन करती है तथा संरचनात्मक रूप से अनुकूल मार्गों के साथ बहुमूल्य धातुओं के स्थानीयकृत निक्षेपण को प्रतिबिंबित करती है।

1.5.13 ICP-MS एनालिसिस (34 एलिमेंट्स): मिनरलाइज़्ड सिस्टम की जियोकेमिकल विशेषताओं का मूल्यांकन करने और संबंधित पाथफाइंडर एलिमेंट्स की पहचान करने के लिए, ICP-MS मेथड से 34 मुख्य और ट्रेस एलिमेंट्स के लिए रिप्रेजेंटेटिव सरफेस सैंपल्स और बोरहोल कोर सैंपल्स का एनालिसिस किया गया। एनालिटिकल नतीजों से Li, Be, B, P, S, Ti, V, Cr, Co, Ni, Cu, Zn, As, Sr, Nb, Mo, Cd, Sn, Sb, Ba, La, Ta, W, Pb, Bi और U सहित मुख्य और ट्रेस एलिमेंट्स की अलग-अलग कंसंट्रेशन का पता चलता है।

1.5.17 ICP-MS एनालिटिकल नतीजों से टाइटेनियम, कॉपर, बेरियम और लैंथेनम का अलग-अलग एनरिचमेंट दिखता है, जबकि एनालाइज़ किए गए ज़्यादातर एलिमेंट बिखरे हुए और अलग-अलग डिस्ट्रीब्यूशन दिखाते हैं। टाइटेनियम की वैल्यू 0.17% से 5.23% तक होती है, कॉपर की वैल्यू डिटेक्शन लिमिट से नीचे से 547.43 ppm तक होती है, जबकि बेरियम और लैंथेनम भी कुछ सैंपल में लोकल एनरिचमेंट दिखाते हैं। हालांकि, इन तत्वों में से कोई भी स्थायी पार्श्व या ऊर्ध्वाधर निरंतरता प्रदर्शित नहीं करता, और जाँच क्षेत्र में संबद्ध धात्विक तत्वों का कोई आर्थिक रूप से महत्वपूर्ण संवर्धन स्थापित नहीं हुआ है। अतः भू-रासायनिक आँकड़े एक कमजोर

हाइड्रोथर्मल संकेतक दर्शाते हैं, जिसमें किसी बड़े बहुधात्विक खनिजीकरण तंत्र का प्रमाण नहीं मिलता।

- 1.5.14 ट्रेस तत्वों का वितरण इंगित करता है कि कार्बोनाट शिराओं एवं सल्फाइड खनिजीकरण के लिए उत्तरदायी हाइड्रोथर्मल द्रवों में संबद्ध धात्विक तत्वों की मात्रा सीमित रही। परिणामस्वरूप, खनिजीकरण मुख्यतः स्थानीयकृत बहुमूल्य धातुओं के संवर्धन तक ही सीमित रहा, न कि किसी महत्वपूर्ण बेस मेटल अथवा बहुधात्विक भंडार का प्रतिनिधित्व करता है। तथापि, ICP-MS आँकड़े हाइड्रोथर्मल तंत्र के भू-रासायनिक विकास के संबंध में उपयोगी जानकारी प्रदान करते हैं और भविष्य के विस्तृत गवेषण के दौरान एक महत्वपूर्ण मार्गदर्शक सिद्ध हो सकते हैं।
- 1.5.15 पेट्रोग्राफिक जांच: कुल 10 रिप्रेजेंटेटिव रॉक सैंपल, जिनमें सरफेस बेडरॉक सैंपल और बोरहोल कोर सैंपल शामिल थे, की MECL पेट्रोलॉजी लेबोरेटरी, नागपुर में विस्तृत पेट्रोग्राफिक जांच की गई। पेट्रोग्राफिक स्टडीज़ ने मुख्य लिथोलॉजिकल यूनिट्स की फील्ड पहचान को कन्फर्म किया और उनकी मिनरलोलॉजिकल बनावट, टेक्सचरल विशेषताओं और बदलाव के इतिहास को स्थापित किया। पहचाने गए मुख्य रॉक टाइप में ग्रेनाइट नाइस, मिग्माटाइट, फाइलाइट, कार्बोनाट रीफ, फेल्डस्पैथिक क्लोराइट-बायोटाइट कार्बोनाट शिस्ट, एम्फीबोलाइट, ग्रेफाइट-बेयरिंग फाइलाइट, कार्बोनेसियस फाइलाइट और डोलेराइट शामिल हैं।
- 1.5.16 माइक्रोस्कोपिक जांच से पता चलता है कि चट्टानें डिफॉर्मेशन और रीक्रिस्टलाइजेशन के कई फेज़ से गुज़री हैं। कार्बोनाट में आमतौर पर अनडुलोज़ एक्सटिक्शन और डायनामिक रीक्रिस्टलाइजेशन दिखता है, जबकि फेल्डस्पार में सेरिसाइटिस और बदलाव दिखता है। मैफ़िक मिनरल अलग-अलग तरह से क्लोराइटिस हो जाते हैं और उनकी जगह सेकेंडरी मिनरल आ जाते हैं, जो हाइड्रोथर्मल ओवरप्रिंटिंग को दिखाता है। ग्रेफाइट वाले फ़िलाइट्स में फ़ोलिएशन के पैरेलल फैले हुए ग्रेफाइट फ़्लेक्स होते हैं, जबकि कार्बोनाट रीफ़ में तेज़ सिलिकिफ़िकेशन और माइक्रो-फ़्रैक्चरिंग दिखती है, जो मिनरलाइज़्ड स्ट्रक्चर के अंदर बार-बार होने वाली हाइड्रोथर्मल एक्टिविटी की पुष्टि करता है।
- 1.5.17 मिनराग्राफिक जांच: कुल 10 प्रतिनिधि शैल नमूनों, जिनमें सतही आधारशिला नमूने तथा बोरहोल कोर नमूने सम्मिलित थे, का विस्तृत शैलविज्ञानिक परीक्षण MECL पेट्रोलॉजी प्रयोगशाला, नागपुर में किया गया। शैलविज्ञानिक अध्ययनों ने प्रमुख शैलविज्ञानिक इकाइयों की क्षेत्रीय पहचान की पुष्टि की तथा उनके खनिजीय संघटन, बनावट संबंधी विशेषताओं एवं परिवर्तन इतिहास को स्थापित किया। पहचाने गए प्रमुख शैल प्रकारों में ग्रेनाइट ग्राइस,

मिग्माटाइट, फ़िलाइट, कार्बोनाइट, फेल्डस्पैथिक क्लोराइट-बायोटाइट कार्बोनाइट शिस्ट, एम्फिबोलाइट, ग्राफाइट युक्त फ़िलाइट, कार्बनयुक्त फ़िलाइट तथा डोलराइट सम्मिलित हैं।

- 1.5.18 ग्रेफाइट प्रॉक्सिमेट एनालिसिस: कार्बन वाले फाइलाइट्स से इकट्ठा किए गए ग्रेफाइट वाले सैंपल्स का नमी, राख की मात्रा, वोलाटाइल मैटर और फिक्स्ड कार्बन जैसे प्रॉक्सिमेट पैरामीटर्स के लिए एनालिसिस किया गया। एनालिटिकल नतीजों से पता चलता है कि राख की मात्रा तुलनात्मक रूप से ज़्यादा है, वोलाटाइल मैटर ठीक-ठाक है और फिक्स्ड कार्बन वैल्यू कम है, जो खराब ग्रेड के ग्रेफाइट खनिजीकरण को दिखाता है। कम फिक्स्ड कार्बन कंटेंट यह बताता है कि मौजूदा मार्केट कंडीशंस में ग्रेफाइट की मौजूदगी के आर्थिक रूप से फायदेमंद ग्रेफाइट रिसोर्स बनने की संभावना नहीं है।

1.6.0 संसाधन और गवेषण परिणाम का आकलन

- 1.6.1 मौजूदा आवीक्षण सर्वेक्षण (G-4 स्टेज) का मुख्य मकसद जामटोला-खंडापार ब्लॉक का जियोलॉजिकल फ्रेमवर्क बनाना, खनिजीकरण के लिए सही लिथोलॉजिकल और स्ट्रक्चरल कंट्रोल को बताना, जियोकेमिकल और जियोफिजिकल गड़बड़ियों की पहचान करना, और एक्सप्लोरेटरी ड्रिलिंग के ज़रिए मिनरलाइज्ड ज़ोन की सबसरफेस निरंतरता का मूल्यांकन करना था। गवेषण प्रोग्राम ने मिनरल्स (एविडेंस ऑफ मिनरल कंटेंट्स) रूल्स, 2015 (MEMC रूल्स) के तहत तय अप्रूव्ड G-4 स्टेज गवेषण गाइडलाइंस के अनुसार जियोलॉजिकल, जियोकेमिकल, जियोफिजिकल और ड्रिलिंग डेटा सफलतापूर्वक जेनरेट किया है। जांच से ब्लॉक की जियोलॉजिकल समझ में काफी सुधार हुआ है और भविष्य में गवेषण के लिए सही टारगेट ज़ोन की पहचान हुई है।

- 1.6.2 जियोलॉजिकल मैपिंग से लिथोलॉजिकल सेक्सेशन का पता चला जिसमें ग्रेनाइट नाइस के साथ मिग्माटाइट, मलंजखंड ग्रेनाइटॉइड्स, फाइलाइट्स, ग्रेफाइट वाले कार्बन वाले फाइलाइट्स, कार्बोनाइट्स, क्रिस्टलाइन लाइमस्टोन, कार्बोनाट वेन्स, शियर्ड कार्बोनाट रीप्स, डोलराइट डाइक्स, बेसाल्टिक फ्लो और लेटराइट्स शामिल हैं। स्ट्रक्चरल इंटरप्रिटेशन से पता चलता है कि इस प्रोविंस में डिफॉर्मेशन के कई फेज आए हैं, जिसके कारण खास शियर जोन, फ्रैक्चर सिस्टम और कार्बोनाट रीप्स बने हैं जो हाइड्रोथर्मल गोल्ड खनिजीकरण के मुख्य कंट्रोल हैं। पेट्रोग्राफिक और मिनराग्राफिक जांच से प्रोविंस के कॉम्प्लेक्स टेक्टोनो-मेटामॉर्फिक इवोल्यूशन की और पुष्टि हुई और होस्ट चट्टानों और उनसे जुड़े सल्फाइड असेंबलेज की मिनरलोजिकल विशेषताओं का पता चला।

- 1.6.3 सरफेस जियोकेमिकल जांच से खंडापार सब-ब्लॉक में सोने और चांदी की अच्छी गड़बड़ियां सामने आईं, जहां शियर्ड कार्टज रीफ से सोने की सबसे ज्यादा वैल्यू 4.89 ppm Au और उससे जुड़ी चांदी की वैल्यू रिकॉर्ड की गई। ये गड़बड़ियां, बड़े पैमाने पर सिलिकिफिकेशन, फेरुजिनाइजेशन और सल्फाइड फैलाव के साथ मिलकर यह दिखाती हैं कि खंडापार प्रोविंस में सोने के खनिजीकरण के लिए एक स्ट्रक्चरल कंट्रोल्ड हाइड्रोथर्मल सिस्टम है। इसी तरह, करवाही सब-ब्लॉक में मैप किए गए ग्रेफाइट वाले कार्बोनेसियस फाइलाइट्स ग्रेफाइट खनिजीकरण की घटना की पुष्टि करते हैं, हालांकि पास के एनालिसिस से तुलनात्मक रूप से कम फिक्स्ड कार्बन कंटेंट और सीमित आर्थिक क्षमता का पता चलता है।
- 1.6.4 ग्राउंड जियोफिजिकल जांच से शियर-कंट्रोल्ड कार्टज रीफ सिस्टम से जुड़ी कई चार्जबिलिटी और रेसिस्टिविटी की गड़बड़ियों का सफलतापूर्वक पता चला। जियोलॉजिकल मैपिंग, जियोकेमिकल सैंपलिंग और जियोफिजिकल इंटरप्रीटेशन के इंटीग्रेशन से स्काउट ड्रिलिंग के लिए सही जगहों की पहचान हो पाई। एक्सप्लोरेटरी ड्रिलिंग से मुख्य लिथोलॉजिकल यूनिट्स, शियर्ड कार्टज रीफ्स, सल्फाइड वाले ज़ोन और ग्रेफाइटिक हॉराइज़न की सबसरफेस निरंतरता की पुष्टि हुई। हालांकि, बोरहोल में मिले मिनरलाइज़्ड ज़ोन आम तौर पर संकरे, अलग-अलग होते हैं और खोजी गई गहराई की रेंज में सीमित गहराई दिखाते हैं।
- 1.6.5 बोरहोल कोर सैंपल के फायर एसे एनालिसिस से पता चलता है कि गोल्ड खनिजीकरण लोकलाइज्ड और स्ट्रक्चरल रूप से कंट्रोल्ड है, बिना लगातार ओर-ग्रेड इंटरसेक्शन बनाए। इसी तरह, ICP-MS जांच से टाइटेनियम, कॉपर, बेरियम और लैंथेनम का अलग-अलग एनरिचमेंट पता चलता है, लेकिन इनमें से कोई भी एलिमेंट लगातार स्पेशल निरंतरता या इकोनॉमिकली सिग्निफिकेंट कंसंट्रेशन नहीं दिखाता है। माइनोग्राफिक जांच से सिर्फ मामूली सल्फाइड खनिजीकरण का पता चलता है जिसमें पाइराइट, पाइरोटाइट, चाल्कोपीराइट और मैग्नेटाइट शामिल हैं, जो हाइड्रोथर्मल एक्टिविटी की पुष्टि करता है लेकिन काफी सल्फाइड-रिच ओर सिस्टम की मौजूदगी का संकेत नहीं देता है।
- 1.6.6 हालांकि खंडापार सब-ब्लॉक में अच्छे जियोलॉजिकल, स्ट्रक्चरल और जियोकेमिकल सिग्नेचर मिले हैं, लेकिन अभी के स्काउट ड्रिलिंग प्रोग्राम में, चाहे नतिलंब के साथ हो या गहराई पर, खनिजीकरण की काफी निरंतरता नहीं दिखी है, जिससे ओर बॉडीज़ का भरोसेमंद डिलाइनेशन हो सके। इसलिए, MEMC रूल्स, 2015 और UNFC गाइडलाइंस के प्रोविज़न के अनुसार मिनरल रिसोर्स का अनुमान लगाने के लिए उपलब्ध ड्रिलिंग डेंसिटी और सबसरफेस जानकारी काफी नहीं है। इसलिए, गवेषण के अभी के स्टेज में जामटोला-खंडापार ब्लॉक में सोने या

ग्रेफाइट के लिए किसी मिनरल रिसोर्स का अनुमान नहीं लगाया गया है, लेकिन चांदी के लिए नीचे दी गई टेबल में दिए गए तरीके से अनुमान लगाया गया है।

क्रमांक	कट-ऑफ (PPB में Au)	संसाधन (टन में)	ग्रेड (PPB में Au)
1.	1000	40406.685	2594.52

1.6.7 गवेषण से यह कन्फर्म हुआ है कि गोल्ड खनिजीकरण खंडापार सब-ब्लॉक में फाइलाइट्स के अंदर और ग्रेनाइटॉइड कॉन्टेक्ट्स के पास बने शियर-कंट्रोल्ड कार्टेज रीप्स से जुड़ा है, जबकि ग्रेफाइट खनिजीकरण करवाही सब-ब्लॉक में ग्रेफाइटिक कार्बोनेसियस फाइलाइट्स तक ही सीमित है। जेनरेटेड डेटा सिस्टमैटिक फॉलो-अप गवेषण की प्लानिंग के लिए एक मजबूत जियोलॉजिकल बेस देता है।

1.7.0 अनुशंसाएँ

1.7.1 मौजूदा आवीक्षण सर्वेक्षण (G-4 स्टेज) ने इंटीग्रेटेड जियोलॉजिकल मैपिंग, जियोफिजिकल इन्वेस्टिगेशन, जियोकेमिकल सैंपलिंग, एक्सप्लोरेटरी ड्रिलिंग और लैबोरेटरी स्टडीज़ के ज़रिए जामटोला-खंडापार ब्लॉक के जियोलॉजिकल फ्रेमवर्क, लिथोलॉजिकल सक्सेशन और मिनरलाइज़ेशन की खासियतों को सफलतापूर्वक स्थापित किया है। जांच ने खंडापार सब-ब्लॉक में शियर्ड कार्टेज रीफ़ से जुड़े स्ट्रक्चरल रूप से कंट्रोल्ड हाइड्रोथर्मल स्वर्ण खनिजीकरण और करवाही सब-ब्लॉक में कार्बोनेसियस फ़िलाइट्स द्वारा होस्ट किए गए ग्रेफाइट मिनरलाइज़ेशन की पुष्टि की है। हालांकि गवेषण के मौजूदा स्टेज के दौरान आर्थिक रूप से महत्वपूर्ण मिनरल रिसोर्स स्थापित नहीं किए गए हैं, गवेषण प्रोग्राम ने अनुकूल जियोलॉजिकल माहौल को सफलतापूर्वक चित्रित किया है और बाद की जांच के लिए भरोसेमंद गवेषण टारगेट तैयार किए हैं।

1.7.2 सरफेस जियोकेमिकल जांच में सोने की अच्छी गड़बड़ियों का पता चला है, जिनकी सबसे ज़्यादा एनालिटिकल वैल्यू 4.89 ppm Au है, जो खंडापार सब-ब्लॉक में बहुत ज़्यादा सिलिसिफ़ाइड और फेरुजिनाइज़्ड शियर्ड कार्टेज रीफ़ में पाई जाती हैं। जियोलॉजिकल मैपिंग, स्ट्रक्चरल इंटरप्रीटेशन और हाइड्रोथर्मल बदलाव की स्टडीज़ मिलकर यह इशारा करती हैं कि ये शियर-कंट्रोल्ड कार्टेज रीफ़ सिस्टम ब्लॉक के अंदर सबसे ज़्यादा संभावित गवेषण टारगेट हैं। हालांकि,

स्काउट ड्रिलिंग से पता चलता है कि गहराई पर मिलने वाला मिनरलाइज़ेशन रुक-रुक कर और लोकलाइज़्ड है, जिससे पता चलता है कि हाइड्रोथर्मल सिस्टम स्ट्रक्चरल रूप से कंट्रोल्ड है और मिनरलाइज़्ड शूट्स की निरंतरता को साबित करने के लिए और ज़्यादा विस्तृत जांच की ज़रूरत है।

1.7.3 ग्राउंड जियोफिजिकल सर्वे ने चार्जबिलिटी एनोमली, मैप किए गए शियर ज़ोन और सरफेस जियोकेमिकल एनोमली के बीच अच्छा कोरिलेशन दिखाया है। जियोलॉजिकल, जियोफिजिकल और जियोकेमिकल डेटासेट के इंटीग्रेशन से सबसरफेस जियोलॉजिकल कंडीशन की समझ में काफी सुधार हुआ है और यह भविष्य की गवेषण की प्लानिंग के लिए एक भरोसेमंद आधार देता है। यह सलाह दी जाती है कि किसी भी बाद के ड्रिलिंग प्रोग्राम में मिनरल वाली संरचनाओं को सटीक रूप से टारगेट करने के लिए इंटीग्रेटेड जियोलॉजिकल और जियोफिजिकल इंटरप्रिटेशन का इस्तेमाल जारी रखना चाहिए।

1.7.4 करवाही सब-ब्लॉक में मैप किए गए ग्रेफाइट की मौजूदगी साइड में बनी हुई है, लेकिन इसमें ज़्यादातर कार्बन वाले फाइलाइट्स के अंदर मौजूद बारीक ग्रेफाइट है। पास के एनालिसिस से पता चलता है कि फिक्स्ड कार्बन कंटेंट कम है और ऐश कंटेंट ज़्यादा है, जिससे पता चलता है कि जांच के मौजूदा स्टेज में आर्थिक संभावना कम है। इसलिए, ग्रेफाइट के लिए तुरंत कोई विस्तृत गवेषण करने की सलाह नहीं दी जाती है, जब तक कि भविष्य की रीजनल जांच में मोटे ग्रेफाइटिक होराइजन या बेहतर ग्रेफाइट क्वालिटी का पता न चले।

1.7.5 माइनोग्राफिक जांच से पता चलता है कि ब्लॉक के अंदर सल्फाइड खनिजीकरण आम तौर पर कमजोर है और इसमें मुख्य रूप से पाइराइट, पाइरोटाइट, मैग्नेटाइट और माइनर चाल्कोपाइराइट शामिल हैं, जिसमें सीमित सुपरजीन बदलाव है। इसी तरह, ICP-MS जांच से पता चलता है कि टाइटेनियम, कॉपर, बेरियम और लैंथेनम में बिना किसी लगातार जियोकेमिकल जुड़ाव के केवल अलग-अलग बढ़ोतरी हुई है। इसलिए, मौजूदा डेटासेट के आधार पर, खास तौर पर जुड़े हुए बेस मेटल्स को टारगेट करने वाली कोई और गवेषण सही नहीं मानी जाती है।

1.7.6 सतह पर सोने की अच्छी गड़बड़ियों और अच्छी स्ट्रक्चरल सेटिंग को देखते हुए, यह सलाह दी जाती है कि खंडापार सब-ब्लॉक में विस्तृत स्ट्रक्चरल जियोलॉजिकल जांच की जाए ताकि मिनरलाइज़्ड शियर कॉरिडोर की ज्योमेट्री, काइनेमेटिक्स और निरंतरता को सही तरह से दिखाया जा सके। क्वार्टज़ रीफ सिस्टम, शियर फैब्रिक, फ्रैक्चर नेटवर्क और छोटे स्केल

(1:2,000 से 1:4,000) पर ऑल्टरेशन ज़ोन की विस्तृत मैपिंग से सोने के मिनरलाइज़ेशन को कंट्रोल करने वाले स्ट्रक्चरल कंट्रोल की समझ में काफी सुधार होगा।

1.7.7 आगे की गवेषण मुख्य रूप से दक्षिण-पश्चिमी खंडापार सब-ब्लॉक पर फोकस होनी चाहिए, जहाँ सबसे मज़बूत सोने की गड़बड़ियाँ अच्छी तरह से विकसित शियर्ड कार्टज़ रीफ़, हाइड्रोथर्मल बदलाव और अच्छे जियोफिजिकल सिग्नेचर के साथ मेल खाती हैं। मौजूदा स्काउट ड्रिलिंग ने इन स्ट्रक्चर का जियोलॉजिकल फ्रेमवर्क बनाया है; हालाँकि, नतिलंब निरंतरता, डिप परसिस्टेंस और मौजूदा प्रोग्राम के दौरान जाँची गई गहराई से आगे हाई-ग्रेड ओर शूट के संभावित डेवलपमेंट की जाँच के लिए और पास-पास ड्रिलिंग की ज़रूरत है।

1.7.9 मौजूदा जांच से पता चलता है कि ब्लॉक के अंदर मिनरलाइज़ेशन मुख्य रूप से स्ट्रक्चरल रूप से कंट्रोल किया गया है, न कि स्ट्रेटा-बाउंड। इसलिए, भविष्य के ड्रिलिंग प्रोग्राम को यूनिफ़ॉर्म ग्रीड स्पेसिंग के बजाय थ्री-डाइमेंशनल स्ट्रक्चरल इंटरप्रिटेशन के आधार पर डिज़ाइन किया जाना चाहिए। बोरहोल को मुख्य शियर ज़ोन को उनके नतिलंब और डिप के लगभग परपेंडिकुलर तरीके से काटने के लिए ओरिएंटेड किया जाना चाहिए ताकि जियोलॉजिकल जानकारी को ज़्यादा से ज़्यादा किया जा सके और मिनरलाइज़्ड स्ट्रक्चर का सही मूल्यांकन किया जा सके।

1.7.10 मौजूदा आवीक्षण सर्वेक्षण के दौरान मिले अच्छे जियोलॉजिकल, स्ट्रक्चरल और सरफेस जियोकेमिकल सबूतों के आधार पर, खंडापार सब-ब्लॉक में चुनिंदा फॉलो-अप गवेषण की सलाह दी जाती है। गवेषण के अगले फेज में विस्तृत स्ट्रक्चरल मैपिंग, पास-पास जियोकेमिकल इन्वेस्टिगेशन, और सबसे अच्छे शियर-कंट्रोल्ड कार्टज़ रीफ़ सिस्टम तक लिमिटेड पास-पास एक्सप्लोरेटरी ड्रिलिंग शामिल होनी चाहिए। ऐसी इन्वेस्टिगेशन से नतिलंब निरंतरता, डेप्थ परसिस्टेंस और मिनरलाइज़्ड ज़ोन के ग्रेड डिस्ट्रीब्यूशन का इवैल्यूएशन हो सकेगा और गवेषण के ऊँचे लेवल पर असेसमेंट के लिए ज़रूरी जियोलॉजिकल जानकारी मिलेगी।

1.7.11 निष्कर्षतः, आवीक्षण सर्वेक्षण (G-4 चरण) ने अपने निर्धारित उद्देश्यों को सफलतापूर्वक पूरा किया है, जिसमें भूवैज्ञानिक रूपरेखा की स्थापना, अनुकूल शैलविज्ञानिक एवं संरचनात्मक नियंत्रणों की पहचान, स्थानीयकृत हाइड्रोथर्मल स्वर्ण खनिजीकरण का सीमांकन तथा जमटोला-खण्डापार ब्लॉक की ग्राफ़ाइट संभाव्यता का मूल्यांकन सम्मिलित है। यद्यपि वर्तमान चरण में आर्थिक रूप से उपयोगी खनिज संसाधनों की स्थापना नहीं हो सकी है, तथापि गवेषण ने प्राथमिकता वाले लक्षित क्षेत्रों की पहचान की है, जिनका व्यवस्थित अनुवर्ती परीक्षण अपेक्षित है। वर्तमान कार्यक्रम के दौरान संकलित भूवैज्ञानिक, भू-रासायनिक, भूभौतिकीय एवं ड्रिलिंग आँकड़े

भावी गवेषण की योजना हेतु एक समग्र डाटाबेस का निर्माण करते हैं तथा मध्य भारतीय टेक्टोनिक ज़ोन के इस खण्ड में खनिजीकरण की समझ को उल्लेखनीय रूप से सुदृढ़ करते हैं।

**GEOLOGICAL REPORT ON RECONNAISSANCE SURVEY FOR GOLD
GRAPHITE AND ASSOCIATED MINERALS IN
JAMTOLA-KHANDAPAR BLOCK (96.62sq. Km.)
DISTRICT: BALAGHAT, STATE – MADHYA PRADESH**

**CHAPTER-1B
EXECUTIVE SUMMARY**

1.1.0 INTRODUCTION

1.1.1 The present scheme of exploration comprising Reconnaissance Survey (G-4 Stage) for Gold, Graphite and associated minerals in the Jamtola–Khandapar Block (96.62 sq.km.), District Balaghat, Madhya Pradesh, was formulated by Mineral Exploration and Consultancy Limited (MECL) under the National Mineral Exploration Trust (NMET) programme to evaluate the mineral potential of the block through integrated geological, geophysical, geochemical and scout drilling investigations. The principal objective of the programme was to identify favourable lithological and structural controls of mineralisation, delineate potential gold- and graphite-bearing zones through systematic exploration, and assess their subsurface continuity by exploratory drilling. The exploration programme was designed in accordance with the provisions of the Minerals (Evidence of Mineral Contents) Rules, 2015 (MEMC Rules) to generate exploration data conforming to Reconnaissance (G-4) level under the UNFC classification system (Code 334). All planned exploration activities, including geological mapping, ground geophysical survey, geochemical sampling, scout drilling, core logging, laboratory investigations, petrographic and mineragraphic studies, and geological interpretation, were completed under NMET funding.

1.2.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

1.2.1 The Jamtola–Khandapar Block falls in Survey of India Toposheet No. 64C/09 and covers an area of 96.62 sq.km. and is situated in Balaghat District, Madhya Pradesh. The block comprises two geographically distinct sub-blocks, namely Khandapar Sub-block (Block-I) and Karwahi Sub-block (Block-II). The block boundary coordinates have been established using DGPS survey on the WGS-84 datum, and the details of the corner coordinates are furnished in the relevant chapter of this report.

1.3.0 GEOLOGY AND STRUCTURE OF THE BLOCK

1.3.1 The Jamtola–Khandapar Block occupies a geologically favourable position within the Central Indian Tectonic Zone (CITZ) and forms part of the southern margin of the

Balaghat–Bhandara Granulite Belt, one of the important Precambrian metallogenic provinces of Central India. The area records a prolonged geological evolution involving multiple phases of magmatism, sedimentation, regional metamorphism, deformation and hydrothermal activity. These geological processes have produced a complex assemblage of granitoids, high-grade metamorphic rocks, younger metasedimentary sequences and intrusive bodies that collectively provide favourable conditions for the development of structurally controlled gold mineralisation and graphite-bearing horizons. Regional studies indicate that mineralisation within the Balaghat region is closely associated with major shear systems, quartz reefs and hydrothermal alteration zones developed during repeated tectonic reactivation.

- 1.3.2 The regional geological succession comprises the Nandgaon Group (Older Metamorphics), Malanjkhand Granitoids, Younger Metamorphics, younger intrusive rocks and the Deccan Trap volcanic sequence, which is locally capped by recent lateritic deposits. The lithological succession exposed within the Jamtola–Khandapar Block includes greenish-grey granite gneiss with migmatitic variants, amphibolite enclaves, granodiorite, biotite granite, aplite, quartzite, crystalline limestone, conglomerate, graphite-bearing phyllite, carbonaceous phyllite, quartz veins, sheared quartz reefs, dolerite dykes, basaltic flows and laterites. This stratigraphic succession reflects repeated tectono-magmatic episodes extending from the Late Archaean to Recent and forms the geological framework controlling mineralisation within the block.
- 1.3.3 The dominant basement lithology of the block is represented by granite gneiss and migmatite gneiss belonging to the Nandgaon Group. These rocks occupy large parts of the central and northern sectors of the block and constitute the oldest exposed lithological unit. Megascopically, the granite gneiss is medium- to coarse-grained, leucocratic to mesocratic, and exhibits a well-developed gneissic foliation defined by alternating felsic and mafic mineral bands. Mineralogically, it consists predominantly of quartz, plagioclase, K-feldspar and biotite with subordinate hornblende and accessory apatite, zircon, sphene and opaque minerals. Migmatitic structures, leucocratic segregations and quartz-feldspar veins are common, indicating repeated episodes of partial melting and granitoid emplacement during regional metamorphism.
- 1.3.4 The basement rocks are intruded by granitoids belonging to the Malanjkhand Granitoid Suite, comprising coarse-grained hornblende granodiorite, diorite, fine-grained biotite granite and pink aplite. These granitoids occur mainly along the western and south-

western sectors of the block and locally exhibit intrusive contacts with the older granite gneiss and younger metasedimentary rocks. In several locations, quartz veins and sheared quartz reefs occur along the granitoid contacts, indicating that intrusive activity played an important role in generating fracture systems subsequently utilised by hydrothermal fluids responsible for gold mineralisation.

- 1.3.5 The younger metasedimentary sequence comprises phyllite, carbonaceous phyllite, graphite-bearing phyllite, quartzite, crystalline limestone and minor conglomerate, representing low- to medium-grade metamorphosed sedimentary rocks. Phyllites are generally grey to dark grey, finely foliated and composed of quartz, sericite, chlorite and mica with subordinate graphite, carbonaceous matter and disseminated sulphides. Carbonaceous and graphite-bearing phyllites occur predominantly within the Karwahi Sub-block, where graphite is developed as thin disseminated flakes and discontinuous bands parallel to foliation. Quartzites occur as resistant, compact ridges composed predominantly of recrystallised quartz, while crystalline limestone forms thin discontinuous lenses associated with metasedimentary horizons. These lithological units represent favourable hosts for graphite mineralisation and locally provide competency contrasts that influence structural deformation.
- 1.3.6 Quartz veins and sheared quartz reefs constitute the most significant lithological feature associated with gold mineralisation in the investigation area. These bodies occur as discordant to sub-concordant veins emplaced along shear zones, fractures and foliation planes within phyllites and near contacts with the Malanjkhanda Granitoids. The quartz reefs are generally milky white, massive to brecciated, and exhibit intense silicification, ferruginisation and sulphide impregnation in mineralised zones. Shearing, fracturing and repeated quartz veining have produced favourable structural traps for hydrothermal fluid circulation, resulting in localized gold enrichment. Surface mapping indicates that the best-developed sheared quartz reefs occur within the Khandapar Sub-block, where they coincide with the highest surface gold anomalies recorded during the present investigation.
- 1.3.7 Basic intrusive rocks are represented by basaltic/dolerite dykes, which constitute the youngest intrusive phase within the block. These dykes are medium-grained, dark grey to greenish-black, hard and massive, and intrude the granite gneiss, migmatites, phyllites and quartz reefs with sharp discordant contacts. Petrographically, the dolerites comprise plagioclase, clinopyroxene, subordinate hornblende and opaque minerals,

exhibiting characteristic ophitic to sub-ophitic textures. Local chloritisation, epidotisation and carbonate alteration are observed along fractures, reflecting low-temperature hydrothermal overprinting. Although these dykes are not directly mineralised, they have locally controlled brittle deformation and provided favourable pathways for subsequent quartz vein emplacement.

- 1.3.8 The youngest lithological units comprise Deccan Trap basaltic flows overlain by lateritic cappings developed through prolonged tropical weathering. The basalts occur mainly in isolated patches, whereas laterites form discontinuous blankets over elevated ground. These weathering products obscure bedrock exposure over large parts of the block and locally mask geological contacts, thereby influencing the distribution of surface sampling locations during exploration. Despite this cover, sufficient bedrock exposures were available in stream sections, hill slopes and quarry faces to establish the geological framework of the area.
- 1.3.9 **Petrography:** Petrographic investigations were carried out on 10 representative rock samples collected from both surface exposures and borehole cores to characterise the principal lithological units encountered during exploration. The petrographic studies confirmed the field identification of granite gneiss, migmatite, phyllite, quartz reef, dolerite, amphibolite, feldspathic chlorite-biotite quartz schist, graphite-bearing phyllite and carbonaceous phyllite. Microscopic examination indicates that the rocks have undergone varying degrees of deformation, recrystallisation and hydrothermal alteration. Quartz commonly exhibits undulose extinction and dynamic recrystallisation, feldspars show sericitisation and alteration, while mafic minerals display chloritisation and partial replacement by secondary minerals, reflecting multiple tectono-metamorphic events affecting the area.
- 1.3.10 **Structure:** The Jamtola–Khandapar Block exhibits a complex structural architecture produced by repeated phases of deformation. The dominant structural elements include gneissic foliation, schistosity, shear zones, joints, fractures, quartz veins and fault-controlled lineaments. Regional foliation generally trends NW–SE to NNW–SSE with moderate to steep easterly dips, although local deviations occur due to folding and shearing. Shear zones are represented by highly fractured and silicified quartz reefs showing brecciation, ferruginisation and intense deformation. These shear corridors constitute the principal structural controls on hydrothermal fluid migration and subsequent gold mineralisation. The intersection of shear zones with competent

lithological contacts, particularly along granitoid–phyllite boundaries, has created favourable sites for mineral deposition.

1.3.11 Hydrothermal Alteration: Hydrothermal alteration is well developed within the mineralised portions of the block and is closely associated with quartz veining and sulphide mineralisation. The principal alteration assemblages include silicification, ferruginisation, chloritisation, sericitisation, carbonatisation and local epidotisation. Silicification is most intense within the sheared quartz reefs, whereas ferruginisation is widespread along fracture surfaces and weathered sulphide zones. Chloritisation and sericitisation affect both phyllites and mafic rocks adjacent to mineralised structures, indicating pervasive hydrothermal fluid interaction. Oxidation of sulphide-bearing zones has resulted in the development of limonitic and lateritic caps at the surface, providing useful exploration guides during geological mapping and geochemical sampling.

1.3.12 Geological Controls on Mineralisation: The present investigation demonstrates that mineralisation within the Jamtola–Khandapar Block is controlled by the combined influence of lithology, structure and hydrothermal alteration. Gold mineralisation is confined mainly to sheared quartz reefs developed within phyllites and along contacts with the Malanjkhanda Granitoids, indicating a structurally controlled hydrothermal lode system. In contrast, graphite mineralisation is lithologically controlled and occurs as disseminated flakes and discontinuous bands within graphite-bearing carbonaceous phyllites of the Karwahi Sub-block. The coincidence of quartz veining, shear deformation, sulphide dissemination and hydrothermal alteration defines the most prospective exploration targets identified during the present G-4 investigation and provides the basis for future detailed exploration.

1.4.0 MINERALISATION

1.4.1 The present Reconnaissance Survey (G-4) has established the occurrence of gold and graphite mineralisation within the Jamtola–Khandapar Block, together with minor sulphide mineralisation represented by pyrite, pyrrhotite, chalcopyrite and magnetite. The mineralisation is spatially associated with two distinct geological environments. Gold mineralisation is confined predominantly to structurally controlled sheared quartz reefs developed within phyllites and along the contact of the Malanjkhanda Granitoids in the Khandapar Sub-block, whereas graphite mineralisation is hosted by graphite-bearing carbonaceous phyllites exposed mainly within the Karwahi Sub-block. The two

mineralisation styles are genetically distinct and occur in separate lithological domains, although both are structurally influenced by regional deformation and fracture systems.

- 1.4.2 **Gold Mineralisation:** Gold mineralisation in the Jamtola–Khandapar Block is characteristically hydrothermal lode type, occurring within silicified and sheared quartz reefs emplaced along major shear zones and fracture systems. The quartz reefs are generally milky white to smoky grey, massive to brecciated, and exhibit intense deformation manifested by shearing, fracturing and local mylonitisation. Mineralisation is associated with disseminated sulphides, ferruginisation and silicification, indicating repeated hydrothermal activity.
- 1.4.3 Surface geochemical investigations indicate that the highest gold values are confined to the south-western part of the Khandapar Sub-block, where well-developed sheared quartz reefs are exposed over appreciable strike lengths. Analytical results of bedrock and channel samples show gold values ranging from Below Detection Limit (BDL) to 4.89 ppm, whereas silver values range from BDL to 6.21 ppm. The highest gold value of 4.89 ppm is associated with strongly silicified and ferruginised sheared quartz reef, while several additional moderate gold anomalies occur within adjoining southern and south-central sectors. These results clearly indicate that gold mineralisation is localized within structurally prepared zones and does not occur uniformly throughout the block.
- 1.4.4 Scout drilling undertaken to investigate the subsurface continuity of the mineralised quartz reefs confirms the presence of sheared quartz veins at depth together with hydrothermal alteration and sulphide-bearing zones. However, analytical results from borehole core samples indicate generally low and discontinuous gold values, suggesting that the surface mineralisation is restricted to localized structural zones and lacks significant depth persistence within the investigated depth range. The present investigation therefore indicates that the auriferous system is structurally controlled and discontinuous, necessitating further exploration to identify favourable structural intersections and deeper ore shoots.
- 1.4.5 **Graphite Mineralisation:** Graphite mineralisation within the block occurs predominantly in the Karwahi Sub-block, where it is hosted by graphite-bearing carbonaceous phyllites belonging to the Younger Metamorphic sequence. Graphite occurs as finely disseminated flakes, thin foliation-parallel bands and locally concentrated streaks within highly carbonaceous phyllites. The mineralisation is lithologically controlled and follows the regional foliation of the host rock. Unlike the

gold mineralisation, graphite shows no apparent association with quartz veining or hydrothermal alteration but represents metamorphic concentration of carbonaceous sediments.

- 1.4.6 A total of 19 representative graphite samples collected from surface exposures were subjected to proximate analysis to evaluate the quality of graphite mineralisation. The analytical results indicate high ash content, moderate volatile matter, and generally low fixed carbon values, suggesting poor to low-grade graphite concentration. The analytical data indicate that although graphite is widely distributed within the carbonaceous phyllites, the quality and concentration of graphite are insufficient to establish an economically significant graphite resource at the present stage of exploration. The graphite occurrences therefore represent localized metamorphic enrichment rather than continuous high-grade graphite deposits.

1.5.0 EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

- 1.5.1 The Jamtola–Khandapar Block was selected for Reconnaissance Survey (G-4 Stage) on account of favourable geological conditions, occurrence of auriferous sheared quartz reefs in the Khandapar area, graphite-bearing carbonaceous phyllites in the Karwahi area, encouraging regional geological information generated by earlier investigations and the strategic location of the block within the Central Indian Tectonic Zone (CITZ). Previous geological investigations indicated that the area possesses favourable lithological and structural conditions for hydrothermal gold mineralisation, particularly along shear-controlled quartz reef systems, while graphitic horizons occurring within carbonaceous phyllites warranted systematic evaluation for graphite potential. Accordingly, an integrated exploration programme comprising geological mapping, geophysical survey, geochemical investigations, scout drilling and laboratory studies was formulated by MECL under the National Mineral Exploration Trust (NMET) to evaluate the mineral potential of the block in accordance with G-4 stage exploration guidelines.
- 1.5.2 The present exploration programme was designed to establish the geological framework of the block, delineate favourable lithological and structural controls of mineralisation, identify geochemical and geophysical anomalies, evaluate the subsurface continuity of mineralised zones through exploratory drilling and generate sufficient geological evidence for recommending further stages of exploration. All exploration activities were carried out in accordance with the provisions of the Minerals (Evidence of

Mineral Contents) Rules, 2015, adopting standard procedures for geological mapping, sampling, drilling, laboratory analysis and data validation. The exploration programme was completed within the approved scope of work, and the geological report has been prepared by integrating all geological, geophysical, geochemical and drilling information generated during the investigation.

1.5.3 Geological Mapping: Large-scale geological mapping on 1:12,500 scale was carried out over the entire 96.62 sq.km. block to establish the lithological succession, structural framework and surface distribution of mineralised zones. The mapping resulted in delineation of granite gneiss with migmatite, Malanjkhanda granitoids, phyllites, graphite-bearing carbonaceous phyllites, quartzites, crystalline limestone, quartz veins, sheared quartz reefs, dolerite dykes, basaltic flows and lateritic cover. Particular emphasis was given to identifying shear zones, quartz reefs, fracture systems, lithological contacts and hydrothermal alteration zones, which constitute favourable controls for gold mineralisation. The interpreted geological map prepared during the investigation forms the basis for subsequent geophysical surveys, geochemical sampling and scout drilling.

1.5.4 Detailed structural mapping revealed that the mineralised quartz reefs are localized within prominent shear corridors developed mainly in the Khandapar Sub-block. Graphite-bearing horizons were mapped in the Karwahi Sub-block, where carbonaceous phyllites constitute the principal host rock. The geological mapping also identified widespread silicification, ferruginisation and quartz veining associated with structurally disturbed zones, providing important field evidence for hydrothermal activity and assisting in prioritizing targets for detailed investigation.

1.5.5 Geochemical Investigations: Surface geochemical investigations constituted one of the principal components of the exploration programme. A total of 213 bedrock and channel samples were systematically collected from representative lithological units including sheared quartz reefs, migmatites, granite gneiss, phyllites, quartz veins, laterites and dolerite dykes for analysis of gold, silver and associated elements. Sampling locations were selected based on geological favourability, structural setting, hydrothermal alteration and availability of fresh rock exposures.

1.5.6 The analytical results indicate that gold values range from Below Detection Limit (BDL) to 4.89 ppm, whereas silver values range from BDL to 6.21 ppm. Significant gold anomalies are concentrated within the south-western part of the Khandapar Sub-

block, where sheared quartz reefs exhibit intense silicification and ferruginisation. Several additional moderate anomalous values occur within adjacent southern sectors, whereas the remaining parts of the block show sporadic and isolated gold values. These analytical results demonstrate that gold mineralisation is localized and structurally controlled rather than regionally pervasive.

- 1.5.7 In addition to precious metal investigations, 19 representative samples collected from graphite-bearing carbonaceous phyllites were subjected to proximate analysis to evaluate graphite quality. Analytical results indicate generally high ash content, moderate volatile matter and low fixed carbon values, suggesting poor to low-grade graphite concentration. The results indicate that although graphite is widespread within the Karwahi Sub-block, the quality of graphite is presently insufficient to indicate economically viable graphite mineralisation.
- 1.5.8 **Scout Drilling:** Based on the integrated interpretation of geological mapping, geophysical anomalies and surface geochemical results, eight scout boreholes were drilled to investigate the subsurface continuity of favourable geological structures and mineralised zones. The boreholes were strategically located to intersect the principal shear-controlled quartz reefs in the Khandapar Sub-block and graphite-bearing horizons in the Karwahi Sub-block. Drilling depths generally varied between approximately 44 m and 100 m, consistent with the objectives of G-4 stage reconnaissance exploration.
- 1.5.9 Geological logging of drill cores indicates that the principal lithologies intersected include quartz reefs, phyllites, feldspathic chlorite-biotite quartz schist, amphibolites, graphite bands and carbonaceous phyllites. The boreholes confirmed the continuation of the mapped geological sequence beneath the surface and intersected several structurally controlled quartz veins, sulphide-bearing zones and graphitic horizons. Hydrothermal alteration, manifested by silicification, chloritisation, ferruginisation and carbonatisation, was recorded in several boreholes, particularly within mineralised shear zones.
- 1.5.10 The scout drilling programme successfully established the geological continuity of the principal lithological units and confirmed that gold-bearing quartz reefs extend below the surface. However, assay results from primary core samples indicate that economically significant gold mineralisation is discontinuous and restricted to localized intervals. Similarly, graphite bands intersected in the Karwahi Sub-block exhibit limited thickness and comparatively low fixed carbon values. The drilling programme therefore

fulfilled the principal objective of testing subsurface geological continuity while providing valuable information regarding the distribution and character of mineralisation.

1.5.11 Fire Assay Analysis: Primary core samples obtained from the scout boreholes were systematically sampled and analysed for gold by Fire Assay. The analytical results indicate that the majority of the borehole samples contain low gold values, with only a limited number of samples returning anomalous values above background concentration. Although sulphide-bearing quartz reefs and altered shear zones were intersected in several boreholes, the gold values remain sporadic and discontinuous, indicating that the mineralisation is localized and lacks lateral as well as vertical continuity within the explored depth. The present drilling therefore suggests that the encouraging surface gold anomalies are restricted mainly to shallow, structurally controlled hydrothermal zones.

1.5.12 Silver Mineralisation: Silver was analysed simultaneously with gold in all representative surface and borehole samples to evaluate the precious metal association within the hydrothermal system. Surface analytical results indicate silver values ranging from Below Detection Limit (BDL) to 6.21 ppm, with the highest values spatially associated with the auriferous sheared quartz reefs exposed in the Khandapar Sub-block. Subsurface investigations indicate that silver mineralisation follows a pattern broadly similar to gold and is confined to isolated mineralised intervals without establishing continuous ore-grade zones. The observed gold–silver association supports the hydrothermal origin of the mineralisation and reflects localized deposition of precious metals along structurally favourable conduits.

1.5.13 ICP–MS Analysis (34 Elements): In order to evaluate the geochemical characteristics of the mineralised system and identify associated pathfinder elements, representative surface samples and borehole core samples were analysed for 34 major and trace elements by ICP–MS method. The analytical results reveal variable concentrations of major and trace elements including Li, Be, B, P, S, Ti, V, Cr, Co, Ni, Cu, Zn, As, Sr, Nb, Mo, Cd, Sn, Sb, Ba, La, Ta, W, Pb, Bi and U.

1.5.14 The ICP–MS analytical results indicate isolated enrichment of Titanium, Copper, Barium and Lanthanum, whereas the majority of the analysed elements exhibit scattered and inconsistent distribution. Titanium values range from 0.17% to 5.23%, copper values vary from Below Detection Limit to 547.43 ppm, while barium and

lanthanum also exhibit localized enrichment in a few samples. However, none of these elements demonstrate persistent lateral or vertical continuity, and no economically significant enrichment of associated metallic elements has been established within the investigation area. The geochemical data therefore indicate a weak hydrothermal signature without evidence of a large polymetallic mineralising system.

1.5.15 The trace element distribution indicates that hydrothermal fluids responsible for quartz veining and sulphide mineralisation carried limited quantities of associated metallic elements. Consequently, the mineralisation remains predominantly restricted to localized precious metal enrichment rather than representing a significant base metal or polymetallic deposit. Nevertheless, the ICP–MS data provide valuable information regarding the geochemical evolution of the hydrothermal system and may serve as an important guide during future detailed exploration.

1.5.16 **Petrographic Investigation:** A total of 10 representative rock samples, comprising surface bedrock samples and borehole core samples, were subjected to detailed petrographic examination at the MECL Petrology Laboratory, Nagpur. Petrographic studies confirmed the field identification of the principal lithological units and established their mineralogical composition, textural characteristics and alteration history. The principal rock types identified include granite gneiss, migmatite, phyllite, quartz reef, feldspathic chlorite-biotite quartz schist, amphibolite, graphite-bearing phyllite, carbonaceous phyllite and dolerite.

1.5.17 Microscopic examination indicates that the rocks have undergone multiple phases of deformation and recrystallisation. Quartz commonly exhibits undulose extinction and dynamic recrystallisation, while feldspars show sericitisation and alteration. Mafic minerals are variably chloritised and replaced by secondary minerals, reflecting hydrothermal overprinting. Graphite-bearing phyllites contain disseminated graphite flakes aligned parallel to foliation, whereas quartz reefs exhibit intense silicification and micro-fracturing, confirming repeated hydrothermal activity within the mineralised structures.

1.5.18 **Mineragraphic Investigation:** To establish the nature and paragenesis of sulphide mineralisation, 10 representative mineralised samples, including both surface and borehole core specimens, were subjected to mineragraphic investigation through

polished section studies. The investigations reveal that magnetite constitutes the dominant opaque mineral within the analysed samples, occurring as subhedral to anhedral grains with variable martitisation. Associated sulphide minerals include pyrite, pyrrhotite and minor chalcopyrite, while ilmenite, hematite and goethite occur as subordinate phases.

1.5.19 Graphite Proximate Analysis: Representative graphite-bearing samples collected from carbonaceous phyllites were analysed for proximate parameters including moisture, ash content, volatile matter and fixed carbon. The analytical results indicate comparatively high ash content, moderate volatile matter and low fixed carbon values, reflecting poor-grade graphite mineralisation. The low fixed carbon content indicates that the graphite occurrences are unlikely to constitute an economically viable graphite resource under present market conditions.

1.6.0 ESTIMATION OF RESOURCE AND EXPLORATION OUTCOME

1.6.1 The principal objective of the present Reconnaissance Survey (G-4 Stage) was to establish the geological framework of the Jamtola–Khandapar Block, delineate favourable lithological and structural controls of mineralisation, identify geochemical and geophysical anomalies, and evaluate the subsurface continuity of mineralised zones through exploratory drilling. The exploration programme has successfully generated geological, geochemical, geophysical and drilling data in accordance with the approved G-4 stage exploration guidelines prescribed under the Minerals (Evidence of Mineral Contents) Rules, 2015 (MEMC Rules). The investigation has significantly improved the geological understanding of the block and has identified favourable target zones for future exploration.

1.6.2 Geological mapping established the lithological succession comprising granite gneiss with migmatite, Malanjhand granitoids, phyllites, graphite-bearing carbonaceous phyllites, quartzites, crystalline limestone, quartz veins, sheared quartz reefs, dolerite dykes, basaltic flows and laterites. Structural interpretation indicates that the area has undergone multiple phases of deformation, resulting in the development of prominent shear zones, fracture systems and quartz reefs which constitute the principal controls of hydrothermal gold mineralisation. Petrographic and mineragraphic investigations further confirmed the complex tectono-metamorphic evolution of the area and established the mineralogical characteristics of the host rocks and associated sulphide assemblages.

- 1.6.3 Surface geochemical investigations delineated encouraging gold and silver anomalies within the Khandapar Sub-block, where the highest gold value of 4.89 ppm Au and associated silver values were recorded from sheared quartz reefs. These anomalies, together with extensive silicification, ferruginisation and sulphide dissemination, indicate that the Khandapar area hosts a structurally controlled hydrothermal system favourable for gold mineralisation. Similarly, graphite-bearing carbonaceous phyllites mapped in the Karwahi Sub-block confirm the occurrence of graphite mineralisation, although proximate analysis indicates comparatively low fixed carbon content and limited economic potential.
- 1.6.4 Ground geophysical investigations successfully delineated several chargeability and resistivity anomalies corresponding to shear-controlled quartz reef systems. Integration of geological mapping, geochemical sampling and geophysical interpretation enabled identification of favourable locations for scout drilling. Exploratory drilling confirmed the subsurface continuity of the principal lithological units, sheared quartz reefs, sulphide-bearing zones and graphitic horizons. However, the mineralised zones intersected in the boreholes are generally narrow, discontinuous and exhibit limited depth persistence within the explored depth range.
- 1.6.5 Fire assay analysis of borehole core samples indicates that gold mineralisation is localized and structurally controlled, without establishing continuous ore-grade intersections. Likewise, ICP–MS investigations reveal isolated enrichment of titanium, copper, barium and lanthanum, but none of these elements exhibit consistent spatial continuity or economically significant concentration. Mineragraphic investigations indicate only minor sulphide mineralisation comprising pyrite, pyrrhotite, chalcopyrite and magnetite, confirming hydrothermal activity but not indicating the presence of a substantial sulphide-rich ore system.
- 1.6.6 Although encouraging geological, structural and geochemical signatures have been established within the Khandapar Sub-block, the present scout drilling programme has not demonstrated sufficient continuity of mineralisation, either along strike or at depth, to permit reliable delineation of ore bodies. The available drilling density and subsurface information are therefore inadequate for estimation of mineral resources in accordance with the provisions of the MEMC Rules, 2015 and UNFC guidelines. Consequently, no mineral resource has been estimated for either gold or graphite within

the Jamtola–Khandapar Block at the present stage of exploration, but for silver it has been estimated as given in below table.

Sr. No	Cut-Off (Au in PPB)	Resource (Tonnes)	Grade (Au in PPB)
1.	1000	40406.685	2594.52

1.6.7 The exploration has confirmed that gold mineralisation is associated with shear-controlled quartz reefs developed within phyllites and near granitoid contacts in the Khandapar Sub-block, whereas graphite mineralisation is confined to graphitic carbonaceous phyllites in the Karwahi Sub-block. The generated data provide a sound geological foundation for planning systematic follow-up exploration.

1.7.0 RECOMMENDATIONS

1.7.1 The present Reconnaissance Survey (G-4 Stage) has successfully established the geological framework, lithological succession, and mineralisation characteristics of the Jamtola–Khandapar Block through integrated geological mapping, geophysical investigations, geochemical sampling, exploratory drilling and laboratory studies. The investigation has confirmed the occurrence of structurally controlled hydrothermal gold mineralisation associated with sheared quartz reefs in the Khandapar Sub-block and graphite mineralisation hosted by carbonaceous phyllites in the Karwahi Sub-block. Although economically significant mineral resources have not been established during the present stage of exploration, the exploration programme has successfully delineated favourable geological environments and generated reliable exploration targets for subsequent investigation.

1.7.2 The surface geochemical investigations have identified encouraging gold anomalies, with the highest analytical value of 4.89 ppm Au, occurring within intensely silicified and ferruginised sheared quartz reefs exposed in the Khandapar Sub-block. Geological mapping, structural interpretation and hydrothermal alteration studies collectively indicate that these shear-controlled quartz reef systems constitute the most prospective exploration targets within the block. However, scout drilling indicates that the mineralisation intersected at depth is discontinuous and localized, suggesting that the hydrothermal system is structurally controlled and requires more detailed investigation to establish the continuity of mineralised shoots.

- 1.7.3 Ground geophysical surveys have demonstrated good correlation between chargeability anomalies, mapped shear zones and surface geochemical anomalies. The integration of geological, geophysical and geochemical datasets has significantly improved the understanding of subsurface geological conditions and provides a reliable basis for planning future exploration. It is recommended that subsequent drilling programme should continue to utilize integrated geological and geophysical interpretation for precise targeting of mineralised structures.
- 1.7.4 The graphite occurrences mapped within the Karwahi Sub-block are laterally persistent but consist predominantly of finely disseminated graphite hosted within carbonaceous phyllites. Proximate analysis indicates comparatively low fixed carbon content together with high ash content, suggesting limited economic potential under the present stage of investigation. Therefore, no immediate detailed exploration for graphite is recommended unless future regional investigations identify thicker graphitic horizons or improved graphite quality.
- 1.7.5 Mineragraphic investigations indicate that sulphide mineralisation within the block is generally weak and comprises mainly pyrite, pyrrhotite, magnetite and minor chalcopyrite with limited supergene alteration. Similarly, ICP-MS investigations indicate only isolated enrichment of titanium, copper, barium and lanthanum without any persistent geochemical association. Consequently, no additional exploration specifically targeting associated base metals is considered justified based on the present dataset.
- 1.7.6 Considering the encouraging surface gold anomalies and favourable structural setting, it is recommended that detailed structural geological investigations be undertaken within the Khandapar Sub-block to accurately delineate the geometry, kinematics and continuity of the mineralised shear corridors. Detailed mapping of quartz reef systems, shear fabrics, fracture networks and alteration zones at smaller scales (1:2,000 to 1:4,000) would significantly improve the understanding of structural controls governing gold mineralisation.
- 1.7.7 Further exploration should focus primarily on the south-western Khandapar Sub-block, where the strongest gold anomalies coincide with well-developed sheared quartz reefs, hydrothermal alteration and favourable geophysical signatures. The present scout drilling has established the geological framework of these structures; however, closer-spaced drilling is required to investigate the strike continuity, dip persistence and

possible development of high-grade ore shoots beyond the depth investigated during the present programme.

- 1.7.9 The present investigation demonstrates that mineralisation within the block is principally structurally controlled rather than strata-bound. Consequently, future drilling programmes should be designed on the basis of three-dimensional structural interpretation rather than uniform grid spacing. Boreholes should be oriented to intersect the principal shear zones approximately perpendicular to their strike and dip in order to maximize geological information and accurately evaluate mineralised structures.
- 1.7.10 Based on the encouraging geological, structural and surface geochemical evidence generated during the present Reconnaissance Survey, selective follow-up exploration is recommended in the Khandapar Sub-block. The subsequent phase of exploration should include detailed structural mapping, closer-spaced geochemical investigations, and closer-spaced exploratory drilling restricted to the most favourable shear-controlled quartz reef systems. Such investigations will enable evaluation of strike continuity, depth persistence and grade distribution of the mineralised zones and provide the geological information necessary for assessment at a higher level of exploration.
- 1.7.11 In conclusion, the Reconnaissance Survey (G-4 Stage) has successfully fulfilled its intended objectives by establishing the geological framework, identifying favourable lithological and structural controls, delineating localized hydrothermal gold mineralisation and evaluating the graphite potential of the Jamtola–Khandapar Block. Although economically viable mineral resources have not been established at the present stage, the exploration has identified priority target zones that warrant systematic follow-up investigation. The geological, geochemical, geophysical and drilling data generated during the present programme constitute a comprehensive database for planning future exploration and significantly enhance the understanding of mineralisation within this segment of the Central Indian Tectonic Zone.

CHAPTER-2

DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

2.1.0 DETAILS OF THE QUALIFIED PERSON(S) / EXPLORATION AGENCY

(To be provided separately for all the qualified persons signing of the report)

Table 1 Details of exploration agency involved during exploration work

TITLE	DETAILS
(a) Name:	Mineral Exploration and Consultancy Limited (Formerly Mineral Exploration Corporation Limited) (A Govt. of India Enterprise; A Miniratna-I PSE) (Ministry of Mines, Govt of India)
(b) Communication Address:	Dr. Babasaheb Ambedkar Bhawan, Highland Drive Road, Seminary Hills, Nagpur-440006.
(c) Contact Mobile	No: 0712-2510289, 0712-2511829
(d) E-Mail id:	cmd@mecl.gov.in gm-exploration@mecl.gov.in
(e) Qualification of Technical Personnel	M.Sc. Geology/ Applied Geology
(f) Experience:	Professionals have more than 30+ years of experience
(g)Affiliation to any Organization/ company, if yes, specify the name of the organization or company.	A Govt. of India Enterprise; A Miniratna-I CPSE Ministry of Mines, Govt. of India

2.2.0 DETAILS OF PERSONS ASSOCIATED WITH VARIOUS ASPECTS OF EXPLORATION ASSESSMENT OF RESOURCES AND RESERVES

2.2.1 The list of personnel associated with the execution of different exploration activities carried out for Reconnaissance survey (G-4 Stage) for Gold, Copper, Graphite and associated minerals in Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh given in the following Table No- 2.

Table 2 List of Person(s) associated with the Exploration Work

S.No	Title	Name of Personnel
1	Overall Guidance	Shri Shrikant Sharma, HoD (Exploration)
2	Overall Planning, Coordination & Supervision	Shri Shrikant Sharma, HoD (Exploration) Shri Md Dasthageer, Sr. Manager (Geology), Shri P. Ravindran, GM (Exploration), (Retired)
3	Project Management & Field operation	Shri Aatish Ashok Bagde, Manager Drilling/ Project Manager, Shri Rishabh Kumar Manager Drilling/ Project Manager, Waraseoni Project, Shri Mohammad Kaif, Asst. Manager (Geology)- Geologist in Charge.
4	Physical Execution of Work	
	Geology	Shri Mohammad Kaif, Asst. Manager (Geology)
5	Sampling	Shri Mohammad Kaif, Asst. Manager (Geology), Shri Nasim A. G. Sheikh, Sr. Tech (Sampling)
6	Survey	Shri Dinesh Ch. Dhaulakhandi, Asst. Survey and Map Officer
7	Drilling	Shri Nitin Waghmare, Jr. Foremen (Drilling), Shri Mohanlal Chawla, Sr. Tech (Drilling)
8	Geophysics	Shri K.K.S.R.K.S. Sai, Deputy GM (Geophysics), Rajat Kumar, Geophysicist
9	Chemical laboratory	Shri Shrikant Sharma, HoD (Exploration) Shri Rohit Sharma, Sr. Manager (Chemical), Dr. Deepti Rahangdale, Manager (Chemical), Shri Fawaz SVP, Manager (Chemical)
10	Petrographic Studies	Shri Sayantan Pal, Manager (Geology)
11	Data Processing & Documentation	Shri Mohammad Kaif, Asst. Manager (Geology)
12	Reprography and Printing	NEM GR Cell

CHAPTER-3

TITLE AND OWNERSHIP

3.1.0 TITLE OF THE REPORT

GEOLOGICAL REPORT ON RECONNAISSANCE REPORT (G-4) FOR GOLD, COPPER, GRAPHITE AND ASSOCIATED MINERALS IN JAMTOLA-KHANDAPAR BLOCK, DISTRICT-BALAGHAT, STATE-MADHYA PRADESH

Ownership: Government of Madhya Pradesh

Name of Prospector: MINERAL EXPLORATION AND CONSULTANCY LIMITED
(Formerly Mineral Exploration Corporation Limited)
(A Govt. of India Enterprise; A Miniratna-I PSE) (Ministry of Mines, Govt. of India)

Address of Prospector: Dr. Babasaheb Ambedkar Bhavan, High Land Drive Road,
Seminary Hills, Nagpur, Pin- 440006

E-mail of Prospector: cmd@mecl.gov.in ; gm-exploration@mecl.gov.in

Telephone numbers of Prospector: 0712-2510289; 0712-2511829

3.2.0 DETAILS OF PERIOD OF PROSPECTING

Background Information

- 3.2.1 India ranked 6th in the world gold production in the year 1905. Now, India is not among the leading gold-producing nations globally. China, Russia, Australia, Canada, USA, Kazakhstan, etc. are among the top global miners by production. As per the Indian Bureau of Mines most recent data, domestic gold production in 2021-22 stood at approximately 1,251 kg of primary gold, representing an ~11 % increase over the previous year; during that period about 491,000 t of ore was mined at an average grade of ~3.20 g/t, while ~482,000 t of ore was treated at ~2.88 g/t gold content (IBM). India's gold reserves and resources (primary) as of April 1, 2020, have been estimated at ~607.26 tonnes of metal, of which ~92.76 tonnes are in the "Reserves" category and ~514.50 tonnes fall under "Remaining Resources." (IBM). Karnataka accounts for nearly 99% of the reported production, with Jharkhand contributing marginally. Exploration activity has seen renewed emphasis under various government schemes

(e.g. through NMEDT funding and GSI initiatives) and new geological reports have been transferred to states such as Madhya Pradesh, Jharkhand and Karnataka for potential auction and further evaluation. Despite these efforts, domestic production remains negligible relative to consumption. Gold demand in India continues to be satisfied predominantly through imports, with import volumes running into several hundred tonnes annually.

- 3.2.2 In Jamtola-Khandapar Block, Gold mineralization is primarily associated with quartz veins hosted within Palaeo–Meso Proterozoic phyllites of the Chilpi Group, with bedrock samples from Khandapar showing encouraging gold values ranging from 0.2 to 2.2 gm/t (Khan et.al., 1995). Geological studies by Tripathi et.al. (1973, 1975, 1979) classify the terrain into an Archaean Basement Complex overlain by Chilpi Group metasediments, comprising a sequence of conglomerate, metavolcanics, and metasedimentary rocks, and suggest correlations with the Sausar Group based on lithological and structural similarities. Subsequent stratigraphic refinement divided the Chilpi sequence into Lower Metavolcanics and Upper Metasedimentaries (Das Gupta et.al., 1981). Integrated geological, geochemical, geophysical, and subsurface investigations (Udhoji, 1976; Neelakantam, 1973, 1974; Chatterji et.al., 1974; Dash et.al., 1972; Dutta et.al., 1975; Neelakantam et.al., 1974; Jaiswar and Guha, 1975; Khan et.al., 1992; Shukla, 1987) have identified mineralization zones in quartz veins, granitoid contacts, and shear zones. Evidence of ancient workings and geochemical data further indicate that areas such as Khandapar and Garhi Dongri, located along contacts of Malanjhand Granite with Amgaon Gneiss and Nandgaon Volcanics, are significant for copper-gold mineralization, with quartz vein samples showing copper (14–591 ppm) and gold (0.10–0.23 g/t), and soil samples recording up to 234 ppm Cu and 0.38 g/t Au (Pal and Sindhupe, 2004; Bhargava, 2000).
- 3.2.3 Same of the bed rock samples, collected by Khan et. al., (1995) from the Khandapar quartz vein, described earlier have analysed very interesting values of gold. Out of the 14 bedrock samples analysed for gold (by AAS), four samples have given very encouraging values (0.2 gm/t, 0.4gm/t, 0.7gm/t, and 2.2gm/t; (Khan et. al, 1995). A graphite band is observed along the granite gneiss-metasedimentary contact, associated with crystalline limestone and carbonaceous phyllite and quartz veins, with average thickness of about 1.5m and extending for about 1.5 km. The fixed carbon content varies from 4.85 to 5.66%. (J.S. Jaggi et al, 1996).

- 3.2.4 In light of the above, MECL has formulated a G4 stage Reconnaissance survey program for Gold, Copper, Graphite and associated minerals in Jamtola-Khandapar Block area with the objective of identifying gold-bearing host rocks, covering an area of about 96.62sq. km.
- 3.2.5 In this connection, DGM, Govt. of Madhya Pradesh given consent to MECL for carrying out Reconnaissance survey (G-4) for Gold, Copper, Graphite and associated minerals in Jamtola-Khandapar Block, District, Madhya Pradesh vide letter No. Geol/N.S.N.61/2023 dated 01.10.2023.
- 3.2.6 The Reconnaissance survey exploration proposal (G4) for Gold, Copper, Graphite and associated minerals in Jamtola-Khandapar Block was discussed in 57th Technical Cum-Cost Committee (TCC) of NMEDT meeting held on 26th & 27th September, 2023. Based on deliberations, committee recommended the proposal for approval of EC for “Reconnaissance Survey (G-4 stage) for Gold, Copper, Graphite and associated minerals in Jamtola-Khandapar Block, District- Balaghat, Madhya Pradesh” over an area of 96.62 sq.km with an estimated cost of Rs. 216.30 lakh (including GST) within time schedule of 12 months.
- 3.2.7 Subsequently, the 32nd meeting of Executive Committee (EC), NMEDT (06th December 2023) approved the project and the same was intimated to MECL vide MoM letter No. F.NO.23/396/2023-NMET/366 dated 12th December, 2023. **Annexure No. XV).**

Details of Period of prospecting:

- 3.2.8 Following the Office Memorandum/ sanction order from NMEDT, MECL initiated field activities and established base camp at Baihar under administrative control of MECL’s Waraseoni project. MECL commenced G-4 stage exploration work (Phase-I) comprising of large-scale geological mapping (1:12500 scale) over entire 96.62 sq.km. area, collection and analysis of surface Bedrock samples (213 nos.) and Borehole Samples (156 nos.) for Gold, and Surface Bedrock Samples (19 nos.) and Borehole samples (21 nos.) for Graphite.
- 3.2.9 Bedrock sample collected from Quartz reefs and Phyllites have shown promising values for Gold and Silver and Graphite. Seven bedrock samples of sheared quartz reefs collected from Khandapar area for Gold have shown 0.11 ppm Au to 4.89 ppm Au, six samples from same area have shown values of 0.01 ppm Au, and Seven Samples have

shown Gold values between 0.02 ppm Au to 0.09 ppm Au, while seven bed rock samples collected from Graphite zone in Karwahi area have shown >2% FC values ranging between 2.09% FC and 3.38% FC and 4 sample ranging between 1.18% FC and 1.79% FC. Mostly the area is concealed under soil cover. Based on the geological mapping and BRS Sample results, two potential areas viz. Khandapar area (1.434 sq.km.) and Karwahi area (2.090 sq.km.) have been demarcated for ground geophysical survey to figure out the sub-surface potentiality of the prospect and concealed extensions of mineralisation if any.

- 3.2.10 The project was reviewed on 11.06.2025 with 3rd TCC-II and based on bedrock sample analysis in the identified two potential areas for Gold and Graphite i.e Khandapar and Karwahi, MECL commenced Ground geophysical survey comprising of I.P. cum Resistivity, SP and Magnetic. Total cumulative 2.5 Lkm survey (1.3 Lkm in Khandapar & 1.2 Lkm in Karwahi) at 100m profile interval and 20m station interval accomplished. Ground geophysical survey indicated some anomalous zones in these two sub areas.
- 3.2.11 subsequently, the project was reviewed on 11.02.2026 with 12th TCC-II for ongoing progress and status. Findings of Ground geophysical survey along with test borehole plan were discussed in 12th TCC-II meeting. Based on geophysical anomalies, total 8 scout boreholes (500 m) were planned (Four Boreholes in Khandapar sub area for Gold and Silver & Four Boreholes in Karwahi sub area for Graphite) to test the anomalies in depth. MECL sought approval for additional drilling (110m) and a timeline extension of six months. MECL appraised the committee that delay in work was due to forest clearance issue and other constraints. The committee approved additional drilling in this meeting.
- 3.2.12 Out of the two sub blocks, one block Karwahi falls in Reserve Forest and another one Khandapar falls in non-forest area. According to forest officials, the area is close to Tiger Reserve (Kanha Tiger Reserve) This was also another constraint for obtaining forest clearance. Forest Clearance was granted on 04.12.2025 vide letter no. S.N/Tech.Room/3644 from DFO (N), Balaghat, Madhya Pradesh.
- 3.2.13 MECL commenced drilling activities on 16th July, 2025 and concluded on 09th March, 2026. Total 8 Nos. test boreholes with a total of 610 .0m were drilled to test the geophysical anomalies and to confirm sub-surface gold or associated mineralisation in Khandapar sub block area and Graphite Mineralisation in Karwahi sub block of

Jamtola-Khandapar block. Scout drilling along with borehole deviation survey (In Khandapar area only) was accomplished.

CHAPTER-4

DETAILS OF THE AREA UNDER STUDY

4.1.0 LOCATION AND ACCESSIBILITY OF THE BLOCK

- 4.1.1 The study area is situated in and around Baihar and Paraswada tehsil of Balaghat district in Madhya Pradesh (Plate-I). Major villages in the block are Khandapar, Patpari, Jamtola, Kinarda, Kiniyan, Karwahi, Barwahi, Katangi etc. Balaghat District, Madhya Pradesh.
- 4.1.2 The Jamtola-Khandapar Block is situated in the northcentral part of Balaghat District, Madhya Pradesh, covering an area of about 96.62sq. km. The block lies between latitudes 21°59'57.65"N to 21°56'30.53"N and longitudes 80°29'56.24"E to 80°39'52.73"E, falling in the Survey of India Topo Sheet No. 64C/09. The terrain is generally undulating to hilly with forest cover in parts, interspersed with agricultural fields and small settlements. The block represents a mix of rural and semi-forested landscape, located to the northeast of Balaghat town. The block location is shown in **Plate-I** and **Text Figure-1**. The locational co-ordinates (Geographic & UTM) of the cardinal points of the Jamtola-Khandapar block, Balaghat District, MADHYA PRADESH are given in **Table 3**.

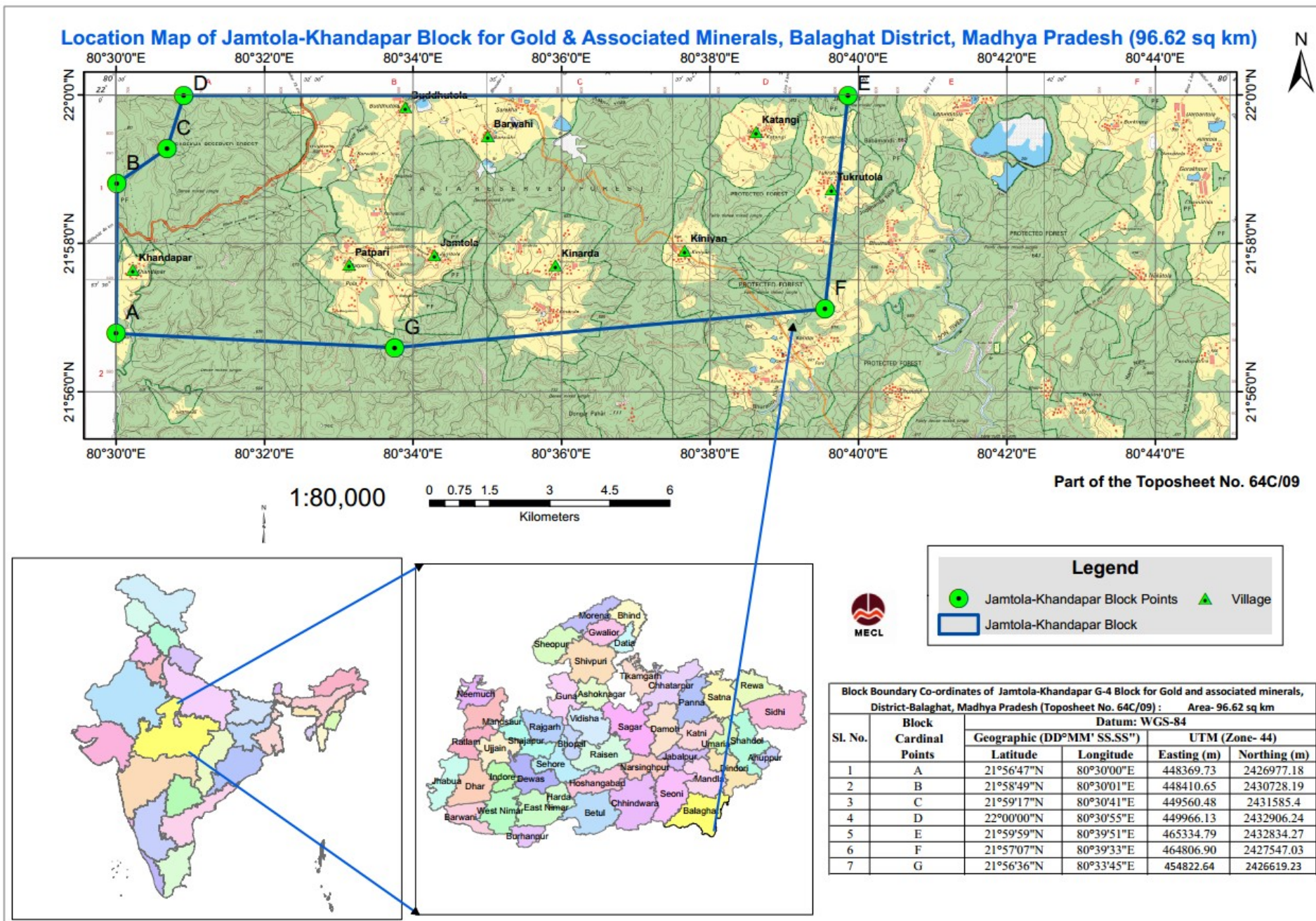
Table 3 Block Boundary Co-ordinates of Jamtola-Khandapar G-4 Block for Gold, Copper, Graphite and associated minerals, District-Balaghat, Madhya Pradesh
(Toposheet No. 64C/09): Area- 96.62 sq km)

Sl. No.	Block Cardinal Points	Datum: WGS-84			
		Geographic (DMS)		UTM (Zone- 44)	
		Latitude	Longitude	Easting (m)	Northing (m)
1	A	21°56'47"N	80°30'00"E	448369.73	2426977.18
2	B	21°58'49"N	80°30'01"E	448410.65	2430728.19
3	C	21°59'17"N	80°30'41"E	449560.48	2431585.4
4	D	22°00'00"N	80°30'55"E	449966.13	2432906.24
5	E	21°59'59"N	80°39'51"E	465334.79	2432834.27
6	F	21°57'07"N	80°39'33"E	464806.90	2427547.03
7	G	21°56'36"N	80°33'45"E	454822.64	2426619.23

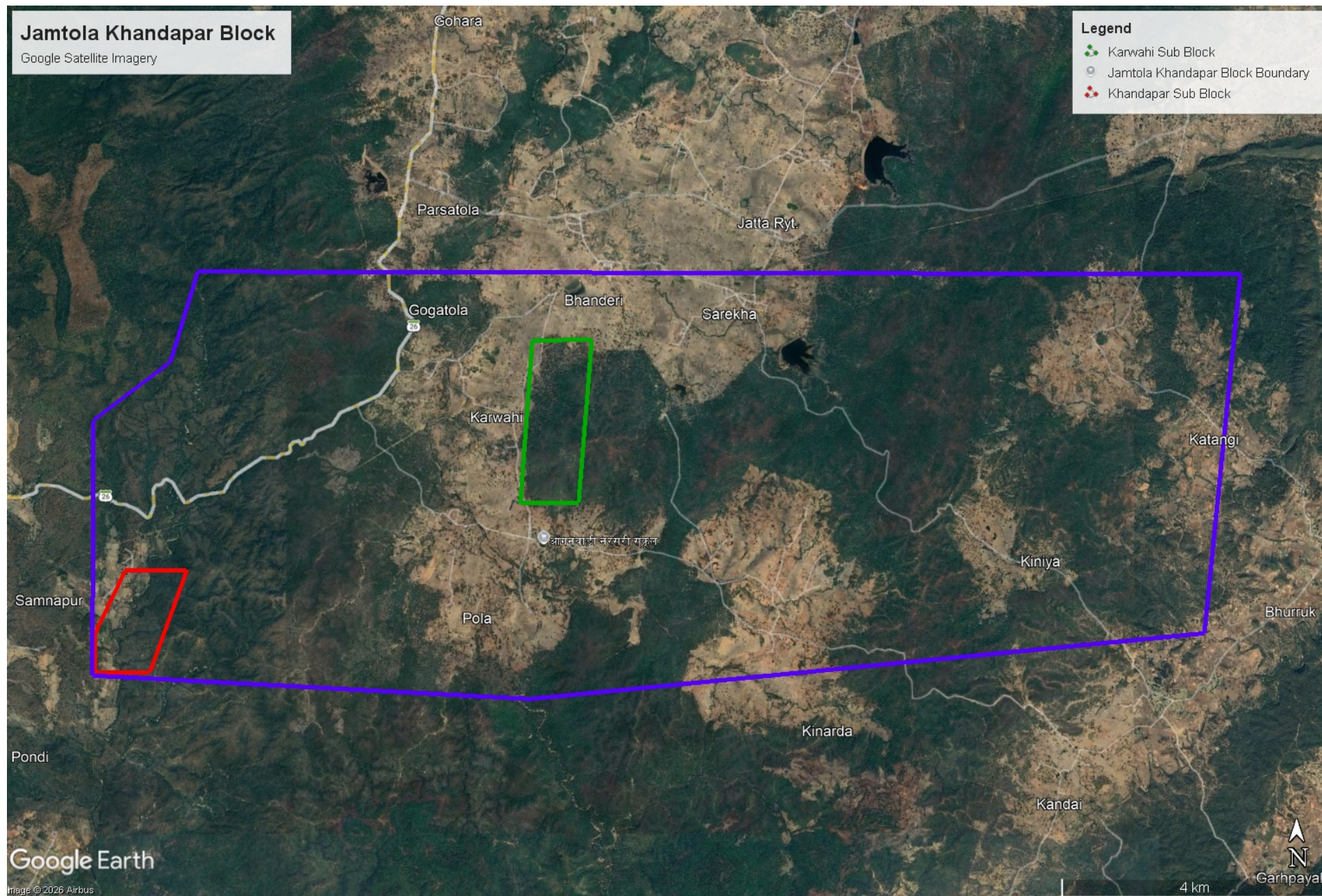
4.2.0 ACCESSIBILITY TO THE BLOCK

- 4.2.1 The proposed block is situated about 40 km in NE direction of Balaghat which is the district head quarter. The proposed block is well connected to Balaghat via MP SH-26 which connects Khategaon and Amarkantak and passes through the NW corner of the proposed block. NH-543 is the spur road of National Highway 43 that passes through Balaghat. Balaghat Junction (station code: BTC) is situated on the Jabalpur–Nainpur–Gondia section of South East Central Railway in Madhya Pradesh. The nearest airport from the proposed block is situated in Gondia in Maharashtra (~65km in SW direction). Another airport is there in Jabalpur, MP (~145 km in SW direction).
- 4.2.2 The block is located in Baihar and Paraswada tehsil of Balaghat district in Madhya Pradesh (Plate-I). Major villages in the proposed block are Khandapar, Patpari, Jamtola, Kinarda, Kiniyan, Barwahi, Katangi etc.
- 4.2.3 The closest airports are at Gondia in Maharashtra (~65km in SW direction) and at Jabalpur in MP (~145 km in SW direction) ensuring regional accessibility to the block.

Text Figure 1 Location Map of Jamtola-Khandapar Block (G4), Balaghat, Madhya Pradesh



Text Figure 2 Location Map of Jamtola-Khandapar Block on Google satellite imagery



4.3.0 DETAILS OF THE AREA WITH LAND USE

- 4.3.1 The Jamtola–Khandapar G4 block for gold, copper, graphite and associated minerals, covering about 96.62 sq. km, is located in Balaghat district of Madhya Pradesh and forms part of Survey of India Toposheet No. 64C/09. The area lies within a rugged and undulating terrain characterized by low to moderate hills, valleys, and structurally controlled landforms. It is well connected to nearby settlements such as Jamtola, Khandapar, Katangi, Kinarda, Barwani, Patpari, and Jhurkutola, which are distributed across the block. The region falls within a forested belt of southeastern Madhya Pradesh, and accessibility is mainly through village roads and forest tracks, with some interior areas remaining relatively difficult to reach.
- 4.3.2 Land use within the block is predominantly influenced by topography, drainage, and underlying geology. A major portion of the area is covered by forest land, including reserved and protected forest patches, as evident from the toposheet. These forested areas are mainly distributed over hilly and elevated terrains and consist of mixed forest and degraded vegetation, supporting local biodiversity and minor forest-based activities. The forest cover forms the dominant land use category in the region.
- 4.3.3 Agricultural land is present in patches, primarily concentrated around village settlements and valley portions where relatively gentle slopes and better soil conditions prevail. These areas support mostly rain-fed agriculture, with crops such as paddy, pulses, and millets being cultivated depending on seasonal rainfall. The agricultural fields are generally small and fragmented, reflecting subsistence-level farming practices.
- 4.3.4 Settlement areas within the block are sparse and scattered, consisting of small rural habitations. These are typically located in relatively flat or gently sloping areas with access to water sources and cultivable land. Infrastructure development is limited, and habitation density is low, which is consistent with the predominantly forested and hilly nature of the terrain.

4.4.0 MINERAL(S) UNDER INVESTIGATION

- 4.4.1 Jamtola-Khandapar Block (96.62sq.km.) explored for Gold, Copper, Graphite and associated minerals at G4 Stage during present investigation.

CHAPTER-5

PHYSIOGRAPHY AND ENVIRONMENT

5.1.0 RELIEF OF THE AREA WITH MINIMUM AND MAXIMUM ELEVATION, DRAINAGE PATTERN, NATURAL WATER COURSES, RESERVOIRS, ETC.

- 5.1.1 The Jamtola–Khandapar block lies within the southern part of Balaghat district, forming part of the eastern extension of the Satpura–Maikal hill ranges. The overall relief of the area is undulating to moderately hilly, with alternating low ridges and shallow valleys. Based on regional topographic patterns and Survey of India toposheets, the elevation in the block ranges approximately from 300 m to 550 m above mean sea level. The minimum elevations (~300–350 m) are generally observed along valley floors and drainage channels in the southern and central parts of the block, while the maximum elevations (~500–550 m) occur over hillocks and forested ridges, particularly toward the northern and north-western sectors. Slopes are generally gentle to moderate, although localized steep gradients occur near ridge flanks.
- 5.1.2 The drainage pattern in the block is predominantly dendritic, indicating relatively homogeneous lithology and structural control typical of crystalline terrains. In certain localized areas, especially near linear ridges or structural trends, a sub-dendritic to weakly trellis pattern may be observed. The drainage density is moderate, with numerous first- and second-order seasonal streams dissecting the terrain.
- 5.1.3 The block is drained by a network of ephemeral to seasonal streams (nallahs) that originate from the elevated ridge zones and flow through narrow valleys. These natural water courses generally follow the regional slope and ultimately contribute to larger river systems of the region, which are part of the Wainganga River basin. Most streams are rain-fed, carrying significant discharge during the monsoon season and remaining dry or with minimal flow during summer months.
- 5.1.4 In terms of natural water bodies, small ponds, tanks, and village-level reservoirs are scattered across the area, mainly used for irrigation and domestic purposes. Additionally, a few minor reservoirs and check dams may exist on seasonal streams to store monsoon runoff. No major large-scale reservoir is located directly within the block.
- 5.1.5 The block location depicted on google satellite imagery is shown as **Text Figure No.2.**

5.2.0 ROADS, RAILWAY TRACK, ELECTRIC TRANSMISSION LINE, TELEPHONE LINE, ETC.

- 5.2.1 The Jamtola–Khandapar block in Balaghat district is moderately well connected by a network of rural and minor roads. These roads link important villages such as Jamtola, Khandapar, Kinhi, and Katangi. The road system consists of both metalled (pucca) roads that connect major settlements and unmetalled (kuccha) roads or tracks that extend into interior and forested areas. Due to the undulating and hilly terrain, many of these roads follow winding paths, and road density is higher near settlements while it becomes sparse in densely forested regions.
- 5.2.2 The MP SH-26 which connects Khategaon and Amarkantak passes through the NW corner of the proposed block in between Ukwa and Baihar. NH-543 is the spur road of National Highway 43 that passes through Balaghat.
- 5.2.3 There is no railway line passing directly through the Jamtola–Khandapar block, as evident from the map. However, the nearest railway connectivity is available at nearby towns such as Balaghat, which serves as an important railway junction on the Jabalpur–Balaghat–Gondia line. The railway network in the district generally follows the Wainganga valley and connects key towns, but within the block itself, rail transport is absent and access depends on surrounding areas.
- 5.2.4 Electric transmission lines are present within the block and can be identified on the map by straight lines often marked with tower symbols. These lines typically pass near or between settlements, helping supply electricity to villages in the region. They are part of the broader rural electrification network and likely include medium to high voltage lines that support domestic use and agricultural activities.
- 5.2.5. Telephone or communication lines are also indicated on the map, usually represented by thin dashed or dotted lines. These lines often run parallel to roads, as this alignment makes installation and maintenance easier. They connect major villages and settlements, indicating the presence of basic communication infrastructure across the block, although modern mobile communication systems are not depicted on such maps.
- 5.2.6 Overall, the infrastructure pattern in the Jamtola–Khandapar block reflects a semi-rural and forested landscape where transport and utility networks are closely tied to settlement distribution. Infrastructure is more developed in inhabited and agricultural

areas and limited in forest zones. The absence of major highways and railway lines within the block indicates that the region relies significantly on nearby towns like Balaghat and Katangi for broader connectivity and access to higher-level services.

5.3.0 HOST POPULATION (LOCAL TRIBES), HUMAN SETTLEMENTS WITHIN AND NEARBY THE AREA

- 5.3.1 The Jamtola–Khandapar block lies within Balaghat District, which is a tribal-dominated and predominantly rural region. The host population of this area mainly consists of Scheduled Tribes (STs), along with other rural communities. According to census data, Scheduled Tribes constitute about 22–23% of the total population of the district, indicating a strong tribal presence in and around the block.
- 5.3.2 The major local tribal groups found in this region include the Gond, Baiga, and Korku communities. Among these, the Gond tribe is the most dominant, widely distributed across forested and hilly terrains. The Baiga tribe, considered one of the primitive tribal groups, is also found in pockets of Balaghat and nearby districts, traditionally dependent on forests for livelihood. These tribes are closely associated with the natural environment and rely on activities such as shifting cultivation, collection of forest produce, and small-scale agriculture.
- 5.3.3 The human settlement pattern within the Jamtola–Khandapar block is predominantly rural and dispersed. The area is characterized by numerous small villages and hamlets, often located near water sources, agricultural land, or forest edges. Settlements such as Jamtola, Khandapar, Kinh, Katangi, and surrounding villages are connected by minor roads and tracks. The distribution of settlements is influenced by topography, forest cover, and availability of cultivable land, resulting in scattered habitation rather than compact urban centers.
- 5.3.4 Nearby settlements include medium-sized towns and tehsil centers such as Katangi and Balaghat, which act as service hubs for surrounding villages. These settlements typically consist of clustered houses made of local materials, with agriculture and forest-based livelihoods forming the economic base.
- 5.3.5 Overall, the Jamtola–Khandapar block exhibits a tribal-dominated host population with dispersed rural settlements, where human habitation is closely linked to natural resources, forest environment, and traditional lifestyles.

Table 4 Administrative Division and population (Census 2011) of Balaghat District, Madhya Pradesh.

Category	Details
District	Balaghat District
State	Madhya Pradesh
Number of Tehsils	10
Tehsils (Sub-districts)	Baihar, Balaghat, Katangi, Khairlanji, Kirnapur, Lalbarra, Lanji, Paraswada, Tirodi, Waraseoni
Total Population	17,01,698
Male Population	8,42,178
Female Population	8,59,520
Sex Ratio	1021 females per 1000 males
Population Growth (2001–2011)	13.60%
Rural Population	1,456,882 (85.6%)
Urban Population	244,816 (14.4%)
Literacy Rate	77.09%
Scheduled Tribe Population	~22–23%
Overall, Character	Predominantly rural and tribal-dominated

5.4.0 SOCIO DEMOGRAPHIC PROFILE OF THE AREA AND NEARBY

5.4.1 The Jamtola–Khandapar area lies within the Balaghat district of Madhya Pradesh, which is predominantly rural and tribal in character. The socio-demographic structure of the region is strongly influenced by forest-based livelihoods, agriculture, and

traditional tribal culture. The population is largely distributed in small villages and hamlets rather than urban settlements, reflecting a dispersed rural settlement pattern.

5.4.2 A significant feature of the area is its tribal population dominance. The major tribal communities include the Gond, Baiga, and Korku tribes. The Gond tribe is the most widespread and socially prominent in the region, while the Baiga tribe, classified as a Particularly Vulnerable Tribal Group (PVTG), is found in smaller pockets. These communities traditionally depend on forests, shifting cultivation, collection of minor forest produce, and subsistence agriculture. Their cultural practices, language, and social organization remain strongly linked to natural resources and forest ecosystems.

5.4.3 According to Census 2011, Balaghat district has a population of about 1.7 million, with more than 85% rural population, indicating that the Jamtola–Khandapar area is part of a largely rural demographic system. The sex ratio of the district is relatively balanced at 1021 females per 1000 males, showing a stable gender structure. Literacy levels are around 77%, but there is a noticeable gap between male and female literacy, especially in rural and tribal areas due to limited access to higher education.

5.5.0 HISTORICAL SITES AND ARCHAEOLOGICAL MONUMENTS, PLACES OF WORSHIP, PUBLIC UTILITIES ETC.

5.5.1 The Jamtola–Khandapar Block in Balaghat district does not contain any major archaeological monuments or nationally protected historical sites. The region is primarily rural and forested, and no large ancient structures or ruins have been recorded within the block in official topographical or archaeological records. However, the wider cultural landscape reflects the long-standing presence of tribal communities such as the Gond and Baiga, whose traditions and settlement history contribute to the local heritage in an ethnographic sense rather than through built monuments.

5.5.2 Old village settlements, customary burial practices, and forest-based cultural markers form part of the local historical identity. The Jamtola–Khandapar block itself does not have prominent historical monuments of national importance.

5.5.3 Places of worship in the area are mainly village-level religious sites and traditional tribal shrines. Most settlements have small temples dedicated to local deities such as Gram Devta, Shiva, and Devi forms. In addition, tribal communities maintain sacred groves and forest shrines (locally known as Dev Gudi), which are important centres of

spiritual and cultural practice. These sites reflect a blend of Hindu religious traditions and indigenous tribal belief systems closely linked with nature.

5.5.4 Public utilities in the region are basic and primarily serve rural needs. Villages are supported by facilities such as electricity supply lines, hand pumps, wells, and small water tanks for drinking water. Educational infrastructure generally includes primary schools and Anganwadi centres, while healthcare is provided through sub-centres or primary health centres located in larger villages or nearby tehsil headquarters. Postal services and basic communication facilities are present but limited in scope.

5.5.5 Overall, the Jamtola–Khandapar area reflects a rural-tribal socio-cultural environment where historical significance is rooted in living traditions rather than monumental heritage. Places of worship are community-based and nature-oriented, and public utilities remain basic, with higher-level services accessed from nearby towns such as Katangi and Balaghat.

5.6.0 FORESTS, SANCTUARIES, NATIONAL PARK AND WILD LIFE SANCTUARIES ETC.

5.6.1 The Jamtola–Khandapar area of Balaghat district is largely covered by tropical deciduous forest, forming part of the extensive forest belt of the southern Madhya Pradesh region. The forests are mainly dry and moist deciduous types, dominated by species such as teak, sal, bamboo, and mixed hardwood trees.

5.6.2 The forest administration in this region falls under the Balaghat Forest- North Division, and a significant portion of the area is classified as reserve and protected forest.

5.6.3 Although there is no national park or wildlife sanctuary directly within the Jamtola–Khandapar block, the area lies in close proximity to some of India’s well-known protected areas. The most important nearby protected area is the Kanha National Park, located in the Balaghat-Mandla region.

5.7.0 FLORA AND FAUNA WITHIN AND NEARBY

5.7.1 The flora of the region is mainly composed of economically and ecologically important tree species. The dominant vegetation includes teak (*Tectona grandis*), sal (*Shorea robusta*), bamboo (*Dendrocalamus strictus*), tendu (*Diospyros melanoxylon*), mahua (*Madhuca longifolia*), and dhaora (*Terminalia anogeissiana*). Teak and sal forests are

especially significant as they form the primary timber-producing species. Bamboo is widely found in undergrowth areas and is an important resource for local tribal communities.

5.7.2. The fauna of the region is diverse and typical of central Indian forest ecosystems. Common herbivores include spotted deer/chital (*Axis axis*), sambar deer (*Rusa unicolor*), barking deer (*Muntiacus muntjak*), wild boar (*Sus scrofa*), and nilgai (*Boselaphus tragocamelus*). These species are commonly found in forested patches and sometimes near agricultural fields, including other mammals such as Bengal foxes (*Vulpes bengalensis*), black-naped hares (*Lepus nigricollis*), golden jackals (*Canis aureus*), and rhesus monkeys (*Macaca mulata*).

5.7.3 The avifauna (bird life) is rich and includes peafowls, francolin/partridges, woodpeckers, eagles, hornbills, kingfishers, and a variety of migratory and resident birds. Wetland patches, streams, and agricultural fields support aquatic and semi-aquatic bird species.

5.8.0 WATER BODIES SUCH AS RIVER, NALA, STREAM, RESERVOIR, ETC

5.8.1 The Jamtola–Khandapar block in Balaghat District is characterized by a well-developed dendritic to sub-dendritic drainage system, comprising numerous seasonal nalas and small streams that dominate the area, especially within forested and undulating terrain. These ephemeral channels primarily carry monsoonal runoff and gradually merge into higher-order streams, ultimately contributing to the regional drainage of the Wainganga River basin. No major perennial river flows directly through the block; however, a small reservoir/tank is observed in the north-eastern part, likely serving irrigation and local water needs, along with scattered village ponds near habitations.

5.9.0 CLIMATIC CONDITIONS

5.9.1 The Jamtola–Khandapar block in Balaghat District experiences a tropical monsoon climate characterized by three distinct seasons—summer, monsoon, and winter. Summers (March–June) are hot and dry, with temperatures often ranging between 30°C to 45°C, occasionally touching higher peaks during May. The southwest monsoon (June–September) brings the majority of the annual rainfall, typically around 1200–1600 mm, resulting in high humidity, rejuvenation of seasonal nalas and streams, and increased surface runoff. Winters (November–February) are mild and pleasant, with temperatures ranging from 10°C to 25°C, and occasional cold waves lowering

temperatures further during December–January. The area, being largely forested and undulating, experiences moderate to high humidity during monsoon and relatively dry conditions in summer, with winds generally light to moderate.

5.10.0 OTHER PHYSIOGRAPHIC, SOCIAL AND ENVIRONMENTAL FACTOR

5.10.1 The Jamtola–Khandapar block in Balaghat District is characterized by a combination of physiographic, social, and environmental factors typical of central Indian forested terrains. Physiographically, the area exhibits undulating to moderately hilly topography with elevations generally ranging between 300–600 m, interspersed with low ridges, gentle slopes, and narrow valleys. The region is largely covered by dense to moderately dense forest, forming part of the wider forest belt of central India, with soils predominantly lateritic to sandy loam, supporting natural vegetation and minor agriculture.

5.10.2 From a social perspective, the area is sparsely populated with small settlements (villages) such as Jamtola, Karwahi, Pola, Gogatola, Kinhyan, and Kukrutiola, etc connected by kutchra and limited pucca roads, and inhabited largely by tribal and rural communities dependent on agriculture, forest produce, and local water resources. Infrastructure facilities like healthcare, education, and markets are moderately developed and mostly concentrated near larger habitations like Katangi.

CHAPTER-6 INFRASTRUCTURE

6.1.0 LOCAL INFRASTRUCTURE WITH ROADS, RAILWAYS, PORT FACILITIES, ELECTRICITY, WATER ETC. WITH DISTANCE FROM THE AREA. DETAILS OF NEAR BY INDUSTRIES IN THE AREA WHICH MAY USE THE MINERAL COMMODITY LIKELY TO BE MINED.

- 6.1.1 The Jamtola–Khandapar exploration block located in Balaghat district has moderate regional infrastructure supported by its proximity to established mining and transport corridors. The area is connected by a network of state roads and nearby national highways such as NH-543, which link it to key towns. The nearest urban center, Balaghat, lies approximately 20–40 km from the block, while Gondia is about 45 km away and serves as an important logistical hub. Nagpur, a major regional centre, is located around 200 km from the area. While regional road connectivity is fairly good, the immediate project area consists of forested terrain where last-mile access is currently dependent on kutchha or semi-developed roads, requiring further strengthening for mining operations.
- 6.1.2 Railway connectivity is a significant advantage for the block. The nearest railhead is Balaghat Junction, located within 20–40 km, which connects to the broader rail network via the Jabalpur–Balaghat–Gondia section. A more prominent railway hub is Gondia Junction, approximately 45 km away, which is well connected to major freight corridors. This rail infrastructure is suitable for bulk transportation of minerals to processing centers and ports. Air connectivity is available through Birsi Airport at about 45 km and Dr. Babasaheb Ambedkar International Airport at around 200 km, mainly serving personnel movement.
- 6.1.3 Electricity infrastructure in the district is available through the state grid, although remote and forested parts of the block may require additional strengthening such as dedicated feeders, substations, and transmission lines for mining activities. The presence of established mining companies in the region has already led to partial infrastructure development in nearby belts. Water availability is primarily dependent on groundwater sources, including wells and borewells, along with seasonal streams and small surface water bodies. While sufficient for preliminary exploration, large-scale

mining would require planned water management systems, including storage and supply arrangements.

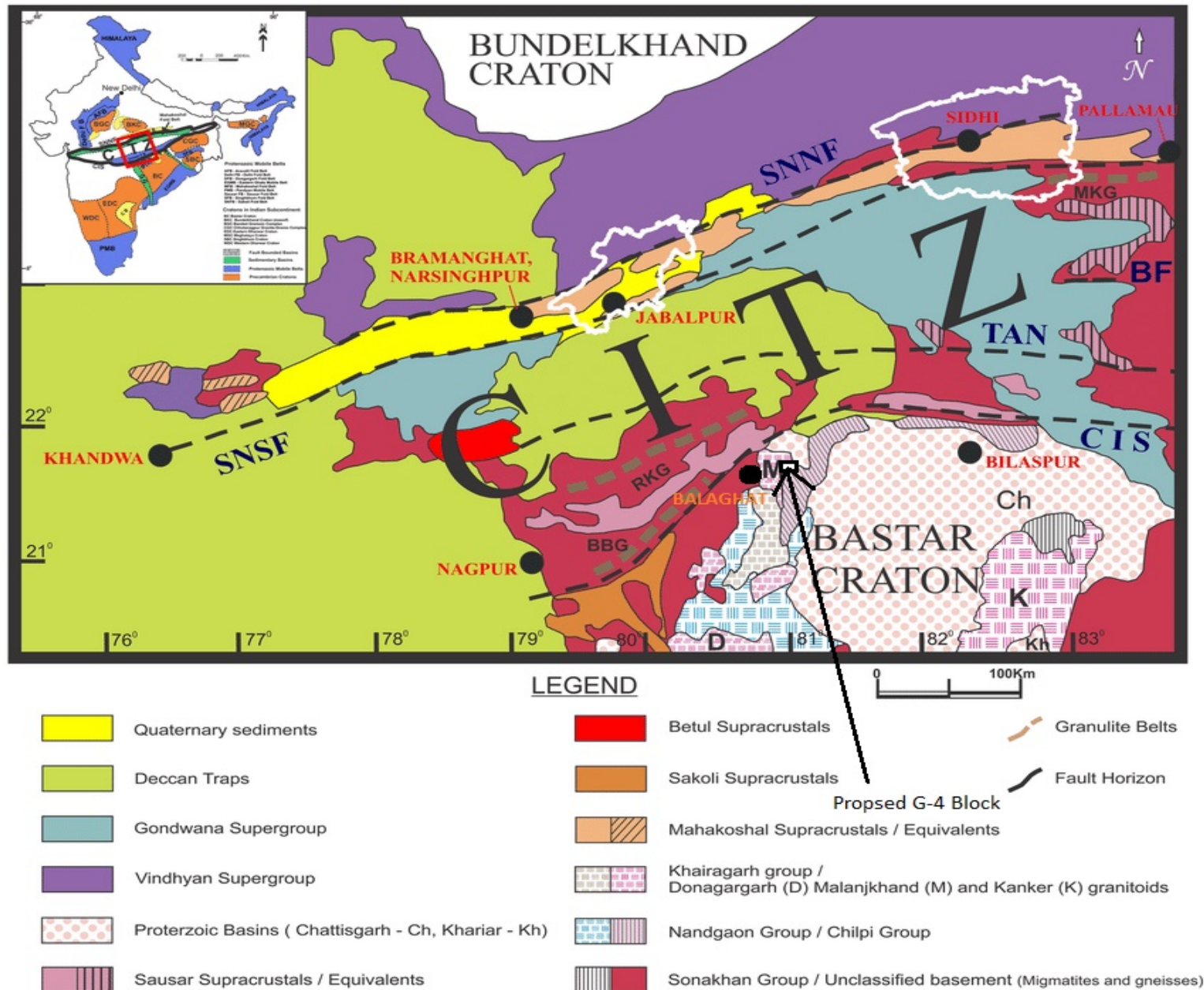
- 6.1.4 The region surrounding the block has a well-established mining and mineral-based industrial ecosystem. A major nearby operation is the Hindustan Copper Limited's Malanjkhand Copper Project, located roughly 40–50 km from the block, which is the largest copper mine in India and represents a key potential consumer for copper resources. In closer proximity, MOIL Limited operates several manganese mines in areas such as Bharveli and Tirodi within 40–50 km of the block. These operations not only indicate the mineral potential of the region but also provide infrastructure synergies such as roads, power, and skilled workforce.
- 6.1.5 In addition to large public sector mining units, the district hosts smaller mineral-based and allied industries concentrated around Balaghat and nearby towns like Waraseoni. These include steel fabrication units, and small-scale industries dealing with dolomite, limestone, and construction materials. Forest-based industries and agro-processing units such as rice mills are also present, contributing to the local economy.
- 6.1.6 Overall, the Jamtola–Khandapar block benefits from its location within an active mining region with reasonable connectivity through road and rail networks, particularly via the Balaghat–Gondia corridor. The proximity to major mining industries and railheads enhances the economic feasibility of mineral extraction and transportation.

CHAPTER-7 GEOLOGY

7.1.0 REGIONAL GEOLOGY

- 7.1.1 Regionally, the area falls near the southern boundary of the Central India Tectonic Zone (CITZ) and Bastar Craton.
- 7.1.2 Central Indian Tectonic Zone (CITZ) in the Nagpur-Balaghat area, trending in the E-W to ENE-WSW direction is about 20 to 40 km wide and 300 to 350km long. The belt is made up of four major geologic components, from south to north; the southern granulite belt, the supra-crustal metasedimentary rocks of the Sausar Group, reworked inliers of the Tirodi gneiss and the northern granulite belt.
- 7.1.3 Due to the effect of CITZ, the area in an around of CITZ including the proposed block area has undergone intense shearing which is responsible factor for various mineralization in the area including Gold, Copper, Manganese etc. The area lies in SW of the famous Malanjkhand Copper deposit. Part of Sausar group also falls in the area. The Chilpi Group was deposited between 2100 and 1800 Ma (Mohanty, 2015).
- 7.1.4 Stratigraphy, structure and metamorphism of the metasedimentary rocks of the eastern parts of Balaghat district have been studied by many workers since the last decade of the nineteenth century due to the economic significance of the manganese deposits in this area. Similarly, the Malanjkhand copper mine and its environs have also been studied by many workers ever since the old workings at Malanjkhand came into light during late nineteenth century.
- 7.1.5 The area is exposed with granite gneiss of Amagaon Gneissic Complex, Gniesses and Migmatites of Tirodi Gneissic Complex, Intrusive Granites of Malanjkhand Granite, Muscovite Schist, Schistose Grit of Sausar Group, Phyllites, Quartzite and Conglomerates of Chilpi Group and Basalts of Deccan Trap and Laterites (PLATE-II). Gold Mineralisation is observed in the Quartz veins present within phyllites.
- 7.1.6 Major Lithology present in the area is Phyllites of Chilpi Group of Palaeo-Meso Proterozoic age which is present in the central, eastern and southern part of the area within which Malanjkhand Granite is observed as intrusive which is the second dominant lithology in the region. Western part of the region is characterized by granite gneiss of Amagaon Gneissic Complex and Gniesses and Migmatites of Tirodi Gneissic Complex.

Text Figure 3 Regional Geological map of Jamtola-Khandapur Block



Geological Map of central sector of the Central Indian Tectonic Zone (CITZ) (with block location (modified after Ramachandra & Roy, 2001; Roy et al., 2002). Inset: Geological map of India showing the location of CITZ. CITZ Central Indian Tectonic Zone, SNNF Son Narmada North Fault, SNSF Son Narmada South Fault, BF Balram Fault, TAN Gavilgarh Tan Shear Zone, CIS Central Indian Suture, MKG Makrohar Granulite Belt, RKG Ramakona Katangi Granulite Belt, BBG Balaghat Bhandara Granulite Belt, Ch Chattisgarh Basin, Kh Khariar Basin, D Dongargarh Granite, M Malanjkhad Granite, K Kanker Granite dominant lithology in the region. Western part of the region is characterized by granite gneiss of Amagaon Gneissic Complex and Gniesses and Migmatites of Tirodi Gniessic Complex

Regional stratigraphic succession of the lithounits after GSI is given in the **Table 5**.

Table 5 Regional Stratigraphic sequence of Litho units (After GSI)

Age	Group	Lithology
Recent to sub-recent	---	Laterite
Eocene to Up cretaceous	Deccan Trap	Basalt
-----Unconformity-----		
Palaeo-Meso Proterozoic	Chilpi Group	Pegmatites and Quartz veins, Phyllite with lenses of schistose grit and Crystalline limestone, quartzite. Ortho quartzite and conglomerate.
Palaeo Proterozoic	Sausar Group	Schistose grit, Muscovite Schist
-----Unconformity-----		
Palaeo Proterozoic	Malanjkhanda Granitoid	Granite
-----Unconformity-----		
ARCHAEOAN	Amgaon Gneissic Complex	Granite gneiss with migmatite gneiss
	Tirodi Complex	Granitic gneisses with migmatite/granite

7.2.0 REGIONAL STRUCTURE

7.2.1 Tripathi et. al. carried out the mapping and elucidated the Stratigraphy and Structure of the Chilpi Group in details. They correlated the metasediments of the toposheet numbers 64B/12 and 64C/09 with the metasediments and the gneisses occurring further west and north-west which were thought to be the continuation of the Sausar rocks. The rocks of the Malanjkhanda area fall in the strike continuity of the rocks of the Ukwa area and have striking lithological and structural similarity with the rocks of the Sausar Group around Ukwa and Khara area (Tripathi et.al. 1973 p. 24). They also mentioned about the similar metamorphism.

- 7.2.2 Isoclinal folds as well as oblique folds are observed within the migmatites in the northwestern part, in the vicinity of the major NNE-SSW trending shear zone. The isoclinal folds show axial planes disposition varying from NNE-SSW in the area north of Khandapar to ENE-WSW west of Ramtola. The axial planes dip towards WNW to NW at angles varying from 25° to 45°.
- 7.2.3 In the greenish grey granite gneiss, the crudely developed pervasive feature is more due to crystal-plastic flow of quartz around the feldspar porphyroclasts than parallel alignment of mafics. The trend of the flattened and partly recrystallized quartz ribbons in greenish grey granite gneiss varies from N05°E to N15°E in the Jatta block (Khan et. al. -1995). The trend of the regional foliation in the greenish grey granite gneisses varies from N40°E to N55°E. Foliation in greenish grey granite gneiss abut against that of the metasediments at a few places such as the area north of Kinarda which are away from the main high strain zone.
- 7.2.4 Primary structures are rarely observed in the metasediments. Stratification is visible in the conglomerate as observed in the Bhutna River section with a fining upward nature. The conglomerate grades into the overlying ferruginous quartzite which shows cross bedding. The palaeocurrent direction measured at Bhutna section is from south-east to north-west. Graded bedding is very clearly observed in the Bhutna section. Rarely scour and fill structures are also observed. In phyllites, a planar feature, resembling bedding planes are found to be thin kink bands under the microscope. In crystalline limestone, though recrystallisation has obliterated the primary features, associated jasper bands (as seen east of Saraitola) represent the primary stratification. The unambiguous stratigraphic way-up criteria at Bhutna section indicates that successively younger rocks are observed from south-east to north-west.
- 7.2.5 The trend of foliation in the metasediments varies from NE-SW in the southeastern part to NNE-SSW in the eastern areas. The strike of foliation in the area south of Baigatola and south of Kinarda is almost ENE-WSW with shallow (15°-20°) dip towards NNW. Between Khandapar and Baigatola the foliation trends show variation from NNE-SSW in the western part to ENE-WSW in the eastern part. The pervasive foliation in the phyllite dips at gentle to moderate angles.
- 7.2.6 The development of foliation within the amphibolites and the presence of folded enclaves of amphibolite in the granite gneiss with parallelism in their fabric indicate the

earlier events of deformation and granite emplacement. The amphibolites have been invaded by the greenish grey granite gneiss.

7.3.0 REGIONAL METAMORPHISM

7.3.1 The effect of CITZ Sausar has induced high-grade metamorphism in the area and it has been suggested that partial melting of the metasediments of the Sausar Group has given rise to part of the gneisses (para-gneiss) intimately associated with it. This has created a controversy on the stratigraphic position of "Tirodi Gneiss" vis-a-vis Sausar Group (Phadke 1990). In general, metamorphic grade is highest in the western and northwestern part of the area where Amagaon Gneisses, Migmatites and Tirodi Gneisses are present. Under the microscope, the amphibolite bearing rocks in the Khandapar area show assemblages in which biotite is replaced by bluish green hornblende. Biotite rich cores show brownish yellow pleochroic colour and are being replaced by bluish green hornblende around the rims (Jaggi, et. al. 1993-94) This indicates the transition from greenschist facies to amphibolite facies (Epidote amphibolite facies).

7.4.0 MINERALISATION IN THE REGION

7.4.1 The Jamtola–Khandapar block in Balaghat District falls within a metallogenically significant zone of central India, known for gold and associated mineralisation. The area is part of the Sausar Group of rocks, comprising metasediments such as quartzite, mica schist, phyllite, and calc-silicate rocks, which have undergone low- to medium-grade metamorphism. Gold mineralisation in the region is typically structurally controlled, occurring in quartz veins, veinlets, and shear zones, often associated with sulphide minerals like pyrite, arsenopyrite, and chalcopyrite. These mineralised zones are generally aligned along major lineaments, faults, and shear planes, indicating strong tectonic control.

7.4.2 In addition to primary (lode) mineralisation, there is potential for secondary (placer) gold within stream sediments and alluvial deposits, derived from the weathering of primary sources and transported through the well-developed drainage network. The region also shows association with base metals and minor sulphide mineralisation, though gold remains the principal target. Exploration activities in nearby areas of Balaghat have indicated anomalous gold values in geochemical sampling, trenching, and drilling, suggesting continuity of mineralised zones. Overall, the mineralisation is

discontinuous, structurally controlled, and requires detailed exploration techniques such as geochemical surveys, geophysical studies, and drilling to delineate economic deposits.

7.5.0 GEOLOGY OF THE BLOCK

7.5.1 The area mostly exposes lithounits belonging to Granite gneiss with migmatite gneiss of Nandgaon Group, Intrusive Granites of Malanjkhanda Granitoids, Phyllites, Quartzite, Graphite and Carbonaceous Phyllite of Chilpi Group (Younger Metamorphics) and Basalts of Deccan Trap and Laterites which are the youngest of all exposed lithounits in the block. (PLATE-II). Gold Mineralisation is observed in the sheared quartz veins present within phyllites and at the contact of Malanjkhanda Granitoids near Khandapar area, also the graphite bands are hosted in carbonaceous phyllites in Karwahi area.

7.5.2 Following important lithologies are present in the area. The local stratigraphic succession of the area is given below in **Table No. 6**.

Table 6 Stratigraphic sequence of the Jamtola-Khandapar G4 Block for Gold, Copper, Graphite and associated minerals

Age	Stratigraphic Unit	Lithology
Recent/Sub-recent	-----	Laterite
Cretaceous to Eocene	Deccan Trap	Basaltic flows
Middle Proterozoic	Younger Metamorphics	Quartz vein, phyllite, graphite + carbonaceous phyllite, crystalline limestone, quartzite, conglomerate
Middle Proterozoic	Intrusives	Quartz vein, basaltic/dolerite dyke
Lower Proterozoic	Malanjkhanda Granitoids	Pink aplite, fine-grained biotite granite, coarse-grained sub-porphyritic hornblende granodiorite, diorite
Late Archaean (?)	Sausar Group	Quartz vein, grey aplite, pink aplite, migmatite with rare enclaves of crystalline limestone and marble
Late Archaean (?)	Nandgaon Group (Older Metamorphics)	Greenish-grey granite gneiss with enclaves of amphibolite, metabasalt

- 7.5.3 The main lithounits intersected in the test boreholes drilled by MECL in Jamtola-Khandapar block are Quartz Reefs, Phyllites, Amphibolites and Feldspathic Chlorite-Biotite Quartz schist, Graphite bands, and Carbonaceous Phyllites.
- 7.5.4 During present investigation, Jamtola-Khandapar Block was covered by large scale geological mapping on 1:12500 scale over 96.62sq.km. area. The interpreted geological map of Jamtola-Khandapar Block with location of bedrock samples and drilled borehole locations are given as **Plate No. IIIA and Plate No. IIIB**.

7.6.0 DESCRIPTION OF DIFFERENT LITHO UNITS

The detailed megascopic characteristics and petrography description of rocks exposed/ intersected in the boreholes in the area are given below.

Granite gneiss with migmatite gneiss forms the dominant basement lithology exposed in the Jamtola–Khandapar Block. It belongs to the Nandgaon Group (Late Archaean) and occurs extensively in the central and northern parts of the block, with younger metasedimentary rocks and intrusive bodies occurring in contact with it. The rock is medium- to coarse-grained, leucocratic to mesocratic, and exhibits a well-developed gneissic foliation defined by the preferred orientation of feldspar and biotite. Mineralogically, it is composed predominantly of quartz, feldspar (plagioclase and K-feldspar), biotite, with minor hornblende and accessory apatite, zircon and sphene. In places, the foliation is moderately to strongly developed and trends predominantly NE–SW to ENE–WSW, conforming to the regional structural grain. Although the granite gneiss itself does not host significant mineralisation, it acts as the competent basement rock and provides structural control for the emplacement of sheared quartz reefs. The migmatites are grey to pinkish-grey, medium- to coarse-grained, and exhibit a characteristic mixed gneissic–granitic appearance resulting from partial melting (anatexis) of pre-existing metamorphic rocks

Granites of Malanjhand Granitoid group are present in the central part of the block as one of the dominant lithology in the block along with a few amphibolites dykes within it. This body forms a suite of rocks varying from diorite, quartz diorite, adamellite to granodiorite. The granodiorite is coarse grained, pinkish grey to grey in colour and comprises quartz, feldspar and mafics. Hornblende is the chief mafic mineral along with chlorite being an alteration product. Shearing along the earlier mentioned trends are common also in the granodiorite. Free quartz is present

predominantly within granodiorite. Inconsistent Copper mineralisation is present within these lithologies. Malanjkhanda Granitoids play an important structural role by providing the host and wall rocks for several sheared quartz reefs. In the Khandapar area, the contact between granitoids and sheared quartz reefs is marked by intense silicification, ferruginisation, and localized sulphide mineralisation, which constitute potential sites for gold mineralisation. Although the granitoids themselves are generally barren, they act as competent host rocks that facilitate fracture development and hydrothermal fluid circulation.

Phyllites, Quartzite with Pegmatites and Quartz veins Major lithology present in the area is Phyllites of Chilpi Group of Palaeo-Meso Proterozoic age which is present in the central, eastern and southern part of the area along with quartzite at places. These are having NE-SW strike and dipping towards NW. Pegmatites and quartz veins which have been emplaced into the metasediments are of different dimensions. The quartz vein exposed near Khandapar has visible indications of gold mineralisation (Indications such as Shearing, Goethitisation etc), as observed in the younger quartz veins (Middle Proterozoic). This quartz vein has undergone ductile deformation along with the surrounding metasediments (Khan et.al. 1995).

Basaltic flows exposed in the Jamtola–Khandapar Block belong to the Deccan Trap volcanic province of Cretaceous–Eocene age and represent the youngest consolidated rock unit in the area. They occur as isolated, discontinuous outcrops and form capping over elevated plateaus and hillocks, unconformably overlying the older Archaean–Proterozoic basement rocks. In many places, the basalts are partially obscured by a mantle of laterite and residual soil. Their weathering has contributed significantly to the development of lateritic capping over upland areas. Although locally fractured, the basalt does not exhibit significant hydrothermal alteration or sulphide mineralisation.

Graphite and Carbonaceous Phyllites constitute one of the important lithological units in the Jamtola–Khandapar Block and belong to the Middle Proterozoic metasedimentary sequence. These rocks are predominantly exposed in the Jamtola and Karwahi sub-blocks, where they occur as discontinuous bands intercalated with phyllite, quartzite and crystalline limestone. The rock is dark grey to black, fine-grained, well foliated, and exhibits a characteristic phyllitic sheen imparted by abundant fine sericite and graphite flakes. It is composed mainly of quartz, sericite/muscovite,

chlorite. Graphite occurs as finely disseminated flakes, thin laminae and streaks aligned parallel to the foliation, imparting a distinct carbonaceous appearance to the rock. Weathering of the graphite-bearing phyllites has resulted in the development of graphitic float material and residual soil, particularly in the Karwahi area, where graphite mineralisation is predominantly expressed as float ore rather than continuous bedrock exposures. Structurally, the graphite-bearing horizons are controlled by regional folding and foliation, and their continuity is influenced by deformation and weathering. No significant sulphide enrichment was observed in association with the graphite bands.

Dolerite occurs as dark grey to greenish-black, medium-grained, massive hypabyssal dykes intruding the migmatites, phyllites and sheared quartz reefs of the Jamtola–Khandapar Block. The dykes are discordant, hard and moderately jointed, displaying sharp intrusive contacts with the host rocks (Mostly in the North central part of the block). Petrographically, they consist mainly of plagioclase and clinopyroxene with subordinate hornblende and opaque minerals, exhibiting typical ophitic to sub-ophitic texture. The dolerite dykes represent the youngest intrusive phase in the block and are not directly associated with economic mineralisation.

Laterite is reddish-brown to dark brown, porous, earthy to ferruginous, and commonly exhibits pisolitic, nodular, and vesicular textures. It is predominantly composed of hydrated iron oxides (goethite and hematite), aluminium hydroxides, residual quartz, and varying proportions of clay minerals. It forms the youngest surficial unit in the Jamtola–Khandapar Block and occurs as a discontinuous mantle capping the elevated plateaus, ridges, and gentle hill slopes. It has developed as a result of prolonged tropical weathering and lateralization of the underlying Deccan Trap basalts, granite gneisses, phyllites, and other Proterozoic lithologies under humid climatic conditions.

7.6.1 Field Photographs:



Photo 1 Sheared Quartz reef exposed in Khandapar area, potential for hosting gold mineralisation.



Photo 2 Graphite boulder (Ex-situ) near borehole No. MJGR-02 in Karwahi area, potential for hosting graphite mineralisation.



Photo 3 Borehole Collar Fixation by DGPS in Karwahi Sub Block of Jamtola-Khandapar Block



Photo 4 Graphite band exposure near borehole no. MJGR-03 in Karwahi Sub Block area





Photo 8 Dense Teak plantation (Forest Nursery) near MJGL-01 in Khandapar Sub block



**Photo 9 Quartz vein Intrusion in Migmatites
near Barwahi village of Jamtola-Khandapar
Block**



Photo 10 Sulphide signatures (Pyrite, Bornite) near Katangi village in Jamtola-Khandapar Block.

7.6.2 Borehole Core Photographs:



Photo 11 Full core photo from borehole No. MJGL-01 (Core Box No-09) from 42.5 to 47.5 m



Photo 12 **Half Splitting core photo from borehole No. MJGL-01 (Core Box No-09)**
from 42.5 to 47.5 m



Photo 13 **Full core photo from borehole No. MJGR-03 (Core Box No-10) from 45.0**
to 50.0 m



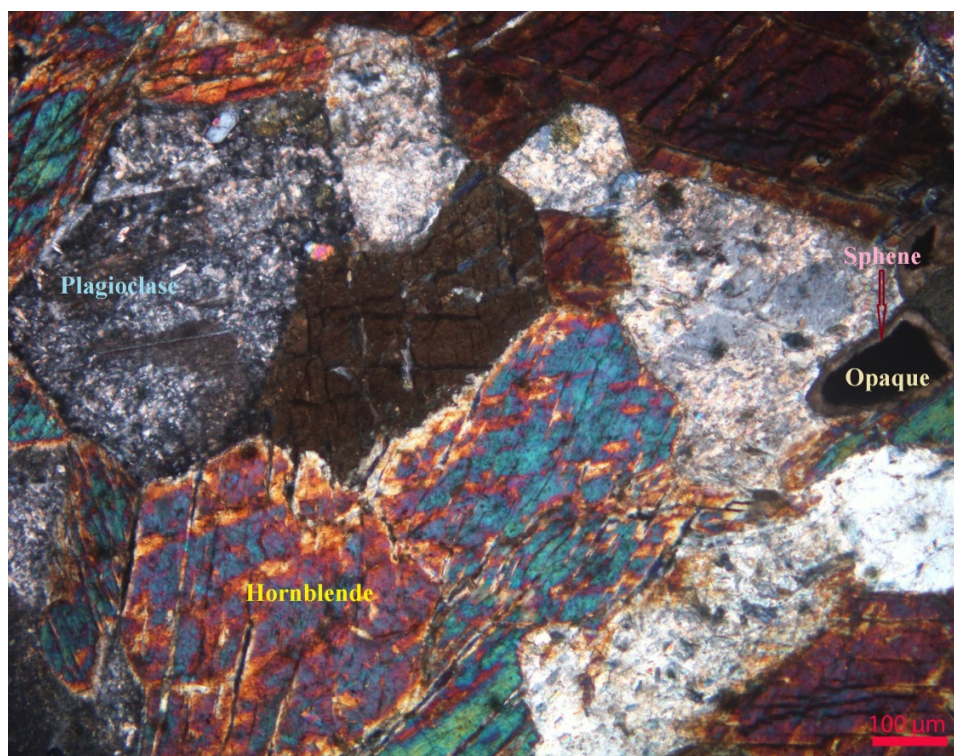
Photo 14 Full core photo from borehole No. MJGR-04 (Core Box No-07) from 30.0 to 35.0 m



Photo 15 Full core photo from borehole No. MJGR-04 (Core Box No-08) from 35.0 to 40.0 m

7.7.0 PETROGRAPHIC STUDY:

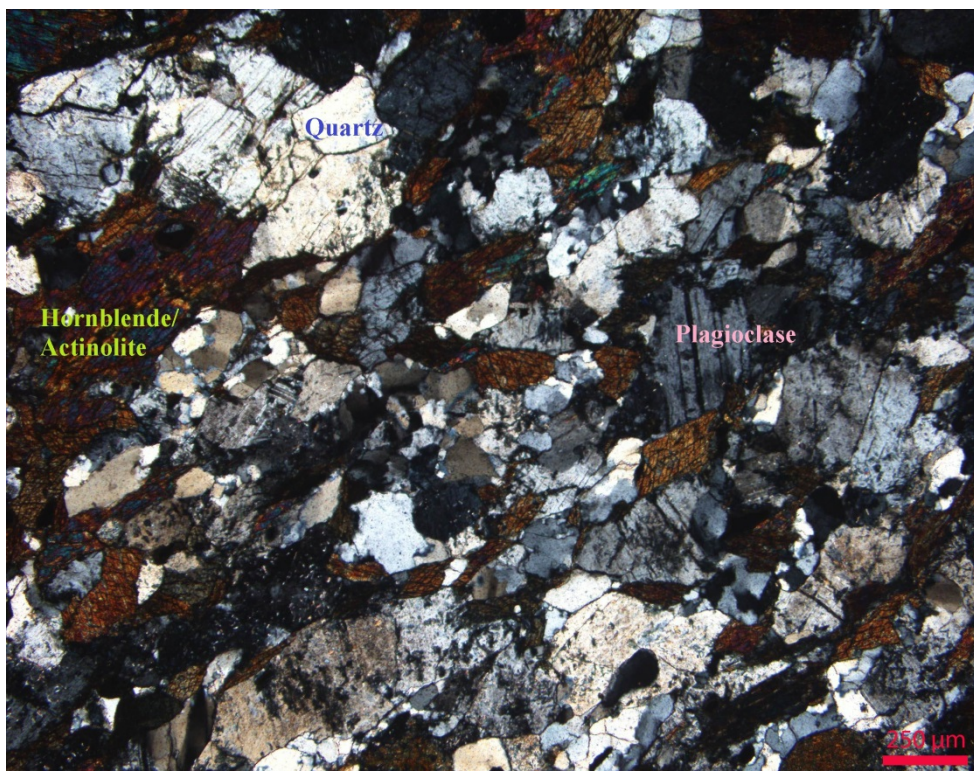
7.7.1 A total of 10 Nos. of rock samples collected from varied litho units exposed in the field and intersected in the boreholes have been subjected to petrographic studies at MECL petrology laboratory, Nagpur. The findings of petrographic study have already been discussed along with the description of rock types. The petrographic study report has been attached as **Annexure No-X**. The photomicrographs of the thin sections are given as **Pmg-1 to Pmg-4**.



Pmg- 1 Photomicrograph depicts association of hornblende and plagioclase, where plagioclase is showing saussuritization and presence of corona of sphene around opaque as minor constituent as seen under crossed nicols.

Specimen No.: MJK/P/01

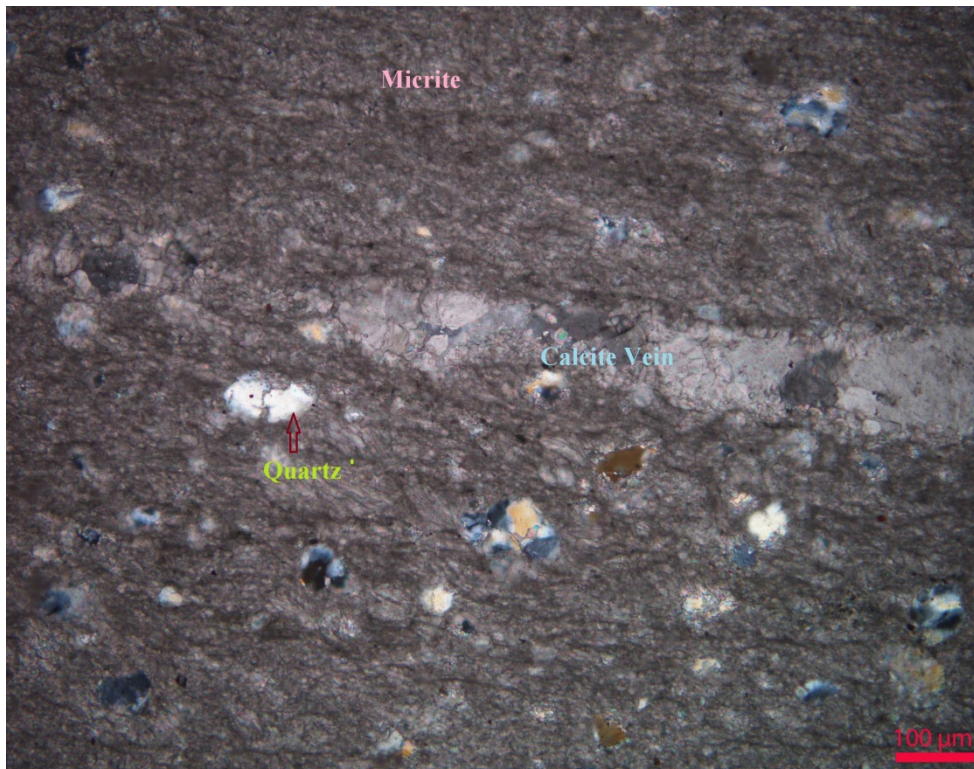
Magnification: 100X



Pmg- 2 Photomicrograph showing association and parallel alignment of plagioclase, amphiboles and quartz in meta-quartz diorite as seen under crossed nicols.

Specimen No.: MJK/P/02

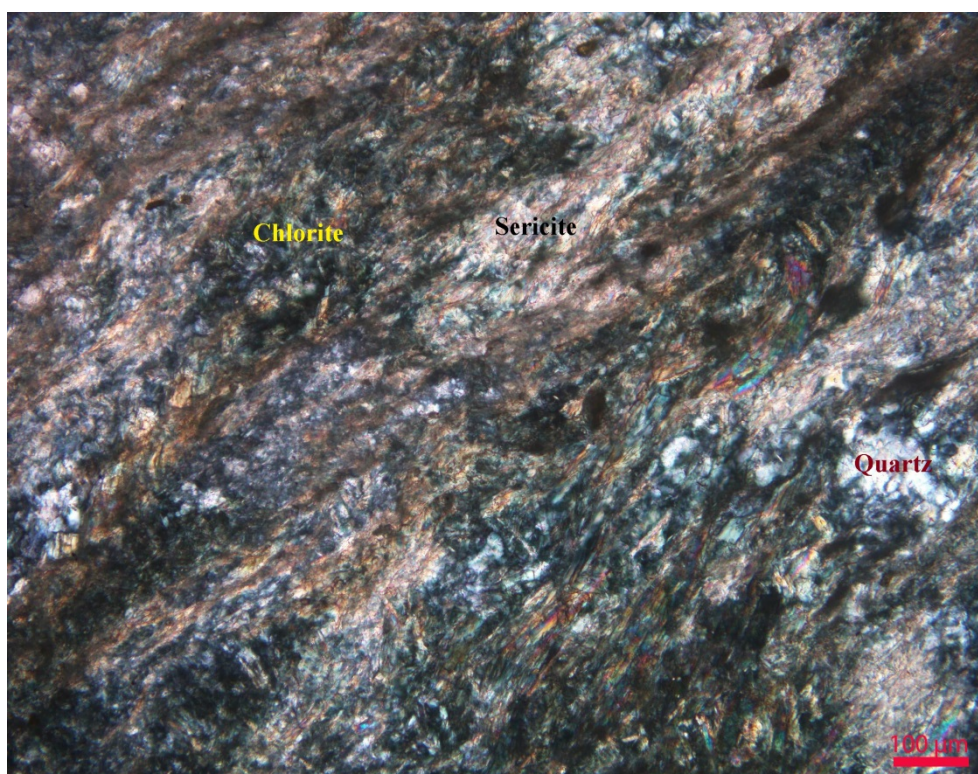
Magnification: 40X



Pmg- 3 Photomicrograph showing dissemination of quartz and intrusion of calcite vein within micritic matrix as seen under crossed nicols.

Specimen No.: JHBHP-02

Magnification: 100X



Pmg- 4 Photomicrograph showing association and parallel alignment of very fine flaky aggregates of chlorite and sericite and associated very fine quartz grains as seen under reflected light.

Specimen No.: JHBHP-06

Magnification: 100X

7.8.0 STRUCTURE

- 7.8.1 The structural data indicate a dominant NW–SE trending fabric, with most strike values clustering around 300° – 320° , suggesting a well-developed regional structural grain. A subordinate set trending NW-SE to N-S (around 330° – 360°) is also present, indicating possible secondary structural control or cross-fracturing. The dip values are highly variable, ranging from gentle (10° – 30°) to steep (60° – 80°), with a majority falling in the moderate dip category ($\sim 30^{\circ}$ – 50°), implying deformation under varying stress regimes. Some readings showing dip directions like 270° or 340° reflect dip azimuths, confirming multi-directional tilting and possible folding or fault-related disturbances.
- 7.8.2 The Dip-Strike readings measured in the block indicate the presence of shear zones, foliations, and fracture systems, which are consistent with tectonically deformed metasedimentary rocks of the Sausar Group. The persistence of a $\sim 300^{\circ}$ strike direction indicates a strong regional control, likely representing the primary foliation or

schistosity, while variations may correspond to local folding, faulting, or mineralized vein orientations. From a mineral exploration perspective, such structural trends are significant, as gold mineralisation in the region is typically associated with quartz veins and shear zones aligned along this major structural orientation, particularly along NW–SE trending weak zones.

7.9.0 MINERALISATION IN THE BLOCK

7.9.1 During previous exploration by GSI (Khan et.al., 1995) 14 bedrock samples analysed for gold (by AAS) from the Khandapar quartz vein, out of which four samples have given encouraging values of Gold (0.2 gm/t, 0.4gm/t, 0.7gm/t, and 2.2gm/t).

7.9.2 As per current observation, the gold mineralization is hosted in Quartz vein within Phyllites of Chilpi Group of Palaeo-Meso Proterozoic Age. The area is mostly soil covered. Bed rock samples collected for Gold and Graphite mineralisation have shown promising values. Seven bedrock samples of sheared quartz reefs collected from Khandapar area for Gold have shown 0.11 ppm Au to 4.89 ppm Au, Six samples from same area has shown values of 0.01 ppm Au, and Seven Samples have shown Gold values between 0.02 ppm Au to 0.09 ppm Au, while seven bedrock samples from Karwahi area for Graphite have shown fixed carbon ranging between 2.09 % FC to 3.38 % FC, and four Sample, between 1.18% FC to 1.79 % FC. Mostly the area is concealed under soil cover. Based on the BRS Sample results and Geophysical studies such as integrated analysis of the Magnetic, IP-Resistivity, and SP data, several anomalous zones have been identified and clearly marked on the resistivity surface anomaly map. The zones exhibiting higher anomalous signatures are particularly noteworthy, as they are likely associated with gold mineralization, and on the integrated analysis of the Magnetic, IP-Resistivity, and SP data, several anomalous zones have been identified and clearly marked on the resistivity surface anomaly map. The zones exhibiting higher anomalous signatures are particularly noteworthy, as they are likely associated with graphite mineralization. Two potential areas viz. Khandapar area (1.434 sq.km.) and Karwahi area (2.090 sq.km.) have been demarcated to target for exploratory drilling.

7.9.3 Surface Manifestation: Geological mapping and bedrock geochemical investigations indicate that the surface expression of gold mineralisation is spatially restricted to structurally controlled sheared quartz reef zones within the Khandapar area, where

anomalous gold values are confined to these silicified shear-hosted lithologies. In contrast, graphite mineralisation identified in the Karwahi area is predominantly represented by float ore occurrences, comprising detached graphitic fragments and boulders dispersed over the surface. The absence of significant in-situ graphite exposures suggests that the primary graphite-bearing horizon is either poorly exposed due to extensive weathering, soil cover and vegetation, or remains concealed beneath the overburden.

- 7.9.4 **Mode of Occurrence and Nature of Mineralisation:** The Jamtola–Khandapar G4 block shows structurally controlled, vein-type mineralisation mainly associated with quartz veins hosted within granite, gneiss, schist, and phyllite. These veins occur along fractures, joints, and shear zones, which acted as pathways for mineral-bearing hydrothermal fluids. The mineralisation is hydrothermal in nature, likely containing gold along with sulphides such as Chalcopyrite, pyrite, Pyrrhotite and arsenopyrite, and is accompanied by alteration features like silicification and sericitization in wall rocks. It is discontinuous and localized, varying in thickness and grade, and currently inferred at reconnaissance (G4) stage, requiring further detailed exploration to establish its economic potential.
- 7.9.5 **Ore and Gangue Mineralogy:** Mineragraphic studies carried out on polished sections from the Jamtola–Khandapar Block reveal that the major ore minerals comprise magnetite/ilmenite, pyrite, sphene, hematite, and goethite, generally occurring as fine disseminations, segregated patches, fracture fillings, and subhedral to anhedral grains within the host rock assemblage. Magnetite and ilmenite commonly occur as disseminated, skeletal, and bladed grains, whereas sphene occurs as fine wedge-shaped grains often enclosing relict ilmenite. Pyrite forms disseminated grains, stringers, and patches, locally associated with chalcopyrite. Minor to accessory ore phases include chalcopyrite, pyrrhotite, limonite, anatase, and rutile, while probable electrum occurs in trace amounts. Hematite and goethite are widely developed as alteration products after magnetite and sulphide minerals, indicating martitisation, oxidation, and supergene alteration processes. Limonite occurs as reddish amorphous fillings and cavity infillings associated with goethite-rich zones, reflecting late-stage weathering and secondary enrichment. Overall, the mineral assemblage suggests a complex oxide–sulphide paragenesis subsequently modified by oxidation and hydrothermal alteration processes.

7.9.6 Controls on Mineralisation: Mineralisation in the block is primarily controlled by lithology, structural features, and hydrothermal alteration processes. The ore minerals are mainly associated with magnetite–ilmenite–sulphide assemblages occurring within structurally disturbed and altered zones. Structural controls such as fractures, shears, joints, foliation planes, veinlets, and brecciated zones have acted as favourable pathways for circulation and deposition of mineralising fluids. The occurrence of sulphide minerals such as pyrite, pyrrhotite, and chalcopyrite along fractures, fillings, stringers, and disseminated zones indicates structurally controlled hydrothermal mineralisation. Sphene enclosing ilmenite relicts and the development of martitisation and goethitisation indicate multiple stages of mineralisation followed by oxidation and supergene alteration. Overall, the mineralisation in the block appears to be controlled by various factors such as structural deformation, hydrothermal activity, and subsequent oxidation processes.

7.9.7 Alteration Characteristics: Prominent hydrothermal alteration signatures were observed within the study area. In the Khandapar Sub-block, the sheared quartz reefs exhibit well-developed ferruginisation and silicification, indicating fluid-assisted alteration associated with gold mineralisation. Extensive lateritisation reflects intense post-mineral weathering under tropical conditions. However, subsurface investigation did not encounter significant alteration features such as pervasive sericitization, carbonate alteration, or sulphidation halos, which are commonly associated with well-developed lode gold system.

7.9.8 During the course of the mapping, main emphasis was given to map the Sheared Quartz Reefs, Carbonaceous Phyllites, and Graphite bands in detail to identify the mineralised zones if any in the area.

7.10.0 MINERAGRAPHIC STUDIES OF MINERALISED SURFACE AND CORE SAMPLES

7.10.1 A total of 10 polished sections were prepared, 04 from bedrock samples (all for sulphides) and 06 from borehole core samples (4 for sulphides and 2 for Graphite) of the Jamtola–Khandapar Block are studied under mineragraphic examination to ascertain the ore mineral assemblages and their textural relationships. The study reveals that magnetite/ilmenite, pyrite, sphene, hematite, and goethite constitute the principal ore minerals occurring in varying proportions within the samples. Minor to accessory

constituents include chalcopyrite, limonite, anatase/rutile, pyrrhotite, and ilmenite, while probable electrum? occurs in trace amounts. Magnetite and ilmenite commonly occur as fine disseminated, subhedral to anhedral, skeletal and bladed grains, frequently segregated in pockets and zones. Magnetite often shows martitisation with development of hematite along fractures and grain boundaries, indicating oxidation effects. Sphene occurs as fine disseminated wedges, occasionally enclosing relict ilmenite grains. Pyrite is observed as fine disseminated subhedral grains, patches, fillings, and stringers, whereas chalcopyrite occurs mainly as very fine specks commonly associated with pyrite and locally preserved as relicts within goethite fillings. Goethite and limonite are developed as patchy fillings, reddish amorphous aggregates, cavity fillings, and alteration products, reflecting supergene oxidation and weathering processes. Pyrrhotite occurs as fine granular segregations within pockets, while anatase and rutile are present as very fine disseminated blades and specks. The overall ore assemblage suggests a complex oxide–sulphide mineralization characterized by magnetite–ilmenite–pyrite association, subsequently modified by oxidation, and supergene alteration processes. The sample wise details of the mineragraphic studies are presented as **Annexure-XI** and the photomicrographs of the polished sections are given as **pmg-5 to pmg-8**.

Magnetite/ilmenite constitute the dominant ore phases in samples JHBHM-01, JHBHM-04, and JHBHM-06, occurring as fine disseminated, subhedral to anhedral, skeletal and bladed grains, commonly segregated in pockets and zones. In several samples, magnetite shows martitisation with development of hematite and goethite along fractures and grain boundaries.

Sphene occurs as a major constituent in sample JHBHM-02, where it is present as very fine to fine disseminated wedge-shaped grains enclosing relict inclusions of ilmenite.

Pyrite forms an important sulphide phase in samples JHBHM-01, JHBHM-03, JHBHM-04, and JHBHM-05, occurring as fine disseminated subhedral grains, patches, fillings, and stringers. In places, pyrite is associated with chalcopyrite and oxide minerals.

Hematite is prominently developed in samples MJK/M/01 and MJK/M/02 as disseminated blades, segregated patches, and fracture fillings, while in other samples it occurs as an alteration product after magnetite due to martitisation.

Goethite constitutes the dominant mineral phase in samples MJK/M/03 and MJK/M/04, occurring mainly as patchy fillings and alteration zones associated with limonite and other oxidation products.

Ilmenite occurs in samples MJK/M/02, JHBHM-01, JHBHM-03, JHBHM-04, and JHBHM-06 as fine disseminated aggregates and relict grains, commonly intergrown with magnetite or enclosed within sphene.

Chalcopyrite is present in trace to minor quantities in samples JHBHM-01 to JHBHM-05 and MJK/M/04, generally occurring as very fine specks associated with pyrite and locally preserved as relicts within goethite-rich fillings.

Pyrrhotite is observed in sample MJK/M/02 as very fine granular segregations occurring within pockets and associated with hematite–ilmenite assemblages.

Limonite occurs in samples MJK/M/02, MJK/M/03, MJK/M/04, and JHBHM-06 as reddish amorphous aggregates, stains, and fillings associated with goethite, indicating supergene oxidation and weathering processes.

Anatase and rutile occur in accessory proportions in samples MJK/M/01, MJK/M/03, and MJK/M/04 as very fine disseminated specks and blades along fractures and alteration zones.

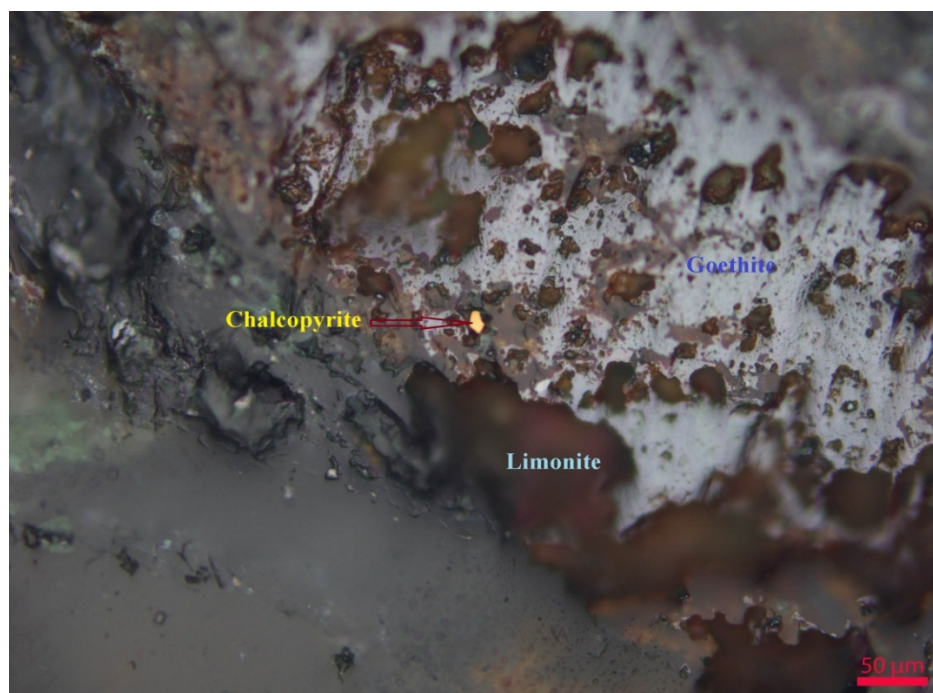
Probable **electrum** is recorded in sample MJK/M/01 as isolated very fine specks occurring along fractures in trace amounts.



Pmg- 5 Photomicrograph showing possible tiny speck of electrum as seen under reflected light.

Specimen No.: MJK/M/01

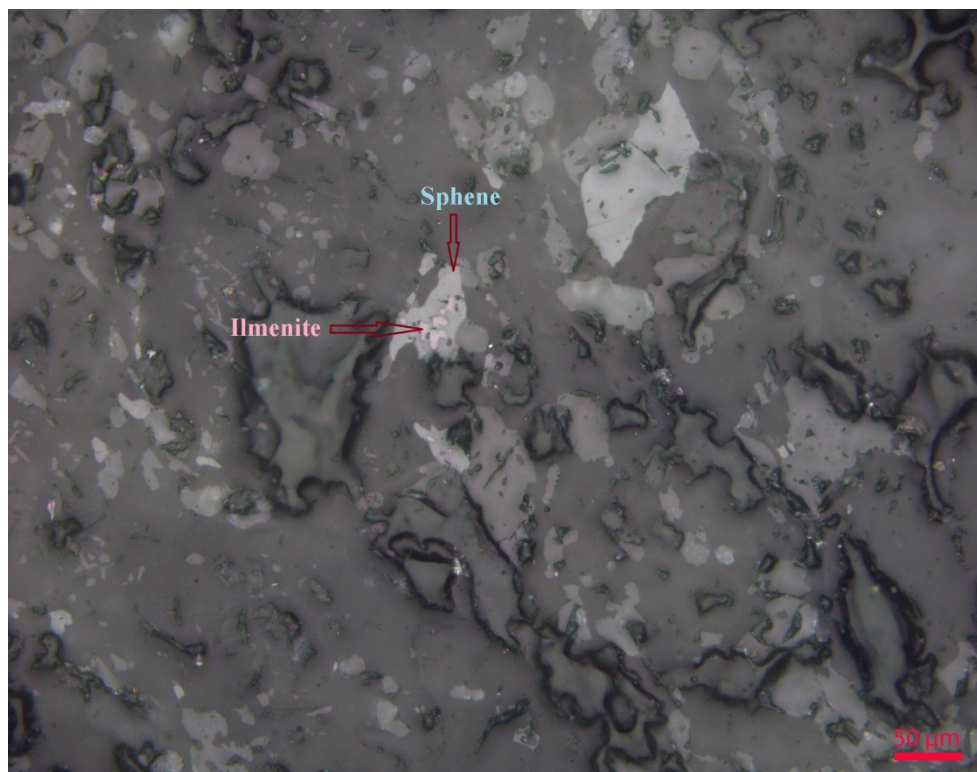
Magnification: 200X



Pmg- 6 Photomicrograph showing presence of chalcopyrite speck in association with goethite and limonite patches as seen under reflected light.

Specimen No.: MJK/M/04

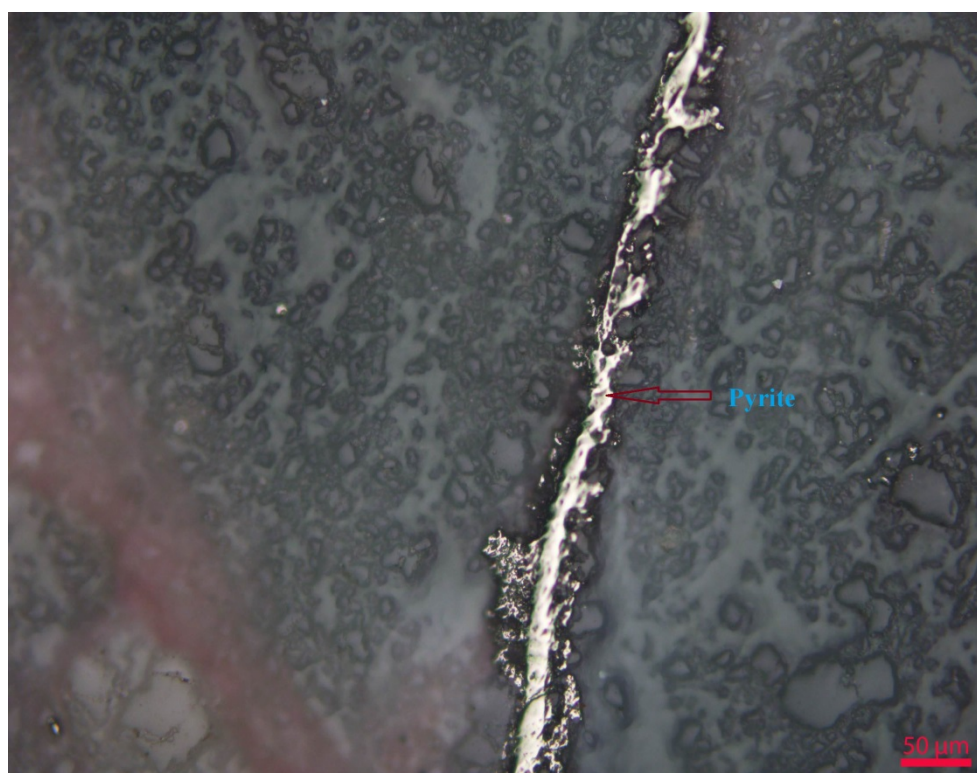
Magnification: 200X



Pmg- 7 Photomicrograph showing very fine relicts of ilmenite within sphene wedges as seen under reflected light.

Specimen No.: JHBHM-02

Magnification: 200X



Pmg- 8 Photomicrograph showing pyrite stringer as seen under reflected light.

Specimen No.: JHBHM-03

Magnification: 200X

CHAPTER-8

PREVIOUS EXPLORATION

8.1.0 DETAILS OF PREVIOUS EXPLORATION CARRIED OUT BY OTHER AGENCIES

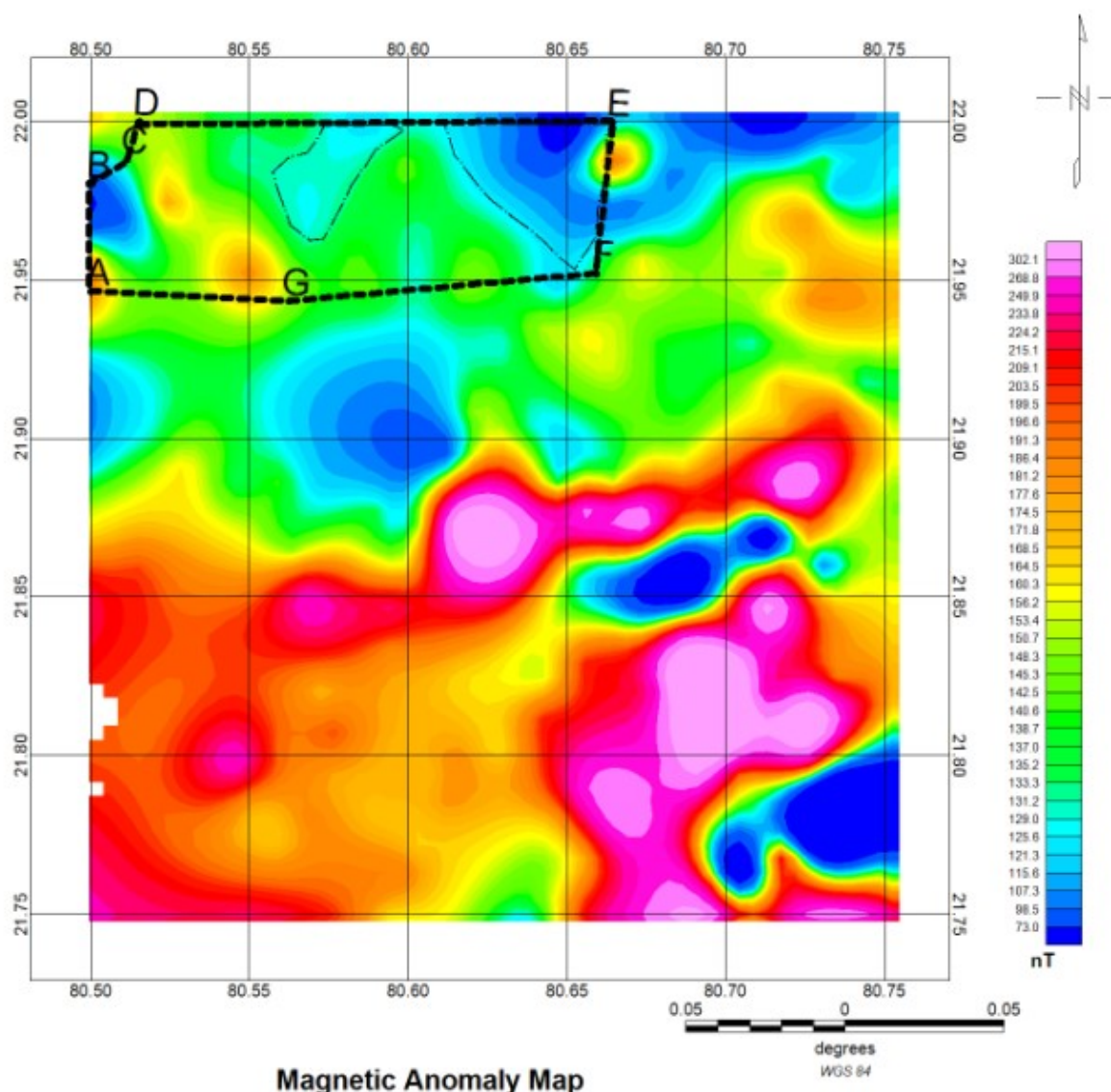
- 8.1.1 Gold mineralization is associated within the quartz vein present in Palaeo-Meso Proterozoic aged phyllites of Chilpi Group of rocks. Some of the bed rock samples, collected by Khan et.al., (1995) from the Khandapar quartz vein, described earlier have analysed very interesting values of gold. Out of the 14 bedrock samples analysed for gold (by AAS), four samples have given very encouraging values (0.2 gm/t, 0.4gm/t, 0.7gm/t, and 2.2gm/t).
- 8.1.2 During the systematic mapping, the area was covered by Tripathi et.al. (1973). These authors classified the rocks in the area into an Archaean Basement Complex overlain by Precambrian metasediments. They further divided the Archaean Basement Complex into two Groups, namely Older Metamorphics and Younger Metamorphics. According to them, the amphibolites and mica schists which occur as isolated patches within the granite and granite gneiss belong to the Older Metamorphic Group. While, “Younger Metamorphics” of these authors constitute quartz veins, pegmatite, basic dykes, gabbro, greenish grey granite, gneiss and andesite. The Precambrian metasediments which overlie the Archaean Basement Complex include mainly the Chilpi Group, which starts with a basal conglomerate and successively overlain by orthoquartzite, grit, calc-silicates, marble with thin bands of mica schist, epidote quartzite, crystalline limestone, sericite mica schists, phyllite with lenses of grit, bands of manganese, and intruded by pegmatite and quartz vein.
- 8.1.3 These authors, who presumably carried out the mapping under the item “Elucidation of the Stratigraphy and Structure of the Chilpi Group”, retained this title for the report. However, they made an attempt to correlate the metasediments of the toposheet numbers 64B/12 and 64C/09 with the metasediments and the gneisses occurring further west and north-west which were thought to be the continuation of the Sausar rocks. They wrote that „the rocks of the Malanjkhanda area fall in the strike continuity of the rocks of the Ukwa area and have striking lithological and structural similarity with the rocks of the Sausar Group around Ukwa and Khara area” (Tripathi et.al. 1973 p. 24). They also mentioned about the similar metamorphism. However, the title and abstract of their report refers, to the metasediments as Chilpi Group.

- 8.1.4 In a subsequent paper, Tripathi (1979) included Baihar gneisses also alongwith the Older Metamorphics of earlier stratigraphy (Tripathi, 1973). In this paper he mentioned that pockets of these gneisses occur within the Malanjkhanda granodiorites (Tripathi, op. cit., p. 162). However, the metasediments south - west of Malanjkhanda were considered in this work as Chilpi which have undergone higher grade of metamorphism and deformation than the Chilpi rocks in the Taregaon area, further east.
- 8.1.5 Chilpi Ghat section and the surrounding areas were mapped by Tripathi et.al. (1975). They reported that the Chilpi Group commences with a conglomerate bed whose base is not seen and is overlain by metavolcanics and which are in turn overlain by metasedimentaries.
- 8.1.6 On the basis of the studies carried out along the type section of the Chilpi Ghat, Das Gupta et.al. (1981), divided the Chilpi Ghat series into Lower Metavolcanics and Upper Metasedimentaries.
- 8.1.7 Over the years geological, geochemical (Udhoji, 1976; Neelakantam 1973; 1974), geophysical (Chatterji et.al. 1974; Dash, et.al. 1972; Dutta,et.al. 1975), subsurface (Neelakantam et.al. 1974; Jaiswar and Guha 1975; Khan et.al.1992) investigations as well as ground checking of aeromagnetic anomalies (Shukla,1987) have been carried out in many blocks where indications of mineralisation were suspected. This includes investigations of quartz veins such as that occurring near Khandapar (Neelakantam, 1973), Chilpi-Granitoid contacts (Neelakantam et.al.1974), and within granitic rocks (Jaiswar et.al. 1975, Shukla 1987).
- 8.1.8 Some of the bed rock samples, collected by Khan et.al., (1995) from the Khandapar quartz vein, (described earlier) have analysed very interesting values of gold. Out of the 14 bedrock samples analysed for gold (by AAS), four samples have given very encouraging values (0.2 gm/t, 0.4gm/t, 0.7gm/t, and 2.2gm/t).
- 8.1.9 Pal, A. B. and Sindhupe G.L. (2004) mentioned that age old gold panning along the streams, ancient workings for gold mineralization in the quartz veins emplaced in Malanjkhanda granitic pluton along the peripheral contacts of older rocks of Amgaon Gneiss and Nandgaon Volcanics besides shear-controlled zones drew the attention of present authors to take up detailed survey. These quartz veins are the locales for future exploration of copper-gold mineralization. Garhi Dongri and Khandapar, occurring at

the peripheral contacts, may be gold rich and copper poor in mineralization and are very significant.

8.1.10 Bhargava, Ind Pal (2000) have located old workings at the Khandapar hill range. Surface samples indicated copper and gold mineralization in quartz veins. In Khandapar prospects, quartz veins occur at the contacts of Malanjkhanda Granite with Nandgaon Volcanics and Amgaon Gneiss respectively. At Khandapar prospect, quartz veins samples show copper content that ranges 14 to 591 ppm and gold from 0.10 to 0.23 g/t. Soil samples show highest copper of 234 ppm and gold 0.38 g/t.

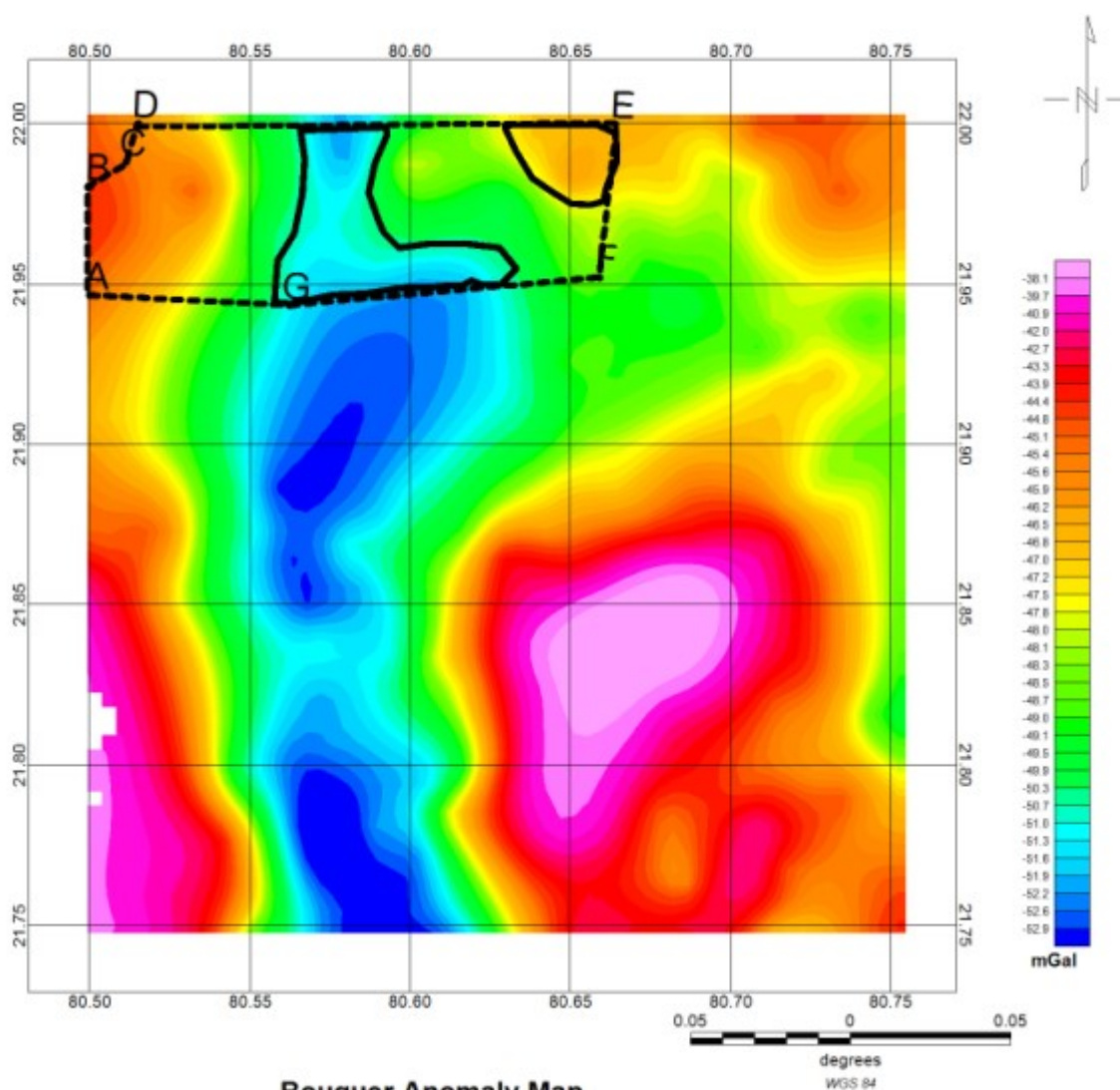
8.1.11 **NGPM Survey:** National Geophysical mapping in Toposheet no. 64 C/09 has been carried out by GSI with an objective to prepare Bouguer gravity and magnetic (Total Field) maps. As shown by geophysical prospecting, Quartz veins cannot be discriminated by the magnetic and gravity method with such a large station spacing (Fig 2.1 and Fig. 2.2). However, volcanic rocks, which are especially dacitic, with hornblende crystals, seem to give rather big magnetic anomalies. Therefore, the magnetic method could be used to discriminate veins and to define their rate of alteration and their size and dimensions.



Text Figure 4 Magnetic Anomaly Map based on the NGPM Data

8.1.12 According to the Bouguer gravity anomaly, there is a basic discontinuity at the center portion of the proposed block. The lowest magnetization is a sign of alteration in the same portion. This discontinuity is the alteration zone dividing the block into three parts. The western side & Northeastern portion has a higher density base rock than the central portion.

8.1.13 Considering these geophysical signatures, potential zones are identified by low magnetization coupled with high-density contrast, and such zones should be prioritized for further investigation.



Text Figure 5 Gravity Anomaly Map based on the NGPM Data

8.1.14 NGCM Investigations: Geological Survey of India under National Geochemical Mapping program carried out systematic stream sediment sampling in the study area in 1 X 1 km interval in grid pattern. A total of 23 stream sediment samples generated falls within the proposed block. None of the samples has given the encouraging values for Gold, Cu, Pb, Zn etc.

CHAPTER-9

AREAL OR GROUND GEOPHYSICAL OR GEOCHEMICAL DATA

9.1.0 AREAL OR GROUND GEOPHYSICAL OR GEOCHEMICAL DATA

Areal/Airborne Geophysical Survey is not the scope of present exploration. As per NGDR portal, the area has not been covered by Airborne Geophysical survey by GSI or any other agency. NGPM data of the area has been reviewed and utilised the same for formulation of ground geophysical survey in Jamtola-Khandapar Block area. During present exploration Ground geophysical survey has been carried out in Jamtola-Khandapar Block.

9.2.0 GROUND GEOPHYSICAL SURVEY

The overall bedrock samples results have shown promising values for Gold and Graphite in Jamtola-Khandapar Block. However, considering the concealed nature of the area and the presence of two potential areas identified, a ground geophysical survey was planned to identify any subsurface mineralized extensions. Accordingly, two sub-blocks—Karwahi (1.434 sq.km) and Khandapar (2.090 sq.km) were selected for ground geophysical work as per the approved quantum and finding discussed in subsequent paragraphs.

9.3.0 INTRODUCTION

9.3.1 All available previous geological, ground geophysical survey data of NGPM data has been consulted for the formulation of Ground Geophysical survey proposal at G4 stage for Gold, Copper, Graphite and Associated mineralisation in Jamtola-Khandapar Block.

9.3.2 During present investigation, Ground geophysical survey comprising of I.P., Resistivity, S.P. and Magnetic Survey planned to demarcate concealed potential mineralisation zones at 100m traverse interval and 20m station interval in Jamtola-Khandapar Block.

9.3.3 The physical properties for different expected ores & host rocks is shown below in **Table 7.**

Table 7 Physical Properties of different expected ores & host rocks

Ore/Rock	Chemical Composition	Density (g/cc)	Magnetic Intensity
Chalcopyrite	CuFeS ₂	4.1-4.3	Paramagnetic
Bornite	Cu ₅ FeS ₄	5.06-5.09	Paramagnetic
Chalcocite	Cu ₂ S	5.5	Diamagnetic
Covellite	CuS	4.68	Diamagnetic
Pyrite	FeS ₂	5.02	Paramagnetic
Biotite	K(Mg,Fe) ₃ AlSi ₃ O	2.92	Medium to low Magnetic
Quartz/Quartzite	SiO ₂	2.6-2.8	Diamagnetic
Galena	PbS	7.6	Diamagnetic
Sphalerite	ZnS	3.9-4.1	Paramagnetic
Graphite	C	2.25	Diamagnetic

9.4.0 OBJECTIVE AND SCOPE OF THE WORK

9.4.1 The scope of work consists of acquisition, processing and interpretation of ground geophysical data across a prospective mineralized area spanning 3.524 square kilometres. The Profile lines were designed and aligned in such a way that it lays across the regional geological strike direction of the targeted potential zones and to be covered with 25 lines km (2.5 Unit) of IP, SP and magnetic Survey Profile as approved by NMEDT.

9.5.0 SURVEY LAYOUT

9.5.1 A base camp was established near the Jamtola-Khandapar block to facilitate the geophysical survey in both the sub blocks. The survey team consisted of three to four members (Table 4.) equipped with specialized instruments including the ENVI Pro Magnetometer for magnetic measurements, the IRIS Syscal R2 Resistivity Meter for SP data recording, the Syscal Kid 72 Channels for IP-cum-Resistivity measurements and Trimble Juno Handheld GPS unit for precise location tracking/marketing. The location Map/Block boundary map, along with its coordinates, is presented in **Table 8**. To

ensure accuracy and minimize disturbances the magnetic base was established outside of the Sub Blocks block boundary area, as specified below.

The field activities consisted of the following:

- Fixing of survey points in 100m x 20m grid for IP cum resistivity survey.
- Fixing of survey points in 100m x 20m grid for Magnetic Survey.
- Acquisition of IP cum Resistivity, SP and magnetic Survey
- Field QC of acquired data on day-to-day basis.
- Fixation of survey points in 20m X 1000m grid with GPS system.
- Magnetic data has been acquired with EnviPro Magnetometer and SP data with IRIS Syscal R2 and the Syscal-Elrec Pro 10 Channels for IP-cum Resistivity measurements
- Field QC of acquired data on daily basis.

9.5.2 Total quantum of work i.e. area surveyed and Line Km recorded in the blocks are given below.

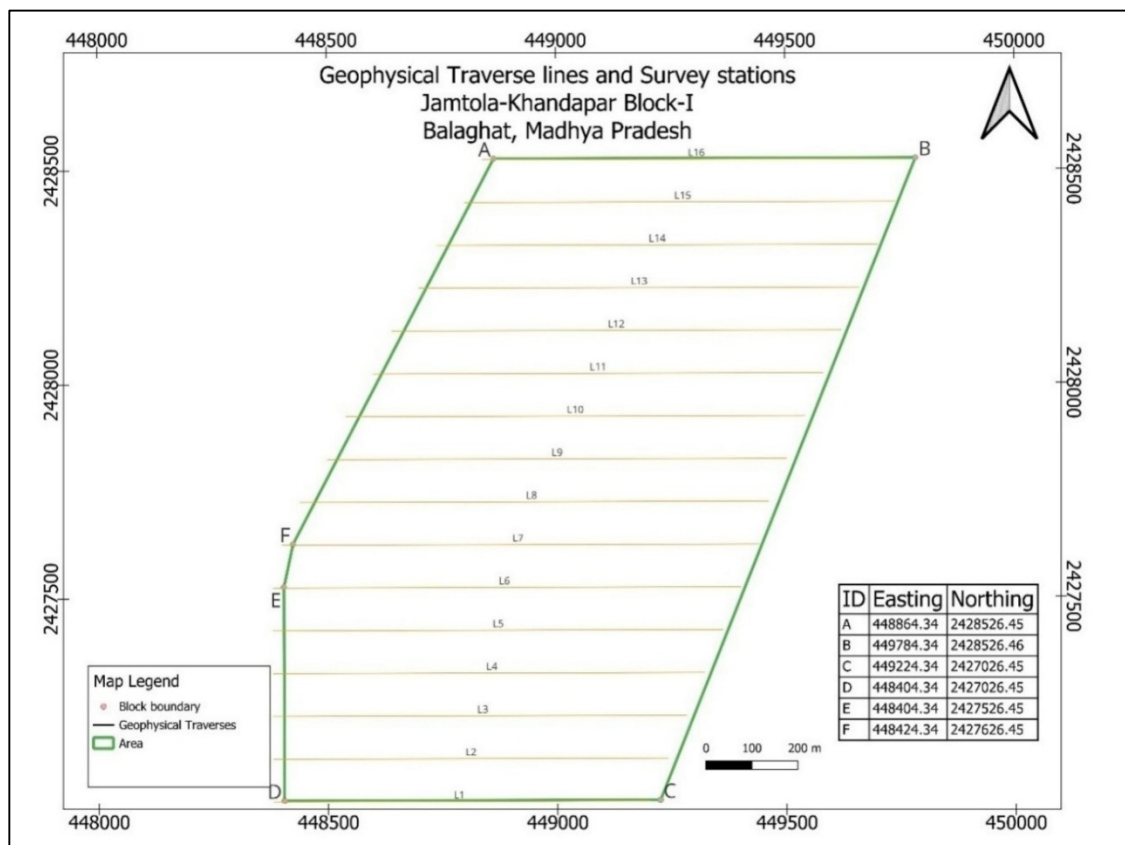
Table 8 Quantum of Ground geophysical work carried out in Block-I (Khandapar) and Block II (Karwahi) of Jamtola-Khandapar Block.

Sub Block-I 1.434 Sq.km., Khandapar Area							
Block Corner Points	UTM ZONE 44-N		Parameter	Grid	Line No	Line Km	Area Covered (KM2)
	Easting	Northing					
A	448864.3	2428526	Magnetic, SP, IP CUM RESISTIVITY	20 x 100	L1 - L16	13	1.434
B	449784.3	2428526					
C	449224.3	2427026					
D	448404.3	2427026					
E	448404.3	2427526					
F	448424.3	2427626					
Magnetic Base	452960	2431498					

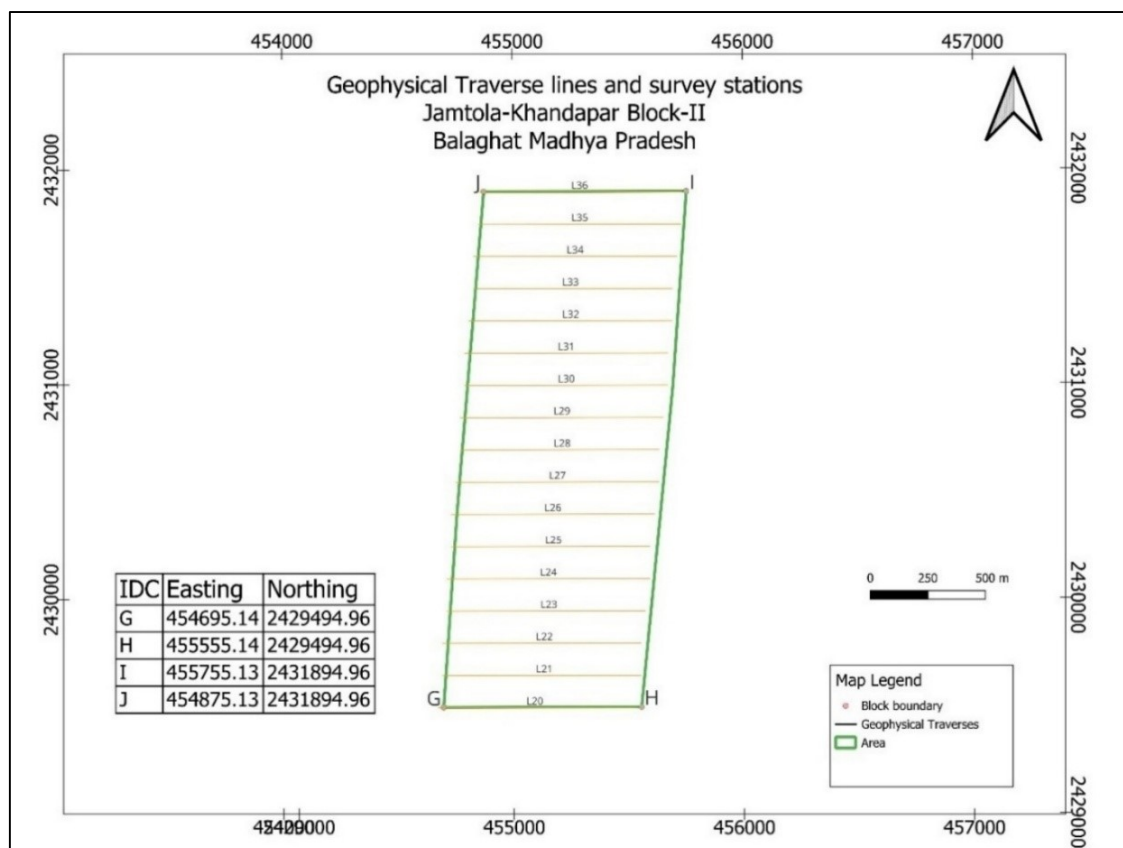
Sub Block-II 2.090 Sq.km., Karwahi Area							
Block Corner Points	UTM ZONE 44-N		Parameter	Grid	Line No	Line Km	Area Covered (KM2)
	Easting	Northing					
G	454695.1	2429495	Magnetic, SP, IP CUM RESISTIVITY	20 x 100	L20 - L36	12.2	2.09
H	455555.1	2429495					
I	455755.1	2431895					
J	454875.1	2431895					
Magnetic Base	452960	2431498					

9.5.3 The Geophysical survey was completed within 60 days i.e. from 24-10-2024 to 24-12-2024.

9.5.4 The Lay-Out map the block is shown in **Text Figure 6 and Text Figure 7** with the location of traverse lines and stations of observations.



Text Figure 6 Block boundary of Khandapar Sub Block-I of Jamtola-Khandapar Block along with Traverse Line



Text Figure 7 Block boundary of Karwahi Sub Block-II of Jamtola-Khandapar Block along with Traverse Line

9.6.0 DATA REDUCTION AND PROCESSING

Instrument Details:

Table 9 Instrument Details

INDUCED POLARIZATION DATA ACQUISITION UNIT	
Type	Multi -Electrode
Make	IRIS(SYSKAL-PRO)
Maximum No of Channel	72
Minimum Channel Interval	10
Sensitivity	1 μ V/0.2
MAGNETOMETER	
Type	Proton Precision Magnetometer (PPM)
Make	Scintrex (ENVI Pro MAG)
Sensitivity	0.1 nT
Accuracy	+1nT
Range	23000 to 100000 nT
RESISTIVITY METER (SP Measuring Unit)	
Type	SYSCAL R2 Resistivity meter with IP & SP measurements
Make	IRIS Instrument
Input impedance	100 MOhm
Voltage resolution	1 μ V/0.2%
Voltage accuracy	0.2%
Automatic compensation of SP	-5V to +5V
SURVEYING	
Type	DGPS
Model	Trimble

9.7.0 FIELD DATA ACQUISITION:

Magnetic Method:

The survey was designed in a grid pattern with a line interval of 100 meters and a station spacing of 20 meters, with positions marked using Hand held DGPS. Survey locations were meticulously demarcated by placing pegs, each indicating the corresponding line and station number. The layout map of the traverse lines and observation stations is shown in text Fig. 6 and 7. The Magnetic data was recorded at every station with starting and ending at the base station on routine basis. The survey was meticulously designed to detect subtle changes in the magnetic field, which could indicate the presence of geological features such as shear zones, faults, and mineralized bodies.

IP Survey Design:

An induced polarization (IP) survey is conducted using various electrode arrangements, typically involving four electrodes: two current electrodes (C1 and C2) and two potential electrodes (P1 and P2). The choice of electrode configuration depends on the specific objectives of the survey. Different arrangements can provide different responses based on geological conditions. For instance, to map lateral changes in geological structures, the Dipole-Dipole and Werner arrays are often more effective. In this case, the Dipole-Dipole array, as illustrated in Figure 6 and Figure 7, has been employed for the Block survey, within the current field survey, a total of 36 channels were used for subsurface imaging, with an electrode spacing of 20 meters and a maximum array length of 720 meters. The multi-electrode channel system automatically selects various combinations of current (C1 and C2) and potential (P1 and P2) electrodes from the 36 available electrodes, enhancing the efficiency of subsurface imaging within an optimal timeframe. Throughout the survey block, a cumulative total of 31-line kilometers of profile data were recorded.

SP Survey Design:

The SP survey was carried out using non-polarizing electrodes and a high-impedance voltmeter, along with an SYSCAL R2 system. The recording was done in a grid pattern, with a station spacing of 20 meters and line spacing of 100 meters. A total of 30 LKM was covered.

9.8.0 DISCUSSION OF RESULTS

9.8.1 Magnetic Anomaly of Block-I (Khandapar) of Jamtola-Khandapar Block

Magnetic survey investigates subsurface geology using anomalies in Earth's magnetic field caused by rock properties. Magnetic anomalies arise from induced or remnant magnetism, with shapes and amplitudes influenced by rock size, depth, geometry, susceptibility, and Earth's magnetic field. Corrected data showed a total variation of 248.4 nT as observed in the Total Magnetic Intensity (TMI), with the maximum value recorded at 45,563.6 nT and the minimum at 45,315.2 nT. Similarly, the Magnetic Anomaly (MA) exhibits a total variation of 240 nT, with the highest value recorded at -180.1 nT and the lowest at -420.1 nT.

Both the TMI and MA maps show characteristic magnetic responses across various lithological units. Geologically, the magnetic anomaly map suggests that the structural control in the area is predominantly oriented in the north-south (N-S) direction. In the northern part of the area, magnetic high anomalous zones dominate, which may be controlled by the underlying geological structure. Additionally, some anomalies in the region show alignment in the east-west (E-W) direction, further suggesting structural influences.

9.8.2 Magnetic Anomaly of Block-II (Karwahi) of Jamtola-Khandapar Block.

A total variation of 507.3 nT in the Total Magnetic Intensity (TMI) was observed, with the highest value recorded at 45,686.5 nT and the lowest at 45,179.2 nT. Similarly, the Magnetic Anomaly (MA) showed a total variation of 509.74 nT, with a maximum value of -83.93 nT and a minimum of -593.67 nT, as illustrated in Figures attached in annexure-XIII (detailed report on Geophysics).

Both the TMI and MA data indicate characteristic magnetic responses corresponding to different lithological units, with a prominent north-south (N-S) orientation. The magnetic anomaly map suggests that the geological structure of the area is primarily controlled along the N-S direction, with a consistent trend observed throughout the region.

9.8.3 Reduced to Pole (RTP) of Block-I (Khandapar) of Jamtola-Khandapar Block:

The Reduction to the Pole (RTP) transformation of the magnetic anomaly map for Block-I was generated to enhance structural trends and highlight anomalous features.

Although the RTP processing improved the clarity of magnetic anomalies and partially aligned them in the N–S direction, thus reducing the asymmetric effects of magnetic sources, no continuous structural trend is distinctly visible in the RTP map. This suggests that the magnetic sources may be discontinuous or structurally complex in nature.

9.8.4 Reduced to Pole (RTP) of Block-II (Karwahi) of Jamtola-Khandapar Block.

The Reduction to the Pole (RTP) transformation of the magnetic anomaly map for Block-II was performed to enhance structural trends and highlight anomalous features. The RTP-processed map clearly delineates an anomalous zone oriented in the north-south (N-S) direction. This transformation effectively realigned the magnetic anomalies toward their true causative sources, thereby mitigating the asymmetry typically caused by the inclination and declination of the Earth's magnetic field. As a result, the RTP map provides a clearer representation of subsurface structures and shows a better alignment of the anomalies with the known mineralization zone. A consistent trend is observed, which is further supported by the correlation with other geophysical data, reinforcing the validity of the anomaly and its geological significance.

9.8.5 Residual Magnetic Anomaly of Block-I (Khandapar) of Jamtola-Khandapar Block:

The Residual Magnetic Anomaly Map was generated by subtracting the 100 m Upward Continuation Map from the Magnetic Anomaly Map using the "Grid Math" function in Geosoft Oasis Montaj software. This residual map effectively highlights local geological features and structures by minimizing the influence of broader regional trends.

In the residual anomaly map, most anomalous zones appear more distinct and sharper, as the effects of regional geological trends have been reduced. Notably, the anomaly zone in the northern part, which was previously dominated by regional geology, now shows enhanced detail.

9.8.6 Residual Magnetic Anomaly of Block-II (Karwahi) of Jamtola-Khandapar Block.

The Residual Magnetic Anomaly Map (Karwahi Sub Block) was generated by subtracting the 100 m Upward Continuation Map from the Magnetic Anomaly Map using the "Grid Math" function in Geosoft Oasis Montaj software. This residual map

effectively highlights local geological features and structures by minimizing the influence of regional magnetic trends.

In the residual anomaly map, the magnetic anomaly previously observed in the northwestern part of the study area has disappeared. This suggests that the anomaly in that region was primarily associated with regional geological influences. In contrast, the anomaly observed in the southeastern part of the block, trending in a N-S direction, remains prominent. This anomaly is likely associated with shear facies in the study area and is more distinctly represented as a residual feature.

Overall, the residual magnetic anomaly map enhances the visibility of smaller, localized anomalies that were previously obscured by strong regional disturbances in the original magnetic anomaly map.

9.8.7 Analytic Signal Analysis Map of Block-I (Khandapar) of Jamtola-Khandapar Block

The Analytical Signal analysis, also known as the Total Gradient method, is a reliable technique for delineating the edges and lithological boundaries of magnetic source bodies. A key strength of this method is its relative independence from the magnetic field orientation and remanent magnetization.

The Analytical Signal Amplitude Map of the study area reveals high-intensity signal amplitudes along geological contacts and shallow magnetic bodies, indicating potential lithological boundaries. However, no continuous trend was observed across the block, suggesting that the magnetic sources are more localized and discontinuous in nature.

While both the Analytical Signal and Reduced-to-Pole (RTP) maps highlight similar anomaly and target zones—generally trending in a north-south (N–S) direction—the Analytical Signal map offers better clarity in defining the discrete boundaries of anomalous bodies.

9.8.8 Analytic Signal Analysis Map of Block-II (Karwahi) of Jamtola-Khandapar Block.:

The Analytical Signal analysis, also referred to as the Total Gradient method, is an effective tool for identifying the edges and lithological boundaries of magnetic source bodies. Its primary advantage lies in the fact that the shape of the analytical signal is nearly independent of the magnetic field orientation and remanent magnetization.

The Analytical Signal Amplitude Map (Fig. 6.1.2.6) of the study area displays high-intensity signal amplitudes along geological contacts and over shallow anomalous sources, helping to infer subsurface lithological boundaries. Contour lines, marked in white, clearly delineate the boundaries of the causative magnetic bodies.

Both the Analytical Signal map and the Reduced-to-Pole (RTP) map indicate consistent anomaly and target zones, predominantly trending in a north-south (N–S) direction. Unlike Block-I, a continuous trend is observed in Block-II, which closely follows the underlying geological structure. Additionally, the Analytical Signal map provides enhanced resolution of the boundaries of these anomalous features, aiding in more accurate geological interpretation.

9.8.9 Radially Average Power Spectrum of Block-I (Khandapar) and Block-II (Karwahi) of Jamtola-Khandapar Block.

The Radially Averaged Power Spectrum (RAPS) plots for Block-I and Block-II, as shown in Fig. 6.1.1.7 and Fig. 6.1.2.7 respectively, indicate that the majority of the magnetic anomaly features and their causative bodies lie within a depth range of approximately 100 to 500 meters. This depth estimation provides valuable insight into the subsurface geological structures and supports the interpretation of near-surface and intermediate-depth magnetic sources across both blocks.

9.8.10 Induced Polarization (IP cum Resistivity) Profiles:

The Resistivity cum IP (Induced Polarization) response in the survey area is characterized by low resistivity and high chargeability values, which are typically associated with Sulphide and Oxides minerals and alteration and shear zones. The combination of low resistivity and high chargeability suggests the presence of mineralized zones, likely containing sulfides or other conductive minerals, within these altered geological formations.

9.8.11 IP Response of Block-I (Khandapar) of Jamtola-Khandapar Block.

The Induced Polarization (IP) survey data reveal significantly low resistivity values and high chargeability values exceeding 40 mV/V along the survey lines. This combination is indicative of the presence of conductive formation zones, which may correspond to gold, copper, and associated mineralization.

A continuous trend is observed from Line 1 to Line 12, after which the trend becomes discontinuous. The dark red zones, corresponding to high chargeability values, and the dark blue zones, reflecting low resistivity, highlight anomalous areas that extend up to 135 meters in depth, as shown in the IP anomaly profiles.

In areas with closely spaced data points, the geophysical anomalies are better defined. Notably, the central part of the block shows overlapping low resistivity and high chargeability values, suggesting continuous mineralization extending to the full investigated depth of 135 meters.

9.8.12 IP cum Resistivity Response of Block-II (Karwahi) of Jamtola-Khandapar Block.

The Resistivity values along the IP lines are significantly low, while the chargeability values are elevated, exceeding 40 mV/V. This combination of low resistivity and high chargeability suggests the presence of conductive formation zones, which may correspond to graphite mineralization within the surveyed area.

Although no consistent trend is observed across all lines, areas showing localized zones of low resistivity and high chargeability may indicate potential mineralization. These zones generally align in a north-south (N-S) direction across the survey area.

The dark red IP anomaly zones, associated with high chargeability values, and the dark blue low resistivity zones point to anomalous areas extending up to 135 meters in depth, as shown in the IP anomaly profiles. Areas with closely spaced data points show better-defined geophysical anomalies, enhancing the identification of mineralized zones.

Notably, the resistivity and chargeability anomalies in the central part of the block suggest continuous mineralization extending to a depth of 135 meters (the full depth of the survey investigation).

9.8.13 Self-Potential (SP) Profiles of Block-I (Khandapar) of Jamtola-Khandapar Block.

The total SP anomalies along each traverse have been generated from the SP data. The total variation of the SP anomaly observed was 158 mV, with the highest value recorded at 294 mV and the lowest at -146 mV. The SP data reveal significant structural disturbances in the area.

The SP data correlate well with the IP, resistivity, and magnetic data, suggesting that the electro-kinetic potential observed in the shear zones is likely due to sulphide mineralization. The low SP values align closely with areas identified by the IP and other data sets, reinforcing the interpretation of the shear zone's role in the mineralization process.

9.8.14 Self-Potential (SP) Profiles of Block-II (Karwahi) of Jamtola-Khandapar Block

The total SP anomalies along each traverse have been derived from the SP data. A total variation of 299 mV was observed, with the highest value reaching 627 mV and the lowest at -328.1 mV. The SP data highlight structural disturbances in the area, providing conclusive results.

The SP data exhibit a strong correlation with the IP, resistivity, and magnetic data, suggesting that the electro-kinetic potential observed in the area is likely due to sulphide mineralization. Block-II, associated with graphite mineralization, the data clearly demonstrate low SP values. These values align with the overall north-south (N-S) trend, indicating the presence of a significant mineralization zone.

9.9.0 CONCLUSIONS AND RECOMMENDATIONS:

9.9.1 The integrated geophysical survey as approved by NMEDT has been conducted in the Khandapar and Karwahi sub blocks of Jamtola-Khandapar Block by adopting IP cum resistivity, SP and Magnetic methods. The effectiveness of these methods along with its limitation depends upon the physical properties contrast of the target and surroundings. To demarcate the zones of interest and their contacts spatial filtering technique like upward continuation, Horizontal derivatives and analytical signal analysis etc. were applied on magnetic data to enhance the outcomes. The area of possible mineralization has also been marked in IP and apparent resistivity sections and has plotted over profile. In order to obtain source depth information, radially averaged power spectrum and analytical signal analysis maps of magnetic anomaly etc. has been generated and depth of the anomalous zones were found ranging from 40m to 90m in different segments of the Sub blocks.

9.9.2 Block-I (Khandapar) of Jamtola-Khandapar Block:

Based on the Magnetic IP cum resistivity data interpretation the following anomalous zone indicated by white dotted line has been marked on the reduced to pole (RTP) anomaly map.

Based on the integrated analysis of the Magnetic, IP-Resistivity, and SP data, several anomalous zones have been identified and clearly marked on the resistivity surface anomaly map. The zones exhibiting higher anomalous signatures are particularly noteworthy, as they are likely associated with gold mineralization.

All four proposed Borehole over line 6, 9, 11 and 13 are following the characteristics of low to moderate resistivity and high chargeability which is well corroborating with low magnetic zone as mineralization could be within the Quartz reefs.

A continuous trend is also observed which is marked as white dotted line for the continuous mineralization.

Table 10 Details of Proposed Boreholes Locations for Block-I (Khandapar) of Jamtola-Khandapar Block

PBH	Line	IP station	DEPTH	EASTING	NORTHING
PBH-1	6	440	80	448821	2427524
PBH-2	9	460	75	449001	2427924
PBH-3	11	440	80	449041	2428024
PBH-4	13	420	90	449161	2428324

9.9.3 Block-II (Karwahi) of Jamtola-Khandapar Block:

Three boreholes are proposed along Line 24, Line 25, and Line 29, all of which fall within a low magnetic zone. These zones exhibit low to moderate resistivity and high chargeability, suggesting a potential association with graphite mineralization. In contrast, the proposed boreholes along Line 29 and Line 32 are located within a high magnetic zone. These locations are characterized by moderate to high resistivity and high chargeability values in the IP sections, indicating a possible association between graphite and phyllite.

Whereas Proposed Boreholes over line 20 falling on transition zone of magnetic high to low with high resistivity and high chargeability may represent the alteration halo region

in which metamorphism has taken place and could be the contact zone of quartz and phyllite.

Based on the Magnetic IP cum resistivity data interpretation the following anomalous zone with a higher anomalous signature, potentially corresponding to graphite mineralization, has been identified indicated by white dotted line has been marked on the reduced to pole (RTP) anomaly map.

Based on the integrated analysis of the Magnetic, IP-Resistivity, and SP data, several anomalous zones have been identified and clearly marked on the resistivity surface anomaly map. The zones exhibiting higher anomalous signatures are particularly noteworthy, as they are likely associated with graphite mineralization.

Zone having higher anomalous signature is marked which may be corresponding to the graphite mineralization zone. Through the correlation of the magnetic data, IP-Resistivity profiles, and SP responses five potential borehole locations have been inferred to further confirm and explore these anomalies.

Table 11 Proposed tentative Borehole Locations for Block-II (Karwahi) of Jamtola-Khandapar Block

BHID	Line	Easting	Northing	IP-Station	Depth
1	24	454931.8	2430093	220	50
2	25	455011.8	2430243	280	60
3	29	455357.8	2430874	580	70
4	32	455326.8	2431293	515	40
5	20	455281.8	2429493	610	48
6	30	455151.8	2430993	360	65

Note: The proposed boreholes depths are indicated as vertical target depths. Hence, inclined boreholes with suitable angle are to be planned to intersect the vertical target depths.

9.9.4 Report on IP, RES, SP & Magnetic Survey in Jamtola-Khandapar Block, District Balaghat, Madhya Pradesh for Gold, Graphite and associated Minerals is enclosed as **Annexure-XIV**.

CHAPTER-10

EXPLORATION UNDERTAKEN DURING CURRENT INVESTIGATION

10.1.0 BACKGROUND INFORMATION

10.1.1 Gold mineralization in the Jamtola–Khandapar area is mainly associated with quartz veins hosted within phyllites of the Chilpi Group (Palaeo–Meso Proterozoic age). Bedrock samples collected by *Khan et.al.*, (1995) from the Khandapar quartz vein have shown encouraging gold values, with four samples yielding 0.2 g/t, 0.4 g/t, 0.7 g/t, and 2.2 g/t Au. The geological framework, as described by *Tripathi et.al.* (1973), comprises an Archaean Basement Complex overlain by Precambrian metasediments, including the Chilpi Group consisting of conglomerate, quartzite, calc-silicates, limestone, mica schist, and phyllite. These rocks show lithological and structural similarities with the Sausar Group, and subsequent works (*Tripathi, 1979; Das Gupta et.al., 1981*) further refined the stratigraphy into metavolcanics overlain by metasediments. Extensive investigations including geological, geochemical, geophysical, and subsurface studies (*Udhoji, 1976; Neelakantam, 1973, 1974; Chatterji et.al., 1974; Dash et.al., 1972; Dutta et.al., 1975; Jaiswar and Guha, 1975; Khan et.al., 1992; Shukla, 1987*) have identified quartz veins, granitoid contacts, and shear zones as favourable sites for mineralization. Evidence of ancient workings and stream gold panning (*Pal and Sindhupe, 2004*) further supports mineral occurrence. Quartz veins along contacts of Malanjkhanda granite with Amgaon gneiss and Nandgaon volcanics show both gold and copper mineralization, with reported values up to 0.38 g/t Au in soil and 0.23 g/t in rock samples, along with copper ranging from 14 to 591 ppm (*Bhargava, Ind Pal, 2000*), highlighting the exploration potential of the area.

10.1.2 In view of the above, the present Reconnaissance Survey (G4 stage) for gold, copper, graphite and associated minerals in the Jamtola-Khandapar Block has been undertaken with the objective of identifying gold-bearing host rocks and assessing the potential of the old workings and their possible extensions, covering an area of about 96.62sq. km. The G4 stage exploration work carried out in two phases. The objectives of present exploration program at G4 stage are as below.

Phase-I

- i) To carry out large scale Geological mapping on 1:12,500 scale for demarcation of gold bearing formations (host rock) with the structural features to identify the surface manifestations and lateral disposition of the mineralized zones.
- ii) To collect surface samples & analyse for Gold and associated minerals to identify the host rock.
- iii) To carry out trenching/pitting work
- iv) Based on the outcome of Geological mapping and surface sample results, carry out ground geophysical survey (IP cum Resistivity, SP and Magnetic) to demarcate potential areas for mineral targeting and giving subsurface positive details of extension of concealed ore body if any.

Phase-II (Phase-II work was carried out after review of Phase-I work),

- v) To carryout scout drilling (610 m in 8 Bhs) in the identified potential mineral bearing area to confirm the subsurface continuity of mineralisation.
- vi) To estimate Reconnaissance resource (334) for Gold and Graphite along with accessory elements if any as per UNFC norms and Minerals (Evidence of Mineral Content) Rules-2015 at G-4 level.

10.2.0 EXPLORATION METHODOLOGY

10.2.1 The components of G-4 level of exploration for Gold in Jamtola-Khandapar Block to full fill the above-mentioned objective in accordance with MEMC rule 2015 (amended till 2021) as approved by NMEDT is furnished in the **Table No. 12** and the field component wise description has been given in subsequent paragraphs.

10.2.2 The Reconnaissance Survey (G-4 stage) for Gold in Jamtola-Khandapar Block included large scale Geological mapping (1:12500 scale) over 96.62sq.km. area collection and analysis of 213 Nos. Bedrock samples for Gold and 19 Nos. Bedrock samples for Graphite. Ground geophysical survey comprising of IP cum Resistivity, SP and Magnetic survey and followed by test drilling (610 m in 8 Boreholes) along with associated activities i.e. borehole deviation survey (For Gold only i.e. in MJGL series

only) & and associated laboratory studies including petrographic, mineragraphic and specific gravity determination studies.

10.2.3 The details of the nature and quantum of work proposed Vs. an actual achievement is given in **Table-12**.

**Table 12 Quantum of Work vs. Achievement by MECL in Jamtola-Khandapar Block,
District: Balaghat, Madhya Pradesh**

Sr. No	Item of Work	Unit	Target	Achieved
A	Geological Work			
	Geological Mapping (1:12500)	sq.km	96.62	96.62
B	Ground Geophysical Survey			
	IP. Induced Polarization (I.P) cum Resistivity S.P and Magnetic	Line Km	2.5	2.5
C	Survey Work			
	BH Fixation and RL determination	Per Point of observation	8	8
D	Trenching/Pitting			
	Excavation of trenches	cu.m	200	0
E	Drilling			
	Drilling up to 300m (Hard Rock)	m	610	610
	Borehole deviation Survey by Multishot Camera	m	610	339
	Construction of concrete Pillar (12"x12"x30")	Nos.	8	0
H	Drill Core Preservation	per m	250	250
G	LABORATORY STUDIES			
1	Chemical Analysis- Geochemical Sampling- Surface samples (Bedrock+Trench+Borehole) (Primary+10% External)			
(i)	Gold			
	a. Primary BRS	Nos	200	213
	b. Trench	Nos	100	0
	c. Borehole Samples	Nos	160	156

Sr. No	Item of Work	Unit	Target	Achieved
	d. External Check	Nos	45	45
(ii)	Graphite			
	a. Primary BRS	Nos	40	19
	b. Trench	Nos	20	0
	c. Borehole Samples	Nos	20	21
	d. External Check	Nos	8	8
(iii)	ICPMS	Nos	50	50
2	Physical & Petrological Studies			
(i)	Petrological studies	Nos	10	10
(ii)	Mineralogical studies	Nos	10	10
(iii)	Digital photomicrographs	Nos	10	10
(iv)	Whole Rock Analysis	Nos	10	10
(v)	Sp. Gravity Determination	Nos	5	5
(vi)	Geological Report	Nos	1	1

10.2.4 MECL commenced Phase-I exploration work comprising of Geological mapping, surface sampling and ground geophysical survey in Jamtola-Khandapar Block in start of January, 2024 and completed in mid of June, 2024. Test drilling activities commenced on 16th July, 2025 and concluded on 09th March, 2026. Total drilling of 610.0m in Eight boreholes (MJGL-01 to MJGL-04) in Khandapar Sub Block and (MJGR-01 to MJGR-04) in Karwahi sub block of Jamtola-Khandapar Block accomplished. The allied field-works including borehole fixation and determination of co-ordinates & reduced level of boreholes by DGPS, drilling work and associated borehole deviation survey & borehole geophysical logging, core logging, core sampling etc. were completed simultaneously. The laboratory studies including chemical analysis and physical analysis i.e. petrographic, mineragraphic and specific gravity studies were carried out simultaneously in MECL laboratories and other external laboratories. Ground Geophysical survey work and findings have already been discussed in previous Chapter IX. Component wise Exploration methodology and findings have been described in subsequent paragraphs.

10.2.5 **Large scale Geological Mapping:** Large scale Geological mapping taken up in the total area of 96.62sq. km on 1:12,500 scale. Available toposheet map and Topographical

contour map generated from Aster data has been utilised to understand the topography, roads, and drainage of the mapped area and was also used as a base map for geological mapping. For recording precise sample location and to carry out a geological survey, handheld BAP-GPS device has been used. The coordinates had been recorded in UTM coordinate system with WGS 1984 datum. Lithological units, attitude of rock types and lithological contacts were mapped. Major litho units mapped in the area are Phyllites, Migmatites, Limestone, Quartz Reefs, Laterites, Basalts, Quarzites etc have been mapped ignoring minor variations. Plain lands and valley portions of hilly terrains are soil covered. Attitude of structural features of rocks, foliation, were recorded by brunton compass. Variation of lithologies align with the structural elements were systematically recorded and the readings and sample locations recorded in the field were plotted and produced in the form of interpreted geological map on 1:12,500 scale and given as **Plate No. III A**. The description of lithology has already been furnished in **Chapter No VII**.

10.2.6 Surface Sampling (Bedrock): During the course of geological mapping, a total of 213 surface bedrock samples were collected from different lithological units including sheared quartz reefs, migmatites, phyllites, laterites, quartz veins, and dolerite dykes, to evaluate the potential for gold and associated mineralization within the block area. The collected samples were analysed for Gold (Au) by Fire Assay and Silver (Ag) by AAS method to assess the geochemical distribution of precious metals. The sampling was done to cover lithological units exhibiting sulphides, quartz veining and alteration features having potential to host mineralization. Analytical results indicate that the majority of samples yielded Au values below the detection limit (<0.01 ppm), while a few isolated samples recorded anomalous Au values with a maximum value of 4.89 ppm and Ag values up to 6.21 ppm.

In addition, a total of 19 surface samples representing graphite-bearing lithologies were collected for proximate analysis to evaluate graphite mineralization within the block area. The samples were analysed for moisture content, ash percentage, volatile matter and fixed carbon (F.C.) content. Analytical results indicate moisture values ranging from 0.06% to 0.40%, ash content from 92.15% to 99.10%, volatile matter from 0.54% to 5.05% and fixed carbon values ranging from 0.06% to 3.38%. A few samples recorded relatively higher fixed carbon values, with the maximum value of 3.38%. The locations of all sample points were recorded using handheld BAP-GPS and plotted on

the geological map of the block area. Analytical details for surface samples of Au, Ag and graphite are provided in the **Annexure No.I-A. and Annexure No.I-B** while sample locations and anomalous values are depicted on the geological map of the Jamtola–Khandapar Block (Plate IIIA and Plate IIIB).

10.2.7 Discussion on Bedrock Sample Results: Surface geochemical investigations involved collection and analysis of 213 bedrock/channel samples from different lithological units including sheared quartz reefs, migmatites, phyllites, laterites, quartz veins and dolerite dykes for assessment of gold and associated mineralization potential within the block area. Analytical results indicate that Au values range from below detection limit (<0.01 ppm) to 4.89 ppm, whereas Ag values vary from below detection limit (<0.01 ppm) to 6.21 ppm. The significant Au–Ag anomalous values are predominantly concentrated in the south-western part of the block i.e within Khandapar Sub Block area, where the highest Au value of 4.89 ppm and associated elevated Ag values were recorded, with additional moderate anomalous values occurring within adjoining southern and south-central sectors.

In addition, a total of 19 surface samples collected from graphite-bearing zones associated with phyllites were analysed through proximate analysis to evaluate graphite mineralization potential within the block area. Analytical results indicate moisture values ranging from 0.06% to 0.40%, ash content from 92.15% to 99.10%, volatile matter from 0.54% to 5.05% and fixed carbon (F.C.) values varying from 0.06% to 3.38%. Relatively higher fixed carbon values are mainly concentrated in the central to north-central part of the block i.e in Karwahi sub block area, with a few isolated occurrences distributed within adjacent sectors.

Litho unit wise summary of chemical analysis of bedrock samples for Gold, Silver and Graphite is given below in Table No. 13 and 14 respectively and chemical analysis of bedrock sample is in Annexure No.I-A. and Annexure No.I-B respectively.

**Table 13 Summary of Bedrock sample analytical results showing Anomalous values for
Au & Ag in Jamtola -Khandapar Block**

S.No.	Eastings	Northings	Sample No.	Ag (PPM)	Au (PPM)
1	448904	2427640	MJSS/071	5.67	1.97
2	448778	2427354	MJSS/072	2.89	0.35
3	448753	2427418	MJSS/074	1.87	0.01
4	448743	2427421	MJSS/075	2.46	0.01
5	448757	2427397	MJSS/076	1.78	<0.01
6	448752	2427316	MJSS/077	1.37	0.03
7	448740	2427302	MJSS/079	2.58	<0.01
8	462811	2428481	MJSS/091	1.54	<0.01
9	462162	2428236	MJSS/095	1.50	<0.01
10	461424	2428416	MJSS/097	1.57	<0.01
11	461484	2428481	MJSS/099	1.29	<0.01
12	461265	2428496	MJSS/102	1.47	<0.01
13	448719	2427307	MJSS/117	6.21	0.61
14	448800	2427484	MJSS/120	1.28	<0.01
15	455315	2430832	MJSS/123	1.59	<0.01
16	455423	2431461	MJSS/124	1.25	<0.01
17	450619	2430184	MJSS/126	1.39	<0.01
18	448896	2427586	MJSS/142	1.11	0.11
19	448887	2427608	MJSS/202	1.01	4.89
20	448900	2427649	MJSS/203	1.50	0.06
21	448880	2427664	MJSS/204	< 0.5	0.31
22	448907	2427689	MJSS/205	1.22	<0.01
23	449011	2427892	MJSS/208	1.41	0.26

Table 14 Summary of Bedrock sample analytical results showing Anomalous values for Graphite in Jamtola -Khandapar Block

S.No.	Northing	Easting	Sample Code	F.C.*%
1	454855.00	2430133.00	MJK/G/01	2.76
2	454835.00	2430108.00	MJK/G/07	3.27
3	454856.00	2430185.00	MJK/G/08	1.79
4	454944.00	2430246.00	MJK/G/09	2.78
5	454979.00	2430276.00	MJK/G/10	3.20
6	455308.00	2430901.00	MJK/G/11	1.18
7	455308.00	2430865.00	MJK/G/12	1.75
8	454845.51	2430107.15	MJK/G/13	3.38
9	455261.00	2431014.00	MJK/G/15	2.09
10	455308.00	2431286.00	MJK/G/16	1.73
11	455317.00	2431298.00	MJK/G/17	3.24

10.2.8 Whole rock analysis: A total of 10 bedrock samples (Four are from surface samples and remaining six are from Borehole samples) representing different lithological units from the Jamtola–Khandapar Block were subjected to whole rock geochemical analysis. The analysed samples exhibit wide compositional variation, with SiO₂ values ranging from about 25.38% to 85.81%, indicating the presence of diverse lithologies varying from calcareous and ferruginous rocks to highly siliceous and felsic types. Samples such as MJMO-02, MJMO-03, MJMO-04, and MJMO-07 are characterized by high silica content (60–86%) and comparatively lower Fe₂O₃, CaO, and MgO concentrations, suggesting felsic to siliceous affinity. In contrast, samples MJMO-01, MJMO-08, and MJMO-10 exhibit enrichment in Fe₂O₃ (up to 40.08%), CaO, and MgO, indicating mafic to iron-rich compositions. The calcareous nature of samples MJMO-05 and MJMO-06 is reflected by very high CaO content (20.52% to 33.50%) coupled with relatively low silica values. Al₂O₃ content varies considerably from about 1.10% to

22.22%, reflecting variable aluminous character among the lithologies. Alkali oxides also show significant variation, with K₂O attaining higher values (up to 10.36%) in potassic lithologies, while Na₂O remains generally low to moderate. The overall geochemical trends reveal an inverse relationship between SiO₂ and Fe–Mg–Ca oxides, indicating compositional differentiation from siliceous felsic rocks to mafic, ferruginous, and calcareous lithologies within the study area. Whole rock analysis of Surface samples and Borehole samples are given in **Annexure No-I-C and Annexure-IX respectively**

10.2.10 Exploratory Drilling:

10.2.10.1 Out of the 8 approved boreholes all 8 boreholes were taken up for drilling in nonforest Khandapar sub block and Forest Jamtola Sub Block. Eight test incline boreholes i.e. four borehole MJGL-01 to MJGL-04 (drilled in Khandapar sub block) & four boreholes MJGR-01 to MJGR-04 (drilled in Karwahi sub block) totalling 610.0 m drilled to test the ground geophysical anomalies and to confirm the gold mineralised zones in depth at specified locations in Khandapar sub block and graphite mineralised zones in Karwahi sub block of Jamtola-Khandapar Block. The details of test boreholes drilled during present exploration by MECL in Khandapar Sub Block and Karwahi sub block of Jamtola-Khandapar Block are summerised in below given **Table No. 15** and also given in **Annexure No. III-A**.

Table 15 Details of scout boreholes drilled by MECL in Khandapar Sub Block and Karwahi sub block of Jamtola-Khandapar Block, District: Balaghat, Madhya Pradesh

S.No.	BHID	Section	Easting (m)	Northing (m)	Elevation (m)	Azimuth (°)	BH angle (°)	Total Depth (m)	Date of Commencement	Date of Closure
1	MJGL-01	S1-S1'	448799.4020	2427529.5590	590.087	120°	61°	81.00	16.07.2025	08.08.2025
2	MJGL-02	S2-S2'	448856.5230	2427845.4830	591.841	120°	49°	90.00	17.08.2025	21.09.2025
3	MJGL-03	S3-S3'	449015.0340	2428043.9430	598.070	120°	50°	90.00	25.09.2025	26.10.2025
4	MJGL-04	S4-S4'	449076.7570	2428183.5600	594.111	120°	69°	90.00	01.11.2025	29.11.2025
5	MJGR-01	S1-S1'	454805.1370	2430086.3360	625.172	127°	45°	100.00	13.12.2025	18.01.2026
6	MJGR-02	S2-S2'	454909.3900	2430316.0220	614.412	127°	45°	65.00	22.01.2026	05.02.2026
7	MJGR-03	S3-S3'	455244.2440	2430985.1060	594.685	30°	50°	50.00	10.02.2026	19.02.2026
8	MJGR-04	S4-S4'	455259.6340	2431293.5960	610.991	30°	50°	44.00	24.02.2026	09.03.2026

10.2.10.2 The location of test boreholes drilled is shown in the large-scale Geological map of Jamtola-Khandapar Block (Plate No. III). Also, a separate geologic map showing location of Khandapar & Karwahi sub block with positive surface sample locations and borehole locations is given as **Plate No. III A and Plate III B**. Geological cross sections drawn along borehole profile S1-S1' to S4-S4' (for both the sub blocks) is given in **Plate No. IV A and Plate No. IV B**

10.2.10.3 Four test boreholes (MJGL-01 to MJGL-04) were drilled in Khandapar Sub Block along sections S1-S1' to S4-S4' targeting low to moderate magnetic zone, supported by IP-resistivity data showing low resistivity and high chargeability signatures indicative of sulphide mineralization in Khandapar sub block. Borehole whereas Four Test Boreholes (MJGR-01 to MJGR-04) were drilled in Karwahi Sub Block along sections S1-S1' to S4-S4' based on the Magnetic IP cum resistivity data interpretation of the anomalous zone with a higher anomalous signature, potentially corresponding to graphite mineralization

10.2.11 Discussion on Drilling Results:

10.2.11.1 During the course of borehole core logging, sulphide-bearing and graphite zones intersected in the exploratory boreholes were subjected to detailed chemical analysis for gold, silver, and graphite. A total of 156 primary core samples generated from boreholes MJGL-01, MJGL-02, MJGL-03, MJGL-04, and MJGR-04 were analysed for Au and Ag by Fire Assay and AAS methods respectively.

The analytical results indicate that gold values are generally low and sporadic in nature. In borehole MJGL-01, gold values were below detection limit (<10 ppb) in all analysed samples, whereas silver values show localized enrichment with values reaching up to 5223.88 ppm Ag. Borehole MJGL-02 also records predominantly low gold values with isolated anomalous intersections, the highest being 33.12 ppb Au, while silver values locally attain 2464.44 ppm Ag, 3569.59 ppm Ag and highest 6259.27 ppm Ag. Borehole MJGL-03 shows very low gold with values ranging from below detection level to a maximum of 41.06 ppb and 14.43 ppb Au, accompanied by very high silver values up to 943.23 ppm Ag. Borehole MJGL-04 records the highest gold anomaly with values reaching up to 55.52 ppb Au, while associated silver mineralization is highly enriched, attaining values as high as 1676.71 ppm Ag

Graphite zones encountered in boreholes MJGR-03 and MJGR-04 were sampled for graphite by proximate analysis including Ash%, Volatile Matter (VM%), Fixed Carbon (FC%), and Moisture content. The ash content varies widely from about 68.4% to 92.2%, while volatile matter ranges from approximately 5.3% to 31.2%. Fixed carbon (FC%) values remain generally low to moderate, ranging from 0.1% to 2.8%, indicating poor to low-grade graphite concentration within the analysed intervals. Overall, the borehole analytical data suggest the presence of localized silver enrichment associated with sulphide-bearing zones; however, gold values remain low and discontinuous, and graphite mineralization is of limited grade and continuity, thereby indicating sub-economic mineralization within the investigated borehole intersections. Borehole primary sample analysis details for Gold and Silver by fire assay method + AAS method and Graphite by proximate analysis are given in **Annexure V-A & Annexure V-B respectively**.

- 10.2.11.2 Borehole core samples were also analysed for 34-element analysis by ICP-MS method. Analytical results of 15 primary samples indicate variable concentrations of major and trace elements. Elements such as Li, Be, B, Ti, V, Cr, Co, Ni, Cu, Zn, As, Sr, Nb, Mo, Cd, Sn, Sb, Ba, La, Ta, W, Pb, Bi and U show noticeable compositional variations across the borehole intersections. Lithium values range from 4.14 ppm to 54.93 ppm, while titanium values vary from 0.12% to 0.61%. Vanadium values range from 44.27 ppm to 166.67 ppm and copper values range from 8.94 ppm to 112.83 ppm. Barium values exhibit considerable variation, remaining below the detection limit (LOD = 0.1 ppm) in most samples but exhibits enriched variations from 585.29 to 0.64%, whereas Lanthanum values range from 15.56 ppm to 49.67 ppm. Tungsten values vary between 1.51 ppm and 47.29 ppm with isolated higher values recorded in a few samples. Although localized enrichment of Ba, Cu, W and certain associated trace elements is observed in some borehole samples, the overall analytical results indicate scattered and inconsistent elemental distribution. No persistent or economically significant enrichment of associated metallic elements is evident across the borehole intersections. Borehole primary sample analysis details for 34-element ICP-MS analysis are given in Annexure-VIII.
- 10.2.11.3 The borehole intersections encountered sulphide-bearing zones represented by pyrite, pyrrhotite and minor chalcopyrite associated within amphibolitic rocks and quartz vein zones. However, geochemical signatures obtained from multi-element ICP-MS analysis

show only localised enrichment of Cu, Ni and Co values without any systematic increase along the mineralised horizons. Elevated Cu values in isolated samples, particularly MJIC/01 (183.95 ppm), MJIC/25 (259.40 ppm) and MJIC/26 (547.43 ppm), along with moderate Co and Ni concentrations, do not exhibit lateral or vertical continuity.

10.2.12 Outcome of Present Work:

- 10.2.12.1 Surface bedrock samples were analysed for Gold (Au) by Fire Assay and Silver (Ag) by AAS method. Out of 213 samples analysed, the majority of samples yielded Au values below the detection limit (<0.01 ppm), indicating poor gold content in the study area. Only a few samples recorded anomalous Au values ranging from 0.01 ppm to 4.89 ppm. The highest Au value of 4.89 ppm was recorded in sample no. MJSS/202 followed by 1.97 ppm in sample no. MJSS/071 and 0.61 ppm in sample MJSS/117. Overall analytical results indicate poor and non-promising gold mineralization within the area except for a few isolated anomalous samples.
- 10.2.12.2 Out of 213 samples, only a limited number of samples yielded anomalous gold values above background concentrations. Samples MJSS/202, MJSS/071, MJSS/117, MJSS/072, MJSS/204 and MJSS/208 recorded Au values of 4.89 ppm, 1.97 ppm, 0.61 ppm, 0.35 ppm, 0.31 ppm and 0.26 ppm respectively, while remaining samples yielded low values generally below 0.10 ppm. The anomalous gold values are spatially restricted and occur in isolated pocket. Such isolated enrichment suggests localized concentration of gold controlled by favourable structures and lithological variations rather than extensive mineralized zones.
- 10.2.12.3 Analytical results of silver show values ranging from below detection limit (<0.01 ppm) to 6.21 ppm. Sample no. MJSS/117 yielded the highest Ag value of 6.21 ppm followed by MJSS/071 (5.67 ppm), MJSS/072 (2.89 ppm), MJSS/079 (2.58 ppm), MJSS/075 (2.46 ppm) and several samples showing Ag values between 1–2 ppm. Elevated silver values are largely confined to samples associated with anomalous Au concentrations and are restricted to a limited zone. However, most of the analysed samples recorded Ag values close to or below the detection limit, indicating weak silver enrichment across the study area.
- 10.2.12.4 Surface bedrock sample analytical results from the study area do not indicate widespread gold or silver mineralization. Although a few isolated samples yielded

encouraging Au and Ag values, the anomalies are continuous and follow a trend in Khandapar area, and mostly confined to exposed sheared Quartz reef.

10.2.12.5 Proximate analysis of 19 surface graphite-bearing samples indicates variable graphite concentration within the study area. Moisture content ranges from 0.06% to 0.40%, suggesting generally low moisture retention in the graphite-bearing lithologies. Ash content varies from 92.15% to 99.10%, while volatile matter ranges from 0.54% to 5.05%. Fixed Carbon (F.C.) values range from 0.06% to 3.38%, with relatively higher values recorded in samples MJK/G/13 (3.38%), MJK/G/17 (3.24%), MJK/G/10 (3.20%), MJK/G/07 (3.27%), MJK/G/09 (2.78%) and MJK/G/01 (2.76%). The majority of samples exhibit low fixed carbon values (<2%), indicating poor to moderate graphite enrichment. The high fixed carbon values observed in a few samples suggest localized graphite concentration within the phyllites; however, the overall high ash content and low fixed carbon percentages indicate low-grade and discontinuous graphite mineralization in the area.

10.2.12.6 Considering the concealed nature of outcrops, ground geophysical surveys were conducted in two sub blocks Khandapar Sub Block (1.434 sq.km.) and Karwahi Sub Block (2.09 sq.km.) to delineate possible concealed mineralised extensions of Gold and Graphite respectively.

10.2.12.7 Ground geophysical survey indicated that, in Khandapar Sub Block based on the Magnetic IP cum resistivity data interpretation anomalous zones indicated by white dotted line have been marked on the reduced to pole (RTP) anomaly map.

Based on the integrated analysis of the Magnetic, IP-Resistivity, and SP data, several anomalous zones have been identified and clearly marked on the resistivity surface anomaly map. The zones exhibiting higher anomalous signatures are particularly noteworthy, as they are likely associated with gold mineralization.

All four proposed Borehole over line 6, 9, 11 and 13 are following the characteristics of low to moderate resistivity and high chargeability which is well collaborating with low magnetic zone as mineralization could be within the Quartzite.

A continuous trend is also observed which is marked as white dotted line for the continuous mineralization.

10.2.12.8 Boreholes were proposed in Karwahi sub block area along Line 24, Line 25, and Line 29, all of which fall within a low magnetic zone. These zones exhibit low to moderate resistivity and high chargeability, suggesting a potential association with graphite and quartzite mineralization. In contrast, the proposed boreholes along Line 29 and Line 32 are located within a high magnetic zone. These locations are characterized by moderate to high resistivity and high chargeability values in the IP sections, indicating a possible association between graphite and phyllite.

Whereas Proposed Boreholes over line 20 falling on transition zone of magnetic high to low with high resistivity and high chargeability may represent the alteration halo region in which metamorphism has taken place and could be the contact zone of quartz and phyllite.

Based on the Magnetic IP cum resistivity data interpretation the following anomalous zone with a higher anomalous signature, potentially corresponding to graphite mineralization, has been identified indicated by white dotted line has been marked on the reduced to pole (RTP) anomaly map.

Based on the integrated analysis of the Magnetic, IP-Resistivity, and SP data, several anomalous zones have been identified and clearly marked on the resistivity surface anomaly map. The zones exhibiting higher anomalous signatures are particularly noteworthy, as they are likely associated with graphite mineralization.

10.2.12.9 Based on the outcome of ground geophysical anomalies, total eight test boreholes were drilled in the Jamtola-Khandapar Block out of which four boreholes were drilled in Khandapar sub block area targeting Sulphide mineralisation and the remaining four boreholes were drilled in Karwahi Sub block area for targeting Graphite mineralisation. Four test boreholes intersected sulphide bearing zones (pyrite, pyrrhotite and chalcopyrite) in sheared quartz reefs but gold values were poor ranging from <10 ppb to 55.52 ppb Au. Graphite-bearing intervals encountered in boreholes MJGR-03 and MJGR-04 were sampled for graphite. The ash content varies widely from about 68.4% to 92.2%, while volatile matter ranges from approximately 5.3% to 31.2%. Fixed carbon (FC%) values remain generally low to moderate, ranging from 0.5% to 2.8%, indicating poor to low-grade graphite concentration within the analysed intervals.

10.2.12.10 ICP-MS analysis of 35 nos. of surface samples and 15 nos of borehole core samples for 34 elements indicated variable concentrations of major and trace elements with isolated

enrichment of elements such as Ti, Cu, Ba and La. Copper values range from below detection limit (BDL) to 547.43 ppm, while Ti values range from 0.17% to 5.23%; however, the majority of samples exhibit scattered and inconsistent elemental distribution without any significant enrichment of associated metallic elements.

10.3.0 DATA SPACING FOR REPORTING OF EXPLORATION RESULTS

10.3.1 During present G-4 stage exploration, total 8 nos. test boreholes were drilled at specified locations to test the geophysical anomalies at depth range between 44 m to 100 m vertical depth from surface. As this being G4 stage, the boreholes are of test boreholes category adhering to approved norms. Exploratory test drilling intersected two mineralised zones for Silver and other One mineralised zone for Graphite.

10.4.0 PETROGRAPHIC STUDY

Petrographic study was carried out on 10 Nos. (4 Nos. Bedrock + 6 nos of borehole core samples) collected from different litho units exposed in the area as well as intersected in the drilled boreholes. The petrographic study results have been discussed along with the description of rock types in **Chapter-VII** and petrographic study report has been attached as **Annexure No-X**.

10.5.0 MINERAGRAPHIC STUDY

Total 10 nos including bedrock and borehole core samples collected from mineralized zones intersected in the drilled boreholes and subjected to mineragraphic study by preparing polished section. Mineragraphic study results have been discussed in **Chapter-VII** and mineragraphic study report has been attached as **Annexure No-XI**.

10.6.0 PREPARATION OF GEOLOGICAL REPORT:

Geological Report has been prepared in Corporate Office, MECL, Nagpur by integration of geological, geochemical and sub-surface drilling data. AutoCAD, ArcGIS & GDM softwares have been used for preparation of various maps. The report has been written using Microsoft word and excel 2021 version.

CHAPTER-11

LOCATION OF DATA POINTS

11.1.0 ACCURACY AND QUALITY OF SURVEY TO LOACTE DRILL HOLES

During present investigation, boreholes locational coordinates fixed and RL determination carried out. The survey of boreholes has been carried out by the DGPS DA2 Catalyst Instrument.

The entire survey work has been carried out with the help of DGPS (Make-Trimble GNSS System, Model- Catalyst DA2). All survey work was done through Survey of India CORS System. Positional (horizontal) accuracy of the survey and while the elevation accuracy is as per the SOI. CORS System.

Total 8 boreholes were drilled out of which 4 boreholes (MJGL-01 to MJGL- 04) drilled in Khandapar sub block and 4 Boreholes (MJGR-01 to MJGR-04) were drilled in Karwahi Sub Block of Jamtola- block by MECL as part of present G4 stage exploration and have been fixed by DGPS survey instrument. Borehole locational co-ordinates & Reduced level (RL) of the borehole are given in Annexure-III-A and also shown in Plate-III A and Plate-III B.

Table 16 Co-ordinates of the base station for DGPS survey of Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh.

Sl. NO.	BASE NAME	WGS-84		RL(m)
		LATITUDE	LONGITUDE	
1	BASE-SOI(BAIIH)	N22°06'14.12421"	E80°32'59.69224"	500.715 m

Table 17 Technical Specification Of DGPS

TECHNICAL SPECIFICATION OF DGPS	
MAKE	TRIMBLE
DGPS MODEL	Catalyst DA2
YEAR	2025

11.2.0 ACCURACY AND QUALITY TO LOCATE BOREHOLES

11.2.1 DGPS survey was conducted using a Trimble GNSS DA-2 Catalyst system. Borehole locations and reduced levels were established using Survey of India CORS base station ‘SOI-BAIH’ through online GNSS post-processing. Survey work carried out by the experienced qualified surveyor as per the prevailing standard procedures.

CHAPTER-12

SAMPLING TECHNIQUES AND SAMPLE PREPARATION

12.1.0 SAMPLING

12.1.1 Sampling includes Surface sampling (Bedrock), and drill core sampling. Surface samples (213 nos.) subjected to analysis for Gold and Silver by fire assay method and Surface Samples (19 Nos.) subject to analysis for Graphite by Proximate analysis. Drill core samples (156 nos.) analysed for Gold and Silver by fire assay method, Drill core samples (40 nos.) analysed for Graphite by Proximate analysis and other associated 34 elements analysis by ICP-MS method.

12.2.0 NATURE, QUALITY AND APPROPRIATENESS OF SAMPLE PREPARATION TECHNIQUE

12.2.1 Sampling methodology adopted for bedrock, channel and borehole core sample is different from each other. The detailed description of sampling technique is discussed in subsequent paragraphs.

12.2.2 Sampling techniques:

A. Bedrock Samples: A total of 213 nos. of bed rock samples (BRS) were collected systematically from varied litho units (mostly Sheared Quartz reef, Migmatites, Phyllites, Amphibolites, Dolerite dykes and Quartz veins) exposed in the study area. The Bedrock chip samples were collected by chipping exposed rock units in 1 m radius by sledge hammer (5kg) and chisel. During the sampling, surface was properly cleaned and each sample was collected in separate plastic bags. After collecting each sample, all the instruments were properly cleaned before proceeding for next sample collection to maintain quality and to avoid contamination. The sample locations are plotted on geological map (**Plate No-III A and Plate No-III B**). All samples collected from field sent to MECL Sampling unit & MECL Chemical Laboratory, Nagpur for sample preparation and analysis. First, each Bedrock sample of around 2 kgs collected from the field was crushed. After crushing, the crushed samples were mixed thoroughly and reduced the sample size to 500 gm by coning and quartering. These representative samples were powdered and completely passed through (-) 120 mesh size for gold analysis and (-) 200 mesh size sieves for Graphite, from which 100 gm sample was packed in polythene sample pouch and sent to MECL Chemical Laboratory, Nagpur for chemical analysis for Au, Graphite and other associated minerals.

B. Drill Core Samples: The sampling and analysis have been carried out for entire mineralized zones/length intersected in the boreholes drilled on visual basis. The primary samples have been marked in the suspected mineralized zones (sulphide bearing zone) intersected in the borehole based on type and concentration of mineralization /lithology. In general, the sample length has been kept as 0.50 m which varied in some instances because of variation in lithology and type and concentration of mineralisation. Mineralised core has been split longitudinally into two equal halves in such a way that the concentrations of ore minerals are uniform in both the equal halves. One half of the core sample has been crushed to (-) 200 mesh size and another half kept in the core box for future reference. By progressive coning and quartering and repeatedly mixing the sample has been reduced to 600 grams. The representative sample completely passed through (-) 120 mesh size for gold analysis and (-) 200 mesh size sieves for Graphite and other elements from which 100 gm sample was packed in polythene sample pouch. All samples prepared at MECL Sampling unit facility at Nagpur and sent to MECL Chemical Laboratory, Nagpur for chemical analysis for Gold by fire assay method and for other associated minerals by ICP-MS method.

12.3.0 QUALITY CONTROL PROCEDURES ADOPTED DURING SAMPLING

12.3.1 The samples have been prepared under the supervision of geologist and qualified sampling technician. During the sampling, surface was properly cleaned and each sample was collected in separate plastic bags. After collecting each sample, all the instruments were properly cleaned before proceeding for next sample collection to maintain quality and to avoid contamination. After collecting the chip samples all samples were properly packed in polythene samples bags with proper labelling.

12.3.2 Further measures have been taken during sieving and pounding/grinding of samples. The sieve and containers have been cleaned after processing of each sample to avoid contamination and measures have also been taken to avoid loss of powder in air. The prepared/processed samples sent to MECL chemical laboratory, Nagpur. All measures taken for packing and transportation of samples. It has been thoroughly checked that none of the sample bags were damaged during transportation.

12.4.0 MEASURES TAKEN TO ENSURE THAT THE SAMPLING IS REPRESENTATIVE OF THE IN-SITU MATERIAL COLLECTED.

12.4.1 It is very important to submit the representative sample of collected material for

geochemical analysis. Bed rock and drill core samples quantity has been reduced by coning and quartering method after thoroughly mixing to maintain the homogeneity of the samples. All measures taken that samples remain representative in nature of in situ material collected.

12.5.0 APPROPRIATENESS OF GRAIN SIZE

12.5.1 Samples were pulverized to an appropriate grain size to ensure representative and accurate analytical results. For gold, the samples were ground to –120 mesh size, which is suitable for achieving uniform particle distribution while minimizing loss of coarse free gold present if any during pulverization. For multi-elemental analysis, the samples were further pulverized to –200 mesh size, ensuring sufficient fineness for complete digestion and homogenous mixing during instrumental analysis. Thus, the adopted grain sizes are considered appropriate and conform to standard analytical protocols for reliable geochemical results.

CHAPTER-13

DRILLING TECHNIQUE AND DRILL SAMPLING EMPLOYED

13.1.0 DRILLING TYPES AND DETAILS

13.1.1 During the present investigation, MECL drilled total two test boreholes involving total 610 m diamond core drilling along with associated borehole deviation survey and borehole core logging, sampling and laboratory studies in the block area. The details of boreholes drilled in Khandapar sub block and Karwahi sub block of Jamtola-Khandapar Block by MECL are given in **Annexure-III-A** and summary of borehole is given in **Table-15 of Chapter-X**.

13.1.2 Drilling operation was carried out by deploying one conventional drill rigs RD-60 (MEC-347). Rotary wash type of wireline drilling method was undertaken. Diamond impregnated NQ bit (outer diameter 75.7 mm and inner diameter 47.6 mm) has been used during drilling operation. At the starting few meters, all the boreholes have been used with HX and NX casing to cover soil cover and loose friable weathered formation. All the precautions had been taken to maintain quality of drilling and achieve maximum core recovery. The core recovery varies from minimum 87.12% (MJGL-01) and maximum 98.35 % (MJGR-04) with an average core recovery is about 94.80 %. The average core recovery in the suspected mineralised zones is more than 95 % which is satisfactory.

13.1.3 All the inclined exploratory boreholes drilled by MECL in the block area have been surveyed to ascertain deviation in azimuth and in the borehole path, if any, with the help of multi shot deviation camera. The specifications of the deviation survey instrument are given in **Table-18**

Table 18 The specifications of the Deviation Survey Instrument

1	Name of instrument	Is Gyro
2	Name of manufacturer (model and make)	Inertial Sensing (Sweden)
3	Parameters	Inclination and azimuth angle
4	Inclination range	0 to 90 degrees
5	Azimuth range	0 to 360 degrees from north
6	Inclination resolution	NA
7	Azimuth resolution	NA

13.1.4 The boreholes have been washed properly after closing and before pull down the deviation camera and after that drill strings have been pulled out from the borehole.

13.1.5 Deviation survey instrument is based on the concept of continuous recording of azimuth and inclination when it is lowered into the borehole. After assembling the deviation survey instrument, it is lowered into the borehole so that its top coincides with the ground level. The instrument is lowered to desired depth i.e., 6.00m interval and keep it stationary for half a minute in order to record stabilized readings required. Several readings have been obtained in this way at regular depth interval i.e., 6.00m till the closure depth of the borehole. Once the survey instrument reaches the closure depth, it is pulled out of borehole and transfer the recording in a system.

13.1.6 Borehole deviation Survey Procedure (Surveyor Software):

13.1.6.1 Input data parameters:

Connect the Instrument sensor part with the battery.

Confirm whether proper connection established between sensor & battery.

Switch on the Tab.

To start double clicks on surveyor icon.

Click on survey icon.

Scanning for device will be in progress.

Click on select button to select IsGyro-331.

Tool will be selected and Bluetooth connection will be established between Tab & Instrument.

Add group name (group name is the folder name) for the survey which will be saved in Local disk C → Is-DATA.

After creating the group name click on next button to continue.

Add survey name (Survey name is in name of the particular survey file).

Hole ID can be optional.

Reference easting, northing and elevation, under direction should be zero.

Reference type should be HRS.

Start depth & start interval should be chosen as per requirement.

For downward survey (down the borehole survey) select in option and for upward survey (up the borehole survey) select out option.

Click on next button to proceed.

Start mode normal & base hours minutes should be zero.

13.6.1.2 Horizontal North Marking:

Click on the start survey button to start the survey.

A window with “mark horizontal direction” appears on the screen.

Mark the horizontal north direction 0 or 360 degree on plane surface with compass. Ensure there is no magnetic materials or interference in the surroundings while marking.

Place the instrument in the marked position facing towards north direction (sensor portion should be first while pointing towards north).

Now click on “mark horizontal direction” button.

Confirm the marking by selecting Yes/No.

After clicking Yes horizontal marking is successful.

13.6.1.3 Deviation Survey/Data Recording:

Actual survey can be started by clicking “mark station” from zero depth.

Instrument should be stand still position for 10 sec. without any physical movement while taking reading/marking.

By default, the next depth interval marking window will appear as per initially selected depth interval.

Repeat the steps to continue the survey.

Click on “end survey” button to end/complete the survey. And confirm the same by clicking the Yes/No.

A window with “start a new survey in this group” will appear on the screen. If you want to end the survey completely, click on “No”. If you want to continue with the upward borehole survey, completely click on “Yes”.

After completing the survey, a window with survey name file appears on the screen.

13.6.1.4 Data Process & Downloading:

Click on download button from the screen.

Survey recording will be stopped.

Two tick mark should be appeared below downloaded and verified columns.

Now click on the done button.

Click on process button from next window and done button from the same window.

The recorded is successfully downloaded and processed.

The downloaded data appears in a new window, click on export button from the same window so that an “XLS” file is created in the folder.

Close the surveyor software window.

All the four boreholes of the MJGL series drilled in the Khandapar area exhibit only minor deviations, ranging from 1.08° to 2.16° between the collar and the end of the hole (EOH). Among them, MJGL-03 is the only borehole that shows a downward deviation of 1.08°, where the inclination at the EOH is steeper than at the collar. The remaining three boreholes exhibit upward deviation, with the inclination at the EOH being less steep than the collar inclination. The borehole wise deviation data of the boreholes is presented as **Annexure-III- C**.

13.2.0 WHETHER CORE AND CHIP SAMPLE RECOVERIES HAVE BEEN PROPERLY RECORDED AND RESULTS ASSAYED

13.2.1 The core samples have been recorded properly and the run wise litholog and summarized lithologs for boreholes drilled by MECL are given in **Annexure- IV- A** and **Annexure- IV- B** respectively. The logging of run wise core as well as the cuttings from boreholes have helped in discerning the physical characters like colour, shape, size and nature of mineralisation as well as texture, structural features such as joints, fractures, foliations etc. and their attitude with respect to core axis and identification of different litho units.

13.2.2 The mineralised zones/length recorded during the geological core logging has been subjected for sampling and analyses for gold and associated elements. The primary sample had been marked in the mineralized zones intersected in the borehole based on ore type and concentration of mineralisation/lithology. In general, the sample length has been kept at 0.50 m interval which varied in some instances because of variation in lithology and type and concentration of mineralisation. The details of analysis of primary borehole core samples for Gold (Au) by fire assay method and Silver by AAS, Proximate analysis of primary borehole core sample for Graphite is given in **Annexure-V-A and Annexure V-B** and for other associated 34 elements analysis by ICPMS method are given in **Annexure-VIII**.

13.3.0 MEASURES TAKEN TO MAXIMIZE SAMPLE RECOVERY AND ENSURE REPRESENTATIVE NATURE OF THE SAMPLES.

13.3.1 The short runs were drilled as per necessity so that optimum core recovery is maintained. The core recovery in the suspected mineralized zones is about more than 95 % which is satisfactory. Whenever core recovery is less, the grade of the recovered portion has been extrapolated over the non-recovered section. The quality of drilling was ensured during the operation.

13.4.0 WHETHER THE RELATIONSHIP EXISTS BETWEEN SAMPLE RECOVERY AND GRADE

13.4.1 The core recovery in the mineralized zones is about more than 95% approximately which is satisfactory. The entire mineralized zones / length recorded during the geological logging on visual basis have been analysed for Gold (Au) and associated elements. As the recovery in mineralized zones is consistently high, it is unlikely to have any significant impact on the grade estimation.

13.5.0 CORE LOGGING

13.5.1 The drilled core recovered from the boreholes has been logged systematically to demarcate various litho-units. The core recovery varies from minimum 87.12% (MJGL-01) and maximum 98.35 % (MJGR-04) with an average core recovery is about 94.80 %. The logging of run wise core as well as the cuttings from boreholes have helped in discerning the physical characters like colour, shape, size and nature of copper mineralisation as well as texture, structural features such as joints, fractures,

foliations etc. and their attitude with respect to core axis and identification of different litho units. Besides, the qualitative analytical data have helped in delineating the ore and non-ore litho units.

13.5.2 The borehole logging was carried out run-wise for boreholes drilled by MECL. As the lithological units within the schistose sequence exhibit frequent variations along the down-hole direction and individual run lengths are relatively short, a consolidated litholog was prepared for all boreholes. The litholog graphically represents the lithological succession along with all relevant geological details for easy interpretation and comparison. The grouping of litho units intersected in the boreholes was done as Top Soil, Sheared Quartz reef, Quartz vein, Phyllite, Amphibolite, Chlorite-Biotite-Quartz Schist, carbonaceous phyllites. Detailed borehole core logging is given as **Annexure-IV-A** and summarised borehole logs given as **Annexure-IV-B** respectively.

13.5.3 Borehole core samples are preserved in GI sheet core boxes with proper labelling. Total 250 m borehole core has been preserved for future reference.

13.6.0 ROCK QUALITY DESIGNATION (RQD %)

13.6.1 During the detailed geological logging of the core samples, RQD have been measured over entire column of the overburden/core, mineralized zone and footwall. RQD data is incorporated in the run-wise lithology, given as Annexure-IVA. Rock Quality Designation (RQD) is a modified measure of the degree of jointing and the fracture in a rock mass, measured as a percentage of drill core in lengths of 10cm or more. High quality rock has RQD more than 75%, Low quality rock has RQD of less than 50%. D.U. Deere (1963) defines the RQD as the ratio of the sum of the total length of the cores of the length 10cm and longer recovered from drilling of one run (3.0 m) drilling.
$$RQD (\%) = (\text{Total length of the core in pieces of 10cm or more}) / \text{Length of the run} \times 100.$$

13.6.2 RQD with reference to the lithologies are given in borehole log in the enclosed **Annexure IV A**. The average RQD of Feldspathic Chlorite-Biotite Quartz schist is 56 %, Chlorite-Quartz-Schist is 65%, Amphibolite is 42 %, Phyllite is above 75% and may be classified as good as per the RQD rock mass classification.

13.7.0 BOREHOLE GEOPHYSICAL LOGGING

13.7.1 Borehole Geophysical Logging have not been carried out during present exploration as it was not the scope of present work.

CHAPTER-14

SUB-SAMPLING TECHNIQUES AND SAMPLE PREPARATION

14.1.0 WHETHER CUT OR DRAWN AND WHETHER QUARTER, HALF OR ALL CORE TAKEN

14.1.1 The details of sampling procedure described in previous Chapters No. **X & XII**. During the sample preparation the borehole core sample has been split longitudinally into two equal halves with the help of hydraulic core splitter. One half has been preserved and the other has been crushed for the preparation of primary samples at - 120 mesh for gold analysis by fire assay method and 200 mesh size for other elements by ICP-MS method. Sample has been homogenized by proper mixing and coning quartering as per the standard sampling procedure.

14.2.0 NATURE, QUALITY AND APPROPRIATENESS OF THE SAMPLE PREPARATION TECHNIQUE

14.2.1 The details of sampling procedure and techniques for bedrock, channel and borehole core primary samples described in previous chapters No. **X & XII**.

14.3.0 QUALITY CONTROL PROCEDURES ADOPTED

14.3.1 Samples have been prepared under the supervision of geologist and qualified and experienced sampling technician. Samples were collected in separate plastic bags for bedrock/channel samples and borehole core samples. After collecting each sample, all the instruments were properly cleaned before proceeding for next sample collection to maintain quality and to avoid contamination. All samples packed in the polythene sample bag with proper tag. Then the entire samples were transported to central sample processing unit located in Nagpur. It has been thoroughly checked that none of the sample bags were damaged during transportation. Standard sampling procedure under the supervision of qualified sampling technician. All samples processed at MECL Sampling Unit, Nagpur. Further measures have been taken during sieving and pounding/grinding of samples. The sieve and containers have been cleaned after processing of each sample to avoid contamination and measures have also been taken to avoid loss of powder in air. Prepared powdered samples packed in sample polythene bags and sent to MECL Chemical Laboratory, Nagpur for analysis. All primary bedrock/channel and borehole core samples analysed at MECL Chemical laboratory, Nagpur. Surface bedrock samples (213 nos.) analysed for Au by fire assay method, and

Silver by AAS method and 19 nos. samples for Proximate analysis for graphite. Total 156 nos. of borehole core samples analysed for Au by fire assay method and Silver by AAS and 21 nos. samples for Proximate analysis for graphite. Similarly 35 Nos. of bedrock samples and 15 nos. of borehole samples were analysed with 34 elements ICP-MS for **Cu, Pb, Zn, Cd, As, Sb, Bi, Co, Ni, Mo, U, Fe, Mn, Si, Al, Ca, Mg, S, Nb, Ta, B, Ba, Be, Cr, K, La, Li, Na, P, Sn, Sr, Ti, V, and W**. All quality control procedures adopted while sample preparation and analysis as per the standard operating procedures. To check the sampling and analytical bias if any, a total of 45 Nos. of bedrock/ Borehole samples analysed as external check samples (10% of primary samples) for analysis of Gold and Silver in External Laboratory, Nagpur and 8 Nos. of bedrock/ Borehole samples were analysed as external check samples (10% of primary samples) for proximate analysis of Graphite at External Laboratory, Nagpur. The analysis of primary and external laboratory are yet to be compared and outcome/comparison of primary and external check will be discussed after receiving of external check samples analysis.

14.4.0 MEASURES TAKEN TO ENSURE THAT THE SAMPLES COLLECTED ARE REPRESENTATIVE OF THE IN-SITU MATERIAL COLLECTED

14.4.1 It is very important to submit the representative sample of collected material for geochemical analyses. Sampling is done of the in-situ exposures representing the mineralised rock/zones. Bed rock/channel samples and drill core samples quantity has been reduced by coning and quartering method after thoroughly mixing to maintain the homogeneity of the samples. All measures taken that samples remain representative in nature of in situ material collected.

14.5.0 WHETHER SAMPLE SIZES ARE APPROPRIATE TO THE GRAIN

14.5.1 The primary samples have been prepared (–) 120 mesh size for analysis of Gold by fire assay method and -200 mesh for analysis of other elements by AAS method and ICP-MS method. As per the previous studies in and surrounding the area, the (–) 120 mesh size is appropriate for the liberation of mineral grains and analysis for Gold (Cu) while -200 mesh is appropriate for other associated elements.

CHAPTER-15

QUALITY OF ASSAY DATA AND LABORATORY TESTS

15.1.0 THE NATURE, QUALITY AND APPROPRIATENESS OF THE ASSAYING AND LABORATORY PROCEDURES

The chemical analysis of primary samples for gold (Au) and associated elements has been carried out in MECL Chemical Laboratory, Nagpur. The analysis for Gold has been carried out by fire assay method and for analysis of Ti, V, Cr, Ni, Co, Cu, Zn, Ag and Pb by Atomic Absorption Spectroscopy (AAS) method by Analytical Jena ZEEnit model instrument. Analysis of other associated elements (34 elements) carried out by ICP-MS method. The Standard Operating Procedure (SOP) for analysis of Gold, and other associated elements using AAS and ICPMS method is given below.

15.1.1 Analysis of Gold (Au) by fire assay method.

Samples are prepared as weighted 50 fusion pots in a batch. Prior to using fusion pots for weighing a visual inspection inside the fusion pot is performed. The sample is weighed 50g in a fusion crucible containing flux of Lead monoxide, sodium carbonate, borax, silica, silver nitrate fused in a preheated fusion furnace 1050°C for 45 minutes and the molten melt is poured into a cast iron mold. The lead button is separated from the slag and oxidized in a cupellation furnace keeping in a cupel for one hour. The obtained Prill is cooled and digested in aqua regia and aspirated in Atomic Absorption Spectrometer for ppm levels.

15.1.2 Analysis of Silver (Ag) by AAS method.

This procedure describes the determination of Silver (Ag) in geological and ore samples using Graphite Furnace Atomic Absorption Spectroscopy (GF-AAS) following nitric acid and hydrofluoric acid digestion.

Principle: A finely powdered sample is digested using Nitric acid and Hydrofluoric acid to decompose silicate matrices and release silver into solution. The digested solution is introduced into a graphite furnace where controlled drying, pyrolysis, and atomization stages produce free atoms that absorb monochromatic radiation emitted from a silver hollow cathode lamp. The absorbance measured during atomization is proportional to silver concentration and is quantified using external calibration.

Sample Digestion: A 0.50 g of finely pulverized sample (–200 mesh) is accurately weighed into a Teflon digestion vessel. Concentrated nitric acid followed by hydrofluoric acid is added and the mixture is heated gently on a hot plate until complete decomposition of the sample matrix occurs. The solution is evaporated carefully to near dryness to remove excess HF. Nitric acid is added again to convert fluorides and dissolve remaining salts. After cooling, the solution is filtered and extracted into a 100 mL volumetric flask, diluted to volume with 2% Nitric acid in Milli-Q water, and mixed thoroughly.

Calibration Standard: A Silver calibration Master standard (in ppb) is prepared from the certified 1000 mg/L (ppm) Ag stock solution by serial dilution in dilute nitric acid matching the sample matrix. A reagent blank is prepared using identical reagents and digestion conditions.

Instrumental Conditions (GF-AAS): Analysis is performed using a graphite furnace equipped with an autosampler after lamp stabilization and wavelength optimization. Silver is measured at **328.1 nm** using background correction. Typical furnace conditions include sequential drying, pyrolysis, atomization, and tube cleaning steps optimized for maximum sensitivity and minimum background interference according to manufacturer recommendations.

Typical temperature program (instrument optimization required):

Stage	Temperature (°C)	Purpose
Drying	100–120	Solvent removal
Pyrolysis	400–600	Matrix removal
Atomization	1000–1600	Ag atom formation
Cleaning	2300–2500	Tube cleaning

Analysis: Firstly, the calibration is established by analysing the blank and calibration standards prepared from the master standard through automatic dilution by the autosampler. Aliquots of sample solution are injected into the graphite tube and

absorbance is recorded during atomization. Samples exceeding calibration limits are diluted using nitric acid matrix and reanalysed.

Quality Control: Each analytical batch of 25 samples includes a reagent blank, one Certified Reference Material (CRM) viz., **CZN-4, GBM 315-15** and one repeat sample to monitor accuracy and precision. CRM results must fall within certified limits and repeat sample agreement must meet laboratory precision criteria. Calibration verification standards are analysed periodically to ensure instrument stability.

Calculation: Silver concentration is calculated using:

$$\text{Ag (ppb)} = (C \times V) / W$$

where C is concentration obtained from calibration (ppb),

V is final volume (100 mL), and

W is sample weight (g).

For a 0.5 g sample diluted to 100 mL, $\text{ppb} = C \times 200$.

Safety and Precaution: HF handling requires extreme caution and must be performed inside a fume hood using HF-resistant gloves, face protection, and appropriate PPE. Calcium gluconate gel must be readily available during HF handling. All digestion vessels must be compatible with HF.

15.1.3 Methodology of Chemical Analyses by ICP-MS

Chemical Laboratory, MECL, Nagpur is having Agilent make ICPMS 7800 model for elemental analyses. ICP-MS (inductively coupled plasma-mass-spectrometry) is a technique to determine low-concentrations (ppb = parts per billion = $\mu\text{g/l}$) and ultra-low-concentrations of elements (ppt = parts per trillion = ng/l). ICP-MS can also measure elements at concentrations up to 100s or even 1000s of parts per million (ppm). Accuracy and precision (standard deviation) for 34 of these elements is either excellent (<5%) or good (5–10%).

15.1.4 SOP for 34 Element Analysis by ICP-MS Procedure:

1. Acid Digestion Method

a) **Weigh and Add Acids:** Place ~0.1–0.5 g of powdered sample in a PTFE vessel. Add ~3 mL concentrated HF + 1-2 mL concentrated HClO₄. Cover loosely with a PTFE lid or watch glass.

b) **Heat to Dryness:** Gently heat at 150–200 °C under the hood. The acid will react, dissolving most matrix; white fumes indicate silica removal. Continue heating until nearly dry (residual melt).

c) **Evaporate to Near Dryness:** Carefully evaporate to a small volume, then add ~1–2 mL concentrated HNO₃ and heat again to remove HF residues. If fuming ceases, add fresh HClO₄ (0.5–1 mL) and repeat to ensure all organics are oxidized.

d) **Re-dissolve:** Cool the vessel and add ~2 mL concentrated HCl or aqua regia (HCl:HNO₃ 3:1) to re-dissolve any residue. Then dilute with 5–10 mL 2% HNO₃, transfer to a 50–100 mL volumetric flask, and dilute to volume with ultrapure/Millipore water.

2. ICP-MS Calibration and Tuning

Inductively Coupled Plasma Mass Spectrometer (ICP-MS) instruments must be warmed up and tuned before each run. Start the plasma and allow ~30 min stabilization. Use a commercial tune solution to adjust torch position, nebulizer gas flow, sample depth, lens voltages, and RF power. Optimize for high count rates and low oxide formation.

a. **Calibration:** Prepare multi-element calibration standards covering the expected concentration range (e.g. 0.1–100 µg/L). Include a calibration blank and at least 4 non-zero. It is common to match the acid matrix of standards to samples (e.g. 2% HNO₃ + a few % HCL).

b. Sample Introduction and Data Acquisition

Introduce samples via an auto sampler and nebulizer (typically concentric or cyclonic) into the plasma.

c. Target Elements (34-Element Suite)

The 34-element geochemical ICP-MS suite typically includes major, minor and trace metals plus all rare earths. Report elemental concentrations in appropriate units (e.g. ppm or mg/kg) on a dried sample basis.

3. Quality Control (CRMs, Blanks, Duplicates)

a) CRM: Digest and analyse at least one certified reference material (geochemical standard of similar matrix) as an unknown. Recoveries should be within ~10% of certified values.

b) Blanks: Process method blanks (all reagents, no sample) through digestion and analysis to detect contamination. Instrument blanks (2% HNO₃) should also be run.

c) Duplicates/Replicates: Include sample duplicates or matrix spike duplicates to assess precision. Relative percent difference (RPD) between duplicates should typically be <10–20%.

d) Calibration Checks: Run a second source standard or CCV to check calibration drift. Internal standard signals should remain within ~80–120% of initial intensities.

15.2.0 NATURE OF QUALITY CONTROL PROCEDURES ADOPTED

15.2.1 The standard procedure of quality control has been adopted during the chemical analysis in Chemical laboratory, MECL, Nagpur which includes

- (i) Analysis of Certified reference materials/measurement standards
- (ii) Analysis of blind samples
- (iii) Use of QC samples and control charts
- (iv) Analysis of blank samples
- (v) Analysis of spiked samples
- (vi) Analysis in duplicate samples

15.2.2 For Gold analysis, NIST traceable liquid CRMs were used for instrument calibration to ensure accurate response across the full analytical range. Additionally, a solid geological CRM (BND 3401.01) was inserted after every five routine samples to verify digestion efficiency, matrix effects, and overall analytical accuracy. Method blanks (acid/matrix blanks) were also included at a frequency of one per five samples to monitor any contamination or carry-over. All CRM and blank results were within acceptable limits, confirming the reliability and validity of the reported data.

15.3.0 CHECK ANALYSIS FROM THIRD PARTY NABL ACCREDITED LABORATORY

15.3.1 In accordance to the standard practice of quality assurance and quality control, total 20 nos. of bedrock/channel primary samples (10% of primary), have been analysed as external check samples for Au in external laboratory. Moreover, 45 nos. of primary samples have been analysed as external check sample for gold and silver by Fire Assay and AAS respectively, whereas 8 samples have been analysed as external check samples for graphite by proximate analysis. In order to assess the reliability of homogeneity of primary samples and repeatability of their chemical analysis with primary samples results of MECL laboratory. 25 borehole core samples that were first analysed in the primary laboratory (MECL) for gold (Au) and silver (Ag) were re-analysed as external check samples in a second laboratory (Shiva Analyticals (India) Private Limited), (Lab Nos. JIC-488 to JIC-512, sender nos. MJEC/021 to MJEC/045). The aim of this exercise is to test how well the primary results can be repeated by an independent external laboratory, so that the assay data can be relied upon for resource estimation. Comparison of Primary Vs Check samples is done in Annexure No- VII-A. The samples come from boreholes of the MJGL/02 (8 samples), MJGL/03 (3 samples), MJGL/04 (12 samples) and MJGR/04 (2 samples) series. Sample lengths are 0.5 m to 1.0 m (core recovery 0.48–0.97 m) at depths of 16 m to 90 m. Results are in ppm (g/t). The detection limit (DL) of the primary lab is 0.01 ppm for both Au and Ag, while the check lab has a DL of 0.01 ppm for Au and 1 ppm for Ag.

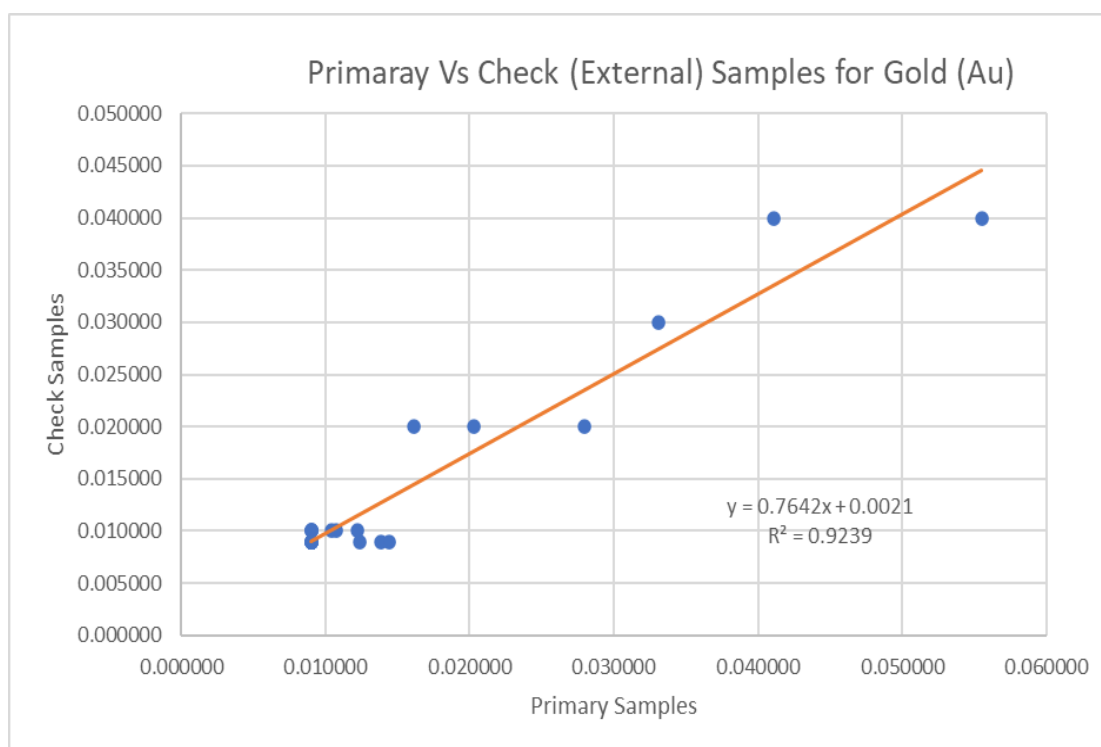
Table 19 Summary of primary and external check assay data for Gold and Silver in Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh.

Parameter	Au Primary	Au Check	Ag Primary	Ag Check
No. of pairs	25	25	25	25
Range (ppm)	0.009–0.056	0.009–0.04	0.009–6.26	0.9–14
Mean (ppm)	0.0154	0.0139	1.00	1.77
Detection limit (ppm)	0.01	0.01	0.01	1
Samples above DL	12	6	8	5

Values reported below DL are entered in the sheet as 0.009 ppm (primary) and 0.9 ppm (Ag, check lab); these are treated as “below detection limit (BDL)”.

Table 20 Comparison of Primary v/s Check sample analysis for Gold (Au) in PPM of primary and external check assay data of Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh.

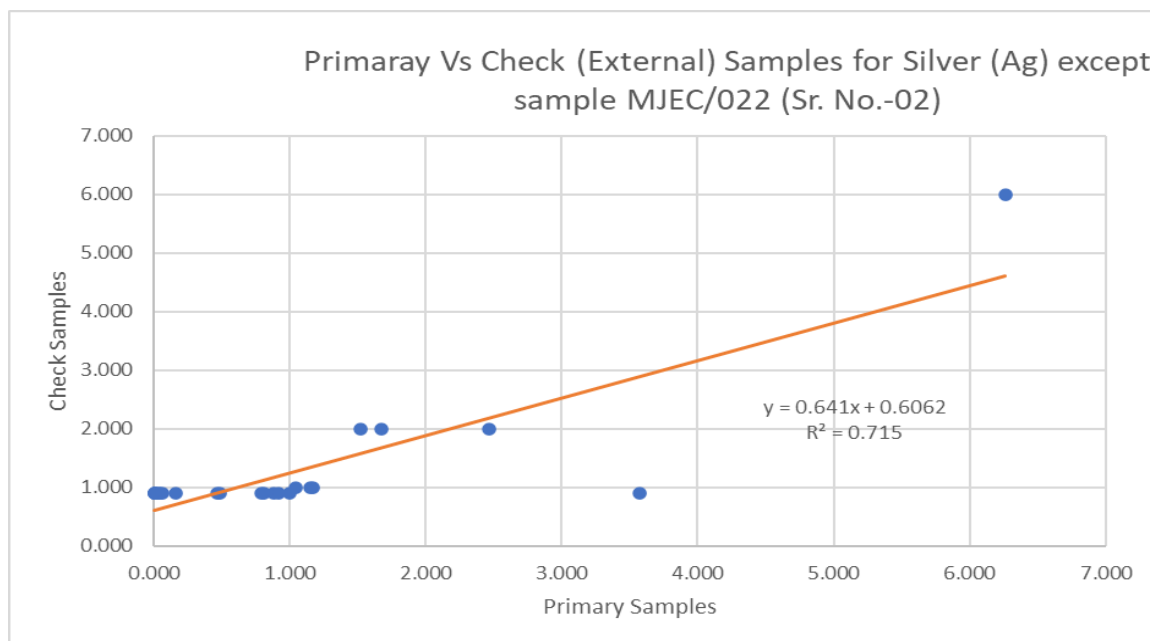
Comparison of Primary v/s Check sample analysis for Gold (Au) in PPM		
Comparison Index	Primary	Check
No. of sample pairs	25	
Arithmetic mean	0.015409	0.013920
Standard Deviation	0.011843	0.009416
Standard error of mean	0.002369	0.001883
Variance	0.000140	0.000089
Mean of deviation	0.00	
Standard Deviation (Error)	0.004	
Correlation Co-efficient	0.961	
Mean absolute error	0.002117215	
Mean relative random error	10.70596546	
Paired T-value	1.952	
F- test	1.582	



Text Figure 8 Scatter Plot of Primary Vs External Check Samples of Gold (Au)

Table 21 Comparison of Primary v/s Check sample analysis for Silver (Ag) in PPM of primary and external check assay data of Jamtola Khandapar Block (G4), District- Balaghat, Madhya Pradesh.

Comparison of Primary v/s Check sample analysis for Silver (Ag) in PPM		
Comparison Index	Primary	Check
No. of sample pairs	24	
Arithmetic mean	1.023936	1.262500
Standard Deviation	1.416498	1.073723
Standard error of mean	0.289141	0.219173
Variance	2.006465	1.152880
Mean of deviation	-0.24	
Standard Deviation (Error)	0.766	
Correlation Co-efficient	0.846	
Mean absolute error	0.561857586	
Mean relative random error	2335.075011	
Paired T-value	-1.525	
F- test	1.740	



Text Figure 9 Scatter Plot of Primary Vs External Check Samples of Silver (Ag)

The Au data show good repeatability: the primary and check results fall close to the 1:1 line and the small differences are of the order of the DL itself. This indicates that the primary Au assays are reliable, although the very low grades limit how strongly the precision can be judged. The slight positive bias of the primary lab (about 0.0015 ppm on average) is of no practical consequence.

Silver (Ag) results are acceptable for the bulk of the samples. Out of 25 sample pairs, 24 pairs agree well, and the scatter plot is within acceptable limits. The exception is Sample No. MJEC/022, which shows an erratic value.

Au: primary and external check results agree well ($r = 0.96$); the primary Au data may be accepted for use in this report.

Ag: results agree for 24 of 25 pairs within ± 1 ppm ($r = 0.85$ excluding Sr. No. 2).

15.4.0 SECURITY AND CHAIN OF CONTROL OF SAMPLES SHOULD BE CLEARLY MENTIONED

15.4.1 The samples have been processed at centralised MECL Sampling unit, Nagpur with proper labelling and tag and samples sent to chemical laboratory, Nagpur. At the sampling unit, standard procedures have been followed and all the precautionary measures have been taken to avoid the contamination. All samples prepared under the supervision of qualified sampling technician and geologist. The samples have been transported from project site to Chemical laboratory, Nagpur with proper sealing of sampling bags and the same has been verified in Sampling unit and Chemical laboratory. Further the remaining half spilt core samples preserved with sample tags for any future reference under the custody of the company.

CHAPTER-16

MOISTURE

16.1.0 METHOD OF DETERMINATION OF MOISTURE CONTENT

16.1.1 Moisture content has been determined exclusively for samples analysed for Graphite by proximate analysis, surface samples- bedrock (19 nos,) and borehole samples (21 nos.)

CHAPTER-17

BULK DENSITY

17.1.0 METHOD OF DETERMINATION AND RESULT

17.1.1 During present exploration, total 5 nos. samples collected from sulphides and graphite bearing suspected mineralised portions intersected in the boreholes subjected to specific gravity determination. Specific gravity determinations have done by Walker's Steel Yard Balance method. The average specific gravity of suspected sulphide mineralised zone determined as 2.75 and suspected graphite mineralised zone as 2.72 details are given in **Annexure-XII**.

CHAPTER-18

BENEFICIATION STUDIES AS MAY BE REQUIRED

18.1.0 DETAILS OF BENEFICIATION STUDIES

18.1.1 Beneficiation studies have not been carried out during present exploration as it was not the scope of present work.

CHAPTER-19

RESOURCE ESTIMATION TECHNIQUES

19.1.0 DISCUSSION ON DATA DENSITY TO ASSURE CONTINUITY OF MINERALISATION

19.1.1 The present G-4 stage exploration programme for Gold, Silver and Graphite mineralisation, includes geological mapping, geochemical sampling, scout drilling, core logging, core sampling and allied laboratory studies. The geological mapping in the block has been carried out at 1:12,500 scale and geochemical bed rock samples have been collected on the basis of presence of favorable outcrop in the area. There are 8 scout boreholes drilled in the block, on the basis of geological mapping and geochemical sampling. The block was explored for Gold, Silver and Graphite; however, the potential gold mineralisation has not been identified during the present exploration. The Silver mineralisation was intersected in only one borehole i.e., MJGL-02, Graphite mineralization was discontinuous, lean i.e. below 2 meters and low grade i.e. just at the threshold value of 2% F.C; therefore resource for graphite is not estimated,

19.2.0 WHETHER PREVIOUS EXPLORATION DATA HAS BEEN USED

19.2.1 Yes, some of the bed rock samples, collected by Khan et.al., (1995) from the Khandapar quartz vein, described earlier have analysed very interesting values of gold. Out of the 14 bedrock samples analysed for gold (by AAS), four samples have given very encouraging values (0.2 gm/t, 0.4gm/t, 0.7gm/t, and 2.2gm/t). On the basis of previous data available and considering the potentiality of the area, the present exploration programme of G-4 has been formulated. Also, the NGPM data of GSI was utilized during preparation of proposal of the Jamtola Khandapar Block, according to the Bouguer gravity anomaly, there is a basic discontinuity at the center portion of the proposed block. The lowest magnetization is a sign of alteration in the same portion. This discontinuity is the alteration zone dividing the block into three parts. The western side & Northeastern portion has a higher density base rock than the central portion. Considering these mineralized zones are characterized with low magnetization and high-density contrast; one should select such zones for further investigation.

19.3.0 THE NATURE AND APPROPRIATENESS OF THE ESTIMATION TECHNIQUE(S) APPLIED AND KEY ASSUMPTIONS

19.3.1 The Silver ore resource of the block has been estimated by “**Geological cross-section Method**” Certain axiomatic assumptions are inherently involved in estimation of overall grade and resource of the deposit, which are given below:

The rule of gradual change or law of linear function has been applied (Constantine C. Popoff, 1966) along with the rule of nearest points for application of influence of half way between successive boreholes.

19.3.2 The boreholes which did not intersect any mineralisation have been considered as negative boreholes and completely eliminated from resource estimation.

19.3.3 The thickness and grade of each mineralized zone intersected in the borehole have been considered as it is for the entire influence area of the borehole.

19.4.0 THE BASIS FOR CLASSIFICATION OF THE MINERAL RESOURCES

19.4.1 The present exploration was planned as per Reconnaissance Survey guidelines i.e., G4 stage exploration of UNFC system and all the activities have been carried out as per the same guidelines. The geological mapping has been carried out at 1:12,500 scale. There are 8 scout boreholes (4 for Gold and 4 for Graphite) have been drilled in the identified potential area to know the subsurface continuity of the mineralisation demarcated on the surface. Considering the G-4 stage for silver ore resource, the mineral resource in the block may be categorised as Reconnaissance resource with 334 code as per UNFC system and specifications given in the Minerals (evidence of Mineral content) Rule-2015.

19.5.0 THE ASSUMPTIONS MADE REGARDING RECOVERY OF BY PRODUCTS

19.5.1 The block has been explored for Gold, Silver and Graphite. However, Silver shows the encouraging value in the block area and there are no other significant minerals / elements are reported in the block.

19.6.0 DETAILED DESCRIPTION OF THE METHOD USED AND THE ASSUMPTIONS MADE TO ESTIMATE TONNAGE AND GRADES

19.6.1 The Silver ore resource of the block has been estimated by “**Geological cross-section Method**” considering the following parameters and assumptions.

1. **Cut-off Grade:** For the purpose of estimation of grade vis-à-vis resource of the silver ore, it is necessary to arrive at a ‘planning’ cut-off grade. Since Silver doesn’t occur as a primary mineral in India, its threshold value is not defined by Indian Bureau of Mines, therefore considering the global scenario of Silver producing mines from Poland, Mexico, Australia and Sweden it is around 50g/Tonne to 100 g/Tonne but the depth of such mines are from 400 m to +1000 m.
2. Considering the shallow deposit and open cast potentiality of the block, the Cut-off grade is considered 1000 PPB and the minimum workable thickness / minimum stopping width of 2.00 m has been considered for resource calculation, also the Maximum parting is also considered as 2.00m.
3. The strike influence for the resource estimation has been considered up to 25m on either side of the section line along which mineralisation intersected.
4. The up-dip influence of silver lode has been considered up to 25 m. The dip influence in down dip has been considered upto 25 m below the intersection in boreholes. The grade of the Silver intersected in the borehole has assigned to its influence.
5. **Specific Gravity:** The average specific gravity of the 4 samples from Ag mineralisation in the block is determined as 2.75, which has been utilized for the resource estimation for Silver. (Annexure-XII).

19.6.2 The Silver resource has been estimated at various parameters based on the zones deciphered and delineated from qualitative data of Silver of primary samples. The zones have been delineated on the basis of primary assay of chemical analysis 1000 PPB Ag cut-off grade. The zones intersected in borehole have been plotted on the geological cross sections and the nomenclature of zones has been given from footwall side. There is 1 main

Silver Lode (L-1). The details of silver ore lodes at 1000 PPB Ag cut-off grade are given in Annexure-VI-A.

19.6.3 The summary of silver lodes at 1000ppb Ag cut-off and 1.00m minimum true thickness is given in Table-19

Table 22 Summary of Silver lodes at 1000 ppb Ag cut-off and 1.00m minimum true thickness in Khandapar Sub Block of Jamtola Khandapar Block, District: Balaghat, M.P.

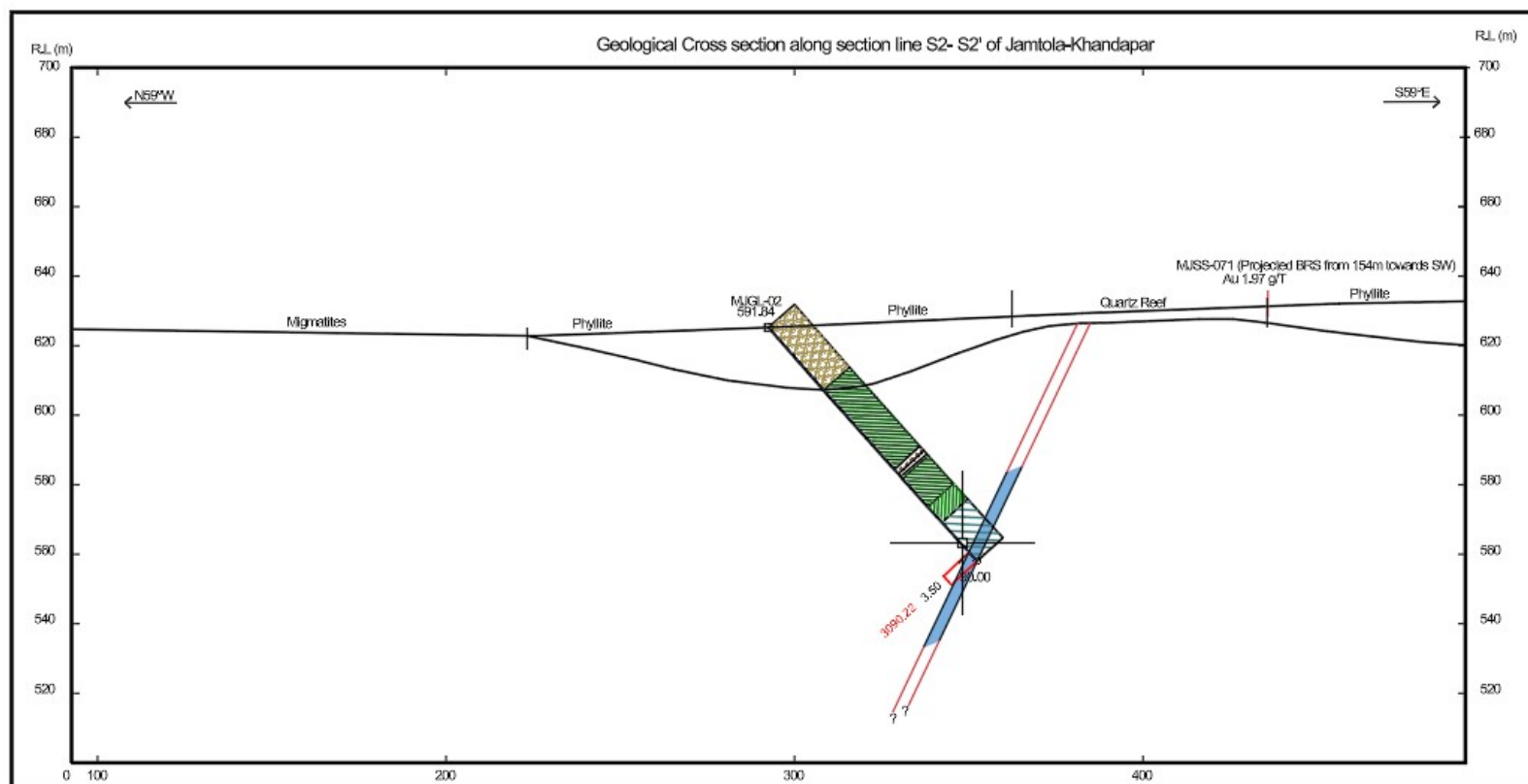
Section No.	Borehole No.	Lode Name	Area	Length of Influence	Specific Gravity	Total Resource (Tons)	Grade (Au in PPB)
S1-S1'	MJGL-01	Lode-1	113.9169	50	2.75	15663.574	1811.48
S2-S2'	MJGL-02	Lode-1	179.9499	50	2.75	24743.111	3090.22
Total Resource and Average Grade						40406.685	2594.52

19.6.4 Methodology adopted in Cross-Section Method of Resource Estimation

Following methodology has been adopted while computation of silver ore resource by Geological Cross-Section Method.

1. Based on the interpretation of surface and sub-surface geological data i.e., litho-units intersected in the borehole and its attitude i.e., foliation angle etc., 1 no. of Geological Cross Sections serially numbered from north to south and west to east as S1-S1' perpendicular to general strike of the mineralised zones have been drawn.
2. The cross-sections have been prepared by marking topography profile along the section line and plotting of surface geology as well as subsurface geology from boreholes along with the borehole data (lithology, nomenclature, thickness and analytical data of mineralisation). The zones delineated at required cut-off have plotted along the section lines with appropriate position, dip angle and thickness intersected in the boreholes and the nomenclature, thickness and qualitative data of zones have been assigned along the same in Plate-IV-A and in Figure-9.

Text Figure 10 Geological Cross section along section line S2-S2' of Jamtola Khandapar Block



INDEX

Profile

MJGL-02
591.84m

Name of Borehole
Reduced Level in meters

Borehole With Thickness (m) of Silver Zone
(Ag in PPB)

3090.22 3.50
T.D 90.00 m

Total Depth in meters

LEGEND

	SOIL/SLUDGE		AMPHIBOLITE
	WEATHERED CHLORITE QUARTZ SCHIST		WEATHERED QUARTZ CHLORITE SCHIST
	CHLORITE QUARTZ SCHIST		FELSPATHIC VEIN
	FELSPATHIC CHLORITE BIOTITE QUARTZ SCHIST		PHYLLITE

3. The resource has been estimated based on the silver zones deciphered on cut-off grades described in para 19.6.1.
4. The area measurements were made with the help of computer aided AutoCAD Map 2020 software.
5. The area of influence was summed up to arrive at the total area for the cross-section.
6. Thus, the area obtained was multiplied by cross sectional influence (strike influence) to obtain the sectional volume.
7. After obtaining ore grade wise volume, each was multiplied by the specific gravity (2.75) to arrive at the resource in tonnes.
8. Thus, the sum of cross-sectional resource is the total geological gross in-situ resource.

19.7.0 DESCRIPTION OF THE GEOLOGICAL INTERPRETATION USED TO CONTROL THE RESOURCE ESTIMATES

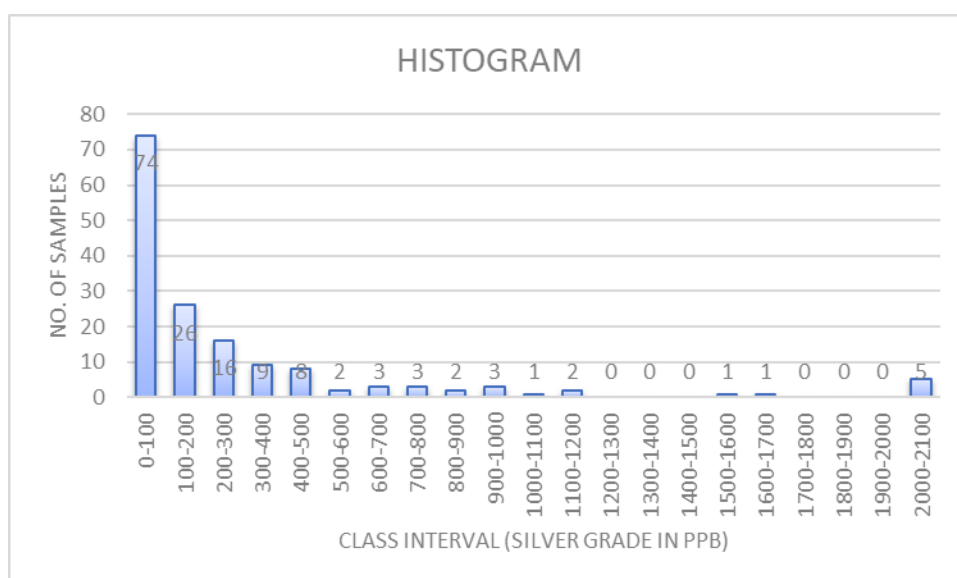
- 19.7.1 The resource has been estimated for Silver by using Geological Cross Section method and placed the estimated resources under 334 category of UNFC which is having the lowest geological confidence limit and may be increased during further up gradation of the block.

19.8.0 DESCRIPTION OF BASIS FOR USING OR NOT USING GRADE CUTTING OR CAPPING

- 19.8.1 No grade cutting or capping has been used for resource calculation, as the exploration was done at reconnaissance level and scout boreholes were drilled and the nos, of samples generated are not much and also as the lodes intersected in both the Boreholes, i.e MJGL-01 and MJGL-02 are at the same level and are of almost same grade. However, the histogram was prepared as given below.
- 19.8.2 The table given below is for Class Interval (grade range) and Frequency (No. of samples falling in particular grade range), which is used to set the grade capping and normalization of samples grade considered for resource calculation.

Table 23 Statement showing Class Interval (Grade range) and Frequency (No. of samples)

Sr. No.	Class Interval	Frequency	Frequency %	Cumulative Frequency	Cumulative Frequency %
1	0-100	74	47.44	74	47.44
2	100-200	26	16.67	100	64.10
3	200-300	16	10.26	116	74.36
4	300-400	9	5.77	125	80.13
5	400-500	8	5.13	133	85.26
6	500-600	2	1.28	135	86.54
7	600-700	3	1.92	138	88.46
8	700-800	3	1.92	141	90.38
9	800-900	2	1.28	143	91.67
10	900-1000	3	1.92	146	93.59
11	1000-1100	1	0.64	147	94.23
12	1100-1200	2	1.28	149	95.51
13	1200-1300	0	0.00	149	95.51
14	1300-1400	0	0.00	149	95.51
15	1400-1500	0	0.00	149	95.51
16	1500-1600	1	0.64	150	96.15
17	1600-1700	1	0.64	151	96.79
18	1700-1800	0	0.00	151	96.79
19	1800-1900	0	0.00	151	96.79
20	1900-2000	0	0.00	151	96.79
21	2000-2100	5	3.21	156	100.00



Text Figure 11
Histogram

19.9.0 GEOSTATISTICAL METHODS DETAIL

19.9.1 The block has been explored for G-4 stage and resource has been estimated by Geological Cross Section method. There is no geostatistical method used for the resource estimation in the block due to insufficient data for geostatistical method.

19.10.0 DATA VERIFICATION AND/OR VALIDATION PROCEDURES USED

19.10.1 Site visits have been undertaken by the authorized persons during survey, core drilling, logging and core sampling. The survey reference/ benchmark points, accuracy levels, software's used in data analysis, contour extrapolations etc. has been verified during the exploration as well as report preparation. The established facilities present at core drilling, sample collection and preparation, sample logging and sample storage center were examined and satisfied. The core drilling, logging, sampling and analytical data obtained was verified and corrections were applied wherever necessary. Core recovery percentages reported in fragmentary and powdery type ores were again verified and proper corrections applied. The raw data from laboratory tests were verified for completeness and was then compiled, processed and assessed for use in mineral resource estimation. The analytical data is saved in digital format as a geological database.

19.10.2 The final report has undergone different stages of Peer Review at MECL, Nagpur and NMET, New Delhi.

CHAPTER-20 REPORTING OF RESOURCES

20.1.0 RESOURCE AND GRADE

20.1.1 The resource estimation has been made by the Geological Cross Section Method at 1000ppb Au cut-off grade for silver mineralisation is given in Annexure-XIII.

20.1.2 The silver ore resource estimated by Geological Cross Section Method are **0.040 million tonnes (mt) Gross geological** in situ resource with an average grade of **2594 ppb Ag**.

20.1.3 Summary of lode wise silver ore resource at 1000 ppb Ag cut-off grade is given in Table-20

Table 24 Lode wise summary of Silver Ore Resource at 1000 ppb Ag cut-off grade and 2.00m minimum true thickness in Jamtola Khandapar Block, District: Balaghat, Madhya Pradesh

Name of Lode	Section No.	Borehole No.	Depth along BH (m)		True Thickness (m)	Resource (Tonnes)	Average grade (ppb)
			From	To			Ag
Lode-1	S1-S1'	MJGL-01	64.50	67.00	2.07	15663.574	1811.48
Lode-1	S2-S2'	MJGL-02	86.0	90.00	3.25	24743.111	3090.22
Total						40406.685	2594.52

20.2.0 COMPUTATION OF AVERAGE GRADE:

20.2.1 All calculations for grade estimation for silver are made by weighted average method. Since the sample interval was uniformly maintained along with different litho-units, the length of the sample was mostly maintained at 0.5 m interval with the exception of litho-unit variations, and any structural implications. The, weighted average has been calculated by following formula:

$$\text{Weighted average grade} = V_1 \times G_1 + V_2 \times G_2 + V_3 \times G_3 + \dots + V_n \times G_n$$

$$V_1 + V_2 + V_3 + \dots + V_n$$

Here 'V' = Volume of Silver ore in individual borehole

'G' = Grade of the respective silver ore in the corresponding borehole

20.3.0 CATEGORY OF RESOURCE:

20.3.1 The present exploration has been formulated for Reconnaissance Survey (G-4) and all the activity has been programmed as per G-4 stage guidelines. The geological mapping was carried out at 1:12,500 scale. There are 8 scout boreholes drilled in the two potential areas, 4 boreholes in Gold/Silver potential area and 4 boreholes in graphite potential area to know the subsurface continuity of the mineralization demarcated on the surface. Considering the G-4 stage for silver ore resource, the mineral resource in the block may be categorised as Reconnaissance resource with 334 code as per UNFC system and specifications given in the Minerals (evidence of Mineral content) Rule-2015.

CHAPTER-21

SUMMARY AND RECOMMENDATIONS

21.1.0 DISCUSSION ON THE OUTCOME OF THE EXPLORATION WORK DETAILING THE NATURE OF THE DEPOSIT

- 21.1.1 The principal objective of the present Reconnaissance Survey (G-4 Stage) was to establish the geological framework of the Jamtola–Khandapar Block, delineate favourable lithological and structural controls of mineralisation, identify geochemical and geophysical anomalies, and evaluate the subsurface continuity of mineralised zones through exploratory drilling. The exploration programme has successfully generated geological, geochemical, geophysical and drilling data in accordance with the approved G-4 stage exploration guidelines prescribed under the Minerals (Evidence of Mineral Contents) Rules, 2015 (MEMC Rules). The investigation has significantly improved the geological understanding of the block and has identified favourable target zones for future exploration.
- 21.1.2 Geological mapping established the lithological succession comprising granite gneiss with migmatite, Malanjkhanda granitoids, phyllites, graphite-bearing carbonaceous phyllites, quartzites, crystalline limestone, quartz veins, sheared quartz reefs, dolerite dykes, basaltic flows and laterites. Structural interpretation indicates that the area has undergone multiple phases of deformation, resulting in the development of prominent shear zones, fracture systems and quartz reefs which constitute the principal controls of hydrothermal gold mineralisation. Petrographic and mineralogical investigations further confirmed the complex tectono-metamorphic evolution of the area and established the mineralogical characteristics of the host rocks and associated sulphide assemblages.
- 21.1.3 Surface geochemical investigations delineated encouraging gold and silver anomalies within the Khandapar Sub-block, where the highest gold value of 4.89 ppm Au and associated silver values were recorded from sheared quartz reefs. These anomalies, together with extensive silicification, ferruginisation and sulphide dissemination, indicate that the Khandapar area hosts a structurally controlled hydrothermal system favourable for gold mineralisation. Similarly, graphite-bearing carbonaceous phyllites mapped in the Karwahi Sub-block confirm the occurrence of graphite mineralisation,

although proximate analysis indicates comparatively low fixed carbon content and limited economic potential.

- 21.1.4 Ground geophysical investigations successfully delineated several chargeability and resistivity anomalies corresponding to shear-controlled quartz reef systems. Integration of geological mapping, geochemical sampling and geophysical interpretation enabled identification of favourable locations for scout drilling. Exploratory drilling confirmed the subsurface continuity of the principal lithological units, sheared quartz reefs, sulphide-bearing zones and graphitic horizons. However, the mineralised zones intersected in the boreholes are generally narrow, discontinuous and exhibit limited depth persistence within the explored depth range.
- 21.1.5 Fire assay analysis of borehole core samples indicates that gold mineralisation is localized and structurally controlled, without establishing continuous ore-grade intersections. Likewise, ICP–MS investigations reveal isolated enrichment of titanium, copper, barium and lanthanum, but none of these elements exhibit consistent spatial continuity or economically significant concentration. Mineragraphic investigations indicate only minor sulphide mineralisation comprising pyrite, pyrrhotite, and magnetite, confirming hydrothermal activity but not indicating the presence of a substantial sulphide-rich ore system.
- 21.1.6 Although encouraging geological, structural and geochemical signatures have been established within the Khandapar Sub-block, the present scout drilling programme has not demonstrated sufficient continuity of mineralisation, either along strike or at depth, to permit reliable delineation of ore bodies. The available drilling density and subsurface information are therefore inadequate for estimation of mineral resources in accordance with the provisions of the MEMC Rules, 2015 and UNFC guidelines. Consequently, no mineral resource has been estimated for either gold or graphite within the Jamtola–Khandapar Block at the present stage of exploration, but for silver it has been estimated as given in below table.

Table 25 Silver Ore Resource at 1000 ppb Ag cut-off grade and 2.00m minimum true thickness in Jamtola Khandapar Block, District: Balaghat, Madhya Pradesh

Sr. No	Cut-Off (Au in PPB)	Resource (Tonnes)	Grade (Au in PPB)
1.	1000	40406.685	2594.52

- 21.1.7 The results are adequate for identification of exploration targets and prioritisation of favourable mineralised zones but are not sufficient for estimation of Mineral Resources under the UNFC classification system. Additional detailed exploration involving closer-spaced drilling, trenching, systematic channel sampling and structural investigations will be required before any resource estimation can be undertaken.
- 21.1.8 Overall, the exploration programme has successfully established the geological framework, structural features and mineralisation characteristics of the Jamtola–Khandapar Block. The investigation has confirmed the presence of localized hydrothermal gold mineralisation associated with sheared quartz reefs and low-grade graphite mineralisation hosted by carbonaceous phyllites. Although economically viable mineral resources have not been established during the present G-4 investigation, the identified mineralised corridors constitute priority targets for future exploration, particularly within the structurally favourable zones of the Khandapar Sub-block.

21.2.0 RECOMMENDATIONS:

Based on the outcome of the present G-4 stage investigation, the establishment of silver mineralisation in the Jamtola–Khandapar Block, together with encouraging surface gold anomalies, favourable shear-controlled quartz reefs, hydrothermal alteration and associated sulphide mineralisation, indicates significant potential for the discovery of economically viable gold mineralisation. As, silver commonly occurs in hydrothermal mineralising systems associated with gold and base metal sulphides, the area possesses favourable potential for gold mineralisation. Accordingly, the following proposals are recommended for the next stage of exploration:

Detailed structural mapping of the mineralized shear zones, i.e Khandapar Sub-Block area at smaller scale.

Conditional boreholes and infilling boreholes should be planned around the high-grade surface gold anomalies in the Khandapar Sub-block.

No further exploration is presently recommended for graphite owing to its low fixed carbon content and poor continuity.

Future exploration should primarily focus on structurally controlled gold mineralisation within the Khandapar Sub-block.

Although silver does not occur as a primary ore mineral in most Indian geological settings, it commonly occurs in association with sulphide mineralisation involving copper, lead, zinc, gold and related metallic systems. Therefore, the delineation of silver mineralisation within the Khandapar Sub Block area indicates the possibility of concealed polymetallic sulphide mineralisation at greater depths. In view of this, it is recommended that deep geophysical investigations, particularly Magnetotelluric (MT) surveys and high-resolution Deep Induced Polarisation (Deep IP) surveys, be undertaken to delineate deep-seated low-resistivity zones, chargeability anomalies, and favourable structural controls along strike and at depth. These investigations would aid in identifying potential zones favourable for hosting silver, gold, and associated sulphide mineralisation. The geophysical anomalies thus identified may subsequently be validated through a limited programme of strategically planned deep exploratory boreholes.

CHAPTER-22

PLATES AND MAPS

22.1.0 LIST OF PLATES

22.1.1 The report includes all the relevant plates maps, plans, sections etc. List of plates are provided in the Geological Report.

CHAPTER-23

ANNEXURE / ENCLOSURES TO THE REPORT

23.1.0 The report includes all the relevant annexure and maps, plans, sections, photographs etc. List of annexures, tables, maps, plans, sections, photographs, Text figures & etc are provided in the Geological Report.

CHAPTER-24

ANY OTHER INFORMATION

24.1.0 GEO-TECHNICAL STUDIES

24.1.1 No specific geotechnical studies have been undertaken as there is no scope of work in present exploration at G4 stage. However, as part of geological logging, the following geo-tech parameters have been collected.

1. Core recovery
2. RQD%

24.2.0 PEER-REVIEW

24.2.1 Draft Geological Report was peer reviewed by Shri R.L. Jat, Director (Retd.), GSI and suggested comments were attended and incorporated in the report (Annexure-XI).

24.3.0 REFERENCES

- i. Constantine C. Popoff (1966)- Computing Reserves of Mineral Deposits: Principles and conventional methods- United States Department of the Interior, Bureau of Mines.
- ii. Khan et al (GSI – 1992, 1995)
- iii. Jaggi G.S. et al (GSI- 1996)- Report on the special thematic mapping of the Kinarda Bhurruk area, Balaghat district, Madhya Pradesh.
- iv. Banerjee D.C. (GSI- 2007)- Assessment of Gold and Basemetal potentiality in Pipardhar area, Balaghat district, Madhya Pradesh (P-I stage).
- v. Bhargawa and Pal (2000)- Cu-Mo-Au Metallogeny Associated with Proterozoic Tectono-magmatism in Malanjkhand Porphyry Copper District, Madhya Pradesh.
- vi. Dora M.L., Rath Ranjit. (2025) Metallogeny vis-à-vis Proterozoic Tectonics of the Central Indian Tectonic Zone (CITZ): An Overview.

CHAPTER-25

CERTIFICATION

25.1.0 CERTIFICATION

This is to certify that geological report has been prepared in respect of Geological Report on Reconnaissance Survey (G-4 Stage) for Gold and Graphite in Jamtola-Khandapar Block (96.62 Sq.Km.) District: Balaghat, State: Madhya Pradesh by Mineral Exploration and Consultancy Limited (MECL) on behalf of National Mineral Exploration and Development Trust (NMEDT). The report has been prepared in accordance with the Minerals (Evidence of Mineral Contents) Rule 2015 specified under Mineral Auction Rule, 2015 and amended up to 2021.

NAME: SHRIKANT SHARMA

DESIGNATION: HoD (Exploration)

DATE: 07.10.2026

LOCALITY INDEX

Locality	Latitude	Longitude
Karwahi	21° 56' 55" N,	80° 30' 21" E
Khandapar	21° 59' 00" N,	80° 33' 51" E
Saraitola	21° 57' 52" N,	80° 33' 49" E
Baigatola	21° 58' 43 "N,	80° 33' 40" E
Kinarda	21° 57' 6" N,	80° 35' 50" E
Pola	21° 57' 14 " N,	80° 33' 17" E
Gogatola	21° 59' 40" N,	80° 32' 57" E
Bhanderi	21° 59' 57" N,	80° 34' 24" E

ABBREVIATIONS USED

SL. No. Abbreviation Full form

- 1 M / m Meter
- 2 Cu m Cubic Meter
- 4 RL Reduced Level
- 5 mRL Reduced Level in metre
- 6 M.S.L. Mean sea level
- 7 IBM Indian Bureau of Mines
- 8 GSI Geological Survey of India
- 9 NMEDT National Mineral Exploration and Development Trust
- 10 NMEDT National Mineral Exploration and Development Trust
- 11 TCC Technical cum Cost Committee
- 12 EC Executive Committee
- 13 MMDR Mines and Minerals (Development and Regulation)
- 14 MEMC Minerals (Evidence of Mineral Contents)
- 15 MECL Mineral Exploration and Consultancy Limited

- 16 NABL National Accreditation Board for Testing and Calibration Laboratories
- 17 JNARDDC Jawaharlal Nehru Aluminium Research Development and Design Centre
- 18 QA/QC Quality Assessment/ Quality Checks
- 19 WGS-84 World Geodetic System-84
- 20 DMS Degree Minute Second
- 21 UTM Universal Transverse Mercator
- 22 Bhs Boreholes
- 23 DGPS Differential Global Positioning System
- 24 XRF X-ray Fluorescence
- 25 ICP-MS Inductively Coupled Plasma Mass Spectrometry
- 26 AAS Atomic Absorption Spectroscopy
- 27 XRF X-Ray Fluorescence Spectroscopy
- 28 BDL Below Detection Limit
- 29 MT Million Tonnes
- 30 RF Reserve Forest
- 31 Sq.km. Square kilometer
- 32 ppm Parts per million
- 33 ppb Parts per billion
- 34 SOI Survey of India
- 35 CORS Continuous operating reference system